Short Term Voyage - May 2012
Discipline: Engineering
ENGR2595-501: Energy Resources: A Global Economic and Environmental Perspective
Lower Division
Faculty Name: Pamela Norris

Pre-requisites: none

COURSE DESCRIPTION

The objectives of this course are: 1) to familiarize students with available energy sources and how they differ with geography, and 2) to impart an appreciation for technical difficulties and attributes of various energy sources, including political and economic issues. This course will provide an overview of energy source technologies- fossil fuels, hydroelectric power, geothermal, ocean thermal energy conversion, thermoelectrics, wind power, nuclear energy, solar power, biomass, and fuel cells. The origin of these resources, their world-wide distribution, advantages, and disadvantages, as well as economic and global environmental concerns will be addressed. Special emphasis will be placed on the energy resources of the countries of our journey.

COURSE OBJECTIVES

1. Students will illustrate an understanding of energy resources by identifying sources of energy presently available and current usage.
2. Students will illustrate an understanding of energy resources by comparing the advantages and disadvantages of energy resources.
3. Students will illustrate an understanding of energy resources by recognizing environmental impacts of each resource.
4. Students will appreciate the connection between current and future energy use and the environment, politics, economics, and society.

REQUIRED TEXTBOOK

Author: Paul Breeze
Title: Power Generation Technologies
Publisher: Elsevier
ISBN #0750663138
Date: 2005

TOPICAL OUTLINE OF COURSE

Depart PUNTARENAS, COSTA RICA, May 21

C1 5/22 Introduction to Energy, World Wide Resources and Usage
What is Energy? How is energy measured? Conversion of energy from one form to another. Turbines. Storage of energy; batteries. US and Worldwide energy usage. The language and issues of energy---sources, consumption, terminology. (Reading assignment: Chapters 1, 2, 10 of Breeze)

C2 5/23 Fossil Fuels
What are fossil fuel resources? Where do they occur? How are they extracted? How do they produce useful energy? What are the advantages? What are the disadvantages? Environmental considerations? Cost? (Reading assignment: Chapters 3, 4, 5 of Breeze)

C3 5/24 Nuclear Energy
What are the sources of nuclear power? Where do they occur? How are they extracted? How are they used to create power? What are the advantages? What are the disadvantages? Environmental considerations? Financial risks? Cost? (Reading assignment: Chapter 17 of Breeze)

CALLAO, PERU, May 25-27

C4 5/28 Solar
What is solar power? Where is it best located? How can it be used for heat (passive solar)? How can it be used for power generation (active solar)? What materials are needed to construct a solar panel? What are the advantages? What are the disadvantages? Environmental considerations? Financial risks? Cost? (Reading assignment: Chapter 13 of Breeze)

C5 5/29 Wind
What is wind power? Where is it best located? How is wind converted to electricity? What are the advantages? What are the disadvantages? Constraints? Environmental considerations? Financial risks? Cost? (Reading assignment: Chapter 11 of Breeze)

MANTA, ECUADOR, May 30-June 2

C6 6/3 Geothermal and Ocean Thermal Energy Conversion
What are geothermal and ocean thermal resources? Where do they occur? How are they extracted? How are they used to create power? How are they used to create heat? What are the advantages? What are the disadvantages? Environmental considerations? Financial risks? Cost? (Reading assignment: Chapters 12 and 14 of Breeze)

C7 6/4 Biomass
What is biomass? How can it be used for electric energy or heat? What are the advantages? What are the disadvantages? What are synthetic fuels? How are they produced? How can they be used? What are the advantages? What are the disadvantages? Environmental considerations? Financial risks? Cost? (Reading assignment: Chapters 15 and 16 of Breeze)

FUERTE AMADOR (PANAMA CITY), PANAMA, June 5-6

C8 6/7 Hydroelectric
Where can hydroelectric power be used? How does it produce power? What are the advantages? What are the disadvantages? Environmental considerations? Financial risks? Cost? (Reading assignment: Chapters 8 and 9 of Breeze)

PUERTO LIMON, COSTA RICA--- June 8-9
6/8 **Required FDP: Waste 2 Energy at the Chiquita Biodigestor**

