CEVE / ESCI / ENST 307
ENERGY AND THE ENVIRONMENT
SPRING 2014

Meeting Times and Location:
T/Th 9:25 – 10:40 a.m., Mech Lab 251

Instructor:
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Office Hours:
Wednesdays 1:30-3:30 p.m. Visits at other times are also welcomed, via email request.

Course Description:
Securing sufficient, reliable, and affordable supplies of energy in an environmentally sustainable manner is among the greatest challenges facing society in the 21st century. Appreciating and addressing this complex challenge requires consideration of the various physical, technological, and societal forces that shape energy use and its impact on the environment.

This course will explore the physical principles of energy and how various sectors and fuels impact Earth's environment and climate. We will also examine policies and technologies that could foster more sustainable use of energy resources. The course will include a group project in which teams of students will design business plans for a particular energy source and assess the associated economic, environmental, regulatory, and practical implications.

Course Objectives and Expected Learning Outcomes:
This course aims not only to impart heightened knowledge of energy and its impacts on the environment, but also to build skills in research, analysis, and critical thinking that will catalyze a lifetime of engagement with this complex topic. Among the learning objectives for this course, students completing this course will be able to:

1) Characterize the performance of engines, heat pumps, and power plants
2) Identify key environmental impacts of various energy sources
3) Compute the energy return on investment, overall efficiency, and resource intensity for an energy source
4) Obtain objective, credible data and projections for energy availability, consumption, and impacts, and critically evaluate conflicting estimates
5) Compare and contrast the challenges posed by regional air pollution and global climate change and their relation to energy use
6) Critically assess conflicting evidence regarding energy technologies or policies
7) Design and present a business plan for an energy source, compute its financial and environmental impacts, and identify its practical and regulatory challenges

The course addresses the following ABET student outcomes for the BSCE degree:

(a) an ability to apply knowledge of mathematics, science, and engineering;

(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability;

(d) an ability to function on multidisciplinary teams;

(e) an ability to identify, formulate, and solve engineering problems;

(f) an understanding of professional and ethical responsibility;

(g) an ability to communicate effectively;

(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context;

(i) a recognition of the need for, and an ability to engage in life-long learning;

(j) a knowledge of contemporary issues

Prerequisites:

This course will apply quantitative approaches, scientific principles, and policy analysis to examine energy and the environment. Physics and calculus background at least to the level of PHYS 101 and MATH 101 (or AP equivalents) are required. Please contact the instructor if you have questions regarding your preparation.

Textbook and Readings:

James Fay and Dan Golomb. *Energy and the Environment, Second Edition*. Oxford University Press, 2012.

Additional readings from outside sources will be assigned and made available on the OwlSpace website for the course.

Honor System Policy:

All students are expected to adhere to the Rice Honor Code. Exams will be given under the honor system and must be entirely a student's own work, using only resources that are explicitly authorized for that exam. Homework assignments may be discussed with other students but must be written individually in your own words. To avoid any possibility of plagiarism, all work must be written entirely in the student's own words, citing all references used and explicitly denoting any quotes in quotations.

Disability Statement:

If you have a documented disability that will impact your work in this class, please contact me to discuss your needs. Additionally, you will need to contact the Disability Support Services Office in the Allen Center.

Grading:

Written assignments (~5)	20%
Midterm Exam	20%
Group presentation	15%
Group paper	15%
Final Exam	30%
Attendance and Participation	up to +/- 4 points on final grade

A note on assignments:
There will be fewer assignments than in past years, allowing time for questions that may include short essays and analyses based on data obtained from reliable sources such as government websites or peer-reviewed publications. While there will be some textbook and textbook-style problems to ensure adequate development of abilities for problem-solving calculations, a key aim of this course is to engage students in critical thinking involving both quantitative and qualitative assessment of emerging scientific literature and available data resources. This higher-level thinking is crucial given the rapidly evolving nature of energy and the environment.

All assignments are due by the end of class on the due date unless otherwise stated. Late assignments will incur a penalty of 25 points and will not be accepted after solutions are distributed. Extensions will be granted only by email request describing specific extenuating circumstances.

Exams:
The format of the midterm exam (in-class or take-home) is to be determined, but is expected to occur the week of March 18/20.
The final exam will be take-home, made available on the last day of class, and due at the end of the examination period assigned by the registrar to our class.

Group Projects:
The group projects are a critical component of the course, and will be conducted in groups of three students. Each team will develop a business plan for the profitable and environmentally friendly use of an assigned energy source. Each group will present an oral proposal making the case for and evaluating the impacts of their plan, and a written business plan due on the last day of classes. Details of the group project will be provided later.

