AC 2010-2262: IMPLEMENTING ENGINEERING AND TECHNICAL EDUCATION TO SUPPORT FLORIDA'S 21ST CENTURY ENERGY SECTOR

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Implementing Engineering and Technical Education to Support Florida's 21st Century Energy Sector

Abstract

As the intensity of attention on optimizing energy generation and use as well as bringing renewable energy technologies into all aspects of mainstream life increases, the need for engineering and implementing technical professionals to support the 21st Century energy age is also apparent. In 2008, Florida's legislature directed the Florida Energy Systems Consortium (FESC), and the State's University and State College systems to develop applied research and specific technical education pathways to allow Florida to meet its 2020 energy generation and demand criteria. The current strategy is entertaining a mix of conventional, nuclear, solar and bio-fuels for generation and a range of options to make Florida "green" within a "smart" grid. In that same legislative action, the National Science Foundation Advanced Technological Education Center for Florida (FLATE) was commissioned to determine the expected skills that would be needed to support this new energy reality. Part of this assignment is to find the common skills that will cross various alternate energy technologies and assess the current and projected status of curriculum for such engineering and technical education. The strategy that FLATE and FESC developed for providing the formal technical education to cover this skill set at various levels within the Florida university, state college, and community college systems will be discussed.

Florida Energy Systems Consortium (FESC)

FESC was created by the Florida State legislature in 2008 to promote collaboration among the energy experts at its 11 supported universities to share energy-related expertise. The consortium assists the state in the development and implementation of an environmentally compatible, sustainable, and efficient energy strategic plan. The Consortium was charged to "perform research and development on innovative energy systems that lead to alternative energy strategies, improved energy efficiencies, and expanded economic development for the state" (5). The legislature appropriated funding for research at six of the universities as well as support for education, outreach, and technology commercialization. The Consortium reports to and supports the Florida Energy and Climate Commission in developing and implementing the State's energy and climate agenda (1).

The Consortium's energy research strategy is a systems approach for a systemic solution to identify innovation opportunities, prepare an energy workforce, and guide economic development. Through collaborative research and development across the State University System and the industry as well as partnership with FLATE as the conduit to the state college and community college system, the goal of the consortium is to become a world leader in energy research, education, technology, and energy systems and analysis. In so doing, the consortium shall:

(a) Coordinate and initiate increased collaborative interdisciplinary energy research among the universities and the energy industry.

(b) Assist in the creation and development of a Florida-based energy technology industry through efforts that would expedite commercialization of innovative energy technologies by taking advantage of the energy expertise within the State University System, high-technology incubators, industrial parks, and industry-driven research centers.

(c) Provide a state resource for objective energy systems analysis.

(d) Develop a statewide integrated education and outreach program to prepare a qualified energy workforce and informed public.

This systemic approach to accomplishing these objectives to achieve its goal direct its members to

- Coordinate and initiate collaborative interdisciplinary energy research among the universities and the energy industry.
- Share research results with a wide audience, including the science community, media, business, governments, and industry.
- Assist in the creation and development of a Florida-based energy technology industry
- Provide a state resource for objective energy systems analysis.
- Work with Florida Department of Education via FLATE to develop framework for curriculum construction that will help prepare a qualified energy workforce.
- Work with the University of Florida's extension service to develop a state wide platform to develop and deliver outreach programs to create an informed public.

Multiple Tier Education Delivery Approach

FESC's focus on education is to be sure that Florida has the talent needed to support the developing and emerging industries that it supporting. The system's approach to energy education requires the integration of three independent education infrastructures; K-12, the state and community colleges, and the universities. Although there are some aligning features among the three, each has its own unique characteristics that must be addressed independently.

Florida State College System

Florida has recently (2008) adopted a hybrid version of the California academic model by blending Florida's previous autonomous community college structure into a joint State College and Community College entity, the Florida College System (FSC), that allows existing community colleges to expand to include selective 4 year programs. The State Colleges, therefore, provide an interesting blend of A.A., A.S., A.A.S., specific B.S. and B.A.S. (Bachelor Degree of Applied Science) programs for their regional service area. At this point, it is not envisioned that any four year degree programs focused specifically on energy will emerge at the

state colleges. Therefore, the FESC/FLATE attention is directed to the state's Curriculum Framework mechanism to define degree and college certificate structures.