C9 6/10 Thermoelectrics, Fuel Cells
What are fuel cells? How are they constructed? How do they work? What are the advantages? What are the disadvantages? What are thermoelectrics? How are they constructed? How do they work? What are the advantages? What are the disadvantages? Environmental considerations? Financial risks? Cost? (Reading assignment: Chapter 7 of Breeze)

C10 6/11 The Great Energy Debate: Classroom Capstone Activity

BELIZE CITY, BELIZE, June 12-13

Final 6/14----Exam

ARRIVE FT. LAUDERDALE

FIELD ASSIGNMENTS
Twenty percent of the contact hours for this course are provided by field work. Students will be required to keep a field journal to record observations from EACH port on the journey, with particular emphasis on observations made during the **required Faculty Directed Practica** (FDPs). Students should record their observations of energy resources and usage at each port and should include technical observations from the FDPs. Journals will be periodically reviewed during the voyage.

Required Faculty Directed Practica --- Waste 2 Energy at the Chiquita Biodigestor
Students will get to see a complete life cycle solution for the "Waste 2 Energy" project at Mundimar, a subsidiary of Chiquita Brands. Students will observe how many different challenges, such as waste water management and odor management, can be overcome with innovative solutions such as an anaerobic biogestor which, rather then consuming additional energy, actually harnesses the energetic potential of organic waste and produces biogas.

We will visit Mundimar, a subsidiary of Chiquita Brands, and students will see a complete life cycle solution for the "Waste 2 Energy" project. This fruit processing facility (focusing on bananas and other fruit juices along with dehydrated tropical fruits, which we will sample) is approaching their wastewater management issues with innovative solutions. Students will tour the

facility, which utilizes anaerobic lagoons in conjunction with a hermetic biogestor, which actually yields a biogas as a byproduct that can supply energy for the plant. Students will observe the many components in this environmentally friendly system, which uses no chemicals for wastewater treatment, removes greenhouse gases, uses no electricity for water purification, and produces organic fertilizer. Students will observe how many different challenges, such as waste water management and odor management, can be overcome with innovative solutions such as an anaerobic biogestor which, rather then consuming additional energy, actually harnesses the energetic potential of organic waste and produces biogas. Lunch will be provided at the cafeteria.

METHODS OF EVALUATION

Beginning of class survey and assignment 5%
Mid-term exam 15%
Final exam 20%
Journal (including detailed reports from the required FDP) 25%
Classroom debate 15%
Class participation* 15%

* *CLASS ATTENDANCE AND PARTICIPATION* is required. Students must come to class prepared to discuss the assigned readings AND contribute to class discussion. Consistency and quality of contributions will be evaluated during each class period.

RESERVE LIBRARY LIST

Author: Christian Ngo, Joseph Natowitz
Title: Our Energy Future: Resources, Alternatives and the Environment

Author: Robert A. Ristinen and Jack P. Kraushaar
Title: Energy and the Environment, 2nd Edition

Author: Gordon J. Aubrech
Title: Energy: Physical, Environmental, and Social Impact, 3rd Edition

Author: Godfrey Boyle, Bob Everett, and Janet Ramage
Title: Energy: *Energy Systems and Sustainability*

ELECTRONIC COURSE MATERIALS

Energy Conversion, Kenneth Weston, (available for free electronically)
http://www.personal.utulsa.edu/~kenneth-weston

A BRIEF HISTORY OF HUMAN ENERGY USE

(copied from http://www.globalchange.gov)

Nearly all organisms rely on energy from the sun captured by plants for survival. Energy flow through food chains begins with solar energy captured by plants. Some of this energy is used by organisms at each level of the food chain, much is lost as heat, and a small portion is passed down the food chain as one organism eats another.

Over time, humans have developed an understanding of energy that has allowed them to harness it for uses well beyond basic survival.

The first major advance in human understanding of energy was a mastery of fire. The use of fire to cook food and heat dwellings, using wood as the fuel, dates back at least 400,000 years.[1] The burning wood and other forms of biomass eventually led to ovens for making pottery, and the refining of metals from ore. The first evidence of coal being burned as a fuel dates back approximately 2400 years.[2]

After the advent of fire, human use of energy per capita remained nearly constant until the Industrial Revolution of the 19th century. This is despite the fact that, shortly after mastering fire, humans learned to use energy from the Sun, wind, water, and animals for endeavors such as transportation, heating cooling and agriculture.

