

ENERGY MARKETS AND POLICY

BEPP/OPIM 763

Spring Semester 2015, Tu/Th 3-4:20PM, JMHH 370

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Course overview. Over the last several decades, energy markets have become some of the most dynamic markets of the world economy. Traditional fossil fuel and electricity markets have seen a partial shift from heavy regulation to market-driven incentives, while rising environmental concerns have led to a wide array of new regulations and “environmental markets”. The growth of renewable energy could be another source of rapid change, but brings with it a whole new set of technological and policy challenges. This changing energy landscape requires quick adaptation from energy companies, but also offers opportunities to turn regulations into new business. The objective of this course is to provide the economist’s perspective on a broad range of topics that professionals in the energy industry will encounter. Topics include the effect of competition, market power and scarcity on energy prices, the impact of deregulation on electricity and fossil fuel markets, extraction and pricing of oil and gas, geopolitical uncertainty and risk in hydrocarbon investments, the environmental impact and policies related to the energy sector, environmental cap-and-trade markets, energy efficiency, the economics and finance of renewable energy, and recent developments in the transportation sector.

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. Managerial Economics (MGEC 611/612) or an equivalent intermediate microeconomics course approved by the instructor.

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. The course has six guest lecturers, who are experts from the energy industry. The guest lecturers' emphasis will be on energy business models, renewable energy finance, and how energy policy affects their business. Attendance is mandatory and the content is fair game for questions on assignments and exams. Most guest lectures are followed by drinks (open to all students) and dinner (signup in advance; first-come-first-served) with the speaker.

Assignments and grading. Three equally weighted assignments (30%), a final exam (30%), the OPEC game (15%), the Electricity Strategy Game (15%), 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 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 phones, but you can use laptops and iPads to take notes during lectures.

Other details: The course is included in IGEL's MBA major in Environmental and Risk Management and in the BEPP-Law School certificate. Non-Wharton students are welcome and encouraged to contact the professor in advance to discuss prerequisites.

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 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.

Lecture 5 (Jan 29): **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.

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 6 (Feb 3): **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>

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

Lecture 7 (Feb 5): **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.

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.

ENERGY AND ENVIRONMENTAL POLICY

Lecture 9 (Feb 12): **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.

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

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

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

Lecture 10 (Feb 17): **Externalities and Policy Instruments & OPEC Group Meetings**

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.

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 11 (Feb 19): **Cap-and-Trade**

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

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

(*) 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.

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 12 (Feb 24): **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.

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.

Lecture 14 (Mar 3): **Disruptive Change in Power Markets**

Topics: real-time pricing; demand-response; regulatory developments.

(* K. Tweed, "Con Ed Looks to Batteries, Microgrids and Efficiency to Delay \$1B Substation Build", *GreenTechMedia*, 8/8/2014.

(* S. Lacey, "Utility Industry: We Need to Promote Electric Vehicles to 'Remain Viable'", *GreenTechMedia*, 7/30/2014.

Lecture 15 (Mar 5): **OPEC Game Debriefing**

--- SPRING BREAK ---

ENERGY EFFICIENCY

Lecture 16 (Mar 17): **Energy Efficiency: Puzzle and Policies & Introduction to the Electricity Strategy Game**

Note: I will spend part of this lecture to give an introduction to the Electricity Strategy Game (ESG) and discuss how to prepare for the portfolio divestiture auction. I will finish this lecture after the auction in Lecture 18.

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).

Lecture 17 (Mar 19): **Energy Efficiency Entrepreneurship**

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

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

Lecture 18 (Mar 24): **Electricity Strategy Game Auction**

(*) Student instructions for the Electricity Strategy Game (on Canvas), plus any other posted materials that help you prepare for bidding in the auction.

TRANSPORTATION

Lecture 19 (March 26): **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 20 (Mar 31): **The Role of Electric Utilities in a Rapidly Changing Market**

Guest speaker: David Crane, Chief Executive Officer, NRG

Lecture 21 (Apr 2): **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.

Lecture 22 (Apr 7): **Business Models and Government Policy for Electric Vehicles**

Topics: the prospects of electric vehicles; government policy for EVs; Tesla’s business model.

THE ECONOMICS AND FINANCE OF RENEWABLE ENERGY

Lecture 23 (Apr 9): **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.

(* 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 24 (Apr 14): **Solar Energy Business Models (1)**

Guest speaker: Albert Luu, VP Structured Finance, SolarCity

Topics: business and financing models for distributed solar energy.

Lecture 25 (Apr 16): **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 26 (Apr 21): **Solar Energy Business Models (2)**

Guest speaker: Ty Jagerson, CEO, VillagePower, and experienced solar energy entrepreneur

Topics: community solar.

Lecture 27 (Apr 23): **Electricity Strategy 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 3-4:20PM.

PRELIMINARY DUE DATES

Assignment dates

Assignment 1: posted on February 6, due by February 20

Assignment 2: posted on February 27, due by March 20

Assignment 3: posted on April 10, due by April 24

OPEC Game

January 29 Introduction to the OPEC game in class
February 4 Production quantities due by 10pm for phase 1, period 1
February 6 Production quantities due by 10pm for phase 1, period 2
February 10 Production quantities due by 10pm for phase 2, period 1
February 11 Production quantities due by 10pm for phase 2, period 2
February 12 Production quantities due by 10pm for phase 2, period 3
February 13 Production quantities due by 10pm for phase 2, period 4
February 17 OPEC group meetings in class
February 20 Production quantities due by 10pm for phase 3, period 1
February 23 Production quantities due by 10pm for phase 3, period 2
February 24 Production quantities due by 10pm for phase 3, period 3
February 25 Production quantities due by 10pm for phase 3, period 4
March 5 OPEC strategy memo due before class
March 5 OPEC game debriefing in class

Electricity Strategy Game

March 17 Introduction to the Electricity Strategy Game in class
March 19 Bids due for the ESG test run
March 24 First ESG divestiture auction, in class
March 25 ESG strategies due by 10pm for year 1, day 1
March 27 ESG strategies due by 10pm for year 1, day 2
March 30 ESG strategies due by 10pm for year 1, day 3
April 1 Sealed portfolio bids for year 2 due by 10pm
April 3 ESG strategies due by 10pm for year 2, day 1
April 6 ESG strategies due by 10pm for year 2, day 2
April 8 ESG strategies due by 10pm for year 2, day 3
April 16 ESG strategy memo due before class
April 23 ESG debriefing in class

Final exam

Tuesday April 28th, 6PM, location TBA