Market Power in Electricity Markets

Slides of this lecture are made with support from Ekaterina Moiseeva, *PhD* | *Market Surveillance Maneger (Nord Pool).*

Matin Bagherpour

Associate Professor, UiO

Senior Algorithm Design Expert, Nord Pool

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Theory of market power

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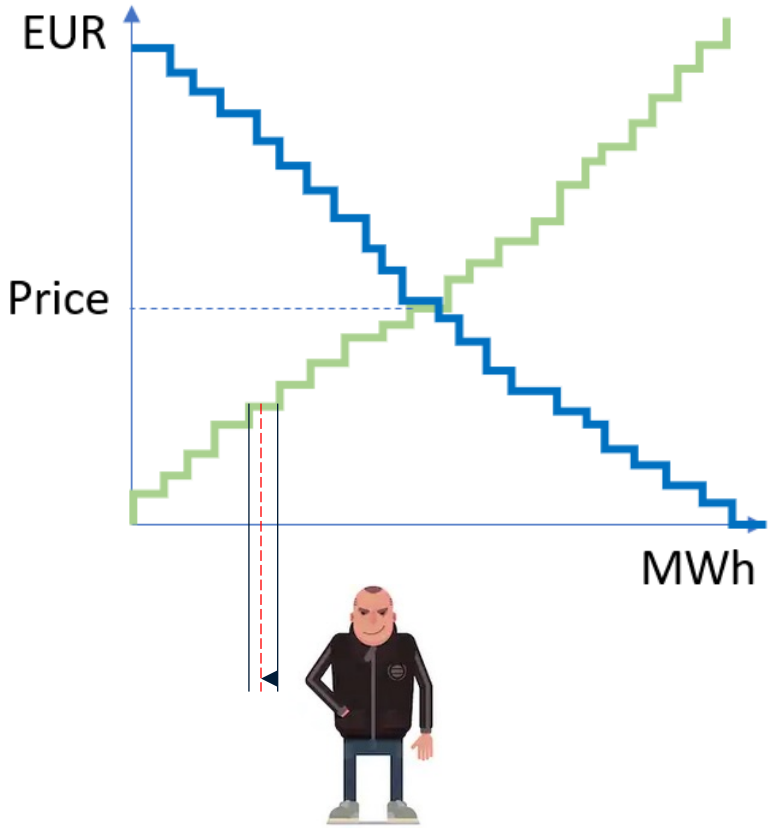
Market power

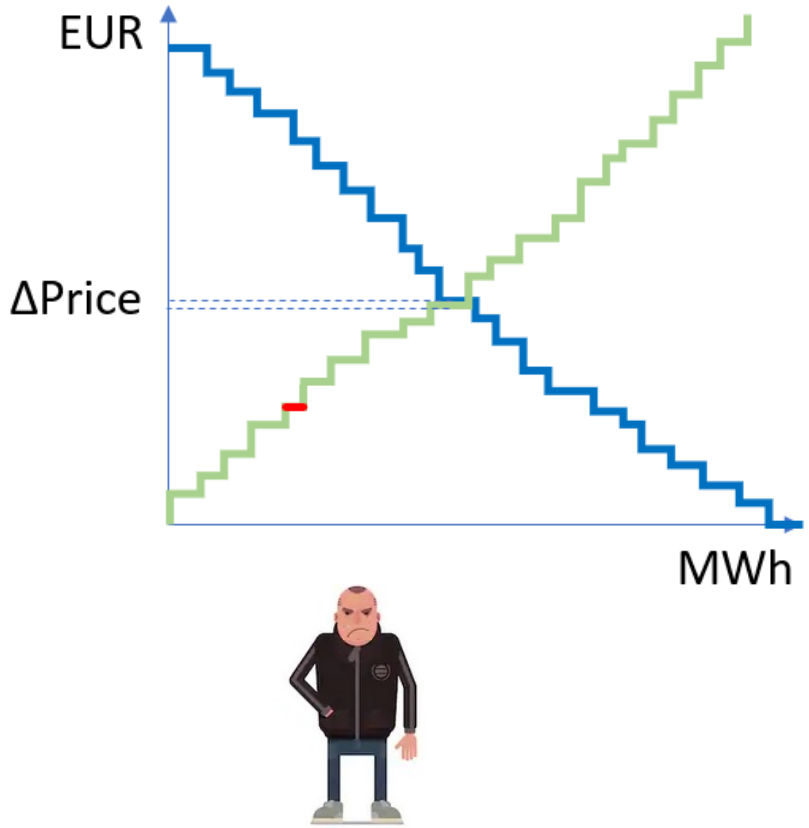
Definition

A generator or load is said **to have market power** if it can affect **the wholesale spot price** by varying its output.

