EAS 402 and EAS 502: RENEWABLE ENERGY AND ITS IMPACTS: TECHNOLOGY, ECOLOGY, ECONOMICS, SUSTAINABILITY.

.

Instructor: Professor Noam Lior

Spring term 2018

Course Objective

The objective is to introduce students to the major aspects of renewable energy, with its foundations in technology, from a quantitative sustainability viewpoint with its association to economics and impacts on the environment and society. This introduction is intended both for general education and awareness and for preparation for careers related to this field. The course spans from basic principles to applications: A brief review of energy consumption, use, and resources; Environmental impacts, Sustainability and design of sustainable energy systems; Introductory aspects of energy economics and carbon trading; Methods of energy analysis; Electricity generation and distribution system principles; Energy storage; Renewable energy in buildings; Solar, wind, hydroelectric, geothermal, biomass, marine energy; Renewable power generation in space for terrestrial use.

Students interested in specializing in one or two energy topics can do so by choosing them as their course project assignments.

Instructor

Professor Noam Lior (Web page: http://www.seas.upenn.edu/~lior/), has decades of experience in energy research and education, is/was editor of major international scientific energy journals, a frequent invited keynote speaker on energy at international conferences, and faculty member of the Wharton IGEL Advisory Committee, the Lauder Institute Graduate group, and of the Institute of Environmental Science. He is a member of the Club of Rome, and Fellow of the World Academy of Art and Science.

No Prerequisites.

Regardless of prior courses taken, any Penn graduate student, and any Penn undergraduate student of Junior or Senior standing, who are interested in renewable energy and its impacts may take this course. Students taking the course as EAS 502 will have assignments commensurate with graduate standing. Undergraduates taking it must be able to learn and work at graduate student maturity level.

Relation to the course EAS 401/501: Energy and its impacts: technology, ecology, economics, sustainability.

The courses differ in that EAS 401/501 covers all energy aspects while EAS 402/502 focuses specifically on renewable energy in much more depth. Both courses can thus be taken.

Note: This is also an approved "Technology in Business and Society" course. Students interested in the relationships among technology, business, and society may choose to substitute up to two of the required social science and humanities courses with selections from the Technology in Business and Society category. They may not, however, be used as engineering electives.

Course conduct
Homework (30% of grade), term projects (Project 1: 20%, Project 2: 25%), final exam (25%).
The projects, typically done by a team of 2 students, will be chosen by the students from a broad menu of projects given by the Instructor, or can be proposed by the students. The projects include critical reviews, analyses, and minor developments of a certain renewable energy area.
Students taking the course as EAS 402 will have somewhat easier assignments and final exam, commensurate with undergraduate standing.

Maximum enrollment
No limitation.

Offering
Spring 2018 semester, TuTh 6-7:30, 303 Towne

Credit Units
1 credit unit course.

Syllabus (#weeks)
1. Introduction: energy consumption, ways of use, and resources. Sustainability. (1)

2. A very brief review of the most needed energy analysis tools and principles: (2)
    2.1 The basic energy laws: energy conservation, energy quality degradation processes
    2.2 Some basic laws of heat, electricity, biochemistry.
    2.3 Principles of energy economics

3. Ecological and social impact of energy activities (0.5)

4. Energy storage. (0.5)

5. Electricity from renewable energy sources: production, transmission and management. (1)
    5.1 Steam and gas power plants
    5.2 Cogeneration and district heating
    5.3 Electricity transmission
    5.4 Regulation and deregulation

6. Solar Energy (3)

6.1 The solar resource
6.2 Solar collectors
6.3 Solar energy storage
6.4 Low temperature applications: building and service water heating, water desalination
6.5 High temperature applications: solar concentrating systems for power generation
6.6 Photovoltaic energy conversion
6.7 Economics
6.8 Environmental and social impacts

7. Wind energy (1.5)
7.1 The technology
7.2 Economics
7.3 Environmental and social impacts

8. Hydroelectric power (0.5)
8.1 The technology
8.2 Economics
8.3 Environmental and social impacts

9. Geothermal energy (0.75)
9.1 The technology
9.2 Economics
9.3 Environmental and social impacts

10. Biomass energy (1.5)
10.1 Sources and energy content
10.2 Collection
10.3 Conversion technologies to fuels and heat
10.4 Economics
10.5 Environmental and social impacts

11. Marine energy: tides, waves, currents, ocean-thermal. (0.25)
11.1 The technology
11.2 Economics
11.3 Environmental and social impacts

12. Future energy systems, including solar power from space for terrestrial use. (0.5)

Text sources
Instructor's notes and selections from several books, with the principal ones being:

J.W. Tester, E.M. Drake, M.J. Driscoll, M.W. Golay, W.A. Peters, "Sustainable energy", 2d Edition, MIT Press 2012. ISBN 978-0-262-01747-3.
J. Randolph and G.M. Masters, "Energy for Sustainability", Island Press.

and others:

V. Smil : Energy at the Crossroads

B. Sorensen, Renewable Energy, 4th Edition: Physics, Engineering, Environmental Impacts, Economics & Planning, 2010, Academic Press.

Ted Trainer, "Renewable energy can not sustain a consumer society", Springer, 2007.

Other sources to be announced.

The Canvas Course Web site: Use and Support

Information, lectures, assignments, materials and just about everything else related to the course are done via Canvas.