Course Syllabus

ISEN 210 – Introduction to Energy Systems for the 21st Century

Northwestern University
Spring 2009

Room: Annenberg Hall, Room G-15

Time: M, W, F 1:00 PM – 1:50 PM

Instructors: Prof. David Dunand and Prof. Mark Ratner
Email: dunand@northwestern.edu; ratner@chem.northwestern.edu
Office hours - TBD

Teaching Assistants:

Christine Dumoulin
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Office Hours: W 2:00 pm – 4:00 pm or by appointment
Location: Tech M128

Christopher Hoyle
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Office Hours: TH 2:00 pm – 4:00 pm or by appointment
Location: Tech L158

Class Notes:
Available on Blackboard the day before class. It is suggested that students print class notes and bring them to class.

Course Summary

This survey course provides an overview of energy issues in the context of climate change and global sustainability. Energy demands for industrial, transportation, housing, and commercial uses are presented, and strategies for demand reduction are discussed. Energy supply is presented from the points of view both of largely mature technologies (fossil and nuclear fuels, hydro power) and of upcoming renewable sources (solar, wind, geothermal, wave and tidal, and biomass or -fuels). Issues associated with energy storage (batteries) and energy transport (smart net) are discussed, with particular emphasis on the hydrogen economy. While this course will address many technical and scientific aspects of energy, no prerequisite technical courses are required from students. Guest lecturers will present other non-technological facets of the energy topic, including social, legal, and economic issues.

Text

Sustainable Energy – without the hot air
Author: David JC MacKay
ISBN: 9780954452933
****An electronic copy of this text is available for download from Blackboard in the Course Documents section.*
Reading assignments should be done prior to the start of class on a given day.

Additional Reading/Viewing:

Energy, Environment and Climate, R. Wolfson, Norton 2008
Fueling our Future, R.L. Evans, Cambridge U. Press, 2007
Sustainable Energy, Choosing among Options, JW Tester et al. MIT Press, 2005

Grading System:

Evaluation will be based on six homework assignments, two quizzes, a Wikipedia entry, and a small-group presentation.

Homework	20%
Quizzes	25%
Wikipedia Entry	10%
Final Report	45%
Paper	20%
Oral Presentation	10%
Slides	10%
Executive Summary	5%

Assignments:

Final Report

A major part of this course will be helping to understand problems at the energy/sustainability frontier in a way that is not probed by any simple exam or test, but rather involves completing a project.

This project will involve groups of students, each containing 4-5 people. Each group will select a topic in the general area of energy and sustainability, which is sufficiently large to be important, and sufficiently focused that the group can attain reasonable mastery of it within a month. The aim of this project is a three-part report: there should be a written report with roughly six pages of prose, analysis, data, figures, and literature citations. There should be a PowerPoint presentation for the class in week nine. And there will be a website presence for each report – we ask for either your PowerPoint conclusion or a different version of your conclusions, to be posted as an executive summary (with all the group names) on the ISEN website.

During the week of April 13th, we will arrange a special evening session of the class during which people can self-select into groups of 4-5 students. At the end of that time, the instructors will be sure that everybody in the class is in a group.

By midnight on April 22nd, each group should submit a single page listing the topic, the people in the group, and a half page overview of what they believe the project will entail. The instructors of the class will either approve or disapprove these submissions by April 24th.

In the ninth week of the year, each group of five will give a PowerPoint presentation to the class. These presentations should take no more than fifteen minutes each. The presentations can be made in PowerPoint, or they can simply be read. The instructors will give the order in which the students should talk during this presentation: in each group, everybody will speak. Because the order will only be determined at the very last minute, everybody in the group should know the presentation well enough to be able to give the whole thing.

Talks will be judged on the basis of understanding, clarity, relevance of the topic, quality of the presentation, and quality of the report.

Course Topics and Schedule:

Week 1 History and Current Status of Energy

March 30: Prof. Ratner: Overview of current energy situation
Reading: MacKay, Ch. 1 (2-21) and Front Matter

April 1: Prof. Ratner: Metrics: Numbers for energy production and use; the first law of thermodynamics
*Reading: MacKay, Ch. 2 (22-28), Ch. I (328-331) Also "first law of thermodynamics" on websites (first page or two only):*http://www.chem1.com/acad/webtext/energetics/CE02.html
http://chemed.chem.purdue.edu/genchem/topicreview/bp/ch21/chemical.php#first
https://chemistry.twu.edu/tutorial/FirstLawSum.html

April 3: Prof. Ratner: Electricity as an example
Reading: MacKay, Ch. 9 (57-59), Ch. 22 (155-156)

Week 2 Energy Demand – Transportation (automotive, aviation); Established low-carbon energy supply

April 6: Prof. Dunand: Hydroelectricity, biomass
Reading: MacKay, Ch. 8 (55-56), Ch. 6 (42-44), Ch. D (283-288)

April 8: Prof. Dunand: Nuclear
Reading: MacKay, Ch. 24 (161-176)