Competitive market vs. Market power

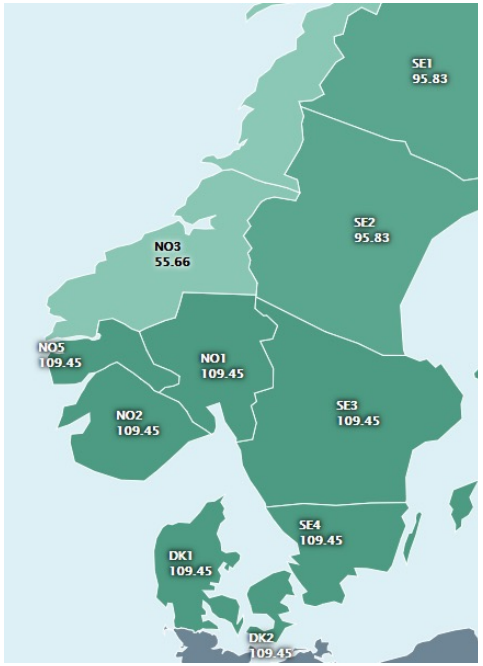
Case 1 – (nearly) Perfect competition



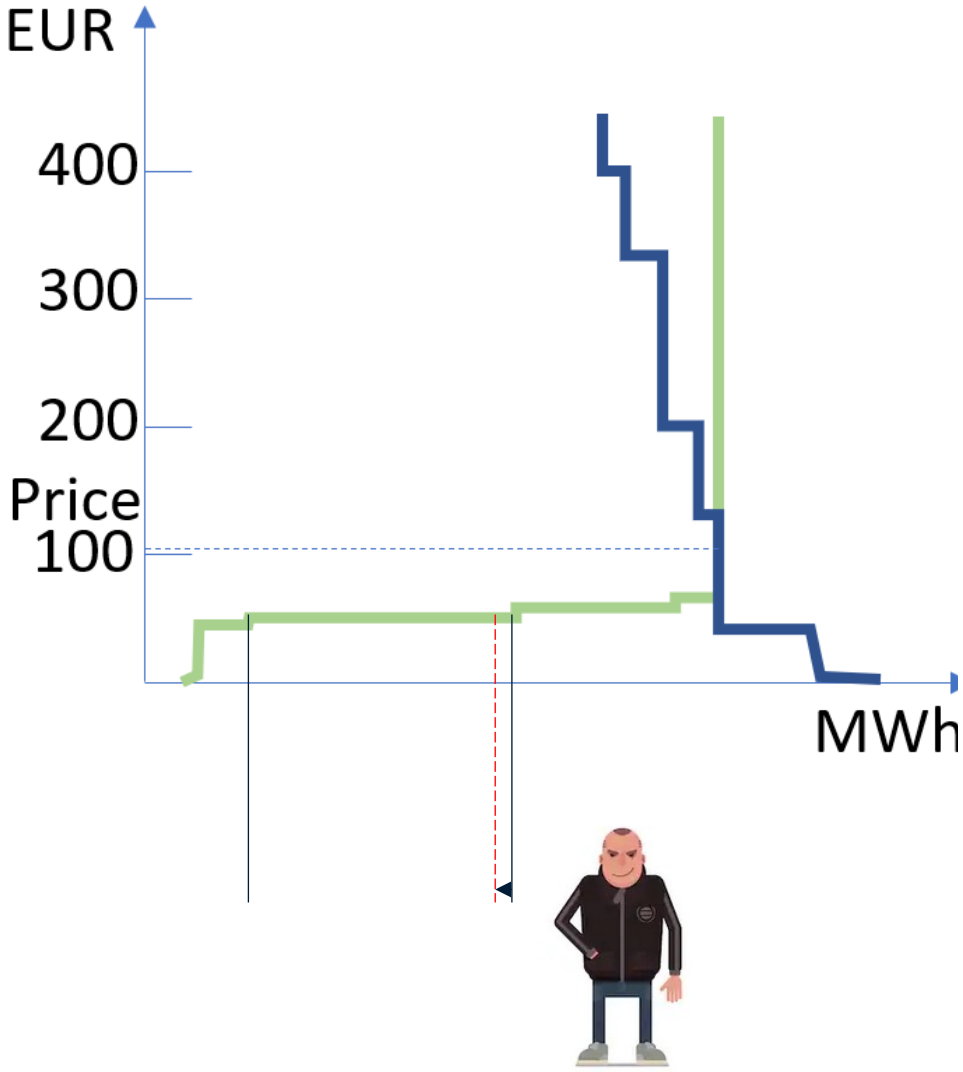


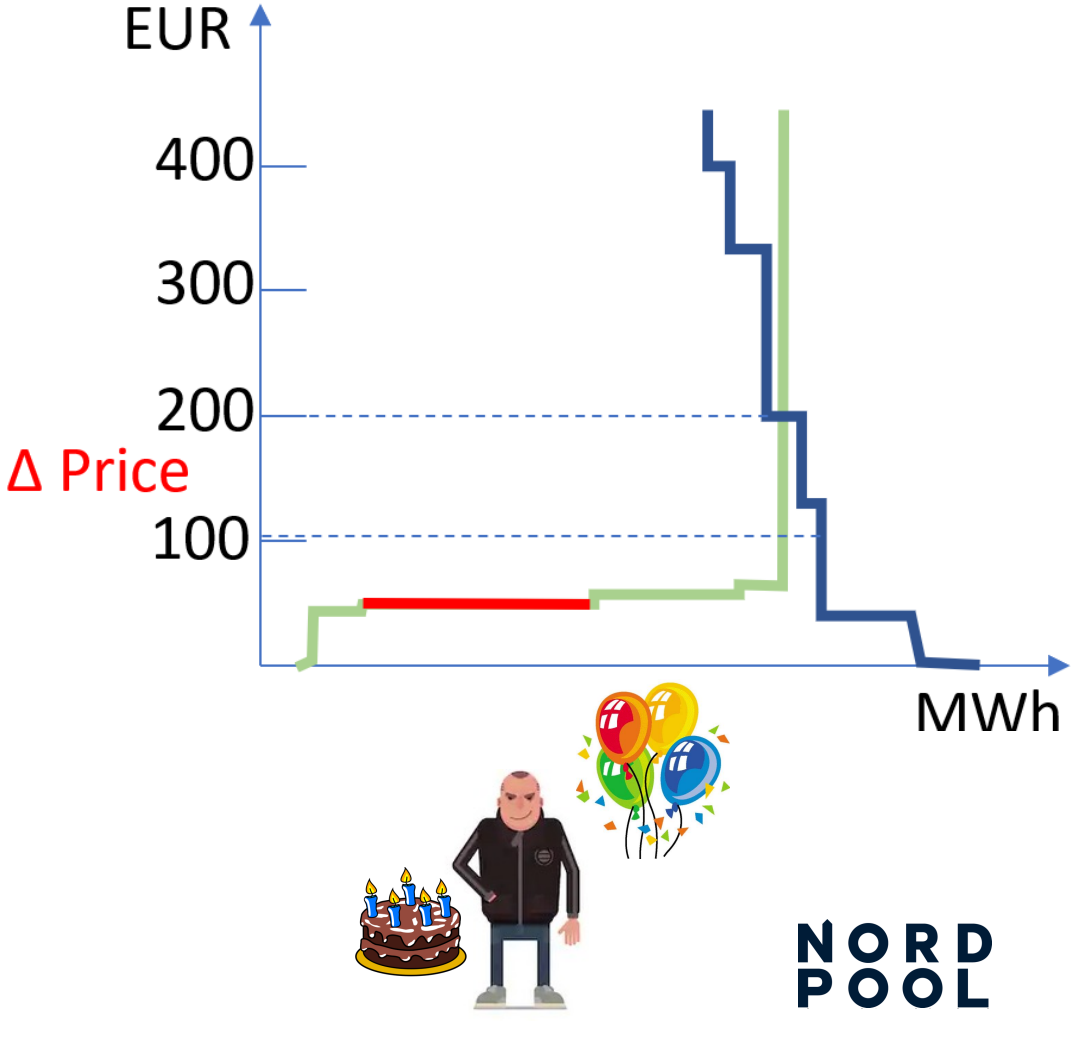
Competitive market vs. Market power

Case 2 – Realistic



24th January 2019





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Market power in electricity markets

Features of electricity markets that make them prone to market power:

- Difficulty of **storing** electricity
- **Steepness of supply curve** at peak times
- **Lack of responsiveness** of most customers to the wholesale price
- **Binding transmission constraints**
- **Repeated game**
- Historically **large generating companies**

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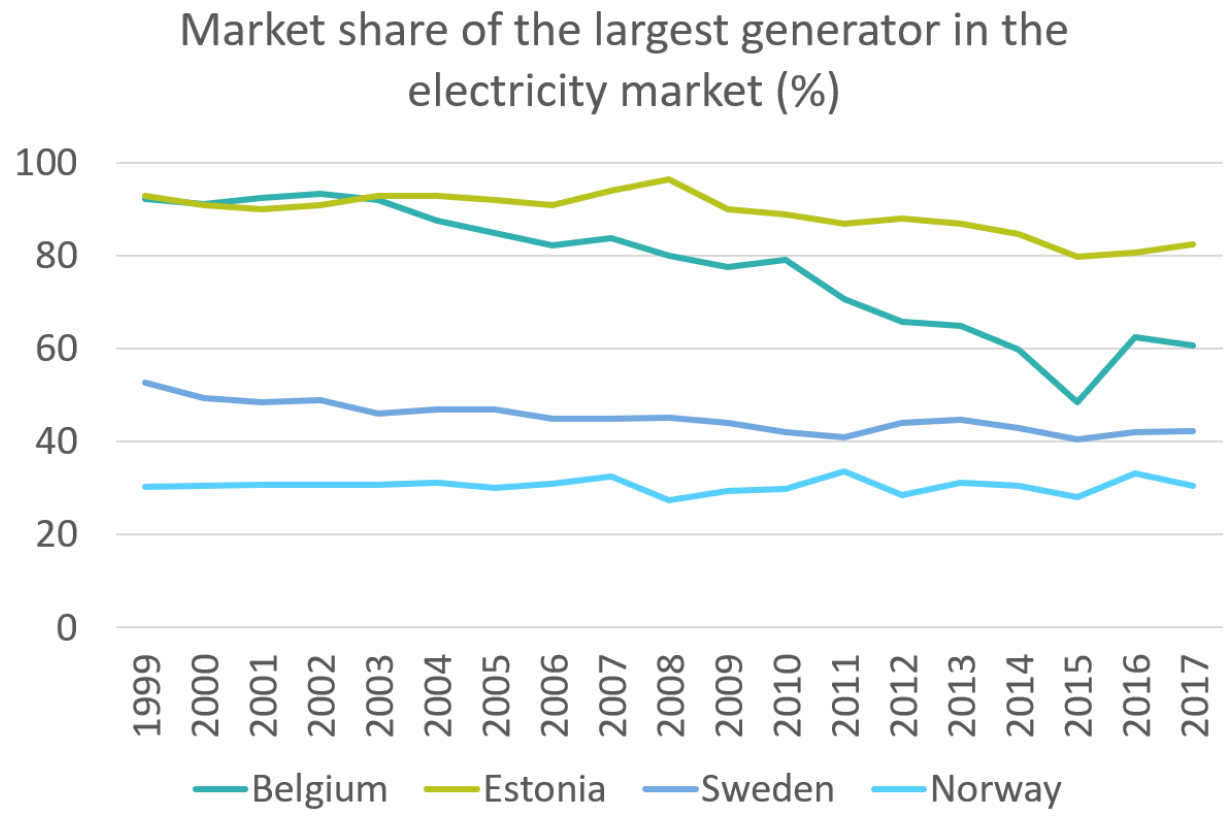
Market power in electricity markets

Features of electricity markets that make them prone to market power

Possessing market power **≠ Exercising** market power



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Why is market power a concern?

- **Inefficiency of production:**
  - Withholding of low variable operating cost generation may result in more expensive generation being used
  - Higher overall fuel bill must be paid for

- **Inefficiency of capital allocation:**
  - Higher prices may induce too much new construction

- **Inefficiency of electricity allocation**:
  - Since demand may be lower because of withheld generation

- **Transfers of wealth** from demand to generators

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Mathematics of market power

What does every company want when participating in the market?

- Profit!
  - $\boldsymbol{\pi(q) = P * q - c * q}$
  - $\pi(q)$ – profit dependent on produced amount, P – price, q – produced amount, c – marginal costs
- How to define price?
  - Intersection of demand curve and supply curve
  - In competitive markets price is a parameter P
  - $P > c$ – company receives profit, $P = c$ – company is neutral to produce or not, $P < c$ – company will not produce

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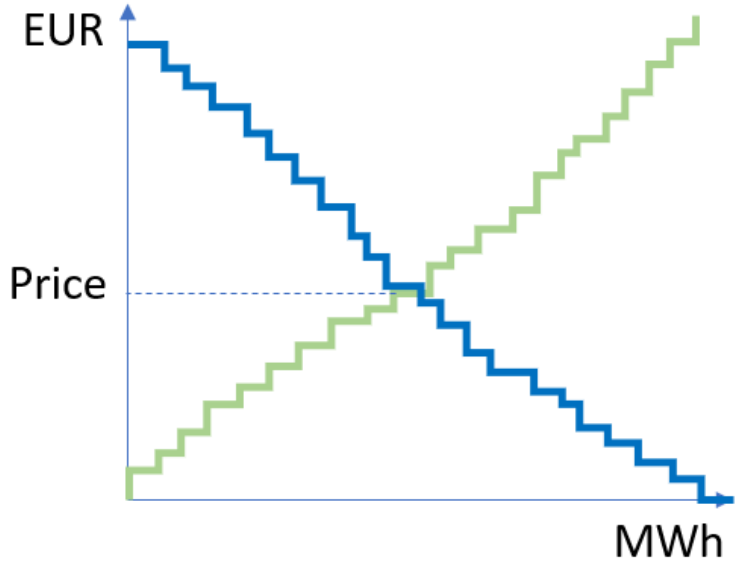
Mathematics of market power

Can we really say that price is a parameter?

