

MAST-622-010, UAPP-626-010, POSC-626-010, Spring 2011

# Conservation and Renewable Energy Policy

Spring 2011, Tuesday & Thursday 2:00 - 3:15, 203 Robinson Hall

Alternative time: Monday, 8:00 - 9:15, 203 Robinson Hall

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Revised: 13 May 2011

This course covers energy efficiency, social and cultural aspects of conservation, rethinking the vehicle fleet, and large-scale integration of renewable energy. In each area, we cover basic principles, measurement and analysis; social and cultural drivers; economics; regulation; understanding current policy, and designing policies to better meet environmental and social goals.

Energy offers an interesting case of environmental policy, both because human energy use is massively altering global systems, and as an example of policies for resource conservation, sustainability, and individual consumption. Energy has been more completely analyzed and has more regulatory experience than most if not all other areas of environmental policy. Within capitalist economies, electric and gas utilities are a unique example of extensive state control of private corporations—over investment, operations, products, even allowed profit.

Requirements: To understand and contribute to discussions, it is essential to complete the readings prior to each seminar. A synthetic essay will be written on two of the four major sections of the course. Three or four small analytical exercises will be carried out, e.g. calculating whether energy efficiency measures are economically justified, or analyzing hydrogen versus other energy carriers for automobiles. The analytical exercises can be done in collaboration with other students, if that is noted on your submission. A final exercise will be a policy proposal; it must be original, but should not be long (about 8 single-spaced pages or 16 dbl). Sporadically, a quiz will be given at the begin of class, on that day's readings. Grading: Synthetic essays (30%), analytical exercises + policy proposal (35%), quizzes (25%) participation in class and site visits (5%).

## Required Texts (in UD Bookstore):

Richard F. Hirsh, 1999, *Power Loss: The Origins of Deregulation and Restructuring in the American Electric Utility System*. Cambridge, MIT Press. [A comprehensive treatment of the evolution of electric utility policy throughout the 20th century, with emphasis on the initial "utility consensus", PURPA and the introduction of renewables, conservation, and finally the factors leading to restructuring in the 1990s.]

George Monbiot, 2007, *Heat: How to stop the planet from Burning*. South End Press. [This is the only analysis I've seen of going thoroughly through multiple sectors of the economy and calculating how to get 90% reductions. Doing the numbers means throwing out a lot of conventional wisdom.]

## Electronic Resources

The class relies on a large collection of electronic documents, available on UD Sakai web site for this class. Providing reprints to students in a class, and the students printing copies for their own use, constitute "fair use" under US patent law.

An energy unit converter will be useful for some of the class exercises. The iPhone/iPod app "Convert-Bot" is fairly comprehensive and very easy to use. The OSX app "RPN Calculator" is very comprehensive in energy units, if you are comfortable with RPN calculators (ask instructor for copy). Web resources require validation before use in publications (or homework), one validated one is at <http://www.eia.doe.gov/kids/>, click on "Energy calculators"

### Supplemental Books:

Scientific American, 1990, *Energy for Planet Earth*. New York: W. H. Freeman and Co. [If you need additional background in energy analysis and technology, I suggest you read most of this book, e.g.: Chapters 1-6 and 8-11.] (A couple of these chapters will also be used as readings for this class.)

Johansson, Kelly, Reddy, Williams, and Burnham, 1993, *Renewable Energy: Sources for Fuels and Electricity*. Island Press: Washington, DC and Covello, CA. \$55. [Comprehensive treatment of most renewable energy technologies, including developed country ones.]

L.D. Danny Harvey, 2010, *Energy Efficiency and the Demand for Energy Services*. London and Washington: Earthscan. [Comprehensive review of energy statistics (Chapter 2), electricity generation (Chap 3), and of the science and engineering of energy efficiency.]

L.D. Danny Harvey, 2010, *Carbon-Free Energy Supply*. London and Washington: Earthscan. [Comprehensive exposition of physical and engineering principles of all major carbon-free energy sources.]

Geller, Howard, 2003, *Energy Revolution: Policies for a Sustainable Future*. Island Press: Washington, DC and Covello, CA. [Policies for energy efficiency and renewable energy.]

Steven M. Nadel, Michael W. Reid and David R. Wolcott, 1992, *Regulatory Incentives for Demand-Side Management*. ACEEE: Washington, DC, and Berkeley, CA. [This is the most thorough, most comprehensive treatment of the state's role in stimulating DSM by state-regulated utilities.] Available from ACEEE (see web address and phone below), \$31.00

Steven Stoft, 2002, *Power System Economics: Designing Markets for Electricity*. Piscataway, NJ: IEEE Press/Wiley-Interscience. [The major text on economics of partially-deregulated electricity supply.]

Willett Kempton and Max Neiman (eds), 1987, *Energy Efficiency: Perspectives on Individual Behavior*, Washington and Berkeley: American Council for an Energy-Efficient Economy. [A range of studies of how human behavior and culture affects energy use and implementation of energy efficiency.]

### Pre-class preparation:

It is assumed that students entering this course already have some background in energy policy. Background might include the social and historical context of energy use, energy technologies, environmental impacts, and some knowledge of major energy policy initiatives and legislation. Students who do not have background in energy concepts and technologies should read through Chapters 1 through 6 and 8 through 11 of the book *Energy for Planet Earth* as pre-class preparation. This is out-of-print but should be in bookstore and can also be ordered used. Students with no background in energy policy should read Chapter 1 in Hirsh, *Power Loss* (see books, above).

