PubAff 809: Introduction to Energy Analysis and Policy

Fall, 2011
University of Wisconsin
La Follette School of Public Affairs
EnvSt-809, PubAff-809, URPL-809

3 credits
Room: 360 Science Hall
Tue., Thu. 9:30–10:45p
Webpage: Learn@UW

Instructor

Professor Greg Nemet

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Office hours, Fall 2011: Tuesday 11–noon, Thursday 11–noon, Room 209 La Follette. *Expect some changes over the semester, announced at least 1 week in advance.*

Course Description and Objectives

Heightened concern about both the availability of energy resources and their environmental impacts has increased demand for leaders and analysts who can navigate the political, economic, scientific, and technological dimensions of these issues to inform critical policy decisions. Few are able to do so; and those who can provide valuable insight. In this course, you will develop an understanding of the dynamics of the global energy system, focusing on ways that public policy can affect these changes in societally beneficial directions. The perspective taken is that of a policy maker confronting decisions about the design and implementation of energy policy. The goal of this course is for you to master a set of simple tools that will enable you to independently analyze problems, and be able to critically assess the work of others.

Students will become familiar with the breadth of energy-related problems at stake through development of methods, tools, and perspectives to analyze them. Topics covered span the full life cycle of energy production and use, including: material extraction, energy conversion, power generation, energy transportation, end use, and environmental impacts. The class surveys the types of energy used historically—from traditional biomass, to coal, to natural gas, to nuclear and renewables, as well as the increasingly diverse possibilities for future use discussed in current policy debates. Coverage also includes a historical review of regulation and policy in the energy industry. The geographic scope is international.

The field of energy analysis and policy is inherently interdisciplinary. As such the class draws on a set of tools and perspectives derived from multiple disciplines, and includes students from diverse backgrounds. While students are welcome to take this course alone, this course is the introductory seminar for the *Energy Analysis and Policy* certificate program and as such provides preparation for subsequent courses in the program.

Requirements

The reading load for this class is typical for a graduate-level class; students are expected to read the required texts before class and participate actively in class discussions. Four problem sets will help develop analytical tools and methods. There will be a midterm exam and a final exam, both of which will include qualitative and quantitative questions.

Evaluation

5% Class participation.
30% Four problem sets.
30% Midterm exam.
35% Final exam.

Readings

There are two required books for this course, which are available at the UW Bookstore:

- Rubin, E. S. (2001). Introduction to Engineering and the Environment. Boston, McGraw-Hill.
- Smil, V. (2005). Energy at the crossroads: global perspectives and uncertainties. Cambridge, MA, MIT Press.

All other readings are available on the Learn@UW website.

Instructor's Bio

Gregory Nemet is an assistant professor at the University of Wisconsin in the La Follette School of Public Affairs and the Nelson Institute Center for Sustainability and the Global Environment (SAGE). He is also a member of the university's Energy Sources and Policy Cluster and a senior fellow at the U.W. Center for World Affairs and the Global Economy (WAGE). His research and teaching focus on improving analysis of the environmental, social, economic, and technical dynamics of the global energy system. This work is motivated by a general interest in understanding how to expand access to energy services while reducing environmental impacts. He teaches courses in energy systems analysis, governance of global energy problems, and international environmental policy. His research analyzes the process of technological change in energy and its interactions with public policy. He is an author for the Intergovernmental Panel on Climate Change (IPCC) and the Global Energy Assessment (GEA). He received his doctorate in energy and resources from the University of California, Berkeley.

Class Schedule and Reading List

1) September 6:

Cheap, clean, and reliable: three energy policy challenges

- Nixon, R. M. (1974). State of the Union Address. Washington, D.C.
- Obama, B. (2010). Remarks by the President on Energy (6/29/09).

optional:

- Stewart, J. (2010). "An Energy-Independent Future"
- Carter, J. (1979). The "Crisis of Confidence" Speech.
- Gore, A. (2008). Energy Speech: "A Generational Challenge to Repower America".
- Holdren, J. P. (2001). "Meeting the energy challenge." Science 291(5506): 945-945.

2) September 8:

Historical development of the production and use of energy

- Smil (2005) ix: Reflections on a life of energy studies
- Smil (2005) Ch. 1: Long term trends and achievements

optional:

- Hamilton, J. (2011). Historical Oil Shocks. Berkeley, CA, UC Center for Energy and Environmental Economics.
- Fouquet, R. and P. J. G. Pearson (1998). "A thousand years of energy use in the United Kingdom." The Energy Journal 19(4): 1-41.