- Price in realistic systems
  - Intersection of demand curve and supply curve, function of produced volume
  - $P = B - A * Q$
  - Residual demand – price curve that one market participant is exposed to: $\mathrm{P} = b - a * q$
- Profit expression for a company in realistic markets:
  - $\pi = (b - a * q) * q - c * q = bq - cq - aq^2$
  - Possible to find a profit-maximizing q



Residual demand curve is equal to market demand curve less supply of other firms.

For each level of output that may be chosen by the generator there is some corresponding wholesale spot price; the higher the level of output of the generator, the lower the resulting wholesale spot price.

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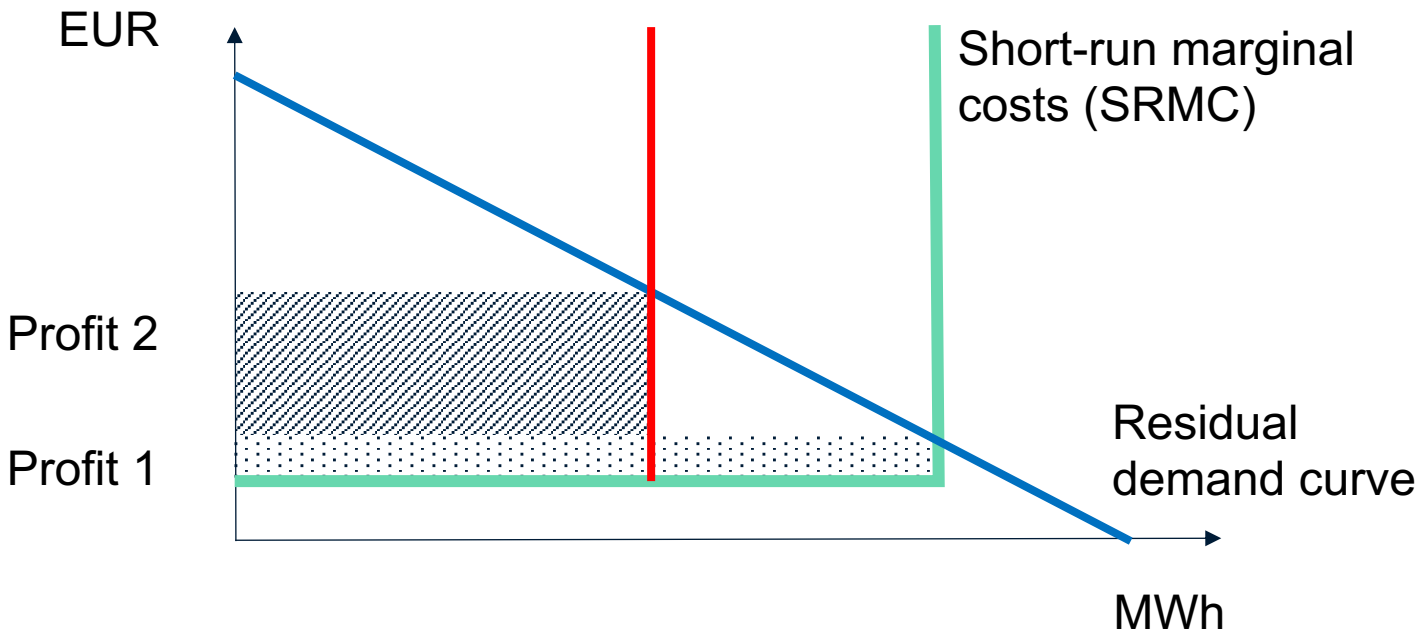
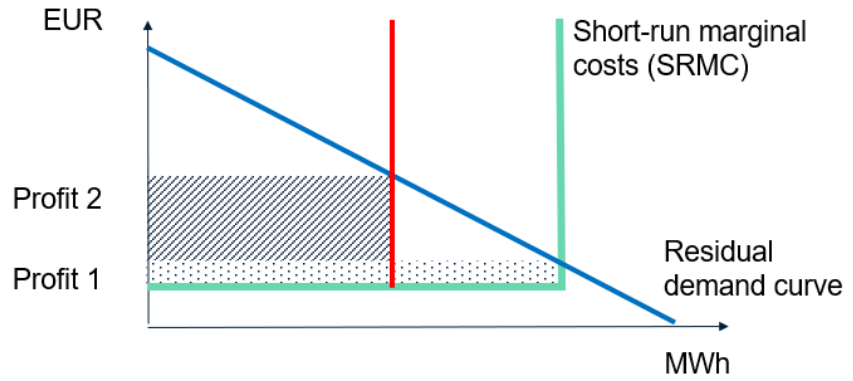
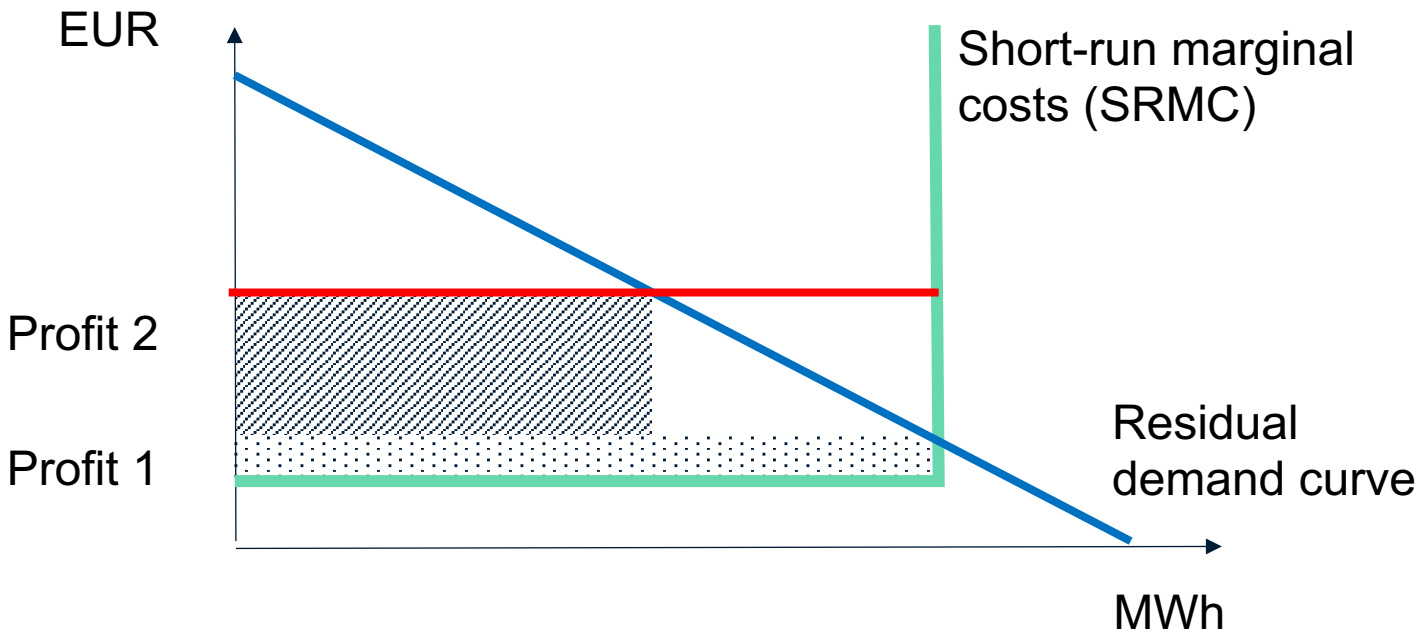
Mathematics of market power



