Procuring Power System Reserves

Market Design and Competition

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Overview

Development

Formerly, monopolistic market:

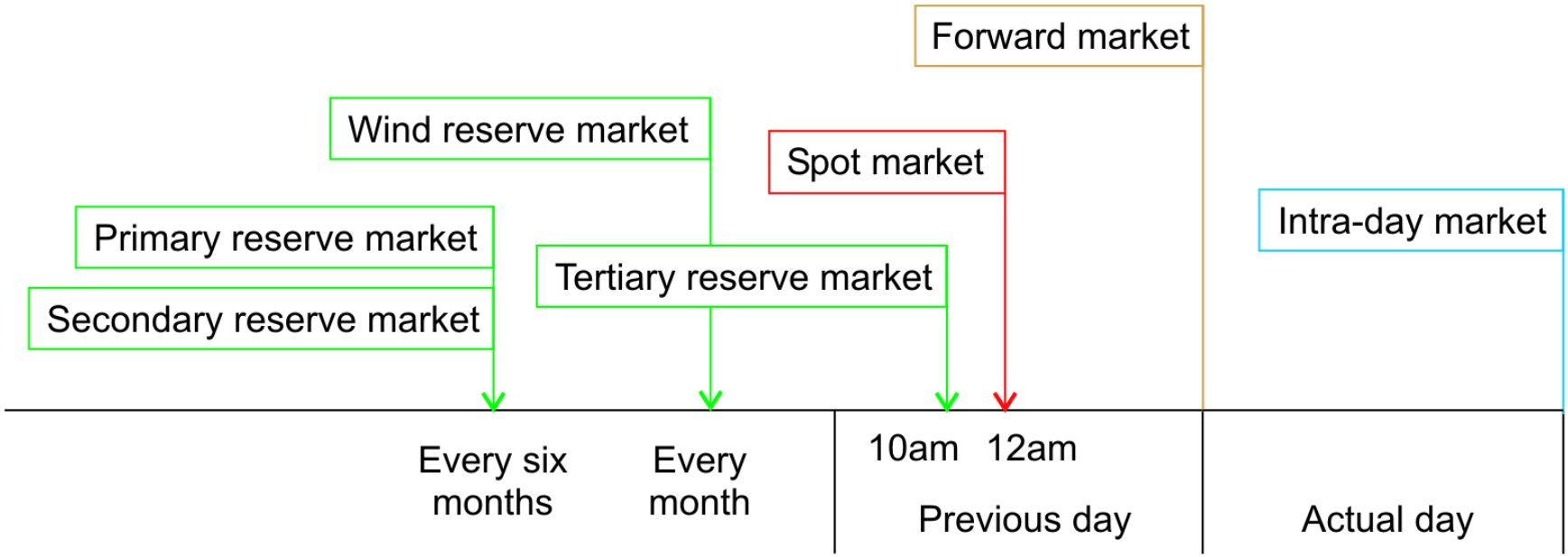
- Any TSO procured power system reserves from associated GENCO.
- Pricing of ancillary services was highly intransparent.

Today, oligopolistic market:

- Market opened for all bidders fulfilling defined technical requirements.
- The four TSOs started to operate a single, web-based procurement auction.

Question: *Is the German market for procuring power system reserves a good example for an incentive compatible market design?*

Integration



- Forward and spot energy markets well established.
- New reserve and intra-day markets with low liquidity.

The devil is in the detail!

Market design has the objective to ensure incentive compatibility.

