The Power of Renewable Energy to Attract Female Students to Electrical Engineering

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***Abstract* - Enrollment of female students in electrical engineering courses in the United States has been declining over the last several years, a very disturbing trend since female students are more prevalent in universities than male students. The global energy situation is of growing concern and renewable energy courses are seeing increased development throughout the world. At Villanova University, we have found that female students have been particularly attracted to this type of course as well as research projects in this area. We have recently graduated two students who performed research in building integrated photovoltaics and have a third student who is performing research in this area - all female undergraduate electrical engineering students. Furthermore, in a first level graduate course, we have a higher enrollment of female students to male students! In this paper we will describe these projects in more detail and report on the attractiveness of this area to female students in particular.**

Index Terms: Female enrollment, renewable energy, solar energy

INTRODUCTION

Female enrollment in science and engineering has steadily climbed from about 25% in 1966 to about 50% in 2001 [1]. Yet the percentage of female students receiving electrical and computer engineering (ECE) degrees in 2003 was only ~ 15% [2]. Enrollments in electrical and computer engineering have been declining over the past 10 years both in the US and in some European countries, primarily driven by the fear of basic electronics and electrical engineering design jobs being outsourced to lower wage countries. A low percentage of enrolled female students is reducing the potential pool of students even further. Several ECE departments have introduced bioengineering and biomedical engineering programs which have attracted significant numbers of female students. However, graduates with such degrees have limited job opportunities and such programs require faculty expertise in this specialized, inter-disciplinary area. A traditional specialty area of electrical engineering is power engineering and there is a growing need for well-trained students in this field since a significant percentage of power engineers is approaching retirement age in the US [3]. Furthermore, there has recently been rapid development of renewable energy contributions to power systems. The fields of environmental science and environmental engineering have female enrollments ~30-40% [2] and so this area has the potential to attract female students. In this paper we present details of how the field of renewable energy has started to grow rapidly in the last few years and how developing programs in this area can be attractive to female students in electrical engineering.

POWER ENGINEERING MOVES TOWARDS DISTRIBUTED GENERATION

The traditional model of power systems comprised large (~1GW), centralized, often remotely located, fossil-fueled, nuclear, or hydroelectric power plants with transmission lines to transmit the power through a national grid network to local distribution centers. However, in the United States, recent trends have been towards development of more small-scale, localized power generation tied into the national grid network [4]. Combined heat and power plants being used for industrial applications together with gas turbine generators have been added to the power generating mix because of their relatively low capital investment and shorter payback periods. This has led to a more distributed generation mix to the traditional power system topology. More recently, both with the increasing price and tightening supplies of natural gas in the US and growing concern over global warming internationally, there has been an upsurge in interest in the use of renewable energy to feed into the power generating mix.

RENEWABLE ENERGY BECOMING A BIG BUSINESS

Germany and Japan have led the development of renewable energy with very strong feed-in tariff programs [5]. These incentives have led to an unprecedented growth in deployment of wind and solar renewable energy systems in these two countries. Indeed, subsidies for solar have been removed in Japan, yet the deployment of solar energy systems continues to grow rapidly [5]. The growth rate for grid-connected solar photovoltaics (PV) worldwide has been ~60% per annum between 2000 and 2004 and for wind energy has been ~40%

per annum for the same period [5]. In Denmark, wind energy supplies almost 20% of the electrical energy needs of the country [6].

In the US, the federal government passed a 10% energy tax credit for renewable energy systems in the Energy Policy Act of 2005 [7] but at the State level, some states offer more aggressive incentives. In New Jersey, for example, rebates of $5.15/peak watt are available for grid-tied PV systems for non-profit organizations for systems < 10kW with progressively smaller rebates per peak watt as the systems are scaled to larger sizes [8]. California recently announced that it will be funding ~3GW implementation of PV systems by 2017 [9]. Many states also have aggressive renewable portfolio standards and renewable energy credit programs [10]. For example, Minnesota is planning to provide 10% of its electricity from renewable energy (primarily wind energy) by 2015 [11].

