Energy & the Environment—ENVS/ENGR 119—Spring 2016- #28635/28232

Instructor: Benoit Delaveau, M.S, Environmental Studies Department, San José State University

Office hours/location: Tu-Th 9–10:00 AM and Monday 2:00-2:45 by appointment only, WSQ 115A

Office hours sign-up email: benoit.delaveau@gmail.com or message me on Canvas

Class meeting days / time / room: Tu-Th / 10:30–11:45 AM, SH 435

Attributes: Area R: Earth & Environment http://info.sjsu.edu/static/catalog/sjstudies.html

Prerequisites: Passing the WST http://testing.sjsu.edu/wst/

MYSJSU Messaging and Canvas

You are responsible for regularly checking with the messaging system through MySJSU and canvas. Course materials such as the syllabus, assignments, readings, and handouts are posted to canvas: https://sjsu.instructure.com Log in with your SJSU One account info. For assistance see: http://www.sjsu.edu/at/ec/support/

Course Description

In this course you will be introduced to the nexus of social, technical, and environmental challenges to providing sustainable energy supplies and patterns of use. You will learn physical principles underlying power generation, conventional forms of energy and their social and environmental impacts, sources of renewable energy, and means to transition to more sustainable energy sources. The political, economic, cultural, historical, and policy dimensions of energy procurement, generation, and consumption will show how energy issues are entangled in deeper social and environmental contexts. Human civilization cannot continue using fossil fueled based energy at our present rate of consumption; we must look for ways to decrease and decarbonize our energy use.

This course is divided into five parts. Part 1 reviews energy generation and consumption patterns and the scientific principles related to energy, heat, and work. Part II of this course explores various sources of energy from conventional forms of energy generation and their social and environmental impacts. Part III focuses on renewables including solar, wind, biomass, wave, tidal, hydroelectric, and geothermal. Part IV centers on questions about making infrastructure more sustainable: food systems, transportation, and buildings. In part V, we will synthesize planning efforts and proposals for making sustainable energy transitions.

General Education Student Learning Objectives

SLO 1: Students will be able to demonstrate an understanding of the methods and limits of scientific investigation. SLO 1 will be assessed in assignments 1, 2, 3 and the final research report.

SLO 2: Students will be able to distinguish science from pseudo-science. SLO 2 will be assessed in assignments 2, 3, and 4.

SLO 3: Students will be able to apply a scientific approach to answer questions about the earth and environment. SLO 3 is assessed in the final research report and assignments 2, 3, and 5.

Course Goals and Student Learning Objectives

At the end of this course, students should be able to:

- Understand the nexus of energy challenges and relevant economic, social, and environmental issues.
- Describe the physical principles related to the energy, heat, power, and work
- Complete basic calculations / conversions in energy, heat, power, and work
- Describe the scientific properties and spatial distribution of conventional and renewable energy sources
- Analyze the relative energy use in U.S. to other nations, and the forces that shift the mix of energy sources over time
- Describe basic principles to improve efficiency and design of energy delivery, recognize opportunities to reduce energy consumption, and promote sustainability;
- Assess basic economic, government policy, and social equity dimensions of energy options
- Utilize tools to evaluate an energy option and assess alternatives.

ENVS Library Liaison Peggy Cabrera, peggy.cabrera@sjsu.edu

Classroom Protocol: You are expected to come to every class on time. Classroom participation will be reflected in your final grade. No cell phone, emailing, or text messaging during class. If you need to make a phone call or send an email, please excuse yourself from class.

Dropping and Adding: Students are responsible for understanding the policies and procedures about add/drop, grade forgiveness, etc. Refer to the current semester's Catalog Policies section at http://info.sjsu.edu/static/catalog/policies.html Add/drop deadlines can be found on the current academic calendar at http://www.sjsu.edu/academic_programs/calendars/academic_calendar. Students should read the Late Drop Policy and be aware of the current deadlines and penalties for dropping classes.

Grading: Use the percentages below and your scores to monitor your grade. Multiply the score you received by the value.

