

# ENERGY ECONOMICS

Universidad Carlos III de Madrid

EnergyEcoLab

Winter 2020

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<b>When:</b>	Tu+Th, 16:00-17:30	<b>Where:</b>	18.1.A07

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**Description:** Drawing on the tools of industrial organization, we study the regulation and competition policy issues raised in energy markets, and in the environmental markets to which they are closely tied. Topics include the performance of organized spot and futures markets for electricity; the impact of emissions regulations on these markets; the environmental impacts and policies related to energy production and use; market power and antitrust; the incentives to invest in generation capacity as well as in energy efficiency; and the effects of policies aimed at promoting demand side response. We study the seminal theoretical and empirical papers in this field, as well as the most recent papers at the frontier. We promote students to search for new ideas in this field that can help them identify future research topics.

**Office Hours:** At students' request, by appointment.

**Course evaluations:** Students will be asked to write a short paper related to the course's material. Students will also be asked to give at least one short class presentation. Evaluation will also be based on active participation in class. There will be no exam.

**Readings and class materials:** A list of papers for each topic is suggested under each topic. Those marked with an \* are required. Class material will be distributed one week ahead. Students are expected to read this material before coming to class. Fabra, N. (2021) "The Energy Transition: An Industrial Economics Perspective" provides a survey which covers part of the course material.

**Participation:** You are expected to come prepared for class by completing the required reading. You will be expected to have identified and analyzed the important concepts in the reading. Effective class participation moves the discussion forward.

## COURSE TOPICS AND READINGS

### 1. Electricity Markets Overview (1 session)

- \*Borenstein, S. (2000). Understanding Competitive Pricing and Market Power in Wholesale Electricity Markets, *Electricity Journal*, July 2000, pp. 49-57.
- Borenstein, S. (2002). The trouble with electricity markets: understanding California's restructuring disaster. *Journal of economic perspectives*, 16(1), 191-211.
- Borenstein, S., and Bushnell, J. (2000) Electricity restructuring: deregulation or reregulation, *Regulation*, 23, 46.
- \*Fabra, N. (2021). The Energy Transition: An Industrial Economics Perspective, *International Journal of Industrial Organization*, forthcoming.
- Griffin, J. 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, 2005, pp. 1-11.
- \*Newbery, D. (2011). Reforming Competitive Electricity Markets to Meet Environmental Targets, Working Paper, Univ. of Cambridge, CWPE 1154 EPRG 1126.
- Wolak, F. A. (2014). Regulating competition in wholesale electricity supply. In *Economic Regulation and Its Reform: What Have We Learned?* (pp. 195-289). University of Chicago Press.

### 2. Theoretical Analysis of Market Power in Electricity Markets (3 sessions)

- Fabra, N., and M.A. de Frutos. (2012). Forward Contract Obligations in Multi-Unit Auctions, *European Economic Review*.
- \*Fabra, N., N.H. von der Fehr, and D. Harbord. (2006). Designing Electricity Auctions, *RAND Journal of Economics*, 37 (1), 23-46.
- \*Fabra, N., and Llobet, G. (2019). Auctions with Unknown Capacities: Understanding Competition among Renewables, CEPR working paper.
- \*von der Fehr, N.H. and D. Harbord. (1993). Spot Market Competition in the UK Electricity Industry, *Economic Journal*, 103(418), 531-46.
- Green, R. and D. Newbery. (1992). Competition in the British Electricity Spot Market, *Journal of Political Economy* 100(5), 929-53.
- \*Holmberg, P. and Wolak, F. (2018). Comparing Auction Designs where Suppliers have Uncertain Costs and Uncertain Pivotal Status, *RAND Journal of Economics*.
- Klemperer, P. and M. Meyer. (1989). Supply Function Equilibria in Oligopoly under Uncertainty, *Econometrica* 57(6), 1243-77.

### 3. Empirical Analysis of Market Power in Electricity Markets (1 session)

- Crawford, G. S., J. Crespo, H.V. Tauchen (2007) Bidding Asymmetries in Multi-Unit Auctions: Implications of Bid Function Equilibria in the British Spot Market for Electricity, *International Journal of Industrial Organization*, 25 (6), 1233-1268.