Curriculum Frameworks for Alternative Energy

A Curriculum Framework is the structure used to define the expected skill development for A.S. degree programs within the Florida College System (2). A Florida Department of Education (FLDOE) approved A.S. degree must be governed by a FLDOE approved Framework. Additionally, all Career and Workforce high school diplomas and post-secondary technical education (PSAV) programs must also be associated with an appropriate Framework.

The guiding principles for the development of any approved framework are visualized in Figure 1. This illustration indicates a required interaction at several levels. Some of these inputs such as industry review and validation, the targeted Florida occupations list, the US Department of Labor occupation codes, need for employability skills a general education component might be common requirements for equivalent degrees throughout the country. However, the industry certification requirement when such certifications exist is a new requirement in Florida.

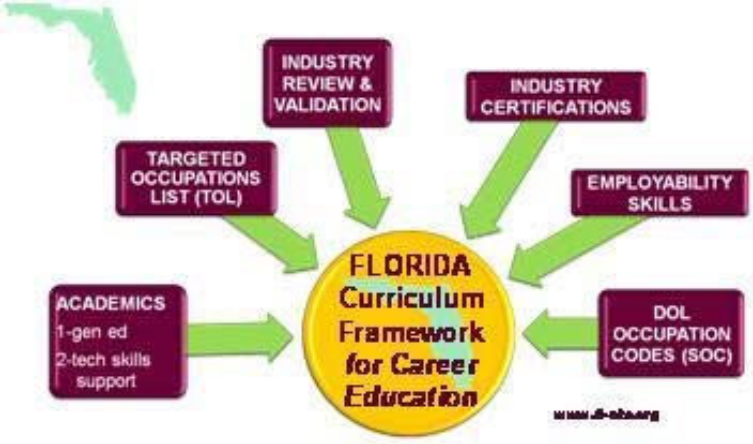

Figure 1: Components of Career Education in Florida

This industry certification component impacts college level degree programs and certificates as well as high school career programs. It is particularly important for the career academy structure currently being implemented throughout in the State's K-12 environment. Each school district in the state must have at least one career academy that provides all of the normal academic courses offered in any high school with a curriculum framework that is aligned with national recognized industry certification. Full Career Academy status (other requirements must also be met) is rewarded by significant increases of state funding (3). For example, a district might create an academy based on the FLATE developed and FLDOE approved Frameworks for the Automation and Production Framework as a Career Academy option. This manufacturing related Framework uses the Manufacturing Skill Standards Council (MSSC) Certified Production Technician (CPT), which is a nationally recognized certification. Student success with the MSSC certification exams also impact high school program funding. A student graduating from this program who holds a valid MSSC CPT, can articulate 15 hours toward an A.S. in Engineering Technology at any one of the nine colleges in Florida that offer this degree. This model is being adopted for a secondary framework that supports education for alternative and traditional energy. A national certification will be aligned with the secondary program and, likewise, that certification will be embedded in an appropriate A.S. degree.

Associate Degree and College Certificates in Alternative Energy Systems

A new Engineering Technology degree specialization "Alternative Energy Systems" and a new, associated college certificate under the specialization has recently been developed to provide technician level education and training in growing alternative /renewable energy and green technology fields. Solar energy technologies have certainly continued to lead Florida's efforts to meet its 2020 energy generation and usage goals (4) and the Engineering Technology specialization does emphasize that particular energy source. All Engineering Technology Degree specializations have 24-27 credit hours of courses to focus on the specialization topic/application beyond the general education and engineering technology technical core. A schematic of the degree is provided in Figure 2, illustrating its multiple entry and exit pathways as well as the role that the articulation of the MSSC certification adds to the program. The specialization "Alternative Energy Systems" will be added to the list of specializations defined in the "Year 2" side, and the total number of specializations will be increased to eight. A ninth specialization in Power Operations is now being researched.

The Alternate Energy Systems specialization was developed with input from stakeholders (industry and academic) across the state over a six month period. This specialization and the associated 15 credit college certificate will first be offered at Brevard Community College in 2010 and is available for all colleges to adopt as their local needs arise. The college certificate has its own framework in the FLDOE, and defines a set of standards that characterize an employable set of skills. Table 1 outlines the five standards that define this ET specialization. Each standard has a number of benchmarks that define specific skills, competencies and knowledge that students must accomplish by the programs end.

