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

Instructor: Professor Noam Lior

Spring term 2020

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 SAS/LPS Master of Environmental Studies program. He is a member of the Club of Rome, Fellow of the World Academy of Art and Science and of the American Society of Mechanical Engineers, and Associate Fellow of the American Institute of Aeronautics and Astronautics.

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.
Attendance in classes is expected.
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 2020 semester, TuTh 6-7:30.

**Credit Units**
1 credit unit course.

**Syllabus (#weeks)**
1. An overview of energy sustainability, resources and use (with emphasis on non-renewables) (2)
2. A very brief review of basic nature laws of energy (thermodynamics, heat transfer, chemical reactions) (1)
3. A very brief intro to scientific sustainability (1)
4. A note on energy conservation, embodied energy, and recycling (0.5)
5. Very brief introduction to energy economics (0.5)
6. Electrical energy and mechanical power generation (1)
7. Electrochemical energy conversion (0.5)
8. Electricity distribution and regulation (0.25)
9. Energy storage (1)
10. Energy and buildings (0.75)
11. Renewable Energy - Definitions, Quantities and Trading (0.5)
12. Solar energy (1.25)
13. Wind power (0.5)
14. Biomass energy (0.75)
15. Introduction to hydropower (0.5)
16. Geothermal energy (0.5)
17. Marine energy (0.25)
18. Sustainable power for earth by generation in space (0.25)
19. Energy - Some possible sustainable paths to the future (0.25)

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


and others:
V. Smil : Energy at the Crossroads

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.