

ENVIRONMENTAL & ENERGY ECONOMICS AND POLICY

BEPP/OIDD 263

Spring Semester 2016, Tu/Th 12:00-1:20PM, SHDH 1206

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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. 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. The Electricity Strategy Game is a simulation of an electricity market. Student teams manage a portfolio of generation units (coal, natural gas, nuclear and renewables) and bid into an electricity market.

Guest lectures. Students must attend the three scheduled guest lectures. These lectures will be joint with the MBA course *Energy Markets and Policy* (BEPP/OIDD 763) and will take place in the same location (SHDH 1206), but from 3:00-4:20PM. These lectures will be videotaped if you have a scheduling conflict, but you need to notify me in advance at the beginning of the semester. 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. Three equally weighted assignments (30%), an exam (40%), the OPEC Game (10%), the Electricity Strategy Game (10%) and class participation (10%). The three assignments are take-home. You will be expected to complete them on your own or with at most one other classmate. The exam will be on the last day of class (in the evening). You should plan to attend the exam. No exceptions.

Practice questions. Practice questions and solutions will be posted during roughly half the weeks of the semester. The TA will discuss them during office hours if needed. (This replaces the optional reviews sessions from previous versions of this course.)

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://provost.upenn.edu/policies/pennbook/2013/02/13/code-of-academic-integrity>.

Electronics. No computers, phones, iPads, etc.

Other details. The course is included in Wharton/IGEL’s undergraduate concentration in Environmental Policy and Management, the Environmental Policy & Application major from the Earth & Environmental Science department, 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.

ELECTRICITY MARKETS

Lecture 1 (Jan 14): Course Introduction & Energy Overview

U.S. Energy Information Administration, 2015. *Annual Energy Outlook*, Executive Summary.

International Energy Agency, 2015. *World Energy Outlook*, Executive Summary.

Lecture 2 (Jan 19): 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.

(*) L. Denning, “Refiners Can Keep Floating on Cheap Oil”, *Wall Street Journal*, 7/21/15.

Lecture 3 (Jan 21): 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 26): 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 less relevant for this course).

(* 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,” Loeff Cabraser Heimann & Bernstein, LLP, San Francisco, CA.

OIL AND GAS MARKETS

Lecture 5 (Jan 28): Oil and Natural Gas Extraction and Pricing (1) & Introduction to the OPEC Game

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 (on Canvas).

Lecture 6 (Feb 2): Oil and Natural Gas Extraction and Pricing (2)

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). This reading is not in the course pack, but available at: <http://search.proquest.com/docview/222033546/8FA09AFA95F4ED1PQ/3?accountid=14707>

(* N. Christie and R. Katakey, “Oil Traders Aren't Dancing the Crude Contango This Time Around”, *BloombergBusiness*, 12/11/15.

Lecture 7 (Feb 4): Upstream Investment under Uncertainty

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

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

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

EXTERNALITIES AND ENVIRONMENTAL POLICY

Lecture 8 (Feb 9): Global Climate Change

Topics: 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.

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

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

Lecture 9 (Feb 11): Externalities and Policy Instruments

Topics: environmental externalities; tragedy of the commons, Coase Theorem; property rights; taxes vs. subsidies vs. standards; effect of regulations on business; double dividend.

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

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

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

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

Lecture 10 (Feb 16): Oil and Gas Investing

Guest speaker: Kyle Bethancourt, Managing Director, Sallyport Investments

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

Note: this lecture will be held outside the regular class time (3-4:20PM; SHDH 1206) and videotaped for those who have a class conflict.

Lecture 11 (Feb 18): Cap-and-Trade & OPEC Group Meetings

Topics: basics of cap-and-trade; cost-effectiveness; introduction to market design issues.

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

(*) 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.

Lecture 12 (Feb 23): **Real-World Environmental Markets**

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

(*) 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.

(*) 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).

Lecture 13 (Feb 25): **U.S. and Global Policy Developments**

Topics: U.S. climate change policy; global carbon trading developments; emissions leakage.

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

(*) A. van Benthem and R. Martin, “Europe’s carbon-trading system is better than thought, and could be better still”, *The Economist*, 12/11/15.

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

Lecture 14 (Mar 1): **OPEC Game Debriefing**

Lecture 15 (Mar 3): **The Changing Landscape for Global Oil Companies**

Guest speaker: Marvin Odum, Executive Committee Member, Unconventional Resources Director, and President of Shell Oil Company, Royal Dutch Shell

Topics: investment decisions in turbulent oil markets, geopolitical challenges, disruptive change in energy markets, pathways to cleaner energy, carbon regulation, leadership style

Note: this lecture will be held outside the regular class time (3-4:20PM; SHDH 351).

