

# PubAff 809: Introduction to Energy Analysis and Policy

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Fall, 2019

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

209 Observatory Hill Office Bldg. email: [nemet@wisc.edu](mailto:nemet@wisc.edu)

Office hours, Fall 2019: 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:TBD

Office hours: Mon. 11–12p, Wed. 4–5p, in Room 175A Science Hall

Grader: TBD

## 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 *Knowledge*, *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. The course credit count of 3 is based on 45 Hours per Credit criterion, which equates to 9 hours of work per week for this class.

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.
- Nemet, G. F. (2019). *How Solar Energy Became Cheap: A Model for Low-Carbon Innovation*, Routledge.

All other readings are available on the Canvas website.

#### ACADEMIC INTEGRITY

By enrolling in this course, each student assumes the responsibilities of an active participant in UW-Madison's community of scholars in which everyone's academic work and behavior are held to the highest academic integrity standards. Academic misconduct compromises the

integrity of the university. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these acts are examples of academic misconduct, which can result in disciplinary action. This includes but is not limited to failure on the assignment/course, disciplinary probation, or suspension. Substantial or repeated cases of misconduct will be forwarded to the Office of Student Conduct & Community Standards for additional review. For more information, refer to [studentconduct.wiscweb.wisc.edu/academic-integrity/](http://studentconduct.wiscweb.wisc.edu/academic-integrity/).

#### A SAFE AND WELCOMING CLASSROOM

Diversity is a source of strength, creativity, and innovation for UW-Madison. We value the contributions of each person and respect the profound ways their identity, culture, background, experience, status, abilities, and opinion enrich the university community. We commit ourselves to the pursuit of excellence in teaching, research, outreach, and diversity as inextricably linked goals. Safe and welcoming classrooms encourage that continual and fearless sifting and winnowing by which alone the truth can be found by fostering an environment of free speech consistent with US law and safe from threats or violence. The University of Wisconsin-Madison fulfills its public mission by creating a welcoming and inclusive community for people from every background people who as students, faculty, and staff serve Wisconsin and the world.

#### MENTAL HEALTH RESOURCES

School is a context where mental health struggles can be exacerbated. If you ever find yourself struggling, please do not hesitate to ask for help. The University and larger Madison community offer mental health resources to support a range of psychological issues in a confidential and safe environment. Confidential Counseling Services: University Health Service (UHS) for 24/7 confidential consultation, 608-265-5600 (option 9).

#### INSTRUCTOR BIOS

**Gregory Nemet** is 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). 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, which he used to write a book on how solar energy became cheap. 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.

TA and grader: TBD

## Class Schedule and Reading List

### 1) September 5:

#### **Cheap, clean, and reliable: three energy policy challenges**

- Nemet: Foreword and Preface
- <https://www.howsolargotcheap.com>
- Energy Primer (section 1) GEA (2014). 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.

*optional:*

- 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 10\*:

*\* Optional math review session 3-4p.*

#### **U.S. energy policy 1973–2018**

- Nixon, R. M. (1974). State of the Union speech.
- Carter, J. (1979). The “Crisis of Confidence” Speech.
- White House (2014). “The All-Of-The-Above Energy Strategy as a Path to Sustainable Economic Growth”, Executive Office of the President.

*optional:*

- 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.

### 3) September 12:

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

- Nemet: Chapter 1 Introduction
- GEA, Energy Primer (section 4–5)
- Rubin 524–529, section 12.9.1 on IPAT.
- Rubin 681–683

*optional:*

- 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.”
- 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.
- 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*

#### 4) September 17:

##### **Historical development of the production and use of energy**

- Nemet: Chapter 2 Answer
- GEA, Energy Primer (section 2–3)

*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.

#### 5) September 19:

##### **EAP Tools 2 : Combustion**

- GEA, Energy Primer (section 6–7)
- Rubin: Ch 1
- Rubin: Ch 2

*recommended:*

- Masters, G. (1991). Introduction to Environmental Engineering and Science. New Jersey, Prentice Hall: 39–47.

*Problem set #1 due*

**6) September 24:****EAP Tools 3: Power plant operation and efficiency**

- Nemet Chapter 3 Science
- Rubin: 5.1–5.4
- 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.

