Understanding Electricity Markets...and Beyond

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Roadmap for today's session

1. Why should we care about electricity markets?
2. Economically-relevant characteristics of electricity
3. Research questions

Why should we care about electricity markets?

Why should we care about electricity markets?

Decarbonizing power is critical to addressing climate change

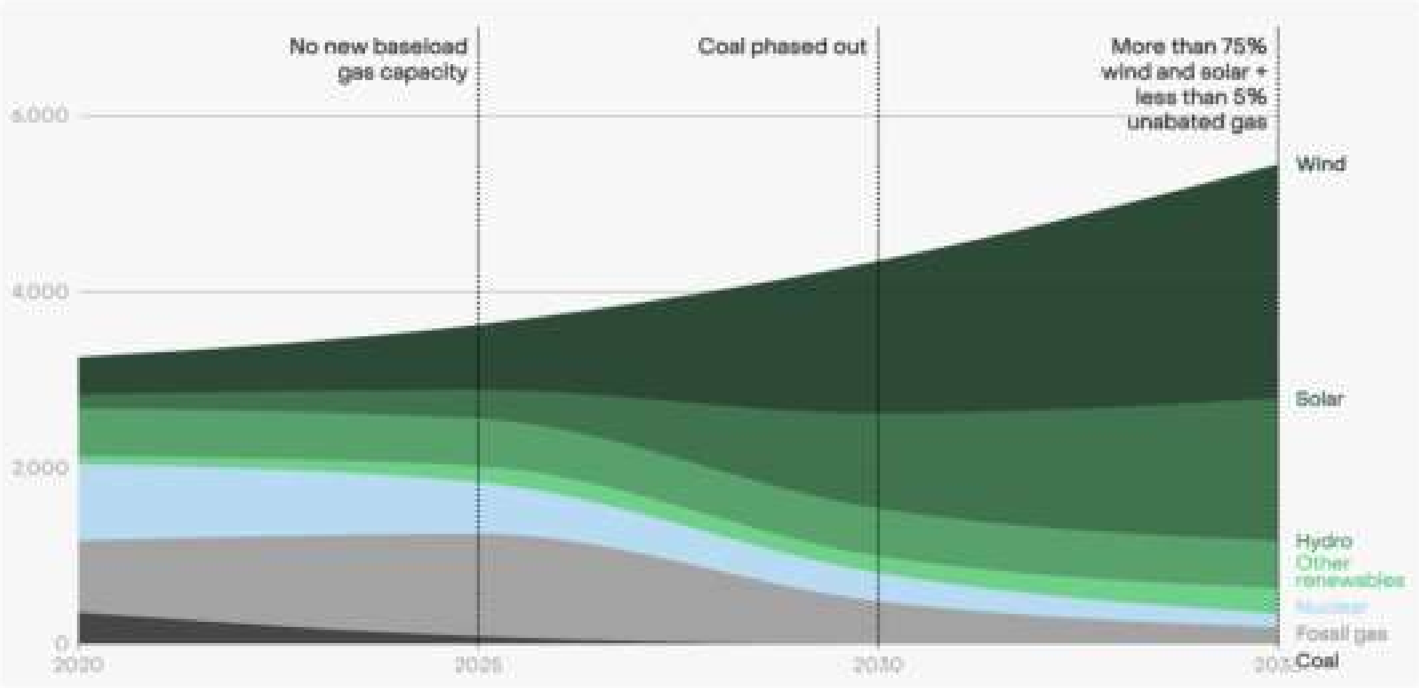
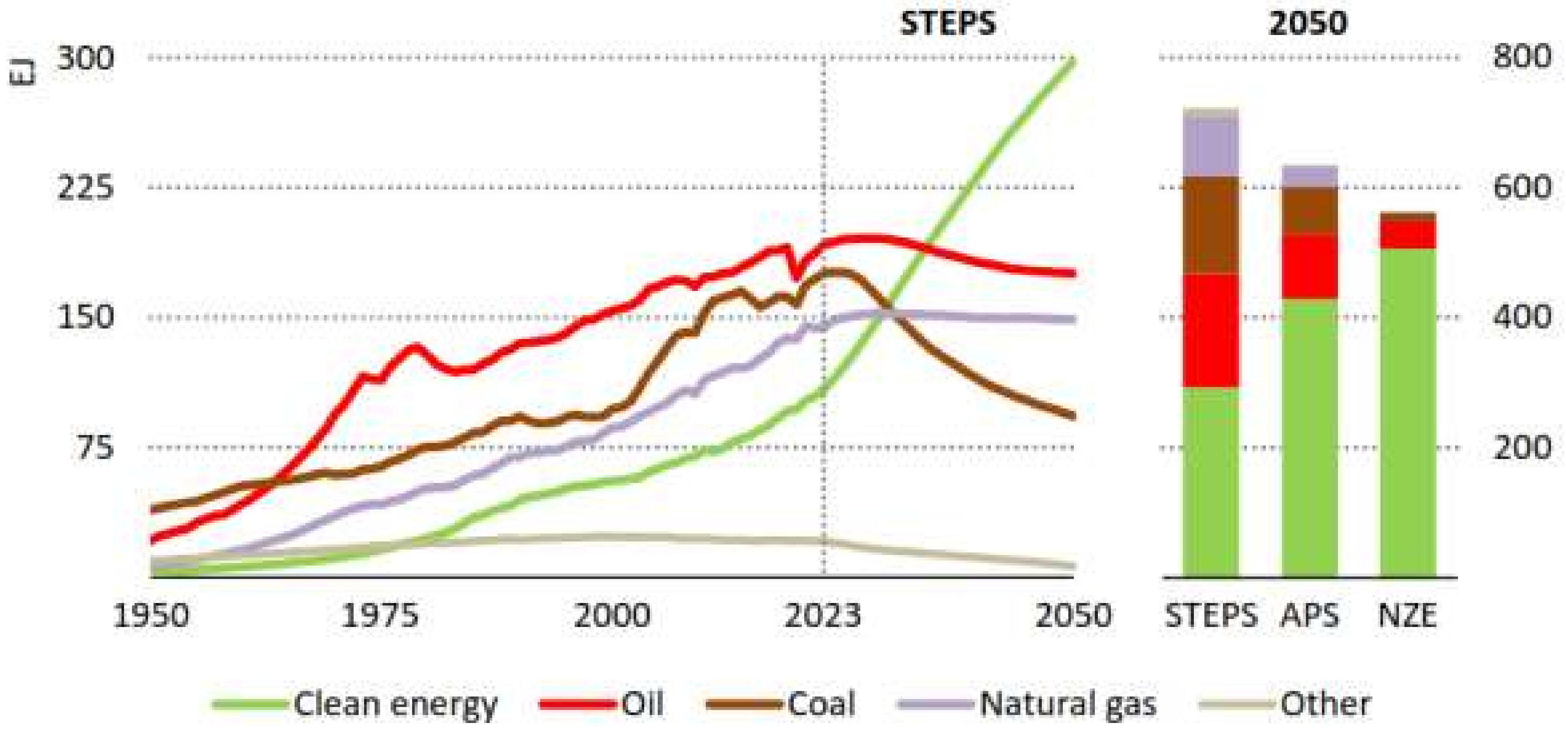


Figure: 1.5C pathways to clean power by 2035 in Europe

Decarbonizing power requires significant investments in renewable energies and storage while fossil fuels are phased out.

