

Energy Generation and Environmental Impact -- Fall 2009

WEEKLY SYLLABUS

Required readings noted in brackets, listing chapters or pages from the textbook (Wolfson), selected articles and papers. See the Reading List.

Week 1 (Sept 9). **The Earth and Energy:** Course overview. Energy, population, economy and the climate link. [*Wolfson Chapters 1 & 2*]

Week 2 (Sept 14 & 16). **Energy and Work:** Atoms and molecules. Fundamental forces. What is energy? Measuring energy and power. Energy transformation and indestructibility (first law of thermodynamics). [*Wolfson Ch. 3 pp. 37-40, 49-65; plus two papers: "Atoms in Motion" and "What is Energy?" pp. 1-6*]

Week 3 (Sept 21 & 23). **Electricity and Heat:** Electromagnetism. Thermal energy and temperature. Heat transfer: conduction, convection, radiation. [*Wolfson Ch. 3 pp. 41-48 & Ch. 4 pp. 68-87; and "What is Energy?" pp. 7-11*]

Week 4 (Sept 28 & 30). **Energy and Entropy.** Heat engines and heat pumps, refrigerators Entropy: quality and degradation of energy (second law of thermodynamics). [*Wolfson Ch. 4 pp. 87-101, Ch. 8 pp. 238-242; and "What is Energy?" pp. 12-15*]

Week 5 (Oct 5 & 7). **Fossil Fuels:** Origin, energy content, resources and reserves of fossil fuels. [*Wolfson Ch. 5*]

Week 6a (Monday, Oct 12). **FIRST MIDTERM**

Week 6b (Oct 14) **Impacts of Fossil Fuels:** Carbon dioxide, air pollution, surface coal mining. [*Wolfson Ch. 6*]

Week 7 (Oct 19 & 21). **Nuclear Energy:** Atomic structure, nuclear fission, uranium and plutonium, reactor design, nuclear waste and radiation, nuclear fusion. [*Wolfson Ch. 7 and Ch. 11 pp. 342-351*]

Week 8 (Oct 26 & 28). **Direct Solar Energy:** Solar resource, passive and active solar heating, solar thermal concentrators, photovoltaic panels. [*Wolfson Ch. 9*]

Week 9 (Nov 2 & 4). **Indirect Solar Energy:** Hydroelectric power, wind power, and biofuels. Resources and environmental impacts. [*Wolfson Ch. 10*]

Week 10 (Nov 9 & 11). **Geothermal, Tidal Energy, Hydrogen:** Geothermal resources, technology and environmental impact; tides and tidal power; hydrogen as an energy currency. [*Wolfson Ch 8 and Ch 11 pp. 332-342*]

Week 11a (Monday, Nov 16). **SECOND MIDTERM**

Week 11b (Nov 18). **Climate and Greenhouse Effect:** Climate and weather, equilibrium temperatures, the greenhouse effect, planetary “experiments”. [*Wolfson Ch. 12 but skip pp. 362-366; read article by Hansen*]

Week 12 (Nov 23 & 25). **Climate Change and Climate Forcing:** Natural and anthropogenic climate change. Paleoclimate record. Carbon cycle. Climate forcing and feedback. [*Wolfson Ch. 13*]

Week 13 (Nov 30 & Dec 2). **Global Warming and Projections:** Evidence for current global warming of the atmosphere, oceans and ground. Climate models and emission scenarios. Impacts of projected changes. [*Wolfson Ch. 14 & 15*]

Week 14 (Dec 7 & 9). **Energy and Climate: Breaking the Link:** Renewable energy sources, energy efficiency, climate engineering, carbon capture and sequestration. [*Wolfson Ch. 16; Lovins article*]

Week 15 (Dec 14): **Social and Economic Implications:** Economics and the laws of physics. Quality of life versus quantity of consumption on a finite planet.

FINAL EXAM (Monday, Dec 21)

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READING LIST

✓ Required Textbook

Richard Wolfson. 2008. *Energy, Environment and Climate*. Norton.

✓ Required Articles and Essays (posted on Blackboard)

Richard Feynman. 1963. Atoms in motion. This is an adaptation for our course from Feynman's celebrated *Lectures on Physics*, Vol. 1.

James Hansen. 2004. Defusing the global warming time bomb. *Scientific American*, March pp 68-77.

Amory Lovins. 2005. More profit with less carbon. *Scientific American*, September pp 74-82.

Steven Soter. 2009. What is energy?

Recommended Books (on reserve shelf of Bobst Library)

Roger Hinrichs & Merlin Kleinbach. 2006. *Energy: Its Use and the Environment*. Thompson/Brooks/Cole. [A straightforward introduction to energy basics]

David JC MacKay. 2009. *Sustainable Energy – Without the Hot Air*. UIT. [A superb manual for evaluating sustainable energy solutions, by a Cambridge professor of physics. Entire text available online at <www.withouthotair.com>]

Vaclav Smil. 2006. *Energy: A Beginner's Guide*. One World. [Handy guide to energy in its many forms – in the natural world, technology and everyday life]

Gabrielle Walker & Sir David King. 2009. *The Hot Topic: What We Can Do About Global Warming*. Harcourt. [A fine discussion of the science, economics and politics of climate change. David King was Chief Scientist of the UK]

Useful Websites

Wikipedia: Global warming

Wikipedia: Mitigation of global warming

Wikipedia: Renewable energy