

# ENERGY MARKETS AND POLICY

## BEPP/OIDD 763 WEMBA (EAST)

*Spring Semester 2021, Philadelphia, virtual via zoom*

*Note: This syllabus may be continuously updated. Please check Canvas for the latest version.  
Note that readings will be updated throughout the semester as policy developments occur.*

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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.

**Course format.** Most of the instruction will happen via live, synchronous sessions during the pre-announced class times. For some lectures, there will be pre-recorded videos and the synchronous class time will be shorter. In such cases, I will stay online for the entire duration of the lecture to answer questions in ‘extra office hours’.

**Attendance and virtual expectations.** Attendance is mandatory. I encourage everyone to turn on video, with a virtual background if you wish. Asking questions is encouraged, either by interrupting me directly or via the hand button in zoom. I will not always be able to monitor the chat window, but will read it after the lecture to see if any lingering questions need to be addressed.

**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 classmates. The exam will be online during the regularly scheduled lecture time on the last day of class (details to be announced later).

**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 8): Course Introduction & Energy Overview**

International Energy Agency, 2020. *World Energy Outlook*, Executive Summary ([link](#)).

### **Lecture 2 (Jan 8): Market Efficiency and Scarcity Pricing**

*Topics:* market efficiency; scarcity pricing; electricity markets; refined products markets.

(\*) Pre-recorded video: Market Efficiency

(\*) 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](#)).

D. Winning and R. Elliott, “Pandemic Pushes Fuel Makers in Richer Countries to the Brink”, *Wall Street Journal*, 12/6/20 ([link](#)).

### Lecture 3 (Jan 8): **Market Power in Electricity Markets (1)**

*Topics*: market power; deregulation.

(\*) Pre-recorded video: Market Power

(\*) 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 8): **Market Power in Electricity Markets (2)**

*Topics*: the California electricity crisis; the rise and fall of Enron.

(\*) Pre-recorded video: Enron and California

(\*) 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 15): 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. Dezember, “U.S. Glut in Natural-Gas Supply Goes Global”, *Wall Street Journal*, 8/27/19 ([link](#)).

J. Wallace, “U.S. Gas Exporters Eye Europe’s Surging Prices”, *Wall Street Journal*, 9/16/20 ([link](#)).

### **Lecture 6 (Jan 15): 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](#)).

### **Lecture 7 (Jan 29): 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 Creditor Cleared to Resume Citgo Seizure Efforts”, *Wall Street Journal*, 9/30/19 ([link](#)).

## ENERGY AND ENVIRONMENTAL POLICY

### Lecture 8 (Jan 29): **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](#)).

United Nations Environment Programme, 2020. *Emissions Gap Report*, Executive Summary ([link](#)).

### Lecture 9 (Feb 12): **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 12): **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 12): **Designing Real-World Environmental Markets & Introduction to the Electricity Strategy Game**

*Topics:* market design issues in cap-and-trade markets; EU Emissions Trading Scheme; RECLAIM; acid rain trading program.

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

(\*) 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 26): **Electricity Strategy Game Auction & U.S. and Global Policy Developments**

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

(\*) 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](#)).

(\*) M. Carr, “Carbon Pollution Costs Are Likely to Rise Again in Europe”, *Bloomberg*, 2/6/20 ([link](#)).

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

(\*) M. Martina and M. Xu, “China Expects First Trade in National Emissions Scheme in 2020”, *Reuters*, 3/30/19 ([link](#)).

S. Mufson, “Are Republicans Coming out of ‘the Closet’ on Climate Change?”, *The Washington Post*, 2/4/20 ([link](#)).

B. Geman, “House Democrats' Climate Bill Aims to Achieve Net-Zero Emissions by 2050”, *Axios*, 1/9/20 ([link](#)).

## Lecture 13 (Feb 26): **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 ([link](#)).

(\*) S. Sengupta, “U.N. Climate Talks End With Few Commitments and a ‘Lost’ Opportunity”, *New York Times*, 12/15/19 ([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 27): The Economics of Renewable Energy**

*Topics:* levelized cost of electricity; environmental benefits of renewables; energy storage basics.

(\*) 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.)

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

### **Lecture 15 (Feb 27): 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 finance and policy (on Canvas).

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

### **Lecture 16 (Mar 12): Renewable Energy Policy (1)**

*Topics:* PACE; net metering; feed-in tariffs; tenders.

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

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

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

J. Deign, “When Will European Offshore Wind See Negative Bids?”, *Greentech Media*, 11/18/19 ([link](#)).

## Lecture 17 (Mar 12): **Renewable Energy Policy (2)**

*Topics:* import tariffs; green subsidy vs. carbon tax; waterbed effect.

(\*) 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](#)).

## Lecture 18 (Mar 26): **Electricity Strategy Game Debriefing**

### **TOPIC: TRANSPORTATION POLICY**

## Lecture 19 (Mar 26): **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](#)).

(\*) C. Davenport, “Trump’s Path to Weaker Fuel Efficiency Rules May Lead to a Dead End”, *New York Times*, 2/13/20 ([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 20 (Apr 10): **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 21 (Apr 10): **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 22-23 (Apr 24): **Exam**

Note: there will be a two-hour online exam through Canvas that you will be able to take during class hours. No live class session on Apr 24.

## **DUE DATES**

### **Assignment dates**

Assignment 1: posted on January 22, due by February 8

Assignment 2: posted on February 19, due by March 8

Assignment 3: posted on April 2, due by April 16

### **Electricity Strategy Game**

February 12	Introduction to the Electricity Strategy Game in class
February 22	Bids due for the ESG test run by midnight EST
February 26	First ESG divestiture auction, in class
March 2	ESG strategies due by midnight EST for year 1, day 1
March 4	ESG strategies due by midnight EST for year 1, day 2
March 6	ESG strategies due by midnight EST for year 1, day 3
March 9	Sealed portfolio bids for year 2 due by midnight EST
March 11	ESG strategies due by midnight EST for year 2, day 1
March 13	ESG strategies due by midnight EST for year 2, day 2
March 16	ESG strategies due by midnight EST for year 2, day 3
March 26	ESG strategy memo due before class
March 26	ESG debriefing in class

### **Exam**

The exam will be online through Canvas on Apr 24.