

Electricity markets

Designs, rules, policies

Market actors and institutions

Different markets for different purposes

(Daily) routine

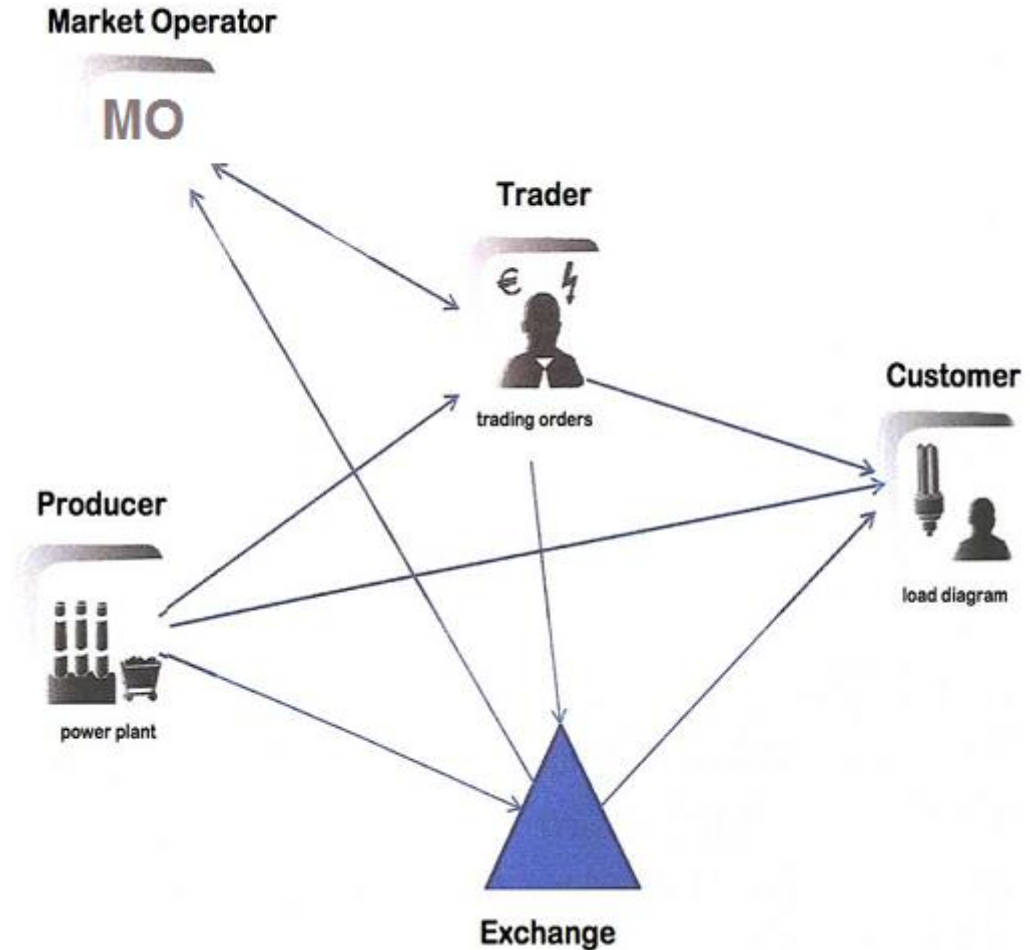
Balancing grids and accounts

Setting the price

Support slides

Market actors and institutions

- Producers
- Consumers
- Traders
- Commodity Exchange
- Transmission System Operator (TSO)
- Market Operator (MO)



Market Operator

- Manages the (commercial) exchange between producers and consumers
- Measures imbalance and facilitates information for clearing
- Ensures clearing is conducted accordingly
- ...
- Can take different formats:
 - Market agents committee (Latin America)
 - Independent System Operator (USA)
 - Power Exchange (most systems in Europe & Australia)

TSO

Transmission system operator

- Runs, maintains, and develops the transmission lines
- Facilitates power transmission between the producers and the customers (offers transmission services)
- Dispatches sources to maintain balance between generation and consumption in any given moment (system services and ancillary services)
- ...
- USA: ISO (Independent System Operator) – dispatching + market operations without grid ownership and responsibility (privatized, regulated)

(Daily) Routine at the electricity market

Day ahead:

- Customers finish contracting electricity
- Producers and traders provide the data to the TSO and the MO => scheduling

Day of delivery:

