

A FIRST COURSE IN RENEWABLE ENERGY

IAP 2009

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

INSTRUCTOR Mohammad-Reza Alam (PhD)

COURSE DESCRIPTION This is an engineering introduction to renewable energy technologies and potentials. The course aims to introduce a general engineering/science audience to the basic concepts of renewable energy. In the interest of time some mathematical criteria will be covered, e.g. Betz limit for wind, limit of efficiency of WEC point absorber. Each lecture contains several examples from real world applications and in-progress industrial developments.

LECTURES Tuesdays and Thursdays 11:00am-12:30am

TEXTBOOK Godfrey Boyle, “ Renewable Energy, Power for a sustainable future”, 2004, Oxford University Press, in association with The Open University.

GRADING Presence in class, Course project+Final in-class presentation

SYLLABUS

Introduction

- Energy: Past, Today, and Future. A brief history of energy consumption.
- Energy & Environment
- Non-renewable energies

Solar Energy

- Sun and its Energy: Basics of Solar Energy
- Solar Energy in the Past
- Solar Thermal Energy
- Solar Photovoltaic

Wind Energy

- Historical Background
- Wind Resources
- Wind Turbines
- Environmental Impact

Ocean Energy

- Ocean Energy Potential against Wind and Solar
- Wave Characteristics and Statistics
- Wave Energy Devices
- Tide characteristics and Statistics
- Tide Energy Technologies
- Ocean Thermal Energy
- Osmotic Power
- Ocean Bio-mass

Geothermal Energy

- Geothermal Resources
- Geothermal Technologies

FURTHER READING

- Aldo V. da Rosa, “Fundamentals of Renewable Energy Processes”, 2005, Academic Press. 712 pages.
Barker Library, TJ163.9.D3 2005
Unlike most renewable energy books that aim general audience, this book is an introductory engineering/scientific guide book to Renewable energies. It is mainly focused on energy extraction from the temperature difference (e.g. thermo-electricity, heat engines) and fuel cells. da Rosa is a faculty emeriti at Stanford.
- Gilbert M. Masters, “Renewable and Efficient Electric Power Systems”, 2004, Wiley-IEEE Press, 680 pages.
Barker Library, TK1005.M33 2004
- Jefferson W. Tester, Elisabeth M. Drake, Michael J. Driscoll, Michael W. Golay, William A. Peters, “Sustainable Energy: Choosing Among Options”, The MIT Press, 2005, 870 pages.
Hayden & Barker Library, TJ808.S85 2005
- Bent Sorensen, “Renewable energy :its physics, engineering, use, environmental impacts, economy, and planning aspects” Elsevier Academic Press, 2004, 952 pages.
Barker Library, TJ163.2.S66 2004
- John Twidell, Tony Weir, Anthony D. Weir “Renewable Energy Resources”, Taylor & Francis, 2005, 601 pages.
Barker Library, TJ808.T95 2006
The first edition of this book published in 1986. Although this is the second edition, the book structure and figures are somewhat dated. But the book is easy to understand and is mostly descriptive. Enough math, however, is given for Each chapter to end with a series of problems. The book starts with an introduction on Fluid Mechanics and Heat transfer, then covers relatively well the solar power. Then it covers other forms of renewable energies such as Hydro-power, wind energy, ocean energy in shorter chapters.
- Andre Brin, ”‘Energy and the Oceans”, Ann Arbor Science Publishing Inc/ The butterfly Group, 1981, 133 pages.
Barker Library, TJ163.2.B7513, 1981
A relatively old but very well written short introductory book on Ocean Energy.
- Ron Pernick, Clint Wilder, “The Clean Tech Revolution: The Next Big Growth and Investment Opportunity”, Collins Business, 2007, 320 pages.
Dewey Library, TD195.E25.P476 2007
- Chiras, Daniel D. “The homeowner’s guide to renewable energy :achieving energy independence through solar, wind, biomass, and hydropower”. New Society, 2006, 352 pages.
Rotch Library, TJ163.5.D86.C48 2006
- Fanchi, John R. ”Energy :technology and directions for the future” Elsevier Academic Press, 2004, 491 pages. Barker Library, TJ163.2.F36 2004
An easy to read non-mathematical introduction to all forms of energies from fossil fuels to renewable energies.
- Fanchi, John R. ”Energy in the 21st century” Hackensack, N.J. : World Scientific, 2005, 243 pages. Barker Library, TJ163.2.F362 2005
This is a non-technical summary of Fanchi’s main book: ”Energy, Technology and Directions for the future”
- Karl Mallon (Editor), “Renewable Energy Policy and Politics: A Handbook for Decision-Making” Earthscan Publications Ltd., 2006, 288 pages.

Dewey Library, HD9502.A2.R446 2006

“Examines the renewable energy sector and its stakeholders, analyzing the reasons for past failures and the key features of successful policies” (from Amazon Editorial Reviews)

- Martin Kaltschmitt, Wolfgang Streicher, Andreas Wiese, “Renewable Energy: Technology, Economics and Environment”, Springer, 2007, 564 pages.
Barker Library, TJ808.E7613 2007
Most of the book is dedicated to Solar energy and Geothermal energy. It briefly covers wind and in its appendix wave power.
- Paul Komor, “Renewable Energy Policy” iUniverse, Inc., 2004, 194 pages.
“Renewable Energy Policy takes a pragmatic, nuts-and-bolts look at the myriad government efforts to promote renewables, and reports back on what works, what doesn’t, and why. In clear, jargon-free language, Renewable Energy Policy shows how and why some policies have achieved impressive results, and others have failed. Skillfully interweaving technology, economics, and politics, Paul Komor reveals how the best of policy ideas often end up with unintended results.” (from Amazon Editorials Reviews)

