PubAff 809: Introduction to Energy Analysis and Policy

Fall, 2023
University of Wisconsin–Madison
EnvSt-809, PubAff-809, URPL-809

3 credits
Tue., Thu. 9:30–10:45am, in-person
Room: 175 Science Hall
`https://canvas.wisc.edu/courses/361918`

Instructor

Professor Gregory Nemet

La Follette School of Public Affairs
209 Observatory Hill Office Bldg. email: `nemet@wisc.edu`

Office hours, Fall 2023: Tuesday 11–noon, Thursday 11–noon, Room 209 La Follette.
Grader: Louise Ferris: `alferris@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.

version: September 7, 2023

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.

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. This class meets for two, 75-minute class periods each week over the fall/spring semester and carries the expectation that students will work on course learning activities (reading, problem sets, studying, etc) for about 3 hours out of the classroom for every class period. The syllabus includes more information about meeting times and expectations for student work.

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:

- Blok, K. and E. Nieuwlaar (2020). *Introduction to Energy Analysis, 3rd edition* Taylor and Francis. ("B&N")
- 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 `https://conduct.students.wisc.edu`.

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). `https://www.uhs.wisc.edu/mental-health/`

Covid-19

Please regularly check this website for the latest on COVID-19 at UW:
`https://covidresponse.wisc.edu`

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) (`gregnemet.net`). 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 was a Lead Author for the Intergovernmental Panel on Climate Change 6th Assessment

Report 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.

Grader: **Louise Ferris** is a Masters student in the Dept. of Nuclear Engineering and Engineering Physics.

Class Schedule and Reading List

1) September 7:

Cheap, clean, and reliable: three energy policy challenges

- New York Times (August 2023) "The Clean Energy Future Is Arriving Faster Than You Think."
- B&N Chapter 1
- Nemet: Foreword and Preface

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 12*:

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

- B&N Chapter 2
- Energy Primer (sections 1,4, and 5) 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.
- Nemet, G. F. "Improving the crystal ball." Nat. Energy 2021 1–2 (2021)

**** Optional math review session 3–4p in La Follette School conference room.***

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]
- Kaya (1989) "Impact of Carbon Dioxide" IPCC meeting in Geneva.

3) September 14:

U.S. energy policy 1973–2022

- B&N Chapter 14
- Nixon, R. M. (1974). State of the Union speech.
- Carter, J. (1979). The "Crisis of Confidence" Speech.
- Biden, J. (2022). The Inflation Reduction Act (By the Numbers).

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.
- Bistline, J., Mehrotra, N., Wolfram, C., 2023. "Economic Implications of the Climate Provisions of the Inflation Reduction Act." Working Paper Series. https://doi.org/10.3386/w31267

Problem set #1 handed out

4) September 19:

Trends in production and use of energy

- Nemet: Chapter 1 Introduction
- Skim `https://www.howsolargotcheap.com`
- B&N Chapter 3
- GEA, Energy Primer (section 2–3)

optional:

- B&N Chapter 4
- 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 21:

EAP Tools 2 : Combustion
== asynchronous - lecture will be recorded and posted on Canvas ==

- Nemet: Chapter 2 Answer
- GEA, Energy Primer (section 6–7)

recommended:

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

Problem set #1 due

6) September 26:

EAP Tools 3: Power plant operation and efficiency

- Nemet Chapter 3 Science
- B&N Chapter 5.4, 5.5, 5.8
- 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 28:

Energy and development, Part I
Guest speaker: Board member of US Export Import Bank, Owen Herrnstadt

- 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:

- Che, X., Zhu, B. & Wang, P. "Assessing global energy poverty: An integrated approach." Energy Policy 149, 112099 (2021).

- (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 3:

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 5:

Fossil fuels: coal and gas

- B&N Chapter 6.1, 6.3, 6.4
- Lu and Nemet (2021) "Unraveling the Political Economy of Coal: Insights from the United States"

optional:

- Edwards, M. R. et al. (2021) "Repair Failures Call for New Policies to Tackle Leaky Natural Gas Distribution Systems." Environ. Sci. Technol. 55, 6561–6570.
- 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.
- 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 10:

EAP Tools 4: Levelized electricity costs for policy analysis

- Nemet Chapter 5 Japan
- B&N Chapter 11
- GEA, Energy Primer (section 9, A.6)
- Lazard (2021). Lazard's Levelized Cost of Energy Analysis, Version 15.0.

optional:

- B&N Chapter 7 and 9
- Borenstein, S. (2013). "The Private and Public Economics of Renewable Electricity Generation." Journal of Economic Perspectives 26(1): 67-92.
- 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

- Nemet Chapter 6 Germany
- B&N Chapter 5.6
- *read pp 11–23* 1. Gilstrap, Matt. "United States Electricity Industry Primer." US Department of Energy (2015).

optional:

- 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.
- 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
Guest speaker: Commissioner Tyler Huebner, Wisconsin Public Service Commission

- Hirsch, R. F. (1999). "Chapter 1. Creation of the Utility Consensus." Power Loss: The Origins of Deregulation and Restructuring in the American Electric Utility System. Cambridge, MA, The MIT Press.
- B&N Chapter 6.6
- *read pp 23–30* 1. Gilstrap, Matt. "United States Electricity Industry Primer." US Department of Energy (2015).
- 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

- 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.
- Ongena, J. and Y. Ogawa (2016). "Nuclear fusion: Status report and future prospects." Energy Policy 96: 770-778.

optional:

- Deutch, J., E. Moniz, et al. (2003). The Future of Nuclear Power: An Interdisciplinary MIT Study. Cambridge, MA, Massachusetts Institute for Technology.
- 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.

Problem set #3 due

14) October 24:

Wind power

- Nemet Chapter 7 China
- B&N Chapter 5.3
- Wiser, R. et al. "Land-Based Wind Market Report: 2021 Edition." (2021).

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:

Mobility and transportation energy

- B&N Chapter 6.2
- Schafer, A. W. & Yeh, S. "A holistic analysis of passenger travel energy and greenhouse gas intensities." Nat. Sustain. 2020 36 3, 459–462 (2020).
- 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.

optional:

- Davis, S., S. Diegel, et al. (2008). Transportation Energy Data Book. Oak Ridge, TN, U.S. Department of Energy. *(browse)*
- 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).

17) November 2:

Discussion: how did solar energy become cheap?

- Nemet: review chapters 1–8 for discussion, focus on Chapter 2
- Nemet Chapter 8 Local learning

18) November 7:

Solar power

- Nemet Chapter 9 Solar as a Model to Follow
- Barbose, G. L. and N. R. Darghouth (2022). "Tracking the Sun: Pricing and Design Trends for Distributed 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. 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.

19) November 9:

Energy efficiency

- Nemet Chapter 10 Applying the Model
- B&N Chapter 10
- Grubler, A. et al. "A low energy demand scenario for meeting the 1.5 °C target and sustainable development goals without negative emission technologies." Nat. Energy 3, 515–527 (2018).

optional:

- B&N Chapter 8 and 13
- 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.
- 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.

Problem set #4 handed out

20) November 14:

EAP Tools 5: Resource depletion, Hubbert and Hotelling

- Nemet Chapter 11 Accelerating Innovation
- B&N Chapter 5.1, 5.2
- Hubbert, M. K. (1949). "Energy from Fossil Fuels." Science 109(2823): 103-109.
- IEA. (2020) The Role of Critical Minerals in Clean Energy Transitions. (*read through page 41*)

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.
- Farrell, A. E. and A. R. Brandt (2006). "Risks of the oil transition." Environmental Research Letters 1(1): 014004.

21) November 16:

Storage: Batteries, PHEVs, H_2, and fuel cells

- IEA. (2021) Global EV Outlook 2021 – Analysis - IEA. *(Focus on pp 16–47)*
- Leibreich (2021) "The Clean Hydrogen Ladder"

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.
- 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.

Problem set #4 due

22) November 21:

EAP Tools 6: Climate change and the energy system

- B&N Chapter 12
- IPCC AR6 WGIII Summary For Policymakers (2022)

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.

November 23:

No class: Thanksgiving

23) November 28:

Climate policy

- B&N Chapter 16 and 6.7
- United Nations (2022) "Emissions Gap Report: The Closing Window, Climate crisis calls for rapid transformation of societies"
- The Gaurdian (2021) "50 years, 25 Cops: the slow-motion movement to save the planet."

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.
- 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.

Problem set #5 out

24) November 30

EAP Tools 7: Modeling technological change

- B&N Chapter 15
- Nemet, G. F. (2013). "Technological change and climate-change policy." Encyclopedia of Energy, Natural Resource and Environmental Economics. Ed: J. Shogren.
- Wilson, C. et al. "Granular technologies to accelerate decarbonization." Science (80-). 368, 36–39 (2020).

optional:

- Grubler, A. (2012). "Energy transitions research: Insights and cautionary tales." Energy Policy 50: 8–16.
- 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.