- \*Hortacsu, A. and Puller, S. (2008) Understanding Strategic Bidding in Multi-Unit Auctions: A Case Study of the Texas Electricity Spot Market, *RAND Journal of Economics*, 39(1): 86-114.
- \*Wolak, F. (2013). Measuring Unilateral Market Power in Wholesale Electricity Markets: The California Market 1998 to 2000. *American Economic Review*, 93, pp. 425–430.
- \*Wolfram, C.D. (1999). Measuring Duopoly Power in the British Electricity Spot Market. *American Economic Review*, Vol. 89, pp. 805–826.
- Wolfram, C. (1998). Strategic Bidding in a Multiunit Auction: An Empirical Analysis of Bids to Supply Electricity in England and Wales, *The RAND Journal of Economics*, Vol. 29, No. 4, 703-725.

#### 4. **Forward Contracting and Vertical Integration** (1 session)

- \*Allaz, B., and J.-L. Vila. (1993). Cournot Competition, Forwards Markets and Efficiency, *Journal of Economic Theory* 59, 1-16.
- Bushnell, J. (2007). Oligopoly Equilibria in Electricity Contract Markets, *Journal of Regulatory Economics* 32 (3), 225-245.
- Bushnell, J., E. Mansur, and C. Saravia. (2008). Vertical Arrangements, Market Structure and Competition: An analysis of Restructured U.S. Electricity Markets, *American Economic Review*, 98 (1), 237-266.
- Fabra, N., and M.A. de Frutos. (2012). Forward Contract Obligations in Multi-Unit Auctions, *European Economic Review*.
- Fabra, N., and J. Toro. (2005). Price Wars and Collusion in the Spanish Electricity Market, *International Journal of Industrial Organization* 23 (3-4), 155-181.
- Liski, M., and J.-P. Montero. (2006). Forward Trading and Collusion in Oligopoly, *Journal of Economic Theory* 131, 212-230.
- Newbery, D. (1998). Competition, Contracts and Entry in the Electricity Spot Market, *RAND Journal of Economics*, 29, 726-49.
- \*Wolak, F.A. (2007). Quantifying the Supply-Side Benefits from Forward Contracting in Wholesale Electricity Markets, *Journal of Applied Econometrics* 22, 1179-1209.

#### 5. **Renewables Policy** (2 sessions)

- Callaway, D., M. Fowle, and G. McCormick (2018). Location, Location, Location: The Variable Value of Renewable Energy and Demand-Side Efficiency Resources. *Journal of the Association of Environmental and Resource Economists*.
- \*Borenstein, S. (2011). The private and public economics of renewable electricity generation, *Journal of Economic Perspectives*, 47.
- \*Fabra, N. and Imelda (2020). Price Exposure and Market Power: Learning from Changes in Renewable Regulation, mimeo, energycolab, Universidad Carlos III de Madrid.

- \*Fabra, N. and Montero, J.P. (2020). Technology-Neutral vs. Technology-Specific Procurement, CEPR Discussion Paper.
- Green R. and A. Yatchew. (2012). Support Schemes for Renewable Energy: An Economic Analysis, *Economics of Energy Environmental Policy* 1.
- Heal, G. (2009). Reflections—the economics of renewable energy in the United States. *Review of Environmental Economics and Policy*, 4(1), 139-154.
- \*Ito, K. and Reguant, M. (2016). Sequential Markets, Market Power and Arbitrage (2014), *American Economic Review*, 106(7): 1921-1957.
- \*Joskow, P. (2011). Comparing the Costs of Intermittent and Dispatchable Electricity Generating Technologies. *American Economic Review Papers and Proceedings* 101(3).
- Gowrisankaran, G., S. Reynolds, and M. (2016). Intermittency and the Value of Renewable Energy. *Journal of Political Economy* 124: 1187-1234.
- Novan, K. (2015). Valuing the Wind: Renewable Energy Policies and Air Pollution Avoided, *American Economic Journal: Economic Policy* 7:3, 291-326.
- Reguant, M. (2019). The Efficiency and Sectoral Distributional Implications of Large-Scale Renewable Policies, *Journal of the Association of Environmental and Resource Economics*.
- \*Weitzman, M. (1974). Prices versus Quantities, *Review of Economic Studies*, October, 41 (4), 477-491.

