

ELECTRICITY ECONOMICS

for the integration of larger
shares of intermittent
renewables

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Content

1. Introduction: Historical background
2. How prices come about (theory)
3. How prices developed in Europe
4. Effects of high shares of renewables
5. Options for a new market design
6. Conclusions

THE EU-DIRECTIVE(S) 1

The European Commission's main expectation was the belief that

“market forces [would] produce a better allocation of resources and greater effectiveness in the supply of services”

- **Intentions of the EC directive:**
 - **Competitive markets**
 - **Free choice of supplier**
 - **lower electricity prices**

THE EU-DIRECTIVE(S) 2

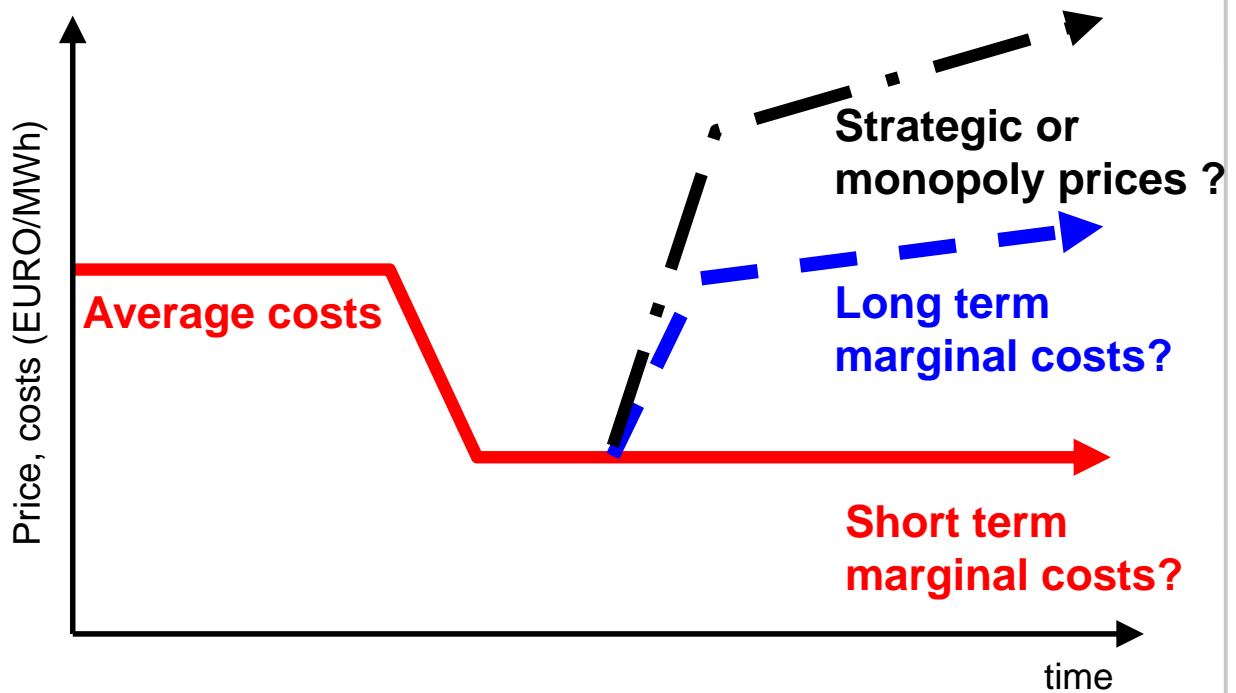
How? Political instruments:

- **Unbundling**
- **Access to the grid**
- **Market opening**

Target:

Competition in one joint European electricity market

2. How prices come about (theory)



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2. How prices come about (theory)

What are average costs (AC)?

$$AC = C(X) / X$$

X ... Total generated (and distributed amount X of electricity

C(X) ... Total costs for generating (and distributing) the amount X of electricity

$$P = AC$$

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What are marginal costs (MC)?

$$MC = C'(X) = dC(x)/dX$$

Marginal costs are the increment of costs due to a generation of one additional unit of kWh

$$P = MC$$

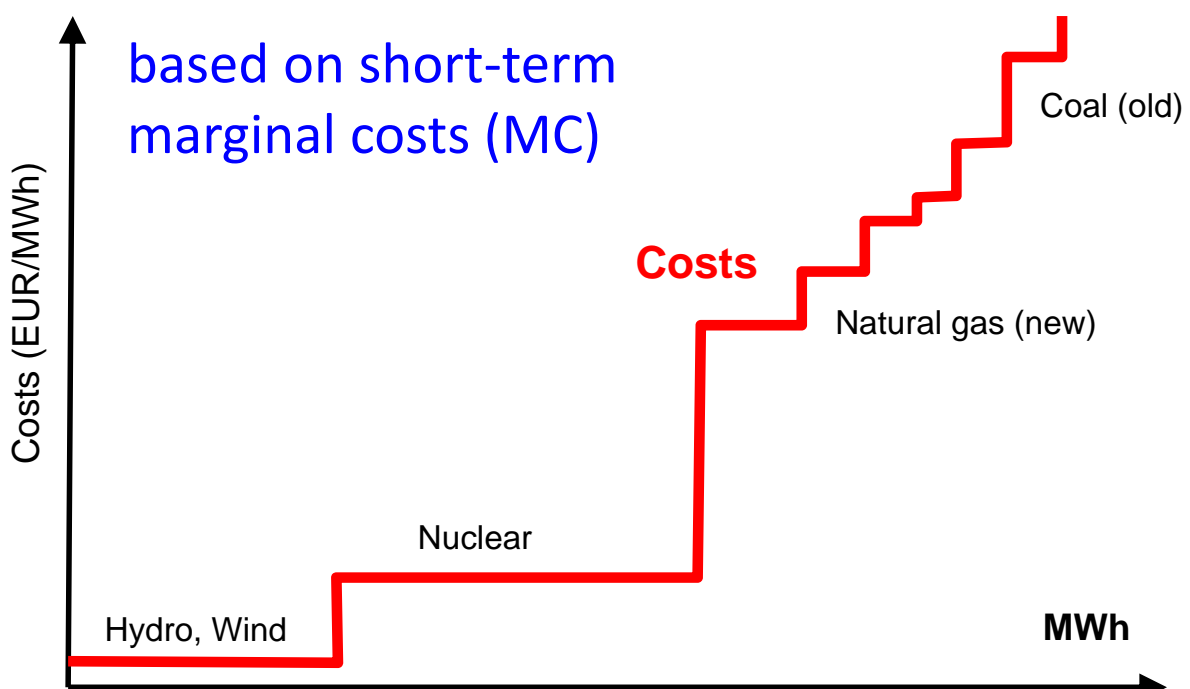
Short-term marginal costs (STMC):

$$STMC = \text{Fuel costs} + \text{CO}_2 \text{ costs}$$

Long-term marginal costs (LTMC):