### Relevant Web Sites:

General UD sites for finding published articles and citations, only open to UD students/staff:

<http://www2.lib.udel.edu/database/websci.html> Web of Science, find by citations, forward and reverse, and download PDFs.

<http://www.lib.udel.edu/ej/> Find electronic versions of many, many journals.

A sample of web sites on energy conservation and renewable energy.

<http://www.eia.doe.gov/> US Energy Information Agency, of the US Department of Energy, a gold mine of energy production and consumption data, both national and broken down by state. Also an authoritative source of energy production and use data. Not necessarily as reliable on future projections.

<http://www.iea.org/> International Energy Agency, like the US EIA but for all countries, with more focus on OECD countries.

<http://www.osti.gov/> From the US DOE Office of Scientific and Technical Information (OSTI)—bibliographic records of documents from DOE and its predecessors, ERDA and AEC. Documents span 1948 to present, from dissertations to patents to papers, articles, and books. Includes abstract, a link to the electronic document when available, the research organization and sponsoring organization, etc.

<http://www.aceee.org/> American Council for an Energy-Efficient Economy. An advocacy, research, and publishing organization. Books and reports can be ordered on web or 202/429-8873.

<http://www.carbonfree.udel.edu/> Center for Carbon-free Power Integration; links to other UD sites.

<http://www.eei.org/> Edison Electric Institute--lots of reports and two-page briefs, giving the industry's position on many electric utility issues.

<http://www.nrel.gov> US National Renewable Energy Laboratory (NREL).

<http://www.ase.org/> Alliance to Save Energy. A US energy NGO with many links to other organizations and country programs.

<http://www.udel.edu/V2G/> Vehicle-to-Grid power web page.

<http://www.eere.energy.gov/> Energy Efficiency and Renewable Energy at US DOE.

<http://www.happyplanetindex.org/> Happy Planet Index, compares life satisfaction with ecological footprint of countries.

<http://www.epa.gov/globalwarming/> EPA global warming web site, with links to 60+ related sites.

## Course Topics and Readings

Readings Key:

☞ on class Sakai site

® textbook

∅ optional reading, not provided by instructor

### 0. INTRODUCTION

Class 1a, 8 February 2011, week 1

Introduction; motivation; survey of course, basic energy concepts. Site visit and alternate class day.

## Class 1b, 10 Feb

Global overview of energy end-use; climate change

The big picture, globally and historically:

☞ Ged R. Davis, 1991, "Energy for Planet Earth." in *Energy for Planet Earth: Readings from Scientific American Magazine*. Pp 1-10. New York: W.H. Freeman and Company. [Essential background: overview of energy transformations, historical change in energy use over 150 years, global energy use, cross-national differences, and the possibilities for a future of sustainable energy supply.]

® Monbiot, *Introduction*, "The Failure of Good Intentions", and *Chapter 1*, "A Faustian Pact". [Motivation and approach of the book. "What will society look like if it reduces CO<sub>2</sub> by 80%?" ]

Optional: ☞ Vaclav Smil, 2000, "Energy In The Twentieth Century: Resources, Conversions, Costs, Uses, and Consequences" *Annual Review of Energy and the Environment* 2000. 25:21–51. [Comprehensive review of changes in energy systems in the 20th century. Includes changes in technology, energy sources, and the economic and social well-being correlates of energy consumption. (A more comprehensive version of the Ged Davis chapter.)]

## I. EFFICIENCY AND UTILITY POLICY

### Class 2a, 15 Feb

Policy Analysis, Climate Change, Quantitative Target of 90%

policy analysis and energy research:

☞ Laurence E. Lynn, Jr., 1980, Chapter 1, "Analysis and Policymaking," in *Designing Public Policy*, pp 1 - 8. Santa Monica, CA: Goodyear Publishing Co. [What is meant by policy analysis? How does one approach it? What makes a policy analysis useful for decisions?]

☞ Dane Archer, Thomas F. Pettigrew, and Elliot Aronson, 1992, "Making research apply: High stakes public policy in a regulatory environment." *American Psychologist* 47(10): 1233-1236. [Academics collide with policy research: Differing "cultures" of program evaluation; the "regulatory triangle"; how to do it with less conflict next time.]

Climate change:

☞ Willett Kempton, Amanda Wenczel, Brian Boutin, Amardeep Dhanju, Clinton Hare, Sara Handy and Stephanie A. McClellan, 2006, "Why Are Scientists Failing to Communicate the Urgency of Climate Change?" (Manuscript, 2006)

### **Handout: measure energy flows in your household**

### Class 2b, 17 Feb

Electric industry history and context, the utility consensus, restructuring; utility regulation and efficiency

® Richard F. Hirsh, 1999, "Creation of the Utility Consensus". Chapter 1 (pp 9-31) in *Power Loss*. [Origin of the electric utilities at the turn of the 20th century; agreement on utilities as "natural monopolies" with strong state regulation.]

☞ Peter Bradford, 1992, "Foreword" in Nadel, Reid and Wolcott. 1992, *Regulatory Incentives for Demand-Side Management*. ACEEE: Washington, DC, and Berkeley, CA, pp ix - xi. [By the early 1990s, utilities were spending \$2 billion per year on Demand-Side Management (DSM), up from essen-

tially zero in the 1970s. Yet the inherent rewards built into utility regulation motivate utilities to spend money but insure that programs actually save little energy. Current regulation creates a fundamental divergence of interests between stockholders and customers regarding DSM, a public-policy problem whose solution is not yet clear. (WK: This problem has not been resolved in the 2 decades since this article was written, and needs to be to achieve successful energy efficiency programs.)]

