PubAff 809: Introduction to Energy Analysis and Policy

Fall, 2017
University of Wisconsin
EnvSt-809, PubAff-809, URPL-809

3 credits
Room: 175 Science Hall
Tue., Thu. 9:30–10:45am

Instructor

Professor Greg Nemet

La Follette School of Public Affairs and Nelson Institute for Environmental Studies
209 Observatory Hill Office Bldg. email: `nemet@wisc.edu`

Office hours, Fall 2017: Tuesday 11–noon, Thursday 11–noon, Room 209 La Follette. *Expect some changes over the semester, announced at least 1 week in advance.*

Teaching Assistant: David Abel, email: `dwabel@wisc.edu`
Office hours: Mon. 11–12p, Wed. 3–4p, in Room 175A Science Hall

Grader: Emily Howell, email: `elhowell@wisc.edu`

Course Description

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.

Learning Objectives

The goal of this course is for students to master a set of simple tools that will enable them 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. It emphasizes the learning objectives of *Knolwedge*, *Applied Research*, and *Professional Skills* within the LaFollette School of Public Affairs MPA and MIPA programs.

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. Five 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.

Please note that I do not distribute problem sets or solutions electronically—although I do accept completed problem sets electronically if necessary. Keep this in mind for your planning of research travel etc. during the semester.

Also note that I will work with students to accommodate absences for Eid-al-Adha, Rosh Hashana, Yom Kippur, and other religious holidays.

People with disabilities will be fully included in this course. Please inform me if you need any special accommodations in the curriculum, instruction, or assessments of this course to enable you to participate fully. Confidentiality of the shared information will be strictly maintained. Certain accommodations may require the assistance of the UW-Madison McBurney Disability Office - http://www.mcburney.wisc.edu/.

Evaluation

5% Class participation.
30% Five 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.
- Yergin, D. (2011). The Quest: Energy, Security, and the Remaking of the Modern World, Penguin.

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

Instructor Bios

Gregory Nemet is an associate 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 chair of the Energy Analysis and Policy (EAP) certificate program. 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 received a Romnes Faculty Fellowship in 2015 and an Andrew Carnegie Fellowship in 2017. He has been 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. His A.B. is in geography and economics from Dartmouth College.

David Abel is a PhD student in Environment and Resources working on the effects of changes in the energy system on air pollution.

Emily Howell is a PhD student in Environment and Resources working on science communication and its effects on political polarization.

Class Schedule and Reading List

1) September 7:

Cheap, clean, and reliable: three energy policy challenges

- Energy Primer (section 1.1) GEA (2012). Global Energy Assessment - Toward a Sustainable Future. Cambridge University Press, Cambridge, UK and New York, NY, USA and the International Institute for Applied Systems Analysis, Laxenburg, Austria.
- Yergin: Introduction
- Nixon, R. M. (1974). State of the Union Address. Washington, D.C.

optional:

- Carter, J. (1979). The "Crisis of Confidence" Speech.
- Holdren, J. P. (2001). "Meeting the energy challenge." Science 291(5506): 945-945.
- Gore, A. (2008). Energy Speech: "A Generational Challenge to Repower America".
- Obama, B. (2009). Remarks by the President on Energy (6/29/09).

2) September 12:

Historical development of the production and use of energy

- Yergin: Prologue.
- GEA, Energy Primer (section 1.2–1.3)

optional:

- Smil, V. (2000). "Energy in the twentieth century: resources, conversions, costs, uses, and consequences." Annual Review of Energy and Environment 25: 21-51.
- 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.
- Interview with Daniel Yergin

3) September 14*:

EAP Tools 1: Units, magnitudes, and rates of change
**** Optional math review session in afternoon.***

- GEA, Energy Primer (section 1.4–1.5)
- Rubin 524–529, section 12.9.1 on IPAT.
- Rubin 681–683
- 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."

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.

Problem set #1 handed out

4) September 19:

EAP Tools 2 : Combustion

- GEA, Energy Primer (section 1.6–1.7)
- Rubin: Ch 1
- Rubin: Ch 2

recommended:

- Swartz, C. E. (1993). Used Math for the First Two Years of College Science, American Association of Physics Teachers. [Ch 1 and 2]
- Masters, G. (1991). Introduction to Environmental Engineering and Science. New Jersey, Prentice Hall: 39–47.