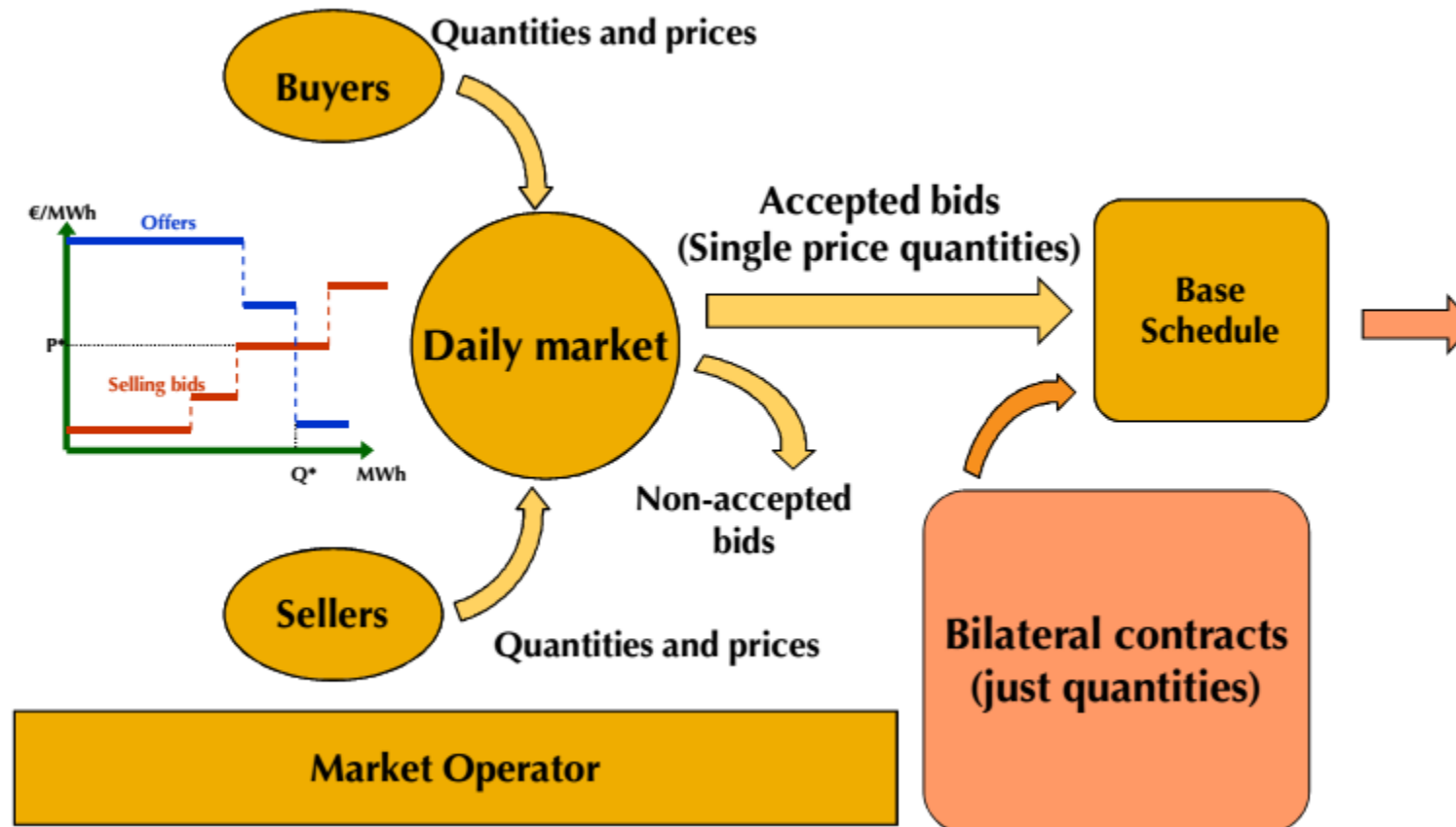
- Producers supply the contracted amount
- The TSO provides adequate power transmission capacities and keeps the grid in balance
- Traders and direct customers take the contracted amounts
- MO collects data about power actually produced and actually consumed

After the delivery:

- The MO initiates all payments of resulting financial obligations of the parties involved (clearing)

