DRAFT Course Outline ENG EK 546 Assessment of Sustainable Energy Technologies:
fall 2009 (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), or graduate senior standing

Textbook: Sustainabile Energy, MIT Press, 2005, J.W. Tester et. al.

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) Environmental impact: emissions, fuels & trade-offs between different waste streams (1 wk)
d) Efficiency: analysis of supply and end-use performance issues (1.5 wk)
e) Manufacturing requirements & materials issues for new technologies (1.5 wk)
f) Technology development: feasibilty, cost, risk (1.5 wk)
g) Full life cycle analysis (1 wk)
h) Technology Development Cases : solar, batteries, fuel cells, micro-cogeneration (1.5 wk)
i) Conservation Cases: : building automation, building energy efficiency (1 wk)
j) Manufacturing Cases: automobile, solar (1.5 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.

Approximately 6 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.

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.

Specific Topics we will touch on:

- Life Cycle Analysis: examples for electricity transmission, plastic vs steel gas tank.

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

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

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

-Advanced turbine power cycles

-Analysis of manufacturing options/issues.

-Analysis of geothermal building energy options/trade-offs.

- Sustainability overview: Crittenden, Princeton group/Socolow.