Credit-hour statement: SJSU classes are designed such that in order to be successful, it is expected that students will spend a minimum of forty-five hours for each unit of credit (three hours per unit per week or two hours outside of class for every hour in class), including preparing for class, participating in course activities, completing assignments, and so on. This three-unit course requires a minimum of 9 hours per week to complete class-related readings and assignments (roughly 2.5 hours in class and 6.5 hours outside class per week.) Careful time management will help you keep up with readings and assignments and enable you to succeed in all your classes. More details about student workload can be found in University Policy S12-3 at http://www.sjsu.edu/senate/docs/S12-3.pdf

20% **Participation**. It is expected that you will participate in class discussions and activities. Come to class having completed all of the assigned readings and something important from the reading in your notebooks. Also make sure to bring the assigned readings each class. Every article we read should be summarizes or noted upon in this notebook. Share your thoughts about the readings when prompted, ask questions about lectures, answer discussion prompts. Keeping good notes about the main points or views taken by authors of course readings is a good means a facilitating a sustained discussion. You will also be asked to work in small groups at times in class, and you will be expected to be a contributing member to your group. *__Current events in energy__* Bring a news story to the classes' attention **twice** over the semester by (1) posting it to the canvas website in the discussion section with a short description; prepare a few remarks as we'll want to know more than just the headline, (2) describing the story at the start of class, (3) turning in a paper copy of your comments and the news article on the day you describe it in class.

20% **Assignments**: As part of the activities in this class, you will complete five graded assignments.

Assignment 1 – Unit conversions, power energy, energy/GHGs (SLO 1)
Assignment 2 – Energy and GHG problem sets (SLO 1 & 2)
Assignment 3 – Carbon footprint calculator (SLO 1, 2, & 3)
Assignment 4 – Social Gap in Wind (SLO 2 & 3)
Assignment 5 – Decarbonization strategies (SLO 3)

20% **Midterm:** Both the midterm and the final exams will be **open notebook**. The exams will include short answers and essay questions. Your notebook should contain lecture notes and short annotations on the readings. If you take notes in the margins of your readings, make sure to transfer important ones to your notebook. You must bring a calculator to the examinations. You will not have access to any electronic devices (other than a calculator). To study for the tests, you should review the readings, course lecture notes, homework, and learning objectives well in advance of the test date. The midterm will include material covered during the first portion of the class. We will include both multiple choice and problems related to the scientific principles of energy, heat, and work. You are encouraged to review the problems sets before the midterm.

20% **Final Research Paper:** Students will individually write a research paper related to renewable or conventional energy technologies. More details on this assignment will be available on the course website.

20% **Comprehensive Final Exam:** There will be a comprehensive final exam.

Course Grading: The course grade will be determined based on a total 100 possible points. Accumulated points that fall within the grade scale below determine your semester grade.

A+ 97–100	A 92–96	A- 89–91	B+ 86–88	B 81–85	B- 79–80	C+ 76–78
C 72–76	C- 69–71	D+ 67–68	D 64–66	D- 60–64	F < 60	

University policy on academic integrity (Strictly enforced)

Your commitment as a student to learning is evidenced by your enrollment at San Jose State University. TheUniversity's Academic Integrity policy (Links to an external site.), located at http://www.sjsu.edu/senate/S07-2.htm, requires you to be honest in all your academic course work. Faculty members are required to report all infractions to the office of Student Conduct and Ethical Development. The Student Conduct and Ethical Development website (Links to an external site.) is available at http://www.sjsu.edu/studentconduct/. **Instances of academic dishonesty will not be tolerated.** Cheating on exams or plagiarism (presenting the work of another as your own, or the use of another person's

ideas without giving proper credit) will result in a failing grade and sanctions by the University. For this class, all assignments are to be completed by the individual student unless otherwise specified. If you would like to include your assignment or any material you have submitted, or plan to submit for another class, please note that SJSU's Academic Policy S07-2 requires approval of instructors.

Campus policy in compliance with the American Disabilities Act

If you need course adaptations or accommodations because of a disability, or if you need to make special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible, or see me during office hours. Presidential Directive 97-03 requires that students with disabilities requesting accommodations must register with the Accessible Education Center to establish a record of their disability.

