

# ENERGY ECONOMICS

Universidad Carlos III de Madrid

EnergyEcoLab

Winter 2023

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<b>When:</b>	Mon+Wed, 16:00-17:30	<b>Where:</b>	15.1.39

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**Description:** Drawing on the tools of industrial organization, we study the regulation and competition policy issues that arise in energy markets and the environmental markets to which they are closely tied. Topics include the performance of electricity markets; 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 renewables, storage and 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 encourage students to search for new ideas in this field to 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 below. Papers marked with an \* are required readings. 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) (NF)

- \*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*, 79.
- Joskow, Paul L (2019). "Challenges for wholesale electricity markets with intermittent renewable generation at scale: the US experience". *Oxford Review of Economic Policy* 35(2), pp. 291– 331.
- \*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) (NF)

- 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. (2022). Auctions with Privately known Capacities: Understanding Competition among Renewables, *Economic Journal*, forthcoming.
- \*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) (NF)

- 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. Renewables Policy (2 sessions)(NF)

- 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 (2022). Market Power and Price Exposure: Learning from Changes in Renewables Regulation, *American Economic Journal: Economic Policy*, forthcoming.
- \*Fabra, N. and Montero, J.P. (2022). Technology-Neutral vs. Technology-Specific Procurement, *Economic Journal*, forthcoming.
- 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 Economists*.

- \*Weitzman, M. (1974). Prices versus Quantities, *Review of Economic Studies*, October, 41 (4), 477-491.

#### 5. Investment Incentives and Capacity Mechanisms (1 session) (NF)

- 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*, Volume46, Issue4, 730-750.

#### 6. The Economics of Energy Storage and Demand Response (2 sessions) (NF)

- \*Andres, D. and Fabra, N. (2022). Storing Power: Market Structure Matters, *Rand Journal of Economics*, forthcoming.
- 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. (2019). Charging with the Sun, *Blog Energy at Haas*.
- \*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).
- \*Cahana, M., Fabra, N., Reguant, M., and Wang, J. (2022). The Distributional Impacts of Real-Time Pricing, *CEPR Discussion paper*.
- \*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*.

- Garcia, A., Reitzes, J. D. and Stacchetti, E. (2001). Strategic Pricing when Electricity is Storable, *Journal of Regulatory Economics* 20(3), 223-247.
- Jessoe, K., and D. Rapson (2016). Knowledge is (Less) Power: Experimental Evidence from Residential Energy Use. *American Economic Review*.
- Joskow, Paul L., and C. Wolfram. (2012). Dynamic Pricing of Electricity. *American Economic Review*, 102 (3): 381-85.

#### 7. Pollution Permits and Taxes (2 sessions) (SL)

- Portney, P. R. (2007). Market-based approaches to environmental policy: a “Re-fresher” course. In *Acid in the Environment* (pp. 225-231). Springer, Boston, MA.
- Gillingham, K. and J. Stock (2018). The Cost of Reducing Greenhouse Gas Emissions. *Journal of Economic Perspectives*, 32(4).
- 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.
- Borghesi, S., Montini, M. (2016). The best (and worst) of GHG emission trading systems: comparing the EU ETS with its followers. *Frontiers in Energy Research*, 4, 27.
- Borenstein, S., Bushnell, J., Wolak, F. A., Zaragoza-Watkins, M. (2019). Expecting the unexpected: Emissions uncertainty and environmental market design. *American Economic Review*, 109(11), 3953-77.
- \*Fabra, N., and Reguant, M. (2014). Pass-through of emission costs in electricity markets, *American Economic Review*.
- Reguant, M. and Fowlie (2018). Challenges in the Measurement of Leakage Risk, with Meredith Fowlie, *American Economic Review Papers & Proceedings*, 2018, 108: 124-29.
- \*Fowlie, M. L., Reguant, M. (2022). Mitigating emissions leakage in incomplete carbon markets. *Journal of the Association of Environmental and Resource Economists*, 9(2), 307-343.
- Martin, R., Muûls, M., De Preux, L. B., Wagner, U. (2014). Industry compensation under relocation risk: A firm-level analysis of the EU emissions trading scheme. *The American Economic Review*, 104(8), 2482-2508.
- Ambec, S. (2022). The european union’s carbon border adjustment mechanism: challenges and perspectives.
- Fowlie, M., Petersen, C., Reguant, M. (2021, May). Border carbon adjustments when carbon intensity varies across producers: Evidence from California. In *AEA Papers and Proceedings* (Vol. 111, pp. 401-05).