Renewable energy has gone from a small industry with a relative low contribution to the energy generating mix to one that is rapidly taking off. Large commercial banks are starting to provide loans for renewable energy systems [5]. Suzlon, a wind energy company in India, recently had an initial public offering and raised $8 billion! The worldwide job market presently stands at >1.7 million jobs and is growing rapidly [5]. Major investments and acquisitions have been made in renewable energy technologies in recent years by leading global companies, such as GE, Siemens, Shell, BP, Sanyo and Sharp [5]. A reflection on how rapidly the field is expanding is that there is a worldwide shortage of silicon for manufacturing solar cells. Until recently, the PV industry was too small to have its own silicon feedstock and solar cells have been manufactured from the waste silicon from the silicon integrated circuit industry. However, the volume of solar module manufacturing is now warranting the establishment of silicon feedstock suppliers exclusively for this industry.

THE NEED FOR A WORKFORCE EDUCATED IN RENEWABLE ENERGY

Clearly, this rapid growth in the renewable energy industry must be supported by education programs that train students to work in this field. Many such courses have been emerging including a new program that we have started at Villanova University. At Villanova University we have started a Sustainable Energy Certificate program at the Master's level. This comprises a group of four courses:

1) Electrochemical Power Sources
2) Renewable Energy Systems
3) Principles of Sustainability
4) Solar Thermal Energy

These courses are open to all engineering students with each course housed in each one of the four engineering departments in the College of Engineering.

We are also offering several renewable energy senior design projects, comprising the design of both stand-alone and grid-tied PV systems. Examples include the design of a water pumping system in Honduras, the design of a stand-alone system for a Bioreserve in India, and the design of a photovoltaic charging station for a plug-in hybrid electric vehicle.

Additionally, several research topics are being explored in renewable energy systems. One project that has been funded by the Commonwealth of Pennsylvania is the development of a software simulation tool for architects to use in locating photovoltaic modules on buildings in an urban setting, taking into account reflections and shading from neighboring buildings. We were recently awarded funding to establish a 3kW photovoltaic system for providing power to the engineering building at Villanova University and to establish educational modules in renewable energy. Future research work is being developed in the simulation of solar module manufacturing, and nanostructured solar cell research.

An engineering company (Conti Enterprises), based in New Jersey, whose CEO (Kurt Conti) is an alumnus of Villanova University's Civil Engineering department, has started a new renewable energy company (Alternity Power). We have been involved in training their workforce in basic solar PV system design.

There has been very strong interest on the part of female students in these renewable energy programs. Three female undergraduate students worked on both the building integrated photovoltaics research project and two of them also worked on a related senior design project. The students also received funding from the US Environmental Protection Agency (EPA) for this project and presented their work at a conference.They also attended a European tutorial in Solar Energy design for the Mediterranean, held in Rome, to learn more about the design of solar energy systems. These students graduated and got jobs in engineering firms where they are working with renewable energy. Another female undergraduate student, presently a junior, has received a renewable energy scholarship from Conti Enterprises, and will be working with Alternity Power this summer. In the graduate renewable energy systems course, the percentage of female enrollment in the course is about 50%! Clearly, we have experienced an unprecedented interest on the part of female students in the area of renewable energy, with an undergraduate female enrollment of < 10%. While the data is very limited at this stage, the interest level displayed by female students in the field of renewable energy is very encouraging and we plan to both track enrollment of female students in the renewable energy courses and use the renewable energy concentration to attract more women into the electrical engineering program.

CONCLUSIONS

Renewable energy is growing in importance and an educated workforce needs to be provided to this sector of the power industry. Electrical engineering enrollments have been declining, and although somewhat stabilizing, the fear of outsourcing of jobs continues to hamper enrollments. A largely untapped potential source of students is female students which constitute only about 10-15% of undergraduate enrollment. On the other hand, the environmental science and environmental engineering fields have traditionally attracted a much higher percentage of female students compared to electrical engineering. Renewable energy education offers the potential for attracting more female students to electrical engineering and to date, our limited experience at Villanova University has supported this thesis.

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