April 10: HOMEWORK 1 DUE
Christine Dumoulin and Chris Hoyle: Fossil Fuels 1
Reading: MacKay, Ch. 23 (157-160)
BP Statistical Review of World Energy 2008 (Executive Summary)
http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2008/STAGING/local_assets/downloads/pdf/statistical_review_of_world_energy_full_review_2008.pdf

Week 3 Fossil Fuels: Production and Use

April 13: Prof. Dunand: Fossil fuel conversion, carbon capture, and sequestration
Reading: Ch 31 (240-249)

April 15: Prof. Dunand: Fossil fuel and transportation
Reading: MacKay, Ch. 3 (29-31), Ch. 5 (35-37), Ch. A (254-262), Ch. C (269-282)

April 17: QUIZ #1 (IN CLASS); HOMEWORK 2 DUE
Prof. Ratner: Fossil fuels 2
Reading: MacKay, Ch. 13 (76-80)

Week 4 Emerging Low-Carbon Energy Supply

April 20: Prof. Dunand: Solar energy
Reading: MacKay, Ch. 6 (38-42)

April 22: Prof. Ratner: Biofuels
Reading: TBA

April 24: HOMEWORK 3 DUE
Prof. Dunand: Wind, waves, geothermal, and tidal energy

Reading: MacKay, Ch. 4 (32-34),Ch. 10 (60-67), Ch. 12 (73-75), Ch. 14 (81-87), Ch. 16 (96-99)

Week 5 Energy Demand: Industry – Conservation, Efficiency, Behaviors
April 27: Guest Speaker: Prof. Kimberly Gray, Civil and Environmental Engineering, Director, Northwestern Institute for Sustainable Practices
"Energy Demand in Cities"
Reading: Ch 11 (68-72) Ch 15 (88-95) Ch 17 (100-102)

April 29: Guest Speaker: Fay Lomax Cook, Director, Institute for Policy Research, NU
"Energy Policy and the Role of Public Opinion"
Reading: Ch 20 (118-124)

May 1: HOMEWORK 4 DUE
Prof. Dunand: Embedded energy in materials, material substitution, recycling
Reading: TBD

Week 6 Energy Demand: The Grid, Buildings
May 4: Guest Speaker: Prof. Lynne Kiesling, Economics
"The Technology and Economics of a Transactive Smart Grid"
Reading: Ch 26 (186-190)

May 6: Guest Speakers:
Roger Frechette, Director in charge of Building Services and Sustainable Engineering, Skidmore, Owings & Merrill LLP
Russell Gilchrist, Chicago Practice Leader, Skidmore, Owings & Merrill LLP
"Towards Zero Energy Buildings"
Reading: Ch 7 (50-54) Ch 21 (140-156) Ch E (289-306)

May 8: TAKE HOME QUIZ #2 DUE
Guest Speakers:
Bill Baker, Structural and Civil Engineering, Skidmore, Owings & Merrill LLP
Brian Lee, Architect and Urban Designer, Skidmore, Owings & Merrill LLP
"Building Integration and Collaboration"
Reading: Ch 25 (177-185)

Week 7 Energy Storage: hydrogen and fuel cells
May 11: Guest Speaker: Prof. Christopher Wolverton, Materials Science and Engineering
"Hydrogen Fuels"
Reading: Ch 26 (191-194) Ch 30 (231-239)

May 13: Guest Speaker: Prof. Harold Kung, Chemical and Biological Engineering , Director of Center for Energy Efficient Transportation
"Batteries and Super-capacitors"
Reading: Ch 20 (124-129, 131-132) Ch 26 (194-201)

May 15: HOMEWORK 5* DUE
Guest Speaker: Prof. Scott Barnett, Materials Science and Engineering
"Fuel Cells"
Reading: Ch 20 (129-131)

Week 8 Energy Economics and Policies: How Does Society Cope with the Issues?
May 18: Guest Speaker: Prof. Klaus Weber, Kellogg Management & Organizations
"Societal and Social Dynamics around Sustainable Energy"
Reading: Ch 18 (103-112)

May 20: Guest Speaker: Prof. Monica Prasad, Sociology
"Adoption of Alternative Energy Technologies"
Reading: Ch 27 (203-213)

May 22: GROUP PROJECT REPORTS DUE
Guest Speaker: Prof. David Dana, Northwestern Law School
"Designing and Implementing a Cap-and-Trade Regime for Carbon"
Reading: Ch 28 (214-221) Ch 29 (222-230)

Week 9 Group Project Reports
May 25: Memorial Day, no class

May 27: Student presentations 1: 3 sessions, with 3 groups of 4-5 students (15 minutes per group)

May 29: HOMEWORK 6* DUE
Student presentations 2: 3 sessions, with 3 groups of 4-5 students (15 minutes per group)

Week 10 Reading Week
June 1: Field Trip, Location TBD

June 3: Reading period

June 5: Reading period

*HOMEWORK 5 and 6 are summaries of talks on Energy given at NU, and can be turned in at any time during the quarter.