Electricity Markets in Transition

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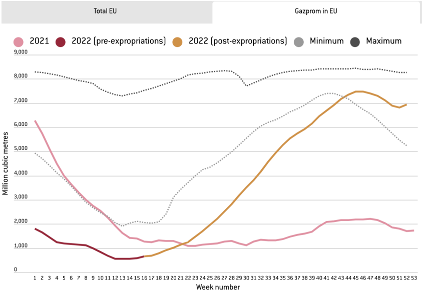
European Research Council
Established by the European Commission

Causes of the Current Energy Crisis

It all started before Feb 24, 2022

Figure: Gas Storage in Europe



(a) By Gazprom

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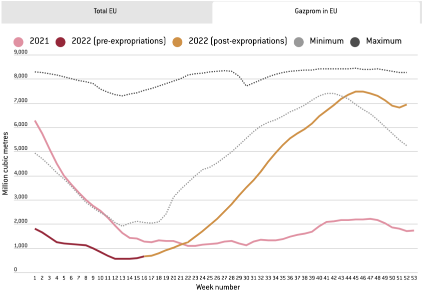

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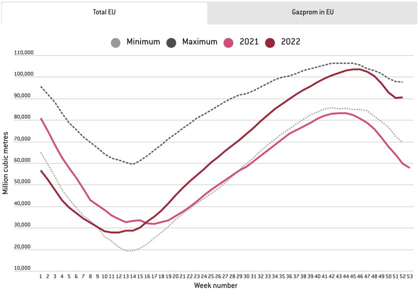

(b) Total Europe

Causes of the Current Energy Crisis

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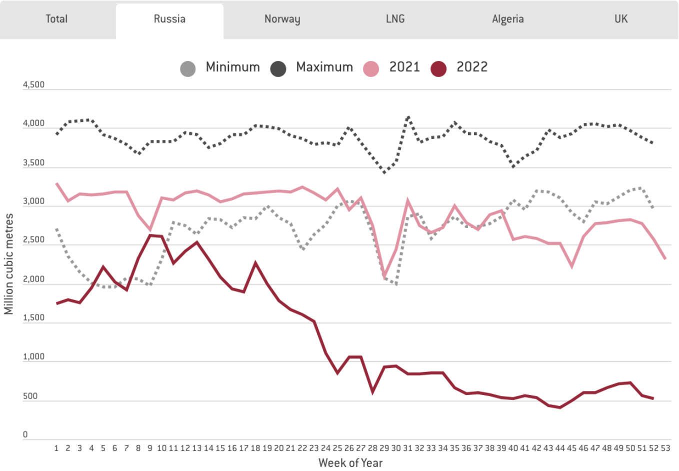

Figure: Gas imports from Russia

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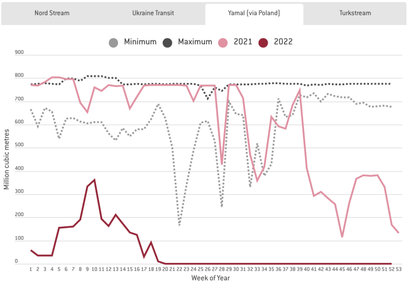
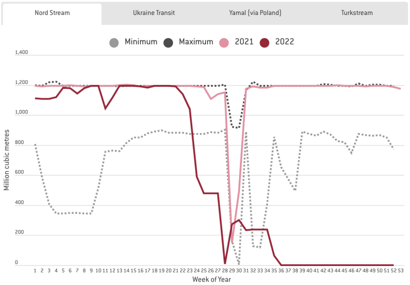


(a) Yamal (via Poland)



(b) Nordstream I

Impacts on Energy Prices

Wholesale gas prices in Europe

Figure: Gas prices in Europe (TTF)