Figure 2: A.S./A.A.S. Engineering Technology Diagram

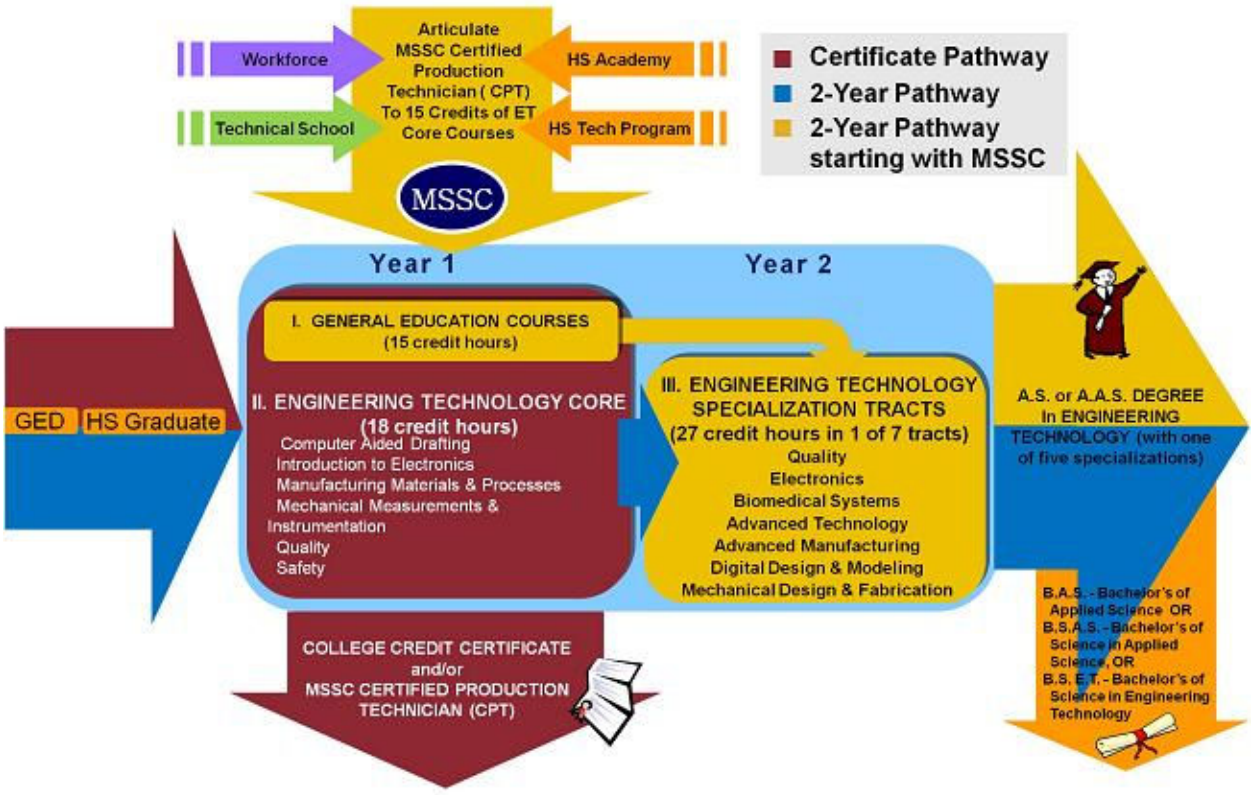

Table 1: Framework Standards (Alternative Energy Systems Specialization)

#	**Curriculum Framework Standards (Alternative Energy Systems Specialization)**
01.0	Interpret AC and DC circuit fundamentals related to energy technologies.
02.0	Characterize alternative energy sources and technologies.
03.0	Apply energy storage, distribution and conversion systems principals.
04.0	Characterize the operation and performance of solar energy systems.
05.0	Apply policy, regulation, and good business practices for alternative energy systems.

The FCS will focus on the technicians and technologists who may work in a multitude of upcoming or evolving energy related jobs. These employment opportunities include positions triggered by the large amount of the American Recovery and Reinvestment Act (ARRA) dollars being funneled into green industries and existing infrastructures to develop programs and job training programs that will help spur the economy. Although this is a national effort, Florida is poised to take advantage of this potential job creation, which in turn, creates the need for educational institutions to offer content to support the workforce, especially at the technician level. Engineering Technicians are prevalent in a multitude of occupational areas, including various energy sectors, electronics, applied technologies, manufacturing, and composites fabrication, to name a few.