Other Campus Resources

- **Computer labs** for student use are available in the **Academic Success Center** located on the 1st floor of Clark Hall and on the 2nd floor of the Student Union. http://www.sjsu.edu/at/asc/ Additional computer labs may be available in your department/college. Computers are also available in the Martin Luther King Library. A wide variety of audio-visual equipment is available for student checkout from Media Services located in IRC 112.
- The **Learning Assistance Resource Center (LARC)** is located in **Room 600 in the Student Services Center**. It is designed to assist students in the development of their full academic potential and to inspire them to become independent learners. The Center's tutors are trained and nationally certified by the College Reading and Learning Association (CRLA). They provide content-based tutoring in many lower division courses (some upper division) as well as writing and study skills assistance. Small group, individual, and drop-in tutoring are available. Please visit the LARC website for more information at http://www.sjsu.edu/larc/
- The **SJSU Writing Center** is located in **Room 126 in Clark Hall**. http://www.sjsu.edu/writingcenter/ It is staffed by professional instructors and upper-division or graduate-level writing specialists from each of the seven SJSU colleges. Our writing specialists have met a rigorous GPA requirement, and they are well trained to assist all students at all levels within all disciplines to become better writers. The Writing Center website is located at http://www.sjsu.edu/writingcenter/about/staff/
- The **Peer Mentor Center** is located on the 1st floor of Clark Hall in the Academic Success Center. The Peer Mentor Center is staffed with Peer Mentors who excel in helping students manage university life, tackling problems that range from academic challenges to interpersonal struggles. On the road to graduation, Peer Mentors are navigators, offering "roadside assistance" to peers who feel a bit lost or simply need help mapping out the locations of campus resources. Peer Mentor services are free and available on a drop –in basis, no reservation required. The Peer Mentor Center website is located at http://www.sjsu.edu/muse/peermentor/

Class schedule (Read = read before class, Q. = question to think about and answer from the reading)

1/28 - First day of instruction

Introduction to the challenges and dilemmas related to energy and its impacts on the environment. Course and syllabus overview, logistics.

Read: Bill McKibben, B. 2012. "Global Warming's Terrifying New Math." *Rolling Stone.* July 24, 2012. McKibben 2012 Global Warming's Terrifying New Math.pdf

Q. *What are the three numbers to know about fossil fuels and climate change and what do they represent?*

Read: Brian Clark Howard. 2014. New Reports Offer Clearest Picture Yet of Rising Greenhouse Gas Emissions. National Geographic. September 21, 2014. http://news.nationalgeographic.com/news/2014/09/140921-climate-change-carbon-budget-un-summit-environment-science/

Keywords & concepts: Environmental impacts of energy choices, GHGs quotas to avoid dangerous climate change.

Slides:

2/2 - Energy, Society, Environment

Read: Vaclav Smil. 2010. Science, Energy, Ethics, & Civilization. Visions of Discovery: New Light on Physics, Cosmology, and Consciousness, ed. R.Y. Chiao, M.L. Cohen, A.J. Leggett, W.D. Phillips, and C.L. Harper, Jr. Cambridge University Press. Smil 2010 science-energy-ethics-civilization.pdf

Read: Vaclav Smil. 2006. Energy. Encyclopedia of World History. Berkshire Publishing. Smil 2006 Energy.pdf

Q. *What are the key shifts in the evolution of energy use? What changed with the shift from biomass to fossil fuels?*

Keywords & concepts: Energy use in historical/evolutionary perspective, mass and energy flows through ecosystems, energy v. power, stationary and mobile prime movers, energy conversions/conversion efficiencies, primary energy supplies, energy types (mechanical, thermal, chemical, solar, nuclear, electrical).

Slides:

2/4 - Energy Science Fundamentals I

Read: Richard Wolfson. 2012. Energy, Environment, and Climate. WW Norton. Chapter 3. Forms of Energy, Electricity, p. 35–44. Wolfson chapter 3 Energy a closer look.pdf

Read: John Randolph and Gilbert Masters. 2011. Energy for Sustainability. Chapter 4, Section 4.1 to 4.3.2 (p., 117–125) and Section 4.4 to 4.5.2 (p. 127–134).