3) September 13:

EAP Tools 1: Units, magnitudes, and rates of change

- Smil (2005) Ch. 3: Against forecasting
- Koomey, J. G. (2001). Turning Numbers into Knowledge. Oakland, CA, Analytics Press, pp 125–141.
- Norgaard (1996) "About calculations and unit conversions."
- Holdren, Harte, and Koomey, "Constants and conversions."
- Rubin 681–683

optional:

- Waggoner, P. E. and J. H. Ausubel (2002). "A framework for sustainability science: A renovated IPAT identity." Proceedings of the National Academy of Sciences of the United States of America 99(12): 7860-7865.
- Lovins, A. B. (1976). "Energy Strategy: The Road Not Taken?" Foreign Affairs 55(1): 65-96.

4) September 15:

EAP Tools 2 : Combustion

- Smil (2005) Ch. 2: Energy Linkages
- Rubin, Ch 1
- Rubin, Ch 2
- Masters, G. (1991). Introduction to Environmental Engineering and Science. New Jersey, Prentice Hall: 39–47.

recommended:

- Swartz, C. E. (1993). Used Math for the First Two Years of College Science, American Association of Physics Teachers. [Ch 1 and 2]

Problem set #1 handed out

5) September 20:

Energy and development

- Bose, S. (1993). Chapter 5. Women, Work, and Household Electrification in Rural India. Bombay, Oxford University Press: 143–181.
- IEA (2002). Energy and Poverty. World Energy Outlook 2002. Paris, International Energy Agency (2002).
- Asaduzzaman, M., D. F. Barnes, et al. (2010). Restoring Balance: Bangladesh's Rural Energy Realities. Washington, The World Bank. [Read: Executive Summary and Chapter 2]
- Rubin 15.4, 15.5

optional:

- Goldemberg, J. (1996). Energy, Environment, and Development. London, Earthscan: 11–37.
- Barnes, D. and M. A. Toman (2004). Energy, Equity and Economic Development. New York, Columbia University, Initiative for Policy Dialogue.

6) September 22:

Traditional biomass and hydropower

- Smil (2005) Ch. 5: Nonfossil energies (p246–271 on hydropower and biomass)
- Leach, G. (1992). "The Energy Transition." Energy Policy 20(2): 116-123.
- Xiaohua, W. and F. Zhenmin (2001). "Rural household energy consumption with the economic development in China: stages and characteristic indices." Energy Policy 29(15): 1391-1397.
- WCD (2000). Executive Summary. Dams and Development: A New Framework for Decision-Making. South Africa, World Commission on Dams.

optional:

- Cullenward, D. and D. Victor (2006). "The Dam Debate and its Discontents." Climatic Change 75(1): 81-86.

Problem set #1 due

7) September 27:

Fossil fuels: coal and gas

- Smil (2005) Ch. 4: Fossil fuel futures (p213–238 on gas and coal)
- MIT (2007). The Future of Coal: options for a carbon constrained world. Cambridge, MA, Massachusetts Institute of Technology. *read pp ix–xv, 1–41, 95–105.*
- Tussing, A. R. and B. Tippee (1995). The Natural Gas Industry: Evolution, Structure, and Economics, PennWell Books, pp1–23.
- Bohannon, J. (2008). "Weighing the Climate Risks of an Untapped Fossil Fuel." Science 319(5871): 1753.

optional:

- Victor, D., A. M. Jaffe, et al. (2006). Natural Gas and Geopolitics: From 1970 to 2040, Cambridge University Press, [Ch 1 and Ch 14]

8) September 29:

EAP Tools 3: Power plant operation and efficiency

- Rubin, 5.1–5.4
- Randolph, J. and G. M. Masters (2008). Energy for sustainability: technology, planning, policy. Washington, Island Press. [pp 364–374]

Problem set #2 handed out

9) October 4:

EAP Tools 4: Life cycle analysis

- Rubin, Ch. 7
- Fthenakis, V. M. and H. C. Kim (2007). "Greenhouse-gas emissions from solar electric- and nuclear power: A life-cycle study." Energy Policy.
- The Economic Input-Output Life Cycle Assessment tool `http://www.eiolca.net/`

optional:

- Hendrickson, C., A. Horvath, et al. (1998). "Economic input-output models for environmental life-cycle assessment." Environmental Science & Technology 32(7): 184A-191A.

- Bergerson, J. and L. Lave (2007). "The long-term life cycle private and external costs of high coal usage in the US." Energy Policy 35(12): 6225-6234.

10) October 6:

EAP Tools 5: Engineering economics for policy analysis

- Rubin, Ch. 13

optional:

- Anderson, D. (2006). Costs and Finance of Abating Carbon Emissions in the Energy Sector. Cambridge, UK, A report prepared for the HM Treasury Stern Review on The economics of climate change.

