AC 2012-4378: A NEW CERTIFICATE PROGRAM IN RENEWABLE ENERGY

Dr. Ali Zilouchian, Florida Atlantic University

Ali Zilouchian is currently the Associate Dean for Academic Affairs and a professor in the College of Engineering and Computer Science at Florida Atlantic University. His recent works include the applications of Proton Exchange Membrane Fuel Cell (PEMFC) technology to transportation. In addition, he has conducted research on the applications of soft computing methodologies to industrial processes including, desalination processes, oil refineries, fuzzy control of jet engines, and fuzzy controllers for car engines for the past 25 years. He has supervised 19 Ph.D. and M.S. students to completion during the last 25 years. He has published one book and more than 155 book chapters, scholarly journal papers, and refereed conference proceedings. His research projects have been funded by many agencies, including NSF, FPL/DOE, Broward School County, and Motorola, Inc., as well as several other sources. In 1996 and 2001, Zilouchian was awarded for the Excellence in Undergraduate Teaching at FAU. He has also received 2003 and 2004 College of Engineering Dean's awards in recognition of his contributions toward achievement of the goals of COE at FAU. He has served as session chair and organizer of 10 different sessions in the international conferences within the last five years. Zilouchian is currently an Associate Editor of the International Journal of Electrical and Computer Engineering out of Oxford, U.K.

Prof. Amir Abtahi, Florida Atlantic University

Amir Abtahi (B.M.E., 19'72, University of Minnesota, and M.S., 1975, and Ph.D. 1981, MIT) teaches an array of fundamental and applied engineering courses in the Department of Ocean and Mechanical Engineering at FAU. With a background in thermal and control engineering, Abtahi emphasizes innovation through hands-on projects in solar engineering, senior design, and an electrical engineering course developed for non-electrical students. Abtahi is a practicing Professional Engineer and LEED AP and has designed and installed more than 300 solar installations and is involved in numerous projects around the world.

Abstract
The primary goal of this newly developed certificate program is to address the need for "green" workforce development related to education, training, and public information dissemination of renewable energy and sustainability. The certificate program incorporates the significant research and teaching experience of faculty members at the College of Engineering and Computer Science in Florida Atlantic University (FAU) to address the industrial needs in this field. An innovative curriculum is designed that includes exposure to all forms of renewable energy including solar, wind, fuel cell, bio-fuels, geothermal, and other clean-energy-related technologies as well as the underlying foundations of sustainable design and implementation of sustainable development initiatives. The certificate program also incorporates content related to complex environmental, social, and economic issues relative to energy and environmental policy, including carbon reduction targets. The impact of human activity on the environment is covered in one of the courses in the program. In addition, students learn how politics and business interests influence the way technology is developed and delivered to the market. With active involvement of industrial leaders in green building, solar, wind, fuel cell, ocean energy, and other energy related technologies including FPL, the newly design certificate is expected to serve as a focal point for university-industry educational partnerships pertaining to renewable energy workforce development around the nation.

I. Introduction

The population of the United States is projected to increase from the current level of 303 million to 438 million by the year 2050[1]. The Department of Energy (DOE) data confirms that currently 59% of oil consumed in the US is imported as compared to 37% imported at the time of the 1973 oil crisis[2]. Only 0.2 % of all energy consumed comes from solar and wind generation, and only 3.3% is derived from bio-fuels and biomass[3].
The reliance on imported oil is a major factor in the overall security of the US, and has wide ranging implications for economic and national security interests of the nation. In addition, the overwhelming evidences that carbon emissions play a role in global warming, and the need to reduce the use of fossil fuels is gaining support at the national level.
The commitment of both political parties in US to lead our nation to a new era of less dependence on energy imports, and a serious move to renewable sources of energy presents great opportunities for job creation and economic development. Jobs that are based on home-grown green energy supplies may be one of the many anchors that may stabilize our nation and help the economic turn-around.

According to a study by Management Information Services Inc., a Washington, D.C., research firm that has been tracking green jobs for two decades, the new industries of environmental management and protection have created 5.3 million jobs in the United States[3] . In the past, environmental jobs were mostly about regulatory compliance; now, they are supporting a wide variety of initiatives, including sustainability, water processing, and alternative energies. By 2020, "green employment" will reach a whopping 6.9 million jobs[4].

University of Massachusetts researchers at Department of Economics and Political Economy Research Institute provide a snapshot of the kinds of jobs that are needed to build a green economy in the United States. They focus on six key strategies and highlight some of the major "green jobs" associated with each of these approaches. The six strategies they reviewed included: building retrofitting, mass transit, energy-efficient automobiles, wind power, solar power, and cellulosic biomass fuels. They found that the vast majority of jobs associated with these strategies are in the same areas of employment in which people already work in today.

