

ENERGY MARKETS AND POLICY

BEPP/OIDD 763 WEMBA (EAST)

Spring Semester 2018, Philadelphia, JMHH G50

Note: This syllabus is always subject to revisions. Please check Canvas for the latest version.

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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 is 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, extraction and pricing of oil and gas, geopolitical uncertainty and risk in hydrocarbon investments, the environmental policies related to the energy sector and their effectiveness, 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, second edition, 2016. 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.

Strategy game. 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. This game requires an initial in-class auction, six online electricity wholesale market bid submissions plus one additional round of auction bids in between class meetings.

Assignments and grading. Three equally weighted assignments (30%), an exam (40%), the Electricity Strategy Game (20%) and class participation (10%). The three assignments are take-home. You may discuss assignments with other students but you need to formulate and submit answers in teams of at most three. The exam will be given in class on the last scheduled class date. You should plan to attend the exam in person.

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>.

ELECTRICITY MARKETS

Lecture 1 (Jan 5): Course Introduction & Energy Overview

International Energy Agency, 2017. *World Energy Outlook*, Executive Summary.

Lecture 2 (Jan 5): 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. Cook and B. Olson, “Hurricanes Stir Up Profits for Refiners”, *Wall Street Journal*, 9/17/17.

Lecture 3 (Jan 6): **Market Power in Electricity Markets (1)**

Topics: market power; deregulation.

(*) S. Borenstein, 2000. “Understanding Competitive Pricing and Market Power in Wholesale Electricity Markets”, *The Electricity Journal* 13(6): pp. 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 6): **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): pp. 191-211.

(*) M. Slezak, “Energy Companies Withholding Supply to Blame for July Price Spike, Report Finds”, *The Guardian*, 8/17/16.

P. Healy and K. Palepu, 2003. “The Fall of Enron”, *Journal of Economic Perspectives* 17(2): pp. 3-12 (remainder is optional and less relevant for this course).

D. Fitzpatrick, R. Smith and R. Tracy. “J.P. Morgan Staring at Record Fine Over Energy”, *Wall Street Journal*, 7/17/13.

OIL AND GAS MARKETS

Lecture 5 (Jan 12): **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 on the Hotelling model for optimal resource extraction (on Canvas).

R. Gold and A. Sider, “Long Promised, the Global Market for Natural Gas Has Finally Arrived”, *Wall Street Journal*, 6/6/17.

Lecture 6 (Jan 12): **Oil and Natural Gas Extraction and Pricing (2)**

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

(*) R. Rowling and J. Blas, “Oil Traders Empty Key Crude Storage Hub”, *Bloomberg*, 9/20/17.

The Strange Geopolitics of Rising Oil Prices”, *The Economist*, 11/26/17.

Lecture 7 (Jan 13): **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*, 10/9/14.

(*) J. Wernau, “As Venezuela’s Default Risk Rises, Battle Heats Up for Control of Refiner Citgo”, *Wall Street Journal*, 5/14/17.

ENERGY AND ENVIRONMENTAL POLICY

Lecture 8 (Jan 13): **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): pp. 38-43.

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

Lecture 9 (Jan 26): **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.

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

(*) KO Chapter 8: “Principles of Market-Based Environmental Policy”, pp. 139-162.

(*) “A Dirty Little Secret”, *The Economist*, 7/23/16.

Lecture 10 (Jan 26): **Cap-and-Trade**

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

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

(*) KO Chapter 9: “The Case for Market-Based Instruments in the Real World” pp. 168-184.

(*) “Carbon Tax v Cap-and-Trade: Which is Better?”, *The Guardian*, 1/31/13.

Lecture 11 (Jan 27): **Designing 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. 190-198.

(*) KO Chapter 10: “Market-Based Instruments in Practice”, pp. 199-207, 208-210 and 217-220.

Lecture 12 (Jan 27): **U.S. and Global Policy Developments**

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

(*) “Up in Smoke”, *The Economist*, 10/10/17.

(*) 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. Buckley, “Xi Jinping Is Set for a Big Gamble With China’s Carbon Trading Market”, *New York Times*, 6/23/17.

“California Shows How States Can Lead on Climate Change”, *New York Times*, 7/24/17.

J. Eilperin and S. Mufson, “Everything You Need to Know About the EPA’s Proposed Rule on Coal Plants”, *Washington Post*, 6/2/14.

ENERGY EFFICIENCY

Lecture 13 (Feb 10): **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.

T. Gerarden, R. Newell and R. Stavins, 2017. “Assessing the Energy Efficiency Gap”, *Journal of Economic Literature* 55(4): pp. 1486-1525.