Q. *What are the differences between forces and energy? What are the key forms of energy? How is electricity made?*

Keywords & concepts: Energy Density, Entropy, Stocks and Flows, Intergenerational Equity, thermodynamic laws; Energy units; efficiency.

Slides:

2/9 - Energy Science Fundamentals II

Read: Richard Wolfson. 2012. Energy, Environment, and Climate. WW Norton. Chapter 3. Quantifying Energy, Energy and Work. Wolfson chapter 3 Energy a closer look.pdf

Read: John Randolph and Gilbert Masters. 2011. Energy for Sustainability. Chapter 4, Section 4.1 to 4.3.2: 117–125.

Q. *What units do we use to measure power and energy? How are basic unit conversions calculated?*

Keywords & concepts: Energy use in transportation, Kinetic and Gravitational Potential Energy, Forces, Electricity, Electro-magnetic induction

Slides:

2/11 - Coal

Assignment 1 due

Read: Jeff Goodell, 2007. Chapter. The Saudi Arabia of Coal. *Big Coal: The Dirty Secret Behind America's Energy Future*. NY: Mariner Books, p. 3-20. Goodell 2007 Saudi Arabia of coal.pdf

Q. *What state and more specifically coal reserve, is considered the Saudi Arabia of coal? What portion of coal supply does it provide to the USA?*

Read: Erik Reece. 2011. Moving Mountains. *Orion Magazine*. *https://orionmagazine.org/article/moving-mountains/*

Q. *What are the most significant impacts of mountain top removal?*

Keywords & concepts: Coal: regions, uses, sources, formation, Carboniferous period, labor hazards, noxious gases, mountain top removal, coal surface mining.

Slides:

2/16 - Coal

Read: Jonathan Watts. 2009. The two faces of China's giant coal. *The Guardian*. industry. http://www.theguardian.com/environment/2009/nov/15/china-coal-industry-mongolia-shaanxi

Q. *Why will China's demand for coal affect the US coal industry? How will coal-to-liquids impact GHG emissions from transportation?*

Read: Eric Holthaus. 2015. The Point of No Return: Climate Change Nightmares are Already Here. August 5, 2015. http://www.rollingstone.com/politics/news/the-point-of-no-return-climate-change-nightmares-are-already-here-20150805

Q. *What is the latest evidence that something is changing about the climate?*

Keywords & concepts: China, export terminals, coal-to-liquids, syngas, clean coal, CCS.

Slides:

2/18 - Natural gas

Read: John Randolph and Gilbert Masters. 2011. Energy for Sustainability. Chapter 4, Section 4.5.3 through 4.5.5: 136–141 (solution Box 4.7).

Q. *How do you calculate the heat and carbon emissions from combustion of methane?*

Read: Chris Mooney. 2011. The Truth About Fracking. *Scientific American.* November: 80–5

Q. *What are the key scientific debates around fracking? What do we know and not know?*

Keywords & concepts: natural gas production, horizontal slant drilling, hydraulic fracturing, shale, water impacts, risks to drinking water, heating value, chemical energy, heat of combustion

Slides:

2/23 - Natural gas

Read: Vaclav Smil. 2012. Placing American gas boom in perspective. *The American.* May 3, 2012.

Q. *What are the claims and counter-claims about the American gas boom?*

Read: Sally Entrekin et al. 2011. Rapid expansion of natural gas development poses a threat to surface water. *Frontiers in Ecology and the Environment* 9(9): 503–511.

Q. *What are the risks of fracking to surface water?*

Keywords & concepts: politics of reserve estimates, Marcellus Shale, impacts to water, natural has and energy security.