--- SPRING BREAK ---

Lecture 16 (Mar 15): **International Environmental Agreements & Introduction to the Electricity Strategy Game**

Topics: international climate agreements; Kyoto Protocol; Montreal Protocol; free-riding; carbon offsets.

(* C. Davenport, “Nations Approve Landmark Accord in Paris”, *New York Times*, 12/12/15.

(* “Inside the Paris Climate Deal”, *New York Times*, 12/12/15.

N. Mandhana, “U.S.-China Climate Deal Puts India in Spotlight”, *Wall Street Journal*, 11/18/14.

(* Student instructions for the Electricity Strategy Game (on Canvas).

ENERGY EFFICIENCY

Lecture 17 (Mar 17): **Energy Efficiency Entrepreneurship**

Guest speaker: Yoav Lurie, Chief Executive Officer, Simple Energy

Topics: energy efficiency business models; economic and behavioral incentives for energy savings.

Note: this lecture will be held outside the regular class time (3-4:20PM; SHDH 1206) and videotaped for those who have a class conflict.

Lecture 18 (Mar 22): **Energy Efficiency: Puzzle and Policies & Electricity Strategy Game Auction**

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.

H. Allcott and M. Greenstone, 2012. “Is There an Energy Efficiency Gap?”, *Journal of Economic Perspectives* 26(1): 3-28 (pp. 3-9 contain the main message).

Lecture 19 (Mar 24): **Energy Efficiency (Continued)**

(*) G. Ip, “Energy-Efficiency Programs ‘Nudge’ Consumers in the Wrong Direction”, *Wall Street Journal*, 6/23/15.

THE ECONOMICS AND FINANCE OF RENEWABLE ENERGY

Lecture 20 (Mar 29): **The Economics and Finance of Renewable Energy**

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.

(*) T. Woody, “SolarCity Prices Its IPO But Is It A Solar Company Or A Financial Firm?”, *Forbes*, 11/27/12.

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

(*) C. Martin, “SolarCity CEO Says He Wishes Strategy Pitched Differently”, *BloombergBusiness*, 11/11/15.

Lecture 21 (Mar 31): **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!

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

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.

VALUING THE ENVIRONMENT

Lecture 22 (Apr 5): **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 23 (Apr 7): **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.

TRANSPORTATION

Lecture 24 (Apr 12): **Fuel-Economy Policy**

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

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

(*) A. van Benthem and M. Reynaert, “Can fuel-economy standards save the climate?”, *The Economist*, 7/16/15.

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

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

Lecture 25 (Apr 14): **Electricity Strategy Game Debriefing**

Lecture 26 (Apr 19): **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.

Lecture 27 (Apr 21): **Unintended Policy Consequences & Course Wrap Up**

Topics: congestion policies; enforcement; cheating; emissions leakage; course summary.

D. Hakim and J. Mouawad, “Galvanized by VW Scandal, E.P.A. Expands On-Road Emissions Testing”, *New York Times*, 11/8/2015.

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.

Lecture 28 (Apr 26): **Exam**

Note: the exam will be held outside the regular class time (6-8PM, location to be announced). Class will not meet during the regular hours from 12:00-1:20PM.

PRELIMINARY DUE DATES

Assignment dates

Assignment 1: posted on February 5, due by February 19

Assignment 2: posted on February 29, due by March 21

Assignment 3: posted on April 8, due by April 21 (before class)

OPEC Game

January 28 Introduction to the OPEC game in class
February 3 Production quantities due by 10pm for phase 1, period 1
February 5 Production quantities due by 10pm for phase 1, period 2
February 9 Production quantities due by 10pm for phase 2, period 1
February 10 Production quantities due by 10pm for phase 2, period 2
February 11 Production quantities due by 10pm for phase 2, period 3
February 12 Production quantities due by 10pm for phase 2, period 4
February 18 OPEC group meetings in class
February 19 Production quantities due by 10pm for phase 3, period 1
February 22 Production quantities due by 10pm for phase 3, period 2
February 23 Production quantities due by 10pm for phase 3, period 3
February 24 Production quantities due by 10pm for phase 3, period 4
March 1 OPEC strategy memo due before class
March 1 OPEC game debriefing in class

Electricity Strategy Game

March 15 Introduction to the Electricity Strategy Game in class
March 19 Bids due for the ESG test run
March 22 First ESG divestiture auction, in class
March 23 ESG strategies due by 10pm for year 1, day 1
March 25 ESG strategies due by 10pm for year 1, day 2
March 28 ESG strategies due by 10pm for year 1, day 3
March 29 Sealed portfolio bids for year 2 due by 10pm
April 1 ESG strategies due by 10pm for year 2, day 1
April 4 ESG strategies due by 10pm for year 2, day 2
April 6 ESG strategies due by 10pm for year 2, day 3
April 14 ESG strategy memo due before class
April 14 ESG debriefing in class

Exam

Tuesday April 26th, 6-8PM, location to be announced