Lecture 14 (Feb 10): Energy Efficiency (Continued) & Introduction to the Electricity Strategy Game

(*) S. Ori, “Why Government Energy-Efficiency Programs Sound Great–But Often Don’t Work”, *Wall Street Journal*, 11/13/17.

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

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

ENERGY, POLITICS AND DIPLOMACY

Lecture 15 (Mar 9): Energy and Politics & Electricity Strategy Game Auction

Topics: U.S. energy and climate politics; the role of the Environmental Protection Agency; federal policy vs. state and local interests; the Climate Solutions Caucus.

Lecture 16 (Mar 9): International Environmental Agreements

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.

THE ECONOMICS AND FINANCE OF RENEWABLE ENERGY

Lecture 17 (Mar 23): The Economics of Renewable Energy

Topics: trends in renewable energy; levelized cost of electricity; environmental benefits of renewables.

(*) S. Borenstein, 2012. “The Private and Public Economics of Renewable Electricity Generation”, *Journal of Economic Perspectives* 26(1): pp. 67-92. (Note: the solar application on pp. 85-86 is based on outdated numbers.)

(*) T. Andresen, “Offshore Wind Farms Offer Subsidy-Free Power for First Time”, *Bloomberg*, 4/13/17.

Lecture 18 (Mar 23): **Renewable Energy Finance**

Topics: tax credits; tax equity; solar leasing; PACE; net metering; (S)RECs.

(*) E. Crooks and L. Hornby, “Sunshine Revolution: The Age of Solar Power”, *Financial Times*, 11/5/15.

(*) Lecture notes on renewable portfolio standards and RECs (on Canvas).

(*) J. Dizard, “Tricky Tax Equity Erodes U.S. Infrastructure Boom”, *Financial Times*, 1/6/17.

J. Brady, “Solar Firms Plan To Return To Nevada After New Law Restores Incentives”, *NPR*, 6/7/17.

Lecture 19 (Mar 24): **Renewable Energy Policy**

Topics: trade disputes; innovation subsidies; learning-by-doing; mix of subsidies; renewable portfolio standards; green subsidies vs. pollution taxes; regulatory uncertainty.

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

(*) W. Nordhaus, 2009. “Designing a Friendly Space for Technological Change to Slow Global Warming”, Snowmass Conference on Technologies to Combat Global Warming, pp.1-8. **Skip Section IV!**

(*) A. Swanson, “To Protect U.S. Solar Manufacturing, Trade Body Recommends Limits on Imports”, *New York Times*, 10/31/17.

TRANSPORTATION POLICY

Lecture 20 (Mar 24): **Fuel-Economy Policy**

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

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

(*) M. Spector, “Trump Heads to Detroit as EPA Reviews Fuel-Economy Targets”, *Wall Street Journal*, 3/14/17.

(*) A. van Benthem and M. Reynaert, “Can Fuel-Economy Standards Save the Climate?”, *The Economist*, 7/16/15.

(*) V. McConnell, 2013. “The New CAFE Standards: Are They Enough on Their Own?”, *RFF Discussion Paper 13-14*, pp. 1-14 (Sections I and II; remainder is optional and less relevant for this course).

Lecture 21 (Apr 6): **Electricity Strategy Game Debriefing**

Lecture 22 (Apr 6): **Unintended Policy Consequences & Course Wrap Up**

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

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

B. Carlson, “Big in China: License-Plate Marriages”, *The Atlantic*, October 2017.

“Day Without a Daft Idea”, *The Economist*, 7/16/14.

Lectures 23-24 (Apr 19): **Exam**

PRELIMINARY DUE DATES

Assignment dates

Assignment 1: posted on January 13, due by January 29
Assignment 2: posted on February 6, due by February 26
Assignment 3: posted on March 23, due by April 13

Electricity Strategy Game

February 10	Introduction to the Electricity Strategy Game in class
March 3	Bids due for the ESG test run by midnight EST
March 9	First ESG divestiture auction, in class
March 16	ESG strategies due by midnight EST for year 1, day 1
March 19	ESG strategies due by midnight EST for year 1, day 2
March 21	ESG strategies due by midnight EST for year 1, day 3
March 24	Sealed portfolio bids for year 2 due by midnight EST
March 26	ESG strategies due by midnight EST for year 2, day 1
March 28	ESG strategies due by midnight EST for year 2, day 2
March 30	ESG strategies due by midnight EST for year 2, day 3
April 6	ESG strategy memo due before class
April 6	ESG debriefing in class

Exam

The exam will be in class on April 19.