

ENVIRONMENTAL & ENERGY ECONOMICS AND POLICY

BEPP/OPIM 263

Spring Semester 2015, Tu/Th 1:30-2:50PM, JMHH 370

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Optional review sessions: Wednesdays 3:00-4:00PM, JMHH F92 (Note: these sessions are optional and will be videotaped for those who cannot attend in person; all materials will be posted on Canvas.)

Course overview. This course examines environmental and energy issues from an economist's perspective. Over the last several decades, energy markets have become some of the most dynamic markets of the world economy, as they experienced a shift from heavy regulation to market-driven incentives. First, we look at scarcity pricing and market power in electricity and gasoline markets. We then study oil and gas markets, with an emphasis on optimal extraction and pricing and geopolitical risks that investors in hydrocarbon resources face. We then shift gears to the sources of environmental problems, and how policy makers can intervene to solve some of these problems. We talk about the economic rationale for a broad range of possible policies: environmental taxes, subsidies, performance standards and cap-and-trade. In doing so, we discuss fundamental concepts in environmental economics, such as externalities, valuation of the environment and the challenge of designing international agreements. At the end of the course, there will be special attention for the economics and finance of renewable energy and policies to foster its growth. Finally, we discuss the transportation sector, and analyze heavily debated policies such as fuel-economy standards and subsidies for green vehicles.

Readings. A mix of newspaper articles, academic papers, reports, plus the following textbook: Nathaniel Keohane and Sheila Olmstead (KO), *Markets and the Environment*, Washington, D.C.: Island Press, 2007. Starred (*) readings are required. Many starred readings are short. Non-starred readings are optional but I will discuss them in class, and you are highly encouraged to read them if you need or want further background on a specific topic. The best way to use the readings is as a supplement to the lectures, which overlap partially (but certainly not perfectly!) with the readings. You will be responsible for required readings not covered in class.

Prerequisites. BEPP 250 or an equivalent intermediate microeconomics course is recommended, but an introductory microeconomics course (ECON1, or another course approved by the instructor) will be sufficient in most cases.

Attendance. Attendance is mandatory. Please email me in advance if you have a good reason not to attend a particular session.

Strategy games. Students will participate in two strategy games. TUNA is a computer simulation in which students are managers of fishing companies and aim to maximize profits by making decisions on where to fish, and how many boats to deploy. The OPEC game is a series of simulations of the world oil market. Student teams represent countries and try to maximize profits by making output decisions that determine the world oil price.

Guest lectures. Students must attend the two scheduled guest lectures. Lecture 8 will be during the usual class time. Lecture 14 will be joint with the MBA course *Energy Markets and Policy* (BEPP/OPIM 763) on Tuesday, March 31st, 3:00-4:30PM. This lecture will be videotaped if you have a scheduling conflict. The content of the guest lectures is fair game for questions on assignments and exams. You are welcome to attend any other MBA guest lectures if the topic fits your interests.

Assignments and grading. Four equally weighted assignments (20%), a midterm exam (25%), a final exam (35%), the OPEC Game (10%), and class/guest lecture participation (10%). The four assignments are take-home. You will be expected to complete them on your own or with at most one other classmate, but you must turn in your own set of solutions. The final exam will be on the last day of class (in the evening). You should plan to attend the final exam. No exceptions.

Cheating policy. It should not be necessary to say this – but for completeness: all students are expected to comply with the University of Pennsylvania’s Code of Academic Integrity. It is the policy of the Department, and this course, to immediately fail any student for the course who is in violation of the University’s Code of Academic Integrity. Cheating in any manner, on a graded assignment or exam, or violating the rules of the strategy games, will result in a failing grade for this course. Additional sanctions may be imposed of the Office of Student Conduct. The Code of Academic Integrity can be reviewed at:
<http://www.upenn.edu/provost/PennBook/academic>.

Electronics. No computers, phones, iPads, etc.