## 6. Investment Incentives and Capacity Mechanisms (1 session)

- Fabra, N., N.-H. von der Fehr and M.-A. de Frutos. (2011). Market Design and Investment Incentives, *Economic Journal*, 121, 1340-1360.
- \*Fabra, N. (2014), A Primer in Capacity Mechanisms, *Energy Economics*.
- Garcia, A. and E. Stacchetti. (2011). Investment Dynamics in Electricity Markets, *Economic Theory*.
- Llobet, G. and Padilla J. (2018). Conventional Power Plants in Liberalized Electricity Markets with Renewable Entry, *The Energy Journal*, 69-91, 2018.
- Bushnell, J. Flagg, M. and E. Mansur (2017) Capacity markets at a crossroad, Haas Working Paper 278.
- European Parliament (2017) Capacity markets for electricity, Members' Research Service, Policy Briefing.
- Schwenen, S. (2015) Strategic bidding in multi-unit auctions with capacity constrained bidders: the New York capacity market, *Rand Journal of Economics*, Volume 46, Issue 4, 730-750.

## 7. The Demand Side: Pricing, Consumers' Response, and Competition (1 session)

- Borenstein, S. (2012). The Redistributive Impact of Nonlinear Electricity Pricing. *American Economic Journal: Economic Policy* 4 (3): 56–90.
- Borenstein, S. (2007). Wealth Transfers Among Large Customers from Implementing Real-Time Retail Electricity Pricing, *The Energy Journal*, 28(2).
- Borenstein, S. (2007). Customer Risk from Real-Time Retail Electricity Pricing: Bill Volatility and Hedgability, *The Energy Journal*, 28(2).
- \*Borenstein, S. and Holland, S. (2005). On the Efficiency of Competitive Electricity Markets With Time-Invariant Retail Prices, *RAND Journal of Economics*, 36.
- Bollinger, B.K. and Hartmann, W (2019). Information vs Automation and Implications for Dynamic Pricing, *Management Science* 66(1).
- \* Fabra, N., Rapson, D., Reguant, M., and Wang, J. (2021). Estimating the Elasticity to Real time Prices: Evidence from the Spanish Electricity Market, *American Economic Association Papers & Proceedings*.
- \*Hortacsu, A. and S. A. Madanizadeh and Puller, S. (2017). Power to Choose? An Analysis of Consumer Inertia in the Residential Electricity Market, *American Economic Journal: Economic Policy*, 9(4): 192-226.
- Holland, S. P., and E. T. Mansur. (2008). Is real-time pricing green? The environmental impacts of electricity demand variance. *The Review of Economics and Statistics* 90.3 (2008): 550-561.
- \*Ito, K. (2014). Do consumers respond to marginal or average price? Evidence from nonlinear electricity pricing. *American Economic Review*, 104(2), 537-63.
- Ida, M., K. Ito, and M. Tanaka. (2019). Information Frictions, Inertia, and Selection on Elasticity: A Field Experiment on Electricity Tariff Choice, mimeo.
- Joskow, Paul L., and C. Wolfram. (2012). Dynamic Pricing of Electricity. *American Economic Review*, 102 (3): 381-85.
- Wolak, F. (2011). Do Residential Customers Respond to Hourly Prices? Evidence from a Dynamic Pricing Experiment. *American Economic Review* 101 (3): 83–7.
- Jessoe, K., and D. Rapson (2016). Knowledge is (Less) Power: Experimental Evidence from Residential Energy Use. *American Economic Review*.

## 8. The Economics of Energy Storage (1 session)

- Bushnell, J. (2003). A Mixed Complementarity Model of Hydro-Thermal Electricity Competition in the Western U.S., *Operations Research*, 51, 81-93.
- \*Andres, D. and Fabra, N. (2020). Storing Power: Market Structure Matters, CEPR Discussion paper.
- Garcia, A., Reitzes, J. D. and Stacchetti, E. (2001). Strategic Pricing when Electricity is Storable, *Journal of Regulatory Economics* 20(3), 223-247.
- \*Borenstein, S. (2019). Charging with the Sun, *Blog Energy at Haas*.