Slides:

2/25 - Natural gas

Assignment #2 due

Read: Ori Gutin. 2015. EPA Releases Fracking Risk Assessment. June 15, 2015 http://www.eesi.org/articles/view/epa-releases-fracking-risk-assessment

Q. *What can we conclude about the public health risks from fracking according to the EPA?*

Read: Joel Levin. 2015. California Needs a Strategy for Sustainable Natural Gas. *Huffington Post*. April 17, 2015. http://www.huffingtonpost.com/joel-levin/california-natural-gas_b_7083328.html

Q. *What are the keys to a strategy for sustainable natural gas?*

Keywords & concepts: water impacts, the watershed view, Energy Policy Act of 2005

Slides:

Optional: EPA's Study of Hydraulic Fracturing for Oil and Gas and Its Potential Impact on Drinking Water Resources. http://www2.epa.gov/hfstudy

3/1 - Petroleum & energy for transportation

Read: Vaclav Smil. 2011. America's oil imports: A self-inflicted burden. *Annals of the Association of American Geographers* 101:1-4.

Q. *What are the factors that drive America's excessive consumption of petroleum?*

Read: Gabriel Isaacson. 2012. Lessons from Air Pollution Past. *Sage Magazine*. February 8, 2012. http://www.sagemagazine.org/lessons-from-air-pollution-past/

Q. *What events prompted public policies to improve air quality?*

Read: Maria Papadakis. 2012. Arctic National Wildlife Refuge. In Mulvaney. *Green Energy: An A-to-Z Guide* Sage. http://knowledge.sagepub.com.libaccess.sjlibrary.org/view/greenenergy/n4.xml

Q. *What is the controversy over ANWR?*

Keywords & concepts: Oil & petroleum consumption & production trends, oil impacts, ANWR, unit: tons of oil equivalent, air pollution & photochemical smog from combustion

Slides:

Additional, optional information

Gulf Spill Map: http://ngm.nationalgeographic.com/2010/10/gulf-oil-spill/gulf-map-interactive

Mapping Global Air Pollution Down to the Neighborhood Level: http://www.citylab.com/weather/2015/08/mapping-global-air-pollution-down-to-the-neighborhood-level/400337/

3/3 - Shale oil, oil shale, & tar sands

Read: Sari Horwitz. 2014. Dark side of the boom: http://www.washingtonpost.com/sf/national/2014/09/28/dark-side-of-the-boom

Q. *What are some of the challenges facing oil & gas boom-towns?*

Read: Jeremy Miller. 2011. The Colonization of Kern County: A story of oil and water. Orion Magazine. January/February.

Q. *What are the largest oil fields in California?*

Read: Alan Taylor. 2014. The Alberta Tar Sands. *The Atlantic*. September 24, 2014. http://www.theatlantic.com/photo/2014/09/the-alberta-tar-sands/100820/

Keywords & concepts: Tar Sands, Synfuels, Bitumen, dilbit, Keystone XL pipeline Carbon intensity, emissions factors

Slides:

Optional: Shifting Sands, review site: http://v1.theglobeandmail.com/v5/content/features/oilsands/index.html
Sierra Club video: http://www.rollingstone.com/politics/news/why-tar-sands-oil-isnt-worth-the-trouble-20120618

3/8 – Clean Vehicles: EVs & Hydrogen

Read: Kristen Casalenuovo. "Electric Vehicle." In D. Mulvaney 2011. *Green Energy: An A-to-Z Guide.* SAGE Publications. http://knowledge.sagepub.com.libaccess.sjlibrary.org/view/greenenergy/n34.xml

Q. *What are the primary obstacles to widespread EV adoption?*

Read: William Isherwood. "Hydrogen." In D. Mulvaney 2011. *Green Energy: An A-to-Z Guide.* SAGE Publications. http://knowledge.sagepub.com.libaccess.sjlibrary.org/view/greenenergy/n74.xml

Q. *Depending on the feedstock for making hydrogen fuel, it could have substantial benefits or very limited benefits if at all. What are the primary challenges to making hydrogen fuel sustainable?*

Keywords & concepts: Sustainable Transportation, lithium, hydrogen, battery energy density, obstacles to EVs

Slides:

3/10 - Carbon Footprint

Assignment 3 Due

Read: Maggie Walser. 2012. Carbon Footprint. Encyclopedia of Earth. http://www.eoearth.org/article/Carbon_footprint

Q. *What is the difference between primary & secondary GHG emissions?*

Read: Jessica Grady-Bensona and Brinda Sarathyb. 2015. Fossil fuel divestment in US higher education: student-led organising for climate justice. *Local Environment*.

