AC 2011-1168: CONTINUATION OF GREEN INITIATIVE IN CAMPUS AND THE CURRICULUM DEVELOPMENT OF A SECOND COURSE CONCENTRATING ON SELECTED CHOICES OF ALTERNATIVE ENERGY SOURCES IN EET PROGRAM THROUGH GLOBAL ECONOMIC AND ENVIRONMENTAL ASPECTS.

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Continuation of Green Initiative in Campus and the Curriculum Development of a Second Course Concentrating on Selected Choices of Alternative Energy Sources in EET Program Through Global Economic and Environmental Aspects.

Abstract

Energy systems play a critical role in everyday life and an important part of engineering. Now a day, non-traditional (green) energy sources are the area of interest in the academia, business and industry alike. There is an urgent demand for a well trained workforce to develope, process, utilize and manage these green sources in an environmentally and economically feasible way. Obviously, the quest for alternative to fossil fuels will add to the growing global effort to combat climate change. The author thinks that more emphasis should be given to the sun tracking solar power system as it can utilize solar power to its full potential followed by the wind energy.

As I mentioned in my last paper, Northwestern State University at Natchitoches, LA has been taken an initiative to promote a green, healthy, and environmentally friendly campus. The progress in that area will be documented here. In order to make this process more attractive and meaningful I offered one survey course online for all disciplines in alternative energy during summer 2010. The findings will be reported in this paper. In continuation, a second course will be offered in classroom environment during spring 2011 with more technical concepts, design aspects, and implementation suitable for EET and IET students. The author will justify the concentration on sun tracking solar and wind energies over other alternative energy sources in terms of economic aspects and environmental issues. A comparison study in this field with some Asian countries will also be discussed.

The experts are expecting a solar market tornado as it has transformed into a worldwide movement and the growth will be around US$ 30 billion and US$ 200 billion in 2010 and 2020 respectively. The impact of alternative energy on global economy is undeniable and its proper use is highly desirable. The students will be motivated by understanding that a career in alternative energy is both rewarding and a positive contribution to the fight against global warming. Knowledge in this emerging and lucrative field of alternative energy engineering will broaden the undergraduate experience of technology and enhance their employment opportunities greatly.

Introduction

Research has made alternative energy more affordable today than it was 25 years ago. But still there are some drawbacks to alternative energy development. Toxic chemicals are used in the manufacturing process of solar or photovoltaic cells as well as in batteries that stores solar electricity through night and on cloudy days. So there is an environmental affect. Producing electricity by solar means would be about four times more expensive than if it were produced in a natural gas-fired power plant. Similarly

wind power generation involves a land use. Wind firm requires 17 acres to produce 1 MW of electricity. Even though farmers and ranchers can use the land beneath wind turbines they can cause erosion in desert areas. They also affect natural views as they tend to be located on or just below ridgelines. So it will be worthwhile to keep on doing research in the implementation of renewable energy systems to gradually replace the fossil fuel plants. This is why I have developed this courage with more emphasis on design aspects of the plants making it more efficient[1].

The energy and its use have become increasingly important to the United States and the World. The demand of energy is increasing rapidly due to the rising living standards and expanding population in countries around the world. Nonrenewable fossil fuel sources are not only running out, but also becoming unstable in nature due to politics in the Middle East and Latin America. Even though only 10 minutes of the finale 90 minute presidential debate during 2008 was devoted to outline energy policy, it was clear that both candidates have studied the energy challenges facing the nation. President Obama proposed his New Energy for America plan and signed the American Recovery and Reinvestment Act (ARRA). The realization is that the component of energy policy must prepare a technical workforce in the alternative energy areas. We must involve all our efforts to ensure the outcome of ARRA to help create five million new jobs by strategically investing $150 billion over the next ten years, to catalyze private efforts to build a clean energy fixture, to have more oil than we currently import from the Middle East and Venezuela combined with 10 years to put 1 million Plug-in-Hybrid cars with up to 150 miles per gallon on the road, to ensure 10 percent of our electricity comes from renewable sources by 2012, and 25 percent by 2025, and to reduce the green house gas emission 80 percent of by 2050[2].

