GeoSci 344: Sustainable and Fossil Energy: Options and Consequences

SYLLABUS: Summer Term 2009, University of Michigan Rocky Mountain Field Station
Professors: Joel Blum and Rodney Ewing

Prerequisites: At least one previous course in Physical Sciences or Engineering and permission of instructor.

Credits: 3 Natural Science

Goals: Students will obtain an understanding of sustainable and fossil energy options and technologies and the environmental consequences of various energy choices. They will gain hands-on experience with alternate energy production and monitoring, as well as gaining experience investigating energy use and conservation strategies using the Camp Davis field station as a model system.

Evaluation: The course will include two mid-term exams (15 points each), four group projects (10 points each), journal entries (20 points) and participation (10%).

Course Overview:

We are exposed on a daily basis to conflicting views on the options and consequences of various forms of energy production. Should the United States implement a "Manhattan Project" type of effort in alternate energy as discussed in a recent Presidential Debate? Do we have the technology for home owners to economically go off the grid and generate their own power? Does "Clean Coal" live up to its name? Is nuclear power worth the environmental cost? These are just a few of the questions circulating though the popular media, and it is important for students to learn more about these topics to prepare themselves for transitions in energy production that will be shaping their future world.

This new course will be taught at the University of Michigan's Camp Davis Rocky Mountain Field Station in Jackson Hole, Wyoming. The facility is situated near hydroelectric generators, wind farms, solar arrays, a nuclear reactor, gas fields, coal mines, uranium mines, geothermal areas and oil fields. The course will integrate lectures and laboratory exercises with visitations to energy-related facilities in the Rocky Mountain Region. Students will benefit from seeing first-hand the engineering requirements and the environmental impacts of a wide range of types of energy production. Discussions will be held with individuals who work in these facilities and grapple with the complex issues related to energy production.

Students will also gain a deeper understanding of energy through hands-on experiments using alternate energy systems that will be established at Camp Davis, and which will include a combination of solar, wind and hydroelectric generation. We will use Camp Davis as a small experimental "city" where energy and resource production and use can be monitored and manipulated by students. Working in small groups students will design experiments, collect data, and draw conclusions about the effectiveness of various alternate energy production technologies, and also about strategies for reducing energy use in this microcosm.

General Course Expectations:

This course is a total emersion educational experience and during the course students are expected to be fully focused on course activities. We will set a reasonable pace for the course, but students should be prepared to spend many evenings in class activities and be aware that there will be only two free days. Wyoming is a large state and we will spend a considerable amount of time driving from site to site. As a result we will

have some long days when we are traveling. Students are expected to keep journals and make entries at all sites discussed by the class.

Lectures
Lecture 1: Review of the basic principles of energy generation, transfer and storage.
Lecture 2: Review of the primary sources and end uses of energy (transportation, commercial, residential)
Lecture 3: Fossil fuels and the global carbon cycle.
Lecture 4: Nuclear energy and the nuclear fuel cycle.
Lecture 5: Hydroelectric power.
Lecture 6: Solar photovoltaics.
Lecture 7: Solar and geothermal heat production.
Lecture 8: Wind power.

Projects:
Project 1: Developing an energy systems model for the Camp Davis facility.
Project 2: Monitoring energy production and usage at the Camp Davis facility.
Project 3: Experiments with the efficiency of alternate energy from solar, wind, geothermal and micro-hydroelectric.
Project 4: Estimating soil and forest carbon storage potential.

Reports:
Report 1. Based on knowledge acquired in this course develop a briefing paper for either the State of Wyoming or the Federal Government providing advice on long term energy policy. Working in groups of 4 you will represent one industry NGO of Government agency as assigned.
Report 2. Throughout the 21 day course keep track of energy usage and sources by the class and compile into a final report

Site Visits:
Dept of Energy Idaho National Laboratory
Hydroelectric Dam and power plant
Gas field
Coal mine
Uranium mine
Geothermal areas
Solar photovoltaic Array
Wind energy project
Oil Refinery
Coal fired power plant

Readings
Energy: A Beginner's Guide, Smil
The Guide to Renewable Energy, Chiras
Energy: Its Use and the Environment, Hinrichs and Kleinbach