Q. *What factor have helped and hindered divestment movements at US institutions of higher education?*

Keywords & concepts: Carbon Emissions Factor, divestment movement

Slides:

3/15 - Nuclear Power

Read: Charles Perrow. 2013. Nuclear Denial: From Hiroshima to Fukushima. Bulletin of the Atomic Scientists. 65(5).

Q. What is being denied with nuclear denial?

Read: Alexander Cockburn. 2011. In Fukushima's Wake: How the Greens Learned to Love Nuclear Power. *New Left Review* 68: 75–79.

Q. Why do the greens love nuclear power? What are the consequences of their support for nuclear?

Keywords & concepts: Sources of nuclear power, nuclear waste, low level radiation, yellow cake, Uranium 235/U238.

Slides:

3/17 - Nuclear Power

Read: Philippe Boudes. “Nuclear Power” In Mulvaney 2011. *Green Energy: An A-to-Z Guide.* SAGE Publications. http://knowledge.sagepub.com.libaccess.sjlibrary.org/view/greenenergy/n92.xml

Q. Is Nuclear a Green, Sustainable, or Renewable Energy?

Read: David Chandler. 2011. Explained: rad, rem, sieverts, becquerels: A guide to terminology about radiation exposure MIT News. http://web.mit.edu/newsoffice/2011/explained-radioactivity-0328.html

Q. How is radiation measured?

Keywords & concepts: Yucca Mountain, passive design, Chernobyl, Three Mile Island, sources of fear

Slides:

3/22 - Hydro-Power

Read: Marc Reisner. 1993. Chapter 4. An American Nile. Cadillac Desert: The American West and its Disappearing Water. Penguin, New York.

Q. What were some of the challenges encountered at Boulder Canyon?

Read: John Randolph and Gilbert Masters. 2011. Energy for Sustainability. Chapter 4, Section 4.3.3. p., 125–127.

Q. *How do you estimate the power output of a hydro-electric system?*

Read: Roopali Phadke. 2012. "Hydro-Electric Power." In Mulvaney 2012. *Green Energy: An A-to-Z Guide.* SAGE Publications. http://knowledge.sagepub.com.libaccess.sjlibrary.org/view/greenenergy/n73.xml (Links to an external site.)

Q. *What are the different kinds of hydro-electric power systems?*

Keywords & concepts: Hydro-electric power, challenges building dams, different kinds of dams.

Slides:

3/24 – Midterm Open notebook; bring a calculator!

4/5 - Wind

Read: John Randolph and Gilbert Masters. 2011. Energy for Sustainability. Chapter 12.

Q. *How is the potential wind power output calculated for a specific site and turbine?*

Keywords & concepts: Wind Power Basics, Power potential

Slides:

4/7 - Wind

Read: Roopali Phadke. 2013. Public Deliberation and the Geographies of Wind Justice. *Science as Culture* 22(2): 247–255.

Q. *How can the social gap in renewable energy be overcome?*

Read: Tina Casey. 2015. First Ever US Offshore Wind Farm Gets First "Steel In Water," No Turning Back Now. http://cleantechnica.com/2015/07/28/first-ever-us-offshore-wind-farm-gets-first-steel-water-no-turning-back-now/

Keywords & concepts: Wind Power, siting challenges, ecological compatibility, the social gap in renewable energy

Slides:

Optional: Check out this cool map: http://eerscmap.usgs.gov/windfarm/

4/12 - Solar

Assignment 4 due

Read: John Randolph and Gilbert Masters. 2011. Energy for Sustainability. Chapter 11.

Read: John Randolph and Gilbert Masters. 2011. Energy for Sustainability. Chapter 7.

Q. *How do photovoltaics generate electricity?*

Keywords & concepts: Solar Photovoltaic (PV) Energy, Solar Thermal Energy, insolation

Slides:

4/14 - Life Cycle Assessment, EROI, EPBT

Read: Frank Kreith. 2012. Bang for the buck. Mechanical Engineering. May 2012.