The grassroots efforts to develop renewable energy are getting support from the consumers. In order to maximize the output of the solar system, a solar tracking system must be introduced to adjust the angle of the solar panels to make the sun normal to the solar panel throughout the day.

To keep up with the national trend I offered an online survey course called introduction to alternative energy for all disciplines in the campus during summer 2010. Most of the students liked it as they became familiar to a hot button area of energy system. 78% have expressed interest to a higher level course in this area. This paper describes the on-going development of this second course. The course syllabus has already been approved by the university curriculum committee and the industry advisory board. Several students in the campus and alumni working in different companies have expressed interest in it. This course will provide many educational benefits for all involved including understanding the design aspects of renewable energies, its uses, comparison study of different renewable energies, its environmental effects and exposure to international renewable energy technologies.

The goals are to provide a broad overview of alternative energies with design aspects such that the students are excited to continue the pursuit of energy alternatives as graduates and future leaders.

NSU Green

The Green initiative launched by the NSU campus for the last seven years included behavioral change, recycling, campus beautification, infrastructure and energy conservation. For campus beautification the authority stated planting trees all around the campus. NSU was chosen as a 2009 Tree Campus USA University for its dedication to campus forestry management and environmental stewarding. During 2008, it was characterized as the first designated Tree Campus USA University in Louisiana by the Tree Campus USA Program. The University officials have started gathering assessments, from energy management contractors to evaluate how efficient the current campus infrastructure is. The new system which replaced a 30 year old unreliable one has provided state-of-the art electrical meters for each building instead of a meter per designated grid area to continually monitor usage and to implement measures to reduce energy use, especially during peak hours. In the process the underground wiring, switches and transformers were replaced. The goal was to make the campus more energy efficient to have money in operations. The print shop, the grounds crew and Red River Janitors have started using more environmentally friendly products and supplies. They are following the same procedure during renovations and construction[3].

Desk side recycling bin (1.5 gallon) is supplied to each faculty and stuff. Recycling various papers, aluminum, cans, plastic bottles, and jugs, is encouraged.
Green NSU and Cane River Green Market teamed up as partners for 'Healthy Livings' to arrange meetings with faculty and staff in the Student Union Building at NSU to promote the importance and availability of fresh, locally grown and harvested fruits and vegetables.

During fall of 2010, the University was awarded three projects through the Empower Louisiana Stimulus Funding through the department of Natural Resources Total.

Finally the NSU has adopted 4.5 days week instead of 5 days week to cut its electric bill.

Course Objectives

The student should be able to:

- Understand, analyze, and explain the shift to alternate energy resources.
- Understand and explain solar power resources and its design aspects such as photovoltaic technologies and thermal applications.
- Understand and explain wind energy systems and its design aspects.
- Understand and Explain geothermal energy systems with design aspects.
- Understand and explain biomass systems.
- Understand and explain ocean wave energy.
- Understand and explain microturbines and induction generators.
- Understand and explain energy storage systems.
- Compare energy systems in the United States with those of the developing world.

Course Topics

- Systems Tools for Energy Systems: Conserving existing energy resources versus shifting to alternate resources. The concept of sustainable development.
- Solar Energy Resources: Availability of energy from the Sun, principles of thermodynamics, thermosolar power plants, photovoltaic power plants, design and operation of practical PV systems, and active and passive solar heating systems.
- Wind Energy Systems: Wind power plants, Alternate wind turbines, using wind data to evaluate a potential location, estimating, general classification, output from a specific turbine, and economics of wind power.
- Geothermal Energy Systems: Introduction, resources, energy systems, ground-source heat pumps, direct production of heat, and electricity production.
- Biomass Energy Systems: Introduction of biomass fuels, such as wood, corps, manure and some garbage, biomass-powered microplants, application of biomass in the U. S. and the developing world.
- Transportation Energy Technologies: Biofuels.
- Machines: Microturbines and induction generators.
- Energy Storage: Lead-acid batteries, ultracapacitors, flywheels, superconducting magnetic storage systems, pumped hydroelectric energy storage, and energy storage as an economic resource.
- Comparative Studies: Alternate energies of the United States with respect to the developing world.

