

The Economics of Energy Markets

Winter 2020, Syllabus

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ENSAE ParisTech
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Introduction: This course presents institutional, theoretical and empirical aspects of the economics of energy markets and environmental regulation. Energy consumption is an essential driver of economic activity and the main source of polluting emissions. While energy industries are strongly driven by fundamental economic forces, regulation is an important safeguard to ensure their well-functioning. This course first examines the economic aspects of electricity markets, including its historical and theoretical foundations as well as recent empirical studies. The second part of this course presents the fundamentals of primary energy markets through the theory of exhaustible resources, and the empirical aspects of crude oil and retail gasoline markets. The third part focuses on environmental regulation and the energy transition through the lens of European objectives and policies including emissions markets, energy efficiency, and renewable energy deployment.

Main concepts: Topics covered include: natural monopoly, vertical integration, price regulation, regulation of networks, peak-load pricing, market power, antitrust regulation, pay-as-bid vs uniform price multi-unit auctions, supply function equilibria, transmission congestions, the effect of forward contracting, demand-response, capacity markets, Hotelling rule, oil prices, mergers, environmental taxes and cap-and-trade regulation, the effects of environmental regulation, pass-through of emissions pricing, energy efficiency, rebound effect, energy transition, and renewable energy policies.

Objectives: This course aims at: 1) developing an understanding of the functioning of energy markets, through the presentation of a variety of relevant concepts and applications; and 2) providing microeconomic and econometric tools of analysis that are useful across many industries beyond energy markets. The course delivers useful background for public and private sector roles in the energy and environmental industries, regulation, research, trading, investment, think tanks, or consultancies.

Evaluation: Enrolled students are expected to actively participate to class (10% of final grade). The evaluation is composed of :

1. a short presentation (15 minutes) about one of the articles marked by a ★ in the outline below (40% of final grade);
2. a research proposal (5 pages) about a relevant topic related to the course (40% of final grade).

Students are expected to use the concepts covered, state a research question, present economic intuitions, and deliver their own discussion of the methods and results.

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At the end of the class, the students must: 1) have acquired knowledge about the functioning of energy markets, 2) understand the main challenges about energy and environmental policies, 3) have a good understanding of the microeconomic and econometric methods of analysis presented in class, and more generally, 4) be able to conduct independent research on relevant topics related to energy economics and policy.

Outline:

The course is organized in 12 sessions of 1h30.

I. The electricity industry

1. Foundations (Session 1)

- A brief history from nationalisation to “deregulation” in Europe and the U.S.
- Evolving paradigms: natural monopoly and competitive markets.
- Economic efficiency, peak-load pricing, regulatory issues, investment adequacy, and profitability.
- The aftermath of “deregulation”: the California crisis, market power and anti-competitive conducts.
 - Carlton, D. and Perloff, J. (2005). *Modern Industrial Organization*. The Addison-Wesley series in economics. Pearson/Addison Wesley.
 - ★ Davis, L. W. and Wolfram, C. (2012). Deregulation, consolidation, and efficiency: Evidence from US nuclear power. *American Economic Journal: Applied Economics*, 4(4):194–225.
 - ★ Fabrizio, K. R., Rose, N. L., and Wolfram, C. D. (2007). Do markets reduce costs? Assessing the impact of regulatory restructuring on US electric generation efficiency. *American Economic Review*, 97(4):1250–1277.
 - Griffin, J. M. and Puller, S. L. (2005). *Electricity Deregulation: Choices and Challenges*. University of Chicago Press.
 - Hansen, J.-P. and Percebois, J. (2017). *Transition(s) Électrique(s)*. Éditions Odile Jacob.
 - Healy, P. M. and Palepu, K. G. (2003). The fall of Enron. *Journal of economic perspectives*, 17(2):3–26.
 - Rose, N. L. (2014). *Economic Regulation and its Reform: What have we learned?* University of Chicago Press.

2. Market power in electricity markets: theory (Session 1-2)

- Multi-unit auctions (pay-as-bid vs. uniform), supply function equilibria, and transmission networks.
 - Ausubel, L. M., Cramton, P., Pycia, M., Rostek, M., and Weretka, M. (2014). Demand reduction and inefficiency in multi-unit auctions. *The Review of Economic Studies*, 81:1366–1400.
 - Joskow, P. L. and Tirole, J. (2000). Transmission rights and market power on electric power networks. *The RAND Journal of Economics*, pages 450–487.
 - Klemperer, P. D. and Meyer, M. A. (1989). Supply function equilibria in

oligopoly under uncertainty. *Econometrica*, 57(6):1243–1277.

- ★ Léautier, T.-O. (2001). Transmission constraints and imperfect markets for power. *Journal of Regulatory Economics*, 19(1):27–54.
- Wilson, R. (1979). Auctions of shares. *The Quarterly Journal of Economics*, pages 675–689.