Global electricity demand is forecast to grow

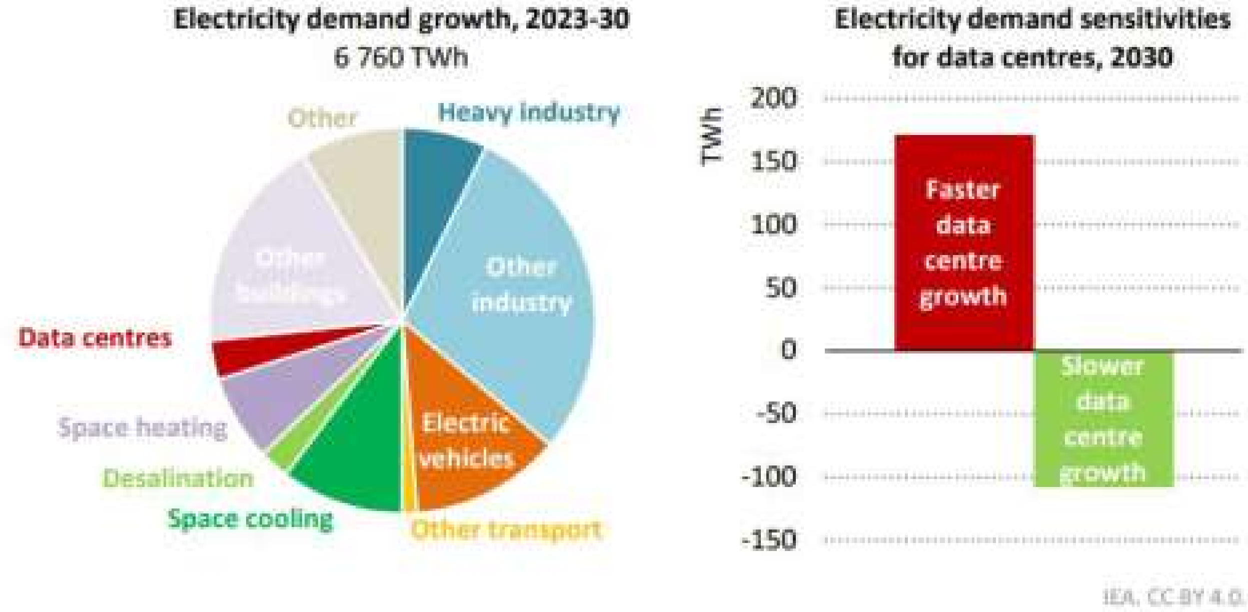
Figure 1.1 ▷ Global energy mix by scenario to 2050



Source: IEA World Energy Outlook 2024

…and it is not only about data centers

Figure 4.11 ▷ Electricity demand growth by end-use in the STEPS, 2023-2030, and data centre sensitivity cases



Data centres account for a small share of global electricity demand growth to 2030, and plausible high and low sensitivities do not change the outlook fundamentally

Note: Other includes electricity demand from agriculture. Electricity demand does not include any own use for generation, nor transmission or distribution losses.

Source: IEA World Energy Outlook 2024

Why should we care about electricity markets?

Electricity prices have systemic effects across the economy

- **Electricity prices influence competitiveness**

  "The first priority is to lower energy prices... We have the highest energy prices: EU companies face electricity prices that are 2-3 times higher than those in the United States and in China." (Draghi Report, 2024)

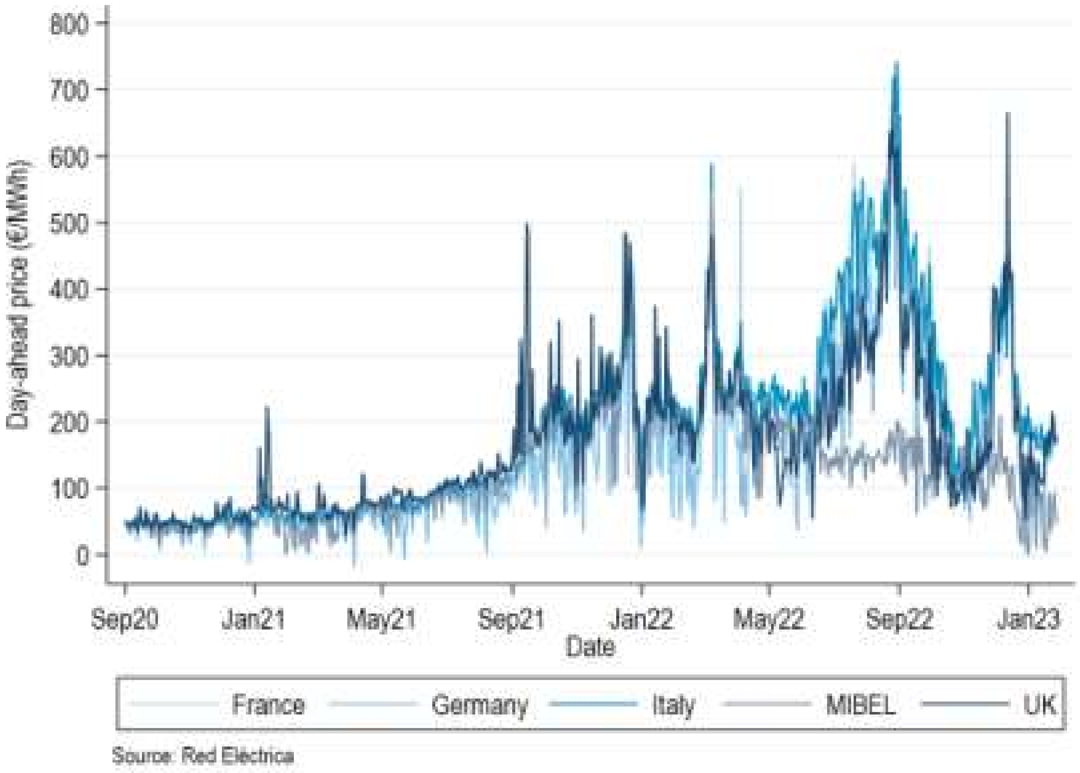
- **Price increases lead to adverse distributional effects** (Fabra et al, 2024)
- **...and exacerbate energy poverty**, with health and mental health consequences (Lee and Yuan, 2024; Bentley et al, 2023)

The 2021 energy crisis in Texas

"*During an exceptionally cold winter storm in February 2021, ERCOT [Texas] experienced* **shortfalls** *on an unprecedented scale...several* **market participants went bankrupt** *and others incurred substantial losses, while some suppliers of uncontracted natural gas made* **windfall profits**. *Beyond monetary losses, over 200* **people lost their lives**."

(May et al, 2022)

The 2021-2023 energy crisis in Europe



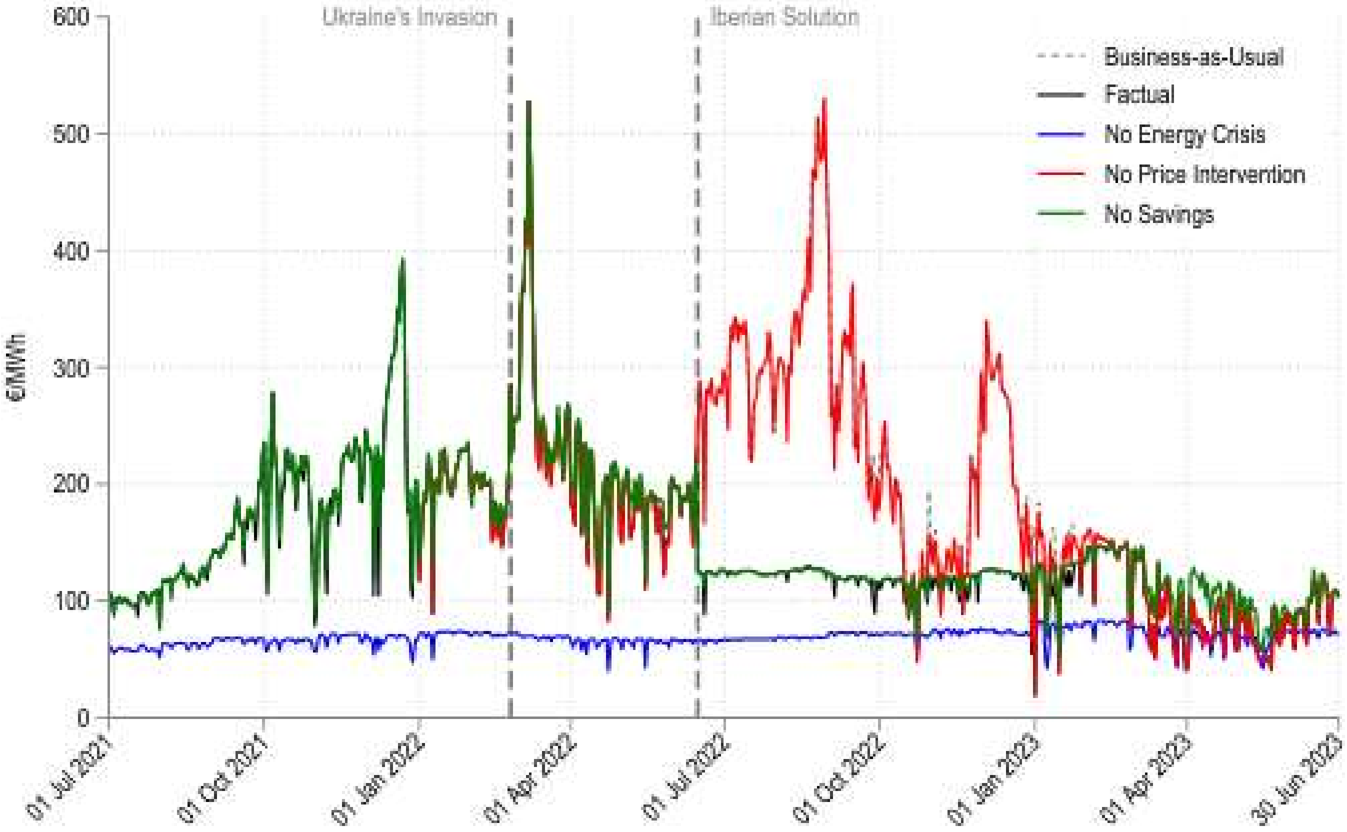
(a) Electricity prices

(b) Inflation in the EU

The 2021-2023 energy crisis in Europe

Fabra, Leblanc and Souza (2025)
"Unpacking the Distributional Implications of the Energy Crisis"