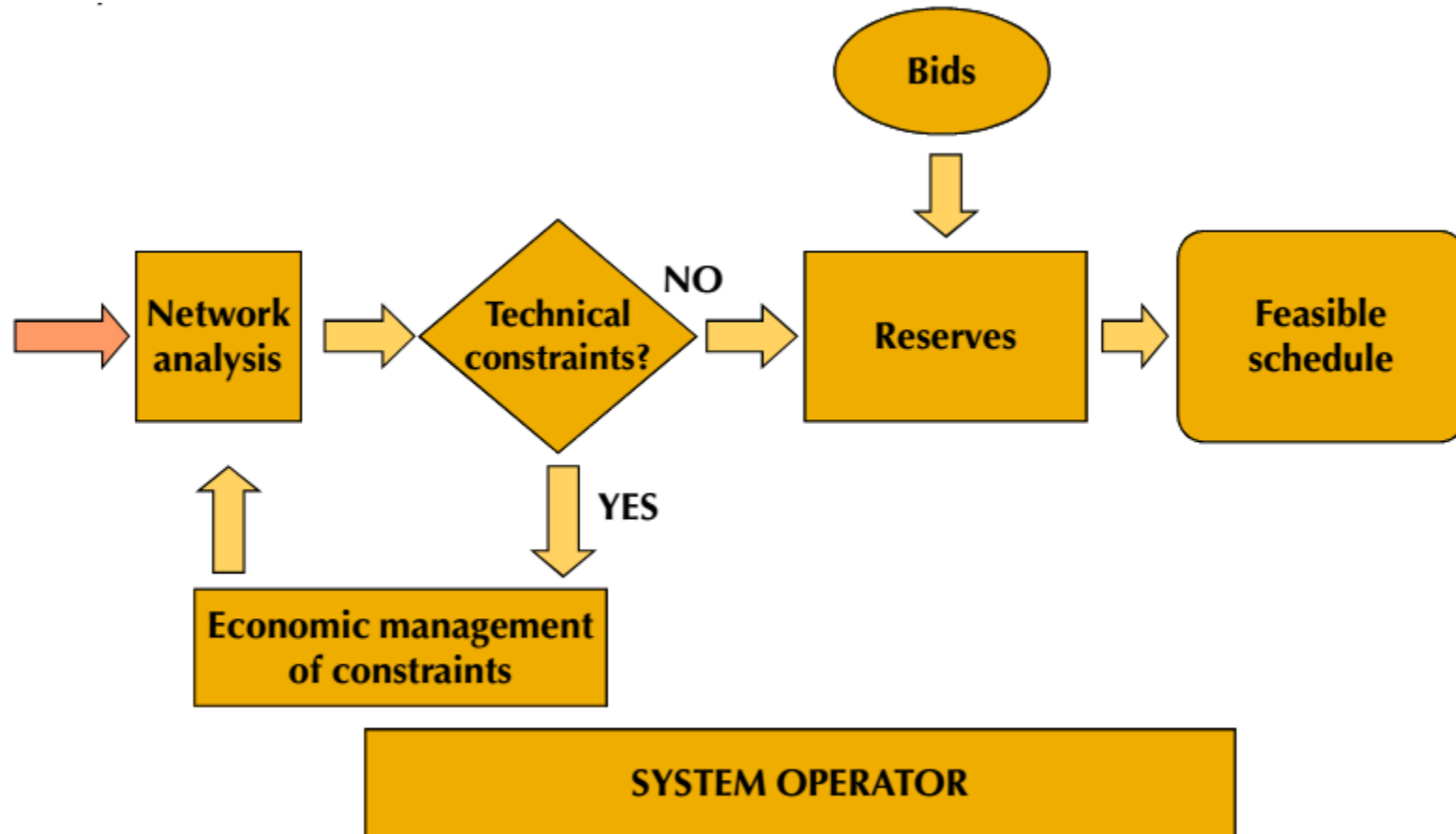
Market sequence

Offers, bids and bilateral contracts (D-1)