Optional:

☞ Price C. Watts (a pseudonym for Mike Rothkopf) 2001, "Heresy? The Case Against Deregulation of Electricity Generation." *The Electricity Journal* 14(4): 19-24. [Good analysis of the inherent problems and contradictions of deregulating electric utilities. From email received by Kempton, dated 19 June 2006: "... I am the pseudonymous Dr. Watts. (At the time of the article, I was consulting for FERC which was pushing deregulation, and it wasn't politic to publish it under my own name.) ... " Regards, Mike Rothkopf, (Professor, Faculty of Management and Operations Research Center, Rutgers University, New Brunswick, New Jersey) ]

Class 3a, 21 Feb, 8:00 AM - 9:15 (RESCHEDULED)

conservation and efficiency policies: history, policy mechanisms (e.g. regulatory incentives versus requirements versus public benefits charges), anti-efficiency arguments; calculating CCE and NPV

® Monbiot, Chapter 3, "A ration of freedom" [Importance (in his view) of policies that are regulatory and impose equal burdens on all.]

® Richard F. Hirsh, 1999, Chapter 8 "The Mainstreaming of Conservation". (pp 135-154) in *Power Loss*. [Chapter 8: Traces the emergence of conservation and efficiency as a concept, a goal for utilities, and an orientation for utility programs. Describes development of some major ideas such as conservation supply curves, soft paths, and least cost planning, and the analysts advancing the ideas. ]

Optional: ® Richard F. Hirsh, Chapter 9 "First Implementation of Conservation Principles by Utilities" (155-167). [Chapter 9: Describes representative conservation programs at several utilities.]

**Discuss questions 1 - 3 for Energy Measurement**

Class 3b, 28 Feb, 8:00 AM (RESCHEDULED)

The debate on efficiency; cost of conserved energy, net present value

**Contrasting arguments on efficiency:**

☞ Andrew Rudin, 2003, "Feel-Good Electric Waste: Like diets that make us fat, efficiency is bad for the environment." April 1, 2003 *Public Utilities Fortnightly*, pp 15-17. [DSM is misguided because more efficiency will ultimately lead to more energy consumption. Energy efficiency is not a desirable goal of policy. Suggests conservation as an alternative, but not specific as to policies. For an argument against efficiency from a different perspective, see Jerry Taylor, 1999, Cato Institute Policy Analysis #356, 20 October 1999)]

☞ Amory Lovins, 2003, "Letter to the Editor" (Reply to Rudin). *Public Utilities Fortnightly*, 1 May 2003, p 9.

Optional, examples of points from Rudin and Lovins:

Optional: ☞ Jack N. Barkenbus, 2006, "The Cold Facts About Refrigerators." *Environment* 48(8): 11 – 20. (This file is a big 9 MB.) [Policy, economic and preference aspects of new refrigerator purchase. Points out that while refrigerators have gotten more efficient, they have also gotten larger and more numerous, thus, no reduction in energy use.]

Optional: Ø David Owen, 2010, "The efficiency Dilemma" (If our machines use less energy, will we just use them more?) *New Yorker*, 20 December 2101, pp 78-85. [This is a popular, light reading (without citations) version of the Rudin-Lovins debate.]

### Cost of Conserved energy:

☞ Alan Meier, Janice Wright, and A. H. Rosenfeld, 1983, "Chapter 2: Developing Supply Curves of Conserved Energy." Chapter 2, pp 15-32 + notes, p 178. [This is the original source for "cost of conserved energy" (CCE): rationale, how to use it, tricky assumptions.]

Optional, If you are planning to use CCE professionally, also see:

☞ Optional Steven E. Stoff, 1995, "The Economics of Conserved-Energy 'Supply' Curves." *The Energy Journal* 16(4): 109-137. Only pp 109, 134-135? are reprinted here. [Develops a basis of conservation supply curves in economic theory; argues that the current method for calculating cost of conserved energy "is incorrect, though not by enough to matter when discount rates are low" (p 134). Notes that the term  $n$  in the original formula should be the lifetime of the conservation measure, not the amortization period (p 134). Provides alternative formulas of increasing complexity.]

### Present value; two descriptions of same method:

☞ OTA, 1993, page 123, box 4-B "Evaluating a project's financial worth" [A gentle introduction to payback and net present value. ]

☞ James Ragan and Lloyd Thomas, 1990, "Discounting expected future returns to compute present value" pp 127-128, in *Principles of Macroeconomics*. San Diego: Harcourt Brace Jovanovich. [A short, clear description of present value.]

### Handout: Cost of Conserved Energy, NPV, and Regulation

#### Class 4a, 1 March

Energy conservation in computers and appliances; alternative policy approaches

#### Two approaches to reducing computer energy use:

☞ "Turn off Computers!" *Comfort and Light* 61 (Spring 96): 2-3. [Addresses the "myth" of wear from turning computers on and off. Suggests turning off if computer will be unused 15 minutes or more. (Students: Please reflect on this article, decide whether you find it convincing, then compare it with Koomey et al, next.)]

☞ Johathan G. Koomey, Timothy Oey, and Eric Bergman, 1992, The economics of cycling personal computers. In 1992 ACEEE Summer Study: 10.97 - 10.100. [The economics of turning off your computer when not in use.]