**9. Pollution Permits and Taxes** (1 session)

- 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.
- Gillingham, K. and J. Stock (2018). The Cost of Reducing Greenhouse Gas Emissions. *Journal of Economic Perspectives*, 32(4).
- Borenstein, S. J. Bushnell, F. Wolak, and M. Zaragoza-Watkins. (2019). Expecting the Unexpected: Emissions Uncertainty and Environmental Market Design, *American Economic Review*, forthcoming.
- Reguant, M. and Fowlie (2018). Challenges in the Measurement of Leakage Risk, with Meredith Fowlie, *American Economic Review Papers & Proceedings*, 2018, 108: 124-29.
- \*Fabra, N., and Reguant, M. (2014). Pass-through of emission costs in electricity markets, *American Economic Review*.
- Portney, P. R. (2007). Market-based approaches to environmental policy: a “Refresher” course. In *Acid in the Environment* (pp. 225-231). Springer, Boston, MA.
- Parry, Ian W.H. and William A. Pizer (2007). Emissions Trading Versus CO2 Taxes Versus Standards. Chapter 5 of *Assessing U.S. Climate Policy Options, Resources for the Future: Washington D.C.*, p. 80-86.
- \*Ellerman, A. D., and Joskow, P. L. (2008). The European Union’s emissions trading system in perspective (pp. 12-64). Arlington, VA: Pew Center on Global Climate Change.

**10. Energy Efficiency** (1 session)

- \*Allcott, H. and M. Greenstone (2012). Is there an Energy Efficiency Gap? *Journal of Economic Perspectives*, 26(1), 3–28.
- \*Gerarden, T., R. Newell and R. Stavins (2017). Assessing the Energy Efficiency Gap. *Journal of Economic Literature* 55(4), 1486-1525.
- \*Borenstein, S. (2015). A microeconomic framework for evaluating energy efficiency rebound and some implications. *The Energy Journal*, 36(1).
- Fowlie, M. Greenstone, M. and Wolfram, C. (2018). Do Energy Efficiency Investments Deliver? Evidence from the Weatherization Assistance Program. *The Quarterly Journal of Economics*, Volume 133, Issue 3, 1597–1644.
- Gillingham, K. R. Newell, and K. Palmer. (2009). Energy Efficiency Economics and Policies, *Annual Review of Resource Economics*, Vol. 1, 597-619.
- Gillingham, K., Rapson, D., and Wagner, G. (2016). The rebound effect and energy efficiency policy. *Review of Environmental Economics and Policy*, 10(1), 68-88.
- Charles, D. (2009). Leaping the efficiency gap. *Science*, 804-811.

**11. Behavioral Energy Economics** (1 session)

- \*Allcott, H. (2011). Social norms and energy conservation. *Journal of Public Economics*, 95(9-10), 1082-1095.
- \*Allcott, H., and Rogers, T. (2014). The short-run and long-run effects of behavioral interventions: Experimental evidence from energy conservation. *American Economic Review*, 104(10), 3003-37.
- \*Myers, E., and Souza, M. (2020). Social comparison nudges without monetary incentives: Evidence from home energy reports. *Journal of Environmental Economics and Management*, 102315.
- Allcott, H., and Mullainathan, S. (2010). Behavior and energy policy. *Science*, 327(5970), 1204-1205.
- Asensio, O. I., and Delmas, M. A. (2015). Nonprice incentives and energy conservation. *Proceedings of the National Academy of Sciences*, 112(6), E510-E515
- Delmas, M. A., and Lessem, N. (2014). Saving power to conserve your reputation? The effectiveness of private versus public information. *Journal of Environmental Economics and Management*, 67(3), 353-370.
- Ito, K., Ida, T., and Tanaka, M. (2018). Moral suasion and economic incentives: Field experimental evidence from energy demand. *American Economic Journal: Economic Policy*, 10(1), 240-67.

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**Tentative 2021 course schedule**

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Week	1st session	2nd session
2-4 February	Electricity Markets Overview	Market Power (Theory)
9-11 February	Market Power (Theory)	Market Power (Theory)
16-18 February	Market Power (Empirics)	Forward Contracts
23-25 February	Renewables	Renewables
2-4 March	Investment	Demand response
9-11 March	Storage	Taxes and Permits
16-18 March	Energy Efficiency	Behavioral Energy Economics
23-25 March	Presentations	Presentations

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