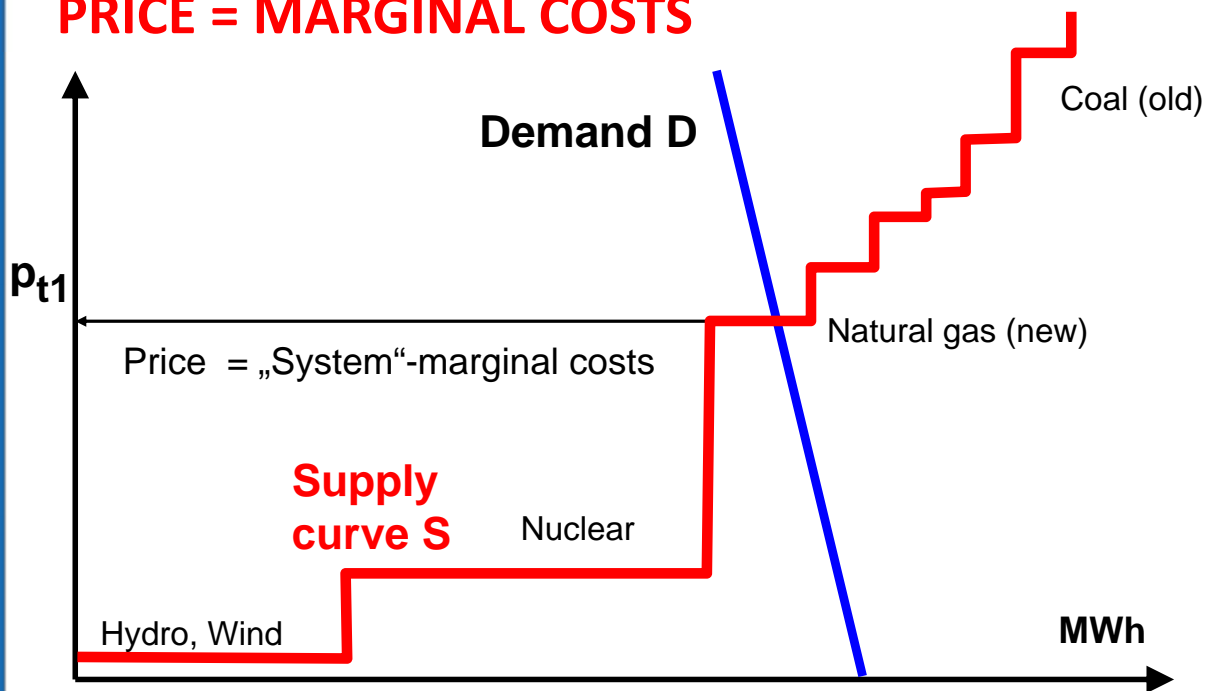
$$LTMC = STMC + \text{Capital costs} + \text{O\&M costs}$$

THE MERIT-ORDER CURVE OF SUPPLY



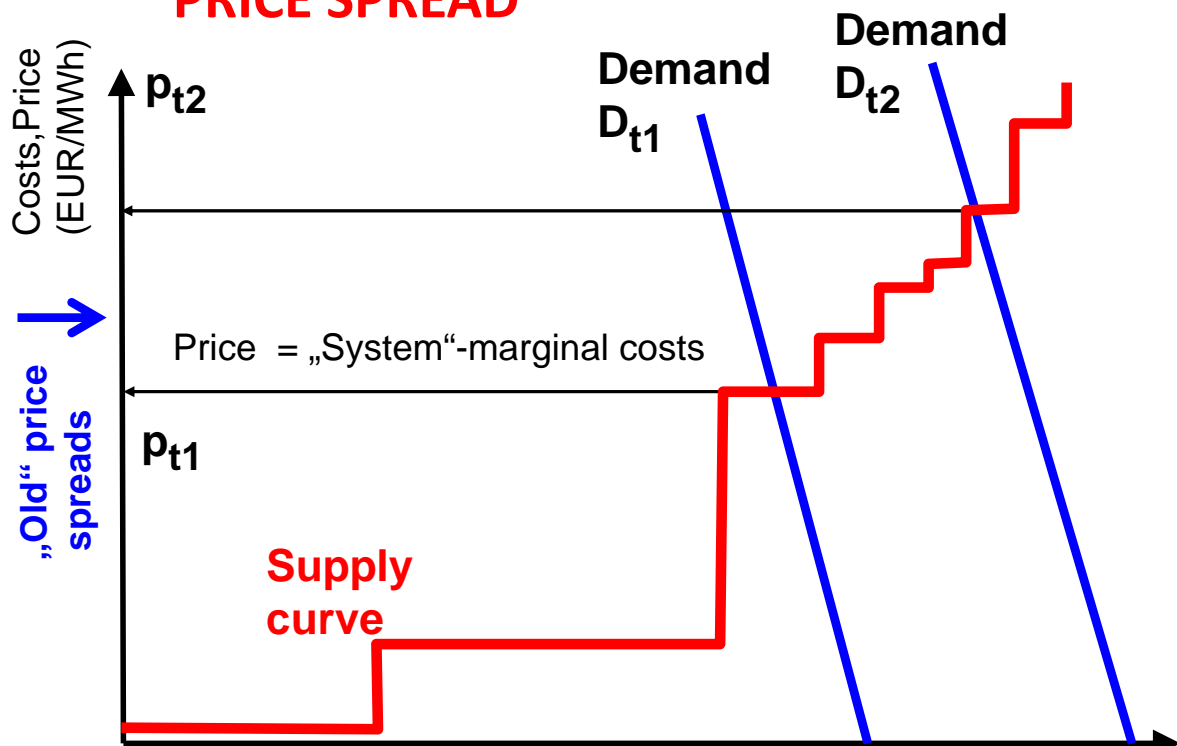
2. How prices come about (theory)

BASIC PRINCIPLE OF COMPETITION: PRICE = MARGINAL COSTS



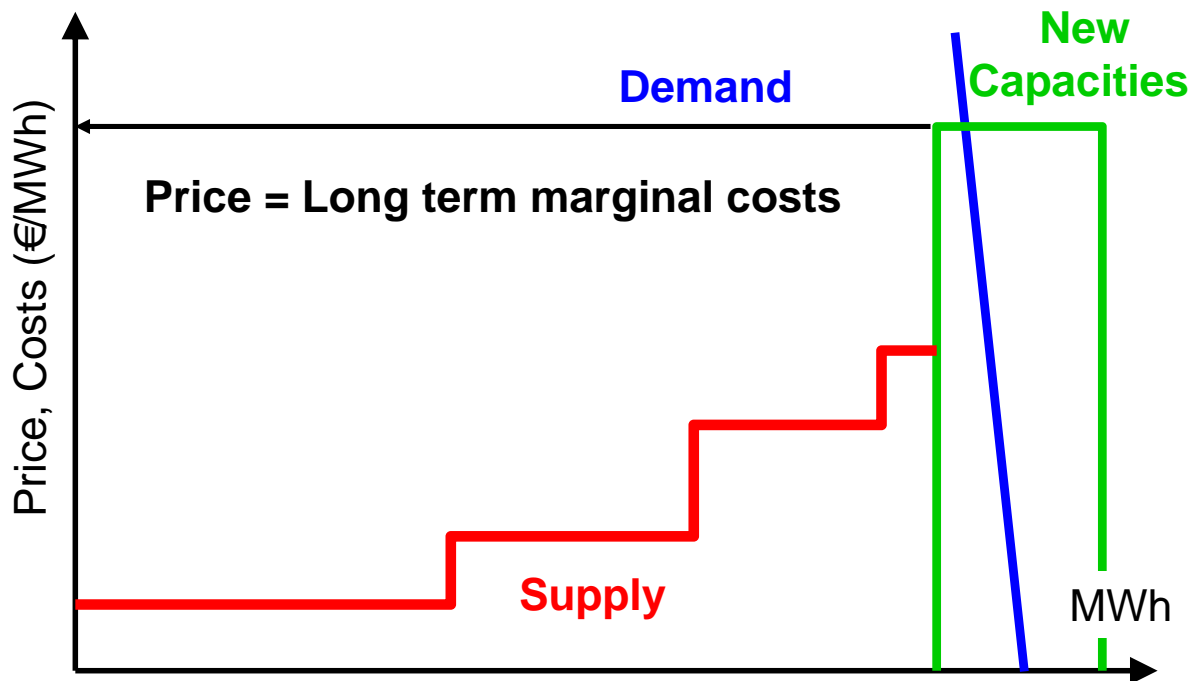
2. How prices come about (theory)

