ENCRY 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.

Professor Arthur van Benthem
Office Hours: by appointment or email
Phone: 215-898-3013
Email: arthurv@wharton.upenn.edu

Teaching Assistants: Chris Murphy (primary) and Angela Gunn
Office Hours: by appointment or email
Email: cwm@wharton.upenn.edu, abtgunn@ewharton.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 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/](https://catalog.upenn.edu/pennbook/code-of-academic-integrity/).

**ELECTRICITY MARKETS**

Lecture 1 (Jan 8): **Course Introduction & Energy Overview**


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”.


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

Topics: market power; deregulation.

(*) Pre-recorded video: Market Power


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


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]).


**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).


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).


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.


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).


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).


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.


(*) 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](#)).


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 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. 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.


(**) Lecture notes on renewable energy finance and policy (on Canvas).


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](#)).


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


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.


(* ) 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.


Lecture 21 (Apr 10): **Unintended Consequences of Transport Policies & Course Wrap Up**

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


“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.