Impacts on Energy Prices

Market clearing in wholesale electricity markets

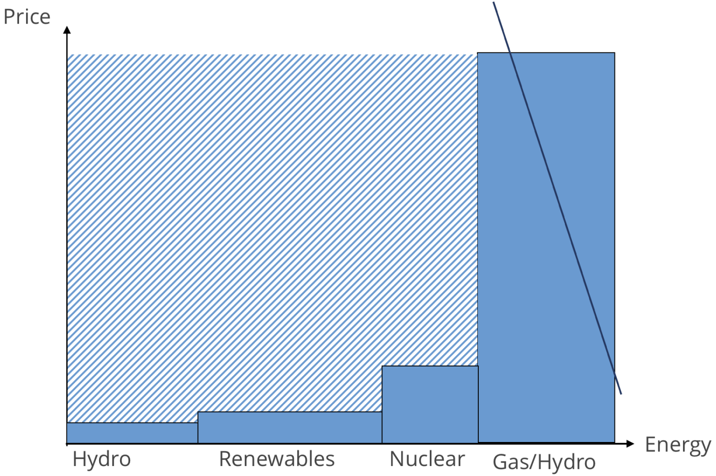


Figure: Gas plants currently set prices in electricity markets

Impacts on Energy Prices

Wholesale electricity prices in Europe

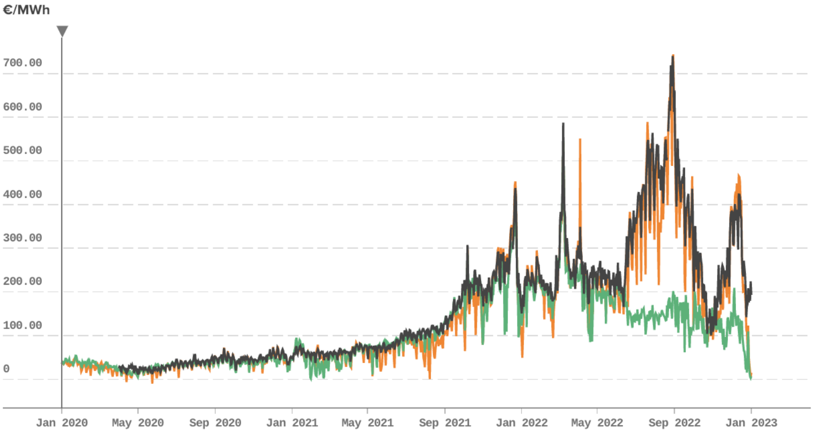


Figure: Electricity prices in Italy (black), France (orange) and Spain (green)

Electricity Prices *versus* Costs

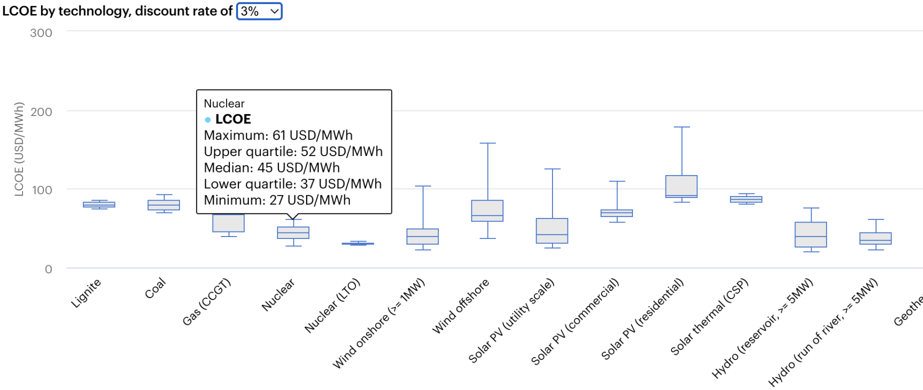


Figure: Average costs of generating electricity across technologies (IEA)

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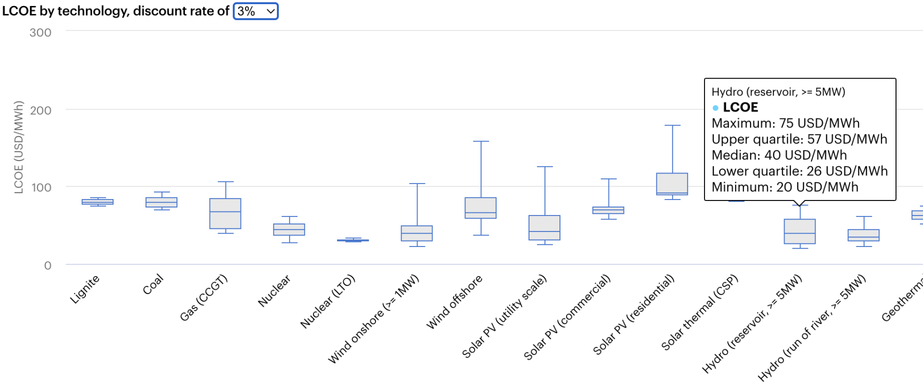

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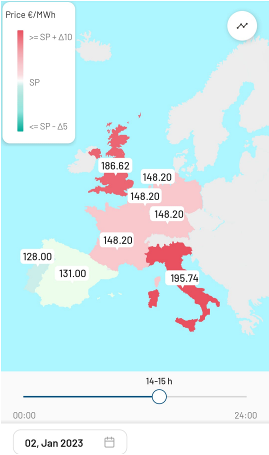
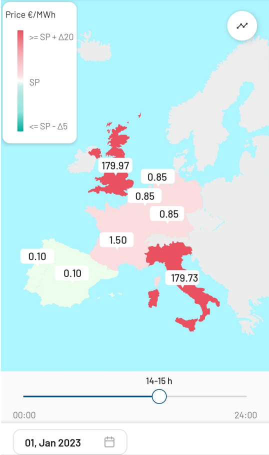
The Need for an Electricity Market Reform