#### Two programs to make appliances more efficient:

☞ Brian J. Johnson and Catherine R. Zoi, 1992, EPA Energy Star computers: The next generation of office equipment. In 1992 ACEEE Summer Study: 6.107 - 6.114. [The sociology of getting the computers to use less power and turn themselves off. This reports on the concept and implementation of the hugely successful Energy Star Computers program.]

☞ Issac Turiel et al, 1991, US residential appliance energy efficiency: Present status and future policy directions. In Ed Vine and Drury Crawley (eds) *State of the Art of Energy Efficiency* Washington, DC: ACEEE. pp 199 - 227. [Detailed analysis to support an efficiency standard. Distribution of available

models, potential technical efficiency, aggregate national statistics. Methods for analytically weighing increased first cost against lifetime lower environmental impact and cost, which are generally applicable across many environmental impacts.]

### **Handout: Synthetic Essays**

#### Class 4b, 3 March

Efficiency in homes & industry

® Monbiot, Chapter 4, "Our leaky homes". [How to achieve 90% CO<sub>2</sub> reductions in residences, both new and used housing stock.]

☞ Marc H. Ross and Daniel Steinmeyer, 1991, "Energy for Industry", in *Energy for Planet Earth: Readings from Scientific American Magazine*, pp 35-46. [Overview of energy use in industry, technical issues, and some decisionmaking issues. (Ok to skim technology examples, but read about decision-making.)]

☞ Marc Ross, 1986, "Capital budgeting practices of twelve large manufacturers." *Financial Management*, Winter 1986, pp 15 - 22. [A study of how industries actually make energy efficiency decisions.]

## **II. RETHINKING LIGHT VEHICLES, FUELS, AND INTEGRATION**

#### 5a, 8 March

automobile efficiency: CAFE versus other policies

☞ Ian W.H. Parry, 2003, Do the Benefits of Tightening CAFE Outweigh the Costs? Available from Climate Policy Center. Or Resources for the Future. November 21, 2003. [Argues that a carbon tax is a better policy than CAFE for reducing CO<sub>2</sub> emissions.]

☞ David L. Greene, 1998, "Why CAFE Worked." *Energy Policy* 26(8): 595 - 613. [Analysis of the major arguments against the Corporate Average Fuel Economy standards in the US. Would it have been better to tax fuel than regulate efficiency? Did a rebound effect negate savings? Did lower vehicle weights cause a safety problem? Does the (almost) concurrent increase in fuel prices explain increased efficiency, without CAFE? Most of these criticisms have been made of other efficiency regulations, and this thorough analysis of them is valuable across end-use sectors.]

Optional: ☞ Terry Tamminen, 2009, Chapter 3, "Desperate Enterprise", in *Lives per Gallon: The True Cost of our Oil Addiction*. Washington, Covelo, and London: Island Press. [Tabulation of subsidies and external costs of petroleum.]

### **Due Thursday, 10 March: Synthetic Essay on I (and 0)**

#### 5b, 10 March

energy carrier for the vehicle fleet?; also, low carbon transport policies

☞ Goldemberg, José, "The ethanol program in Brazil " *Environ. Res. Lett.* 1 (2006) 014008 (5pp) doi:10.1088/1748-9326/1/1/014008 [Cane-based ethanol has been used as an engine fuel since 1903. Recent Brazilian policy to encourage its use. Could the world emulate Brazil's program? Is plant-derived alcohol the best replacement for gasoline?]

Optional: ☞ David Morris, 2003, "A better way to get from here to there: A commentary on the hydrogen economy and a proposal for a alternative strategy." December 2003 [Compares H2 with biofuels and electricity for the light-vehicle fleet. Also compares PHEVs with varying battery range. A readable introduction to such comparisons--optional, but if Jacobson (below) is too dense, reading this first may help.]

☞ Mark Z. Jacobson, 2009, "Review of solutions to global warming, air pollution, and energy Security" *Energy Environ. Science* 2, 148-173. DOI: 10.1039/b809990c Review Article. [What is the best way to power the vehicle fleet? Compares across transportation carriers, and across primary energy going into each of those carriers. Creating an innovative metric, he compares externalities, but not market price—based on the rationale that price is a byproduct of policy. This is a dense article; leave extra time to read and comprehend.]

® Monbiot, Chapter 8 "A New Transport System" [how to accomplish local and regional travel; combines technical, behavioral and policy changes.]

Optional: ® Monbiot, Chapter 9 "Love miles" [Air travel—the most difficult sector of the economy to accomplish the 90% reduction analysis]

### Class 6a, 15 March

Vehicle to grid power, markets and equations

☞ Kempton, W. and J. Tomić. 2005. "Vehicle to Grid Fundamentals: Calculating Capacity and Net Revenue" *J. Power Sources* Vol 144, Issue 1, 1 June 2005, Pages 268-279. doi: 10.1016/j.jpowsour.2004.12.025. [This is our best exposition of the fundamentals of both the vehicle fleet and electric markets. The basic 17 equations of V2G are derived. (Correction to published version: Page 275, Table 3, line 3: should be "27.4 kWh" not "27.4 \$/kWh".)]

☞ Benjamin K. Sovacool, Richard F. Hirsh, 2009, Beyond batteries: An examination of the benefits and barriers to plug-in hybrid electric vehicles (PHEVs) and a vehicle-to-grid (V2G) transition *Energy Policy* 37: 1095-1103. [Reviews the opportunities offered by plug-in vehicles and by V2G. Then suggests barriers to V2G, including social and cultural barriers, and business and institutional barriers.]