Figure: Simulated Wholesale Electricity Prices in the Iberian Market across Scenarios



The 2021-2023 energy crisis in Europe

Fabra, Leblanc and Souza (2025)

The crisis meant large wealth transfers from consumers to electricity generators

Table: The Effects of the Policy Interventions and the Energy Crisis (M€, July 2021-July 2023)

	Earnings	Costs	Profits
Full Intervention effect	-4,052	8,585	-12,651
Savings Intervention effect	-1,605	9,721	-11,344
Price Intervention effect	-2,346	-1,480	-861
Energy Crisis effect	49,287	22,189	27,090

The 2021-2023 energy crisis in Europe

Fabra, Leblanc and Souza (2025)

The crisis had regressive impacts across households as the bill increases relative to income were higher for the low quantiles

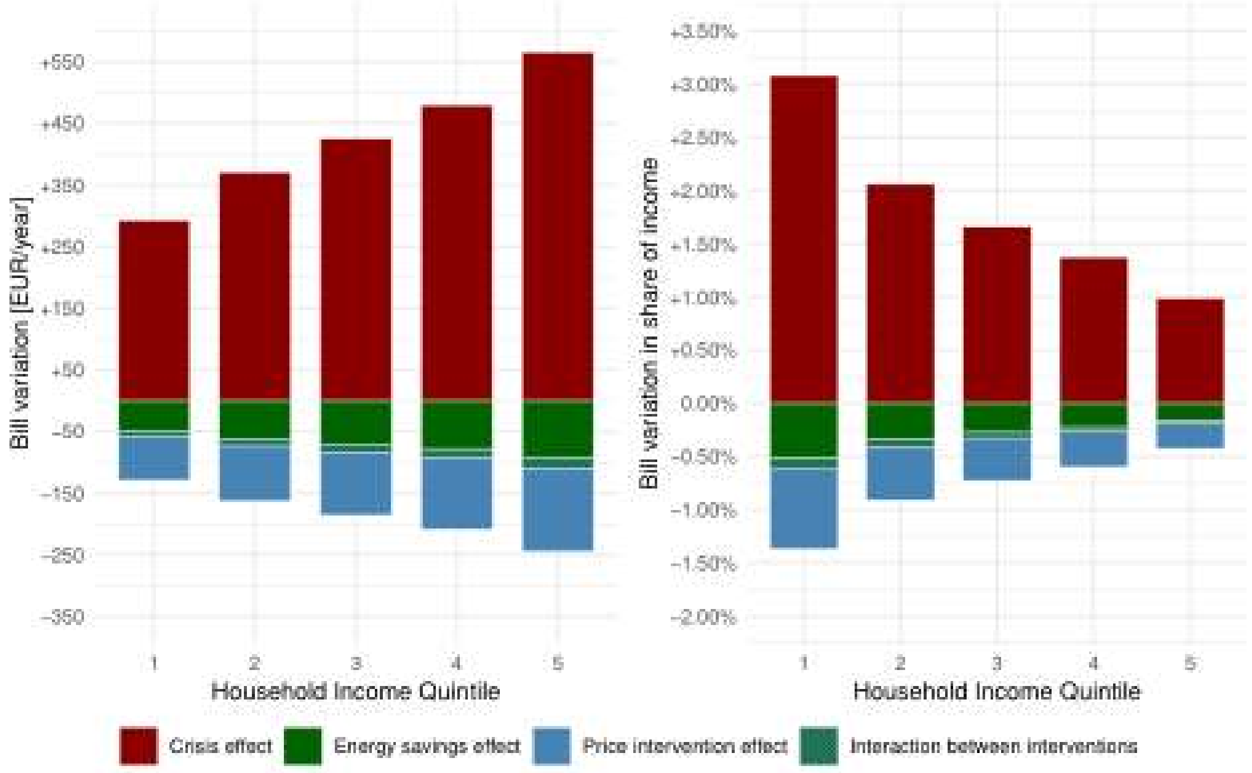
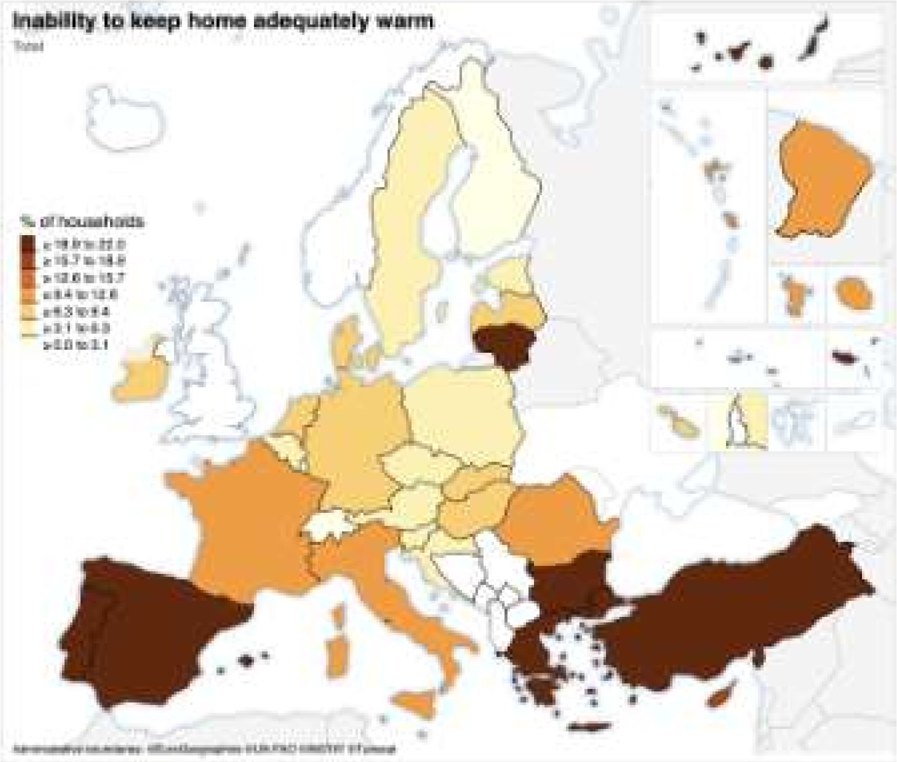


Figure: Average bill effects on households across income quintiles

Increasing energy poverty in Europe

6.9%	9.3%	10.6%
in 2021	in 2022	in 2023
		(source: Eurostat, 2024)



Source: Energy poverty Advisory Hub

Why should we care about electricity market design?

Understanding the workings of electricity markets helps us **design them so that**:

- **Market power is mitigated**, allowing electricity prices to reflect marginal costs.
- Firms have **incentives to invest** in an efficient mix of **low-carbon** technologies while preserving **security of supply**.
- Public policies are implemented to address **remaining market failures**.

These questions raise **exciting and highly policy-relevant research opportunities.**

Economically-Relevant Characteristics of Electricity

Non-storability of electricity at large scale

Electricity is difficult to store at large scale (exception: hydroelectricity)

- Demand must be **instantaneously balanced** with supply at every point in time, across the network.

Implications

- Imbalances can cause system-wide disruptions (blackouts), requiring a **central coordinator** to maintain equilibrium.
- Investments in **reserve capacity**, energy storage, and demand flexibility are critical.
- Blackouts impose large externalities, making such investments **public goods**.