Not just a matter of addressing the current crisis

Figure: A Tale of Two States: Prices in Europe



(a) "Energy crisis"

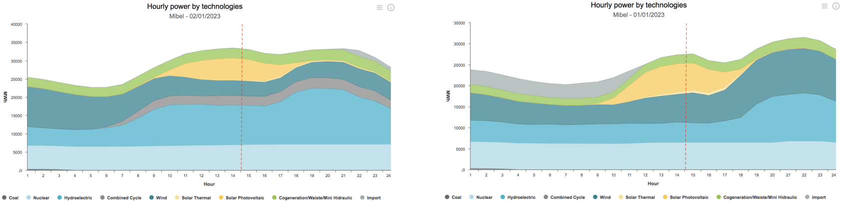


(b) "Energy transition"

The Need for an Electricity Market Reform

Not just a matter of addressing the current crisis

Figure: A Tale of Two States: Generation in Spain

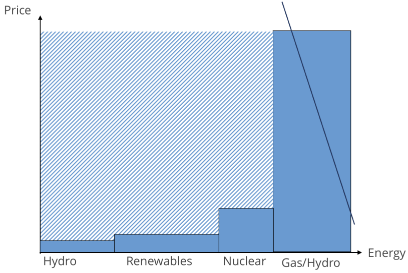


(a) “Energy crisis” (b) “Energy transition”

The Need for Reform

A Tale of Two States

Figure: A Tale of Two States: Market Clearing



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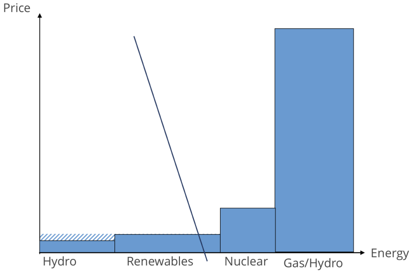

(b) “Energy transition”

The Need for Reform

What do these two states have in common?

1. Prices driven to the marginal cost of the price-setting technology
2. Prices differ from average costs
3. No free entry (or exit): excessive profits or losses not competed away

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Sources of inefficiency:

During the energy crisis:

- Electricity as an input → loss of global competitiveness
- Increase in inflation and interest rates → likelihood of recession
- Electrification discouraged → energy transition at risk

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More generally, in electricity markets...

- Large risks for cost recovery → investment delays, risk premia...
- Externalities: security of supply, learning economies...

A new electricity market architecture is needed

Which objectives?

1. **Short-run efficiency:** production and consumption
   - The least cost production units must be dispatched at all times
   - The price signal should reflect the system short-run marginal cost
2. **Long-run efficiency:** investments
   - Investments at the scale necessary
   - Investments of the “right” technology at the “right” locations
   - Investment risks allocated to the least risk-averse party
3. **Equity**
   - Electricity prices should be cost-reflective

Which electricity market architecture?

Market/Regulation & Horizon	Contract type	Technologies	Key challenge
Short-term market	Spot pay-as-clear	All plants	Productive efficiency
Auctions for long-term contracts	Capacity Payments	CCGTs Energy Storage Demand response	Price exposure for optimal operation Missing money problem Mitigate market power
	Contracts for Differences	Renewables	Derisk investments
Regulated long-term contracts		Hydro power Nuclear power	Cost-reflective prices

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The trade-off between exposing plants to the short-run price signal vs. derisking the investments depends on technology characteristics

European Commission's draft proposal

"Policy Options to Mitigate the Impact of Natural Gas Prices on Electricity Bills"

Objectives:

- *"Mitigate the effect of high gas prices on power prices"*
- *"The benefits of lower cost renewables...to consumers"*.

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"Policy Options to Mitigate the Impact of Natural Gas Prices on Electricity Bills"

Objectives:

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Key ingredients:

1. *"Remunerating Renewables and other Technologies Based on Their True Production Costs"*
   - Contracts-for-Differences allocated through auctions
   - For the existing plants: current inframarginal cap
2. *"Effective Competition for Gas in Well-Functioning Short-Term Markets"*

Designing long-term contracts

Contracts for Differences (CfD)

- Generators sell their electricity at the market price (p).
- Pay/receive diff btw a strike price f and a reference price p':

$$\pi = pq + (f - p')q$$

Designing long-term contracts

Contracts for Differences (CfD)

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$$\pi = pq + (f - p')q$$

- Rearranging the above expression...

$$\pi = fq + (p - p')q$$

...as if generators receive a fixed price f and keep the diff btw the market price p and the reference price p' (**non-linear pricing**).