Teaching Schedule

The teaching schedule for the 15 weeks delivery is as follows:

Week	Topic
#1	Introduction to alternative sources of energy.
#2	Cont. of alternative sources of energy. Principles of thermodynamics: State of a thermodynamic system, fundamental laws and principles, and examples of energy balance.
#3	Wind Power Plants: Appropriate location, wind power, general classification of wind turbines, and **Quiz #1.**
#4	Generators and speed control used in wind power energy, analysis of small generating systems, economics of wind power, environmental impacts, and wind energy application.
#5	Thermosolar Power Plants: Water heating by solar energy, heat transfer calculation of thermally isolated reservoirs, and heating domestic water.
#6	Thermosolar energy, Photovoltaic Power Plants: solar energy, generation of electricity by photovoltaic effect, dependence of a PV cell characteristic on temperature, solar cell output characteristics, and

	Test #1.
#7	Equivalent models and parameters for photovoltaic panels, photovoltaic systems, applications of photovoltaic solar energy, and economic analysis of solar energy.
#8	Biomass-powered microplants: Introduction, fuel from biomass, biogas, biomass for biogas, and biological formation of biogas.
#9	Factors effecting biodigestion, characteristics of biodigesters, and **Test # 3.**
#10	Construction of biodigester, generation of electricity using biogas, geothermal energy production: introduction, geothermal energy: why, for whom and how? and geothermal heat pumps systems.
#11	Direct production of heat, electricity production, glossary, the place of biofuels in the energy environment, and current systems.
#12	Future systems: use of lignocelluloses, economic and environmental balance of biofuel production systems, ocean thermal energy conversion (OTEC), tidal energy, wave energy, and **Quiz # 2.**
#13	Storage systems: Energy storage parameters, lead-acid batteries, ultracapacitors, flywheel, superconducting magnetic storage system, pumped hydroelectric energy storage, compressed air energy storage, and storage heat, and comparison studies with the developing world.
#14	Induction generators: Principles of operation, representation of steady state operation, power and losses generated, self-excited induction generator, mathematical description of the self-excitation process, interconnected and stand-alone operation, speed and voltage control**.**
#15	**Final Exam.**

Rationale

As the world is transforming, it will be a great idea to change our life for better by joining the fastest growing green job arena which is expected to be a 1.5 trillion dollar industry [4]. This market will only continue to grow. As the world has been experiencing a great shortage of energy now a day's, the energy which is everywhere surrounding the environment should be considered to be captured, stoned, conditioned and utilized by alternative techniques. Green energy area is vast. So the concentration on its different aspects should also be different in order to obtain higher efficiency and usefulness. The

author thinks that we should concentrate more on solar, wind, geothermal, biomass and less on bio-fuels, wave energy etc.

Solar Energy

Solar Energy is abundant and everlasting in nature. The sunlight that falls on the United States in one day contains more than twice the energy the country normally consumes in a year. The most emphasis should be given to find ways to make the conversion an efficient as possible. The orientation of the solar panel using a solar tracker may increase the efficiency of the conversion system from 20% to 50%. There is a room for the improvement in the Sun Tracking Solar Power Systems especially in the area of computer hardware and software[5]. The traditional energy sources such as coal and natural gas are facing a number of challenges including rising prices, security concern over dependence on imports from foreign countries having significant but limited fossil fuel supplies, and growing environmental concerns over the climate change due to carbon emission during power generation. It has emerged as one of the most rapidly growing renewable source of electricity because of inherent advantages.