**8. The Impact of Climate Change Policies on Regulated Industries** (1 session) (SL)

- \*Martin, R., Muûls, M., Wagner, U. J. (2015). The Impact of the European Union Emissions Trading Scheme on Regulated Firms: What Is the Evidence after Ten Years? *Review of Environmental Economics and Policy*
- Dechezleprêtre, A., Sato, M. (2017). The impacts of environmental regulations on competitiveness. *Review of Environmental Economics and Policy*, 11(2), 183-206.
- \*Martin, R., de Preux, L. B., & Wagner, U. J. (2014). The impact of a carbon tax on manufacturing: Evidence from microdata. *Journal of Public Economics*, 117, 1–14.
- Gerster, A., Lamp, S. (2020). Energy tax exemptions and industrial production. Available at SSRN 3841576.
- Calel, R., & Dechezlepretre, A. (2016). Environmental Policy and Directed Technological Change: Evidence from the European carbon market. *The Review of Economics and Statistics*, 98(1), 173–191.
- \*Fowlie, M., Reguant, M., Ryan, S. P. (2016). Market-based emissions regulation and industry dynamics. *Journal of Political Economy*, 124(1), 249-302.

**9. Behavioral Energy Economics** (1 session) (MS)

- 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* 101, 102315.
- Allcott, H., and Mullainathan, S. (2010). Behavior and energy policy. *Science*, 327(5970), 1204-1205.
- 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.
- Andor, M. A., Gerster, A., Peters, J., and Schmidt, C. M. (2020). Social Norms and Energy Conservation Beyond the US. *Journal of Environmental Economics and Management* 103, 102351.
- \*Hahn, R., and Metcalfe, R. (2016). The Impact of Behavioral Science Experiments on Energy Policy. *Economics of Energy & Environmental Policy* 5(2). 27-44.

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

- 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.
- \*Christensen, P., Francisco, P., Myers, E., and Souza, M. (2021). Decomposing the Wedge Between Projected and Realized Returns in Energy Efficiency Programs. *The Review of Economics and Statistics* (*Forthcoming*): <http://e2e.haas.berkeley.edu/abstractWP046.html>
- Myers, E. (2020). Asymmetric information in residential rental markets: Implications for the energy efficiency gap, *Journal of Public Economics* 190
- 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., Keyes, A., and Palmer, K. (2018). Advances in Evaluating Energy Efficiency Policies and Programs, *Annual Review of Resource Economics* 10:1, 511-532
- 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.
- Walls, M., Gerarden, T., Palmer, K., and FangBak, X. (2017) Is energy efficiency capitalized into home prices? Evidence from three U.S. cities. *Journal of Environmental Economics and Management* 87, 104-124.

**11. Targeting Energy Interventions** (1 session) (MS)

- Allcott, H., and Kessler, J. B. (2019). The Welfare Effects of Nudges: A Case Study of Energy Use Social Comparisons. *American Economic Journal: Applied Economics* 11(1), pp. 236–76.
- \*Gerarden, T. D., and Yang, M. (2022). Using Targeting to Optimize Program Design: Evidence from an Energy Conservation Experiment. *Journal of the Association of Environmental and Resource Economists*. *Forthcoming*.
- Ida, T., Ishihara, T., Ito, K., et al. (2022). Choosing Who Chooses: Selection-Driven Targeting in Energy Rebate Programs. NBER Working Paper 30469.
- Knittel, C. R., and Stolper, S. (2019). Using Machine Learning to Target Treatment: The Case of Household Energy Use. NBER Working Paper 26531.
- \*Christensen, P., Francisco, P., Myers, E., Shao, H., and Souza, M. (2022). Energy Efficiency Can Deliver for Climate Policy: Evidence from Machine Learning-Based Targeting. NBER Working Paper 30467.

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**Tentative 2023 course schedule**


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The week of	1st session	2nd session
30-Jan-23	Electricity Markets Overview	Theoretical Analysis of Market Power in Electricity Markets
6-Feb-23	Theoretical Analysis of Market Power in Electricity Markets	Analysis of Market Power in Electricity Markets
13-Feb-23	Empirical Analysis of Market Power in Electricity Markets	Renewables policy
20-Feb-23	Renewables policy	Investment Incentives and Capacity Mechanisms
27-Feb-23	The Economics of Energy Storage	No class
6-March-23	The Economics of Energy Storage	Pollution Permits
13-March-23	Pollution Permits	Impact of Climate Policies
20-March-23	No Class	Behavioural Energy Economics
27-March-23	Energy Efficiency	Energy Efficiency

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