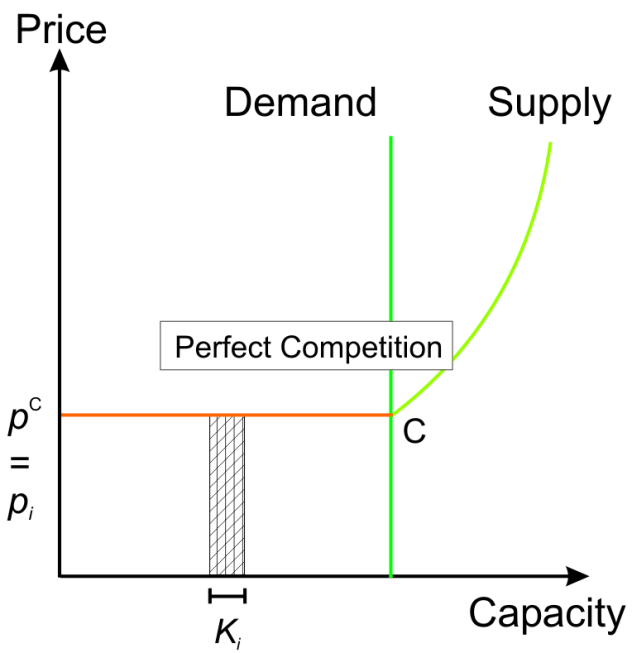
- Bidders should maximize expected profit by truthfully revealing any private information asked for.
- Here, the bidders should reveal their respective variable generation costs in the energy price bids.
- If perfect competition cannot be achieved, any strategic bidding behavior should be confined to the capacity price bids.
- In general, simple solutions tend to be inefficient and efficient solutions tend to be difficult to implement.

Market structure as the principal problem

- Price inelastic and ex-ante known capacity demand as well as price inelastic but only ex-post known energy demand.
- Existence of a restricted monopsony, i. e. a market with one procurer (TSO) and a few bidders (GENCOs) only.
- Comparably high barriers to entry the market (technical requirements, minimal bidding capacities) lead to low liquidity.
- Problem of the markets liquidity is strengthened with currently separate supply curves and core portions for the four TSOs.

The market structure holds the risk of strategically influenced market outcomes and a reduced efficiency/welfare.

Design option I: Settlement-rule



- With uniform pricing a single market-clearing price p^{C} is determined that is remunerated to all accepted offers.
- With pay-as-bid pricing any accepted offer is remunerated with the submitted bid price p_i.
- A bidder's profit is $\Pi_i^{\mathrm{Uni}} = p^{\mathrm{C}} \times K_i$ with uniform and $\Pi_i^{\mathrm{PaB}} = p_i \times K_i$ with pay-as-bid pricing.
- Under perfect competition both settlement-rules lead to the same results.

Design option II: Bidding-mechanism

Next to the choice of the settlement-rule the market design offers the choice of the bidding mechanism. Here, principally three mechanisms are available:

Case 1) Fixing the energy price and auction based on the capacity price only (reserve capacity market);

Case 2) Fixing the capacity price and auction based on the energy price only (reserve energy market);

Case 3) Auction based on the capacity and the energy price, while the auction can be a) simultaneous or b) sequential.

If the auction is based on two-part price bids, as in Case 3, it is essential to choose an efficient scoring-rule to derive the merit-order of the offers.

Design option III: Market-integration

Here, market-integration refers mainly to the gate closure times of the different markets. Gate closure means the latest time for trade nomination.

- In principle, the gate closure time should be as near to the physical delivery as possible; this would lead to real-time trading.
- Electricity generation has very high technical requirements on (flexible) plant operation; this can lead to intra-day or day-ahead trading.
- Power system reserves have even higher technical requirements; still energy can be traded intra-day, while capacity is traded day-ahead.
- The latter leads to a sequential auction for procuring reserves based on the capacity and the energy price; easily allows cross-border trade.

German market

- Competitive tendering started due to merger control requirements in 2001.
- Procurement auctions with day-ahead tendering of multiple generation units.
- Any bid consists of the capacity and two prices: capacity and energy price.
- For paying the accepted offers the pay-as-bid settlement-rule is applied.
- About $+3300$ MW/-1900 MW of tertiary reserve are traded each hour.

Auction
- One-sided.
- Procurement.
- Multi-unit.
- Pay-as-bid.

Bidding
- Multi-part (p^{E}, p^{K}).

Trading
- Day-ahead.

European markets I: Overview

	Capacity[1]	Settlement-rule	Bidding-mechanism[2]					Market-integration		
	15	Pay-as-bid	p^{K}	before	|	p^{E}	before	Day-ahead	|	
	10	Pay-as-bid	p^{K}	before	|	p^{E}	after	Day-ahead	|	
	10	Pay-as-bid			|	p^{E}	after	Day-ahead	|	Intra-day
	3	Pay-as-bid			|	p^{E}	after	Day-ahead	|	Intra-day
	5	Uniform	p^{K}	before	|	p^{E}	after	Day-ahead	|	Intra-day
	10	Uniform			|	p^{E}	after	Day-ahead	|	Intra-day
	10	Uniform			|	p^{E}	after	Day-ahead	|	Intra-day
	25	Uniform	p^{K}	before	|	p^{E}	after	Day-ahead	|	Intra-day

[1] Minimal bidding capacity in (MW).
[2] Trading time compared to spot market.

