

ENERGY MARKETS AND POLICY

BEPP/OIDD 763 WEMBA (EAST)

Spring Semester 2019, Philadelphia, location to be announced

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 and transportation sectors and their effectiveness, cap-and-trade markets, and energy efficiency. There is special emphasis on the economics and finance of renewable energy.

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 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. Contact me if you have a scheduling conflict with another class, a medical issue, or an emergency. No other exceptions. Please do not email me about alternative exam dates for other reasons as I have no flexibility to accommodate such requests out of fairness to other students.

Practice questions. An extensive set of practice questions and solutions will be posted early in the semester.

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 11): Course Introduction & Energy Overview

International Energy Agency, 2018. *World Energy Outlook*, Executive Summary ([link](#)).

Lecture 2 (Jan 11): 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 ([link](#)).

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

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

(*) L. Cook and B. Olson, “Hurricanes Stir up Profits for Refiners”, *Wall Street Journal*, 9/17/17 ([link](#)).

Lecture 3 (Jan 26): **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 ([link](#)).

(*) 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): pp. 191-211 ([link](#)).

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

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; [link](#)).

D. Fitzpatrick, R. Smith and R. Tracy. “J.P. Morgan Staring at Record Fine over Energy”, *Wall Street Journal*, 7/17/13 ([link](#)).

OIL AND GAS MARKETS

Lecture 5 (Feb 8): **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 ([link](#)).

Lecture 6 (Feb 8): **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 ([link](#)).

T. DiChristopher, “Citi Forecasts Oil Goes Nowhere in 2019 as OPEC Cuts and US Pumps More”, *CNBC*, 12/10/18 ([link](#)).

Lecture 7 (Feb 9): **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 ([link](#)).

(*) A. Scurria, “Venezuela Strikes Deal to Save Citgo from Seizure”, *Wall Street Journal*, 11/25/2018 ([link](#)).

ENERGY AND ENVIRONMENTAL POLICY

Lecture 8 (Feb 9): **Global Climate Change**

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

(*) Lecture notes on climate change mitigation and discount rates (on Canvas).

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

“The Latest Report on Global Warming Makes Grim Reading”, *The Economist*, 10/11/18 ([link](#)).

Intergovernmental Panel on Climate Change, Summary for Policymakers, 2018 ([link](#)).

Lecture 9 (Feb 9): **Externalities and Policy Instruments (1)**

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”.

(*) A. Lustgarten, “Palm Oil Was Supposed to Help Save the Planet. Instead It Unleashed a Catastrophe”, *New York Times*, 11/20/18 ([link](#)).

Lecture 10 (Feb 22): **Externalities and Policy Instruments (2) & Cap-and-Trade**

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

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

(*) 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.

(*) L. Taschini, S. Dietz and N. Hicks, “Carbon Tax v Cap-and-Trade: Which is Better?”, *The Guardian*, 1/31/13 ([link](#)).

Lecture 11 (Feb 22): **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.

(*) 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 ([link](#)).

(*) R. Morison and J. Hodges, “Carbon Reaches 10-Year High, Pushing up European Power Prices”, *Bloomberg*, 8/23/18 ([link](#)).

Lecture 12 (Mar 8): **U.S. and Global Policy Developments & Introduction to the Electricity Strategy Game**

Topics: U.S. climate change policy; recent environmental policy developments; regulatory rollbacks; global carbon trading developments; emissions leakage.

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

(*) K. Bradsher and L. Friedman, “China Unveils an Ambitious Plan to Curb Climate Change Emissions”, *New York Times*, 12/19/17 ([link](#)).

(*) L. Friedman, “Trump’s Plan for Coal Emissions: Let Coal States Regulate Them”, *New York Times*, 8/17/18 ([link](#)).

“California Shows How States Can Lead on Climate Change”, *New York Times*, 7/24/17 ([link](#)).

Lecture 13 (Mar 8): **International Environmental Agreements**

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

(*) B. Plumer, “Climate Negotiators Reach an Overtime Deal to Keep Paris Pact Alive”, *New York Times*, 12/15/18 ([link](#)).

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

C. Davenport et al., “Inside the Paris Climate Deal”, *New York Times*, 12/12/15 ([link](#)).

THE ECONOMICS AND FINANCE OF RENEWABLE ENERGY

Lecture 14 (Mar 9): **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 ([link](#)). (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 ([link](#)).

Lecture 15 (Mar 9): **Renewable Energy Finance**

Topics: tax credits; tax equity; solar leasing; securitization; renewable portfolio standards; (S)RECs.

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

(*) 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 ([link](#)).

J. Brady, “Solar Firms Plan to Return to Nevada after New Law Restores Incentives”, *NPR*, 6/7/17 ([link](#)).

Lecture 16 (Mar 22): **Electricity Strategy Game Auction**

Lecture 17 (Mar 22): **Renewable Energy Policy**

Topics: PACE; net metering; feed-in tariffs and tenders; import tariffs; green subsidies vs. carbon tax.

(*) J. Deign, “More 'Subsidy-Free' Offshore Wind Emerges in Europe”, *Greentech Media*, 4/5/18 ([link](#)).

(*) N. Groom, “Billions in U.S. Solar Projects Shelved after Trump Panel Tariff”, *Reuters*, 6/7/18 ([link](#)).

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

TOPICS: ENERGY EFFICIENCY AND TRANSPORTATION

Lecture 18 (Apr 5): **Energy Efficiency: Puzzle and Policies**

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

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

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

Lecture 19 (Apr 5): **Energy Efficiency (Continued)**

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

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

Lecture 20 (Apr 6): **Fuel-Economy Policy (1)**

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 ([link](#)).

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

(*) 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; [link](#)).

Lecture 21 (Apr 6): **Fuel-Economy Policy (2)**

Topics: unintended consequences from fuel-economy standards; cost-benefit analysis.

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

(*) A. Bento et al., 2018. “Flawed Analyses of U.S. Auto Fuel Economy Standards”, *Science* 362(6419), pp. 1119-1121 ([link](#)).

Lecture 22 (Apr 19): **Electricity Strategy Game Debriefing**

Lecture 23 (Apr 19): **Unintended Consequences of Transportation Policies & 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 ([link](#)).

B. Carlson, “Big in China: License-Plate Marriages”, *The Atlantic*, October 2017 ([link](#)).

“Day without a Daft Idea”, *The Economist*, 7/16/14 ([link](#)).

Lecture 24 (May 2): **Exam**

PRELIMINARY DUE DATES

Assignment dates

Assignment 1: posted on February 8, due by February 25

Assignment 2: posted on February 22, due by March 11

Assignment 3: posted on April 6, due by April 26

Electricity Strategy Game

March 8	Introduction to the Electricity Strategy Game in class
March 18	Bids due for the ESG test run by midnight EST
March 22	First ESG divestiture auction, in class
March 25	ESG strategies due by midnight EST for year 1, day 1
March 27	ESG strategies due by midnight EST for year 1, day 2
March 29	ESG strategies due by midnight EST for year 1, day 3
April 3	Sealed portfolio bids for year 2 due by midnight EST
April 5	ESG strategies due by midnight EST for year 2, day 1
April 8	ESG strategies due by midnight EST for year 2, day 2
April 10	ESG strategies due by midnight EST for year 2, day 3
April 19	ESG strategy memo due before class
April 19	ESG debriefing in class

Exam

The exam will be in class on May 2nd from 9-11 am, location to be announced