Q. *What is EROI and how do you calculate it?*

Keywords & concepts: Life Cycle Analysis, EROI, EPBT for PV and Wind

Slides:

4/19 – Biofuels, energy crops

Read: Barry Solomon. 2010. Biofuels and Sustainability. *Annals of the New York Academy of Sciences* 1185: 119–34.

Q. *What do sustainability issues and biofuels production intersect? Why are sustainability criteria important?*

Keywords & concepts: Bioenergy, First Generation Crops, GHG balances for biofuels, conversion efficiency, direct/indirect land use change, eutrophication, sustainable biofuels criteria.

Slides:

4/21 – Biofuels, low carbon and carbon negative fuels

Read: M. Fatih Demirbas. 2011. Biofuels from algae for sustainable development. *Applied Energy* 88: 3473–3480.

Q. *What are the advantages and disadvantages of biofuel production using microalgae?*

Read: Johannes Lehmann. 2007. A Handful of Carbon. Nature 447: 143–144.

Q. *How does biochar sequestration work?*

Keywords & concepts: Second, Third Generation biofuels, water use, water quality.

Slides:

4/26 - Geothermal

Read: John Randolph and Gilbert Masters. 2011. Energy for Sustainability, Geothermal heat pumps.

Q. *How does a geothermal heat pump work? What can it do?*

Read: Julie Cart. 2014. Geothermal power industry lost steam but may be poised for comeback. *Los Angeles Times*. October 19, 2014. http://www.latimes.com/local/la-me-geothermal-20141020-story.html#page=1

Q. *What are the key challenges to California's geothermal energy industry and what are the emerging trends?*

Keywords & concepts: Geothermal Energy

Slides:

4/28 - Wave and Tidal Resources

Read: Mohammad-Reza Alam. 2011. Wave Energy. Technology Avenue. *IRIS*.

Q. *What are the types of devices to collect wave power?*

Read: Dave Levitan. 2014. Why Wave Power Has Lagged Far Behind as Energy Source. *Yale Environment 360*. April 28, 2014. http://e360.yale.edu/feature/why_wave_power_has_lagged_far_behind_as_energy_source/2760/

Q. *What are the key challenges to deploying more wave power?*

Keywords & concepts: Wave and Tidal Resources

Slides:

5/3 - Agri-food systems & energy

Read: Nathan Pelletier, et al. 2011. Energy Intensity of Agriculture & Food Systems. *Annual Review of Environment & Resources* 36: 223–46. http://libaccess.sjlibrary.org/login?url=http://dx.doi.org/10.1146/annurev-environ-081710-161014.

Q. *What are the key drivers of energy use and greenhouse gases in agriculture and food systems?*

Keywords & concepts: Energy in food production, nitrogen fertilizer, food miles, carbon footprints, food security.

Slides:

5/5 – Energy Efficiency and Conservation

Read: Tom Dietz. 2015. Altruism, self-interest, and energy consumption. Proceeding of the National Academies of Sciences. 112(6): 1654–1655.

Q. *What motivates people to conserve energy?*

Keywords & concepts: Energy use & conservation

Slides:

5/10 - Energy & water

Read: James McMahon & Sarah Price. 2011 Water & Energy Interactions. *Annual Review of Environment Resources* 36:163–91. http://libaccess.sjlibrary.org/login?url=http://dx.doi.org/10.1146/annurev-environ-061110-103827

Q. *How is water used in energy production?*

Keywords & concepts: Uses of water in energy production

Slides:

5/12 - Decarbonization strategies

Assignment 5 due

Stephen Pacala & Robert Socolow. 2004. Stabilization wedges: solving the climate problem for the next 50 years with current technologies. S*cience* 305(5686): 968-972.

Keywords & concepts: wedge of GHG emissions reduction, sequestration, fuel switching.

Slides:

FINAL EXAM TUESDAY Wednesday, May 18, 9:45–12:00

http://info.sjsu.edu/static/catalog/final-exam-schedule-spring.html