Attendance and Participation:
Attendance and participation are crucial to the success of this course. While I hope not to need to formally check attendance, basic expectations are:

- Attendance of all classes, except in extenuating circumstances
- Participation when called upon or when representing a small group in class discussion
- Attend your group's session to prepare for group presentation
- Peer evaluations of the presentations (scoring or voting on each presentation, and detailed evaluation of 2 groups)

Points may be added to the final grade for especially active participation in class and/or office hours, or subtracted for not meeting the basic expectations above.

TENTATIVE SCHEDULE (*subject to change*)

DATE	THEME	TOPIC	TEXTBOOK	OUTSIDE READINGS**
1/14	**Introduction**	The Energy Challenge	Ch. 1; Ch. 2.1-2.6	Watch the movie "Switch" (Owlspace)
1/16 *	**Energy: Physical Principles**	Energy, work, and power; First Law of Thermodynamics	Ch. 3.1-3.4	
1/21		Second Law; Heat transfer and heat engines	Ch. 3.5-3.9	Wolfson textbook excerpt
1/23		Refrigerators and heat pumps; energy processing	Ch. 3.10-3.13	
1/28	**Energy: Sectors**	Electricity and the Electric Sector	Ch. 5.1-5.3; Ch. 6	life-cycle ghg power plants (Weisser)
1/30		Transportation Sector	Ch. 9.1-9.6	CAFE standards (Taking Sides); Plug-in hybrids (EIA)
2/4	**The Environment**	Water & land	Ch. 10.3-10.4	Water/transportation (King); land/ electricity (Fthenakis)
2/6		Air	Ch. 10.1-10.2	Ozone and particulate matter (US EPA)
2/11		Climate	Ch. 11	IPCC summaries
2/13		Climate (cont.)		CO_2 policy options (Pacala)
2/18		Emissions control; carbon capture & storage	Ch. 6.2.10; Ch. 9.7; Ch. 12	Carbon capture (IPCC; Rubin)
2/20	**Comparing Energy Options**	Cost and energy metrics		EROI (Murphy); well-to-wheels (Wang)
2/25		Environmental metrics		Prospect theory (Jain); externalities (Stirling)
2/27	**Policy Responses**	Regulatory and market-based approaches		Articles on emission taxes and trading
3/3 – 3/7		SPRING BREAK		

* Due to hosting a NASA conference on campus January 15-17, Lecture 2 will be provided as a video recording via Owlspace, accompanied by detailed lecture notes. I will also be unavailable for January 15 office hours.

** Outside reading assignments will be made available via the course OwlSpace website. The list of outside readings is tentative and may change as the semester progresses.

DATE	THEME	TOPIC	TEXTBOOK	OUTSIDE READINGS**
3/11	**Non-Renewable Fuels**	Oil and Natural Gas	Ch. 2.7.2-2.7.5; Ch. 4.2-4.3	Peak oil (GAO); oil supply (Kjarstad); Life cycle impacts of natural gas (Burnham)
3/13		Coal and Nuclear	Ch. 2.7.1; 4.5.1; Ch. 7	Future of coal (MIT); article from Nature; Future of nuclear (MIT; Scientific American); Open cycle (Taebi)
3/18 or 20	**Renewable Fuels**	Energy conservation & efficiency; Demand response; Energy storage	Ch. 5.4	Efficiency policies (Geller)
3/18 or 20	**MIDTERM EXAM******			
3/25		Solar and Wind	Ch 8.5-8.6	Comparing alternatives (Jacobson); NREL solar market report; DOE Wind market report
3/27		Biomass energy; Agriculture and food	Ch. 4.4, 4.6, 8.3	Biofuel net impacts (Hill)
4/1		Hydroelectricity, Oceans, and Geothermal	Ch. 8.2, 8.4, 8.7-8.9	Ocean energy (NREL); geothermal (NREL)
4/3		SPRING RECESS		
4/8		Group Presentations***		
4/10		Group Presentations***		
4/15		Group Presentations***		
4/17		Group Presentations***		
4/22		Hydrogen; futuristic options	Ch. 4.7-4.8; Ch. 9.6.3	Hydrogen; futuristic options (Scientific American)
4/24	**Summary**	Summing up the Energy Challenge		** Group paper due **
		FINAL EXAM (take-home)		

** Outside reading assignments will be made available via the course OwlSpace website. The list of outside readings is tentative and may change as the semester progresses.
*** For presentation days, we will likely need to begin class at 9:00 a.m., to accommodate presentations by 4 teams each day. Attendance will be crucial for providing peer discussion and feedback.
**** Date and format TBD, but likely to occur during this week (3/18 or 3/20).