Problem set #2 due

11) October 11:

Transmission and distribution

- Meier, S. v. (2006). Electric Power Systems: A Conceptual Introduction, Wiley: IEEE Press. [Ch 6]
- Fairley, P. (2001). "A Smarter Power Grid." Technology Review: 41–49.
- Maris, E. (2008). "Energy: Upgrading the grid." Nature 454: 570-573.

12) October 13:

Power Plant tour

West Campus Co-generation Facility

- *Logistical details available on Learn@UW*
- WCCF Technical fact sheet
- WCCF Air quality fact sheet

13) October 18:

The electricity industry, markets, and restructuring

- Joskow, P. (2000). Deregulation and Regulatory Reform in the US Electric Power Sector. Cambridge, MA, Massachusetts Institute of Technology, Center for Energy and Environmental Policy Research, pp 1–17.
- Borenstein, S. (2002). "The trouble with electricity markets: Understanding California's restructuring disaster." Journal of Economic Perspectives 16(1): 191-211.

optional:

- Dahl, C. (2004). International Energy Markets: Understanding Pricing, Policies and Profits, Pennwell Books. [Ch 4]

14) October 20:

Nuclear power

- Smil (2005) Ch. 5: nonfossil energies (p309–316 on nuclear)
- Rubin 2.6, 5.6.1,
- Deutch, J., E. Moniz, et al. (2003). The Future of Nuclear Power: An Interdisciplinary MIT Study. Cambridge, MA, Massachusetts Institute for Technology. *Read summary*
- Peterson, P. F., W. E. Kastenberg, et al. (2006). "Nuclear waste and the distant future." Issues in Science and Technology 22(4): 47-50.
- Deutch, J. M. and E. J. Moniz (2006). "The nuclear options." Scientific American 295(3): 76-83.
- Goldemberg, J. (2007). "The limited appeal of nuclear energy." Scientific American 297(1): 38-40.

optional:

- MIT Study, full report
- Tolley, G. S. and D. W. Jones (2004). The Economic Future of Nuclear Power, University of Chicago.

Problem set #3 handed out

15) October 25:

Wind power

- Smil (2005) Ch. 5: nonfossil energies (p239–245 and 272–283 on wind)
- Rubin 5.6.5
- Wiser, R. and M. Bolinger (2010). 2008 Wind Technologies Market Report. Berkeley, CA, Lawrence Berkeley National Laboratory.
- Lewis, J. I. and R. H. Wiser (2007). "Fostering a renewable energy technology industry: An international comparison of wind industry policy support mechanisms." Energy Policy 35(3): 1844-1857.

optional:

- Nemet, G. F. (2010). "Demand-pull, technology-push, and government-led incentives for non-incremental technical change." Research Policy 38(5): 700-709.
- Lu, X., M. B. McElroy, et al. (2010). "Global potential for wind-generated electricity." Proceedings of the National Academy of Sciences 106(27): 10933-10938.

16) October 27:

Solar power

- Smil (2005) Ch. 5: nonfossil energies (p284–296 on solar and other renewables)
- Rubin 5.6.7
- Lewis, N. S. (2007). "Toward Cost-Effective Solar Energy Use." Science 315(5813): 798-801.
- Zweibel, K., J. Mason, et al. (2008). "A Solar Grand Plan." Scientific American(January): 64–73.
- Wiser, R., G. Barbose, et al. (2010). Tracking the sun: The installed cost of Photovoltaics from 1998–2007, Lawrence Berkeley National Laboratory.

optional:

- Nemet, G. F. (2006). "Beyond the learning curve: factors influencing cost reductions in photovoltaics." Energy Policy 34(17): 3218-3232.
- Borenstein, S. (2008). The Market Value and Cost of Solar Photovoltaic Electricity Production. Berkeley, CA, University of California Energy Institute's Center for the Study of Energy Markets.
- Brightsource (2008). "PG&E Signs Contracts With Brightsource Energy For Up To 900 Megawatts Of Solar Thermal Power."
- Butler, D. (2008). "Thin films: ready for their close-up?" Nature 454: 558-559.

Problem set #3 due

17) November 1:

MIDTERM EXAM

18) November 3:

Biofuels and lifecycle analysis

Guest lecture: Dr. Paul Meier, U.W. Energy Institute

- Hill, J., E. Nelson, et al. (2006). "Environmental, economic, and energetic costs and benefits of biodiesel and ethanol biofuels." Proceedings of the National Academy of Sciences of the United States of America 103(30): 11206-11210.
- Farrell, A. and M. O'Hare (2008). Greenhouse gas (GHG) emissions from indirect land use change (LUC). Berkeley, CA, University of California.