PRICE SPREAD



2. How prices come about (theory)

NO EXCESS CAPACITIES, PERFECT COMPETITION



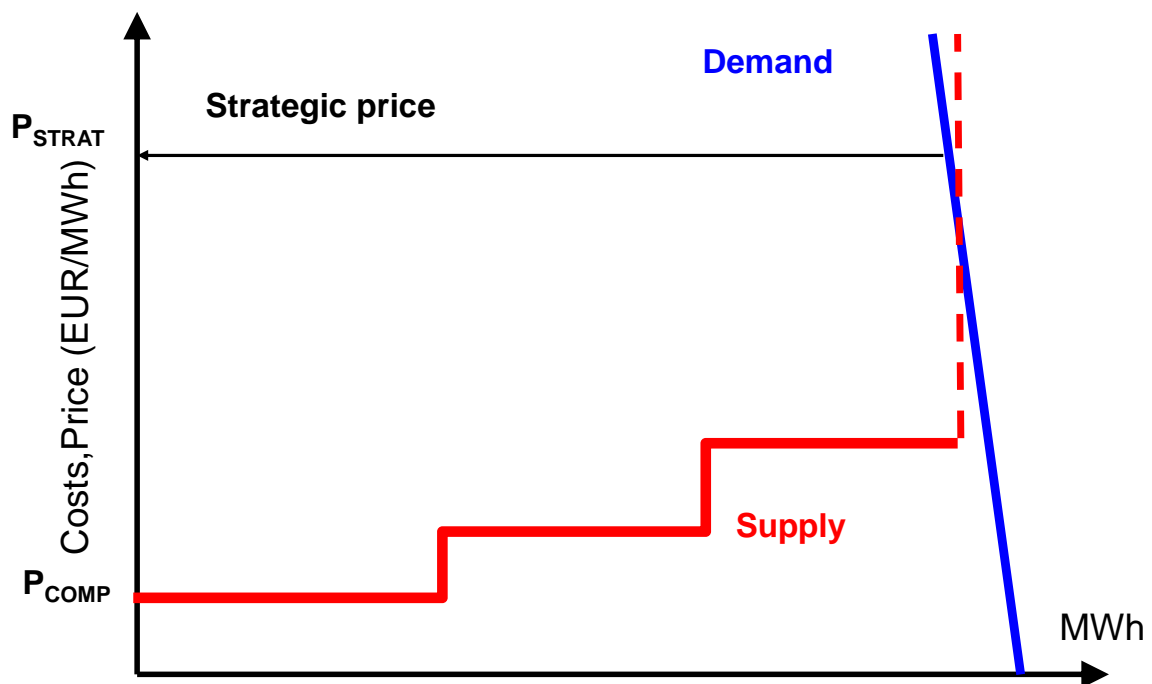
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2. How prices come about (theory)

NO EXCESS CAPACITIES: NO PERFECT COMPETITION!



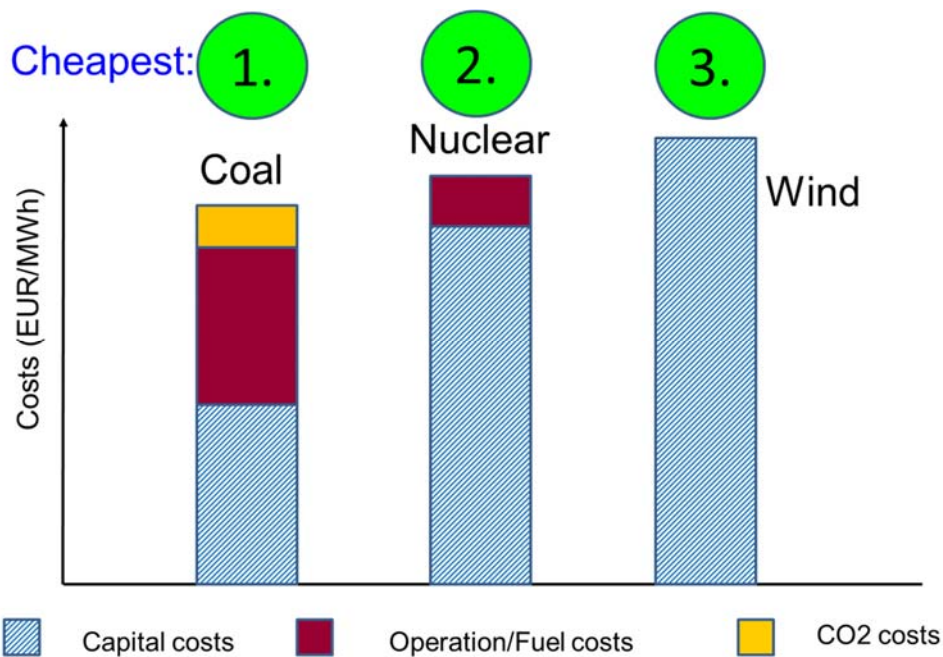
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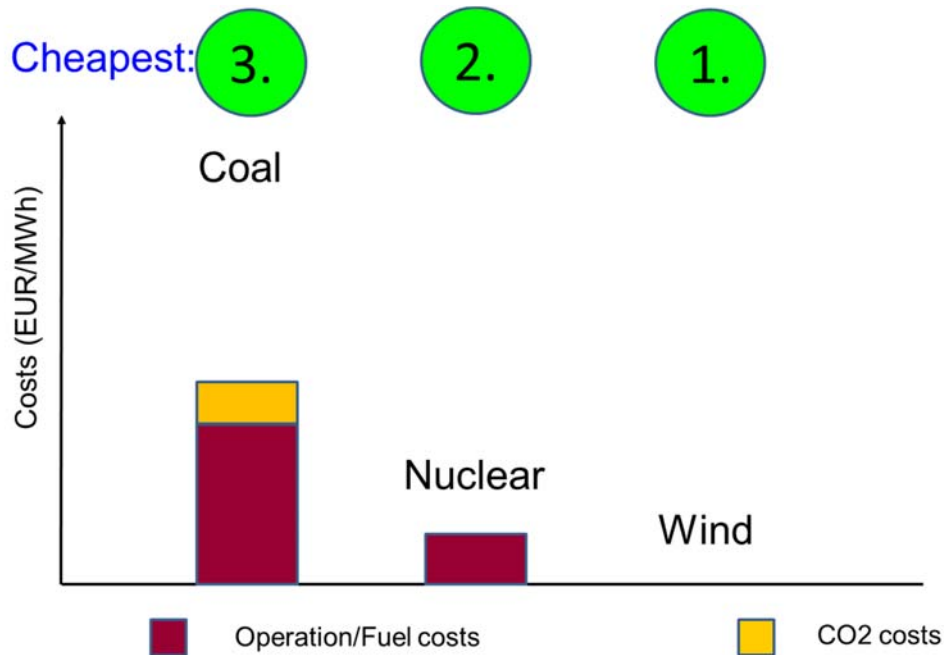
LONG-TERM VS SHORT-TERM MARGINAL COSTS