25) December 5:

Energy Justice

- Jenkins, K., D. McCauley, R. Heffron, H. Stephan and R. Rehner (2016). "Energy justice: A conceptual review." Energy Research & Social Science 11: 174-182.
- Reames, T. G., M. A. Reiner and M. B. Stacey (2018). "An incandescent truth: Disparities in energy-efficient lighting availability and prices in an urban U.S. county." Applied Energy 218: 95-103.

optional:

- McCauley, D., V. Ramasar, R. J. Heffron, B. K. Sovacool, D. Mebratu and L. Mundaca (2019). "Energy justice in the transition to low carbon energy systems: Exploring key themes in interdisciplinary research." Applied Energy 233-234: 916-921.
- Reames, T. G. (2016). "Targeting energy justice: Exploring spatial, racial/ethnic and socioeconomic disparities in urban residential heating energy efficiency." Energy Policy 97: 549-558.
- Sovacool, B. K., M. Burke, L. Baker, C. K. Kotikalapudi and H. Wlokas (2017). "New frontiers and conceptual frameworks for energy justice." Energy Policy 105: 677-691.
- Heffron, R. J. and D. McCauley (2017). "The concept of energy justice across the disciplines." Energy Policy 105: 658-667.

Problem set #5 due

26) December 7:

Discussion: How Can Solar Energy be a Model to Follow?

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

27) December 12:

Review of semester

28) December 15:

FINAL EXAM
9:30-11:30am

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
- Joule
- Nature Climate Change
- Nature Energy
- 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.gov/`
E.IA. mapping `http://www.eia.gov/state/maps.cfm`
BP Statistical Review of World Energy
`https://www.bp.com/en/global/corporate/energy-economics.html`
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/the-world-factbook/`
Wisconsin Energy Statistics:
`https://psc.wi.gov/Pages/Programs/OEI/wisconsinEnergyStatistics.aspx`

Other Help

– Scientific notation `https://www.mathsisfun.com/numbers/scientific-notation.html`
– Swartz, C. E. (1993). Used Math for the First Two Years of College Science, American Association of Physics Teachers.

EnvSt/PubAff/URPL 809 : Intro. to Energy Analysis & Policy

Fall 2023

Prof. G. Nemet

SCHEDULE OF CLASSES: INTRO. EAP, FALL 2023

W	Date	Lec-ture #	Topic	Problem sets Handed-out, due	Cover-age
1	7-Sep	1	Cheap, clean, and reliable: 3 energy challenges		1
2	12-Sep	2	EAP Tools 1: Units, magnitudes, rates	PS 1 out	1
	14-Sep	3	U.S. energy policy 1973 - 2018		1
3	19-Sep	4	Trends in production and use of energy		2
	21-Sep	5	EAP Tools 2 : Combustion	PS 1 due	2
4	26-Sep	6	EAP Tools 3: Power plants		2
	28-Sep	7	Energy poverty, and development 1	PS 2 out	2
5	3-Oct	8	Energy poverty, and development 2		3
	5-Oct	9	Fossil fuels: coal, and gas	PS 2 due	3
6	10-Oct	10	EAP Tools 4: Cost assessment		3
	12-Oct	11	Transmission & Dist.	PS 3 out	3
7	17-Oct	12	Electricity Industry [Cmsnr. Huebner]		MT
	19-Oct	13	Nuclear power	PS 3 due	MT
8	24-Oct	14	Wind		MT/4
	26-Oct	15	**MIDTERM EXAM**		
9	31-Oct	16	Mobility and transportation energy		4
	2-Nov	17	How did Solar Get Cheap?		4
10	7-Nov	18	Solar power		4
	9-Nov	19	Energy efficiency	PS 4 out	4
11	14-Nov	20	EAP Tools 5: Resource depletion		5
	16-Nov	21	Energy storage	PS 4 due	5
12	21-Nov	22	Climate change and energy		5
	23-Nov		*No class: thanksgiving*		
13	28-Nov	23	Climate policy	PS 5 out	5
	30-Nov	24	EAP Tools 6: technical change		5
14	5-Dec	25	Energy Justice	PS 5 due	F
	7-Dec	26	Can Solar be a Model?		F
15	12-Dec	27	Discussion and Review		F
	15-Dec		**FINAL EXAM**		