Wind Energy

The global wind resources technically recoverable are more than twice as much as the projection for the world's electricity demand in 2020. So far wind energy made up 11.5% of renewable share. In terms of electric generation, wind seems destined to still dominate the U.S. renewable picture with enormous potential still untapped on the great lakes. With the arrival of the Alta Wind Energy Center (AWEC) in the Mojave-Desert foothills it is rapidly becoming the epicenter of the renewable energy in the United States with hundreds of turbines spinning. With all the projects completed, it could generate as much as 3,000 megawatts of power. At the same time there are already hundreds of megawatts of installed solar capacity. The Mojave solar park will become the world's largest solar installation at 553 MW when completed in 2011[6].

It is established that wind blowing over deeper water (offshore) is consistent and strong. So, there is a movement now to use floating wind turbines to avoid anchoring into a deep seabed. Marine innovation & technology's windfloat can theoretically support giant 5 MW turbines. Some projects can put turbines in the water by 2011-2012. Floating turbines based 10 miles away would be largely invisible removing the complains of visual disturbances[7]. The floating turbines will significantly be less expensive since they would not need seabed construction, large ships, or equipment out at sea, or require decommissioning a large installed structure. The bottom line is that it is very much environmentally friendly.

The wind energy capacity in the United States has come down from 10 gigawatts in 2009 to 6 gigawatts in 2010. So, there is a doubt in earlier famous DOE report that wind could in principle supply 20 percent of US electricity demand by 2030. By earlier 2010, there was an unexpected increase in wind operating and maintenance costs and diminishing

returns from wind as the best turbine sites are occupied. Also wind cost varies much more widely than traditional base load generating cost especially in the United States.

Geothermal

Geothermal energy is the thermal energy contained in the earth. Surface manifestations (thermal anomalies, hot springs, geysers etc.) signals the presence of geothermal reservoirs containing aqueous fluids ready to give up thermal energy, once brought to the surface. Mankind uses geothermal energy to heat their homes and to generate electricity by digging deep wells and pumping the heated underground water or steam to the surface. Naturally occurring large areas of hydrothermal resources are called geothermal reservoirs. Three main uses of geothermal energy are as follows:

- Hot water from springs or reservoirs near the surface in direct use and direct heating systems.

- The United States generates more geothermal electricity than any other country.

- Geothermal heat pumps use the earth's constant temperatures between 50^0 and 100^0 Fahrenheit to heat and cool buildings. In recent years the U.S. Department of Energy along with the EPA have partnered with industry to promote the use of heat pumps. As a result the heat pumps are becoming more popular.

The environmental impact of geothermal energy is minimal. Geothermal power plants release less than 1% of the carbon dioxide emission of the fossil fuel plant. They emit 97% less acid rain causing sulfur compounds than those of fossil fuel plants. The used water is always injected back into the earth. Obviously there will not be any negative impact on the environment if direct use and heating applications are made.

Bio-fuels Energy Systems:

Using food to make transportation fuel such as ethanol is too expensive. It did not work as it also affects the food supply for the human beings as well as animals. Some companies are using non-food cellulose such as sorghum, agricultural and wood waste to make fuels for car. The future will tell its effectiveness.

A Comparison Study

According to the U.S. department of energy report, 2009 was a banner year for wind power. The United States added 10 MW representing a 40% increase to maintain its lead in cumulative capacity. Texas with its 9.4 GW of total capacity of wind power could have ranked sixth in the world. The shepherds Flat wind firm, owned by Caithness energy in the north-central Oregon will be the largest when it will open in 2012. The capacity will be 845 MW with total generation of 2 billion kilowatt-hours of clean electricity a year. It is enough to power 230,000 households. The main advantage is that the equivalent fossil-fuel plant would produce 1.5 million tons greenhouse gasses a year. GE is manufacturing

338 of its 2.5 MW wind turbines. Southern California Edition will buy electricity for the next 20 years. Germany's E.ON company is the current record holder by operating a781.5 MW wind firm 200 miles west of Fort Worth, Texas, from October, 2010. The head of GE's power and water unit expressed frustration of losing the momentum of doing business in the United States to Europe and China which have clear standard if the United States does not enact a national renewable energy standard[9].

