Spring 2007

Energy Systems for Earth and Aerospace Applications

Alternative Energy Systems on Earth are Standard Technologies in Space

Instructor:
Jean N. Koster
Dept. Aerospace Engineering Sciences
429 UCB
(303)492-6945
Jean.koster@colorado.edu

Overview:
Oil is a major energy resource for aircraft and blamed recently for several bankruptcies of major airlines. But oil has never been a major energy resource for space applications; the main alternative energy systems, that are nowadays heralded as "sustainable" or "renewable" for Earth applications have long been used in Space systems. The aerospace industry has spearheaded the development of these energy systems. The goal of the course is to provide engineering students with basic and in depth knowledge of the scientific foundations for four alternative energy resources for space and Earth applications.

Course rationale for topics:
The course is research and development oriented and will focus on 4 major topics. Photovoltaic systems have been the main power systems for space applications and will be discussed first. Materials Science of solar cells will be followed by manufacturing challenges. Then the new photovoltaic concepts that are under scientific evaluation and development will be discussed. The second topic will be the concentrated solar power technology which is currently developed for electrical utilities. Those systems will be of interest to human habitats on the moon and Mars. Hydrogen is often promoted as the next "economy" on earth. Hydrogen fuel cells have for a long time been used in space systems; the most infamous news being the Apollo 13 near-tragedy. In the near future hydrogen technology will play a major role in future space systems, in unmanned aerial vehicles, perhaps on commercial aircraft. For deep space missions there is probably no alternative to nuclear systems. We will review the concept of the SP100 and the thermionic and thermoelectric systems. Also, nuclear technology will most likely become a major player in the future production of hydrogen on earth. Finally we will study current research on future aircraft and spacecraft concepts using the above energy technologies. We will discuss the use of those energy resources on the moon and planets as energy provider for probes and human habitats as well as technologies for planetary resource utilization.

Prerequisites:
Students are required to have a junior level background in the following fields: Materials Science, Thermodynamics, Fluid Mechanics, Physics, Chemistry.

Weekly Schedule Spring 2007 (guideline):

Week 1		Introduction
		Photovoltaic Systems, Electronic materials and devices, Principles of solar cell operation
Week 2		Crystalline and polycrystalline Silicon
		Manufacturing,
Week 3		Thin film PV technologies
		High Performance PV
Week 4		Space System PV
		Field Visit
Week 5		**Concentrated Solar Power,** Electrical Power Utilities
		Thermal Systems, Parabolic Trough, Dish
Week 6		Thermal Storage
		Field Visit
Week 7		**Hydrogen Systems,** Fuel Cells, basic concepts
		Hydrogen Generation, Hydrogen Storage and Transportation
Week 8		Molten Carbonate cells, Solid oxide cells, other
		H2 fuel cells in space- and aircraft
Week 9		**Field Visit**
		Nuclear Systems, Nuclear Hydrogen production
Week 10		SP100 concept
		Thermionic and thermoelectric systems
Week 11		**Future AeroSpace Applications,** Aircraft, Spacecraft
		Planetary Systems
Week 12		Solar Energy Resource Utilization
		Field Visit
Week 13		**Curiosities**
Week 14		**Student Presentations**
Week 15		**Student Presentations**

Learning Assessment:

	ASEN 4519-xxxx	**ASEN 5519-xxxx**
Biweekly research reports	30	15
Reading quizzes	20	10
Semester research paper	40	60
Roadmap paper	10	15

About the Instructor:

The instructor's first encounter with renewable energies was during his Diploma-thesis on the "Direct solar energy conversion into electrical energy" in 1975. The instructor was then involved in research related to nuclear energy systems for 6 years specializing in thermal convection issues relevant to reactor safety. He has more than 20 years experience in materials science and crystal growth of III-V materials which are used in high performance solar cells. He did research on thermal convection and heat transfer, a topic governing concentrated solar power systems, for the majority of his 27 year career. In 2006 he is on sabbatical at NREL and participates in several projects on solar thermal storage and high temperature materials needed for hydrogen production. He is affiliated with the Aerospace Department since 1987 and has taught a course on space power systems before.