19) November 8:

Mobility and transportation energy

- Schafer, A. and D. G. Victor (2000). "The future mobility of the world population." Transportation Research Part A: Policy and Practice 34(3): 171-205.
- Rubin Ch 3
- Yergin, D. (1991). The Prize: The Epic Quest for Oil, Money, and Power. New York, Simon and Schuster. [prologue]
- Davis, S., S. Diegel, et al. (2008). Transportation Energy Data Book. Oak Ridge, TN, U.S. Department of Energy. *(browse)*

optional:

- Greene, D. L. (1998). "Why CAFE worked." Energy Policy 26(8): 595-613.
- Simmons, M. R. (2007). Another Nail in the Coffin of the Case Against Peak Oil.
- Schaeffer, A. (2007). "Long-Term Trends in Global Passenger Mobility." The Bridge 36(4).

20) November 10:

Storage: Batteries, PHEVs, H_2, and fuel cells

- Smil (2005) Ch. 5: nonfossil energies (p296–309 on hydrogen)
- Sperling, D. and D. Gordon (2008). "Advanced Passenger Transport Technologies." Annual Review of Environment and Resources 33(1): 63.
- Romm, J. (2004). "The Hype about Hydrogen." Issues in Science and Technology.
- Sperling, D. and J. Ogden (2004). "The Hope for Hydrogen." Issues in Science and Technology.

optional:

- Samaras, C. and K. Meisterling (2008). "Life Cycle Assessment of Greenhouse Gas Emissions from Plug-in Hybrid Vehicles: Implications for Policy." Environ. Sci. Technol. 42(9): 3170-3176.
- Lemoine, D. M., D. M. Kammen, et al. (2008). "An innovation and policy agenda for commercially competitive plug-in hybrid electric vehicles." Environmental Research Letters(1): 014003.

21) November 15:

EAP Tools 6: Resource depletion, Hubbert and Hotelling

- Smil (2005) Ch. 4: Fossil fuel futures (p181-213 on oil)
- Hubbert, M. K. (1949). "Energy from Fossil Fuels." Science 109(2823): 103-109.
- Ahlbrandt, T. (2002). "Future Petroleum Energy Resources of the World." International Geology Review 44(12): 1092 - 1104.

- Farrell, A. E. and A. R. Brandt (2006). "Risks of the oil transition." Environmental Research Letters 1(1): 014004.
- Kerr, R. A. (2010). "How Much Coal Remains?" Science 323(5920): 1420-1421.

optional:

- Devarajan, S. and A. C. Fisher (1981). "Hotelling's 'Economics of Exhaustible Resources': Fifty Years Later." Journal of Economic Literature 19(1): 65-73.

22) November 17:

EAP Tools 7: Modeling technological change

- Rubin ch 15, (read 15.6 particularly closely)
- McDonald, A. and L. Schrattenholzer (2001). "Learning Rates for Energy Technologies." Energy Policy 29: 255-261.
- Fouquet, R. (2010). "The slow search for solutions: Lessons from historical energy transitions by sector and service." Energy Policy 38(11): 6586-6596.

optional:

- Grübler, A., N. Nakicenovic, et al. (1999). "Dynamics of Energy Technologies and Global Change." Energy Policy 27: 247-280.

23) November 22:

Energy efficiency

- Smil (2005) Ch. 6: Possible futures (p317–338 on efficiency)
- Rubin Ch 6.6–6.8, pp 262–275
- Gillingham, K., R. Newell, et al. (2006). "Energy Efficiency Policies: A Retrospective Examination." Annual Review of Environment and Resources 31(1): 161-192.
- Tietenberg, T. (2010). "Reflections–Energy Efficiency Policy: Pipe Dream or Pipeline to the Future?" Rev Environ Econ Policy: rep004.
- Charles, D. (2010). "Leaping the Efficiency Gap." Science 325(5942): 804-811.

optional:

- Lovins, A. (2007). Energy Myth Nine—Energy Efficiency Improvements Have Already Maximized Their Potential. Energy and American Society Thirteen Myths, Springer.
- Vine, E., M. Kushler, et al. (2007). Energy Myth Ten—Energy Efficiency Measures are Unreliable, Unpredictable, and Unenforceable. Energy and American Society Thirteen Myths, Springer.