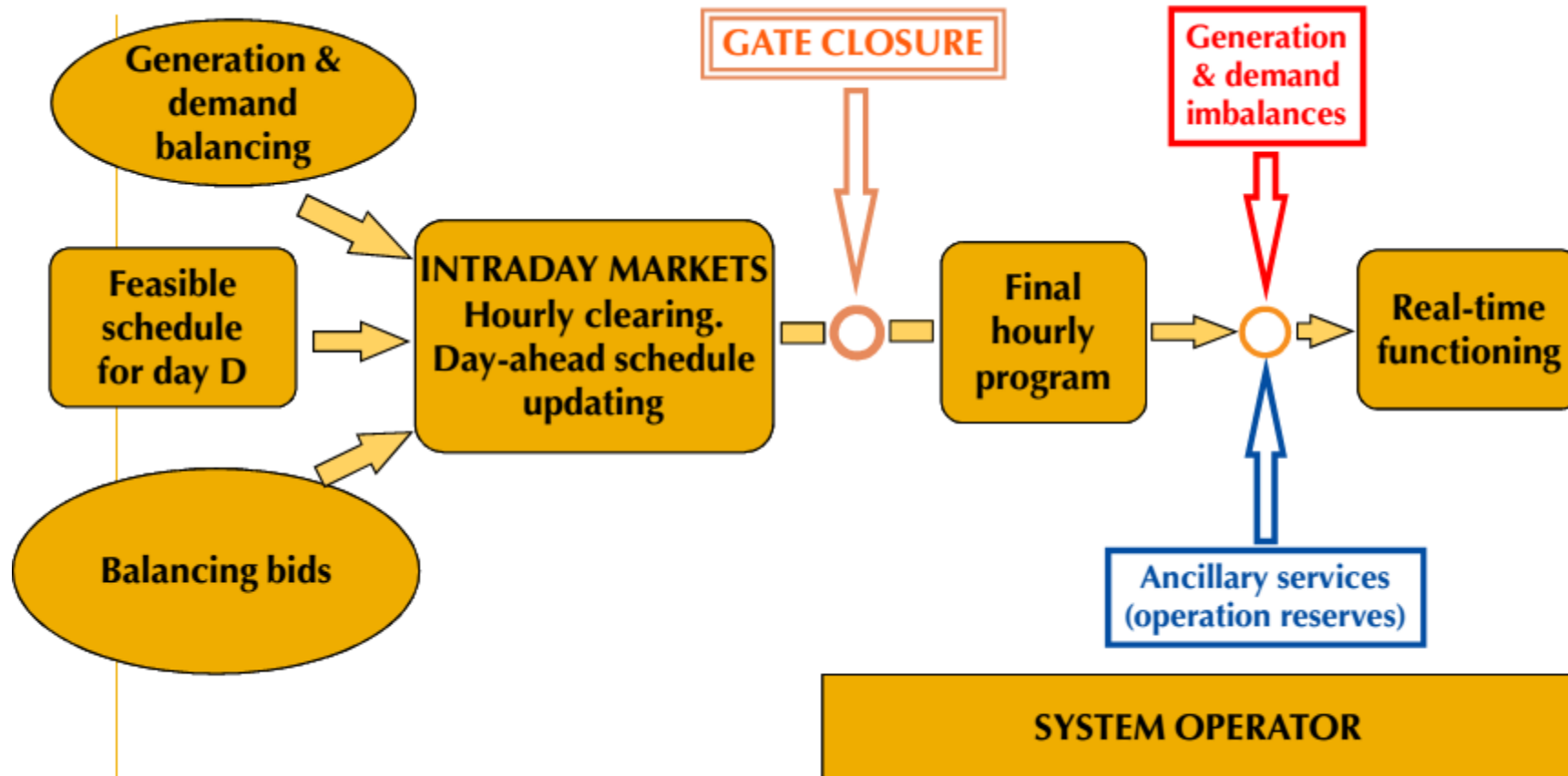
Market sequence

Feasible schedule calculation (D-1)

