SYLLABUS - Global Energy Sources, Uses and Issues – CSxx – Fall 2011

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THIS SEMINAR IS BEING RE-FOCUSED PER STUDENT INPUT TO MAINTAIN THE OVERVIEW LECTURE STRUCTURE, BUT TO STIMULATE BETTER INDIVIDUAL READING/STUDY IN AREAS OF INDIVIDUAL INTEREST

Review and analysis of major energy supply and demand issues, behaviors and choices, with critical reading and comment on competing views of fossil, alternative and renewable fuels availability and usage, and active observation of energy consumption behavior in the Yale environment.

Energy plays as critical a role in the life of every Yale student as the blood and oxygen that feed the cells or the dollars that pay for tuition and books. The study of energy challenges and issues requires an interdisciplinary approach that includes the fields of biology, chemistry, demographics, engineering, economics, environmental studies, geography, geology, history, law, medicine, physics, political science, psychology and sociology among relevant fields of study. This seminar, is intended to give an initial but critical insight into the extraordinary physical and economic infrastructure through which energy resources are obtained, transformed and used, and to introduce the student to critical observation and thinking in the consideration of energy-related challenges and responses, particularly in the domestic arena.

This course has two goals. First, it is structured to convey the broad spectrum of technical, economic, political and cultural issues arising from the tensions among rapidly increasing global demand for energy, the increased difficulty and expense of finding, producing and delivering the fossil fuels that fire energy consumption (and associated adverse impacts on the environment), and the challenges and controversies surrounding proposed solutions to the problems, especially in the United States. The course surveys the availability and uses of natural energy resources, the complex global infrastructure (from well and mine to refinery and power plant to transmission and pipe lines) required to make energy forms available for end use, and the interplay of fuel types with their most common and critical uses. The subject matter also presents some of the leading proposals for addressing and resolving perceived challenges in the domestic market. The seminar is of necessity very broad in scope, and energy-related issues that are covered elsewhere in the Yale curriculum, such as global warming, will not be addressed in detail.

Second, this course seeks to engage the student in the evaluation of contemporary energy theory and in the informed observation and criticism of ambient energy usage. Students will analyze and critique opposing theories of energy scarcity, and weigh the merits of major energy alternatives, such as coal v. nuclear v. wind/solar, as well as the dynamics and efficacies of conservation and substitution initiatives. Out of class exercises will task the student to become an observer of and reporter on inefficient energy
use in the Yale community. Readings and assignments are intended to develop an understanding of the interplay of elements that will enhance the student’s knowledge of the issues and ability to make informed determinations regarding energy usage and consumption choices. There will be at least one field trip to an operating power plant.

Mid-term (7-8 pages) and final (13-15 pages) papers will be required, in which the student may either analyze competing energy application practices or proposals, or the pros and cons of a particular existing or proposed energy application. All paper topics must be discussed with and approved by me beforehand. Each class member will also be required to submit three bi-weekly reports of 200 words or more on one or more aspects of specific ongoing excessive or inefficient energy use observed on the Yale campus, with a recommendation for improving such usage. These reports will be graded based upon insight novelty, proposed solution practicality and clarity of expression. All submissions are due by hand delivery and email (to teweil@mac.com) on the due date.

The only prerequisites for this course are intense interest and an inquiring mind. While we will address certain technical issues that arise in this context, no scientific or engineering background is required. Within the constraints imposed by the college seminar selection process, I hope to be able to create some “areas of study” student diversity in the classroom; the exchange of knowledge and opinions among students from different relevant majors can be one of the most valuable and enjoyable aspects of this seminar. A desirable class composition might include, inter alia, architecture, economics, engineering, environmental and political science majors.

Grades will be weighted as follows: classroom attendance and participation 25%; three observation reports 6% each; mid-term paper 21%; final paper 36%.

**Week 1**

*Material to be covered:* Brief history of energy sources and uses; global overview of fossil fuel energy sources and uses; review of principal domestic energy extraction / production, conversion, distribution and consumption streams, and industrial, commercial and residential applications / uses.

*No readings;* handout.

**Week 2**

*Material to be covered:* Readings and the political, economic and environmental impacts of global and domestic energy infrastructure (part one): technical, political, economic and environmental issues relating to the discovery and production of oil and gas; critical survey of controversies regarding remaining conventional fossil fuel reserves, including “Hubbert’s Peak” theory, review of Shell Oil’s reserve restatements, and discussion of continental U.S. offshore and North Slope oil and gas exploration and production issues.

*Readings:* Chapters to be assigned from Vaclav Smil, *Energy at the Crossroads: Global Perspectives and Uncertainties*; handout.

**Week 3**

*Material to be covered:* Readings and the political, economic and environmental impacts of global and domestic energy infrastructure (part two): the development, permitting,
financing, construction, ownership and operation of (a) oil, gas (including LNG) and coal extraction, crude transportation, refining, product transportation, storage and distribution facilities and (b) central and major supplemental power generation, transmission and distribution facilities, and power grid operation; brief case studies on the Enron/GE/Bechtel Dabhol (India) liquid fuel/LNG power generation and Occidental Petroleum/Conoco Ingleside (Texas) natural gas cogeneration projects; issues relating to power plant air emissions.

Readings: Chapters to be assigned from Vaclav Smil, *Energy at the Crossroads: Global Perspectives and Uncertainties*; handout.

Week 4

Material to be covered: Readings and energy industry regulation: federal, state and local regulation, taxation and economic support of oil, natural gas, coal and power generation and related (pipelines, shipping, storage) enterprises; Congressional efforts to regulate the energy industry and stimulate energy security/independence, energy conservation and alternative energy source development; consideration of the impact of the Public Utility Regulatory Policy Act of 1978 (and resulting deregulation) and subsequent federal energy legislation.

