

The Need for Engineers Educated in Renewable Resources

The demand for renewable resources has increased drastically because of political, environmental, and ethically debated issues. The result is an increased demand for new and better technologies that will decrease our use of fossil fuels and other natural finite resources. Reducing waste, protecting the environment, securing the world for future generations, and protecting natural landscapes are a few reasons for engineers to consider venturing into the industry of renewable resources. There are monetary benefits that continue to grow, and career opportunities that are long lasting with a great need of more people. Universities, and other educational institutions have a moral obligation to meet the demand for professionals in renewable resources by providing the necessary education.

A natural resource is defined as a resource that can be replenished via natural means, at a rate comparable to that of its consumption. Though, there are many forms of renewable resources, some yet to be discovered, we are currently focused on the discussion of photovoltaic, geothermal, hydro, and wind.

The sun bathes the Earth in a continuous, enormous flow of radiant energy that far exceeds the electrical energy needs of the world. Generating electricity from the sun's rays doesn't deplete the Earth of any of its natural resources (this fact was obtained via many sources on the internet that sought to measure the impact of massive solar electric

usage. No significant impact was reported). Photovoltaic pertains to the use of silicon-based cells to harness energy from the sun. The cells, when exposed to sunlight, generate a voltage potential. This voltage is then connected in parallel with the electrical production grid in which the system will operate. Electricity is produced by the system for the owner's use. In some states, such as California, net metering is used – excess electricity produced by the PV system is sold back to the electric company.

Wind has been harvested as a source of energy for hundreds of years. Large machines, for grinding grain, and other heavy duty jobs, have used wind-driven turbines to harness wind kinetic energy. Today, state-of-the-art wind power plants use large spinning blades to capture the kinetic energy in moving wind, which then is transferred to rotors that produce electricity. Current costs of wind-generated electricity at prime sites approach the costs of a new coal-fired power plant. Wind power is the lowest-cost renewable energy technology available on the market today. According to the Department of Energy (as presented on www.powerscorecard.org), the costs of wind power are projected to continue to fall and may rank the cheapest electricity source of all options by 2020.

There are several types of hydropower facilities. Storage facilities trap water behind a dam, forming a reservoir. Water is released through turbine-generators to produce electricity. Run-of-River facilities use relatively low dams where the amount of water running through the powerhouse is determined by the water flowing in the river. Because these plants generally do not hold back water behind storage dams, they tend to affect upstream water levels and downstream flow less than storage projects. Electricity generation from these plants will vary with changes in the amount of water flowing in the

river. Pumped-storage projects use off-peak electricity to pump water from a lower reservoir to an upper reservoir. During periods of high electrical demand, the water is released back to the lower reservoir to generate electricity.

Geothermal is the use of the Earth's interior heat for energy. Pumps can be placed in deep wells that can circulate water to the deeper, warmer levels of the Earth's crust. The well is used as a heat supply in the winter and a heat sink in the summer. Electricity can also be generated using either "flash" technology or "binary" technology. Both use pumps to move the super heated water in condensed form to a steam-driven turbine.

“The current production of geothermal energy from all uses places third among renewables, following hydroelectricity and biomass, and ahead of solar and wind. Despite these impressive statistics, the current level of geothermal use pales in comparison to its potential” (Energy Information Association, www.eia.com). The EIA also went on to list a chart itemizing the production of energies and the percentage of demand that was met by each energy type. Renewable energies are only used to produce 5% of the current energy needs world wide. Geothermal energy is available in more places than it is currently implemented. The opportunities for engineers in civil, electrical, and other disciplines, are plentifully available. With residential and commercial building construction alone, nearly every design can implement a geothermal system.

There are many more forms of renewable resources being explored, including innovations in automobile manufacturing, digital paperless books, and fuels made from corn. Even including these, renewable resources are still but a burgeoning industry when compared to that of more traditional resources. Many still contend that renewable resources don't have enough economic potential to invest time and money into. This is a

false assumption, as will be explained below. Not only are businesses making large profits in the renewable resource energy while providing an increasing number of employment opportunities for engineers, but other motivating factors exist, also.

