

ESM 288: Energy, Technology, and the Environment

Syllabus, Fall 2018

Time & Room: Tuesdays & Thursdays, 3:30-4:45pm, BH1424
 No class on 11/20 and 11/22 (Thanksgiving week)

Assignments: There will be 4 assignments

Exams: Closed-book midterm: Monday, 11/1, 3:30-4:45am, BH1424
 Open-book final: Finals week, BH1424

Instructor: Roland Geyer, BH3426, extension 7234, geyer@bren.ucsb.edu

Office hours: Tuesdays & Thursdays, 4:45-5:45pm

Recommended books:

- Energy: Its Use and the Environment, Hinrichs & Kleinbach, Fifth Edition, Brooks/Cole, Boston, MA, 2013
- Energy and Fuels in Society, L R Radovic
 (available at <http://www.ems.psu.edu/~radovic/matsc101.html>)
- Sustainable Energy – Without the Hot Air, David JC MacKay, UIT Cambridge, 2008
 (available at <http://www.withouthotair.com/>)
- Technical: Energy Science – Principles, Technologies, and Impacts, J. Andrews & N. Jelley, Oxford University Press, 2007

Date	Topics & Readings
Session 1: Introduction to Energy	
9/27	Topics: <ul style="list-style-type: none"> • Definitions of energy, work, and power • Units and unit conversions • Energy forms, sources & uses • 1st and 2nd law of thermodynamics
Session 2: Energy Forms I	
10/2	Topics: <ul style="list-style-type: none"> • Mechanical energy • Chemical energy Reading: <ul style="list-style-type: none"> • Chapter 2 (Energy Mechanics) from “Energy: Its Use and the Environment”, Hinrichs & Kleinbach, 2013, Fifth Edition, Brooks/Cole, Boston
Session 3: Energy Forms II	
10/4	Topics: <ul style="list-style-type: none"> • Electromagnetic energy • Nuclear energy Hand out 1st assignment Reading: <ul style="list-style-type: none"> • Chapter 2: Concept of Energy pp.7-25 in L R Radovic, Energy and Fuels in Society

Session 4: Energy Forms III	
10/9	<p>Topics:</p> <ul style="list-style-type: none"> • Temperature and heat, heat transfer • Ideal gas equation • Thermodynamic processes <p>Reading:</p> <ul style="list-style-type: none"> • Review slides from Session 1, 2, and 3
Session 5: Conversion Technologies & Their Efficiencies	
10/11	<p>Topics:</p> <ul style="list-style-type: none"> • Thermodynamic cycles • Heat engines, heat movers • Overview of conversion technologies <p>Hand in 1st assignment</p> <p>Reading:</p> <ul style="list-style-type: none"> • Chapter 4: Efficiency of Energy Conversion pp.53-76 in L R Radovic, Energy and Fuels in Society
Session 6: System Efficiencies	
10/16	<p>Topics:</p> <ul style="list-style-type: none"> • Electricity production • Heating • Transportation <p>Hand out 2nd assignment</p> <p>Reading:</p> <ul style="list-style-type: none"> • Chapter 21: Smarter Heating pp. 140-154 in Sustainable Energy - without the hot air, David JC MacKay, UIT, Cambridge, UK, 2009
Session 7: Transportation Energy Use	
10/18	<p>Topics:</p> <ul style="list-style-type: none"> • Transportation energy demand by mode • Automotive energy demand by force • Power train efficiency • Modeling vehicle energy demand <p>Reading:</p> <ul style="list-style-type: none"> • Chapter 20: Better Transport pp. 118-139 in Sustainable Energy - without the hot air, David JC MacKay, UIT, Cambridge, UK, 2009
Session 8: Renewable Energy - Solar	
10/23	<p>Topics:</p> <ul style="list-style-type: none"> • Solar radiation • Concentrating solar power • Photovoltaics <p>Hand in 2nd assignment</p> <p>Reading:</p> <ul style="list-style-type: none"> • Chapter 17: Solar Energy pp.313-333 in L R Radovic, Energy and Fuels in Society