5) September 21:

Energy and development, Part I

- GEA, Energy Primer (section 1.8)
- (ExecSumm + Sec. 2.1–2.4) Karekezi, S., et al. (2012). Chapter 2 - Energy, Poverty and Development. Global Energy Assessment. Cambridge University Press, Cambridge, UK and New York, NY, USA and the International Institute for Applied Systems Analysis, Laxenburg, Austria: 151-190.
- Bose, S. (1993). Chapter 5. Women, Work, and Household Electrification in Rural India. Bombay, Oxford University Press: 143–181.

optional:

- Rubin 15.4, 15.5
- (See especially Exec. Summary and Introduction) IEA (2014). Africa Energy Outlook. Paris, International Energy Agency (IEA).
- Oparaocha, S. and S. Dutta (2011). "Gender and energy for sustainable development." Current Opinion in Environmental Sustainability 3(4): 265-271.
- Barnes, D. F. (2011). "Effective solutions for rural electrification in developing countries: Lessons" Current Opinion in Env. Sustainability 3(4): 260-264.

Problem set #1 due

6) September 26:

Energy and development, Part II

- Yergin: 9. China's Rise
- Yergin: 10. China in the Fast Lane
- (Sec. 2.5–2.12) Karekezi, S., S. McDade, et al. (2012). GEA Chapter 2 - Energy, Poverty and Development.

optional:

- 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.

7) September 28:

EAP Tools 3: Power plant operation and efficiency

- Rubin: 5.1–5.4
- Yergin: 20. Fuel Choice
- Randolph, J. and G. M. Masters (2008). Energy for sustainability: technology, planning, policy. Washington, Island Press. [pp 364–374]
- Wu, X., J. Shen, Y. Li and K. Y. Lee (2015). "Steam power plant configuration, design, and control." Wiley Interdisciplinary Reviews: Energy and Environment.

optional:

- Friedmann, J. (2011). "Carbon Capture and Green Technology: Environmentalism's Step Forward–and Two Steps Back " Foreign Affairs.

Problem set #2 handed out

8) October 3:

Fossil fuels: coal and gas

- Yergin: 16. The Natural Gas Revolution
- 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.*

optional:

- Yergin: 15. Gas on Water
- Tussing, A. R. and B. Tippee (1995). The Natural Gas Industry: Evolution, Structure, and Economics, PennWell Books, pp1–23.

- Victor, D., A. M. Jaffe, et al. (2006). Natural Gas and Geopolitics: From 1970 to 2040, Cambridge University Press, [Ch 1 and Ch 14]
- Bohannon, J. (2008). "Weighing the Climate Risks of an Untapped Fossil Fuel." Science 319(5871): 1753.
- MIT (2010). The Future of Natural Gas: An Interdisciplinary MIT Study, Massachusetts Institute of Technology (MIT).

9) October 5:

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.
- Hall, C. A., J. G. Lambert and S. B. Balogh (2014). "EROI of different fuels and the implications for society." Energy Policy 64: 141-152.
- The Economic Input-Output Life Cycle Assessment tool `http://www.eiolca.net/`

optional:

- Renssen (2011). "What's in a name?" Nature Clim. Change 1(5): 241-242.
- 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.

Problem set #2 due

10) October 10:

EAP Tools 5: Engineering economics for policy analysis

- GEA, Energy Primer (section 1.9)
- Rubin: Ch. 13
- Borenstein, S. (2013). "The Private and Public Economics of Renewable Electricity Generation." Journal of Economic Perspectives 26(1): 67-92.

optional:

- Lazard (2014). Lazard's Levelized Cost of Energy Analysis, Version 8.0.
- 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.

11) October 12:

Transmission and distribution

- Yergin: 17. Alternating Currents
- 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.

optional:

- DOE (2006). National electric transmission congestion study, Washington, DC: US Department of Energy, Office of Electricity Delivery & Energy Reliability. August.