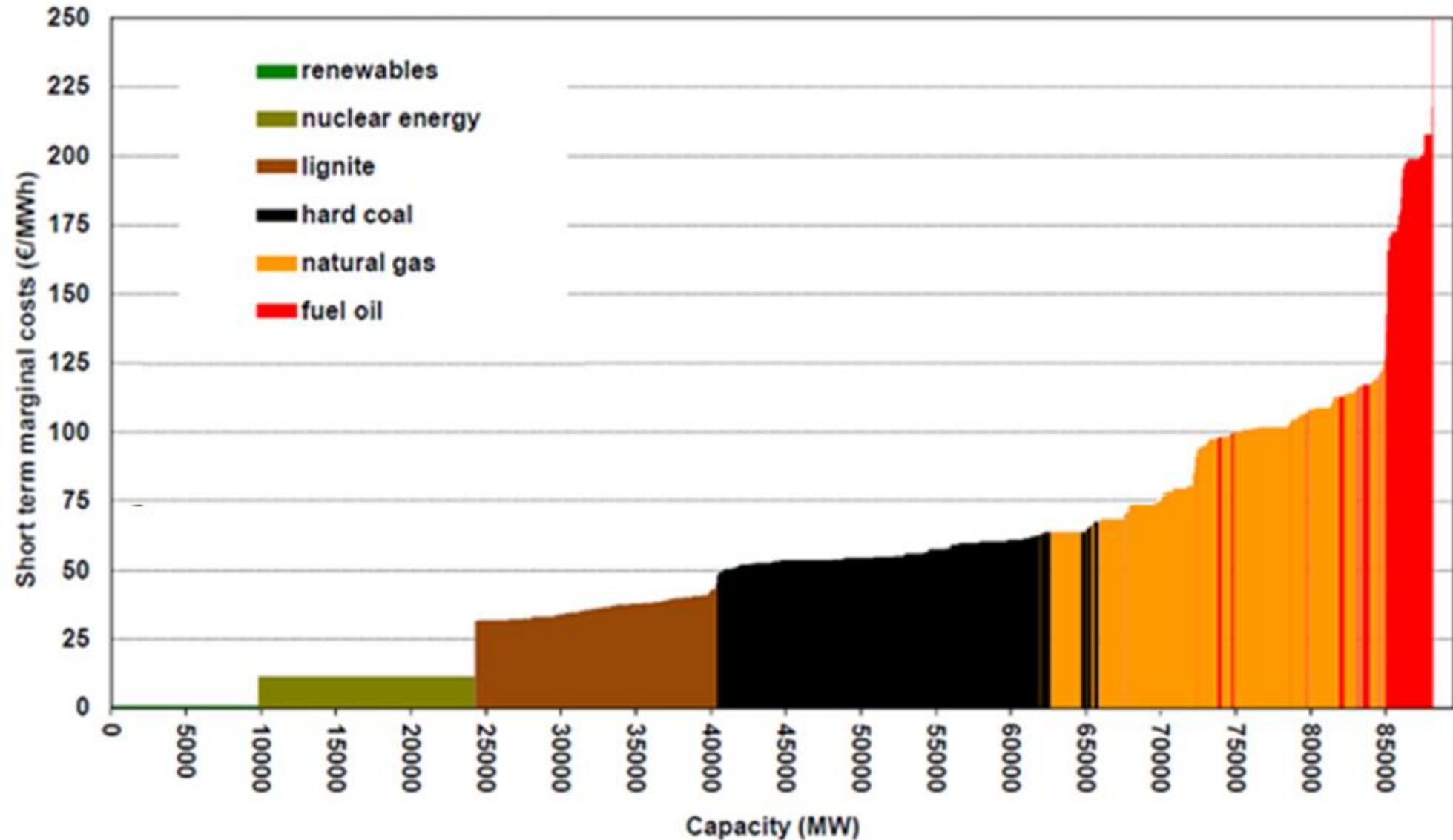


Commodity trading (MO)