The key role of energy storage

With fossil fuels, supply can follow demand
With renewables, storage becomes critical

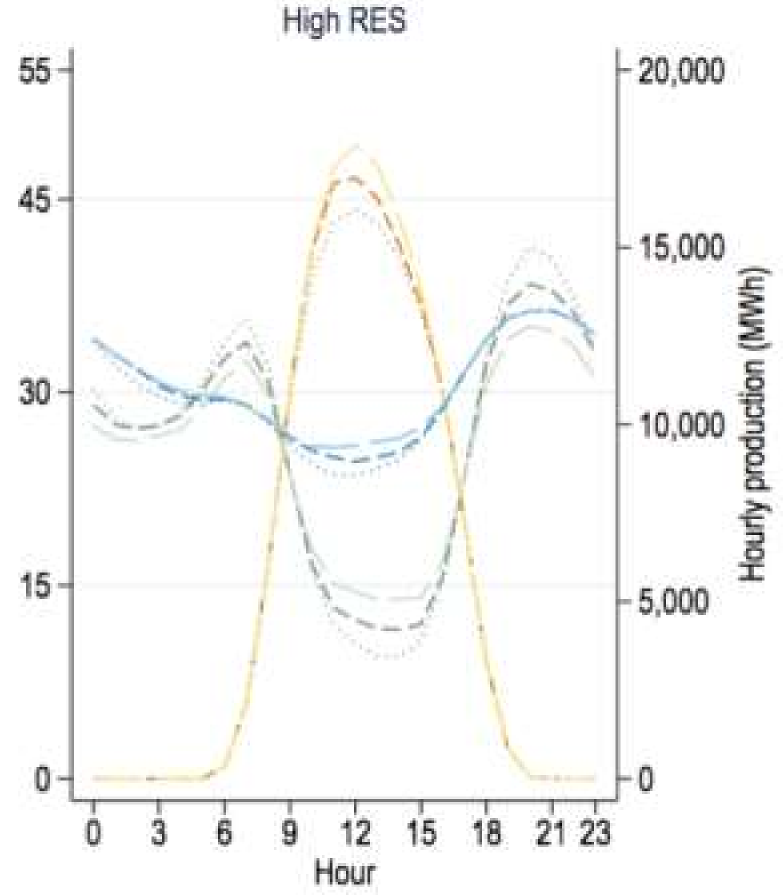
- Storage provides energy when renewables are not available.
- Storage reduces generation costs and emissions.

Implications

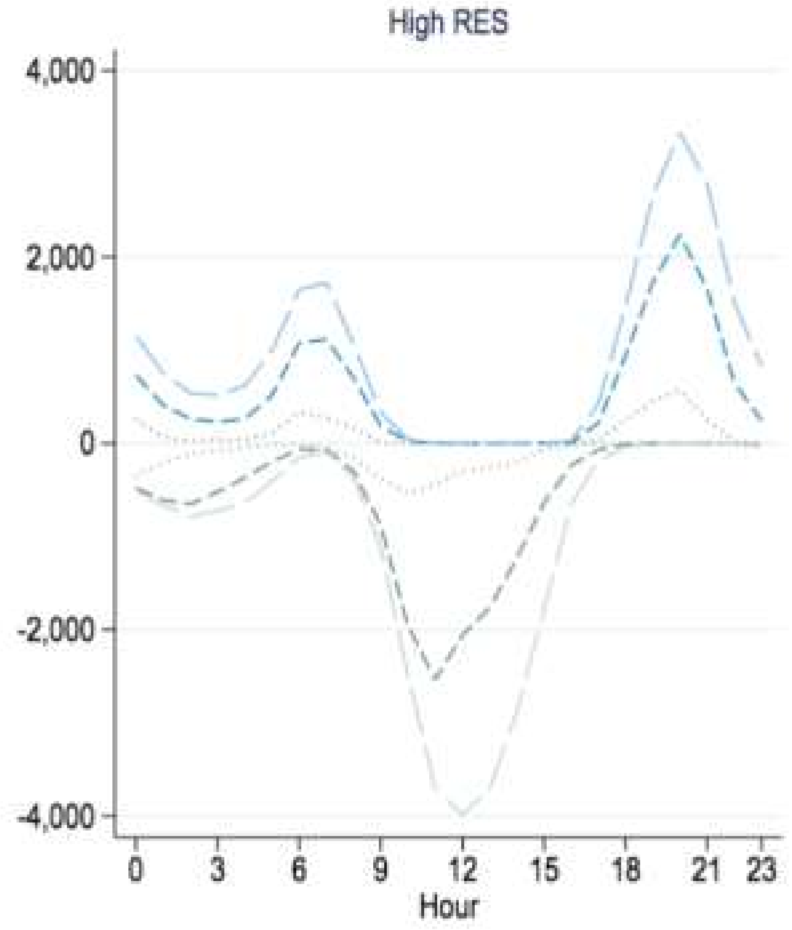
- Key to provide efficient incentives to invest in and operate storage facilities, but will market prices alone induce firms to internalize the social value of storage?
- When renewable energies are sufficiently deployed, **storage and renewable energies** become **complements**.
- Market power can distort the efficient operation of storage facilities.

Illustration: renewable energies and storage over the day

Andrés-Cerezo and Fabra (2024)



(a) Prices and renewable production



(b) Storage

Demand: seasonality and weak elasticity

Electricity demand is seasonal and inelastic

- Demand elasticity is **limited by installed equipment**.
- Final consumers' tariffs **do not change in real-time**.
- Hourly price differences rarely induce consumers to react to prices.

Implications

- Market power concerns vary across time:
  - Peak times: weak competition, lack of demand elasticity raises prices.
- Investments in **reserve capacity**, energy storage and demand response are necessary.

Illustration: demand seasonality

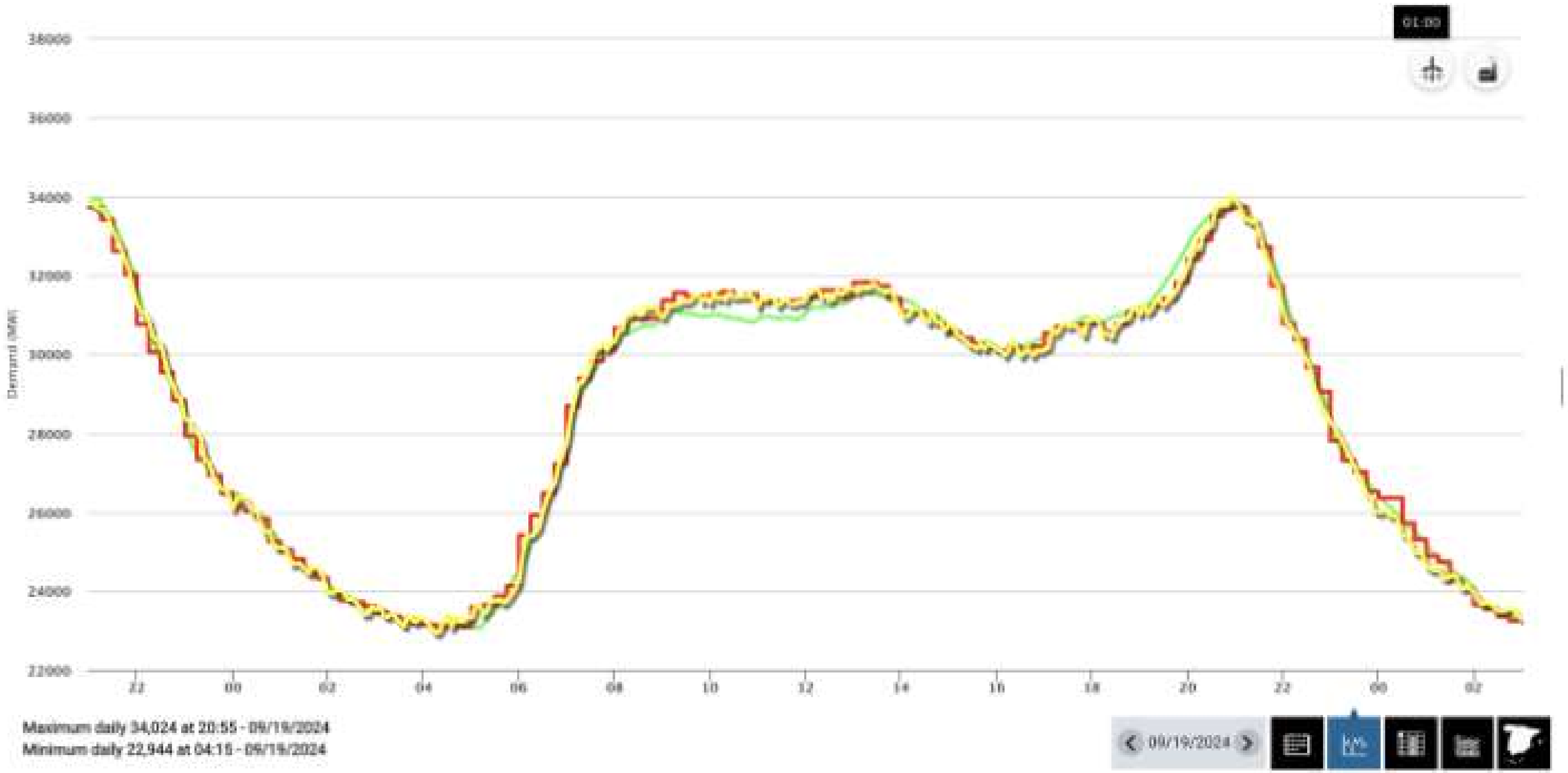
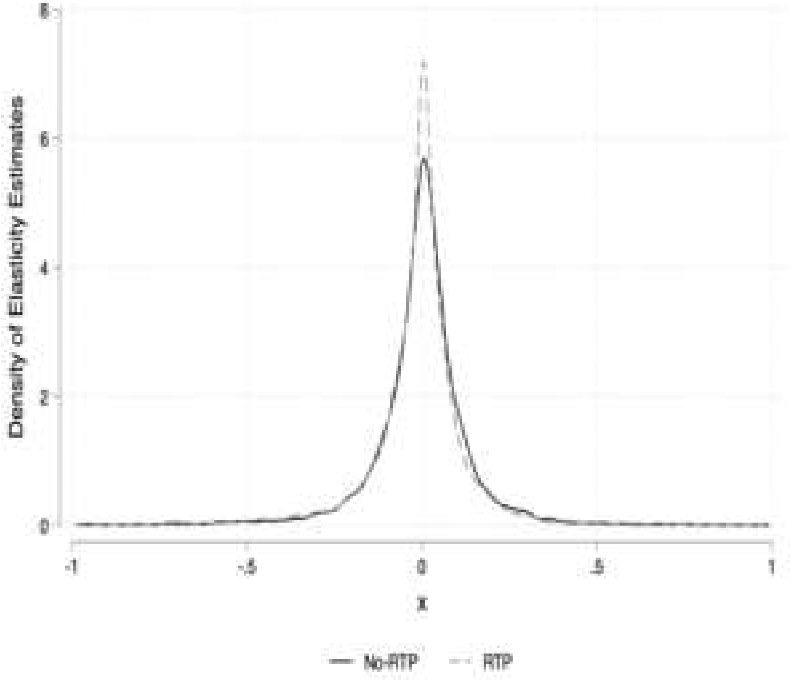


