

ENERGY MARKETS AND POLICY

BEPP/OIDD 763

Spring Semester 2016, Tu/Th 3-4:20PM, SHDH 1206

Note: Due to potential guest speaker schedule changes, this syllabus might be updated slightly during the semester. Please check Canvas for the latest version.

Professor Arthur van Benthem

Office Hours: Mondays 4:30-5:30PM, SHDH 1354

Phone: 215-898-3013

Email: arthurv@wharton.upenn.edu

Teaching Assistants: Scott Reich and Andreas Shepard

Office Hours: Thursdays 12:00-1:30PM, SHDH 109

Email: ashepar@wharton.upenn.edu, score@wharton.upenn.edu

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 (25%), an exam (35%), 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 exam will be on the last day of class (in the evening). You should plan to attend the 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://provost.upenn.edu/policies/pennbook/2013/02/13/code-of-academic-integrity>.

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.

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).

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 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.

ENERGY 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.

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 in 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.

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; leveled 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.

Lecture 22 (Apr 5): **Batteries, Fuel Cells, or Fuel Economy: Where Will Gasoline-Saving Policy Lead?**

Note: this panel discussion is optional and will be held outside the regular class time (5:30-7:00PM; Kleinman Energy Forum, Fischer Fine Arts Building, 4th floor). Class will not meet during regular hours. The panel discussion will set the scene for the upcoming lectures on transportation. Please check <http://kleinmanenergy.upenn.edu/events/> for the latest details.

Guest speakers: William Chernicoff, Manager of Energy & Environmental Research, Toyota; Mark Jacobsen, Associate Professor of Economics, UC San Diego; Andrew Stober, Vice President of Planning and Economic Development, University City District (discussion moderated by Arthur van Benthem)

Topics: gasoline-saving policies; fuel-economy standards; the effects and future of subsidies to battery-electric vehicles; the role of local/city policies to encourage cleaner transportation; environmental impacts of electricity, hydrogen and other gasoline substitutes.

Lecture 23 (Apr 7): **Renewable Energy Business Models**

Guest speaker: Albert Luu, VP Structured Finance, SolarCity

Topics: business and financing models for distributed solar energy; recent developments in renewable energy finance.

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): **Business Models and Government Policy for Electric Vehicles**

Guest speaker: Pat Romano, President and CEO, ChargePoint

Topics: business models for electric vehicle charging; battery technologies; EV policies.

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 3-4:20PM.

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