LONG-TERM MARGINAL COSTS



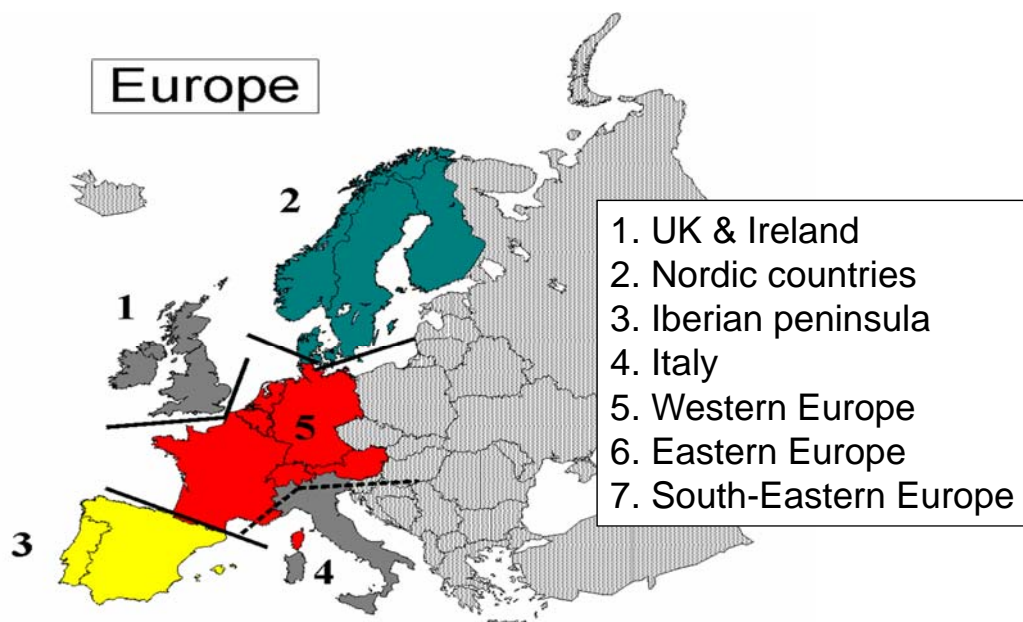
2. How prices come about (theory)

SHORT-TERM MARGINAL COSTS



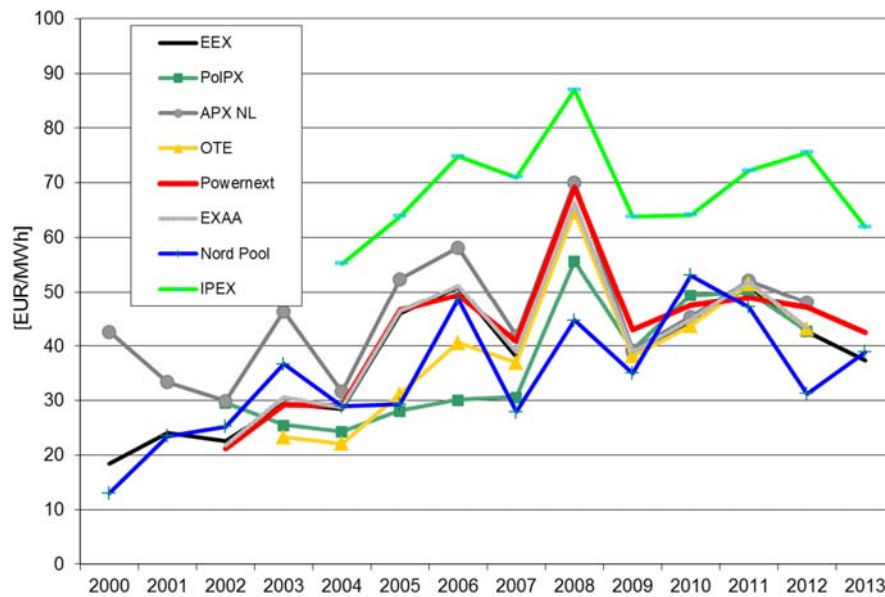
3. How prices developed in Europe

EUROPEAN ELECTRICITY SUB-MARKETS



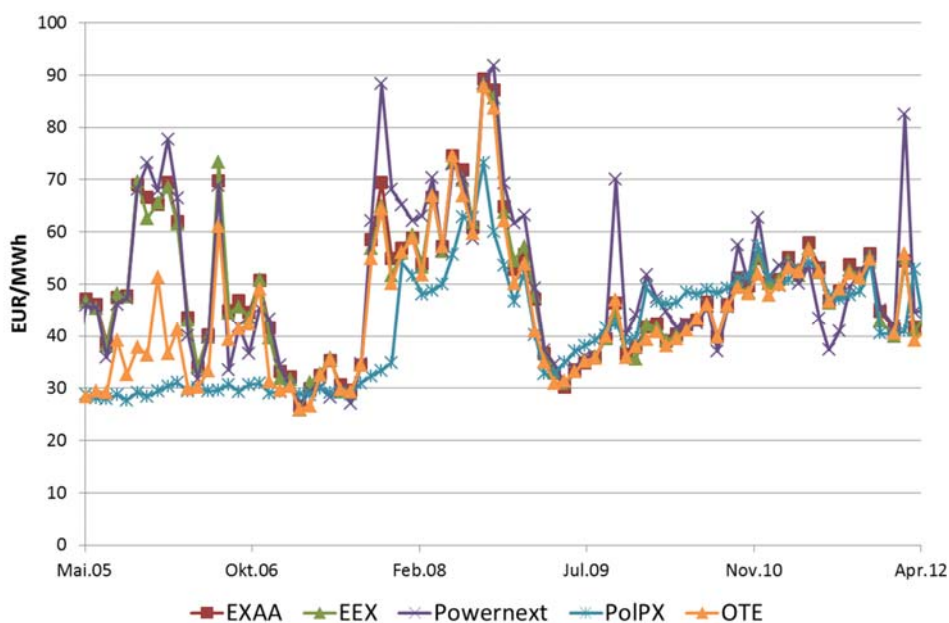
3. How prices developed in Europe

DEVELOPMENTS AT SPOT MARKETS AT, DE, FR, CZ, PL → One market!