One motivation for the aspiring engineer is to help fight the negative effects of fossil fuel consumption. All four forms of renewable resources thus far listed, could drastically reduce, if not completely eliminate, the need for fossil fuels. Our out-of-control fossil fuel consumption is contributing to the warming of the Earth, the negative impact our immediate environment has on health, and constant war over the control of our Earth's oil supplies. The generation of electric power produces more pollution than any other single industry in the United States. Recent data (collected by www.powerscorecard.com) shows the U.S. electricity industry was responsible for:

- 63% of sulfur dioxide emissions that contribute to acid rain
- 22% of NO_x emissions that contribute to urban smog
- 39% of carbon emissions that contribute to global climate change
- 33% of mercury emissions that pose significant health risks

Among the other major environmental issues linked to electricity are water impacts, generation of wastes, and the disruption of land uses. Electricity is also playing an increasingly important role in our personal lives and in the economy that feeds us. Electricity powered computer and communication systems are more and more important parts our lives and our economy. Because we are demanding more electricity service there is also an increased demand to avoid increasing the damage to our environment. Engineers can find many opportunities for implementing methods of using electricity efficiently and obtaining electricity from the cleanest sources available.

Besides filling a moral call of duty to save the environment, job security is another promising reward for engineers to apply their technical prowess to renewable energies. 123Jump.com is a website dedicated to the public disclosure of IPO reports from all businesses listed for public trading. Searching by category, one can find under “energy”, a list of several significantly sized companies dealing exclusively with renewable resources. Also, many companies, such as BP Energy, PG&E, Sharp Inc., and GM Motors, have begun to invest business resources into marketable forms of energy that exclude the use of fossil fuels. Table 1 lists the revenues generated for a random sample of these companies in the last two years. Data in the table indicates that companies’ revenue is increasing rapidly in the current market. USA Today reported on August 26, 2007, “Venture-capital firms pumped \$264 million into solar companies in 2006, up from \$64 million in 2004...”

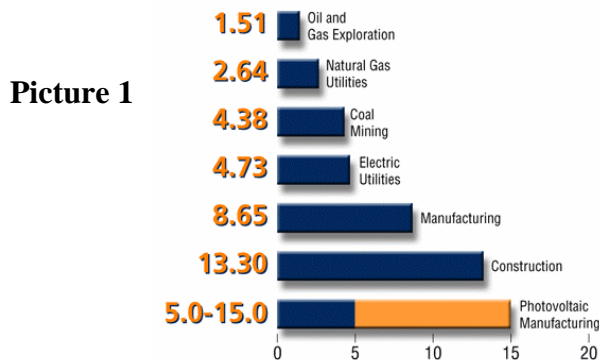
Table 1

Company	2006 Revenue (millions)	2007 Revenue (millions)	Percent Increase
Renewable Energy Group (USA)	\$21.5 mil	\$55.5 mil	158%
Yingli Green Energy (Japan)	\$36.2 mil	\$88.4 mil	144%
Trina Solar Limited (China)	\$27.3 mil	\$75.7 mil	177%
China Sunergy	\$14k	\$150k	971%
Clean Energy Fuels Corp. (USA)	\$78.0 mil	\$91.5 mil	17%
VeraSun Energy (USA)	\$110k	\$236k	115%
All data provided by www.123jump.com IPO reports.			

Factors responsible for influencing this growth are heightened demand for cleaner, cheaper energy, and independence from foreign oil, along with government incentives that stimulate the market’s growth. USA Today, in the same article, went on to report that start-ups

have benefited from \$159 million in U.S. research grants this year, from efforts to reduce power plants' global-warming emissions. The Federal Energy Policy Act of 2005 provides for a federal tax credit of 30 percent of total system cost of a solar system, up to a maximum of \$2000, per system. In California, this is joined with a performance-based state rebate of \$2.50/watt for residential and commercial construction, and \$3.25/watt for government entities.

Not only are companies doing well now, but it is projected by Greenjobs.com that Solar has grown rapidly, achieving an average annual growth of 25% or more over the past couple of decades, and will continue this trend well into the foreseeable future. The site then goes on to report that, “By the time the generation born today reaches adulthood in 2020, solar energy could easily provide energy to over a billion people globally and provide 2.3 million full-time jobs.” SunPower, which says it will earn about \$90 million on \$740 million in sales this year, and expects its prices to be competitive with grid power by 2012. Naturally this growth has been accompanied by the creation of new jobs. Interestingly, because the technology is fairly young and has yet to attain economies of scale, it has also created more jobs per dollar invested or megawatt installed than traditional energy sources. This information is displayed in Picture 1, which has been provided by the U.S. Photovoltaic Industry’s “Road Map”. The horizontal axis in the picture measures the jobs per dollar/megawatt produced.