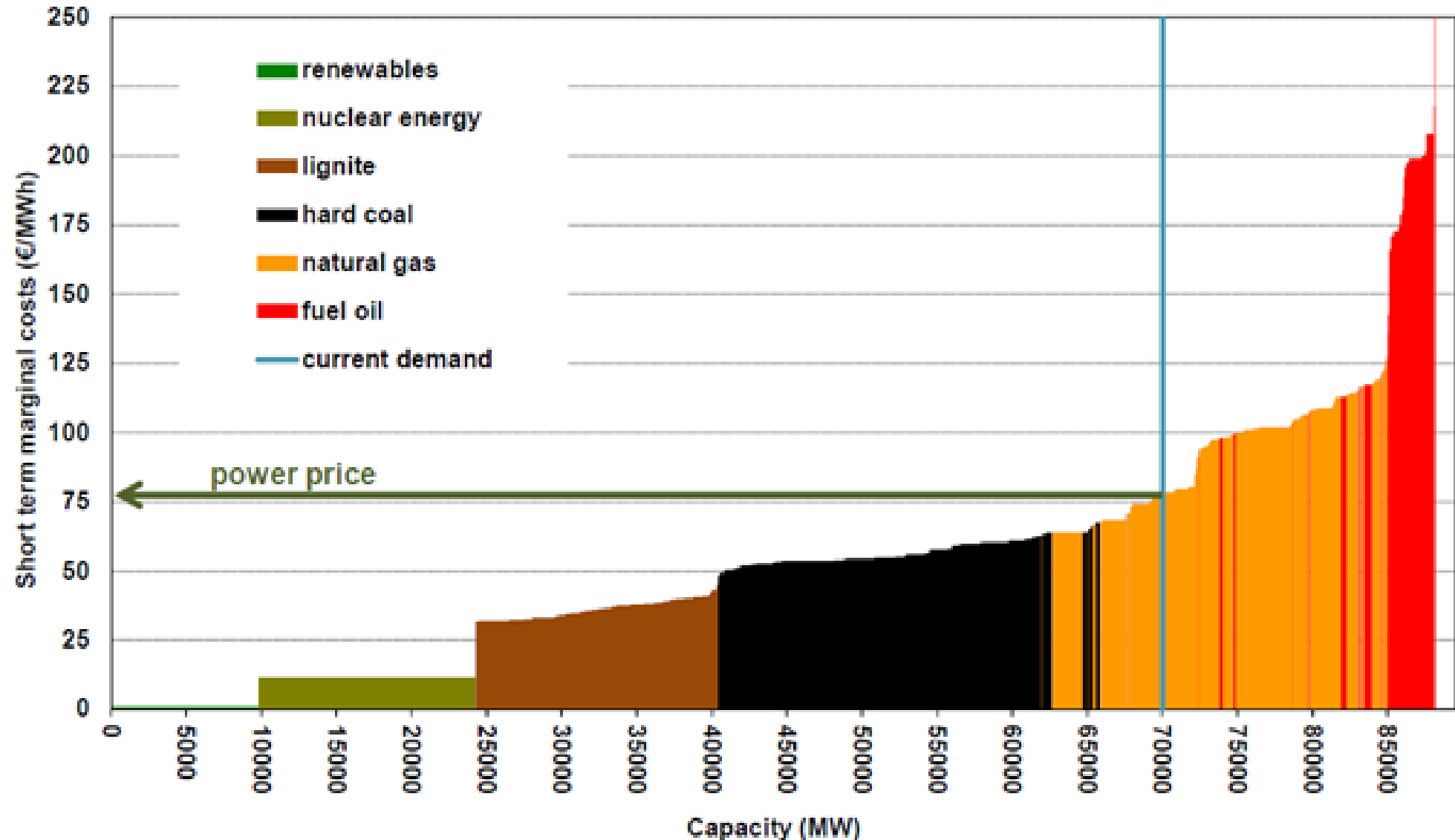
Balancing markets (D)



Schedulling and price setting: Merit order



Scheduling and price setting: Merit order



Merit order

Does reflect:

- Short term marginal costs (costs of producing one MWh)