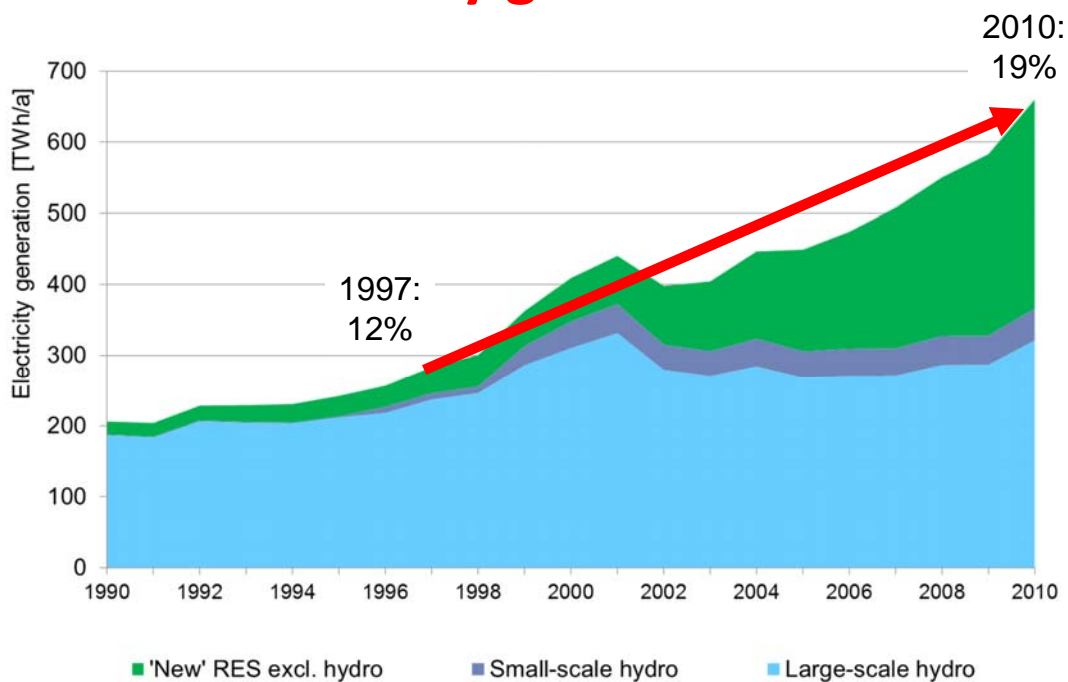
3. How prices developed in Europe

FRANCE, GERMANY, AUSTRIA, CZECH REPUBLIC, POLAND – ONE CONVERGING MARKET?