Figure: Electricity demand over the day - Spanish electricity market

Illustration: electricity demand is highly price inelastic

Fabra, N., D. Rapson, M. Reguant, and J. Wang (AER *P&P* 2021)

(a) Density for specification (2)



(b) Mean estimates with alternative specifications

	(1)	(2)	(3)	(4)
RTP	-0.054	-0.0072	-0.014	-0.017
	(0.0025)	(0.0019)	(0.0016)	(0.0027)
No RTP	-0.058	-0.0031	-0.011	-0.013
	(0.0028)	(0.0022)	(0.0016)	(0.0030)

Notes: Table shows mean elasticities by type of tariff (RTP vs non-RTP). Standard errors clustered at the postal code level. $N = 17,928$. Individual elasticity estimates using (1) block and temperature bin fixed effects and interactions, plus block times solar output; (2) adding aggregate demand as a control; (3) temperature and temperature squared instead of temp bins; (4) post-lasso with Fourier transforms at daily, weekly and annual frequency interacted with aggregate demand, solar production, temperature, and temperature square.

Figure: Estimated demand elasticities to Real-Time prices in Spain

Supply: multiple technologies

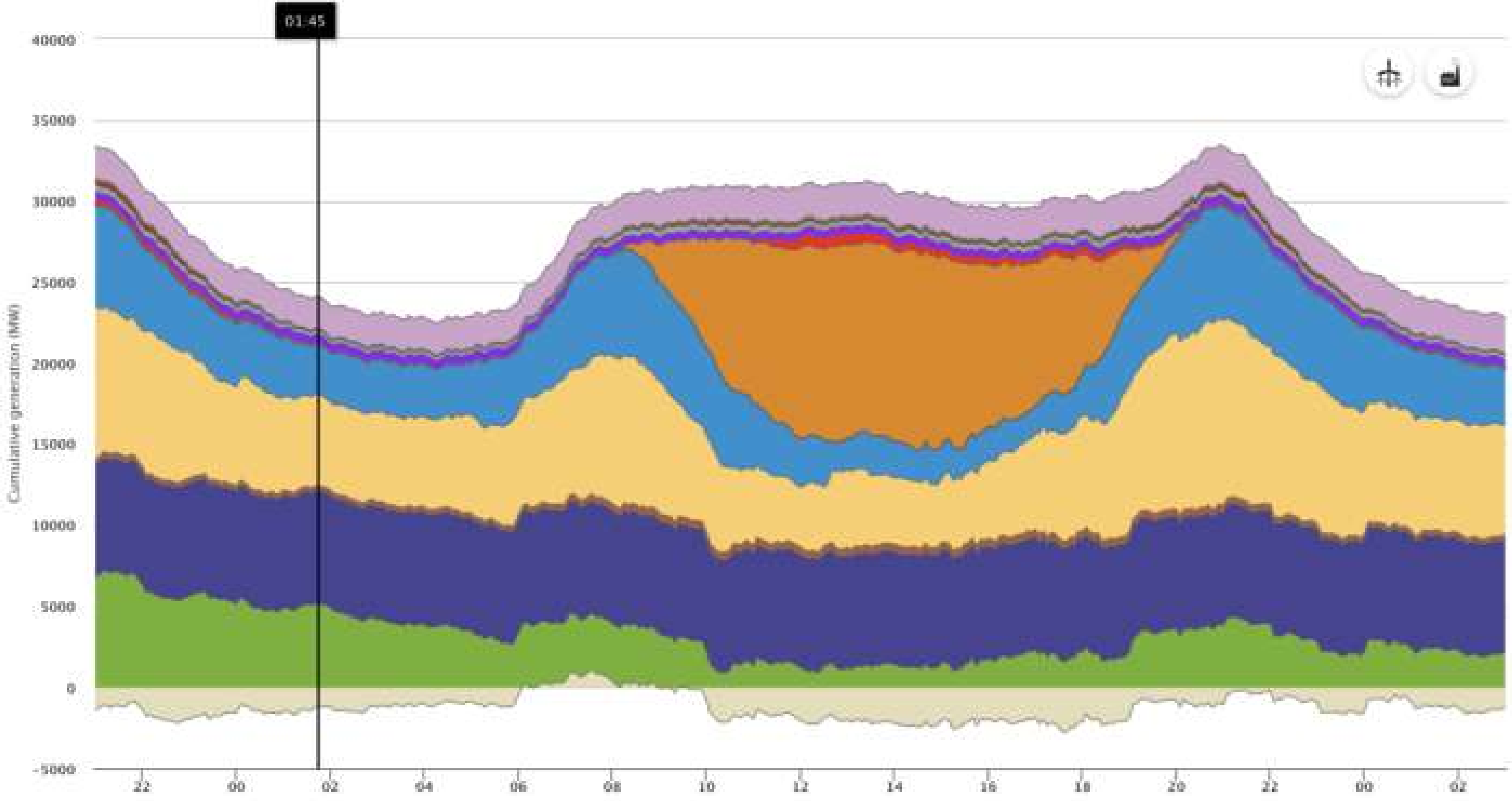
Multiple technologies with distinct characteristics produce a homogeneous good.

- Inverse relationship between fixed and marginal costs across technologies.
- Each has unique characteristics (e.g., renewables' intermittency, carbon emissions).

Implications

- Competition occurs among **marginal units**, making technology concentration key in assessing market power.
- Prices typically reflect the **marginal cost** of the marginal technology.