Session 9: Biomass & Sun-to-Wheels	
10/25	<p>Topics:</p> <ul style="list-style-type: none"> • Photosynthesis • Bioethanol, biodiesel, bioelectricity <p>Reading:</p> <ul style="list-style-type: none"> • Chapter 6: Solar pp.38-49, Chapter D: Solar II pp.283-288 in Sustainable Energy - without the hot air, David JC MacKay, 2009 • K Johnson, New York Times, 3 September 2012 • Geyer, Stoms, Kallaos (2013), Spatially-Explicit LCA of Sun-to-Wheels Transportation Pathways in the U.S., EST, 47(2), 1170-1176
Session 10: Renewable Energy - Wind	
10/30	<p>Topics:</p> <ul style="list-style-type: none"> • Wind power • Wind profiles • Wind turbines <p>Reading:</p> <ul style="list-style-type: none"> • Chapter 4: Wind pp.32-34, Chapter 10: Offshore wind pp.60-67, Chapter B: Wind II pp.263-268 in Sustainable Energy - without the hot air, David JC MacKay, UIT, Cambridge, UK, 2009
Session 11: Midterm Exam	
11/1	<p style="text-align: center;">Closed-book Midterm</p> <p><i>Hand out 3rd assignment</i></p>
Session 12: Renewable Energy - Water	
11/6	<p>Topics:</p> <ul style="list-style-type: none"> • Hydropower • Wave power • Tidal energy <p>Reading:</p> <ul style="list-style-type: none"> • Chapter 12: Wave pp.73-75, Chapter 14: Tide pp.81-87 in Sustainable Energy - without the hot air, David JC MacKay, 2009
Session 13: Intermittency, Storage, Hydrogen	
11/8	<p>Topics:</p> <ul style="list-style-type: none"> • Intermittency of renewable electricity and the smart grid • Batteries and other energy storage technologies • Hydrogen and fuel cells <p><i>Hand in 3rd assignment</i></p> <p>Reading:</p> <ul style="list-style-type: none"> • TBD
Session 14: Fossil Energy	
11/13	<p>Topics:</p> <ul style="list-style-type: none"> • Coal, crude oil & natural gas <p>Reading:</p> <ul style="list-style-type: none"> • BP Statistical Review of World Energy, June 2018, https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html

Session 15: Environmental Impacts I	
11/15	<p>Topics:</p> <ul style="list-style-type: none"> • Climate change • Criteria air pollutants <p>Reading:</p> <ul style="list-style-type: none"> • Chapter 11: Fossil Fuels: Environmental Effects pp.191-218 in L R Radovic, Energy and Fuels in Society
Session 16: Environmental Impacts II	
11/27	<p>Topics:</p> <ul style="list-style-type: none"> • Land use • Electricity production <p>Hand out 4th assignment</p> <p>Reading:</p> <ul style="list-style-type: none"> • Fthenakis & Kim, Land use and electricity generation: A life-cycle analysis, Renewable & Sustainable Energy Rev. 13 (2009) 1465–1474
Session 17: Global and U.S. Energy Consumption	
11/29	<p>Topics:</p> <ul style="list-style-type: none"> • Energy use per country, per capita and per GDP • Energy use per source, per end use • I=PAT • The rebound effect <p>Reading:</p> <ul style="list-style-type: none"> • BP Statistical Review of World Energy, June 2018, https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html • Sorrell, Dimitropoulos & Sommerville, Empirical estimates of the direct rebound effect: A review, Energy Policy 37(2009) 1356-1371
Session 18: Renewable Energy Scenarios	
12/4	<p>Topics:</p> <ul style="list-style-type: none"> • Cost of energy • Levelized cost of electricity • Course review, part 1 <p>Hand in 4th assignment</p> <p>Reading:</p> <ul style="list-style-type: none"> • Lazard’s Levelized Cost of Energy Analysis, Version 11.0 https://www.lazard.com/perspective/levelized-cost-of-energy-2017/
Session 19: Renewable Energy Scenarios	
12/6	<p>Topics:</p> <ul style="list-style-type: none"> • Renewable energy pathways • Renewable energy scenarios • Course review, part 2 <p>Reading:</p> <ul style="list-style-type: none"> • Jacobson & Delucchi, A Path to Sustainable Energy by 2030, Scientific American, pp. 58-65, November 2009The cost of energy