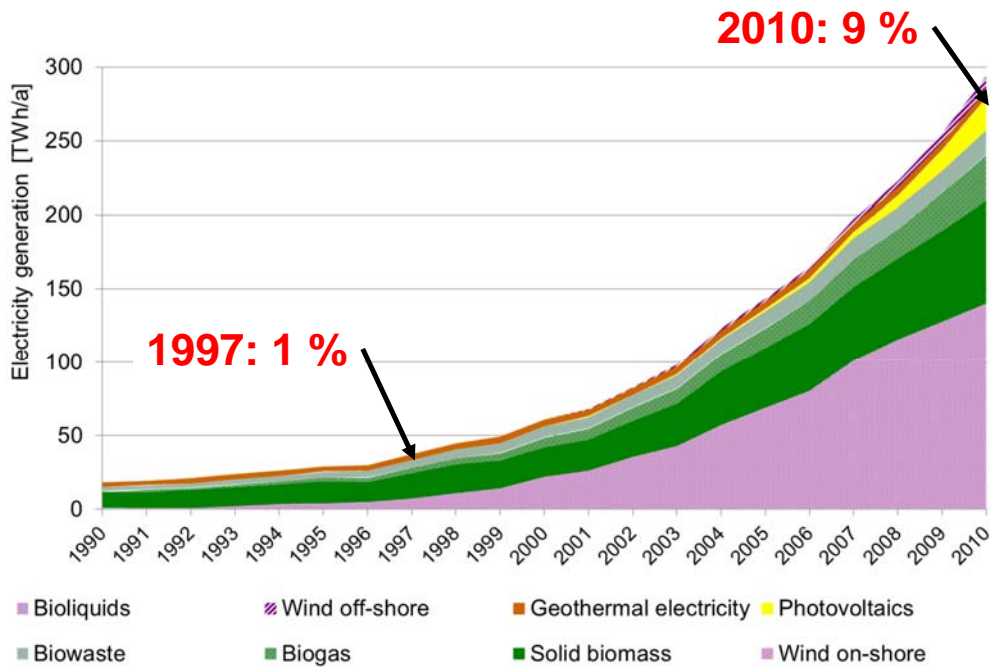
DIRECT EFFECTS OF HIGH SHARES OF RES-E ON ELECTRICITY MARKETS

RES for electricity generation EU-27



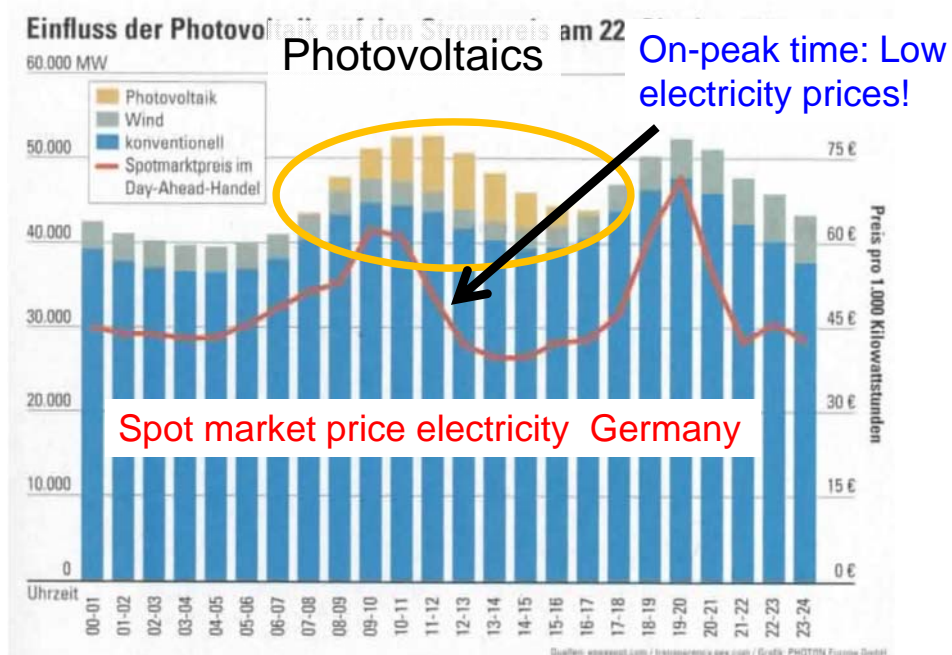
4. Effects of high shares of renewables

EU-27: Electricity generation from „new“ RES



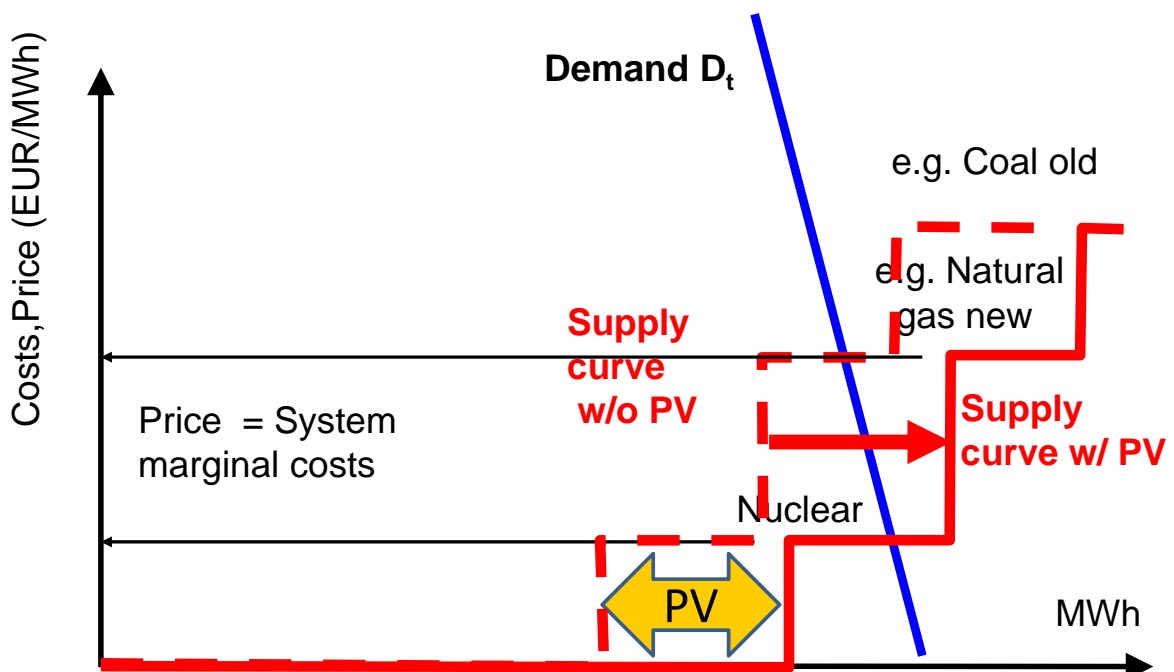
4. Effects of high shares of renewables

IMPACT OF PV ON THE ELECTRICITY MARKET PRICE IN GERMANY



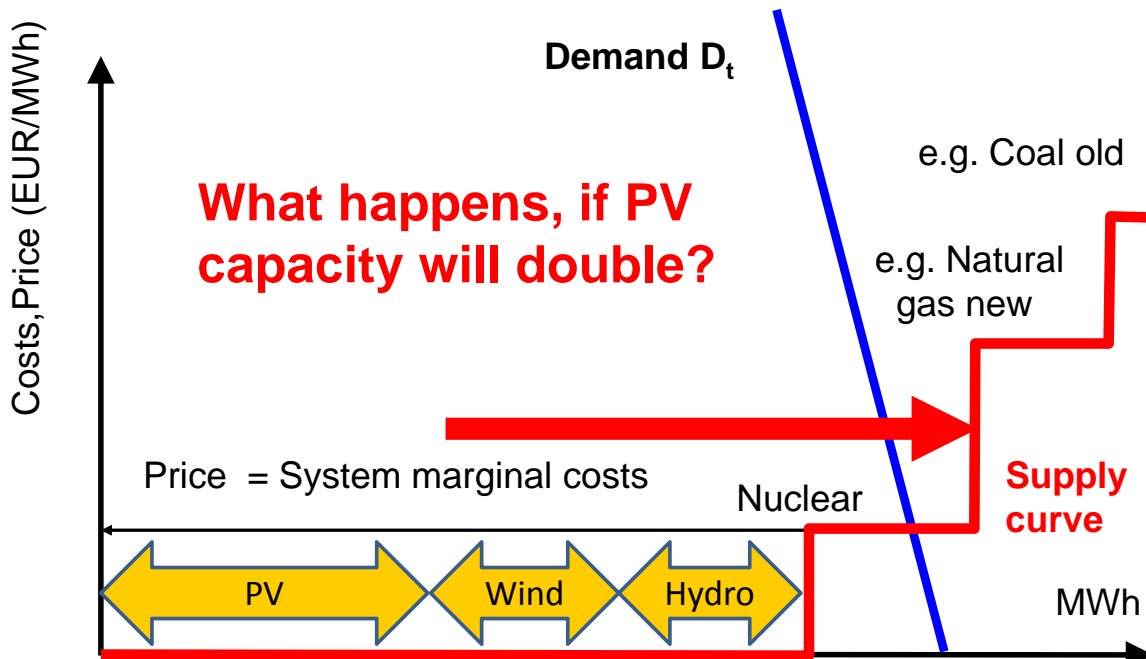
WHY?

ON-PEAK NICE SUMMER DAY: PRICE = SHORT-TERM MARGINAL COSTS



4. Effects of high shares of renewables

ON-PEAK NICE SUMMER DAY: PRICE = SHORT-TERM MARGINAL COSTS



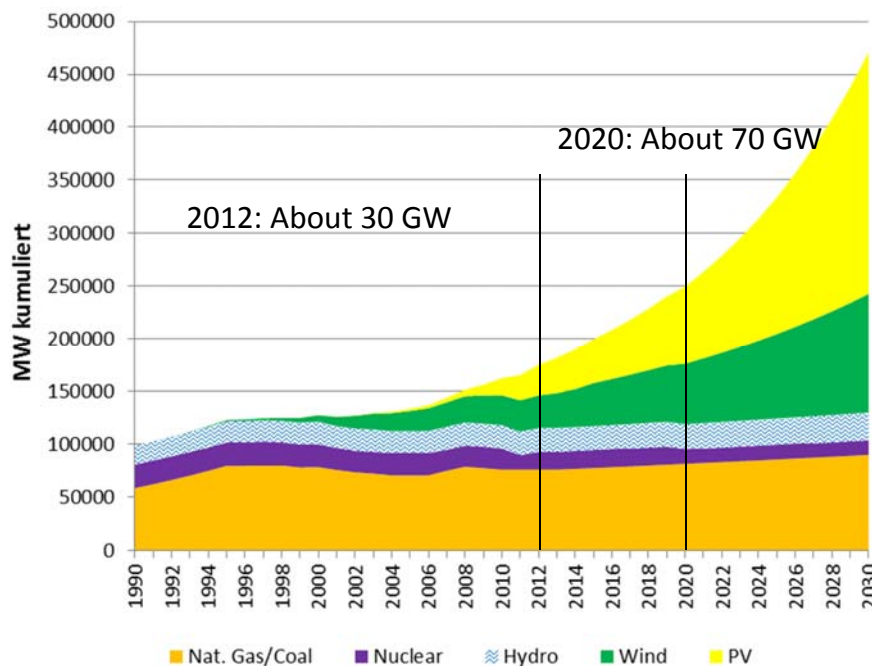
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4. Effects of high shares of renewables