**7) September 26:****Energy and development, Part I**

- GEA, Energy Primer (section 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 #2 handed out*

**8) October 1:****Energy and development, Part II**

- Nemet Chapter 4 US
- (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.

## 9) October 3:

### **Fossil fuels: coal and gas**

- 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:*

- 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).

*Problem set #2 due*

## 10) October 8:

### **EAP Tools 4: Levelized electricity costs for policy analysis**

- Nemet Chapter 5 Japan
- GEA, Energy Primer (section 9, A.6)
- Rubin: Ch. 13

*optional:*

- Borenstein, S. (2013). “The Private and Public Economics of Renewable Electricity Generation.” *Journal of Economic Perspectives* 26(1): 67-92.
- Lazard (2018). *Lazard’s Levelized Cost of Energy Analysis, Version 12.0*.
- 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 10:****Nuclear power** (*Guest lecture Prof. Mike Corradini*)

- 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 handed out*

**12) October 15:****Transmission and distribution**

- Nemet Chapter 6 Germany
- 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.

**13) October 17:****The electricity industry, markets, and restructuring**

- 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]

*Problem set #3 due*

#### **14) October 22:**

##### **Wind power**

- Nemet Chapter 7 China
- 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 24:**

##### **MIDTERM EXAM**

**16) October 29:****Solar power**

- Nemet Chapter 8 Local learning
- 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.

*optional:*

- Nemet, G. F. (2006). “Beyond the learning curve: factors influencing cost reductions in photovoltaics.” *Energy Policy* 34(17): 3218-3232.
- Baker, E., M. Fowle, 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) October 31:****Mobility and transportation energy**

- 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).

**18) November 5:****Discussion: how did solar energy become cheap?**

- Nemet: review chapters 1–8 for discussion, focus on Chapter 2
- Nemet Chapter 9 Solar as a Model to Follow

**19) November 7:****Storage: Batteries, PHEVs, H<sub>2</sub>, and fuel cells** (*Guest lecture: Will Sierzechula, Navigant Consulting*)

- 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 12:****EAP Tools 5: Resource depletion, Hubbert and Hotelling**

- Nemet Chapter 10 Applying the Model
- 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 14:****EAP Tools 6: Modeling technological change**

- 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 19:****Energy efficiency**

- Nemet Chapter 11 Accelerating Innovation
- Rubin Ch 6.6–6.8, pp 262–275
- Fowlie, M., M. Greenstone and C. D. Wolfram (2015). “Are the Non-Monetary Costs of Energy Efficiency Investments Large? Understanding Low Take-up of a Free Energy Efficiency Program.” *American Economic Review*.

*optional:*

- Charles, D. (2010). “Leaping the Efficiency Gap.” *Science* 325(5942): 804-811.
- Gillingham, K., R. Newell, et al. (2006). “Energy Efficiency Policies: A Retrospective Examination.” *Annual Review of Environment and Resources* 31(1): 161-192.
- 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.

**23) November 21:****EAP Tools 8: Climate change and the energy system**

- Rubin Ch 12
- IPCC (2014). Summary for Policymakers. Climate Change 2014, Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. O. Edenhofer, R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlmer, C. von Stechow, T. Zwickel and J.C. Minx. Cambridge, United Kingdom and New York, NY, USA, Cambridge University Press.

*optional:*

- 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.

**24) November 26****Climate 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.

*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.

*Problem set #5 out*

**November 28:**

*No class: Thanksgiving*

**25) December 3:****Discussion: How Can Solar Energy be a Model to Follow?**

- Nemet: review last 3 chapters (9–11) for discussion

*Problem set #5 due*

**26) December 5:****International energy governance**

- Florini, A. and B. K. Sovacool (2009). “Who governs energy? The challenges facing global energy governance.” *Energy Policy* 37(12): 52395248.
- Van de Graaf, T. and D. Lesage (2010). “The International Energy Agency after 35years: Reform needs and institutional adaptability.” *The Review of International Organizations*.

*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*.
- 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.

**27) December 10:**

**Review of semester**

**28) December 12:****FINAL EXAM**

9:30-11:30am, 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.I.A. 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.