- Well developed electronic markets with differences in transparency.
- Market design in Europe not at all harmonized until today.

European markets II: Harmonization

Settlement-rule: Both settlement rules are about to be used in equal fractions; uniform pricing gains ground.

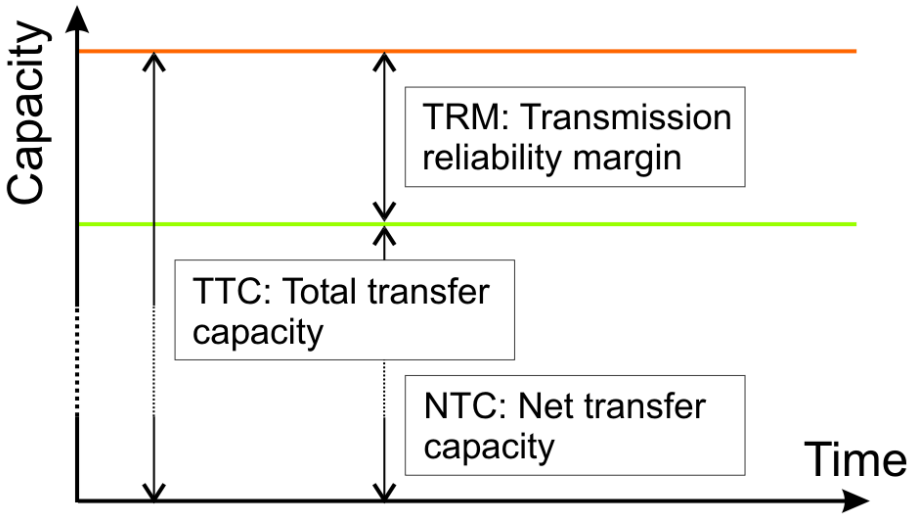
Bidding-mechanism: Often, fixing of the capacity price (agreement) and auctioning on the energy price (trade).

Market-integration I: Generally, the tenders for reserve energy take place after spot market trading.

Market-integration II: Day-ahead tender is common practice; intra-day tender starts in several countries.

Harmonization of the procurement auctions is important to increase cross-border trading of power system reserves.

Problems with cross-border trading



- Reserves and energy trade compete for the same available interconnection capacity.
- Reservation of interconnection capacity for reserves could imply a waste of available resources.

Efficient congestion management and cross-border trading may be:

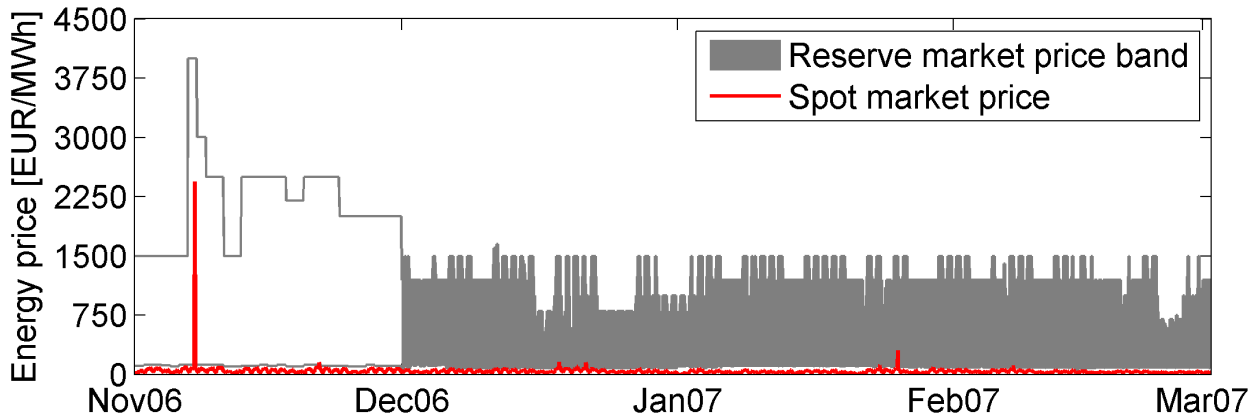
i. Congestion management till day-ahead.
ii. No capacity reservation for the exchange of reserves.
iii. Unused net transfer capacity (NTC) for the intra-day trade.
iv. Remaining NTC for the cross-border trading of reserves.

