

**JOHN F. KENNEDY SCHOOL OF GOVERNMENT
HARVARD UNIVERSITY
API-166: Electricity Market Design
Monday, Wednesday 10:15–11:30 am
124 Mount Auburn Street, Suite 100 Rm. 106
Fall 2017
PROFESSOR WILLIAM W. HOGAN**

Syllabus

COURSE DESCRIPTION

Topics in electricity market design starting from the foundations of Coordination for Competition, Infrastructure Investment, Resource Adequacy, Pricing Models, Cost Allocation, Energy Trading, Forward Hedging, Market Manipulation, Distribution Regulation, and Policy for Clean Energy Innovation. Assumes some knowledge about the engineering, economics, and regulation of the power sector. Students using this course to meet a PhD requirement will need to choose an appropriate paper topic in consultation with the instructor.

PREREQUISITES

Multivariate calculus recommended. API-102, IGA-410, IGA-411, or equivalent. Permission of the instructor.

EXPECTATIONS AND GRADING

Students will participate in the classroom discussion of readings on a series of electricity market policy issues that relate to market design. Each student will define an electricity market policy problem of interest and provide: (i) a one page précis of the policy issue with identification of the key analytical questions and associated readings; (ii) a draft paper addressing the policy issue; and (iii) a final paper with analysis and recommendations to address the selected policy issue.

Course grading will be 30% based on the draft paper, 30% on the final paper, 40% on classroom discussion, and follow the Harvard Kennedy School recommended grade distribution.

COURSE MATERIALS

The readings for each class provide a selection of papers and books of interest. All materials are available online, with a link as indicated on the list at the end of this syllabus. As noted just above the list, four reference books are also on reserve at the Kennedy School Library.

COLLABORATION IN WRITTEN WORK

Discussion and the exchange of ideas are essential to academic work. For assignments in this course, you are encouraged to consult with your classmates on the choice of paper topics and to share sources. You may find it useful to discuss your chosen topic with your peers, particularly if you are working on the same topic as a classmate. However, students must observe Kennedy School and Harvard University rules regarding the citation of sources. Any sentences or paragraphs taken verbatim from the writing of (or interviews with) any other person or persons, or from your own writing that has been published elsewhere, must be placed in quotation marks and their source must be clearly identified. Changing the wording of a sentence or passage slightly does not evade the requirement for citation. Indeed, whenever you are drawing an important argument or insight from someone else, even if you reword it into your own words, a reference to the source is required.

Including material from others in the assignments without appropriate quotation marks and citations is regarded, as a matter of School and University policy, as a serious violation of academic and professional standards and can lead to a failing grade in the course, failure to graduate, and even expulsion from the University. (Source: Adapted from Harvard Kennedy School Course Syllabus – IGA-408M: Learning from the Failure of Climate Policy, Professor David Keith, Spring 2014; Harvard University Course Syllabus – Gov 20: Foundations of Comparative Politics, Professor Steven Levitsky, Fall 2013.)

OFFICE HOURS

William Hogan, Room B318, W 1-2 pm and by appointment (sign-up sheet at B315 or contact Paul Sherman [B315] at paul_sherman@hks.harvard.edu for times outside of W 1-2 pm).

SCHEDULE

Monday, Wednesday 10:15–11:30 am

124 Mount Auburn Street, Suite 100 Rm. 106, Harvard Kennedy School

Class 1: Wednesday, August 30

1. Electricity System Fundamentals (Ruff, 1970) (Office of Technology Assessment, 1989) (Federal Energy Regulatory Commission, 1996) (FERC Office of Enforcement, 2012) (Joskow, 2006) (Hogan, 2002) (Shuttleworth, 2015) (Hartman, 2016) (Kavulla, 2017) (Hartley et al., 2017)
 - a. Integrated Resource Planning
 - b. Traditional Utility Regulation
 - c. Electricity Restructuring
 - i. Wheeling and Dealing
 - ii. Unbundling and Stranded Assets
 - d. Open Access and Non-Discrimination

Class 2: Friday, September 1 (special Friday meeting)

2. Economic Dispatch and Locational Marginal Prices (Bohn, Caramanis, & Schweppe, 1984) (Hogan, 1995) (International Energy Agency, 2007)
 - a. Dispatch and Transmission Pricing
 - b. Regional Transmission Organizations and Bilateral Trading
 - c. Price Formation and Dispatch Based Pricing
 - d. Successful Market Design (SMD)

**SEPTEMBER 4.
NO CLASS. LABOR DAY.**

Class 3: Wednesday, September 6

3. Financial Transmission Rights (Hogan, 1992) (J. B. Bushnell & Stoft, 1996)
 - a. Financial and Physical Transmission Rights
 - b. Revenue Adequacy
 - c. Auctions
 - d. Auction Revenue Rights

Class 4: Monday, September 11

4. Price Manipulation and Market Power (Borenstein, Bushnell, & Wolak, 2002) (Borenstein, 2002) (Harvey & Hogan, 2001) (Mansur, 2008) (J. Bushnell & Saravia, 2002)
 - a. Market Monitoring
 - b. Structural Reforms
 - c. Offer Caps

Class 5: Wednesday, September 13

5. Energy Trading (Allaz & Vila, 1993) (Bajpai & Singh, 2004)
 - a. Forward Contracts and Spot Markets
 - b. Forward Markets and Energy Trading
 - c. Forward Markets and Market Power

Class 6: Monday, September 18

6. Intertemporal Arbitrage and Energy Storage (R. Sioshansi, Denholm, Jenkin, & Weiss, 2009) (Peterson, Whitacre, & Apt, 2010) (Bradbury, Pratson, & Patiño-Echeverri, 2014) (Salles, Aziz, & Hogan, 2015) (McConnell, Forcey, & Sandiford, 2015)

Student Deadline: Submit a one page précis of the electricity market policy issue with identification of the key analytical questions and associated readings. Include links to or copies of the proposed readings. Please bring hard copy to class, September 20, 2017.

