Integrating a Renewable Energy Degree into an Existing Mechanical Engineering Program

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Abstract

The following paper will discuss the need to integrate renewable energy programs into technology-based colleges. Illustrated in this paper is the basis of a renewable energy program, which can be adapted to an existing mechanical engineering or mechanical engineering technology degree. Many of the courses offered at major technological colleges in their mechanical engineering programs will fit the proposed curriculum. Technological colleges will be the focus of education because of their "hands on" educational approach. Oregon Institute of Technology will be used as the foundation of a typical technical college. The paper will also give an overview of the many different possible studies of renewable energy, such as biomass energy, fuel cells, geothermal, hydroelectric, solar electricity, solar thermal, and wind energy; however, an emphasis on biomass in the form of ethanol fuel research is given.

I. Introduction to integrating a renewable energy degree

The renewable energy industry continues to rapidly expand. A key component in the drive to developing a sustainable energy supply is the training of a large number of renewable energy engineers. The photovoltaic industry has been growing at a rate of 30% annually.[1] In addition, the National Renewable Energy Laboratory and the National Center for Photovoltaics predicts that within 20 years, the photovoltaic industry will employ more than 150,000 Americans in the domestic, high-tech photovoltaic industry.[2] Many technology-based schools often overlook educational programs in renewable energy engineering. This can lead to a shortage of appropriately trained engineers in such fields. Implementing a renewable energy-engineering program will give the student a solid foundation in fundamental physics and design-installation techniques required to work with renewable technologies. The field of study will be considered in many categories including biomass energy, fuel cells, geothermal, hydroelectric, solar electricity, solar thermal, and wind energy. Learning would include hands-on training in a modern computer-based laboratory setting where engineering standards would be emphasized throughout. Employment opportunities exist in small renewable energy businesses, energy companies, equipment supply companies, oil & gas field service companies, utilities, and international agencies. The growth of system installations is outpacing the training of qualified technicians. A personnel shortage is expected to increase demand for employees who are familiar with the science behind the technology and who are able to adapt to rapid changes in the field. The goal of such a program would be to educate the next generation of engineers who will design the renewable energy systems of the future.

Currently, there is an ever-growing need for renewable energy engineers; however, very few properly trained renewable energy engineers are entering the work field. Today in the United States, very few colleges offer renewable energy engineering degrees. Most people who work in this field have adapted to this by on the job learning. Presently, this is accepted in the engineering field, out of necessity, but it should not be that way.

Students should be willing to take an extra year of courses toward the concurrent renewable energy degree because it will add specialization to the mechanical engineering degree already being pursued. Generally, mechanical engineering programs train their students to be jack of all trades but masters of none. Many mechanical engineering graduates leave college with little or no direction to the career field they will be entering. The dual degree adds specialized experience which will make the graduate more attractive to employers. Currently renewable energy engineers pay is above average when compared to the typical mechanical engineering salary. This gives incentive for students to add the renewable energy degree to the mechanical degree.

The technical background is expressed as a real world hands on experience. At most major universities, real life hands-on learning is not experienced until in industry. At most technical schools, hands-on leaning is the basis of education. Oregon Institute of Technology makes a great place to adapt such a program because it is a technical university instead of a non-technical university.

II. Adaptation of renewable energy degree

The renewable energy degree could have many different possible studies, such as biomass energy, fuel cells, geothermal, hydroelectric, solar electricity, solar thermal, and wind energy within the mechanical engineering program. Most universities could easily incorporate a renewable energy degree by adding a small number of courses to the mechanical engineering program. For example, currently at Oregon Institute of Technology we have a dual degree in Mechanical and Manufacturing Engineering. Incorporating both engineering degrees adds one year of courses the student needs to complete. Oregon Institute of Technology could easily incorporate renewable energy courses in place of the manufacturing courses for a mechanical/renewable energy dual degree. This can also be incorporated at most other technical universities. An example of renewable energy program could be a Bachelor of Engineering degree program in Biomass Engineering. This program is modeled under present Oregon Institute of Technology standards for concurrent degrees. Oregon Institute of Technology curriculum is based on fall, winter, and spring terms. A proposed chart to illustrate the concurrent Biomass Engineering curriculum of additional courses within a renewable energy-engineering program is seen in Table 1.