CENTRAL EUROPE: SCENARIO 2030



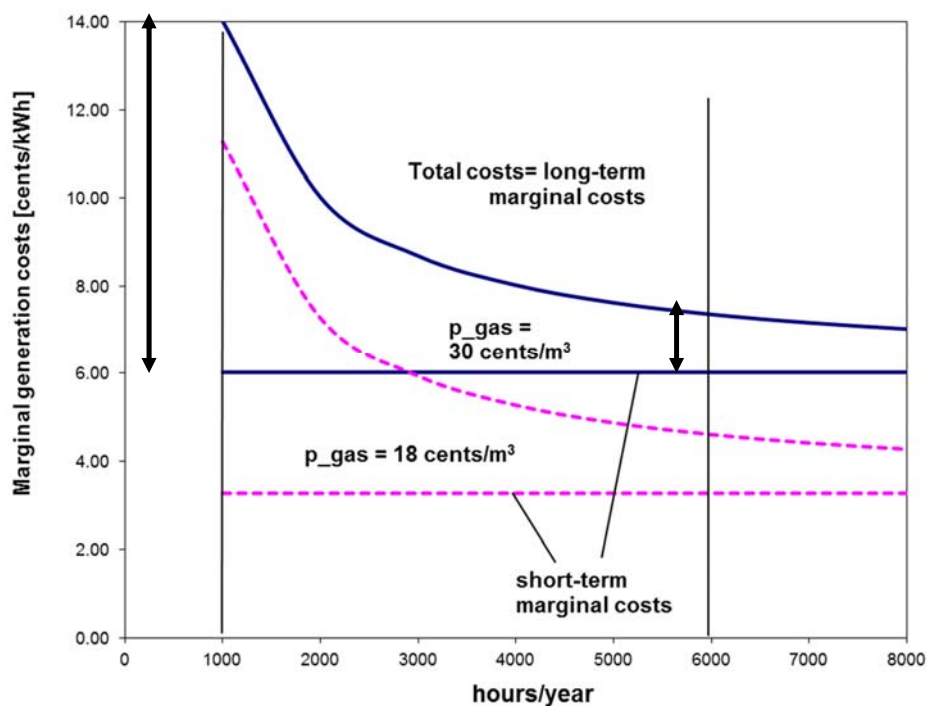
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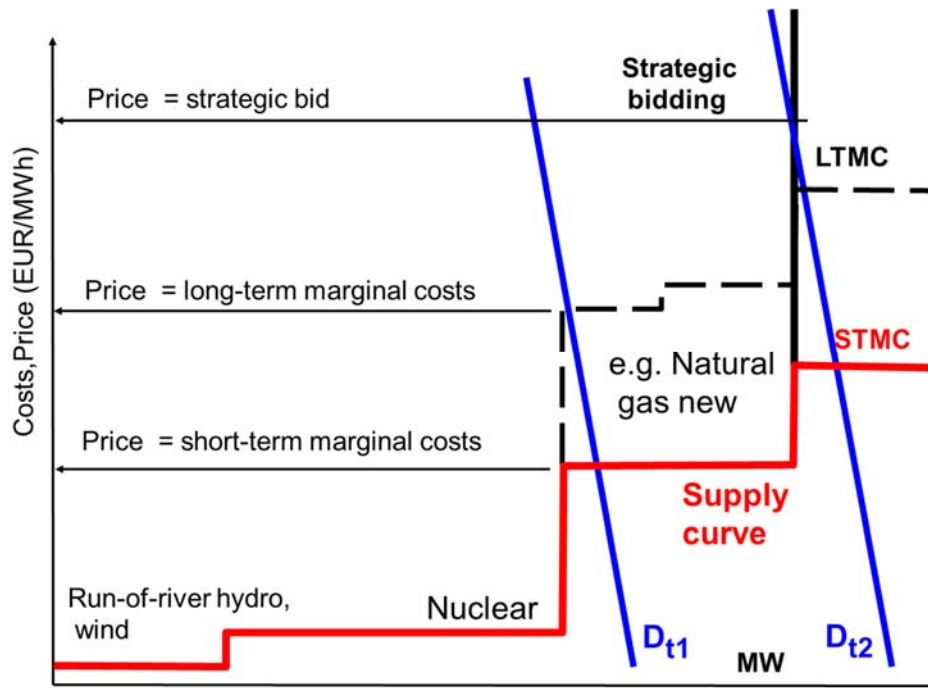
INDIRECT EFFECTS OF HIGH SHARES OF RES-E ON ELECTRICITY MARKETS

Long-term vs short-term marginal costs



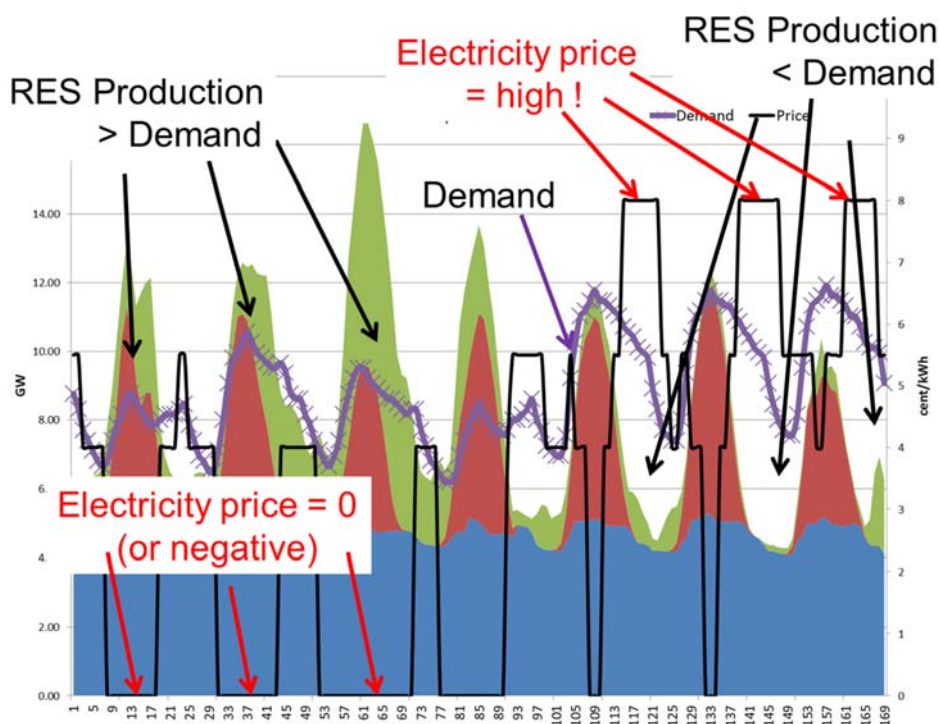
4. Effects of high shares of renewables

Prices under scarce capacities



4. Effects of high shares of renewables

Supply and Demand

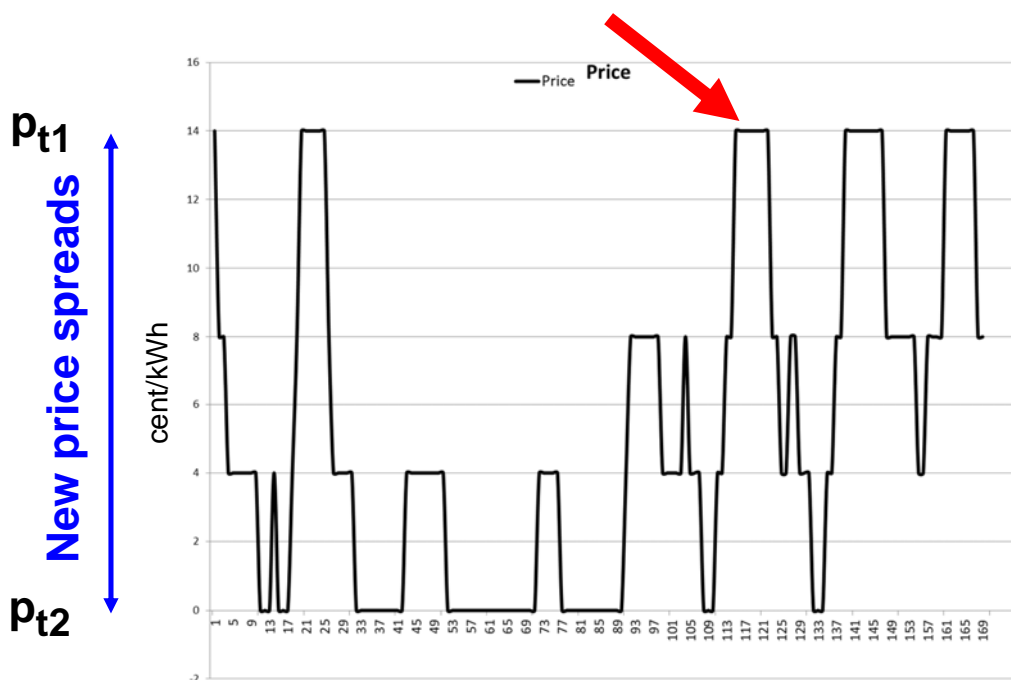


Given this price pattern it would be attractive for (some) power plant operators to stay in the market