3. Market power in electricity markets: empirical studies (Session 3)

- Measuring market power, the effects of forward contracts and the empirical study of bidding behaviors in multi-unit auctions.
 - Borenstein, S., Bushnell, J. B., and Wolak, F. A. (2002). Measuring market inefficiencies in california’s restructured wholesale electricity market. *American Economic Review*, 92(5):1376–1405.
 - Borenstein, S., Bushnell, J., and Knittel, C. R. (1999). Market power in electricity markets: Beyond concentration measures. *The Energy Journal*, pages 65–88.
 - Bushnell, J. B., Mansur, E. T., and Saravia, C. (2008). Vertical arrangements, market structure, and competition: An analysis of restructured us electricity markets. *American Economic Review*, 98(1):237–66.
 - ★ Green, R. and Newberry, D. (1992). Competition in the British electricity spot market. *Journal of Political Economy*, 100.
 - Hortaçsu, A. and Puller, S. L. (2008). Understanding strategic bidding in multi-unit auctions: a case study of the texas electricity spot market. *The RAND Journal of Economics*, 39(1):86–114.
 - ★ Ito, K. and Reguant, M. (2016). Sequential markets, market power, and arbitrage. *American Economic Review*, 106(7):1921–57.
 - ★ Reguant, M. (2014). Complementary bidding mechanisms and startup costs in electricity markets. *The Review of Economic Studies*, 81(4):1708–1742.
 - ★ Sioshansi, R. and Oren, S. (2007). How good are supply function equilibrium models: an empirical analysis of the ERCOT balancing market. *Journal of Regulatory Economics*, 31(1):1–35.
 - ★ Willems, B., Rumiantseva, I., and Weigt, H. (2009). Cournot versus supply functions: What does the data tell us? *Energy Economics*, 31(1):38–47.
 - Wolak, F. A. (2000). An empirical analysis of the impact of hedge contracts on bidding behavior in a competitive electricity market. *International Economic Journal*, 14(2):1–39.
 - Wolak, F. A. (2003). Identification and estimation of cost functions using observed bid data: An application to electricity markets. *Advances in Economics and Econometrics - Theory and Applications*, pages 115–149.
 - Wolak, F. A. (2007). Quantifying the supply-side benefits from forward contracting in wholesale electricity markets. *Journal of Applied Econometrics*, 22(7):1179–1209.
 - ★ Wolak, F. A. and Patrick, R. H. (2001). The impact of market rules and market structure on the price determination process in the england and wales electricity market. Technical report, National Bureau of Economic Research.
 - ★ Wolfram, C. D. (1999). Measuring duopoly power in the British electricity spot market. *American Economic Review*, pages 805–826.

4. Investment and capacity markets (Session 4)

- Peak-load pricing, the fundamentals of capacity markets, and the study of empirical behavior in capacity markets.
 - ★ Bushnell, J., Flagg, M., and Mansur, E. (2017). Capacity markets at a crossroads. *report to the Department of Energy, Office of Energy Policy and Systems Analysis, Washington, DC.*
 - Cramton, P., Ockenfels, A., and Stoft, S. (2013). Capacity market fundamentals. *Economics of Energy & Environmental Policy*, 2(2):27–46.
 - Fabra, N. (2018). A primer on capacity mechanisms. *CWPE 1814.*
 - ★ Joskow, P. and Tirole, J. (2007). Reliability and competitive electricity markets. *The RAND Journal of Economics*, 38(1):60–84.
 - ★ Schwenen, S. (2015). Strategic bidding in multi-unit auctions with capacity constrained bidders: the new york capacity market. *The RAND Journal of Economics*, 46(4):730–750.

5. Demand and retail markets (Session 4)

- The theory of retail competition, the role of demand-response and the econometrics of price elasticities.
 - ★ Borenstein, S. (2012). The redistributive impact of nonlinear electricity pricing. *American Economic Journal: Economic Policy*, 4(3):56–90.
 - ★ Ito, K. (2014). Do consumers respond to marginal or average price? Evidence from nonlinear electricity pricing. *American Economic Review*, 104(2):537–63.
 - Joskow, P. and Tirole, J. (2006). Retail electricity competition. *The RAND Journal of Economics*, 37(4):799–815.
 - Patrick, R. H. and Wolak, F. A. (2001). Estimating the customer-level demand for electricity under real-time market prices. *NBER Working Papers 8213, National Bureau of Economic Research.*
 - Reiss, P. C. and White, M. W. (2005). Household electricity demand, revisited. *The Review of Economic Studies*, 72(3):853–883.

II. Other energy markets

1. Exhaustible resources (Session 5-6)

- Dynamic management of an exhaustible resource, the Hotelling rule and the empirical economics of oil prices.
 - ★ Asker, J., Collar-Wexler, A., and De Loecker, J. (2018). (Mis)allocation, market power, and global oil extraction. *NBER Working Papers 23801, National Bureau of Economic Research.*
 - ★ Benchekroun, H., van der Meijden, G., and Withagen, C. (2017). OPEC, shale oil, and global warming-on the importance of the order of extraction. *CESifo Working Paper No. 6746. Category 10: Energy and Climate Economics.*
 - Gaudet, G. (2007). Natural resource economics under the rule of Hotelling. *Canadian Journal of Economics/Revue canadienne d'économique*, 40(4):1033–1059.
 - Hamilton, J. D. (2009). Understanding crude oil prices. *The Energy Journal*, 30:179–206.