Optional: ☞ Ramteen Sioshansi, and Paul Denholm, 2009, "Emissions Impacts and Benefits of Plug-In Hybrid Electric Vehicles and Vehicle-to-Grid Services" *Environ. Sci. Technol.*, 2009, 43 (4), 1199-1204. Doi: 10.1021/es802324 [Calculates the air quality improvement from using V2G in place of one electric service, spinning reserves. By displacing generation for this service, there is a substantial air quality improvement, even after considering extra generation of electricity for charging.]

### **Handout: V2G Exercise**

### **Due Tuesday, 15 March: cost of conserved energy**

### Class 6b, 17 March

V2G for renewable energy integration

☞ Kempton, W. and J. Tomić. 2005. "Vehicle to Grid Implementation: from stabilizing the grid to supporting large-scale renewable energy". *J. Power Sources* Volume 144, Issue 1, 1 June 2005, Pages 280-294. doi:10.1016/j.jpowsour.2004.12.022. [Overall size of V2G in comparison to electric generation and load, control strategies and business models for implementation, analysis of V2G as storage



for large-scale renewable electricity. Appendix gives practical considerations and capacity of power connections.]

☞ Kempton, W. and A. Dhanju, "Electric Vehicles with V2G: Storage for Large-Scale Wind Power". *Windtech International* 2 (2), pp 18-21 (March 2006). [Analyzes the duration of low-wind events as a measure of storage needs, and compares national-level potential V2G power with average load in 11 countries. This version has two corrections from the March 2006 issue of *Windtech International*. Copyright 2006 by Siteur Publications.]

☞ Henrik Lund, Willett Kempton, 2008 "Integration of renewable energy into the transport and electricity sectors through V2G" *Energy Policy* 36 (9): 3578-3587. doi:10.1016/j.enpol.2008.06.007 [A model is produced for Denmark at higher levels wind, up to 100%. This model shows effects on emissions and wind spillage, and with multiple scenarios of electric vehicles and charging or V2G.]

### **Due 18 March: V2G exercise**

#### Class 7a, 22 March

Implementing V2G on the distribution system

☞ Kersting, William, 2002, *Distribution System Modeling and Analysis*. CRC Press. [Intro to textbook on the electrical distribution system. How to determine the system's capacity.]

☞ Willett Kempton, Victor Udo, Ken Huber, et al, 2009, "A Test of Vehicle-to-Grid (V2G) for Energy Storage and Frequency Regulation in the PJM System" Report, University of Delaware. [Report on initial implementation of V2G in one vehicle. Issues of distribution system capacity.]

#### Class 7b, 24 March

Business models for electric vehicles and V2G

☞ Joann Muller, 2008, "A light bulb goes on" *Forbes* 7 Jan 2008, pp 100 - 105. [Revenues for V2G operation.]

☞ Additional article, **TBA**

**Spring Break**, 28 Mar – 1 April 2009

## **III. CONSERVATION, SOCIETY and CULTURE**

#### Class 8a, 5 April

Why social science is needed for energy and climate policy formulation. How energy decisions are made by consumers, versus beliefs of most policymakers.

☞ Loren Lutzenhiser, 2008, "Setting the Stage: Why Behavior is Important" Overview essay for the Behavior, Energy and Climate Change conference, Keynote Address. June 10, 2008. Conference presentations at [http://piee.stanford.edu/cgi-bin/htm/Behavior/2007\\_becc\\_conference.php](http://piee.stanford.edu/cgi-bin/htm/Behavior/2007_becc_conference.php) [This is an overview of a conference in response to climate change legislation in California, that included voluntary action by consumers and other measures involving cultural/social/behavioral analysis. Covers: what is known from prior research and what is not; the (large) effect of behavior on the California electric crisis of 2001-2002; need to link behavior and policy.]

## Policy makers versus consumers (two articles)

☞ Paul C. Stern, 1993, Policy Forum: A second environmental science: human-environment interactions. *Science* 260: 1897-1899. (25 June 1993). [When policy makers apply common sense about human motivation and behavior to shape policy, they often create ineffective policies. (The next two articles are examples of consumer versus policymaker perspectives.)]

☞ Peter duPont and Deirdre Lord, 1996, "Reality check: Comparing policymaker perceptions with consumer energy behavior" Proceedings, 1996 ACEEE Summer Study on Energy Efficiency in Buildings. 8.27-8.37. [Compares what policy makers think about consumer use of appliance energy labels, with what consumers reveal of their energy efficiency decisions in interviews.]

☞ Willett Kempton, 1993, Will public environmental concern lead to action on global warming? *Annual Review of Energy and Environment* 18: 217-245. [How does environmental concern affect consumer purchases and political activity? How might that affect energy use?]

## 5 April Synthetic Essay on II due

### Class 8b, 7 Apr

Programs based on information, education and marketing.

☞ Merrilee Harrigan, 1994, Can we transform the market without transforming the customer? *Home Energy* 11(1): 17 - 23 (including sidebars). [Programs educating energy users have demonstrated energy savings at high cost-effectiveness.]

☞ Willett Kempton and Linda L. Layne, 1994, "The consumer's energy analysis environment." *Energy Policy* 22(10):857-866. [How consumers analyze their own energy use, based on their bills. This extends the Kempton and Montgomery analysis.]

Classic analysis prior to Kempton and Layne

Optional: ☞ Willett Kempton and Laura Montgomery, 1982, "Folk quantification of energy" *Energy--The International Journal* 7(10): 817-827. [Home energy decisions are based on calculations that are general-purpose and easy-to-make but potentially misleading.]