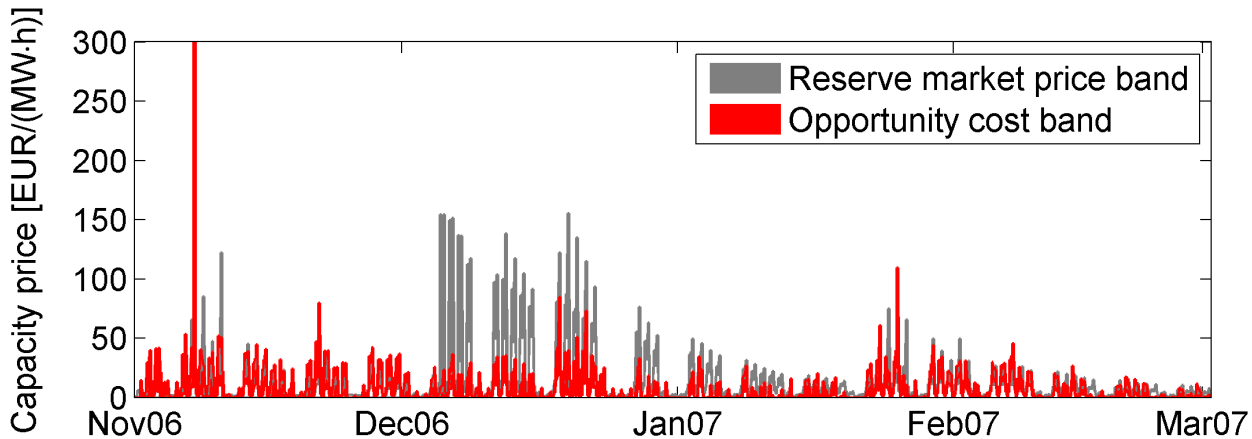
Example: Cross-border trade between DK and Nordel

Reserves are exchanged between TSOs based on cross-border trading that closely follows the ETSO technical model 3, variant 2.

- TSOs have the possibility to use energy reserves (regulation power) procured in either of the control areas.
- Capacity reserves are still provided/procured in the respective country; however, in a harmonized way.
- Activation of cross-border reserves is only possible when unused interconnector capacity is available.
- Can be implemented in a very decentralized manner, as TSOs only have to coordinate the exchange programs.

Trading incremental tertiary reserve in Germany





Establishing a uniform, transparent market?

- Trading volume tends to increase; energy prices remain on a non-competitive level; capacity prices jumped up and decrease slowly.
- Trading before the spot market starts allows to reduce price-spikes and helps to guarantee a higher liquidity on the reserve market.
- Transparent publishing of market results lead to reduced discrimination of small bidders; market results are accurately signalled to all bidders.
- There is a single reserve power market, however, still separate supply curves and core portions for the four TSOs are considered.

A uniform, transparent market is highly recommended as this increases liquidity and accurately signals market results.

Energy price to be linked to spot market price?

- With two-part price bids the schedule of the merit-order is not trivial as energy and capacity price bids need to be scored (scoring-rule).
- Today, procuring is based on the capacity price bid only, i. e. the probability of reserve energy demand is expected to be zero.
- It has been shown that this cannot lead a bidder revealing the variable costs in the energy price bid; the market is not incentive compatible.
- Truthful revelation can be achieved if the energy price bids are scored following a scoring-rule based on the reserve power duration curve.

Fixing the energy price is not recommended as this does not allow to accurately signal the particularities of providing reserve.

Settlement to be based on uniform pricing?