Course Number	Course Title	Credit Hours
ENGT 415	Occupational Safety	3
RNW 314	Introduction to Biomass Engineering	3
RNW 315	BioSystems Engineering I	3
RNW 316	BioSystems Engineering II	3
RNW 317	Biomass Engineering Chemistry	3
RNW 318	Biomass Energy Crops	3
RNW 319	BioEnergy I	3
RNW 320	BioEnergy II	3
RNW 415	Biomass Materials	3
RNW 416	Biomass Production	3
RNW 417	BioFuels I	3
RNW 418	BioFuels II	3
	Renewable Energy Elective	3
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Table 1. Biomass Engineering Example Curriculum

Very few changes will have to be made in the college's departmental staffing depending on their experience and qualifications in renewable energy and their current workload. A curriculum coordinator with a background in renewable energy is the only mandatory addition to staffing, which means the integration would be completed with an addition of courses taught by existing staff. The curriculum coordinator would be in charge of creating seminars for the current staff to bring them up to speed with today's renewable technology. Ideally the coordinator would direct these seminars with assistance from current leaders in renewable energy. Current staff will then have a way to facilitate the most up to date information to the students. Most, if not all, renewable energy courses are more specialized adaptations of classes currently offered by mechanical engineering, chemistry, and electronics engineering programs.

The technical aspect of this degree will be education based on the use of computers and the most up to date technology in the field. A "hands on approach" to learning is defined as education through performance and practice. Much of this learning will be seen in the form of laboratory work and research. Depending on the amount of new equipment that will be selected to aid in the learning of the major, additional laboratory space will be needed. However, most technology focused colleges will already have sufficient laboratories for implementing the program. For instance, Oregon Institute of Technology presently has an Electronics Engineering major which its laboratories are also used to instruct photovoltaic courses. Depending on the cooperation of the departments, the laboratories can be shared. Sharing laboratory areas will in turn lower the overall cost of implementation. Suggested equipment would include the most up to date tools and demonstration devices. Field work will be seen as a form of internship where you will apply your knowledge to a given job. An example of this would be implementation and testing of photovoltaic panels on solar homes.

Graduates from the course will be able to make an immediate contribution to the world's expanding renewable energy programs. Graduates will also have an impact on the development of programs to meet the motivated targets for reduced dependence on fossil fuel. Each graduate will have a firm grasp of the science, technologies, and engineering principles involved.

III. Advantages of renewable energy degrees

The market for renewable energy engineers is growing rapidly due the demand of increased awareness for a more resourceful environment. Today, advanced research has shown the need for a more reliable and cost efficient source of energy. From this, we need professionally trained engineers to obtain this type of energy, which is safer for the environment.

Currently, most renewable energy mechanical engineers consist of mechanical engineers who have been trained within the work force. The need for on site training is eliminated by having a renewable energy engineering degree. Thus, employers will be able to hire renewable engineers without having to provide and pay for extra training. Job placement becomes much easier because a renewable engineer already has a grasp of renewable energy knowledge.

The environment will also benefit as a reduction of landfill needs will come from implementation of advanced research in reusable materials. This will be made possible by educating more renewable energy engineers. With further education provided, the public would become more knowledgeable of how important the reductions of landfills are.

Cleaner air will also be a benefit of educating more renewable energy engineers. Fossil fuel burning has put 135 billion tons of CO^2 into the atmosphere since 1975. More opportunities for alternative fuel research will exist by having more renewable energy engineers. In turn, this will reduce the use of fossil fuels.[1]

IV. Possible studies in renewable energy

Biomass is plant matter such as trees, grasses, agricultural crops, or other biological material. It can be used as a solid fuel, or converted into liquid or gaseous forms, for the production of electric power, heat, chemicals, or fuels. All of these products can be made in one facility called a biorefinery, by integrating a variety of biomass conversion processes.[2]

Fuel cells harness the chemical energy of hydrogen to generate electricity without combustion or pollution. Hydrogen is the simplest and most abundant element in the universe. Hydrogen can be produced from a wide variety of domestic resources using a number of different technologies.[2]

Geo-energy involves the exploitation of different grades of thermal energy stored within the Earth, which are exploited as ground source heat and as geothermal energy. Geothermal energy is derived from the very high temperatures at the Earth's core and ground source heat exploits solar energy that has been stored at relatively shallow depths within the Earth.[2]

Hydroelectric power is the energy derived from the flowing water in rivers, or from a man-made installations where water flows from a high reservoir down through a tunnel. Hydroelectric power requires the source either to be relatively close to the site of power usage, or to a suitable grid connection. Hydroelectric systems can be connected to the main electricity grid, or as part of a stand-alone power system. In a grid-connected system, any electricity generated in excess of consumption on site can be sold to electricity companies. In an off-grid hydroelectric system, electricity can be supplied directly, or via a battery bank.[2]