As can be seen by the growing market, there is also a growing demand for knowledgeable, educated engineers in this field. It is likely that more engineering students graduating with either a B.S. or M.S. will be heading into the renewable resource industry. The question is – are they equipped to work in the field? Are schools offering a curriculum that keeps pace with this market, and are enough professionals being produced that can fill the demand for people?

The majority of universities researchable on the internet, offer no classes specifically designed to educate students in solar, hydro, geothermal, or wind energies. The implementation of these technologies requires the cooperative efforts of professionals from many engineering disciplines. Dams, wind-turbines, solar system roof tops and geothermal wells are all structurally designed by civil engineers, and built with components designed by electrical, computer, and mechanical engineers. Nearly all engineering fields are at some point involved in the drive for renewable resource supply.

The University of California in Davis, offers no courses for the development of natural resources, nor is there any degree emphasis option for such a field. The University of Wyoming offers one course called, “Research Planning in Renewable Resources”, and Purdue University has invested in a Laboratory of Renewable Resources Engineering. Appalachian State University, offers both bachelors and master’s degree programs focusing primarily on some aspect of renewable energy production. The San Juan College in New Mexico offers a two-year Associates degree or one-year certificate in renewable energy technologies. The majority of schools that list such programs are not in states such as California, that have shown leadership in setting standards and offering incentives to curb global warming.

Universities and vocational schools offering advanced education in renewable resources would stimulate a cyclical response in the industry. With a higher influx of engineers into the work force, companies will be better equipped to produce more efficient, and more innovative products. There will be an increase in competition to design better, more cost effective products. This in turn will increase quality and availability. As seen through history, the increase in quality and availability of reliable products will increase the demand and usage of these products. Critics that create fear of a negative economic impact as a result of departing from fossil fuels disregard the fact that not only are more professional positions made available, but also indirect markets associated with the operation of business also find themselves engaged by a growing market.

Solar, wind, hydro, and geothermal energy resources represent but a glimpse at what could be considered a modern technological revolution. Society is at a moment of change that could be monumental in historical perspective. The world has increased its energy consumption to an incredible level. Need for change in our energy policies has been bred by soul-shaking fear of war over resources and irreparable damage to our earth. We have breached the technological barriers stopping us from solving these problems, and are capable of replacing old habits with newer, cleaner behavior on a societal level. Students of technology and sciences would benefit greatly by realizing the opportunities that lay ahead of them, if they choose to venture into this uncharted horizon. Universities have an obligation to keep pace with real world demands and society's changes. A sense of moral obligation to planet Earth can be satisfied, in a profitable manner. New markets will replace dying ones, and we can change from a wasteful world, reliant on fossil fuels,

to a world in which efficiency and innovation are not only profitable, but also expected of every technology firm out there.

References and useful links:

Go Solar California: www.gosolarcalifornia.com

Consumer Energy Center: www.consumerenergycenter.com

123Jump Financial Markets: www.123Jump.com

USA Today: www.usatoday.com

Power Score Card (rates states on energy consumption):

www.powerscorecard.org **Energy Information Association:** www.eia.com

Green Directory:

http://www.greenjobs.com/Public/GreenDirectory/green_directory.htm

American solar energy association: <http://www.ases.org/>

European Photovoltaic Association: <http://www.epia.org/>

Renewables Information 2003, IEA:<http://www.iea.org/>

REPP - CREST: <http://www.repp.org/solar/index.html>

Solar Electricity in 2010,

EPIA:<http://www.epia.org/05Publications/EPIAPublications.htm>

US DOE Energy Information Administration:

<http://www.eia.doe.gov/cneaf/solar.renewables/page/solarphotv/solarpv.html>

US PV Industry Roadmap: Solar Electric Power. The U.S. Photovoltaic

Industry Roadmap, May 2001:

www.nrel.gov/ncpv/pvmenu.cgi?site=ncpv&idx=3&body=infores.html

World Energy Council: <http://www.worldenergy.org/wec->

[geis/publications/reports/ser/solar/solar.asp](http://www.worldenergy.org/wec-geis/publications/reports/ser/solar/solar.asp)