- With pay-as-bid pricing bidders try to bid as close to the expected marginal price as possible („guess the clearing price“), i. e. an additional uncertainty has to be faced discriminating small and new bidders.
- Bidding prices are likely to be set similar to previous day’s marginal price; thus, they can be much higher than variable or opportunity costs and market prices tend to decrease slowly following a price jump.
- These principal problems of pay-as-bid pricing can lead to very high market prices and may reduce the contestability of the market in the long-run; they may thus jeopardize security of supply.

Uniform pricing is recommended as it can lead to reduced market prices and a higher long-run contestability of the market.

Integration of an intra-day reserve energy market?

- The need for power system reserves can be reduced if the GENCOs have the opportunity to trade electricity up to the last minute.
- Possible scarcity is accurately reflected in the reserve energy price bids (incremental reserve energy will not cost less than spot energy).
- Requires sufficient offers and a guaranteed liquidity; thus, reserve capacity need to be procured by the TSOs in advance.
- Capacity reservation can either be based on long-term agreements or day-ahead reserve capacity trading; GENCOs are then obliged to bid.

Harmonized sequential day-ahead trading of reserve capacity and intra-day trading of reserve energy is recommended.

Conclusions

- Germany is about to get a uniform, transparent market to procure power system reserves (with option for institutional market operation).
- Small bidders are no longer discriminated regarding transparency of market results and the market's liquidity is about to increase.
- However, the reserve market is still not incentive compatible and redesign of the procurement auction is strongly recommended.
- Simple solutions, like fixing the energy price to the spot market price, may be easy to implement but do not guarantee an efficient market.

Proposal: *Uniform, transparent reserve market with day-ahead capacity and intra-day energy trade; based on uniform pricing.*

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Selected Literature

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Research activities

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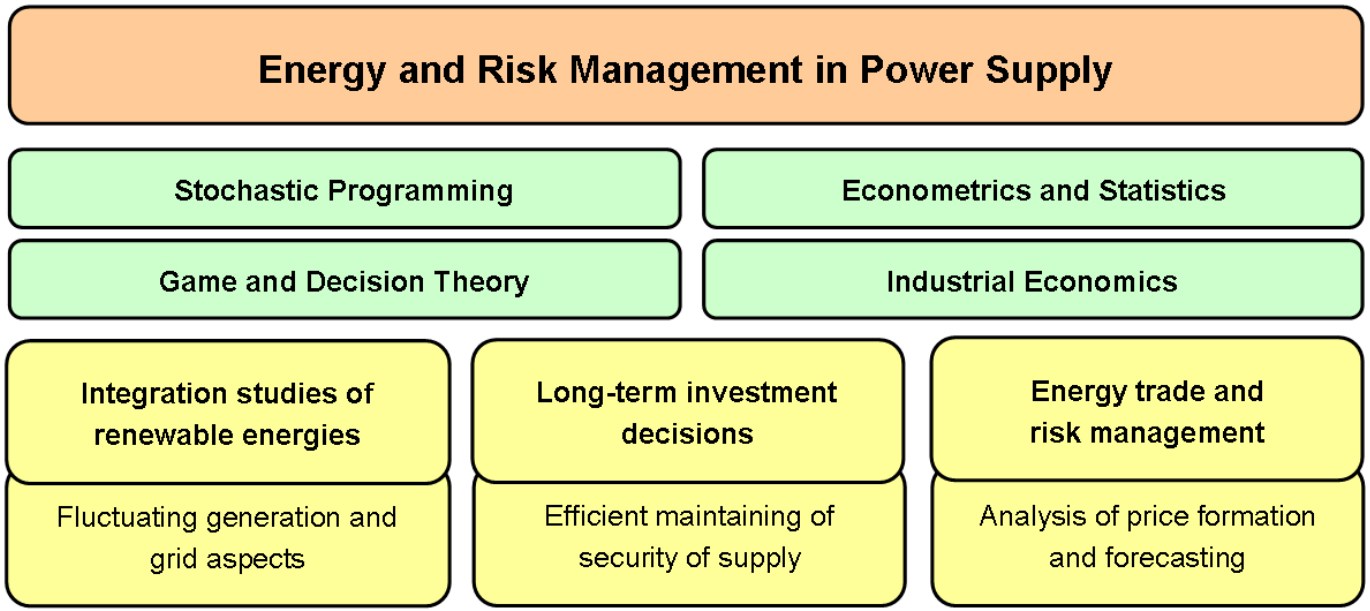

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