Physics 200 The Physics and Technology of Energy

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Introduction

The word "Energy" conjures up a whole lot of impressions, all the way from recent snipes at or by this year's presidential candidates to a rather well defined definition within the discipline of physics. Mainly for us, Energy will be a commodity that has enormous value and its use has broad implications from the environment, our economy, and our technical future. And there is a lot going on. Energy from wind and the sun have become competitive. We are almost flooded with natural gas and oil (petroleum). The economics of oil are having a major impact on world politics and even terrorism that is dominating the news as I am writing this. Our objective this semester will be to sort out the sources and use of energy in terms availability, consequences, future prospects, and new technologies.

It will be important to keep in mind that nobody has a "lock" on the right ideas. It is perfectly alright to disagree with the book, me, or other students. I like discussion and controversy since that usually brings clarity. Physical laws as they pertain to this subject are rather rigid, facts are just that, but policy – what you do with the facts – are much more open and subject to priorities, ethics, and expectations.

When I first taught this course, societal concern about energy was at low ebb. Gas was cheap as it is now; energy independence was not a concern; and environmental consequences were not on anybody's list of major issues concerning our future and well-being. Since then, prices and other concerns have gone to historic highs. We have now come full circle and after some scares, the cost of gasoline is again low. But, there is a widespread concern about global warming (climate change). Energy policy is certainly on the National agenda with issues like the Keystone pipeline, coal mining, in the news daily. Recently we added a new word to add to our vocabulary "fracking" and the issues around recovery of previously unreachable hydrocarbon resources are becoming a really big deal. Worldwide nuclear power generation plants (along with our local electrical electric companies), have run unto more snags, and the likelihood of using nuclear power has dimmed, for perhaps the next decade or more. I would like to go behind many of these issues to understand the physics and technology that forms the basis of so much of our modern life.

One early goal of this course is to develop an intuitive sense of what energy is – from the physicist's perspective. Along with that intuitive sense, we need to try to understand numbers. Numbers play in important role because the scale of the energy needed to keep our society going is huge. (How much of the nations energy supply does that Exxon supertanker sitting in our own harbor, San Pedro, represent?) Energy is measured in strange units – barrels of oil, tons of coal, cubic meters of gas, megawatt hours of electricity, etc.

There is some interesting and fundamental physics in the understanding about how energy passes through society. Physics says that energy is conserved, so why do we keep needing more energy? Why do we have waste? We will address these questions.

Climate change, clean energy, nuclear energy are examples of what are currently being referred to as "wicked problems" as are "war and peace" poverty, diseases, among others. As in many of society's larger issues, there are no simple answers. In fact, there may not be complete answers. There are instead a lot of choices, some better or "less bad" than others. This theme shows up in the way possible solutions for existing energy problems play out. What looks like a great idea on a small scale may look terrible on a large scale. A technology that seems "clean and green" may have negative consequences that are severe. So if you want a simple answer so that at the end of the day you can say "Now I know the solution" you may be disappointed. But, I

hope you will come to appreciate that simple answers are often false – energy policy as well as most other important questions in life are complex. Sometimes the person with all the answers should be the first person to distrust!

Textbook

We will use *Energy, Its use and the environment* and the authors are Roger A. Hinrichs and Merlin Kleinbach 5th Edition. Please note there are earlier editions and a bargain on an earlier edition is not going to be useful. I have been a bit horrified about the new price around $230, there seems to be plenty of used ones (still 5th edition) that are much more reasonably priced around $90. You might even be able to rent a copy, while I have no experience there. I have been also been looking at the following book that we should find interesting and useful – *Energy for Future Presidents: The Science Behind the Headlines* 1st Edition
by Richard A. Muller. This one is around $12 on Amazon and used books are also available for less. I recommend that you get a copy of both books as soon as possible. The Muller book is mainly a commentary of energy issues, we may well not agree with all of his conclusions – after all this is a "wicked problem." In addition to these sources, I will suggest web sites where you should look for further reading and more up to date information. In some cases, we will want to improve on the coverage of basic physics ideas, and I will supply notes on those points. Please make sure that you can access web sites. If you do not have web access, please see me for assistance.

Clickers

USC has adopted a standard for clickers. I will demonstrate one in class, but we will be using them from the first day. They can be purchased at the Bookstore, and you will need to get one. The good news here is that if you have any other class that needs one, you can use it there as well. You may have a friend who has one and that will be okay, since I register the clickers in class. In addition the Bookstore has promised to buy them back or you can always sell yours to another student who needs one next semester. We will register them starting in the first class and use them starting the second lecture. For the class, we will use the clickers as a way of getting an idea of how you are thinking about issues and to initiate discussions.

Student presentations and capstone project

Throughout the course, questions will come up. Students will be assigned to come up with a short presentation on these questions. Usually (but not necessarily always) your presentation will be a 5 minute Power Point on an intentionally narrow topic. Examples of topics might be: What is the price history for petroleum; How much wind power is being produced in the US this year; How much solar power do we produce; etc. The presentation assignments will be done on a rotating basis with each student responsible for at least one.

We will have a "capstone" project for this course. In many cases, students can elect to expand on their short presentation. There are two types of projects: a term paper or a class presentation. Research is critical to any presentation. I will talk about citing literature during the course. For the moment, the most important thing to do is to arrange a meeting with me to discuss your project ideas. These will be one-on-one meetings where you should be prepared to show some preliminary research.

Important elements of the capstone project:

- Presentation of quantitative information via graphs, tables, and numbers where they have meaning.
- Citations for references cross referenced in a reference section at the end of the paper (bibliography).
- Organization should include an introduction and conclusions based on the information presented.

Project/contest

We will have a solar collector contest in April. I will distribute the rules for a project to design a solar energy collector. The idea is to see who can come up with the best design, but holding the cost low. You might want to start looking at ideas for your solar collector right away.

Exams

There will be a midterm and a final in this class. The in-class exams will all be open book and open notes.

Homework

Homework will be due on Tuesdays. We will have short in-class quizzes based on the homework that will be graded. I will post homework assignments (mostly from Hinrichs and Kleinbach) before the semester starts.

Web access, news group etc.

The course web page is on BlackBoard. You already have access to this web page and should check it for updates, homework solutions, and course materials.

Office hours

I really want to see students during office hours. The office hours are currently on Tuesday and Thursday from 12:00 to 3:00. I will take a poll early in the semester and change those hours if that is needed. If these hours don't work for you, please let me know and we will adjust them. In any case, you can always email me or call me to schedule an appointment. My office hours will be considerably extended for project reviews. If you need to see me at other times, please do not hesitate to email me so that we can arrange a time that will work for both of us.