Designing long-term contracts

Contracts for Differences (CfD)

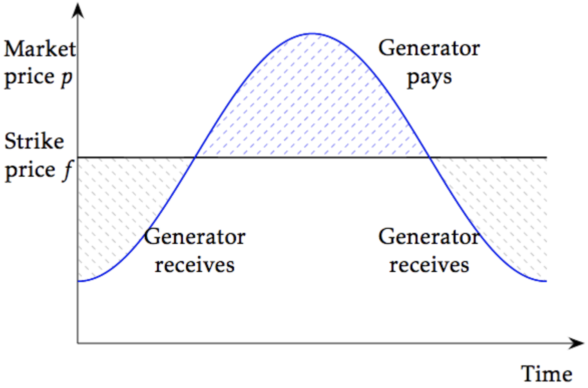

Figure: A CfD in which $p' = p$ (no price exposure)

Des-risking investments while protecting consumers

Designing long-term contracts

Setting strike prices and reference prices of CfDs

Strike price: a key factor of profitability

- For **new plants**, set f through an auction.
  - If auctions are sufficiently competitive, f gives a fair rate of return.
- For **existing plants**, regulate f in a cost-reflective manner.

Designing long-term contracts

Setting strike prices and reference prices of CfDs

Reference price: a key factor of price exposure

- **For renewables:** set $p' =$ price captured by plants of the same technology over a month.
  - Provides incentives for location, equipment choices, maintenance.
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Designing long-term contracts

Setting strike prices and reference prices of CfDs

Reference price: a key factor of price exposure

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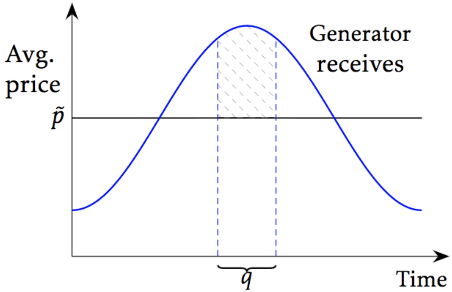
  - Provides incentives for location, equipment choices, maintenance.
  - Allows for derisking the investments.
- **For hydro and nuclear:** set $p' =$ average market price over a year.
  - Preserves incentives to produce (or avoid maintenance) at peak times.
  - Allows adjusting their profitability.

Designing long-term contracts

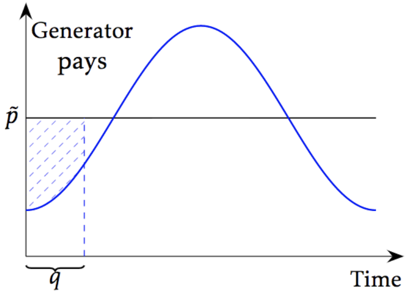
CfDs contracts for hydro and nuclear power plants

Payments are (where $\tilde{p}$ is annual average):

$$\pi = fq + (p - \tilde{p})q$$



(a) Flexibility bonus



(b) Flexibility penalty

Strong incentives to dispatch at peak times

Designing long-term contracts
Reliability options for CCGTs

- A one-way CfD for the whole capacity k, in exchange for a capacity payment sk:

$$\pi = sk + pq + max(0, p - f)k$$

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Benefits of using reliability options:

- Incentives to be available at times if high prices.
- Market power mitigated.
- Generators receive sk regardless of production: lower risks.

Designing long-term contracts

Capacity payments for storage and demand response

- Plants earn market revenues plus capacity payments sk.
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- Suitable for assets that arbitrage price differences:
  - Energy storage, demand response.

Benefits of proposed market architecture

1. Carbon-free power markets, at least cost for consumers and society.
2. Gas prices do not propagate through the entire electricity market.
3. Lower capital costs of low-carbon assets through de-risking.
4. Lower and less volatile consumer prices while price signal preserved.
5. Market power mitigated.
6. Windfall profits and losses avoided.
7. Instruments to ensure security of supply, with fewer fossil fuels.

Conclusions

- There is an urgent need to reform electricity markets:
  1. Tackle the energy crisis
  2. Support the energy transition
- New electricity market architecture: aim at efficiency & equity
  1. Liquid short-run markets
  2. Auctions for long-run contracts
  3. Contracts should respond to the characteristics of the technologies
     - Balance costs/benefits of de-risking vs price exposure

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Power markets can be a powerful source of efficiency for our economies...as long as we design them right!

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Thank You!

Questions? Comments?

More info at nfabra.uc3m.es and energyecolab.uc3m.es

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