Illustration: multiple generation technologies



Source: www.ree.es

Illustration: different cost structures

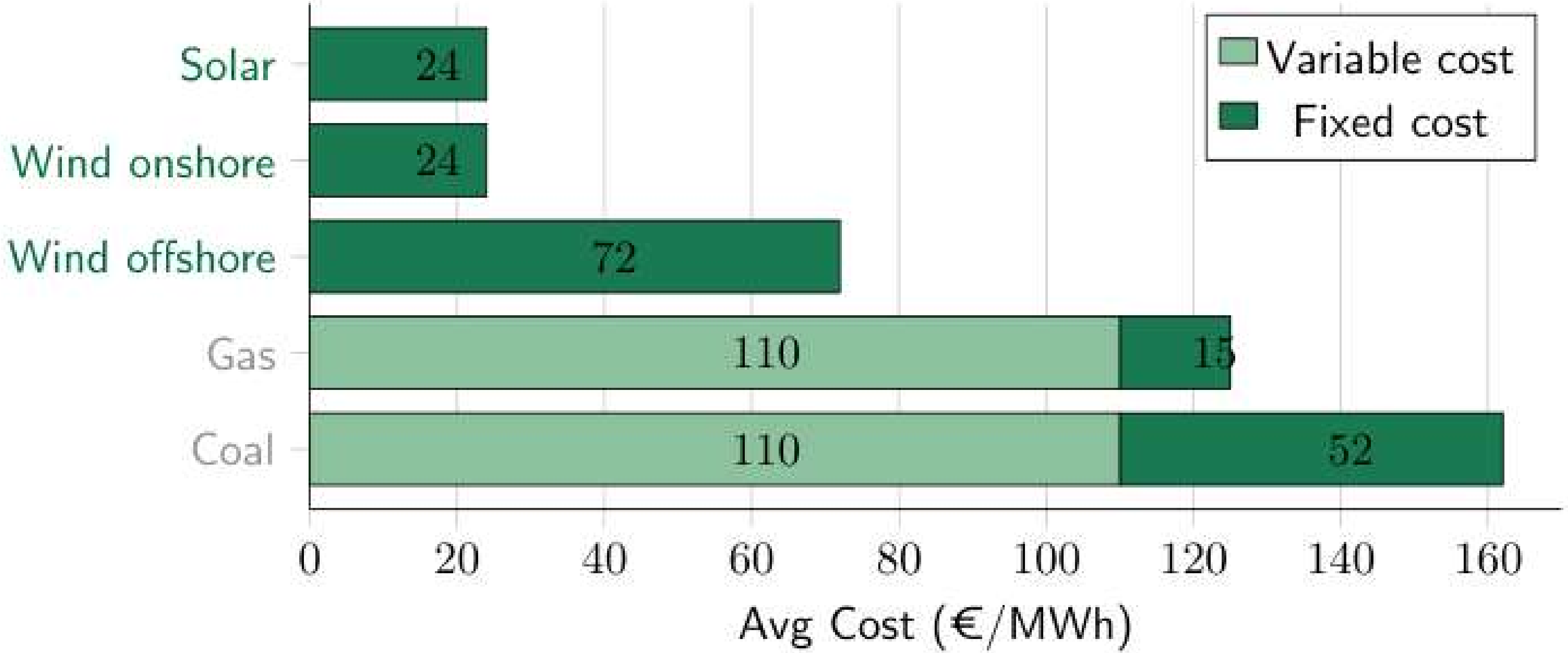


Figure: Cost break-up of power generation technologies

Source: Lazard (2023); own computations (ass. 90€/Ton CO_2; 40€/MWh gas)

Illustration: prices (often) reflect the marginal costs of gas-fired plants

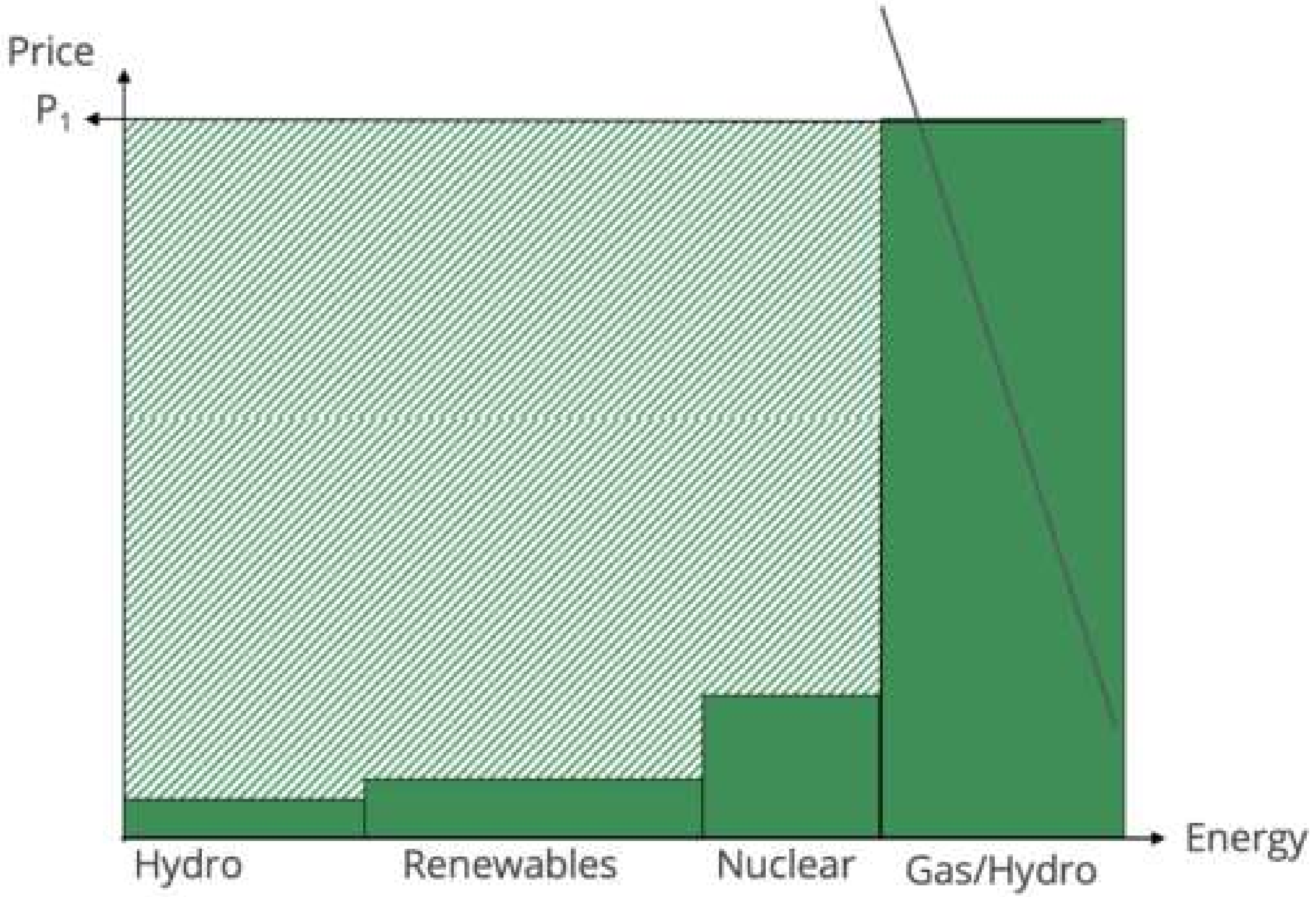
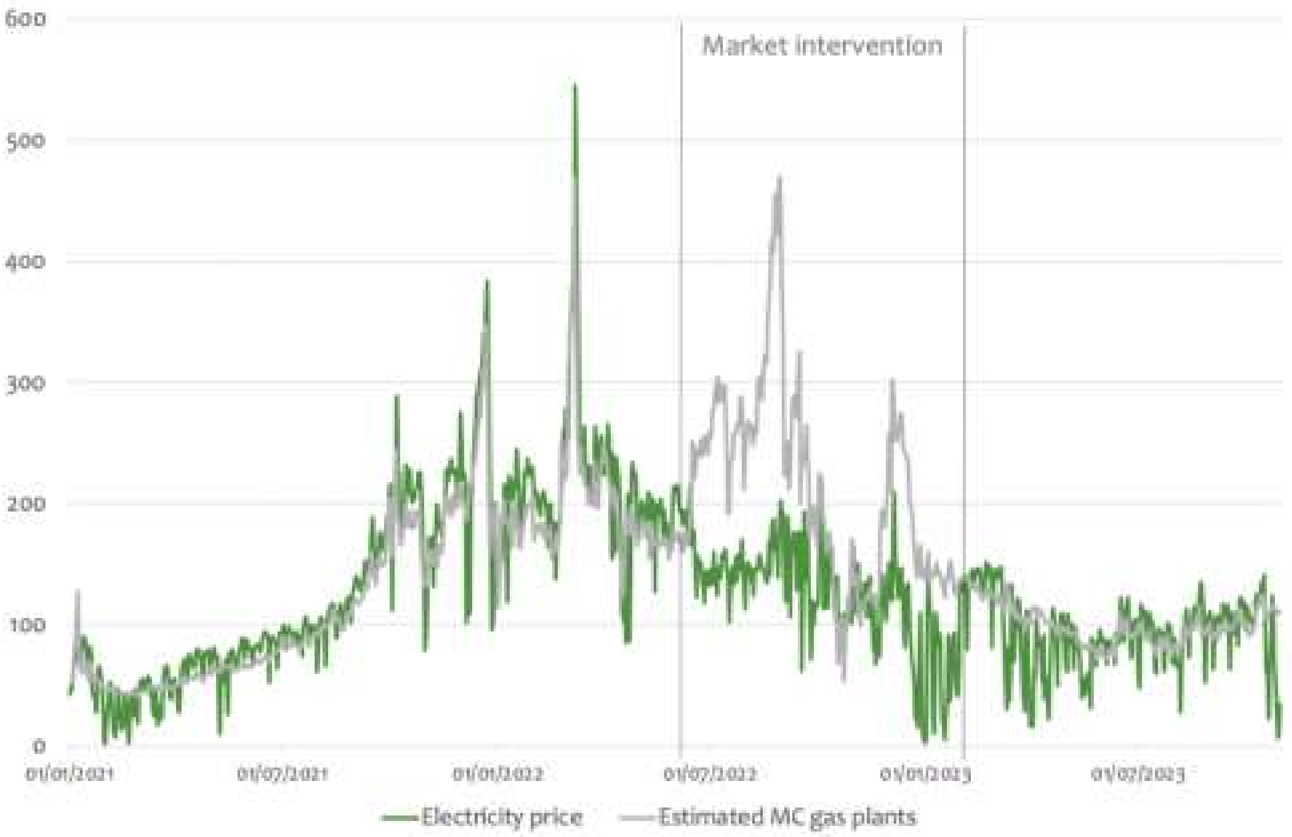