Mathematics of market power



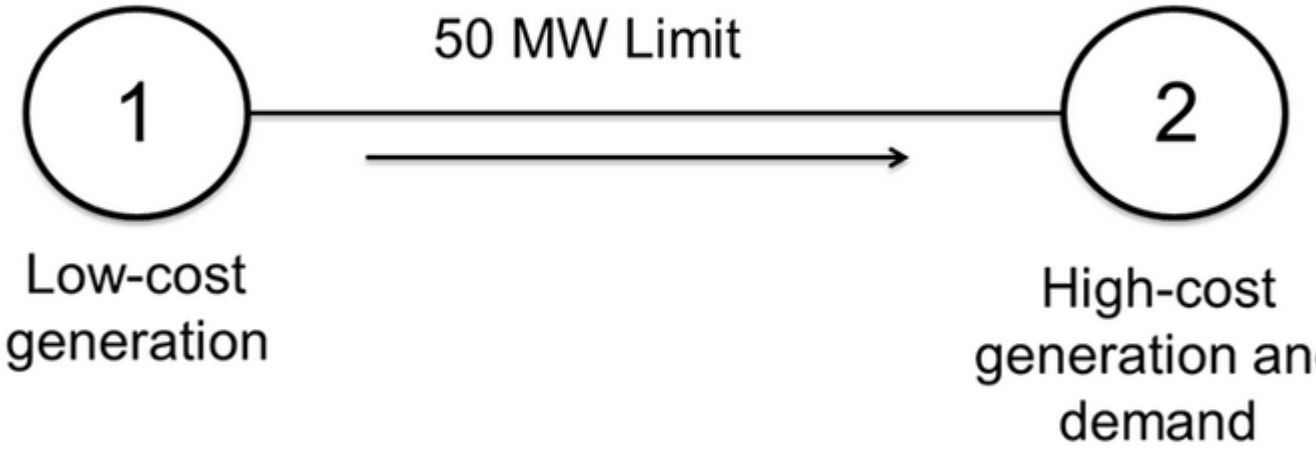


Withholding of physical capacity = **physical withholding**

Pricing up the existing capacity = **economical withholding**

Locational market power

Transmission constraints matter a lot!



Generator 1 is EUR20/MWh, Generator 2 is EUR40/MWh
Demand curve is given by $P = 200 - 2(G1 + G2)$

- Residual demand curve for G2?
- Profit-maximizing production?
- Price in node 2?

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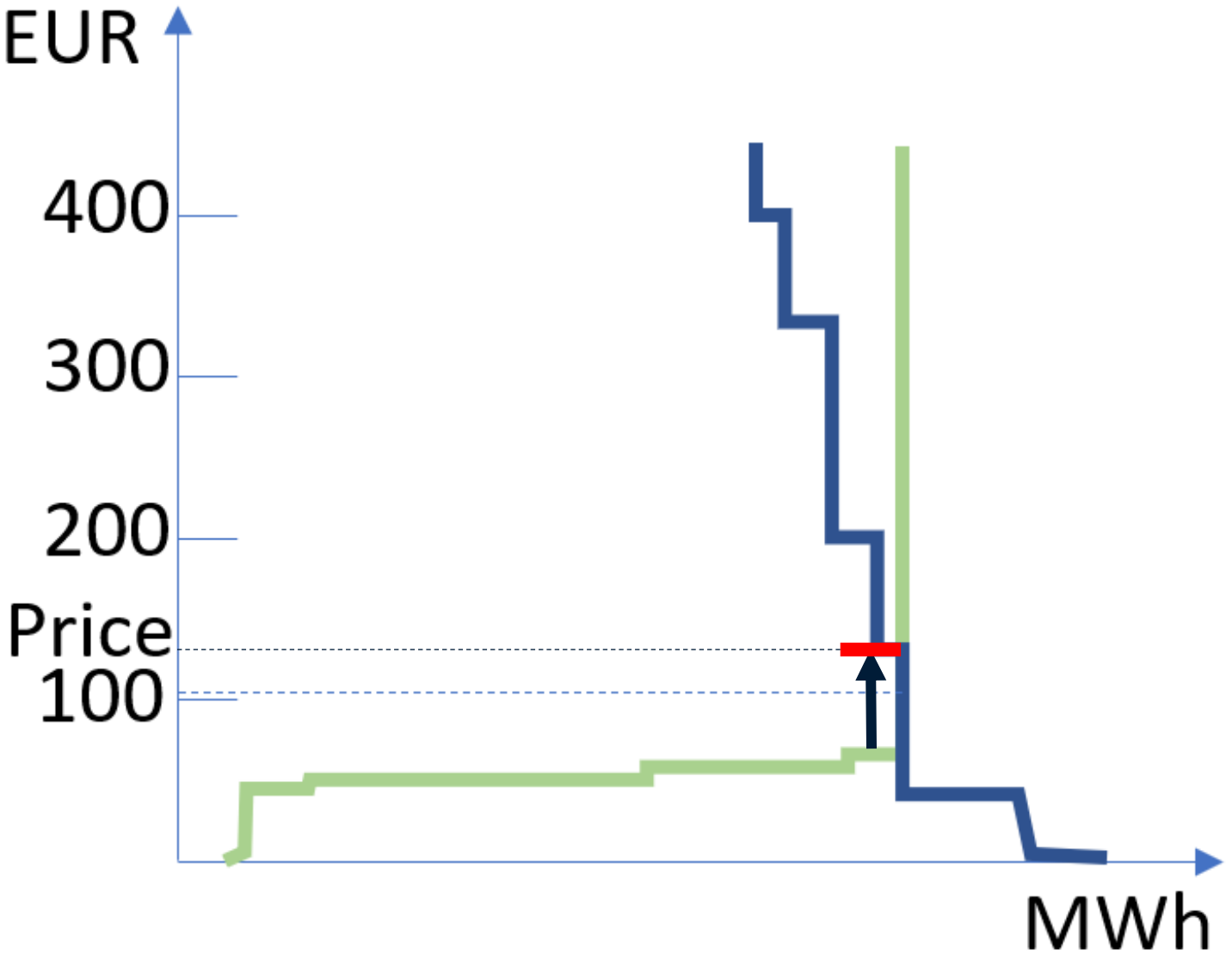
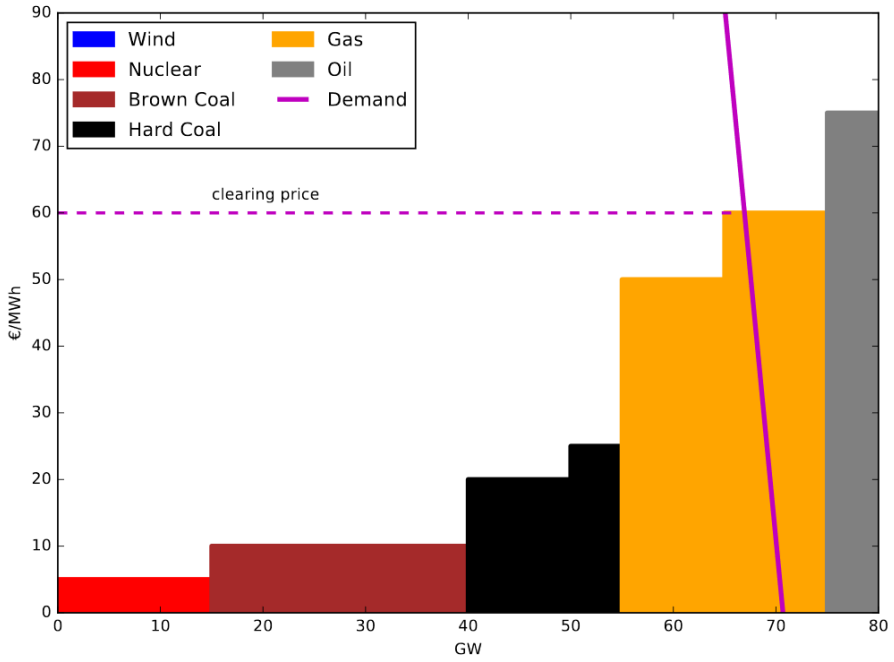
Pricing up marginal unit

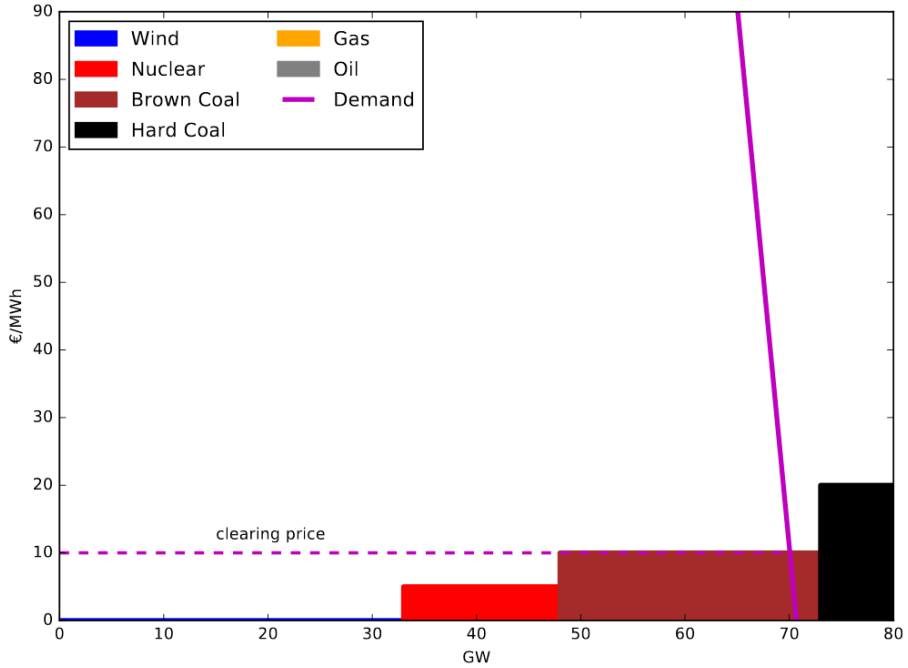
If company knows that it is marginal…



Market power in high RES power systems

When wind does not blow – market power appears





In systems with high penetration of renewables, “tight” situations occur when the wind does not blow.