Other details. The course is included in Wharton/IGEL’s undergraduate concentration in Environmental Policy and Management, the Wharton Social Impact Initiative’s course list and in the University Interschool Minor in Sustainability and Environmental Management. Non-Wharton students are welcome and encouraged to contact the professor in advance to discuss prerequisites.

MARKET POWER AND SCARCITY IN ENERGY MARKETS

Lecture 1 (Jan 15): **Course Introduction & Energy Overview**

(*) U.S. Energy Information Administration, 2014. *Annual Energy Outlook*, Executive Summary.

International Energy Agency, 2014. *World Energy Outlook*, Executive Summary.

Lecture 2 (Jan 20): **Market Efficiency and Scarcity Pricing**

Topics: market efficiency; scarcity pricing; electricity markets; refined products markets.

(*) KO Chapter 4: “The Efficiency of Markets”.

(*) J. Mouawad, “A Fast-Growing Independent Strikes Gold in Oil Refining”, *New York Times*, 5/18/05.

(*) J. Mouawad, “Oil Refiners See Profits Sink as Consumption Falls”, *New York Times*, 5/14/08.

(*) C. Krauss, “Oil Refining’s Fortunes Rise”, *New York Times*, 10/24/12.

Lecture 3 (Jan 22): **Market Power in Electricity Markets (1)**

Topics: market power; deregulation.

(*) S. Borenstein, 2000. “Understanding Competitive Pricing and Market Power in Wholesale Electricity Markets”, *Electricity Journal*: 49-57.

(*) J. Griffin and S. Puller, 2005. “A Primer on Electricity and the Economics of Deregulation”, in *Electricity Deregulation: Choices and Challenges*, Griffin and Puller eds., Chicago: University of Chicago Press, pp. 1-4 and 12-23 (remainder is optional).

Lecture 4 (Jan 27): **Market Power in Electricity Markets (2)**

Topics: the California electricity crisis; the rise and fall of Enron.

(*) S. Borenstein, 2002. “The Trouble with Electricity Markets: Understanding California's Restructuring Disaster”, *Journal of Economic Perspectives* 16(1): 191-211.

(*) P. Healy and K. Palepu, 2003. “The Fall of Enron”, *Journal of Economic Perspectives* 17(2): 3-12 (pp. 13-26 are optional).

(*) D. Fitzpatrick, R. Smith and R. Tracy. “J.P. Morgan Staring at Record Fine Over Energy”, *Wall Street Journal*, 7/17/2013.

W. Bernstein, 2004. “The Rise and Fall of Enron’s One-to-Many Trading Platform,” Lieff Cabraser Heimann & Bernstein, LLP, San Francisco, CA.

EXTERNALITIES AND ENVIRONMENTAL POLICY

Lecture 5 (Jan 29): TUNA

Computer simulation game facilitated by the Wharton Learning Lab. Location: TBA.

Lecture 6 (Feb 3): Externalities and Policy Instruments (1)

Topics: environmental externalities; tragedy of the commons; Coase Theorem; property rights; government intervention in energy markets.

(*) KO Chapter 2: “Economic Efficiency and Environmental Protection”.

(*) KO Chapter 5: “Market Failures in the Environmental Realm”.

(*) KO Chapter 8: “Principles of Market-Based Environmental Policy”, pp. 125-143.

US Environmental Protection Agency, 2014. *Air Quality Trends*.

Lecture 7 (Feb 5): Externalities and Policy Instruments (2)

Topics: emissions taxes; output taxes; command-and-control regulation; effect of regulations on business; double dividend.

(*) “Sorting Frack from Fiction”, *The Economist*, 7/14/2012.

National Research Council, 2010. *Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use*, Summary.

M. Fowlie, “Will coal exports abroad offset hard-won carbon reductions at home?”, *Energy Institute at Haas Blog*, 7/28/2014.

Lecture 8 (Feb 10): **Investing in Shale Gas**

Guest speaker: Kyle Bethancourt, Managing Director, Sallyport Investments

Topics: evaluating investments in the oil and gas industry; the rise of shale gas.

