

# ENERGY MARKETS AND POLICY

## BEPP/OIDD 763 WEMBA (EAST)

*Spring Semester 2020, Philadelphia, JMHH G50*

*Note: This syllabus may be updated during the semester. I will also update readings up to the first class session. 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, including an introduction to energy storage.

**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 in all fairness to other students.

**Practice questions.** An extensive set of practice questions and solutions will be posted early in the semester. You can discuss them with the TA or with me if needed.

**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: <https://catalog.upenn.edu/pennbook/code-of-academic-integrity/>.

## **ELECTRICITY MARKETS**

### **Lecture 1 (Jan 17): Course Introduction & Energy Overview**

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

### **Lecture 2 (Jan 17): 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 18): **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 18): **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 (Jan 31): **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 (Jan 31): **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 1): **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 1): **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 14): **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. Lustgarten, “Palm Oil Was Supposed to Help Save the Planet. Instead It Unleashed a Catastrophe”, *New York Times*, 11/20/18 ([link](#)).

Z. Colman and E. Wolff, “Why Greens Are Turning Away from a Carbon Tax”, *Politico*, 12/9/18 ([link](#)).

## Lecture 10 (Feb 14): **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.

(\*) 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 15): **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 (Feb 15): **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).

(\*) 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](#)).

(\*) 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 (Feb 28): **Electricity Strategy Game Auction & 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 (Feb 28): **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 28): **Electricity Strategy Game Debriefing**

## Lecture 16 (Mar 28): **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 energy incentives (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 17 (Apr 10): **Renewable Energy Policy**

*Topics:* PACE; net metering; feed-in tariffs; tenders; import tariffs; green subsidy 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](#)).

(\*) S. Mundy, “India’s Renewable Rush Puts Coal on the Back Burner”, *Financial Times*, 1/1/19 ([link](#)).

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

## **TOPIC: TRANSPORTATION POLICY**

## Lecture 18 (Apr 10): **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 19 (Apr 17): **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 20 (Apr 17): **Unintended Consequences of Transport 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](#)).

## Lectures 21-22 (May 1): **Exam**



## **PRELIMINARY DUE DATES**

### **Assignment dates**

Assignment 1: posted on January 31, due by February 17

Assignment 2: posted on February 21, due by March 9

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

### **Electricity Strategy Game**

February 15 Introduction to the Electricity Strategy Game in class

February 24 Bids due for the ESG test run by midnight EST

February 28 First ESG divestiture auction, in class

March 3 ESG strategies due by midnight EST for year 1, day 1

March 5 ESG strategies due by midnight EST for year 1, day 2

March 7 ESG strategies due by midnight EST for year 1, day 3

March 10 Sealed portfolio bids for year 2 due by midnight EST

March 12 ESG strategies due by midnight EST for year 2, day 1

March 14 ESG strategies due by midnight EST for year 2, day 2

March 17 ESG strategies due by midnight EST for year 2, day 3

March 28 ESG strategy memo due before class

March 28 ESG debriefing in class

### **Exam**

The exam will be in class on May 1 from 9:30-11:30am in JMHH G50