

ENVS 4100: Energy Science and Technology
Course Outline

5 June 2008
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ENVS 4100: Energy Science and Technology

- **Are we really running out of oil?**
- **What are the risks – and benefits – of nuclear power?**
- **Can solar and wind provide the electricity we need?**
- **What's a “negawatt”?**
- **Can technology solve the climate problem?**

These and other energy-related questions will be covered in a new course: ENVS 4100, Energy Science and Technology. This course will provide an understanding of the basics of energy science and technologies. We'll start with energy concepts (such as power, resources, and carriers), and then move on to a closer look at how we produce, transform, and consume energy in the U.S. We'll explore how energy use contributes to environmental challenges, notably climate change. And we'll assess alternatives, including renewables and energy efficiency, to better understand their potentials and limitations.

No technical background is required. This course is open to all students. There are no prerequisites, however basic algebra skills are necessary.

Course requirements: This course will have weekly readings – some from the course text, and some from additional articles and papers. There will be weekly assignments, which will include problem sets and short papers. There will be a midterm and a final exam.

Course meets Tuesdays and Thursdays, 3:30-4:45pm; and is also offered online.

Course text: Ristinen and Kraushaar, *Energy and the Environment*, 2nd edition (2006), Wiley.

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Week 1: The big picture: Energy production, conversion, and use

Historical trends in energy consumption and production
Snapshot of energy use: World and U.S.
Problems and Solutions

Week 2: Language and tools for energy analysis

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Scientific notation, powers of ten, exponential growth

Energy units and conversions:

SI units and commonly used U.S. units for each energy source

Energy vs. power -- units and concepts

Energy sources and carriers: definitions and examples

Week 3: Fossil and nuclear energy resources

Oil, Coal, Natural Gas, Uranium: Where, how much, rates of use, reserves

The peak oil controversy

New sources: tar sands, oil shale

Location and potential

Extraction and conversion techniques

Environmental and climate impacts

Week 4: Energy extraction and transportation

Technologies and processes: mining, drilling, extraction, and transport to site of use

Links to environmental issues: mining wastes, oil spills

Weeks 5 and 6: Energy conversion/electricity generation

Fossil-fired power plants

Thermodynamic principles and limits

How today's plants work

Environmental effects:

Air emissions, including CO₂

Pollution control techniques

New technologies:

IGCC, carbon capture and sequestration

Cost and performance

Nuclear power plants

How they work: Traditional designs - BWR, PWR

Environmental effects: High-level waste, Accident risks and probabilities

New technologies: Pebble bed reactors, breeder reactors

Case Study: Colorado's new Comanche 3 coal plant

Week 7: Electricity Systems

Grid operations: transmission and distribution

Storage: pumped hydro, CAES, other approaches

Challenges of grid operation

Case study: Boulder's "Smart Grid" project

Weeks 8, 9 and 10: Renewable electricity

Definitions: What is a renewable resource?

Resources: Wind, solar, geothermal, biomass

Technologies for conversion

How they work

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Costs today, and cost reduction potentials
Technical potentials and constraints
Noncost attributes: variability, environmental impacts
Case study: Colorado's 1000 MW of wind

Weeks 11 and 12: Energy use and electric efficiency

End-use Breakdowns and Trends in technical efficiency
The efficiency potential: How much and why it exists
If it's such a good idea...why don't we do more of it?
Case study: CU-Boulder campus' efficiency gains and remaining potential

Weeks 13 and 14: Transportation

System description/historical trends
Projections and implied problems
Technological alternatives
 Public transit
 Alternative fuels
 New vehicle technologies
Case Study: PHEVs

Week 15: Energy futures

Where we are headed
Alternative energy futures: roles for renewables and efficiency
Case study: can technology 'solve' the climate problem?