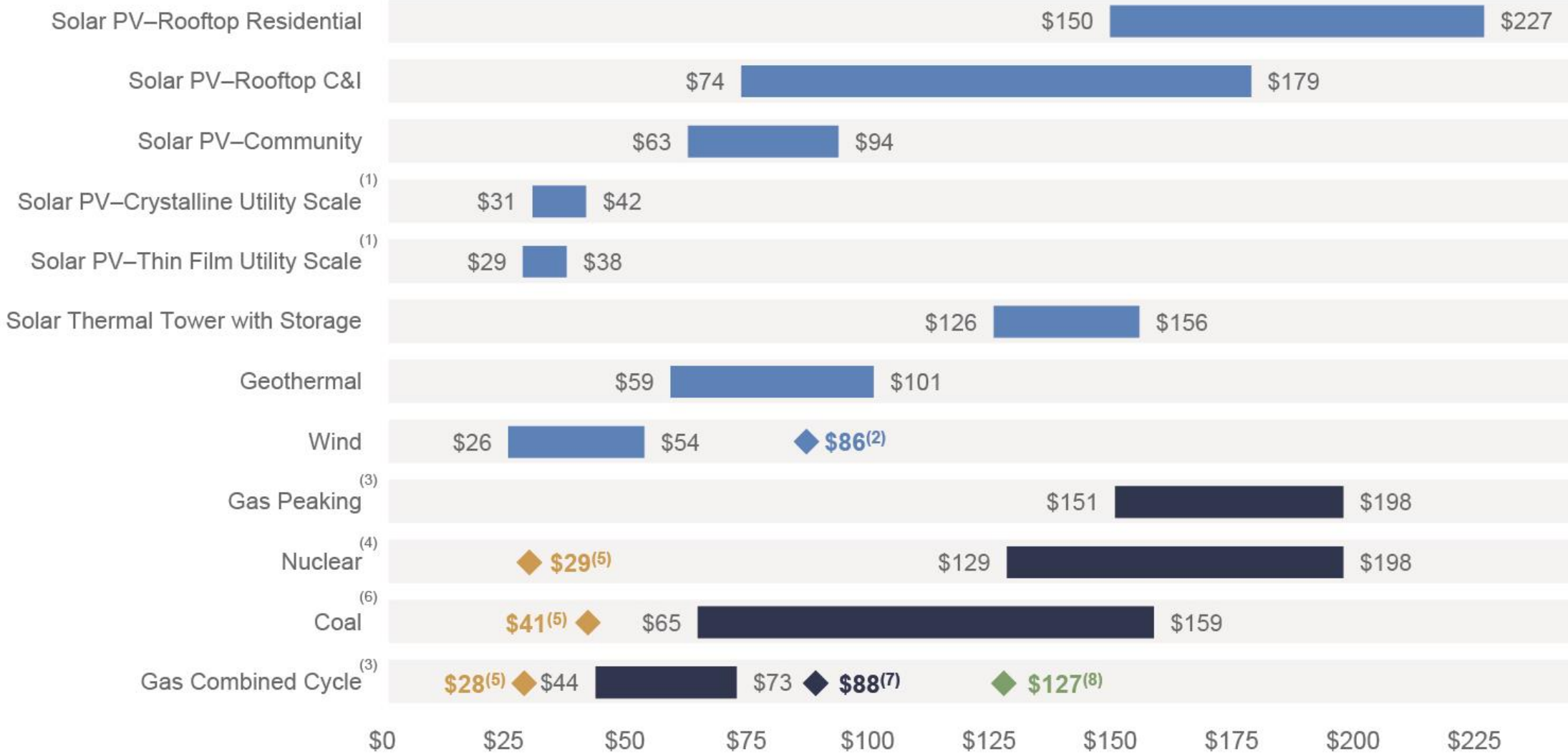
Does not reflect:

- Other power plant costs
- External costs (unless they come as fuel or CO2 costs)
- Quality, reliability, flexibility, location

Levelized costs of electricity (USA, 2020, \$/MWh)

Renewable Energy

Conventional



PX trading

- Anonymous trading
- Underlying asset: electricity (electric energy)
- Base contract is 1 MW per every hour of contract duration (month, quarter, year; hour)
- Unit: EUR/MWh
- Closed deals cannot be cancelled
- Regulated and enforceable rules
- Deals are guaranteed (clearing is assured)

- Typology: Over the Counter (OTC), Futures, Spot

PX trading

Over the Counter (OTC)

- Deals closed outside the PX
- Inserted into the PX system for clearing reasons
- Bilateral – direct contract
- Mediated – via a broker
- Each party inserts the respective part of the deal (offer/bid) or both parts are inserted by the broker
- The exchange sends information about closing the deal to the parties/the broker

PX trading

Futures

- The subject is future delivery
 - Physical – really delivered
 - Financial – limited to financial clearing (speculation/hedging)
- Overall financial position (profit/loss) is revealed only after the end of the delivery period
- Both parties are obliged to buy/sell the underlying asset in the day of delivery at price set beforehand
- The obligation emerges in the day of contract maturity (actually traded are yet-nonexistent goods)

PX trading

Futures - example

- 1. 12. 2020: closed deal for 10 MW for 3/2021, at 60 €/MWh
- 1. 1. 2021 price 65 € - does not matter
- 1. 2. 2021 price 52 € - does not matter
- 1. 3. 2021 closing price at 55 €/MWh
 - Buyer („long position“) $D1 = - 5 \times 10 \times 24 \text{ €}$
 - Seller („short position“) $D1 = + 5 \times 10 \times 24 \text{ €}$
- 2. 3. 2021 closing price at 62 €/MWh
 - Buyer $D2 = + 2 \times 10 \times 24 \text{ €}$
 - Seller $D2 = - 2 \times 10 \times 24 \text{ €}$
- ...
- After the clearing:
 - Buyer = $D1 + D2 + \dots + D31 \text{ €}$
 - Seller = $D1 + D2 + \dots + D31 \text{ €}$

PX trading

Spot: day-ahead and intra-day markets

- Day-ahead: hourly products with next day delivery
- Intra-day: hourly products with delivery after 60 minutes and more
- Every hour is a trading interval (24 different prices per day)
- Purpose: balancing miscalculations, renewables