Throughout 2008 and the beginning of 2009, more than 1000 additional MW of geothermal power come on line in the United States. The U.S. Bureau of Land Management (BLM) leased 301,588 acres of land for geothermal power development during 2008/2009. The United States has signed the International Partnership for Geothermal Technology (IPGT) with Iceland and Australia. Investments in geothermal is continued to grow. Both small and modular low temperature electricity generations are the significant portions of the overall geothermal market[8]. Even though there is no established clear correlation between energy consumption and economic growth i.e. GDP (Gross Domestic Product) there might be greater linkage for developing countries compared to more affluent industrial countries. For example, The U. S. energy consumption grew only 45 % although the U. S. GDP increased by 160 %.

Floating Wind energy firms are ideal for countries such as Norway, Italy, and Japan which do not have shallow coastal water. According to the Wind Energy Council 810 of more than 1000 gigawatts of off-shore wind potential are in water deeper than 30 meters. So, this will make a strong case for the United States to install floating wind turbines.

Researchers from Harvard University and Tsinghua University have found that China could meet its electricity demands from wind energy by 2030. It has set the target of 100 GW of wind power by 2010. It has identified wind power as a key growth component of its economy. As of 2010, China has become the world's largest maker of wind turbines commonly in the range of 1.5 MW to 2 MW surpassing USA. China is encouraging foreign companies especially from the USA to visit and invest in the wind power generation. China also has emerged as the world's largest manufacturer of solar panels in the last two years. Six biggest solar companies with a combined value of $ 1.5 billion are involved along with numerous smaller companies in manufacturing solar photovoltaic technology. A new thin film solar plant developed by Anwell technology in Henan province has become a milestone for solar industry and technology development in China. In 2009, the Chinese president pledged at the UN climate summit that China would target to use 15% of its energy from renewable sources within a decade. It is desperate to reduce its dependency on coal and oil imports as well as the pressure on its environment by using renewable energy. It also appeared that the solar and wind energies are unaffected by the global financial crisis[9].

Saudi Arabia also intends to become the world's largest exporter of clean energy produced from its abundant sunlight in future years. It also wants to utilize its two vast windy regions along the Arabian Gulf and the Red sea Coastal areas. Even though it expressed interest in joining the IRENA (International Renewable Energy Group) during 2010, it warned on rapid shift to renewable energy. Switching too early to slowly

evolving alternative fuels risks may be counterproductive to the global energy security by reducing levels of investment in fossil fuels[10].

The United Arab Emirates as an important oil producer with the fifth largest proved oil reserves in the Middle East has been producing 97% of the electricity using natural gas. The demand for electricity in the UAE has been growing at double digit for many years and will continue in the foreseeable future. The country has come to realize two facts based on Kyoto protocol and awareness. The first one is that the conventional energy sources such as oil will deplete sooner or later and the second one is the higher carbon emission will further pollute the environment. So, the government of Abu Dhabi initiated ambitious plans for solar, biomass, wind and other renewable energy projects. Dubai electricity and water authority has launched a pilot project using wind energy to replace conventional energy sources. The gulf region enjoys sunshine for around 300 days for an average of nine hours per day. The solar energy projects are also getting priorities. They are interested in saving high value fossil fuels for exports by exploring other sources of energy[11].