The invention of the steam engine was at the center of the Industrial Revolution. It converted the chemical energy stored in wood or coal into motion energy. The steam engine was widely used to solve the urgent problem of pumping water out of coal mines. As improved by James Watt, Scottish inventor and mechanical engineer, it was soon used to move coal, drive the manufacturing of machinery, and power locomotives, ships and even the first automobiles.[3] It was during this time that coal replaced wood as the major fuel supply for industrialized society. Coal remained the major fuel supply until the middle of the 20th century when it was overtaken by oil.

The next major energy revolution was the ability to generate electricity and transmit it over large distances. During the first half of the 19th century British physicist, Michael Faraday demonstrated that electricity would flow in a wire exposed to a changing magnetic field, now known as Faraday's Law. Humans then understood how to generate electricity. In the 1880's, Nikola Tesla, a Serbian born electrical engineer designed alternating current (AC) motors and transformers that made long distance transmission of electricity possible. Humans could now generate electricity on a large scale, at a single location, and then transmit that electricity efficiently to many different locations. Electricity generated at Niagara Falls, for example, could now be used by customers all over the region.

Although hydropower, largely in the form of water wheels, has been in use by human society for centuries, hydroelectricity is a more recent phenomenon. The first hydroelectric power plants were built at the end of the 19th century and by the middle of the 20th century were a major source of electricity. As of 2010, hydropower produced more than 15% of the world's electricity.[4]

In the 20th century, Einstein's Theories of Relativity and the new science of quantum

---

[1] Bowman DM, Balch JK, Artaxo P *et al.* Fire in the Earth system. *Science*. 2009;324(5926):481–4

[2] Metalworking and Tools", in: Oleson, John Peter (ed.): *The Oxford Handbook of Engineering and Technology in the Classical World*, Oxford University Press, ISBN 978-0-19-518731-1, pp. 418–38 (432)

[3] AAAS, 10J/M2

[4] Source of data is the U.S. Energy Information Administration (http://www.eia.doe.gov) unless otherwise noted.

mechanics brought with them an understanding of the nature of matter and energy that gave rise to countless new technologies. Among these technologies were the nuclear power plant and the solar or photovoltaic cell. Both of these technologies emerged as practical sources of electricity in the 1950's. Nuclear energy quickly caught on as a means of generating electricity. Today, nuclear energy generates almost 15% of the world's electricity. Solar energy provides less than 1% of the world's electricity. Solar is the only human energy source that generates electricity without relying on Faraday's Law. Particles of light provide the energy for the flow of electrons directly.

Humans have also managed to harness the geothermal energy of the earth to produce electricity. The first geothermal power plant was built in 1911 in Larderello, Italy. Geothermal energy is a result of the continuous radioactive decay of unstable elements beneath the earth's surface and gravitational energy associated with the earth's mass. The radioactive decay and gravitational energy produce heat that makes its way to the surface of the earth, often in the form of hot water or steam.

Another innovative way humans have found to harness energy for use beyond basic survival is through what are called biofuels. Biofuels are plant materials and animal waste used as fuel. For example, ethanol is a plant-based fuel used more and more commonly in vehicles, usually in conjunction with petroleum based fuels.

Although humans have found many different sources of energy to power their endeavors, the fossil fuel category remains the primary source by a wide margin. The three primary fossil fuel sources are coal, oil and natural gas. Oil has been the major fuel supply for industrialized society since the middle of the 20th century and provides more of the energy used by humans than any other source. Coal is second on this list followed closely by natural gas. Together they accounted for more than 85% of the world's energy use in 2004.

Industrialization and the rise in access to energy resources have taken place at very disparate rates in different countries around the world. For example, as of 2006, there were 1.6 billion people on earth with no access to electricity.[5]

As with any human endeavor, the harnessing of energy resources and the production of electricity has and will have impacts and consequences, both good and bad. Awareness of the energy used to grow, process, package and transport food, or the energy used to treat water supplies and waste water is important if society is to minimize waste and maximize efficiency. These are just a few examples of the many energy issues that people can become informed on.

Human society has, and will continue to develop rules and regulations to help minimize negative consequences. As new information comes to light and new technologies are developed, energy policy is reevaluated. Individuals and communities will have to make decisions. This guide outlines the understandings necessary for these decisions to be informed.

[5] International Energy Agency, World Energy Outlook, 2006