☞ Deirdre Lord, et al, 2006, Energy Star Billing: Innovative Billing Options for the Residential Sector” Proceedings, 1996 ACEEE Summer Study.

☞ Leslie Kaufman, 2009 Utilities Turn Their Customers Green, With Envy, *New York Times*, January 30, 2009. Also at <http://www.nytimes.com/2009/01/31/science/earth/31compete.html> [A program resulting from the Lord et al research, above.]

## Due 6 April: Measure energy flows in your household

### Class 9a, 12 April

Theoretical perspectives on energy and society

☞ Amory B. Lovins, 1977, Chapter 9 "Sociopolitics." In *Soft Energy Paths: Toward a durable peace*. Cambridge: Ballinger. pp 147 - 159. [The social, political and equity implications of our choice of energy systems.]

☞ Willett Kempton and Lee Schipper, 1994, "Expanding the Human Dimensions Research Agenda" *Proceedings, 1994 Summer Study on Energy Efficiency in Buildings*, pp 1.85 - 1.90. [To find policies to reduce energy consumption enough to solve pressing environmental problems, this paper argues that energy reductions will require more research on human demand, not just how to increase efficiency.]

☞ Loren Lutzenhiser, 1993, Social and behavioral aspects of energy use. *Annual Review of Energy and Environment* 18: 247-289. [Most energy research, and most energy policy, has been based on the physical-technical-economic model (PTEM). This is a review of the alternatives.]

☞ Harold Wilhite, Elizabeth Shove, Loren Lutzenhiser and Willett Kempton, 2000. "The Legacy of Twenty Years of Energy Demand Management: we know more about Individual Behaviour but next to Nothing about Demand" pp 109-126 In Eberhard Jochem, Jayant Sathaye, and Daniel Bouille (editors), *Society, Behaviour, and Climate Change Mitigation*. Dordrecht/Boston/London: Kluwer Academic Publishers. [Four energy social scientists collaborated on this statement. To understand energy use, we must understand energy users. However, when energy research has focused on the end-user, it has primarily taken an "behavior" approach. A broader perspective is needed, focusing on the causes and construction of demand.]

#### Class 9b, 14 April

Low consumption: Advocating and measuring it

☞ Vicki Robin, 1994, "Consume less now." Paper presented at Conference on "Consumption, Global Stewardship and the Good Life", Institute for Philosophy and Public Policy, University of Maryland. Manuscript, 12 pp. [Although presented at an academic conference, this is more a tract by a true believer than an academic article. Makes the case for lower consumption (of all goods) to increase quality of life.]

☞ Philip A. Lawn , 2003, "A theoretical foundation to support the Index of Sustainable Economic Welfare (ISEW), Genuine Progress Indicator (GPI), and other related indexes." *Ecological Economics* 44, Issue 1 , February 2003, pp 105-118. [Reviews studies linking GDP to measures of well being or welfare (see Figure 1). Compares these indices and provides theoretical support for them.]

☞ Joseph E. STIGLITZ, Amartya SEN, Jean-Paul FITOUSSI, 2009, Report by the Commission on the Measurement of Economic Performance and Social Progress. [A proposed national indicator of well-being, as a replacement for GNP. Executive summary given here.]

Optional: ☞ Jerome M. Segal, 1999, "Are We Simple Creatures?" in *Report from the Institute for Philosophy & Public Policy* 19 (2/3): 14-18 (issue on "Natural Environments, Human Communities", Spring-summer 1999). Available from School of Public Affairs, U of Md: College Park. [Are those who advocate low consumption and simple living claiming that humans are "simple creatures?" Need for self-esteem, marketing, arguments for simple living. Example of how universal human needs get translated into buying a \$200,000 house. See closing list of nonmaterial assets or wealth.]

#### Class 10a, 19 April

Low-energy nations; consumption and quality of life

☞ Allen Johnson, 1978, "In search of the affluent society" *Human Nature*, September 1978. pp 50 - 59. [Compares leisure time, demand for goods by French and Machiguena, addresses quality of life issues and forces for adoption of technology.] [Also see Rappaport, below in "optional".]

☞ Christopher Flavin, 1990, "Last road to Shangri-La." *World Watch*, July-August 1990. Pp 18-26 [Bhutan has established policies to restrict consumption and consumer goods, to preserve the nation's

environment. The King states that "Industrial development and wealth accumulation should be secondary to the goal of sustainability."]

☞ Miriam Jordan, 1996 "Marketing Gurus Say: In India, Think Cheap, Lose the Cold Cereal." Wall Street Journal, 11 Oct 1996, page A9. [Marketers see a major problem in India--a billion people who are happy without buying much. Advice for companies to penetrate "this frugal market."]

☞ Kempton and Payne, **TBA** or use social evolution article

Optional: Ø Roy A. Rappaport, 1971, The flow of energy in an agricultural society. *Scientific American*, September 1971. [Careful analysis of all energy flows in a small-scale society. This society has a sustainable energy system and sustainable agriculture that have functioned over a millennium. An excellent article that provides an existence proof for a sustainable society.]