→ 30-minute and 15-minute products (trading intervals) introduced at RES-heavy markets

Amount of intra-day trades in Germany	
2011	363,000
2012	677,000
2013	1,287,000

Balancing the grid (TSO)

Transmission services

- Facilitating power transmission from producers to customers (distribution system operators and end-users directly connected to the transmission network)
- New connections to the network
- Capacity reservation
- Cross-border capacity auctions

Balancing the grid (TSO)

Provides system services

- Keeps stable voltage
 - Keeps stable frequency
- ⇒ Keeps the network working

The TSO gets paid for

Contracts ancillary services

- Regulation energy
(reserves/balancing market)
 - Positive
 - Negative

The TSO pays for

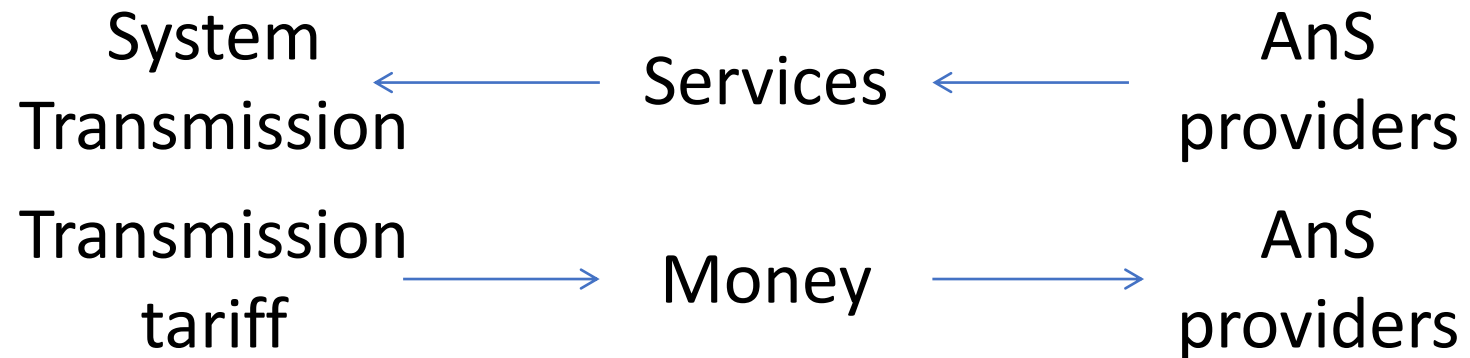
Balancing the grid (TSO)

Ancillary services: regulation

- Power reserves at certified production facilities and arrangements with subjects capable of regulating its consumption according to the needs of the TSO
- Ancillary services market: organized by the TSO with the TSO being the single buyer

Balancing the grid (TSO)

TSO: money – services flow



Balancing the grid (TSO)

Ancillary services vs. power supply

The producer:

- Power supply
 - Demand-dependent profits
 - Actual need to produce the power
 - Fuel (and CO2) costs
- Ancillary services
 - Capacity payment
 - The production does not need to be activated
 - Fuel costs savings

Most AnS suppliers are also power suppliers.

Balancing the grid (TSO)

Balancing market

- Excessive supply/demand offered by the licensed participants
- Bilateral relations (participant – TSO)
- The price is equal to or higher than the offer, or equal to or lower than the bid
- Trading excess capacities
 - Help the TSO to reduce the AnS costs
 - Help the participants to prevent imbalances

Preventing imbalances in the grid is therefore...

A problem of the TSO

- ← Nets imbalances with neighboring TSOs
- ← Contracts Ancillary services
- ← Runs regulation energy market; in the manner that is:
 - Reliable
 - Cheap
 - Considerate towards its contractors

A problem of producers and consumers (imbalance agents)

- ← Invest in estimation of their production/consumption
- ← Take advantage of other agents' imbalances
 - Offer regulation energy
 - Participate at the intra-day market

Different purposes, different markets

Different products

- Energy
- Capacity

Different time frames

- Forward
- Day ahead
- Intraday
- (AnS market)

Designs, rules, policies: electricity markets interact with wider socio-technical culture

Electricity markets are shaping and shaped by

- Electricity policy (market design, resource policy, technology policy)
- Energy policy (energy efficiency, resource policy, transport, heating)
- Technology and innovation policy
- Economic policy (the role of state in economy)
- Social policy (subsidies)
- Political culture