Problem set #3 handed out

12) October 17:

The electricity industry, markets, and restructuring

- Yergin: 19. Breaking the Bargain
- Hirsch, R. F. (1999). Creation of the Utility Consensus. Power Loss: The Origins of Deregulation and Restructuring in the American Electric Utility System. Cambridge, MA, The MIT Press.
- Borenstein, S. and J. Bushnell (2015). "The U.S. Electricity Industry After 20 Years of Restructuring." National Bureau of Economic Research Working Paper Series No. 21113.

optional:

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

13) October 19:

Nuclear power (*Guest lecture Prof. Paul Wilson*)

- Yergin: 18. The Nuclear Cycle
- 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*
- 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:

- Hannum, W. H. (2014). "Modern and future nuclear fuel cycles and the relationship with nuclear waste management." Wiley Interdisciplinary Reviews: Energy and Environment 3(4): 323-329.
- MIT Study, full report
- Ongena, J. and Y. Ogawa (2016). "Nuclear fusion: Status report and future prospects." Energy Policy 96: 770-778.

Problem set #3 due

14) October 24:

Wind power

- Yergin: 27. Rebirth of Renewables
- Yergin: 30. Mystery of Wind
- Rubin 5.6.5
- Wiser, R. H. and M. Bolinger (2017). 2016 Wind Technologies Market Report.

optional:

- Nemet, G. F. (2009). "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.
- 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.

15) October 26:

MIDTERM EXAM

16) October 31:

Solar power

- Yergin: 29. Alchemy of Shining Light
- Rubin 5.6.7
- Barbose, G. L. and N. R. Darghouth (2016). Tracking the Sun IX: The Installed Price of Residential and Non-Residential Photovoltaic Systems in the United States.
- Nemet, G. F. (2006). "Beyond the learning curve: factors influencing cost reductions in photovoltaics." Energy Policy 34(17): 3218-3232.

optional:

- Baker, E., M. Fowlie, et al. (2013). "The economics of solar electricity." Annual Review of Resource Economics 5(1).
- 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.
- Butler, D. (2008). "Thin films: ready for their close-up?" Nature 454: 558-559.

17) November 2:

Energy and Air Pollution (*Guest lecture David Abel*)

- Readings to be determined.

18) November 7:

Mobility and transportation energy

- Yergin: 34. Internal Fire
- Rubin: Ch 3
- 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.
- 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).

19) November 9:

Storage: Batteries, PHEVs, H_2, and fuel cells

- Yergin: 35. The Great Electric Car Experiment
- Bakker, S., H. van Lente, et al. (2012). "Competition in a technological niche: the cars of the future." Technology Analysis & Strategic Management 24(5): 421-434.
- Tran, M., D. Banister, et al. (2012). "Realizing the electric-vehicle revolution." Nature Climate Change 2(5): 328-333.
- Sperling, D. and J. Ogden (2004). "The Hope for Hydrogen." Issues in Science and Technology.

optional:

- IEA (2013). Global EV Outlook: Understanding the Electric Vehicle Landscape to 2020.
- 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.
- Sperling, D. and D. Gordon (2008). "Advanced Passenger Transport Technologies." Annual Review of Environment and Resources 33(1): 63.

Problem set #4 handed out

20) November 14:

EAP Tools 6: Resource depletion, Hubbert and Hotelling

- Yergin: 11. Is the World Running Out of Oil?
- Yergin: 12. Unconventional
- Hubbert, M. K. (1949). "Energy from Fossil Fuels." Science 109(2823): 103-109.
- Farrell, A. E. and A. R. Brandt (2006). "Risks of the oil transition." Environmental Research Letters 1(1): 014004.

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.
- Ahlbrandt, T. (2002). "Future Petroleum Energy Resources of the World." International Geology Review 44(12): 1092 - 1104.
- Kerr, R. A. (2010). "How Much Coal Remains?" Science 323(5920): 1420-1421.

21) November 16:

EAP Tools 7: Modeling technological change

- Yergin: 28. Science Experiment
- Rubin ch 15, (read 15.6 particularly closely)
- Nemet, G. F. (2013). "Technological change and climate-change policy." Encyclopedia of Energy, Natural Resource and Environmental Economics. Ed: J. Shogren.
- Grubler, A. (2012). "Energy transitions research: Insights and cautionary tales." Energy Policy 50: 8–16.

optional:

- 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.
- Ridley, M. (2014). "The World's Resources Aren't Running Out." The Wall Street Journal.