Lecture 9 (Feb 12): **Cap-and-Trade**

Topics: basics of cap-and-trade; cost-effectiveness; uncertainty about marginal abatement costs; introduction to market design issues.

(*) Lecture notes about the economics of cap-and-trade.

(*) KO Chapter 8: “Principles of Market-Based Environmental Policy”, pp. 143-152.

(*) KO Chapter 9: “The Case for Market-Based Instruments in the Real World” pp. 153-168.

(*) “Carbon Tax v Cap-and-Trade: Which is Better?”, *The Guardian*, 1/31/2013.

M. Weitzman, 1974. “Prices versus Quantities”, *Review of Economic Studies* 41(4): 477-491.

I. Parry and B. Pizer, 2007. “Emissions Trading versus CO₂ Taxes versus Standards”, Chapter 5 of *Assessing U.S. Climate Policy Options*, RFF, Washington D.C.: 80-86.

Lecture 10 (Feb 17): **Real-World Environmental Markets**

Topics: market design issues in cap-and-trade markets; EU Emissions Trading Scheme; RECLAIM; acid rain trading program.

(*) R. Newell, B. Pizer and D. Raimi, 2013. “Carbon Markets 15 Years after Kyoto: Lessons Learned, New Challenges”, *Journal of Economic Perspectives* 27(1), pp. 123-139 (remainder is optional).

(*) KO Chapter 9: “The Case for Market-Based Instruments in the Real World” pp. 173-181.

(*) KO Chapter 10: “Market-Based Instruments in Practice”, pp. 182-190.

GLOBAL ENVIRONMENTAL AGREEMENTS

Lecture 11 (Feb 19): **Global Climate Change**

Topics: measuring climate change impacts; the climate change debate; discounting; risk and uncertainty.

(*) B. Litterman, 2013. “What Is the Right Price for Carbon Emissions?”, *Regulation* 36(2): 38-43.

Intergovernmental Panel on Climate Change. *Climate Change 2014: Synthesis Report*, Summary for Policymakers.

“In the balance”, *The Economist*, 4/5/14.

J. Oliver, “Climate Change Debate”, *Last Week Tonight*, 5/11/14, available at: <https://www.youtube.com/watch?v=cjuGCJJUGsg>

Lecture 12 (Feb 24): **International Environmental Agreements**

Topics: Kyoto Protocol; Montreal Protocol; free-riding; leakage.

(*) N. Mandhana, “U.S.-China Climate Deal Puts India in Spotlight”, *Wall Street Journal*, 11/18/2014.

Lecture 13 (Feb 26): **U.S. and Global Policy Developments**

Topics: U.S. climate change policy; global carbon trading developments; international climate agreements.

(*) C. Davenport, “Large Companies Prepared to Pay Price on Carbon”, *New York Times*, 12/5/13.

(*) J. Eilperin and S. Mufson, “Everything You Need to Know About the EPA’s Proposed Rule on Coal Plants”, *Washington Post*, 6/2/2014.

(*) “ETS, RIP?”, *The Economist*, 4/20/13.

THE ECONOMICS OF OIL AND GAS

Lecture 14 (Mar 3): **Oil and Natural Gas Extraction and Pricing (1)**

Topics: trends in oil and gas reserves; optimal extraction; Hotelling model.

(*) KO Chapter 6: “Managing Stocks: Natural Resources as Capital Assets”.

(*) Lecture notes about the Hotelling model for optimal resource extraction.

D. Yergin, 2008. *The Quest: Energy, Security, and the Remaking of the Modern World*, Chapter 11: Is the World Running out of Oil?, Chapter 12: Unconventional and Chapter 16: Shale Gas, New York: The Penguin Press.

Lecture 15 (Mar 5): **Midterm Exam**

--- SPRING BREAK ---

Lecture 16 (Mar 17): **Oil and Natural Gas Extraction and Pricing (2) & Introduction to the OPEC Game**

Topics: oil price volatility; oil price forecasting; oil futures.

