Alternative Energy Science

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Fall semester, 3 weekly lecture hours, 3 Credits,

Abstract

Modern society relies on stable, readily available energy supplies. Renewable energy is an increasingly important component of the new energy mix. The course covers history, utilization and storage for renewable technologies such as wind, solar, biomass, fuel cells and hybrid systems. The course also touches upon the environmental consequences of energy conversion and how renewable energy can reduce air pollution and global climate change.

Course Objectives and goals

I. Understand the utilization and storage for renewable technologies such as wind, solar, biomass, fuel cells and hybrid systems and for more conventional fossil fuel-based technologies.

II. Understand the environmental consequences of energy conversion and how renewable energy can reduce air pollution and global climate change.

III. Understand and evaluate the regional environmental problems and the role of the renewable energy in solving these problems.

Course structure

This course will focus on new developments in renewable energy technologies. There will be 13 course sessions of 3-hrs. each. The program is based on lectures, site visits, home works and discussion periods.

Grading

The final grade will be based on classroom participation (20%), midterm exam (20%) final exam (40%) and a home works (20%).

Course outline

Lesson 1. Introduction to energy basics: Energy - where to get it from, how to use it efficiently, and how to reduce negative environmental impacts from its production, conversion, distribution and use**.**

Readings: Boyle, G., Renewable Energy: Power for Sustainable Future, Oxford University Press Inc. New York, 2004. Chapter 1.

Lesson 2. World Energy and world related green gas emissions

This lecture will cover the both traditional and renewable energy sources and the green gas emissions generated from the use of these energy sources in the world and the region.

Readings: Tester, J. W., E. M. Drake, M. W. Golay, M. J. Driscoll, and W. A. Peters. Sustainable Energy: Choosing Among Options. Cambridge, MA: MIT Press, 2005. Chapter 2.

Lesson 3. Renewable Energy

This unit will cover an introduction of the key renewable energy sources for sustainable energy systems. The history of each energy source will also be covered.

Readings: Tester, J. W., E. M. Drake, M. W. Golay, M. J. Driscoll, and W. A. Peters. Sustainable Energy: Choosing Among Options. Cambridge, MA: MIT Press, 2005. Chapter 9.

Lesson 4. Biomass

This lecture will review the use of agricultural crops and biomass wastes in the production of alternative fuels.

Readings: Tester, J. W., E. M. Drake, M. W. Golay, M. J. Driscoll, and W. A. Peters. Sustainable Energy: Choosing Among Options. Cambridge, MA: MIT Press, 2005. Chapter 10.

Lesson 5. Wind

This lecture will outline the principles of wind turbine and; will review the process of electricity generation and supply to the grid (wind farms).

Readings: Tester, J. W., E. M. Drake, M. W. Golay, M. J. Driscoll, and W. A. Peters. Sustainable Energy: Choosing Among Options. Cambridge, MA: MIT Press, 2005. Chapter 15.

Lesson 6. Geothermal

This lecture will cover the uses of geothermal energy and the geothermal power plants.

Readings: Tester, J. W., E. M. Drake, M. W. Golay, M. J. Driscoll, and W. A. Peters. Sustainable Energy: Choosing Among Options. Cambridge, MA: MIT Press, 2005. Chapter 11.

Lesson 7. Solar energy and Photovoltaics

This lecture will discuss the need of solar energy in the world and the region**.** Also

will examines the basics of converting sunlight into electricity; the behavior of solar cells; cell properties; system components; applications; grid connection; and applications. Experimental work will be carried out at the alpha site where there are operating PV systems.

Readings: Boyle, G., Renewable Energy: Power for Sustainable Future, Oxford University Press Inc. New York, 2004. Chapter 3.

Tester, J. W., E. M. Drake, M. W. Golay, M. J. Driscoll, and W. A. Peters. *Sustainable Energy: Choosing Among Options*. Cambridge, MA: MIT Press, 2005. Chapter 13.

Lesson 8. Solar energy: solar thermal: This component reviews the technologies and applications of solar thermal energy.

Readings: Boyle, G., Renewable Energy: Power for Sustainable Future, Oxford University Press Inc. New York, 2004. Chapter 2.

Lesson 9. Energy Conversion in Organisms

Basic concepts on plants as terrestrial organisms, and alga as aquatic organisms.

Basic concepts on photosynthesis- conversion of light energy to chemical energy.

Productivities of various plants/alga, conversion ratio of solar energy.

Plants/alga as a source for energy- advantages and weaknesses of each.

The 3 main components of the cell and their energetic value.

What are the different sources for biofuels, and their different products.

Readings: Julia Farber Renewable energy policy project. 2004.

http://www.repp.org/bioenergy/index.html

Lesson 10. Bioenergy

Energy plants: examples of uses: Sugar cane, Yatrofa, Sugar beet, sweet sorghum and various grasses,

Alga: examples of uses: biodiesel from power plants and cement factories, biomass fermentation. Different bioreactors.

Biodiesel: procession and final product. Advantages and weaknesses.

Ethanol/methane: procession and final product. Advantages and weaknesses.

Whole biomass: procession and final product. Combustion and degradation to sugars. Advantages and weaknesses.

Economic considerations.

Readings: Julia Farber Renewable energy policy project. 2004.

http://www.repp.org/bioenergy/index.html

Lesson 11. Solar Fuels and Solar energy in Israel: This lecture will cover the technologies of producing solar fuels. The second part of the lecture will focus on the Israeli technologies in solar applications and the research institutes in the region.

Readings: J. Solar Energy Engineering 126 (3), 2004.

C. Wieckert, C., Frommherz, U., Kräupl, S., Guillot, E., Olalde, G., Epstein, M., Santén, S., Osinga, T. and Steinfeld A. 2007. A 300 kW Solar Chemical Pilot Plant for the Carbothermic Production of Zinc. J. Sol. Energy Eng. 129. Pp. 190.

Lesson 12. Field trip to the regional institutions or power plants.

Lesson 13. Energy storage, Fuel cells and hydrogen: this lecture will cover the energy storage technologies, the production and storage methods of hydrogen and the principles and applications of the fuel cells.

Readings: Tester, J. W., E. M. Drake, M. W. Golay, M. J. Driscoll, and W. A. Peters. Sustainable Energy: Choosing Among Options. Cambridge, MA: MIT Press, 2005. Chapter 16.

Recommended readings

1. International Energy Agency. Worldwide Trends in Energy Use and Efficiency- *Key Insights from IEA Indicator Analysis* 2008.
2. Twiddel J. and Weir, T., 2006, Renewable Energy Resources. Franchis & Tylor, NY, USA, Chap. 1.
3. Campbell, K.M. and Price, J., 2008, The Global Politics of Energy. THE Aspen Institute, Washington DC, USA. Chap.1 and 6.

Other recommended readings will be provided during the course