

Phys 131 Physics of Energy

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Course Website: powerdown.physics.unc.edu/Atutor

MWF 10-10:50, Phillips 247

PHYS 131 is a 3 credit lecture linked to 1 credit lab course 131L; budget cuts killed the lab this year but perhaps it will be offered next. Lectures explore how to adapt to declining per capita energy use in the developed world because of constrained fossil fuel supplies and the limited potential of substitutes to fill the gap. Energy textbooks don't take this perspective, so I'll distribute my draft one as we progress. We will find a situation worse than media pronouncements, and that solutions are much more complex than "drill baby drill".

The dawning realization that our daily life is unsustainable and "progress" has stalled on many fronts in the guise of a "global financial crisis" can be a downer. So the course will give you hands-on experience with renewables, discuss career implications, and brainstorm what can be done to alter uninformed but widely held opinions. We will examine our "liquid fuels crisis" as a logical argument, search for flaws and highlight the many uncertainties. We will assess critically and quantitatively which alternative power sources can scale sufficiently to supplement declining supplies of oil and natural gas hence slow the decline of living standards in OECD nations and develop other economies.

To maintain energy-intensive lifestyles of the dwindling pool of profligate energy users, oil prices worldwide will continue to decouple from past assumptions as demand rebalances with the reducing supply. Our dispersed suburban landscape and expensive foreign excursions assume cheap oil and result from elite recognition of our perilous oil supply, respectively. As debt crushes middle class expectations, who will pay for more expensive new energy on a large enough scale to mitigate environmental degradation?

Learning Objectives

This course will guide you to

1. quantify modes of energy generation, its current distribution as electricity and future as hydrogen gas, patterns of its consumption in industrial, commercial and residential structures, transportation, and food production and distribution, both in OECD nations and in the developing world;
2. frame logically and present coherently an unusual but quantitative topic like End of Cheap Oil to skeptical audiences;
3. model possible energy futures using systems dynamics run on your laptop.

These skills will benefit you elsewhere.

Assessment

Bi-weekly **homework** (25% of grade) will quantify physical and engineering issues and master energy units, yet require only a calculator and ability to plot graphs (any spreadsheet). I will be available for hints and techniques. The rest of each assignment will be a several page essay on implications of recent in-class/on-line discussions, readings, or movies. You should plan on an hour of reading/study/homework outside each class.

Homework is due one week after distribution. The rest of the course grade comes from readings/movies discussed in online & in-class discussions and attendance (10%), term paper on mutually agreed upon energy topic (25%), mid-term quiz (15%), and final (25%); all material must be submitted by posted deadlines and must conform to UNC's Student Honor Code. Class attendance is mandatory; to avoid course grade impact, absences need an official medical or sports excuse. There is considerable writing in this course, appropriate because all GC classes require at least 10 written pages beyond exams.

Required Materials

1. *Sustainable Energy —without the hot air* (SE) by D. MacKay is available from amazon for \$30 or free as pdf at www.withouthotair.com. He advocates critical thinking about energy issues, something I endorse in this course!
2. *Out of the Oil Trap: Energy in Transition* is my draft text on energy and peak oil, which will be distributed chapter by chapter as necessary.

Course Website

To distribute material including class movies, I'm using A Tutor, a more flexible alternative to Blackboard/Sakai. I'll use Blackboard only to record your grades. ATutor requires that you register at powerdown.physics.unc.edu/ATutor/registration.php A test email goes to me and I approve your registration for PHYS131, which you enter using the link at top of this sheet. Remember your password!

At powerdown, I'll distribute Windows programs for your CCI computer. Those of you who opted to double their PC price by buying the Mac wrapper must buy/install Parallels+Windows 7 license to run these.¹ You will encounter this issue often at UNC, so solve it now! You'll be asked to bring your laptop to several classes to present reports and to install/test programs. I **will** banish computers used in class for Web surfing, Facebook updating, on-line shopping, etc.

Topic Coverage (readings will be assigned as we progress)

Most topics span 3 classes to give time for reflection and problem solving.

Aug. 24 to end-Sept

Introductions & these Course Policies.

Energy in Rapid Transition. Beforehand read handouts, SE preface + chaps 1-2 + appendix-A (Cars). Assign #1 out

Efficiency of Energy Conversions, Heat Engines, Geothermal Energy. Assign #2 out

Petroleum. Assign #1 in

Natural Gas, Coal, Heavy Oils. Assign #2 in, #1 back

Field trip to campus coal powerplant

Oct

Fossil Fuel Emissions. Assign #3 out, #2 back

Fossil Fuel Use in Agriculture.

Nuclear Power: Today & Tomorrow

Nuclear Waste, Radioactivity & Weapons Proliferation

¹Here is the simplest way to setup your Mac to run Windows programs. 1) buy a Windows license for \$30 from Microsoft at <http://tinyurl.com/3l7rdh5> (This is the official Microsoft site, I just converted the URL to something easy to type.) 2) download the free trial and eventually buy for \$40 the latest VMware Fusion at <http://www.vmware.com/vmwarestore/academicstore.html>

Mid-term quiz mid-Oct (details in class)

Virtual field trip to Harris nuclear power plant?

Discussion of nuclear power issues. Assign #3 in, #4 out

Oct. 21 NO CLASS (Fall Recess)

Visit by Dr. Laurel Miner, UNC graduate and senior assistant to the Undersecretary of Science at US DOE.

Electricity: the Grid and Solar Electric. Assign #3 back

Wind Power, Water Power & Storage. Assign #4 in. Paper draft is due.

Experimenting with renewables

Nov

Powering Transportation: Biofuels, Electricity, & Hydrogen. Assign #4 back, #5 out

Building a Logical Framework for Peak Oil. Assign #5 in

Nov. 23 & 25 NO CLASS (Thanksgiving)

Dec. 7 Our final meeting may be a panel discussion in a role-playing format. Costumes and appropriate mannerisms will be encouraged. Details to come.

Final exam Dec. 10, 8-11 AM