Problem set #4 handed out

November 24

No class: Thanksgiving

24) November 29:

EAP Tools 8: Climate change and the energy system

- Smil (2005) Ch. 6: Possible futures (p339–349 on energy and the biosphere)
- Rubin Ch 12
- IPCC (2007). Climate change 2007: Mitigation. Contribution of Working group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom and New York, NY, USA, Cambridge University Press.
- Edmonds, J. and S. J. Smith (2006). The Technology of Two Degrees. College Park, MD, Pacific Northwest National Laboratory, Joint Global Change Research Institute, at the University of Maryland.

optional:

- IEA (2008). Energy Technology Perspectives: Scenarios and Strategies to 2050. Paris, International Energy Agency.

25) December 1

Public policy and low-carbon energy technologies

- Hoffert, M. I., K. Caldeira, et al. (2002). "Advanced technology paths to global climate stability: Energy for a greenhouse planet." Science 298(5595): 981-987.
- Letters in response to Hoffert et al.
- Pacala, S. and R. Socolow (2004). "Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies." Science 305: 968-972.
- Pielke, R., T. Wigley, et al. (2008). "Dangerous Assumptions." Nature 452(7187): 531-532.

optional:

- Nemet, G. F. and D. M. Kammen (2007). "U.S. energy research and development: Declining investment, increasing need, and the feasibility of expansion." Energy Policy 35(1): 746-755.
- Prins, G., I. Galiana, et al. (2010). The Hartwell Paper: a new direction for climate policy after the crash of 2009. London, London School of Economics.

26) December 6:

U.S. energy policy in the 1970s

- Nixon, R. M. (1974). State of the Union speech.
- Lovins, A. B. (1976). "Energy Strategy: The Road Not Taken?" Foreign Affairs 55(1): 65-96.

- Carter, J. (1979). The "Crisis of Confidence" Speech.

27) December 8:

Contemporary U.S. energy policy

- Smil (2005) Ch. 6: Possible futures (p349–373)
- Randolph, J. and G. M. Masters (2008). A brief chronology of U.S. Federal Energy Policy. Energy for sustainability: technology, planning, policy. Washington, Island Press: 681.
- Holdren, J. P., W. K. Reilly, et al. (2004). Ending the Energy Stalemate: A Bipartisan Strategy to Meet Americas Energy Challenges. Washington, DC, The National Commission on Energy Policy.
- Obama, B. (2009). Remarks by the President on Energy (6/29/09).
- Long, J. C. S. (2008). "A Blind Man's Guide to Energy Policy." Issues in Science and Technology.

optional:

- Cheney, R. (2001). National Energy Policy. Washington, DC, National Energy Policy Development Group, Office of the Vice President.
- Revkin (2008) "Can Climate Campaigns Withstand a Cooling Test?" Dot Earth - New York Times blog.

Problem set #4 due

28) December 13:

International energy governance

- Florini, A. and B. K. Sovacool "Who governs energy? The challenges facing global energy governance." Energy Policy In Press, Corrected Proof.
- Van de Graaf, T. and D. Lesage (2010). "The International Energy Agency after 35years: Reform needs and institutional adaptability." The Review of International Organizations.
- Suding, P. H. and P. Lempp (2010). "The Multifaceted Institutional Landscape and Processes of International Renewable Energy Policy." International Association of Energy Economics: 4–9.

optional:

- Witte, J.-M. (2010). Governing Global Oil in the 21st Century: Trends, Challenges and Policy Implications for the Transatlantic Alliance. Berlin, Global Public Policy Institute.
- Wood, G. (2010). "Re-Engineering the Earth." The Atlantic.

29) December 15

Discussion and Review

December 16:

FINAL EXAM
10:00-12:00, location: TBD

ADDITIONAL RESOURCES:

Energy Journals

Annual Review of Energy and the Environment, Ecological Economics, Energy Economics, Energy Policy, Energy, The Energy Journal, Environmental Research Letters, Environmental Science and Technology, Issues in Science and Technology, Nature, Renewable and Sustainable Energy Reviews, Resource and Energy Economics, Science.

Energy Data

International Energy Agency `http://www.iea.org/`
U.S. Energy Information Administration `http://www.eia.doe.gov/`
BP Statistical Review of World Energy `http://www.bp.com/`
U.S. Bureau of Economic Analysis `http://www.bea.gov/`
U.S. D.o.E. Energy Citations Database `http://www.osti.gov/energycitations/`
U.S. Statistical Abstract `http://www.census.gov/compendia/statab/`
CIA Factbook `https://www.cia.gov/library/publications/the-world-factbook/`
Wisconsin Energy Statistics `http://power.wisconsin.gov/`

Other Help

– Scientific notation `http://www.nyu.edu/pages/mathmol/textbook/scinot.html`
– Swartz, C. E. (1993). Used Math for the First Two Years of College Science, American Association of Physics Teachers.