(*) J. Hamilton, 2009. “Understanding Crude Oil Prices.” *The Energy Journal* 30(2): 179-189 (remainder is optional).

(*) C. Ngai and J. Resnick-Ault, “Looking for a floor in oil markets? Check the contango”, *Reuters*, 11/XX/14.

Lecture 17 (Mar 19): **Upstream Investment under Uncertainty**

Topics: NOCs vs. IOCs; upstream contracts; drilling investment under uncertainty; geopolitical risk; expropriations.

(*) “Slippery Negotiations: The Give and Take of Oil Contracts in Foreign Countries”, *Knowledge@Wharton*, 11/20/2012.

(*) A. Ulmer and C. Pons, “Venezuela ordered to pay Exxon \$1.6 billion for nationalization”, *Reuters*, 10/9/2014.

VALUING THE ENVIRONMENT

Lecture 18 (Mar 24): **Market Valuation (1)**

Topics: philosophical issues; use vs. non-use value; travel cost method.

(*) KO Chapter 3: “The Benefits and Costs of Environmental Protection”, pp. 31-43.

(*) E. Goodstein, 2010. *Economics and the Environment*, 6th edition, Wiley, Chapter 8: Measuring the Benefits of Environmental Protection.

K.Y. Chay and M. Greenstone, 2005. “Does Air Quality Matter? Evidence from the Housing Market”, *Journal of Political Economy* 113(2): 376-424.

Lecture 19 (Mar 26): **Market Valuation (2)**

Topics: hedonic pricing; cost-benefit analysis; value of a statistical life.

(*) KO Chapter 3: “The Benefits and Costs of Environmental Protection”, pp. 43-53.

K. Viscusi and J. Aldy, 2003. “The Value of a Statistical Life: A Critical Review of Market Estimates Throughout the World”, *The Journal of Risk and Uncertainty* 27(1): 5-76.

Lecture 20 (Mar 31): **The Role of Electric Utilities in a Rapidly Changing Market**

Guest speaker: David Crane, Chief Executive Officer, NRG

Note: this lecture will be held outside the regular class time (3-4:20PM, location TBA) and videotaped for those who have a class conflict.

Lecture 21 (Apr 2): **Non-Market Valuation**

Topics: contingent valuation.

(*) P. Portney, 1994. “The Contingent Valuation Debate: Why Economists Should Care”, *Journal of Economic Perspectives* 8(4): 3-17.

(*) M. Hanemann, 1994. “Valuing the Environment Through Contingent Valuation”, *Journal of Economic Perspectives* 8(4): 19-43.

(*) P. Diamond and J. Hausman, 1994. “Contingent Valuation: Is Some Number Better than No Number?”, *Journal of Economic Perspectives* 8(4): 45-64.

THE ECONOMICS AND FINANCE OF RENEWABLE ENERGY

Lecture 22 (Apr 7): **The Economics and Finance of Renewable Energy & OPEC Group Meetings**

Topics: overview of renewables industries; levelized cost; solar leasing; tax equity.

(*) S. Borenstein, 2012. “The Private and Public Economics of Renewable Electricity Generation”, *Journal of Economic Perspectives* 26(1): 67-92.

(*) D. Cardwell, “Bonds Backed by Solar Power Payments Get Nod”, *New York Times*, 11/14/13.

(*) “SolarCity is Not a Solar Company”, *Bloomberg New Energy Finance*, 10/12/12.

Lecture 23 (Apr 9): **Renewable Energy Policies**

Topics: innovation subsidies; learning-by-doing; green subsidies vs. brown taxes; tax credits; feed-in tariffs; renewable portfolio standards; regulatory uncertainty; trade disputes.

(*) I. Galiana and C. Green, 2009. “Let the Global Technology Race Begin”, *Nature* 426(3): 570-571.