Figure: Stylized representation of market clearing in electricity wholesale markets

Illustration: prices (often) reflect the marginal costs of gas-fired plants

Figure: Electricity prices and MC of gas-fired plants - Iberian market 2021-2023 (€/MWh)



Source: Redeia, Migbas, own calculations of marginal costs (assuming 55% efficiency rate and 37% emission rate for gas-fired plants)

Illustration: prices fall when renewables become marginal

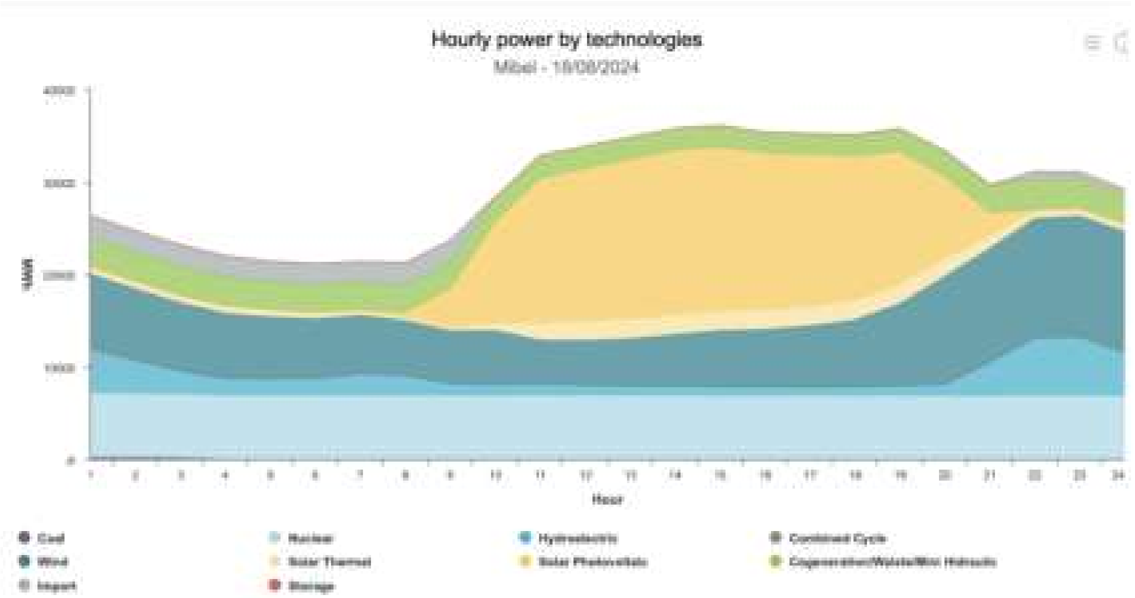


Figure: Wholesale electricity prices and generation by technology in Iberia on 18/08/2024

Source: Omie

Generation technologies have different availability patterns and flexibility

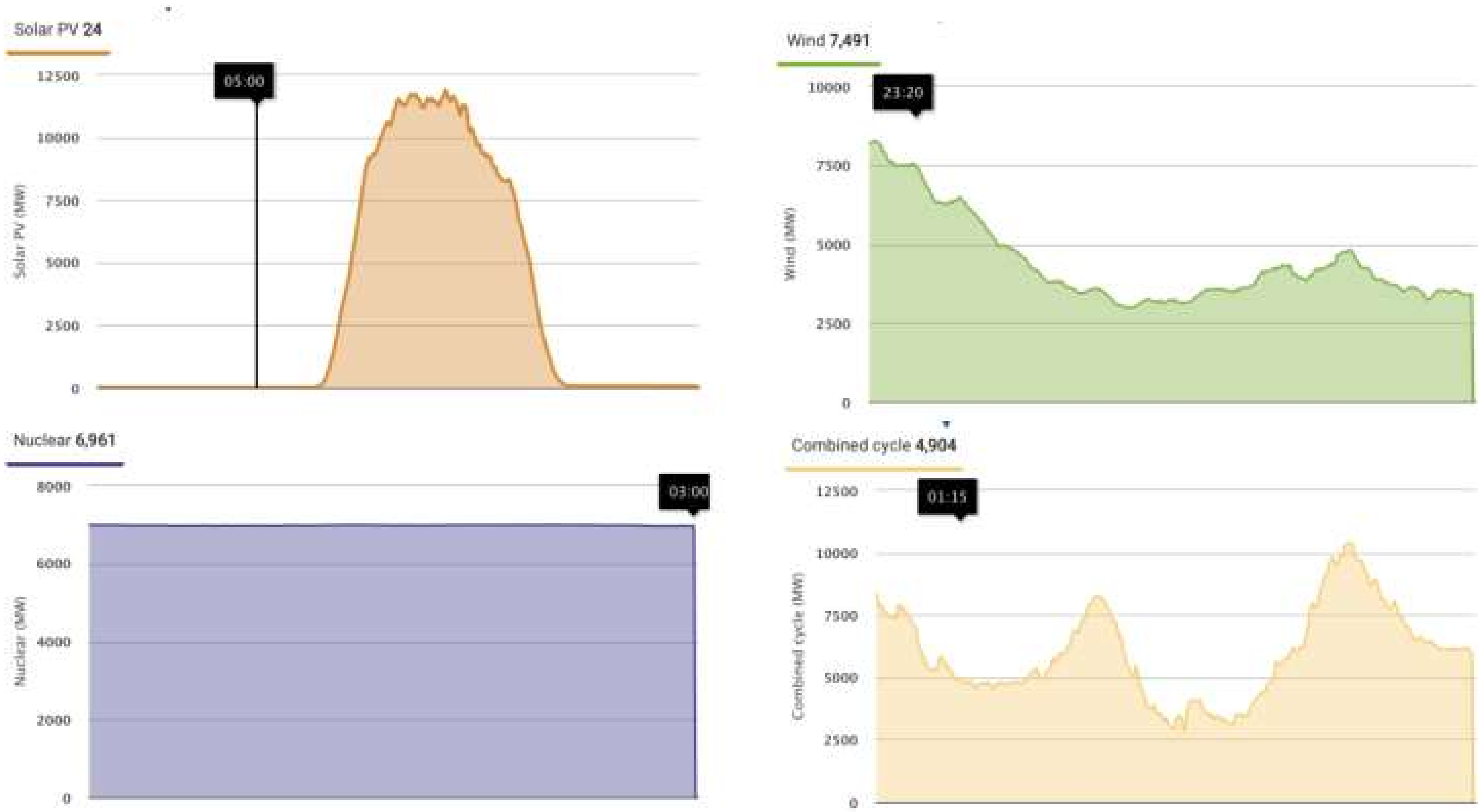


Figure: Production patterns of various technologies over the day

Electrons flow through grids

Electricity must be delivered through the transmission network

- There is usually no way to distinguish MWhs produced by each firm, hence the term *electricity pools*.

