

Syllabus
Physics 401
Future Energy Technologies
Spring 2009
3 credit hours,; meeting times TBA

Instructor:

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Students:

This course is offered as the *capstone experience* for physics majors, but is open to others - upper level undergraduate or graduate students in various science or engineering departments.

Course introduction:

This three-credit hour course will make the students aware of the new world issues relating to energy and will help to prepare them for careers that may be somehow connected to energy use, supply, and policy. The emphasis of the course will be on the technical underpinnings of the energy choices for the future. An increasing emphasis in the U.S. and in the world is on finding solutions to the problems of supply and use of energy, including decreasing our dependence on oil, finding alternatives to fossil fuels, developing sustainable energy solutions for the future, and controlling the effects of climate change. The timing for this course at the university is very appropriate, as sustainability is increasingly important at UT - construction, energy use, research. The public mostly accepts climate change as real and seems poised to move to new energy solutions that emphasize sustainability. UT enjoys a close relationship with Oak Ridge National Laboratory, which contributes to energy emphases and expertise in many areas. ORNL experts and facilities for tours will be incorporated into this course.

Textbook:

The book to be used is *Sustainable Energy – Choosing Among Options*, by Jefferson W. Tester et al., MIT Press, 2005. This book was developed for an undergraduate course for students of many disciplines at MIT: <http://mitpress.mit.edu/catalog/item/default.asp?ttype=2&tid=10566>
There will be several supplemental books made available to the students for additional resource material:

- *Energy and American Society – Thirteen Myths*, by Benjamin Sovacool and Marilyn Brown, ORNL, 2007
- *Alternative Energy Resources – the Quest for Sustainable Energy*, by Paul Kruger of Stanford University (John Wiley & Sons, 2004).
- *Introduction to Engineering and the Environment*, by Edward S. Rubin and Cliff I. Davidson, McGraw-Hill International Editions: Environmental Engineering Series, 2001

Course requirements:

The grade for the course will be determined by class attendance and participation (20%) and a project (80%). For the project, each student must pick a topic related to the course, write a detailed paper, and make a presentation to the class on that topic. Students must submit two or three potential topics for this project at the end of the first week of the course and then together we will decide on the project for each student by the end of the second week. Each student will be expected to make a short presentation to the class halfway through the semester on the status of their project, and then a full presentation at the end of the semester. All presentation will be Powerpoint based.

Course structure:

This course will have the following components at various levels of detail:

1. Sustainable energy basics - Chapters 1 - 6
2. Fossil fuels - Chapter 7
3. Nuclear power - Chapter 8
4. Renewable energy - Chapter 9
5. Biomass energy - Chapter 10
6. Solar energy - Chapter 13
7. Wind energy - Chapter 15
8. Storage, transportation, and distribution - Chapter 16
9. Transportation - Chapter 18

We will likely pick two sustainable energy options to explore more fully than others. Guest lecturers from ORNL and UT will be used in a few relevant areas of discussion. Tours of ORNL energy-research facilities will be arranged.

Course overview:

The course will focus on the technical underpinnings of various energy options, but will include some discussion of history, policy, and economics of energy use, in addition to the environmental impact of various energy forms. A key consideration is climate change and the associated buildup of carbon dioxide in our atmosphere. Any discussion of future energy sources must include a consideration of their CO₂ emissions and the effect on the climate change problem of the planet.

Textbook
Sustainable Energy – Choosing Among Options
Jefferson W. Tester et al.
MIT Press, 2005

Chapters:

1	Sustainable Energy---The Engine of Sustainable Development	1
2	Estimation and Evaluation of Energy Resources	51
3	Technical Performance: Allowability, Efficiency, Production Rates	87
4	Local, Regional, and Global Environmental Effects of Energy	137
5	Project Economic Evaluation	207
6	Energy Systems and Sustainability Metrics	259
7	Fossil Fuels and Fossil Energy	295
8	Nuclear Power	361
9	Renewable Energy in Context	407
10	Biomass Energy	419
11	Geothermal Energy	453
12	Hydropower	519
13	Solar Energy	543
14	Ocean Waves, Tide, and Thermal Energy Conversion	589
15	Wind Energy	613
16	Storage, Transportation, and Distribution of Energy	647
17	Electric Power Sector	693
18	Transportation Services	727
19	Industrial Energy Usage	761
20	Commercial and Residential Buildings	777
21	Synergistic Complex Systems	797
22	Choosing Among Options	823