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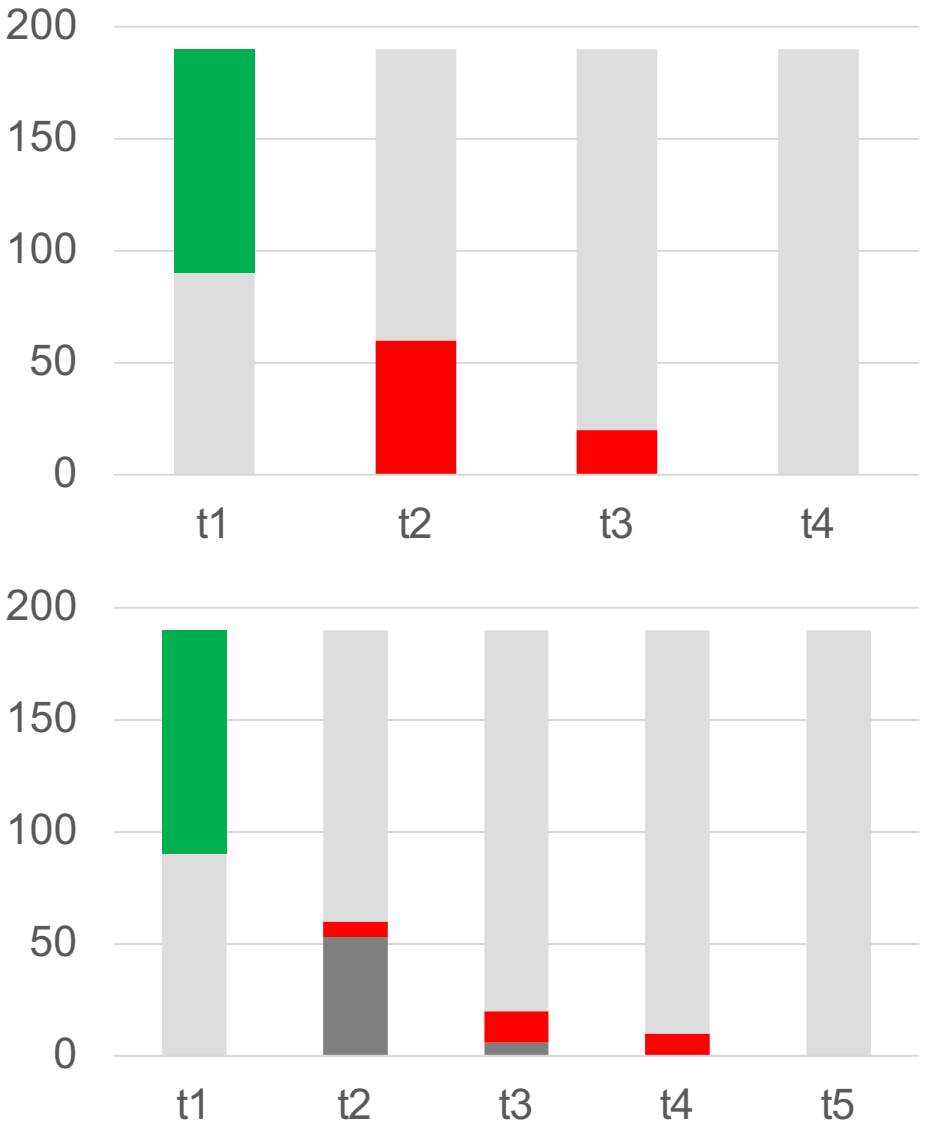
Market power in high RES systems

Flexibility is the new gold

Ramp rate – rate at which market participant can change its output in time

- Flexibility, expressed in ramp rate, becomes crucial in power systems with high amount of renewables

- When wind disappears, fast generator has incentives to ramp slower, because then a very expensive generator sets the price in some time periods



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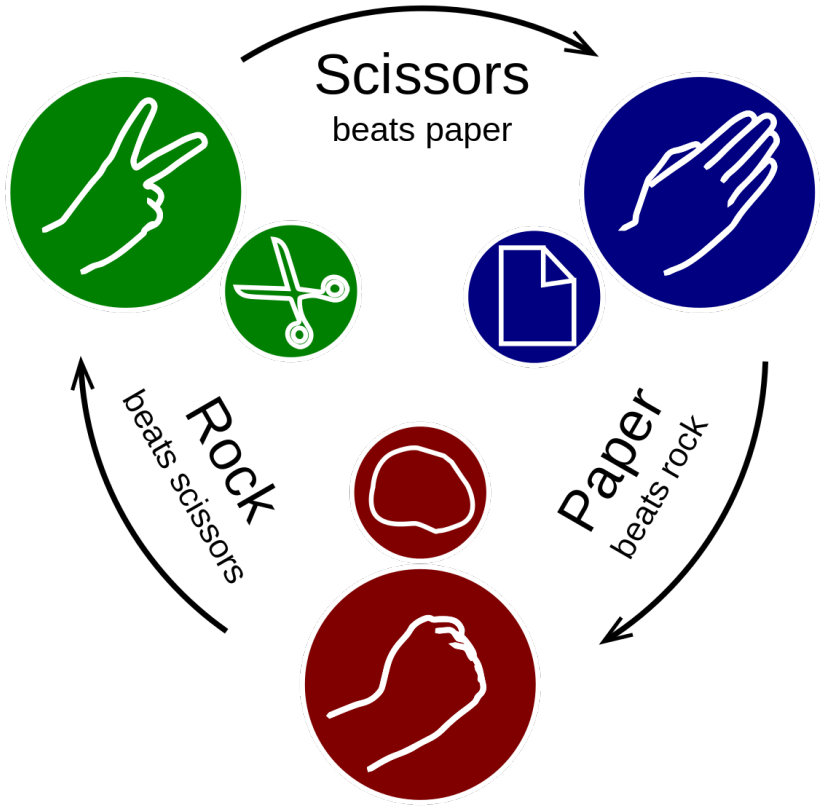
Electricity markets and strategic interactions

It is not “simply” profit maximization

Rational company in the market understands that its profit does not only depend on its own actions, but also on the actions of its competitors.

- Think about rock-paper-scissors
- Think about mobile phone sales
- Same happens in power industry



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Game theory in electricity markets

Game Theory can be used to predict the outcome of a market.

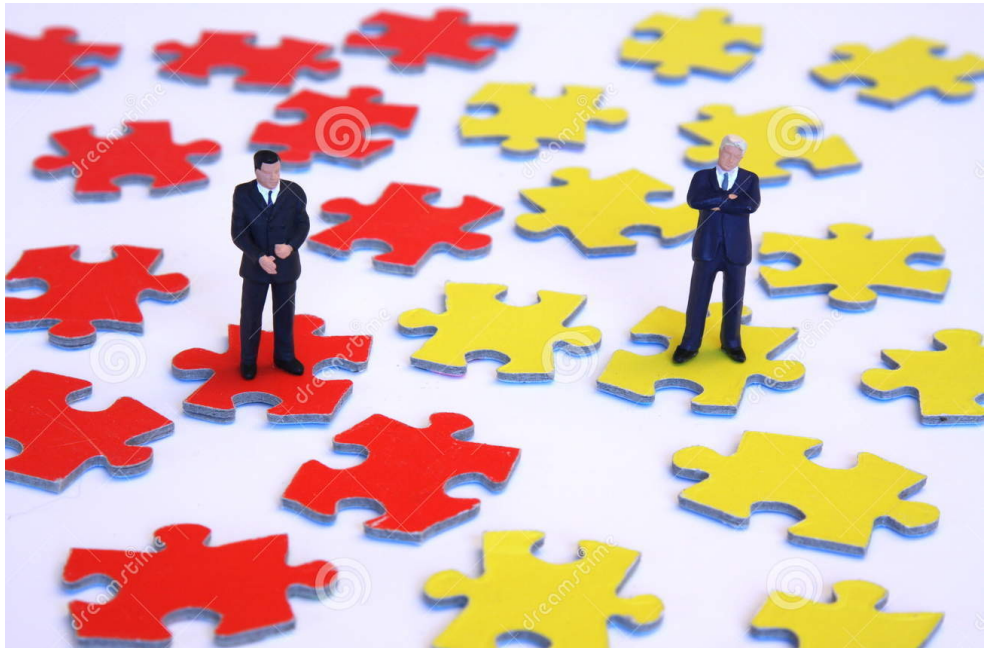
Two electricity generating firms are competing on having the highest profit in the market. Marginal costs are the same c.