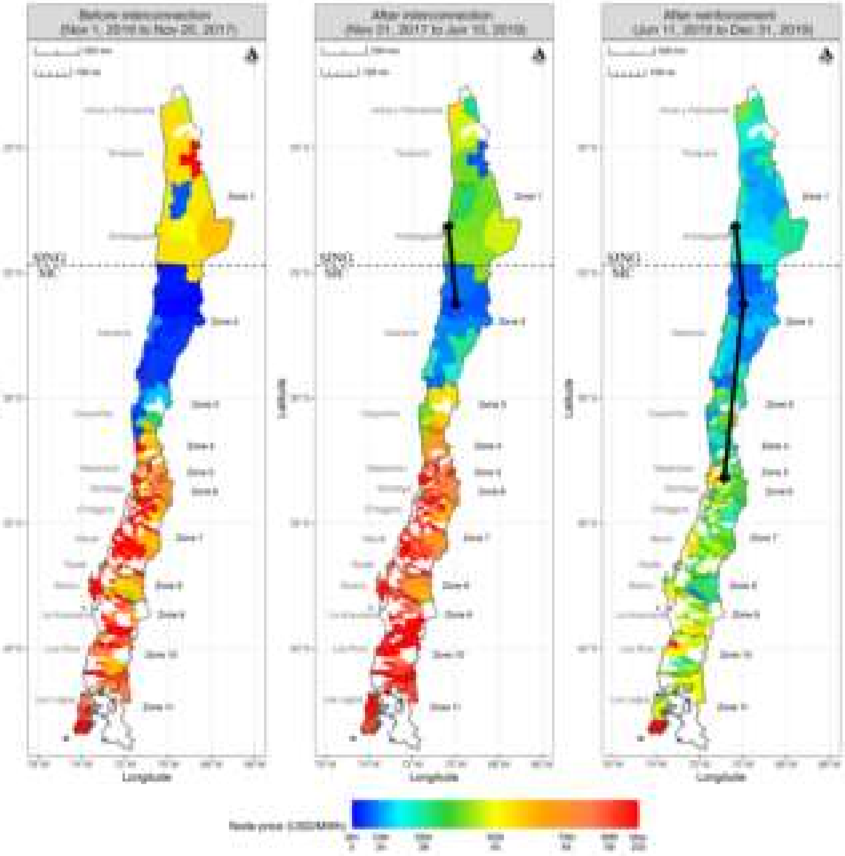
Implications

- The **relevant market** changes over time: local pockets of market power may emerge.
- **Pricing rules under congestion** are critical, as is pricing access to network facilities.
- Transmission expansion mitigates market power.

What is the value of market integration?

Gonzales, Ito, and Reguant (Etca, 2023)

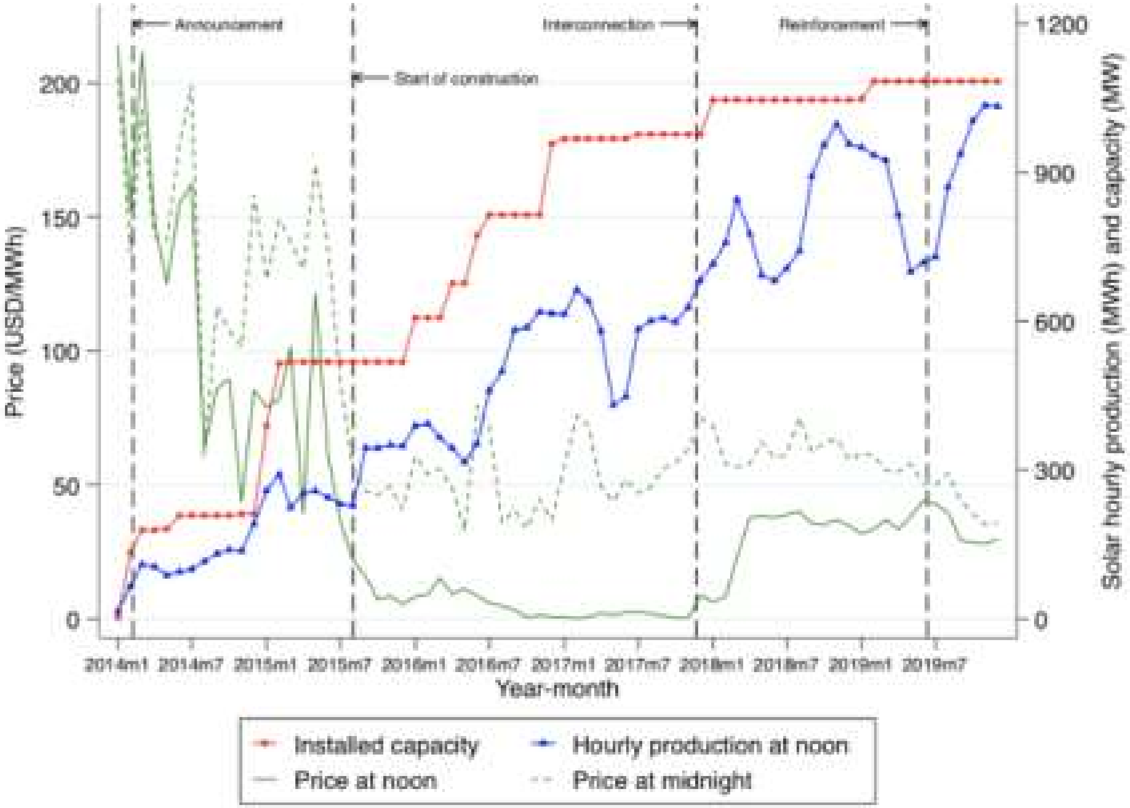
Market integration generates gains from trade and cost reductions as it promotes investments in solar energy. It contributes to **price convergence**



Market integration promotes investments in renewables

Gonzales, Ito, and Reguant (Etca, 2023)

Market integration in Chile increased solar generation by around 180%, even before the interconnection was completed



Research Questions

Research questions

1. Electricity market design
2. Renewable energies
3. Energy storage
4. Socio-economic impacts

Electricity market design

- Short-term markets, long-term markets or both?
- Which auction format for the wholesale market?
- How do firms exercise market power in wholesale markets?
- Do firms have incentives to invest?
- How does regulation and market design affect strategic behavior in wholesale markets?
- What is the impact of emissions regulation on electricity markets?

Electricity market design

Some papers:

1. Fabra, N. (2003) "Tacit Collusion in Repeated Auctions: Uniform versus Discriminatory auctions", Journal of Industrial Economics.
2. Fabra, N., von der Fehr, N.H. and Harbord, D. (2006) "Designing Electricity Auctions", Rand Journal of Economics.
3. Fabra, N., N.H. von der Fehr and M.A. De Frutos, M.A. (2011) "Market Design and Investment Incentives", Economic Journal.
4. Fabra, N. and Reguant, M. (2014) "Passthrough of Emission Costs in Electricity Markets", American Economic Review.
5. Fabra, N., (2023) "Reforming European Electricity Markets: Lessons from the Energy Crisis", Energy Economics.
6. Fabra, N. and Llobet, G. (2025) "The Costs of Counterparty Risk in Long-Term Contracts", in progress.

Renewable energies

- How do renewable energies compete in electricity markets?
- How to design the auctions for the new investments in renewables?
- How to design the long-term contracts for renewables?

Some papers:

1. Fabra, N. and Llobet, G. (2025) "Designing Contracts for the Energy Transition" International Journal of Industrial Organization.
2. Fabra, N. and Llobet, G. (2023) "Auctions with Privately Known Capacities: Understanding Competition among Renewable Energies", The Economic Journal.
3. Fabra, N. and Montero, J. P. (2023) "Technology Neutral versus Technology Specific Procurement," The Economic Journal.
4. Fabra, N. and Llobet, G. (2025) "Fossil Fuels and Renewable Energy: Mix or Match?" Rand Journal of Economics.
5. Fabra, N. and Imelda (2023) "Market Power and Price Exposure: Learning from Changes in Renewables Regulation", American Economic Journal: Economic Policy.

Energy storage

- How do storage owners exercise market power?
- Does it matter whether generators own storage assets?
- Do renewables and storage complement each other?

Some papers:

1. Fabra, N. and Andrés-Cerezo, D. (2023) "Storing Power: Markets Structure Matters", RAND Journal of Economics.
2. Fabra, N. and Andrés-Cerezo, D. (2025) "Storage and Renewable Energies: Friends or Foes?", in progress.

Relevant research questions

Socio-economic impacts

- Do renewable investments create jobs? Locally?
- Do they attract population?
- Do they help create new firms?
- How do they affect tourism?

Some papers:

1. Fabra, N., Gutiérrez E., Lacuesta A., and Ramos, R. (2024) "Do Renewable Energy Investments Create Local Jobs?", Journal of Public Economics.
2. Fabra, N., Minale L., and Tagilati, F. (2025) "Do Renewable Energies Attract Migrants?", in progress.
3. Fabra, N., Gutiérrez E., and Ramos, R. (2025) "The End of Coal: Assessing Labor Market Transitions in Coal-Dependent Regions", in progress.

Electricity markets provide unique settings and rich data to explore economically and policy relevant questions

Our research can make a difference in how to organize these markets to achieve efficiency and equity

ENERGYECOLAB

Thank You!

Questions? Comments?

More info at nataliafabra.org and energyecolab.org

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