Course Outline ENG EK 546 Assessment of Sustainable Energy Technologies:
Fall 2010 (M/W 11-12:30) Professor Michael Gevelber, Mechanical Engineering

Critical to launching new energy ventures and implementing new energy policies is developing an understanding of how technically feasible the proposed project/technology is in meeting economic, environmental, and end-use requirements. This course will provide students with the background needed to asses the potential for energy efficiency and effectiveness of different technologies, the related economics, as well as identify the key technical risks in emerging technologies. Examples will be drawn from a variety of emerging technologies such as solar photovoltaics, fuel cells , advanced transportation technology, as well as conservation options such as motors, cogeneration, building automation and HVAC. This course will also address evaluating the life cycle implications of emerging technologies, including manufacturing issues, end-of life, as well as estimating performance.

Prerequisites: Phys 105 or Chem 101 or ES 105 or equiv, Calculus (MA 121 or equiv),

Textbook: Sustainabile Energy, MIT Press, 2005, J.W. Tester et. al.
http://www.withouthotair.com/download.html

Topics:
a) Energy physics fundamentals: efficiency & availability for electrical, mechanical, & electrochemical systems (2 wks)
b) Supply and demand issues: major sectors and critical requirements (1 wk)
c) Efficiency: analysis of supply and end-use performance issues (1.5 wk)
d) Manufacturing requirements & materials issues for new technologies (1.5 wk)
e) Technology development: feasibilty, cost, risk (1.5 wk)
Environmental impact: emissions, fuels & trade-offs between different waste streams (1 wk)
f) Full life cycle analysis (1 wk)
g) Technology Development Cases : solar, batteries, fuel cells, micro-cogeneration (1.5 wk)
h) Conservation Cases: : building automation, building energy efficiency (1 wk)
i) Manufacturing Cases: solar (1.s wk)

Requirements:

Students will pursue a semester long project and willpresent an oral and written report on a specific energy technology, analyzing the above issues. Project teams will be comprised a mix of ENG, SMG and CAS students. In addition, there will be a mid term exam that covers energy technology fundamentals and application requirements. Mid term will include both an inclass exam (tentatively 11/3) and take home (tentatively due 11/8).

Approximately 6 to 8 homework assignments related to the key lecture topics will be assigned throughout the course. While students make discuss these assigments with others, their handed in work should be their own write up and analysis.

Project:

Students will select a project to conduct, that addresses the technology issues, economics, and R&D development issues in an area related to emerging energy supply, use, and efficiency technology. For example, they might study the issues related to developing thin film PV systems, building HVAC automation systems, automotive energy storage systems. All projects will include a final written report as well as an oral presentaion. Where applicable, these projects will be team based. Examples from last year include: energy in developing countries, off shore power: wave and wind, hybrid-pev, building energy use: resididential & commercial, industrial waste heat recovery, smart grid.

All groups should be addressing the following issues:
- technology [how it works as well as key tech development issues]
- application & requirements
- economics
- business issues: market, demand, agent issues
- risks
- sustainability analysis

Final Presentations: expected Dec: 1,6, and 8. Mid project presentation: Oct 12 & 13

Goal: Students will be able to evauluate alternative energy technology options in terms of a variety of different dimensions that affect the technologies commercial viability and life-cycle performance/effectiveness. This course seeks to integrate a broad set of engineering, energy, economic, and environmental issues.

Grading: 20% homework, 48% midterms (14% inclass), 32% project (team and individual grades, mid project presentation 6% out of the 32%, so make sure your team is working with me before hand.)

Specific Topics we will touch on:

- Energy analysis basics: 1st & 2nd law, efficiency, combustion, fuel cells, wind turbines examples.

- Efficiency & Conservation: Lovins Negawatt concept and proposals. Building energy use.

- Energy Economics & Cost Analysis: efficiency vs BAU vs supply

- Business issues: Christensen's analysis of the "Innovator's Delemma", Agency issue, various business cases from HBS such as A123, capital requirements for large projects, etc.

- Life Cycle Analysis: use of CMU's EIO/LCA tool and examples for electricity transmission, plastic vs steel gas tank.

-Electricity: demand curves, transmission losses, smart grid.

- Solar cells: options for manufacture of silicon, different concepts, and energy payback analysis.
- Wind: on and off shore

-Advanced turbine power cycles

-Analysis of manufacturing options/issues; ex of silicon mfg.

- Transportation: electrification, battery technology