DVDs

- Energy crossroads :a burning need to change course /produced by Tiroir A Films Productions; written and edited by Christophe Fauchere.2007
Barker Library, Browsery, DVD HD9502.A2.E54367 2007
- E.Energy /director, Tad Fettig ; executive producers, Karena Albers and Tad Fettig ; series producer, Elizabeth Westrate ; senior producer, Beth Levison ; producer, Midori Willoughby ; production of Kontentreal Production. [United States] : PBS Home Video, 2007
Rotch Library, Service Desk, DVD TJ820.E22 2007
- Saved by the sun, produced by Steve Latham, Larry Klein, Evan I. Schwartz ; written by Larry Klein and Evan I. Schwartz ; directed by Steven Latham ; a Steven Latham production for WGBH/Nova ; WGBH Educational Foundation. WGBH Video, 2007.
Barker Library, Media, DVD TJ810.S28 2007
A non-technical very descriptive and application-oriented introduction to solar energy. Most of the film is people talking about professional/non-professional experiences with solar energy.
- Transforming energy :[what is our future after oil?] /an Electric Lodge/Throughline production ; written & directed by Chuck Davis ; produced by Joel Shapiro. [Boulder, Colo.] : Electric Lodge : Throughline, 2006.
Barker Library, Media, DVD TJ808.T74 2006
Interesting Interviews about solar energy.
- Modern marvels :renewable energy, produced by Actuality Productions, Inc. for the History Channel ; written and produced by Anthony Lacques ; producer, Bruce Nash. [New York] : A & E Television Networks : Distributed by New Video, 2006.
Barker Library, Browsery, DVD TJ808.M63 2006
A quick review of some of renewable energy resources. Very interesting pictorial introduction.
- Powershift, written, directed & produced by Kirk Bergstrom ; a production of WorldLink Media. [San Francisco] : WorldLink Media, 2004.
Rotch Library, Browsery, DVD TJ808.P69 2004

- Alternative energy 101 :an introduction to manufacturing fuel cells & advanced batteries /Society of Manufacturing Engineers. Dearborn, Mich. : Society of Manufacturing Engineers, 2004
Barker Library, Media, DVD TJ163.2.A49 2004
- The Power of the Sun /executive producer, Walter Kohn ; produced by David Kennard, Victoria Simpson ; InCA Productions. [United States] : The Regents of the University of California, 2005.
Barker Library, Browsery, DVD TK2960.P69 2005
A very interesting video both educational (describing the mechanisms) and historical.
- The power of wind, produced by the American Wind Energy Association with the support of the U.S. Department of Energy. American Wind Energy Association (AWEA), 2005.
Barker Library, Media, DVD TJ820.P69 2005
A 11 minute very interesting qualitative introduction to wind energy. Starting with a historical background going to the most advanced wind turbines currently being installed.

SCIENTIFIC/TECHNICAL
JOURNALS

- Renewable Energy, An International Journal
The journal seeks to promote and disseminate knowledge of the various topics and technologies of renewable energy and is therefore aimed at assisting researchers, economists, manufacturers, world agencies and societies to keep abreast of new developments in their specialist fields and to unite in finding alternative energy solutions to current issues such as the greenhouse effect and the depletion of the ozone layer. The scope of the journal encompasses the following: Photovoltaic Technology Conversion, Solar Thermal Applications, Biomass Conversion, Wind Energy Technology, Materials Science Technology, Solar and Low Energy Architecture, Energy Conservation in Buildings, Climatology and Meteorology (Geothermal, Wave and Tide, Ocean Thermal Energies, Mini Hydro Power and Hydrogen Production Technology), Socio-economic and Energy Management.
- International Journal of Renewable Energy Technology (IJRET)
The objective of IJRET is to provide a means for the publication and interchange of information, on an international basis, on all aspects of renewable energy technology. It aims to highlight contributions describing the development of techniques of the different marine renewable energy sources.
- IET Renewable Power Generation
This journal from the IET (The Institution of Engineering and Technology) brings together the topics of renewable energy technology, power generation and systems integration. Other technologies having a direct role in sustainable power generation such as fuel cells and energy storage will also be covered, as will system control approaches such as demand side management, that facilitate the integration of renewable sources into power systems, both large and small.
- Journal of Energy Resources Technology
Technology for Energy Generations; Conversion and Storage; Extraction of Energy from Natural Resource; Petroleum Engineering; Offshore and Deepwater Mechanics and Technology; Petroleum Equipment and Design; Natural Gas Technology; Underground Injection and Storage; Rock and Material Mechanics for Energy Resources; Alternative and Unconventional Energy Sources; Energy Co Generation Systems; Fundamental Combustion of Energy Resources; Advanced Energy Resources-Systems-Analyses; Energy Resource Recovery from Biomass and Solid Wastes; Environmental Aspects of Energy Resources; Pollution Control in Energy Technology; Economics of Energy Resource Exploitation.

- **Journal of Energy Engineering**
The Journal of Energy Engineering reports on the scientific and engineering knowledge in the planning, development, management, and finances of energy-related programs. The Journal is dedicated to civil engineering aspects of the issues, sources, and programs that are either directly related to, or can ultimately contribute to, the production, distribution, and storage of energy. Multidisciplinary subjects are especially encouraged. Original contributions are encouraged, but not limited to, the following areas.
- **Journal of Energy and Environmental Research**
from National Energy Technology Laboratory (NETL)
- **Journal of Solar Energy Engineering**
Fundamentals, Solar Optics, Solar Collectors, Solar Thermal Power, Photovoltaic, Solar Chemistry and Bioconversion, Solar Space Applications, Wind Energy, Heating and Cooling, Energy Storage, Testing and Measurement, Conservation and Solar Buildings, Emerging Technologies, Energy Policy.