#### Class 10b, 21 April

Low-energy societies, and subgroups; consumption and quality of life

☞ Lawrence Agbemabiese, Kofi Berko and Peter duPont, 1996, "Air Conditioning in the Tropics: Cool comfort or cultural conditioning?" *Proceedings, ACEEE Summer Study on Energy Efficiency in Buildings* 8.1 - 8.9. [If air conditioning is adapted in developing tropical countries the way it is used in the United States, it will cause massive power supply problems. The authors analyze current non-compressor cooling strategies, and find them to be, in some ways, superior to compressor-run air conditioning.]

☞ Jesse S. Tatum, 1991, "The home-power movement and the assumptions of energy-policy analysis" *Energy--The International Journal* 17(2): 99 – 107. [Approximately 25,000 US homes produce their own electricity, mostly from photovoltaic cells. Due to power constraints, members of these households are very aware of the energy consumption of their activities and appliances.]

☞ Interfaith Coalition on Energy, 1991, "Energy, Religion and Lifestyle" 7 pages. *ICE Melter Newsletter* # 45, September 1991. [Amish religion prohibits connecting to the electric utility grid and owning automobiles. They believe that this prohibition *increases* the quality of their lives.]

Optional: Ø H. Wilhite, H. Nakagami, T. Masuda, Y. Yamaga, and H. Haneda, 1996, "A cross-cultural analysis of household energy use behavior in Japan and Norway." *Energy Policy* 24(9): 795-803. [Comparison of the differing cultural patterns that produce national differences in energy use behavior and thus in measured household energy consumption.]

## **IV. RENEWABLE ENERGY: SOURCES AND POLICIES**

#### Class 11a, 26 April

How much renewable resources are there?

**Due Tuesday (26 April): synthetic essay on III**

® Monbiot, 2006, *Heat*, Chapter 6. "How much energy can renewables supply?" pp 100-123. [Chapter 6 title is self-explanatory. Note that some quantities are drawn from careful studies, others from not so

careful studies, others without any basis.] (Optional: Chapter 7, The energy internet, pp124-141; optional because this analysis is deeply flawed.)

☞ Jacobson, Mark Z. and Mark A. Delucchi, 2011, Providing all global energy with wind, water, and solar Power, Part I. *Energy Policy* doi:10.1016/j.enpol.2010.11.040 [Analysis of how global power can be provided with wind, water and solar. They pick one mix of percentages to make 100%, others are also possible.]

☞ P. Lund, 2007, "Upfront resource requirements for large-scale exploitation schemes of new renewable technologies" *Renewable Energy* 32: 442-458. [Are there enough materials to build a fully renewable energy system? How much would the materials cost?]

Optional: ☞ Chauncey Starr and Milton F. Searl, 1990, "Global energy and electricity futures; demand and supply alternatives." *Energy Systems and Policy* 14(1): 53-83. (This journal is now titled *Energy Sources*.) [Even with high efficiency and conservation, global energy use will expand dramatically. Renewables cannot achieve more than 36% of the electricity supply by the year 2060. The remaining 64% will be provided by fossil fuels, nuclear and hydro. This analysis was done in 1990 and illustrates how wrong resource estimates can be.]

#### Class 11b, 28 April

More regional, more detailed, and more valid resource estimates

☞ Amardeep Dhanju, Phillip Whitaker, Willett Kempton (2008), [Assessing offshore wind resources: An accessible methodology](#) *Renewable Energy* 33(1): 55- 64. doi:10.1016/j.renene.2007.03.006 [A detailed study of a specific local area, Delaware area waters. A more valid resource assessment was developed.]

☞ Governor's Energy Advisory Council, Footprint Work Group, 2009, "Reducing the Environmental Footprint of the Energy Delawareans Use..." This is a good overview of Delaware energy use. Assigned for this class is Appendix C, including table C1, which estimate total Delaware resources.]

☞ Baker, Scott, 2011, Chapter 4, PJM Offshore Wind Resource, Chapter 4, Results. [This is an in-progress master's thesis. Chapter 4 estimates the wind resource in the Atlantic, adjacent to the PJM Interconnect transmission area. This is a draft, title will change, and some numbers may change by  $\pm 15\%$ , please do not distribute outside this class. Final version should be available by Fall 2011.]

Optional: ☞ Center for Energy and Environmental Policy, 2009, "CREATING A SOLAR CITY Determining the Potential of Solar Rooftop Systems in the City of Newark." A Renewable Energy Applications for Delaware Yearly (READY) Project. "Final Report", 54 pp, Center for Energy and Environmental Policy, University of Delaware. [This is a very detailed analysis of the roof area available for solar installations in Newark Delaware--a great example of resource estimation for all building solar, also has cost comparisons and policy discussion.]

#### Class 12a, 3 May

Renewable energy Policies

☞ Nancy Rader and Richard B. Norgaard, 1996, Efficiency and Sustainability in Restructured Electricity Markets: The Renewables Portfolio Standard. *The Electricity Journal*, July 1996, also posted on AWEA web site, with permission (the latter used here). [An excellent comparison of RPS, versus Green Marketing, versus System Benefit Charges--three major policy approaches to renewables.]

☞ Benjamin K. Sovacool, 2008, The problem with the "portfolio approach" in American energy policy. *Policy Sci* (2008) 41:245–261. DOI 10.1007/s11077-008-9063-1. [Rebuttal to an earlier article (not used here) that, borrowing from investment theory, suggested a mix of old and new technologies for energy

sources. This article gives a detailed review of external costs of various energy sources, and suggests how to use external costs from those studies, despite the wide variance in results.]

☞ US Department of Energy, and US Department of Interior, 2011, *A National Offshore Wind Strategy: Creating an Offshore Wind Energy Industry in the United States*. February 2011. [This is the DOE plan for creating an industry. Note their selection of policies to accomplish this.]