Readings: Chapters to be assigned from Richard Heinberg, *Power Down: Options and Actions for a Post-Carbon World*; handout.

Week 5 - First observation report due (approx. 250 words)

Material to be covered: Readings and the political, economic and environmental impacts of global and domestic energy infrastructure (part three): the development, permitting, financing, construction, fueling and operation of domestic alternative power generation facilities; case studies on the NISCO Lake Charles (Louisiana) petroleum coke, Energy America North Branch (West Virginia) waste coal and Exxon/TOSCO Western Slope (Colorado) shale oil projects.

Readings: Chapters to be assigned from Richard Heinberg, *Power Down: Options and Actions for a Post-Carbon World*; handout.

Week 6

Material to be covered: readings and alternative fuels and power generation and usage (part one): Issues relating to the introduction into the economy and energy infrastructure of biofuels (corn and cellulosic ethanol, agri-waste (crop cuttings and animal waste gas), wood, municipal waste (garbage-to-electricity and landfill methane) and waste oils); the introduction into the economy and energy infrastructure of substrate hydrocarbon-based fossil fuel alternatives (enhanced oil recovery techniques, peat, tar sands, coal bed methane and oil shale) and off-grid, mobile (barge mounted) and backup power generation systems.

Readings: Chapters to be assigned from Peter W. Huber and Mark P. Mills, *The Bottomless Well: The Twilight of Fuel, the Virtue of Waste, and Why We Will Never Run Out of Energy*; handout.
Week 7 – Mid-term paper due (7-8 pages)

Material to be covered: Readings and alternative fuels and power generation and usage (part two): Issues relating to the introduction into the economy and energy infrastructure of geothermal, water (tidal and gravity-driven mechanical and electric) and solar (thermal and electric) generated energy; critical consideration of competing theories of the potential impact of solar power, and distributed solar generation and availability issues.

Readings: None

Week 8

Material to be covered: readings and alternative fuels and power generation and usage (part three): Issues relating to the introduction into the economy and energy infrastructure of wind energy power generation, including NIMBY and distributed generation and availability issues; case study of Goldman Sachs purchase and sale of wind generation assets.

Readings: Chapters to be assigned from Peter W. Huber and Mark P. Mills, The Bottomless Well: The Twilight of Fuel, the Virtue of Waste, and Why We Will Never Run Out of Energy; handout.

Week 9 – Second observation report due (approx. 250 words)

Material to be covered: Readings and coal and nuclear power generation: pros and cons; a review of industry successes, failures and challenges; coal plant emissions controls and carbon sequestration; plant and regional safety issues, including accidents and security challenges; the French nuclear model; domestic economic, regulatory and political issues (local opposition and waste disposal).

Readings: Chapters to be assigned from Jeff Goodell, Big Coal: The Dirty Secret Behind America's Energy Future and David Mackay, Sustainable Energy - without the hot air; handout.

Week 10

Material to be covered: Readings and coal and nuclear power generation (cont’d): pros and cons; a review of industry successes, failures and challenges; coal plant emissions controls and carbon sequestration; plant and regional safety issues, including accidents and security challenges; the French nuclear model; domestic economic, regulatory and political issues (local opposition and waste disposal); special consideration of lessons learned from the current earthquake and tsunami-triggered problems at the Fukushima Daiichi Nuclear Power Station in Japan.

Readings: Chapters to be assigned from Jeff Goodell, Big Coal: The Dirty Secret Behind America's Energy Future and David Mackay, Sustainable Energy - without the hot air; handout.
Week 11 – Third observation report due (approx. 250 words)

*Material to be covered:* Readings and coal and nuclear power generation (cont’d): pros and cons; a review of industry successes, failures and challenges; coal plant emissions controls and carbon sequestration; plant and regional safety issues, including accidents and security challenges; the French nuclear model; domestic economic, regulatory and political issues (local opposition and waste disposal); continued discussion of the Fukushima Daiichi incident.

*Readings:* Chapters to be assigned from Jeff Goodell, *Big Coal: The Dirty Secret Behind America’s Energy Future* and David Mackay, *Sustainable Energy – without the hot air*; handout.

Week 12

*Material to be covered:* Readings and the energy consumption infrastructure; fuel and appliance efficiency and substitution issues; the natural gas and coal fuel swing and coal-to-gas or –liquid alternatives; challenges to the substitution of energy production, distribution and use infrastructures (fertilizer, petro-chemical feedstock and petroleum coke applications); consideration of substitution in transportation fuels and vehicles (hydrogen cells, natural gas, substitute and supplemental liquid fuels, hybrid technology) and in domestic heating, cooling and lighting (efficiency upgrades, passive solar, solar thermal and power generation, and substrate and ambient air heat pumps).

*Readings:* To be assigned; handout.

Week 13

*Material to be covered:* Demand side management: concepts of and efforts at energy conservation; political, economic and cultural aspects of reducing energy demand by increased efficiency and/or decreased consumption; car and appliance efficiency standards, greenhouse gas emissions, green building codes, utility renewable energy portfolio requirements, and consumer energy tax incentives; time-of-day usage pricing and real-time usage monitoring; case studies of CAFE initiatives, Ameresco shared energy savings model and energy conservation efforts introduced at Yale; review and discussion of class member observations of energy consumption and proposals for additional conservation policies and initiatives at Yale; efforts to motivate personal and collective action to reduce energy demand; impact of rising standards of living and growing populations; consideration of “bottomless well” theory of consumption and availability; review of principal barriers to resolution of energy supply/demand issues; optimism/pessimism poll and farewell.

*Readings:* None

Final paper due at close of reading period (13-15 pages)

*Readings* (hb – hardback; pb – paperback)