- Hotelling, H. (1931). The economics of exhaustible resources. *Journal of political Economy*, 39(2):137–175.
- Kilian, L. and Murphy, D. P. (2014). The role of inventories and speculative trading in the global market for crude oil. *Journal of Applied Econometrics*, 29(3):454–478.

2. Retail gasoline (Session 7-8)

- Mergers, collusion, Edgeworth cycles and sticky prices in retail gasoline markets.
 - ★ Hastings, J. S. (2004). Vertical relationships and competition in retail gasoline markets: Empirical evidence from contract changes in southern California. *American Economic Review*, 94(1):317–328.
 - Houde, J.-F. (2012). Spatial differentiation and vertical mergers in retail markets for gasoline. *American Economic Review*, 102(5):2147–82.
 - Hosken, D. S., McMillan, R. S., and Taylor, C. T. (2008). Retail gasoline pricing: What do we know? *International Journal of Industrial Organization*, 26(6):1425–1436.
 - ★ Klier, T. and Linn, J. (2010). The price of gasoline and new vehicle fuel economy: evidence from monthly sales data. *American Economic Journal: Economic Policy*, 2(3):134–53.
 - Noel, M. D. (2007). Edgeworth price cycles, cost-based pricing, and sticky pricing in retail gasoline markets. *The Review of Economics and Statistics*, 89(2):324–334.
 - ★ Slade, M. E. (1992). Vancouver’s gasoline-price wars: An empirical exercise in uncovering supergame strategies. *The Review of Economic Studies*, 59(2):257–276.

III. Energy transition and environmental regulation

- Brief introduction to the energy transition in Europe. (Session 9)
 - Hansen, J.-P. and Percebois, J. (2017). *Transition(s) Électrique(s)*. Éditions Odile Jacob.

1. Energy efficiency (Session 9)

- Investment, rebound effect and efficiency gap.
 - Allcott, H. and Greenstone, M. (2012). Is there an energy efficiency gap? *Journal of Economic Perspectives*, 26(1):3–28.
 - Borenstein, S. (2015). A microeconomic framework for evaluating energy efficiency rebound and some implications. *The Energy Journal*, 36(1):1–21.
 - Burlig, F., Knittel, C., Rapson, D., Reguant, M., and Wolfram, C. (2017). Machine learning from schools about energy efficiency. *NBER Working Paper 23908*, National Bureau of Economic Research.
 - ★ Fowlie, M., Greenstone, M., and Wolfram, C. (2018). Do energy efficiency investments deliver? Evidence from the Weatherization Assistance Program. *The Quarterly Journal of Economics*.

2. Environmental markets and regulation (Session 10)

- Functioning of environmental markets, the effects of environmental regulation, and pass-through of emissions pricing.

- ★ Borenstein, S., Bushnell, J., Wolak, F. A., and Zaragoza-Watkins, M. (2018). Expecting the unexpected: Emissions uncertainty and environmental market design. *NBER*.
- Bushnell, J. B., Chong, H., and Mansur, E. T. (2013). Profiting from regulation: Evidence from the european carbon market. *American Economic Journal: Economic Policy*, 5(4):78–106.
- Fabra, N. and Reguant, M. (2014). Pass-through of emissions costs in electricity markets. *American Economic Review*, 104(9):2872–99.
- ★ Fowlie, M., Reguant, M., and Ryan, S. P. (2016). Market-based emissions regulation and industry dynamics. *Journal of Political Economy*, 124(1):249–302.
- ★ Ganapati, S., Shapiro, J. S., and Walker, R. (2018). The incidence of carbon taxes in us manufacturing: Lessons from energy cost pass-through. *NBER Working Papers 22281*, National Bureau of Economic Research.
- ★ Ryan, S. P. (2012). The costs of environmental regulation in a concentrated industry. *Econometrica*, 80(3):1019–1061.

3. Renewable support policies (Session 11-12)

- Market integration of renewables, support mechanisms and the costs of fossil fuel subsidies.
 - ★ Ambec, S. and Crampes, C. (2012). Electricity provision with intermittent sources of energy. *Resource and Energy Economics*, 34(3):319–336
 - Fischer, C. and Newell, R. G. (2008). Environmental and technology policies for climate mitigation. *Journal of environmental economics and management*, 55(2):142–162.
 - ★ Cullen, J. (2013). Measuring the environmental benefits of wind-generated electricity. *American Economic Journal: Economic Policy*, 5(4):107–33.
 - ★ Percebois, J. and Pommeret, S. (2018). Cross-subsidies tied to the introduction of intermittent renewable electricity. An analysis based on a model of the french day-ahead market. *The Energy Journal*, 39(3).
 - Reguant, M. (2018). The efficiency and sectoral distributional implications of large-scale renewable policies. *National Bureau of Economic Research*.