(*) W. Nordhaus, 2009. “Designing a Friendly Space for Technological Change to Slow Global Warming”, Snowmass Conference on Technologies to Combat Global Warming.
Skip Section IV!

(*) R. Stavins, “Will Europe Scrap Its Renewables Target? That Would Be Good News for the Economy and for the Environment”, *The Huffington Post*, 1/18/2014

(*) K. Bradsher, “To Conquer Wind Power, China Writes the Rules”, *New York Times*, 12/14/10.

(*) D. Cardwell, “U.S. Imposes Steep Tariffs on Importers of Chinese Solar Panels”, *New York Times*, 6/3/2014.

D. Cardwell, “U.S. Raises Tariffs on Chinese Wind-Turbine Makers”, *New York Times*, 7/27/12.

Lecture 24 (Apr 14): **Energy Efficiency: Puzzle and Policies**

Topics: the “energy efficiency puzzle”; informational barriers and market failures; rebound effect; energy efficiency policies.

(*) D. Owen, “The Efficiency Dilemma”, *The New Yorker*, 12/20/10.

(*) “Money for nothing”, *The Economist*, 4/26/14.

(*) H. Allcott and M. Greenstone, 2012. “Is There an Energy Efficiency Gap?”, *Journal of Economic Perspectives* 26(1): 3-11 (up to Figure 3; pp. 14-28 optional).

TRANSPORTATION

Lecture 25 (Apr 16): **Fuel-Economy Policy**

Topics: policy developments in the car industry; fuel-economy standards; gasoline tax.

(*) R. Tracy, “Final Rules Set On Car Mileage”, *Wall Street Journal*, 8/28/12.

(*) E. Porter, “Taxes Show One Way to Save Fuel”, *New York Times*, 9/11/12.

(*) S. Anderson, C. Fischer, I. Parry and J. Sallee, 2011. “Fuel Economy Standards: Impacts, Efficiency, and Alternatives.” *Review of Environmental Economics and Policy* 5(1): pp. 89-98 and 105 (skip section “Standards versus Feebates”).

“Fuel’s paradise”, *The Economist*, 12/13/14.

Lecture 26 (Apr 21): **Unintended Consequences of Transport Policies**

Topics: congestion policies; overlapping regulation; emissions leakage.

(*) T. Ying and A. Ho, “In China, the License Plates Can Cost More Than the Car”, *Bloomberg Businessweek*, 4/25/13.

(*) “Day without a daft idea”, *The Economist*, 7/16/14.

CONCLUSIONS

Lecture 27 (Apr 23): **OPEC Game Debriefing & Course Wrap Up**

Lecture 28 (Apr 28): **Final Exam**

Note: the exam will be held outside the regular class time (6-8PM, location TBA). Class will not meet during the regular hours from 1:30-2:50PM.

PRELIMINARY DUE DATES

Assignment dates

Assignment 1: posted on February 6, due by February 16

Assignment 2: posted on February 20, due by March 2

Assignment 3: posted on April 3, due by April 10

Assignment 4: posted on April 20, due by April 27

Midterm exam

March 5 (in class)

OPEC Game

March 17	Introduction to the OPEC game in class
March 25	Production quantities due by 10pm for phase 1, period 1
March 27	Production quantities due by 10pm for phase 1, period 2
March 30	Production quantities due by 10pm for phase 2, period 1
April 1	Production quantities due by 10pm for phase 2, period 2
April 3	Production quantities due by 10pm for phase 2, period 3
April 6	Production quantities due by 10pm for phase 2, period 4
April 7	OPEC group meetings in class
April 10	Production quantities due by 10pm for phase 3, period 1
April 13	Production quantities due by 10pm for phase 3, period 2
April 15	Production quantities due by 10pm for phase 3, period 3
April 17	Production quantities due by 10pm for phase 3, period 4
April 23	OPEC strategy memo due before class
April 23	OPEC game debriefing in class

Final exam

Tuesday April 28th, 6PM, location TBA