Passive solar design is the application of principles when a building is constructed to ensure that heat loss is avoided, solar radiation is utilized and natural ventilation reduces dependency on mechanical systems such as air conditioning. Active solar water heating uses the application of collectors, usually on the roof of a building, to capture and store the sun's heat via water storage systems. The collectors provide heat to a fluid, which circulates to a water tank. The heat is primarily used for heating water in domestic dwellings, industrial facilities and commercial buildings.[2]

Photovoltaics (PV) involve the conversion of energy from the sun into electricity by means of semiconductors. The solar energy excites electrons so that they break free from their atoms, allowing the electrons to flow through the semiconductor material to produce electricity. A number of PV technologies exist including polycrystalline, mono-crystalline and thin-film. Solar PV cells can be arranged in panels on a building's roof or walls and often directly feed electricity into the building for use as lighting or power.[2]

Wind as a renewable energy resource involves harnessing the power contained in moving air. Wind represents a vast source of energy which man has harnessed for hundreds of years. Wind turbines use aerodynamic forces to produce mechanical power that can then be converted to electricity. Wind turbines can be used as stand-alone applications for water pumping or communications, or they can be connected to a utility power grid or even combined with a photovoltaic system.[2]

V. Ethanol emphasis

Ethanol is a high-octane, liquid, domestic, renewable fuel produced by the fermentation of plant sugars. In the United States today, ethanol is typically produced from corn and other grain produce; however, in the future it may be economical to produce ethanol from biomass resources such as agriculture and forestry waste. The reason for this emphasis is the fact that reliance on foreign oil places the United States in a vulnerable position. Other reasons are the current price instability of fuel. With the addition of advanced ethanol research, dependency on fossil fuels would diminish and fuel prices would become more stable since ethanol can easily be produced in the United States. Furthermore, such action could improve the economy by producing more local jobs. Ethanol is also a clean burning fuel, which demonstrates environmentally friendly ways of life with a reduction of carbon dioxide emissions. The leading problem with fossil fuels is that they are not renewable and reserves are finite. In addition, fossil fuel burning is a key player in global warming.

Since 1908, ethanol has been used as fuel in the United States.[3] Even though early efforts to continue a U.S. ethanol program failed, interest in ethanol returned in the late 1970s due to trouble in the Middle Easts oil supply and environmental concerns over the use of lead as a gasoline octane booster.[4] Due to Federal and State ethanol tax subsidies and the mandated use of high-oxygen gasolines, production of ethanol grew from 175 million gallons in 1980 to 1.4 billion gallons in 1998 in the United States.[4]

Presently ethanol is used to extend the volume of conventional gasoline and perform as an oxygenate. Ethanol is currently produced from the fermentation of sugar by enzymes produced from specific varieties of yeast. The majority of ethanol currently produced in the United States is made from corn because carbohydrates are easier than cellulose to convert to glucose, which produces large quantities of carbohydrates.[3] Another benefit for carbohydrate over cellulose conversion is that the organisms and enzymes used are easy to come by.[4]

In the future, with the aid of renewable energy engineers, ethanol will be produced from biomass more efficiently. The conversion of cellulosic biomass to ethanol parallels the corn conversion process. The cellulose must first be converted to sugars by hydrolysis and then fermented to produce ethanol.[4] The greatest potential for ethanol production from biomass, however, lies in enzymatic hydrolysis of cellulose. The enzyme cellulase, now used in the textile industry to stone wash denim and in detergents, simply replaces the sulfuric acid in the hydrolysis step. The cellulase is used at lower temperatures, 30 to 50 degrees C, which reduces the degradation of the sugars.[5]

VI. Summary and conclusions

This paper illustrates the need for integrating renewable energy programs into technology-based colleges and how to implement the program. It also suggests the ease of integration into an existing mechanical engineering or mechanical engineering technology program. The approach of integration was focused on and developed based on current standards at Oregon Institute of Technology for concurrent degrees. It is also expressed that the renewable energy industry is growing which poses a need for more renewable energy engineers. The advancements in renewable fuels, derived from biomass, and their importance can clearly be seen. Further implementation of renewable fuels is near and will be made possible by the addition of renewable energy degrees. As reflected in the current environment, the importance of educating young minds about such forms of renewable energy is clearly obvious.

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