The report clearly concludes that millions of U.S. workers, across a wide range of familiar occupations, states, and income and skill levels will benefit from transforming the United States into a green economy. This report also presents data on employment conditions in twelve states, including Florida. For each state they report the number of people employed in each of the green economy strategies and what the average wages are in states for each of these jobs[4].

The technical and scientific challenges to provide reliable and renewable sources of energy for an additional 70 million Americans in a short 30 year period are enormous, especially so when combined with the strategic and economic concerns mentioned above. It is clear that as part of the mix of energy sources necessary to deal with these challenges, alternative energy sources will play a critical or even a central role to address the demand. The US Department of Energy, as well as a number of the national laboratories and academic institutions, have been aware of the importance of alternative energy sources for some time. Recently, the energy industry, car manufacturers, transportation experts, and even utilities are paying attention to alternative and sustainable sources of energy for the future. The universities need to play an even more important role in addressing not only the research component of the transition from fossil fuels to sustainable sources of energy, but the educational aspects and green workforce development as well. This role includes a wide range of tasks that include general public education requirements at one end of the spectrum to specific recruitment, mentoring, and retention of highly qualified students at the other end of the spectrum.

The development of the proposed certificate program will address the educational, training, and to some extent the information dissemination components related to alternative energy and sustainability.

II. State of Florida Needs

According to the latest U.S. Census Bureau report[5], Florida has a total of 18 million residents (number reported as of 2006). In terms of workforce development, South and Central Florida regions encompass more than 60% of the population of the entire State[5] (approximately 5.5 million residents in the tri-counties in South Florida).

According to the recent Greenforce Florida report[6], sales in the green industries including energy suppliers and consumer-products makers are expected to climb to $496 billion in 2020. This growth will definitely be accompanied by a growth in the job market. In the other hand, Florida has committed to reducing greenhouse gases emissions, increasing energy efficiency and removing market barriers to renewable energy technologies. In fact, Florida is positioned to become a national leader in solar energy use after State of

California. The 2009 Alternate Energy (AE) Workforce Profile published by Greenforce Florida[6] drew several conclusions:

- *Alternative Energy (AE) educational programs are limited in Florida;*
- *Florida should fast track the creation of AE career pathways;*
- *Institutions should work together in concert with existing workforce development entities;*
- *Florida industries surveyed anticipate expansions in their areas by 2010;*
- *Shortages are expected in installation, maintenance, and repair*.

According to the recent Greenforce Florida report, educational programs and curriculum in alternative energy technology are limited throughout Florida and the United States[6]. Recently, several educational organizations throughout the U.S. have announced the offering of new programs including Ohio State. The certificate program as developed is the initial step for the possible development of a full master program in Florida to realize its potential as a leader in alternative energy education related to advanced green workforce work development.

III. Program Significance

The proposed certificate program will provide advanced technical training to allow its graduates to find ***solutions*** to current energy and sustainability problems. In keeping with current research in sustainability, the program has been designed to be ***integrated across multiple disciplines***, The certificate program is offering an innovative ***curriculum*** which answers the call from employers throughout the state including FPL, Progress, Golf energy Company, Enerfuel, South Florida Water Management District, County Planning Agencies, the Army Corp of Engineers, and a variety of other local agencies and energy industry firms that have growing needs for highly trained individuals in advanced technology, field application, and a sound grounding in the principles of sustainability. While the main focus of the program will be on traditional, full-time students at FAU, the program will also welcome part-time students who wish to maintain their professional employment while earning the certificate program. The courses will be offered on-line in the second phase.

The certificate program, combining aspects of alternative energy and sustainability, will be tailored to the changing needs of the south Florida service regions through an innovative curriculum that includes cross-disciplinary course work in many areas of alternative energy and sustainability including green buildings, solar, wind, fuel cell, ocean energy, biomass, environmental education, water resource management, leadership, and public engagement.

Understanding human, environmental, economic, and energy issues and modeling to predict for the future, as well as having the skills to identify and resolve related problems is critical to national energy independence and local and global sustainability.

The existing strengths of the several Departments within both College of Engineering and Science have been integrated to provide a dynamic program covering both regional and global aspects of alternative energy and sustainability:

- The program stresses both breadth and flexibility

- Students with either a Science or Engineering degree will be qualified to participate and be admitted into the certificate program. Therefore, the program has been designed with sufficient flexibility to accommodate students with different backgrounds.

- Strong research involvement of the participating faculty. . The program offers unique opportunities for practical training (through CO-OP/internship in industry, government agency settings) and for exposure to the business aspects of the energy industry sector.

- The program builds on the highly successful graduate certificates programs including Leadership and Sustainability.

- Excellent and strong relationship with the energy-related sector including FPL, Pratt & Whitney, Lockheed Martin or small, highly specialized companies such as Enerfuel Inc., Solar sources and BV Engineering Inc.