- Set of players is $N = \{1,2\}$
- Each player $i = 1,2$ has set of strategies $S_i = [0, +\infty)$, with a typical element q_i
- The payoff function of player i is:

$$\pi_i(q_1, q_2) = q_i P(q_1, q_2) - cq_i,$$

where $P(q_1, q_2) = a - q_1 - q_2$ with $a > c \geq 0$.

What is best response of both firms?



Game theory in electricity markets

Game Theory can be used to predict the outcome of a market.

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$$\pi_i(q_1, q_2) = q_i P(q_1, q_2) - cq_i,$$

where $P(q_1, q_2) = a - q_1 - q_2$ with $a > c \geq 0$.

Each participant wants to maximize its profit and understands that the price of electricity depends on the actions of both actors:

$$maximize\ \pi_1 = q_1(a - q_1 - q_2) - cq_1$$

and

$$maximize\ \pi_2 = q_2(a - q_1 - q_2) - cq_2$$

- $\pi(q_1, q_2) = q_1(a - q_1 - q_2) - cq_1 = aq_1 - q_1^2 - q_1q_2 - cq_1$
- Using the first order optimality condition: $a - 2q_1 - q_2 - c = 0$
- Output / strategy of company 1 that will maximize its output, in other words – best response, – is: $\hat{q}_1 = \frac{a-c-q_2}{2}$
- Find the best response of the second company.
- Nash equilibrium is the point of intersection of the best response functions. It is obtained by simultaneously solving two equations of the best response functions.
- NE = $(\frac{a-c}{3}, \frac{a-c}{3})$. Corresponding price: $P = \frac{a+2c}{3}$

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Practice of market power

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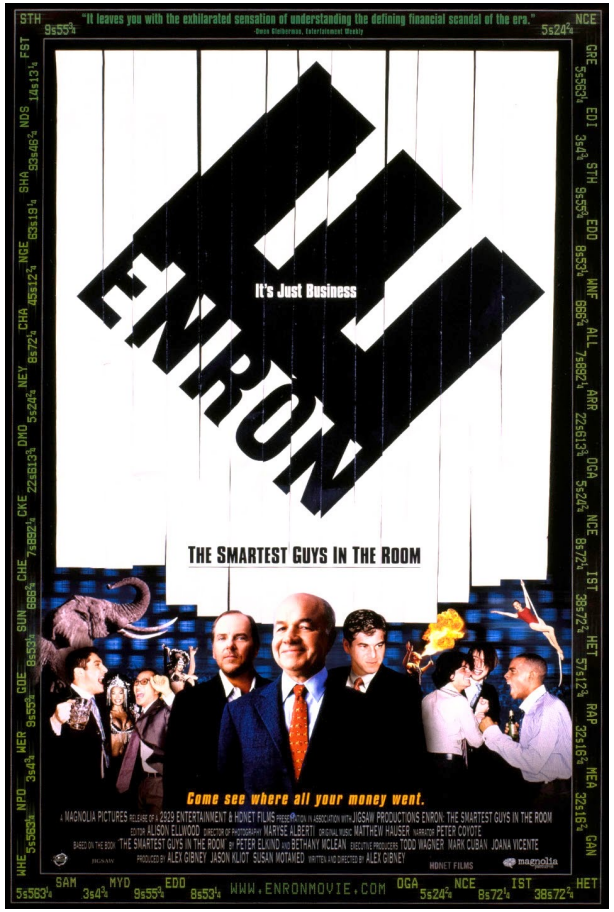
California energy crisis

When market design does not consider market power

- A system with high penetration – highly reliable on hydropower
- An 800 % increase in wholesale prices from April to December 2000
- 97 000 customers affected by rolling blackouts
- The crisis cost up to $45 billion

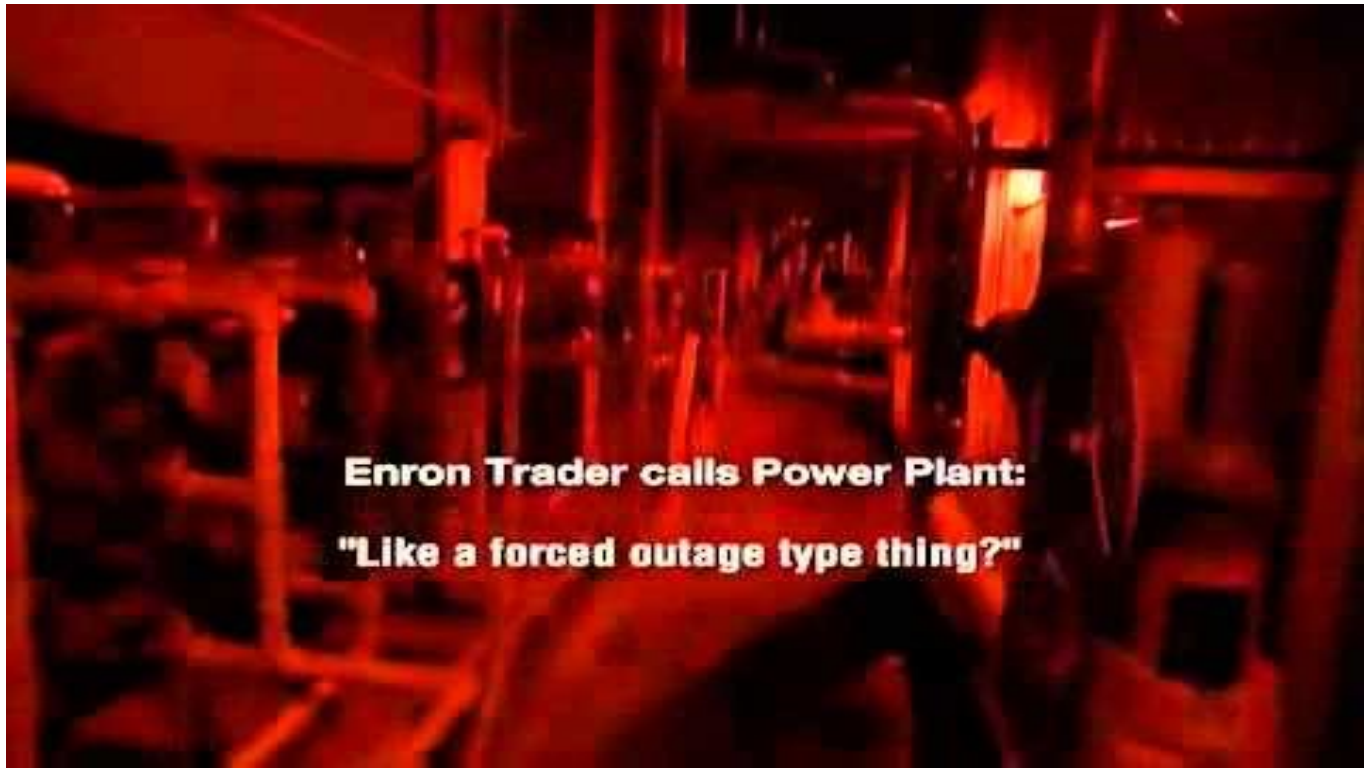
Main reason – market power – an ability of a generating company to affect the wholesale price by varying its output



Fragment from the film

Vocabulary

- Tim Belden – head of trading in Enron Energy Services
- “Wheeling power out of California” – selling power outside of California in order to create a tight situation
- Arbitrage – taking the benefit of a higher price elsewhere. Steal - …
- Shutting down power plants = physical withholding, creating a shortage of supply (artificial shortage)
- Forced outage – a fail of a power plant to produce power



Market manipulation

Entering into transaction

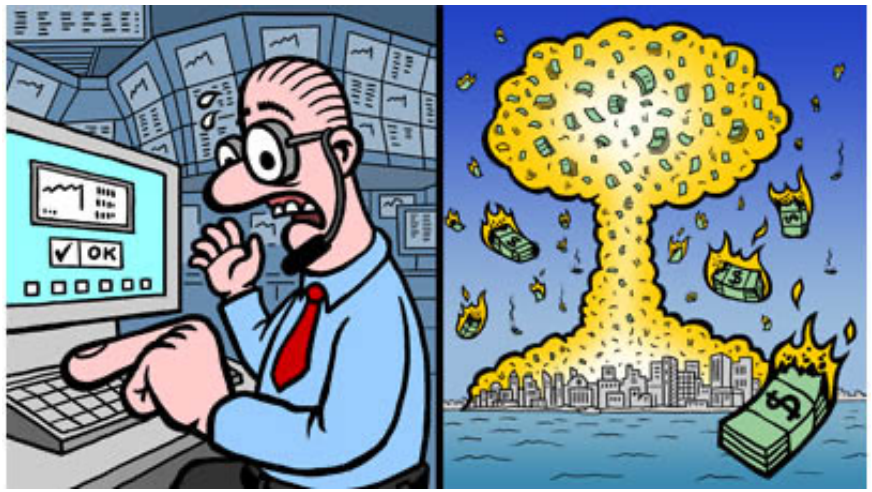
Issuing order to trade

in wholesale energy product, which:

Gives misleading signals to the market

Secures the price at an artificial level

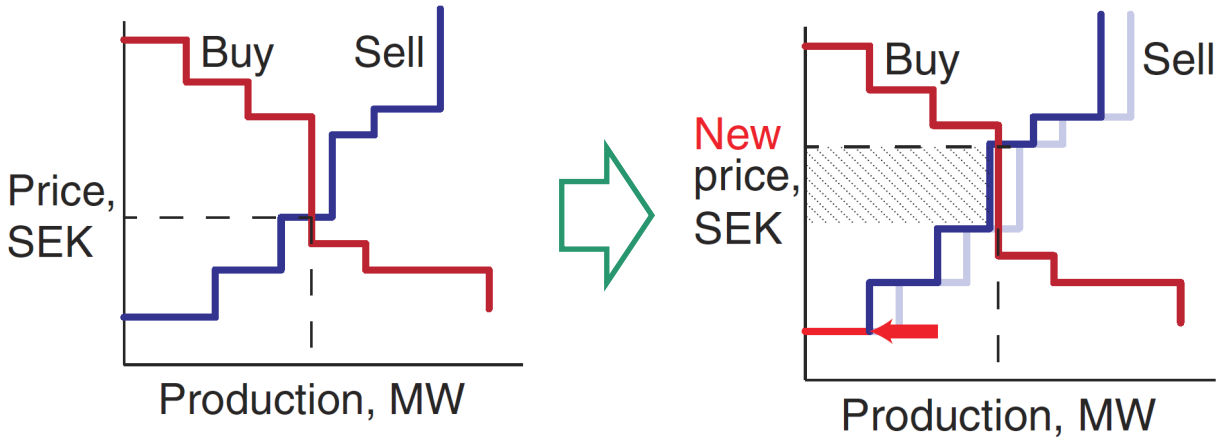
No intention is required!



Examples of Market Manipulation

- ***Physical withholding***
  - For example not offering on the market, without justification, a power plant whose marginal cost is lower than the spot prices, misusing infrastructure, transmission capacities, etc., that would result in abnormal high prices

- ***Comments:***
  - Not offering a power plant to the market by falsely claiming that the unit is in need of maintenance



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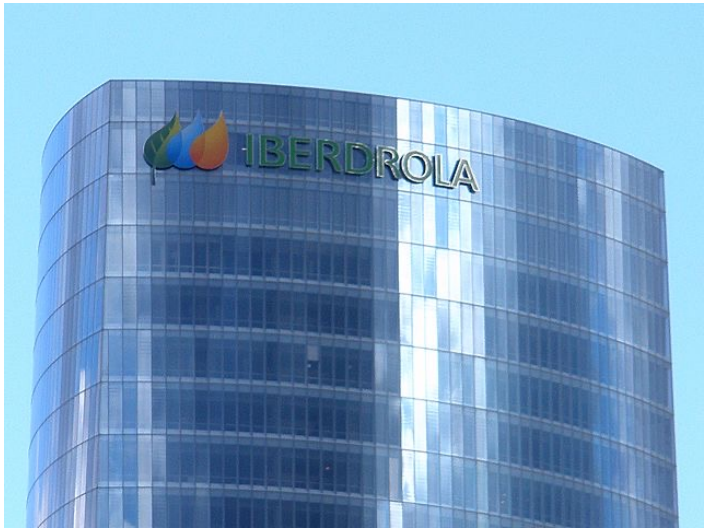
Alleged manipulation by Iberdrola

"Following an investigation, the competition watchdog fined Iberdrola €25 million in November 2015 for manipulating the Spanish wholesale electricity market."



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≡ EL PAÍS IN ENGLISH

POLITICS ARTS SPORTS OPINION SPANISH WAY OF LIFE

ENERGY PRICES ›

Leading Spanish electricity firm Iberdrola accused of manipulating prices

Anti-corruption prosecutor says electric utility hatched plan to "illicitly" make €20 million

JOSÉ ANTONIO HERNÁNDEZ
Investigación EL PAÍS

Madrid - 12 MAY 2017 - 08:52 CEST

Iberdrola, the Spanish energy giant, allegedly worked to alter the price of electricity and make "an illicit profit of €20 million" during the winter of 2013, coinciding with a cold spell. The accusation has been brought by anti-corruption prosecutor Antonio Romeral in a complaint lodged against the company with the Audiencia Nacional, Spain's central High Court.

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Examples of Market Manipulation

- ***Dissemination of false or misleading information***
  - **Example:** Publishing erroneous information when publishing inside information
  - **Example:** Spreading false rumors regarding expected outages or political decisions

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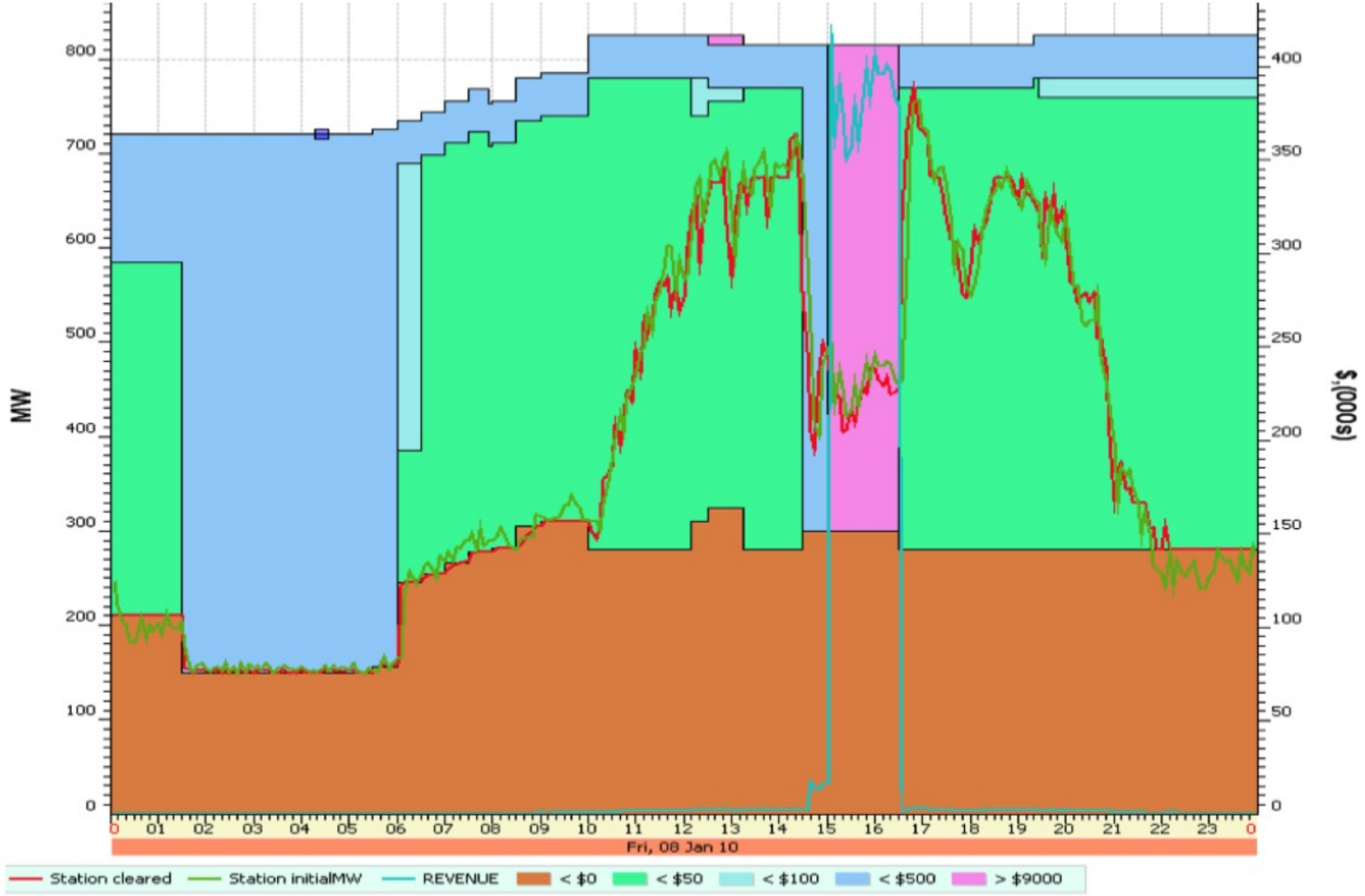
Exercise of market power in Australian power markets



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Market surveillance at Nord Pool

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Nord Pool is required to do market surveillance

Requirements for performing market surveillance are outlined in **REMIT**, market place **license** by NVE and **CACM**

Article 15

Obligations of persons professionally arranging transactions

Any person professionally arranging transactions in wholesale energy products who reasonably suspects that a transaction might breach Article 3 or 5 shall notify the national regulatory authority without further delay.

Persons professionally arranging transactions in wholesale energy products shall establish and maintain effective arrangements and procedures to identify breaches of Article 3 or 5.

Article 6

NEMO designation criteria

1. An applicant shall only be designated as a NEMO if it complies with all of the following requirements:

...