Problem set #4 due

22) November 21:

Energy efficiency

- Yergin: 31. The Fifth Fuel—Efficiency
- Yergin: 32. Closing the Conservation Gap
- 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.
- Charles, D. (2010). "Leaping the Efficiency Gap." Science 325(5942): 804-811.

optional:

- Jenkins, J., T. Nordhaus, et al. (2011). Energy Emergence: Rebound And Backfire As Emergent Phenomena. Oakland, CA, The Breakthrough Institute.
- Lovins, A. (2007). Energy Myth Nine—Energy Efficiency Improvements Have Already Maximized Their Potential. Energy and American Society Thirteen Myths, Springer.
- Tietenberg, T. (2010). "Reflections–Energy Efficiency Policy: Pipe Dream or Pipeline to the Future?" Rev Environ Econ Policy: rep004.

November 23:

No class: Thanksgiving

23) November 28:

EAP Tools 8: Climate change and the energy system

- Yergin: 21. Glacial Change
- Yergin: 22. The Age of Discovery
- 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.

optional:

- Yergin: 23. The Road to Rio
- Krey, V. (2014). "Global energy-climate scenarios and models: a review." Wiley Interdisciplinary Reviews: Energy and Environment 3(4): 363-383.
- Wigley, T. M. L. and B. D. Santer (2013). "A probabilistic quantification of the anthropogenic component of twentieth century global warming." Climate Dynamics: 1-16.
- IEA (2008). Energy Technology Perspectives: Scenarios and Strategies to 2050. Paris, International Energy Agency.

Problem set #5 out

24) November 30

Climate policy and low-carbon energy technologies

- Yergin: 24. Making a Market
- Yergin: 25. On the Global Agenda
- 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.

optional:

- Rogelj, J., M. Schaeffer, P. Friedlingstein, N. P. Gillett, D. P. van Vuuren, K. Riahi, M. Allen and R. Knutti (2016). "Differences between carbon budget estimates unravelled." Nature Clim. Change 6(3): 245-252.
- 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.

25) December 5:

U.S. energy policy in the 1970s

- Yergin: 13. The Security of Energy
- 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.
- Graetz, M. (2011). The End of Energy: the Unmaking of America's environment, security, and independence. Cambridge, MA, MIT Press. (chronology)

optional:

- Stewart, J. (2010). "An Energy-Independent Future"
- Nixon (1973) "Project Independence" speech.

Problem set #5 due

26) December 7:

Contemporary U.S. energy policy

- Yergin: 26. In Search of Consensus
- Yergin: Conclusion: "A Great Revolution"
- White House (2014). "The All-Of-The-Above Energy Strategy as a Path to Sustainable Economic Growth", Executive Office of the President.
- Cheney, R. (2001). National Energy Policy. Washington, DC, National Energy Policy Development Group, Office of the Vice President.
- 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.

optional:

- Obama, B. (2013) Speech at Georgetown University (6/24/2013).
- Florini, A. and B. K. Sovacool (2009). "Who governs energy? The challenges facing global energy governance." Energy Policy 37(12): 52395248.
- Lipton, E. and C. Krauss (2011). A Gold Rush of Subsidies in the Search for Clean Energy. The New York Times.
- Revkin (2008) "Can Climate Campaigns Withstand a Cooling Test?" Dot Earth - New York Times blog.

27) December 12:

Discussion and Review

28) December 14:

FINAL EXAM
9-11am, 175 Science Hall.

ADDITIONAL RESOURCES:

Energy Journals

- Annual Review of Energy and the Environment
- Climatic Change
- Energy Economics
- Energy Policy
- Energy
- Energy Research & Social Science
- The Energy Journal
- Environmental Research Letters
- Environmental Science and Technology
- Issues in Science and Technology
- Nature Climate Change
- Renewable and Sustainable Energy Reviews
- Science
- Wiley Interdisciplinary Reviews: Energy and Environment

Energy Data

International Energy Agency `http://www.iea.org/`
U.S. Energy Information Administration `http://www.eia.doe.gov/`
E.IA. mapping `http://www.eia.gov/state/maps.cfm`
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/`
CIA Factbook `https://www.cia.gov/library/publications/the-world-factbook/`
Wisconsin Energy Statistics `http://www.stateenergyoffice.wi.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.