In Bangladesh, the major constraint to economic growth and quality of life is the lack of access to electricity by 60% of the population. Both government and non-government organizations (NGOs) are working to bring sustainable energy to the rural population. The idea is to empower the poor to the extent possibilities towards suitable live hood. One IDA (International Development Association) financed rural electrification and renewable energy development project was launched during 2002 and established the renewable energy option as a practical cost-effective alternative for solar electricity to achieve the Government target of full access to its entire rural population. The project was implemented by the Rural Electrification Board (REB) through its rural electric cooperatives with the cooperation of NGO'S and private sector companies. The center of energy studies (CES) of Bangladesh University of Engineering and Technology (BUET) organizes different training programs, workshops, seminars, and energy fairs with the different leading organizations and universities in the field of renewable (e.g. solar wind, hydros) energy to increase the awareness of the public.

As of June 2009, more than 600,000 new customers had been connected to the grid for the first time. Concurrently 320,000 consumers had new solar systems, surpassing the original target of 50,000 by a factor of 600 percent. It is going to fulfill the target of connecting 1 million rural consumers by 2012. The participating organizations have extended micro-credits for the customers to buy solar home systems. ADB (Asian Development Bank) would provide US $500 million for the feasibility study on solar grid connectivity in the country. The organization has increased its technical assistance to scale up its projects for better access to modern and reliable sources of clean energy and also allocated recently two million US dollars for some Asian Countries including Bangladesh. The ADB projects worth $418 million, translated to about 243, 600 new households connected to modern energy compared to the average of 169, 200 between 2003 and 2008. It will also provide two units of its newly innovated solar and Wind run combined power plants to Bangladesh for the power generation. The joint venture of

Bangladesh Auto Power Private Limited and Chinese Zhejiang Jinxi Solar Energy Equipment Company Limited is expected to start producing low cast, but more efficient solar panel to tape the country's growing market for green energy, especially among rural population by early 2011. Similarly, Green Housing and Energy Limited (GHEL) and Rahimafrooz Renewable Energy (RREL) will collaborate to design and develop products, adapted to the specific needs of the people at the bottom of the socio economic pyramid RREL which claims 40% of the overall market share established a solar panel assembling plant to grab the domestic market for solar home systems. All the accessories for installing solar systems, except the solar panels have come from domestic manufacturers. Every month 30,000 home solar systems were added during 2010. A private organization called 'Purabi Green Energy' has set up a 100 kW solar power plant in Sandwip (an island) to feed power to 10 establishments including a few banks and a police station with the help of a state-owned Infrastructure Development Company Limited (IDCOL) during October 2010. This organization along with GTZ (German Technical Cooperation) and Grameen Shakti have geared up their activities to increase the biogas plants. It has changed the life style of rural people[5].

Conclusion

NSU is continuing its focus on the environment, energy conservation, and sustainability through the initiative known as Northwestern Green which is definitely a very positive approach to be followed by other campuses nationwide. The awareness of the consumers about air pollution from carbon emission due to power generation using fossil fuels and its effect on the climate change fluctuates with the gasoline price in the pump. We must utilize this awareness of the public from summer of 2008 to get energy independence by developing more and more renewable energy sources. In this paper I have justified the concentration on design aspects of solar, wind and geothermal energies to make it even more efficient and environmental friendly. Energy storage involves with battery bank having toxic liquids. The author thinks that we must continue to work on how best to handle the contributions of wind and solar to power mixes in order to reduce the need for storages. The apparent slow down both in solar and wind energy production during 2010 should not discourage us from developing cost effective and efficient systems in 2011 and beyond. It is also encouraging that many in engineering and technology, corporate and political committees advocate greater stance on alternative energy. The author has presented the utilization of especially solar and wind and biomass out of all kinds of alternative energies in some developing countries in Asia. An introductive course in alternative energy has already motivated the students towards developing a workforce with environmental awareness. The engineers and the technologists must figure out the way to use unlimited availability of renewable energies in an economic way in contrast to fossil fuels which are finite and ultimately expensive.

It is anticipated that the improving economy and alternative energy sources are combining to create unique opportunities to obtain energy independence as well as keeping the environment green. Overall, this second course will motivate some of the students to pursue carrier in this lucrative and emerging field which will be beneficial to the society.

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