(g) it shall have appropriate market surveillance arrangements in place;

8. Markedsovervåkning

8.1 Konsesjonæren plikter å ha hensiktsmessige ordninger for å overvåke aktørenes opptreden i norske prisområder på markedsplassen. Disse skal dokumenteres og forelegges NVE på forespørsel.

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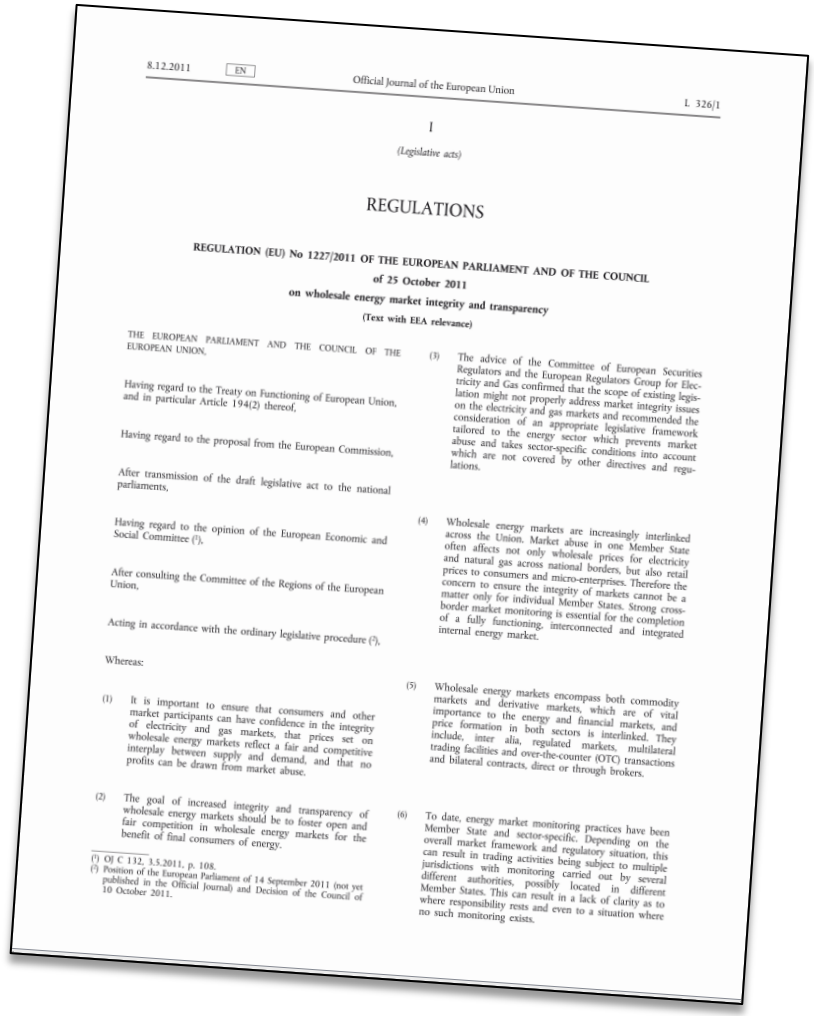
REMIT – The first set of common rules for wholesale energy markets in Europe

REMIT – **RE**gulation on wholesale **M**arket **I**ntegrity and **T**ransparency

Aims to ensure on European level:

- Confidence in the market integrity
- Prices that represent a fair and competitive interplay between supply and demand
- No profits are drawn from market abuse



8.12.2011 EN Official Journal of the European Union L 326/1

I

(Legislative acts)

REGULATIONS

REGULATION (EU) No 1227/2011 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 25 October 2011
on wholesale energy market integrity and transparency
(Text with EEA relevance)

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty on Functioning of European Union, and in particular Article 194(2) thereof,

Having regard to the proposal from the European Commission,

After transmission of the draft legislative act to the national parliaments,

Having regard to the opinion of the European Economic and Social Committee (1),

After consulting the Committee of the Regions of the European Union,

Acting in accordance with the ordinary legislative procedure (2),

Whereas:

(1) It is important to ensure that consumers and other market participants can have confidence in the integrity of electricity and gas markets, that prices set on wholesale energy markets reflect a fair and competitive interplay between supply and demand, and that no profits can be drawn from market abuse.

(2) The goal of increased integrity and transparency of wholesale energy markets should be to foster open and fair competition in wholesale energy markets for the benefit of final consumers of energy.

(1) OJ C 132, 3.5.2011, p. 108.
(2) Position of the European Parliament of 14 September 2011 (not yet published in the Official Journal) and Decision of the Council of 10 October 2011.

(3) The advice of the Committee of European Securities Regulators and the European Regulators Group for Electricity and Gas confirmed that the scope of existing legislation might not properly address market integrity issues on the electricity and gas markets and recommended the consideration of an appropriate legislative framework tailored to the energy sector which prevents market abuse and takes sector-specific conditions into account which are not covered by other directives and regulations.

(4) Wholesale energy markets are increasingly interlinked across the Union. Market abuse in one Member State often affects not only wholesale prices for electricity and natural gas across national borders, but also retail prices to consumers and micro-enterprises. Therefore the concern to ensure the integrity of markets cannot be a matter only for individual Member States. Strong cross-border market monitoring is essential for the completion of a fully functioning, interconnected and integrated internal energy market.

(5) Wholesale energy markets encompass both commodity markets and derivative markets, which are of vital importance to the energy and financial markets, and price formation in both sectors is interlinked. They include, inter alia, regulated markets, multilateral trading facilities and over-the-counter (OTC) transactions and bilateral contracts, direct or through brokers.

(6) To date, energy market monitoring practices have been Member State and sector-specific. Depending on the overall market framework and regulatory situation, this can result in trading activities being subject to multiple jurisdictions with monitoring carried out by several different authorities, possibly located in different Member States. This can result in a lack of clarity as to where responsibility rests and even to a situation where no such monitoring exists.

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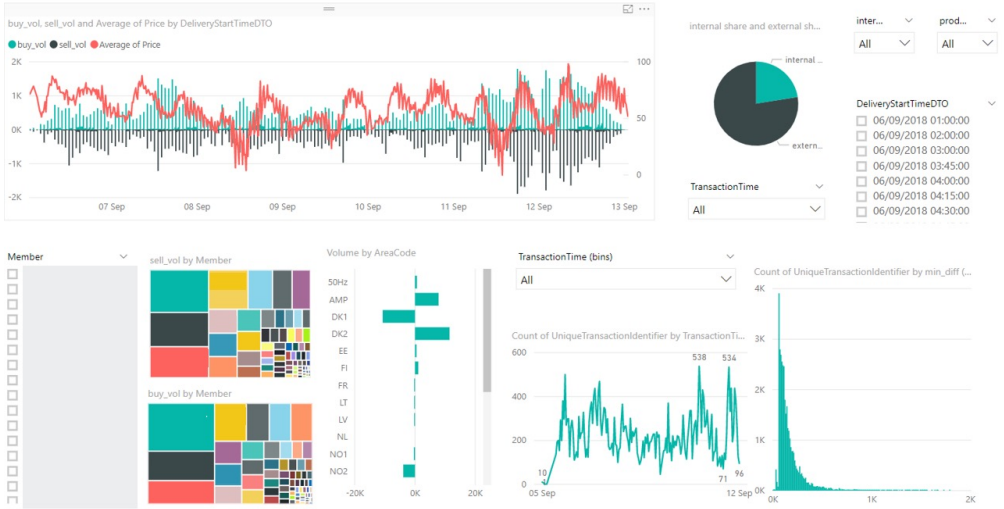
REMIT ensuring entities and their tasks

ACER sends cases to NRAs, similar to what Nord Pool does. The NRA is responsible for the final investigation and sanctioning of breaches

Market surveillance at Nord Pool

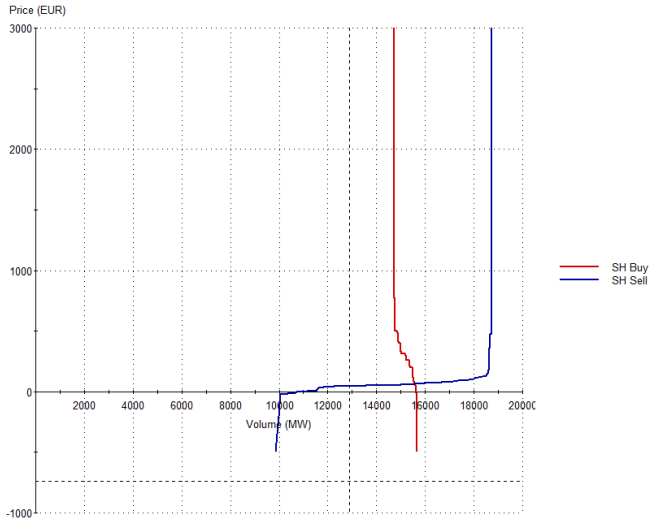
Development of alerts and checks:

- Processing trading data in Python
- Visualization in Power BI



Market **analysis and monitoring**:

- Explaining price movements, volume movements
- Explaining behaviour of individual participants



Relevant data are crucial for our work!

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