Class 7: Wednesday, September 20

7. Prices and Price Volatility (Monitoring Analytics, 2014) (Ayres, 2013)
 - a. Missing Money
 - b. Price Duration Profiles

Class 8: Monday, September 25

8. Capacity Markets (Joskow, 2008) (Newell, Spees, Pfeifenberger, & Karkatsouli, 2014) (Charles River Associates, 2017) (Shavel, Kline, Lueken, & Ruiz, 2017) (Hibbard, Tierney, & Franklin, 2017)
 - a. Reliability Standards and Deliverability
 - b. Capacity Product Definition
 - c. Locational Capacity Auctions

Class 9: Wednesday, September 27

9. Capacity Auctions and Minimum Offer Price Rules (Cramton, Ockenfels, & Stoft, 2013) (Hogan, 2011a) (PJM, 2017)

Class 10: Monday, October 2

10. Capacity Markets and Performance Incentives (FERC-ISONE, 2014) (Wilson, 2015)

Class 11: Wednesday, October 4

11. Transmission Dispatch and Topology Control (Hedman, Ferris, O'Neill, Fisher, & Oren, 2010)

**OCTOBER 9.
NO CLASS. COLUMBUS DAY.**

Class 12: Wednesday, October 11

12. Transmission Expansion Decisions Rules (J. B. Bushnell & Stoft, 1996) (Littlechild & Skerk, 2008)

Class 13: Monday, October 16

13. Transmission Cost Allocation (Campbell & Vann, 2012) (Hogan, 2011b)

Class 14: Wednesday, October 18

14. External Coordination (Kim & Baldick, 1997) (Cadwalader, Harvey, Hogan, & Pope, 1999)

Class 15: Monday, October 23

15. Scarcity Pricing and Operating Reserves (Hogan, 2013) (Hogan, 2014) (Hogan & Pope, 2017) (Hogan & Pope, 2017)
 - a. Co-optimization of Energy and Reserves

- b. Enhanced Operating Reserve Demand Curves

Class 16: Wednesday, October 25

- 16. Unit Commitment and Economic Dispatch (Baldick, Helman, Hobbs, & O'Neill, 2005) (Fu, Shahidehpour, & Li, 2005)
 - a. Reliability Unit Commitment
 - b. Resource Sufficiency Guarantees and Uplift Management

Class 17: Monday, October 30

- 17. Extended Locational Marginal Pricing (O'Neill, Sotkiewicz, Hobbs, Rothkopf, & Stewart, 2005) (Gribik, Hogan, & Pope, 2007) (Coutu & White, 2014)

Class 18: Wednesday, November 1

- 18. Virtual Bidding and Financial Traders (PJM, 2015) (Hogan, 2016)
 - a. Settlement Rules
 - b. Arbitrage Conditions
 - c. Uplift Costs and Allocation

Class 19: Monday, November 6

- 19. A Regulatory Framework for Price Manipulation and Enforcement (Ledgerwood, 2013) (Hogan, 2012)
 - a. Rules and Principles
 - b. Notification

Class 20: Wednesday, November 8

- 20. Forward Markets, Virtual Trading and Manipulation (Ledgerwood & Pfeifenberger, 2012) (Lo Prete & Hogan, 2014)
 - a. Entry and Trading Equilibrium
 - b. Transaction Costs

Class 21: Monday, November 13

21. Environmental Regulation and Power Markets (National Research Council, 2010) (Greenstone & Looney, 2012) (Interagency Working Group on Social Cost of Carbon, 2013) (Environmental Protection Agency, 2014) (Hogan, 2015) (Marcantonini & Ellerman, 2015) (Callaway, Fowlie, & McCormick, 2015) (Levin & Botterud, 2015) (Kotchen, 2016)
- a. Command and Control
 - b. Cap and Trade Systems
 - c. Clean Power Plan

Student Deadline: Submit draft final paper. Please bring hard copy to class, November 15, 2017.

Class 22: Wednesday, November 15

22. Renewable Portfolio Standards, Feed-in Tariffs (Schmalensee, 2011) (Morey & Kirsch, 2014) (Green & Léautier, 2015) (Cullenward & Coghlan, 2016)

Class 23: Monday, November 20

23. Demand Participation (Loxley & Salant, 2004)
- a. Default Options
 - b. Vesting Contracts

**NOVEMBER 22.
NO CLASS. THANKSGIVING BREAK.**

Class 24: Monday, November 27

24. Demand Participation (Chao, 2010) (Massachusetts Department of Public Utilities, 2014) (Faruqui, Hledik, & Palmer, 2012) (NYS Department of Public Service, 2014) (Tabors, Parker, Centolella, & Caramanis, 2016)
- a. Demand Response and Net Benefit Tests
 - b. Dynamic Pricing

Class 25: Wednesday, November 29

25. Net Metering and Retail Rate Design (Darghouth, Barbose, & Wisser, 2011) (Borenstein, 2016)

Student Deadline: Submit final paper. December 15, 2017

EDITED VOLUMES ON ELECTRICITY MARKET DESIGN POLICY ISSUES

The following volumes cover a range of topics. Hard cover versions of these books are on reserve in the Kennedy School Library: (Griffin & Puller, 2005) (F. P. Sioshansi, 2011) (Rosellón & Kristiansen, 2013) (Pérez-Arriaga, 2013)

READINGS AND BACKGROUND REFERENCES

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