- Excellent working relationships with local governmental units and agencies such as the South Florida Water Management District, USGS, Florida Department of Environmental Protection, and various County Planning Offices.

- Rapidly escalating local job markets highly geared towards alternative energy, environmental analysis, sustainability leadership and planning in South Florida.

- Ocean energy technologies are emerging as an area of significant R&D at Florida Atlantic University and Florida is at the forefront of this trend[7]. Inspired by the abundance of this natural resource in the state and by the world-class expertise in the field that has been generated over decades, ocean energy research is now booming in state. Florida Atlantic University faculty members within the College and companies are already developing the ocean energy technology systems and components of tomorrow.

IV. Curriculum Design

The design curriculum for the program aims to prepare students to live in a world where the complex issues of alternative energy, environmental quality, environmental justice, and sustainability are paramount. In addition, the integration of economy and business complexity into curriculum is critical component for "green" workforce development. Given the research strengths of FAU in a several areas related to renewable energy, as well as, exiting academic constraints, a hybrid and innovation curriculum to have been developed including a Sustainability leadership from the College of Education.
In addition to four technical courses in the area of power system, the proposed FAU certificate will integrate complex environmental, social, and economic issues relative to energy and environmental policy, including carbon reduction targets. The certificate consists of four (out of 5) of the following courses dependent upon the particular need of the participants:

- *Engineering, Sustainability and Green Leadership*
- *Introduction to Alternative Energy Technologies*
- *Solar Energy and Smart Grid*
- *Renewable Distributed Generation & Energy Storage*
- *Cyber Security for Smart Grid*

In this section the detailed description of each of the above courses are presented.

IV.1 Engineering, Sustainability and Green Leadership:

This course offers an overview of leadership and innovation for engineers within the context of a planet in distress. This field is rapidly garnering attention around the world from academics, researchers, entrepreneurs, private citizens, corporations, nonprofit organizations, communities, and governments that have understood that business-as-usual has ceased to offer a viable framework for society. Given their profound impact, this imperative "to create a healthy, just, and sustainable society" is particularly relevant to all fields of engineering and computer science.
Sustainability leaders aim to integrate social, environmental and competitive financial returns through their products, services, and public engagement. Their core purpose is to channel their personal passion for innovation and design into viable enterprises that promote radically new, regenerative approaches in business, industry, education, and community. In order to fulfill their vision, they engage all their stakeholders in researching, designing, prototyping and mainstreaming innovative solutions that solve problems while seeking to grow prosperity, celebrate community, and enhance the health of all species for all time. By the end of the course, students can expect to:

- Have gained an understanding of the principles of sustainability/regenerative leadership and innovation as they apply to personal and organizational change in their engineering field.
- Have acquired the knowledge, skills, and dispositions necessary to engage in regenerative engineering.
- Have been exposed to leaders who are designing and applying regenerative approaches that are revolutionizing their industries, and who are solving some of the critical environmental and social issues not addressed by conventional practices.
- Have developed a sustainability-focused team project by engaging in a reflective, integrated design process.

IV.2 Introduction to Alternative Energy Technologies

The primary goal of the proposed course is to address the "green" workforce development related to education, training, and to some extend the public information dissemination of renewable energy and sustainability. The students will learn about all forms of renewable energy including solar, wind, fuel cell, bio-fuels, geothermal, and other clean-energy-related technologies as well as the underlying foundations of

sustainable design and implementation. The students will participate in several experimental lab studies as well as computer model simulations to aid them pertaining to understanding of complex and large-scaled systems. Issues of specific interest to engineering students including power management and hybrid control of the systems will be covered in greater depth. In addition, students will be made aware of the impact that human activity has on the environment, and how politics and business interests influence the way technology is developed and delivered to the market. This course is designed to provide a foundation in several areas including:

- Conventional Energy Source Technologies and their promise, advantages, and disadvantages.
- Renewable Energy Source Technologies and their promise, advantages, and disadvantages.
- Basic Economic Principles and the future "Hydrogen Economy"
- Greenhouse gases, global warming, and carbon credits
- System integration and power management of energy sub-systems
- Modeling of large-scale systems and performance optimization

IV.3 **Solar Energy and Smart Grid:**

Aside from system reliability and security, automated meter-reading (AMR), and transmission/distribution monitoring and control, the new Smart Grid (SG) needs to enable the needs of numerous stakeholders. The utilities are interested in more aggressive load shedding tools, such as smart appliances, Plug-in Hybrid Electric Vehicle (PHEV) storage, and consumption management. They are also looking at the Smart Grid for timely and efficient management of large-scale wind and solar assets that is coming online at accelerated rates. Consumers are hoping that the SG will help curtail ever increasing utility costs with time of use (TOU) electric rates, and net-metering options that allows two-way power transmission and accounting. The Federal and State governments want to assure a secure system that can handle any conceivable threat, whether natural, man-made, accidental or intentional. The matrix of interactions and interests between all the members, and the distinct elements that will eventually become a Smart Grid is complex and will require extensive analysis and discussion. In this course, we will discuss one of the major elements of the Smart Grid, distributed solar generation. This course is structured to provide:

- A general background in Solar Energy technologies including solar thermal, solar photovoltaic, concentrating thermal and combined thermal-photovoltaic technologies.
- An introduction to the latest advances in Smart Grid Designs and Protocols
- The interaction of the Smart Grid with Solar and other renewable energy generating sources,
- The available tools for integrating solar and other renewable sources with the Grid,
- Potential problems with distributed solar and other sources: Case Studies

IV.4. Renewable Distributed Generation & Energy Storage:

As the "smart grid" is defined and implemented, distributed generation may be a significant contributor to the stability and efficiency of this new grid. The course begins with a review of properties of present generation, transmission and distribution of energy. This course will then focus on the technical details of a variety of small-scale, local, electrical generation technologies as well as on the communication, control and regulatory issues that may accompany a distributed generation paradigm. The course is intended for any engineer who has taken engineering coursework through electrical circuit analysis. This course is designed to provide a foundation for several interest groups, including:

- Existing utility workers who may become involved with certification and monitoring of distributed generation systems and integrating them into the existing grid structure,
- Engineers who will be participating in the design of distributed generation systems along with the corresponding control, communication and monitoring systems,
- Engineering students whose goal is to become involved in implementation of smart grid associated distributed generation technologies,
- Engineering students with business orientations who have an interest in the fiscal and regulatory issues relevant to enabling distributed generation technologies.

IV.5. Cyber Security for Smart Grid:

Smart grid promises efficient, adaptable, and reliable transmission and distribution of electrical energy. In doing so, its integration with cyber infrastructure is essential. This integration, while necessary and immensely beneficial, creates some challenges as well. One of the strongest challenges is smart grid's vulnerability due to its integration with Cyber infrastructure. The size of smart grid and potential intrusion points make its protection and security even more complex. This course discusses smart grid, its operational structure, integration with cyber infrastructure, challenges and opportunities, and its protection and security. This course is designed to provide a foundation in several areas:

- Existing utility workers who like to enhance their skills, understanding, and knowledge about smart grid and cyber security.
- Engineers who will be participating in the design of smart grid and its integration with cyber infrastructure with a particular emphasis on security and protection from cyber threats and attacks.
- Engineering students whose goal is to become involved in implementation of smart grid and cyber security.

V. Program Assessment

The evaluation will focus on how effectively and efficiently the project objectives have been met. To achieve this goal, the evaluation will focus on utility and adhere to the Program Evaluation Standards. It will make use of valid and reliable measures when

quantitative data are involved and in the case of qualitative data will take steps to ensure credibility and trustworthiness.

Assessment Outcomes

Learning Outcome 1
Students shall have an ability to apply specific science & engineering fundamentals, tools, and experimental methodologies for improving alternative energy and sustainability that meet the needs of current and future generations.
Learning Outcome 2
Students shall understand the complex economic, environmental, and social issues relative to energy, and environmental policy, including carbon reduction targets.
Learning Outcome 3
Students shall have an ability to effectively communicate their ideas and results pertaining to alternative energy to a multidisciplinary group both orally and in writing.
Assessment Phases

Phase I	Develop the initial concept and approach for course evaluation, connecting the major course objectives as indicated above on section 4 with the proposed modules.
Phase II	a. Develop of data collection instruments including in-class evaluation of the proposed modules, Teaching Assistant inputs and students' projects. b. Clear delineation of the role of the formative evaluations, data and protocols for making midstream corrections to the evaluation plan, of the course based on what becomes evident during the formative phases including substantial modification to the proposed topics, modules and hands-on project. c. Development of data analysis criteria and formative evaluation of these criteria using the class &/on-line test data.
Phase III and IV	• Collect initial data from first set of the students in 5 courses (Sp. 2012, and summer 2012) including project-related activities. • End of year two: Provide formative evaluation report focusing on data collection completed to date to FPL and project advisory committee for their inputs.

A combination of quantitative and qualitative data will be used to help fully document the strengths, weaknesses, achievements, and improvement areas of the proposed course.

This mixed methods approach will lead with quantitative measures/criteria wherever possible. Qualitative data will be used to help triangulate and explicate the measured/observed phenomena.
The assessment will be completed within this academic year (fall 201, spring 2012 and summer 2012) for all these courses. There are currently 16 students in the Alternative Energy class. The results for the first phase of the project will be dissemination by DOE/ FPL upon the completion of the first year of the project implementation on August 2012.

References

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