Many examples of potential employment opportunities can be found around the state weekly as new, alternatively fueled energy production facilities are announced by public utilities, academic institutions, government agencies, and private citizens. The public utilities in Florida have already integrated solar energy production sites into their transmission grids. This includes a10 Mw system being built in Brevard County, plans to build an additional 100Mw farm in Brevard, a large system at TECO farms in Polk County and a solar/biomass system proposed for Harmony, FL. The need for more technicians who are educated in renewable and alternative energy technologies will increase over time. The FCS is designed to seed that initial technical workforce with those new and emerging skills, and will feed directly into the Engineering Technology AS/AAS degree program for career advancement.

Energy Related Education with the Florida University System

The approach to energy education at the university level in Florida is influenced by several factors. Some of these forces include, regional service need, intensity of energy related research efforts and interest, and the extent of university interest and resources. At least four of the Universities in Florida have a nominal enrolment of at least 45,000 students. Each of these institutions have a variety of academic interests and expertise that span from stand alone to interactive arts, science, education and professional programs. Defining and developing unifying connections among these universities and university programs to create a system approach to energy education, application, and technology development was a major incentive for the state legislative to create FESC. At this point in time FESC's complete portrait for energy education within the university system is still a work in progress. However, there are some identifiable trends that suggest its final form.

At the 4 year degree level, individual universities define specific bachelor degree programs. Degrees at this level are intimately controlled by each separate university academic administration and program development is under parochial guidelines, rules, and financing. Energy related degree programs that may develop at individual universities will be connected to academic departments that deal with the policy, environmental or physical sciences, or perhaps business aspects of energy production and transmission and/or energy efficiency and auditing. It is not likely that the Engineering Colleges within these universities will develop standalone B.S. Engineering degrees in energy. The cost, ABET implications, and overall faculty commitment requirements for such a program created at the expense of existing ABET B.S. Engineering discipline programs represents a significant barrier for the formation of a new energy degree. It is possible that existing engineering college departments will "adopt" the undergraduate energy engineering courses as a minor. It is also possible that a college will offer a cross department energy degree under the existing B.S. Engineering degree available in all the engineering colleges in the state system. This hybrid energy degree does have the advantage that courses can be assembled using existing faculty. However, there is still the general issue of ABET accreditation for such a degree program.

An energy degree at the post Bachelor of Science Engineering level is also under development and also has some definite shape. The Universities within FESC, Florida A & M University, Florida Atlantic University, Florida Gulf Coast University, Florida International University, Florida State University, University of Central Florida, University of Florida,

University of North Florida and the University of South Florida are working together to define a M.S. Engineering Degree that will be supported by each University with the course load distributed among the experts at their resident university. Thesis and non-thesis tracts are under development and a state wide distance learning system is available for course transmission. A new M.S. degree program in Sustainable Energy and Power Engineering that will be distance delivered to make it available to the broadest of audiences will also be developed.

A Ph.D. in Energy is a possibility but it is most likely that the terminal degree will be defined as the degree within the department the research was conducted in. This will be the case for FESC supported research efforts. Although FESC funded research is dictated by the deliverable expectations as directed by guidelines provided in the funding legislation, the actual funds go directly to the University to support the faculty conducting that work (5). Since that faculty is already resident within defined discipline driven engineering college departments, the Ph.D.'s spun from that research will be subject to those department dissertation, publication, and defense standards. Thus, a dissertation on an alternate fuel technology research might be from a Chemical Engineering Department at one University, while the vehicle designed for that fuel consumption might be supported as a Ph.D. from a Mechanical Engineering Department from a different University with dissertation committee members shared by both departments.

Bibliography

1) URL: http://www.floridaenergy.ufl.edu/
2) URL: http://www.fldoe.org/workforce/dwdframe/forward.asp Curriculum Framework Statutory Reference
3) URL: http://www.fldoe.org/workforce/fcpea/ CAPE legislation: Florida Career and Professional Education (CAPE) Act Chapter 2007-216, LOF
4) URL: www.myfloridaclimate.com
5) FESC: 2008 Florida Senate Bill 1544 and House Bill 7135