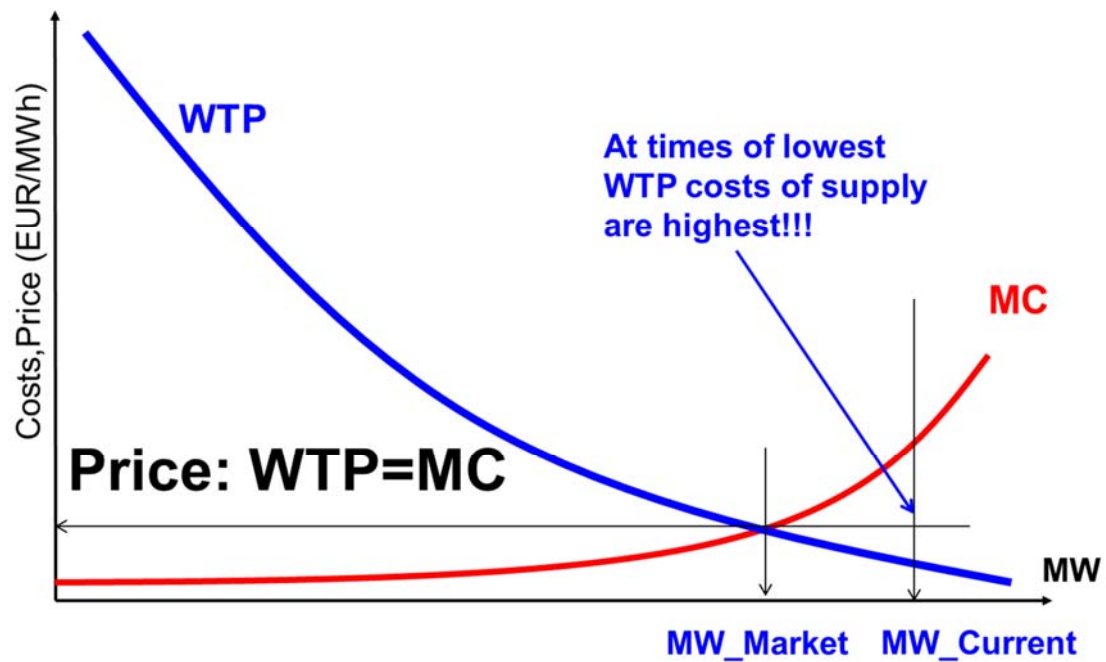


REVISED ENERGY-ONLY MARKET

ARE THESE PRICES TOO HIGH?



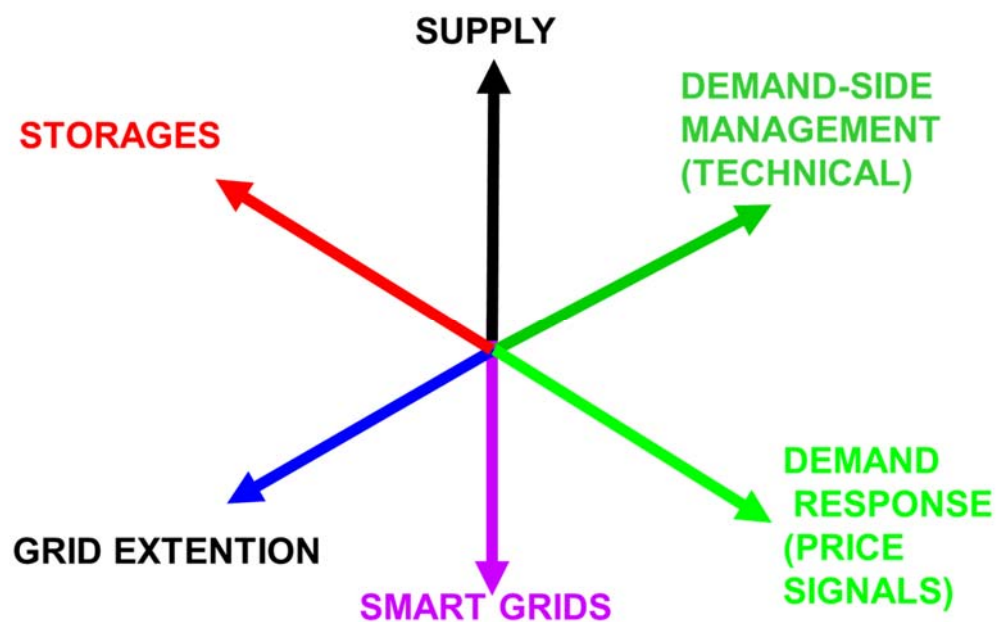
5. Options for a new market design



PhD thesis Praktijnjo: A wide range of WTP on the demand-side!

5. Options for a new market design

DIMENSIONS OF ELECTRICITY MARKETS



CONDITIONS:

$$MC_{\text{Gen}} = MC_{\text{Sto}} = MC_{\text{Grid}} = MC_{\text{DSM}}$$

$$P_t = MC = WTP$$

THE OPTION OF CAPACITY MARKETS

WHAT GENERATORS OF FLEXIBLE CAPACITY RECEIVE:

Energy-only markets (EOM)

- Payments for energy (higher!)

Capacity markets (CM)

- Payments for energy;
- Payments for existing plants;
- Payments for new plants

NEW MARKET MODELS

	P= STMC	P= LTMC	DS contracts	Exist. cap.	New cap.
EOM classic	X				
EOM revised		X			
EOM + DCM		X	X		
Compreh. CCP	X			X	
Focused CCP	X			X	X

EOM...Energy-only market
 CCP...Centralized capacity payments
 DCM...Demand-side capacity market

OPEN QUESTIONS REGARDING CCP:

Which quantity of capacity where?

How to split in existing and new capacity?

How to tune with grid extention?

Who plans? On national or international level?

E.G. CCP in DE influence operation of Austrian and Swiss hydro storages

integrating larger shares of volatile Renewables

- i. **Higher price volatilities**
- ii. **Higher bids of flexible plants (e.g. gas-based) reflecting also fixed and capital costs**
- iii. **Increasing relevance of storages and “smart” components**
- iv. **Capacity markets: completely neglect the demand-side**
- v. **most important now: exhaust full potential of creativity of all market participants especially on demand-side**



Thank you for your attention!