Optional: ☞ Richard F. Hirsh, 1999, "Radical Technologies in the PURPA Era". Chapters 6 & 7 (pp 101-131) in *Power Loss*. [Good study of an earlier policy approach, PURPA. The effects of PURPA in developing and deploying small generators and renewable energy technologies.] (OK to skim this)

Optional: ☞ Ryan Wiser, Mark Bolinger, Edward Holt, 2000, "Customer Choice and Green Power Marketing: A Critical Review and Analysis of Experience to Date." ACEEE Summer Study on Energy Efficiency in Buildings, Panel 5, pp 5.365-5.380 [An empirical review of Green Power marketing programs. Much more data but reaches the same conclusion as Radar and Norgaard did on mostly theoretical grounds.]

#### Class 12b, 5 May

Integration of renewables

☞ Delucci, Mark A., and Jacobson, Mark Z. 2011, Providing all Global energy with wind, water, and solar power, Part II: Reliability, system and transmission costs, and policies. *Energy Policy* (2010), doi: 10.1016/j.enpol.2010.11.045. [How to design the electric system for variable generation? Economics of these approaches. Suggested policies.]

☞ NERC (North American Electric Reliability Corporation), 2009, "Accommodating high Levels of Variable Generation". Report, April 2009, NERC, Princeton, NJ 08540. [NERC is responsible for rules to keep the electric system reliable. This report argues that the currently expected level of wind will create challenges for the electric system, and suggests ways to plan for it.]

Optional: ☞ J. Charles Smith, Robert Thresher, Robert Zavadil, Edgar DeMeo, Richard Piwko, Bernhard Ernst, and Thomas Ackermann, 2009, A Mighty Wind. *IEEE Power and Energy Magazine*, March/April 2009. DOI 10.1109/MPE.2008.931492 [Near term outlook for wind. Expansion past 20% will require improved integration into the grid. This has some updates on cost of recent projects, then delves into technical analysis of integration of wind onto the grid.]

#### Class 13 a, 10 May

Developing country renewables

☞ Daniel M. Kammen, 1999, "Bringing Power to the People." *Environment* 14(5): 10-15, 34-41. [Reviews policies for renewables in developing countries, evaluating successes and failures. Focus on "institutional capacity" as critical for success. Proposes policy foci, for example, to fund institutions rather than projects, based on this review.]

☞ Ashok Gadgil, 1994, "Development, Environment, and Energy Efficiency" pp 451-466 in Socolow, Andrews, Berkhout and Thomas (eds), *Industrial Ecology and Global Change*. Cambridge Univ Press. [An attempt to invest in a compact fluorescent lamp factory in India illustrates the market and institutional barriers to energy efficiency.]

☞ Kirk R. Smith, Gu Shuhua, Huang Kun and Qiu Daxiong, 1993, "One hundred million improved cookstoves in China: How was it done?" *World Development* 21(6):941-961. [The largest energy efficiency

program on the planet. Program success was due to administration, institutional structure, and perhaps political culture; technology was not the driving force.]

Optional: ☞ Gautam S. Dutt and N.H. Ravindranath, "Bioenergy: Direct applications in cooking" *Renewable Energy*, pp 653-698. [A thorough analysis of potential rural cooking systems: technical potential, environmental and health impacts, and user acceptance. This is a model of what to consider in rural technology evaluation (but see "cooking in the sunshine" for a different evaluation process).]

#### Class 13b, 12 May

Next generation wind and solar technologies

☞ Kroposki, B. R. Margolis, and D. Ton, 2009, Harnessing the Sun, An Overview of Solar Technologies. *IEEE Power and Energy Magazine* May/June 2009. [Good but non-quantitative overview of solar electric technologies.]

☞ Jörg Schlaich, Rudolf Bergermann, Wolfgang Schiel, Gerhard Weinrebe, (undated) Design of Commercial Solar Updraft Tower Systems – Utilization of Solar Induced Convective Flows for Power Generation. Manuscript. [This is a great description of the basic principles of the Solar Updraft system, also known as the Solar chimney. Unfortunately a manuscript, no publication information.]

(Optional) Ø Rich Garvine, 2009, “Resident Kinetic Energy of Western Boundary Currents and the Effects of Extracting Ocean Current Power“ manuscript, Not for circulation

☞ Bryan W. Roberts, David H. Shepard, et al, 2007, Harnessing High-Altitude Wind Power. *IEEE Transactions On Energy Conversion*, VOL. 22, NO. 1, March 2007. [Technology for tapping high-altitude winds for power generation.]

☞ Cristina L. Archer, and Ken Caldeira, 2009, Global assessment of high-altitude wind power. *Energies* 2009, 2, doi:10.3390/en20x000x [Resource analysis of high altitude winds to match with the Roberts et al on engineering.]

☞ Hardham, Corwin, 2011, The Makani Airborne Wind Turbine. *Windtech International*, January/February 2011, pp 29 - 31. [A teathered tirbine, with much lower-mass, that functions in lower wind speeds.]

#### Class 14 a -- last class, -- 17 May

**Policy proposal presentations, about 8 minutes each**

Wrapup lecture

**17 May, Written Policy Proposal Due**

® Monbiot, Chapter 11, “Apocalypse Postponed.” Pp 204 -215.

**19 May, Synthetic essay on IV due**

(Very optional, FYI: 22-25 May conference, Windpower 2011)

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