

PRICING INTRADAY CAPACITY

European Energy Regulators'
Intraday Capacity Pricing Workshop

PMI Consulting – Thibault Henri

- **Methodology and steps in the analysis**
 - Analysis of inputs
 - Differences day-ahead vs intraday / auction vs continuous
 - Requirements from CACM Regulation and Framework Guidelines: focus on possible interpretations (e.g. « continuous »)
 - List of options and assessment
- **Main conclusions**
 - **Pricing capacity in continuous power markets is not as « natural » and straightforward as in auction-based markets**
 - Expected interesting options do not fulfil the requirements (see option C in Annex in the report)
 - **Some options fulfil the requirements (options 1 and 3.c.)**
 - Options are high-level options: further analysis is needed before implementation

- **Continuous vs auction-based**
 - The intraday term (compared to day-ahead) is not in question;
 - The continuous nature of the intraday market makes capacity pricing less straightforward than in auction-based markets;
- **Capacity pricing in current day-ahead auction-based markets**
 - Capacity price is implicitly derived as price difference between interconnected bidding zones;
 - Technically capacity price is a dual variable (i.e. a shadow price) in a welfare optimization problem;
- **Examples why capacity pricing is difficult in continuous markets**
 - **Not defined: bidding zone price; welfare;**
 - **Capacity utility cannot be known until trading session is over;**

- **Concept of scarcity: auction-based vs continuous**

- ▷ Scarcity = **benefit from possessing an additional quantity**: this scarcity is priced in the auction-based mechanism.
- ▷ Scarcity = amount of **opportunity cost**: opportunity costs cannot be recovered within the first-come first-served principle.
 - In continuous markets, capacity is not scarce (according to the auction-based meaning) until it is congested; capacity is scarce only when it is zero;
 - In continuous market, no natural price of cross-zonal capacity;
 - However, scarcity can be priced at the level of the opportunity cost which results from the application of the first-come first-served principle;

- **Concept of scarcity: auction-based vs continuous**
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 - ▷ Scarcity = amount of **opportunity cost**: opportunity costs cannot be recovered within the first-come first-served principle.
- **Key points for the discussion**
 - ▶ **Which concept of scarcity to apply?**
 - ▶ **How to interpret “continuous” and to which extent intraday auctions are possible?**

- **Implicit allocation**

- ▷ **Implicit operation** = no action required from market participants for capacity purchase.

- ▷ **Implicit pricing** = capacity price should not be exogenous but derived from capacity utility for the collectivity.

- Implicit operation can be compatible with exogenous (i.e. non implicit) pricing;

- Interpretation of the requirements: **purchase and pricing** should be implicit;

- **Implicit allocation**

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- **Key points for the discussion**

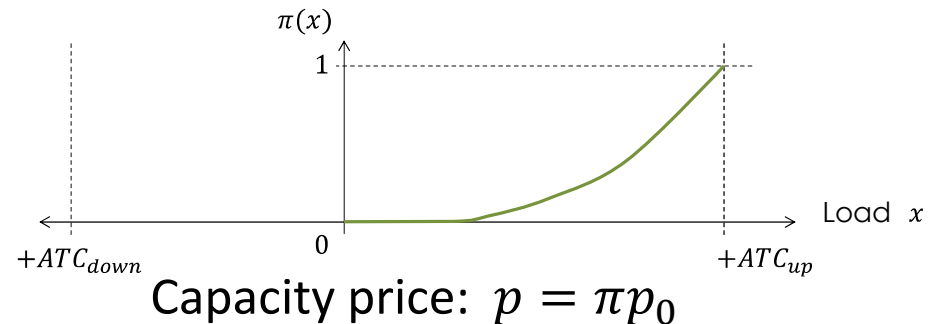
- ▶ **How to interpret “implicit allocation”?**
- ▶ **How to cope with the requirements that capacity price should reflect scarcity?**
- ▶ **Is the seeking for the highest willingness to pay for capacity compliant, especially when capacity is abundant?**

- **Option 1 - Congestion forecast during trading session**
Capacity price should reflect the opportunity cost, which is equivalent to reflect scarcity understood as a probable lack of capacity: if congestion is likely to occur, capacity price should reflect this probability.
- **Option 2 - Ex-post calculation of capacity price**: relies on the idea that **actual scarcity can be observed for certain after the end of trading session only**. Even if it is not possible to set capacity price during trading session, a price cap could guarantee market participants that they will not pay beyond their willingness to pay.
- **Option 3 – Auctions during trading session**: attempts to introduce **auctions in intraday trading**, with gradual variants **combining the current continuous trading with auctions**.
- Annex in the report shows other possible options which have been discarded.

Option 1 (Congestion forecast during trading session) - Description

- **Capacity price** reflects the **opportunity cost** and is given through the probability the interconnection is congested at the end of trading session.

- Principle: pricing capacity when it makes sense i.e. selecting between XB trades which do not really need to be executed and XB trades for which capacity is really useful and which are therefore ready to pay for capacity.



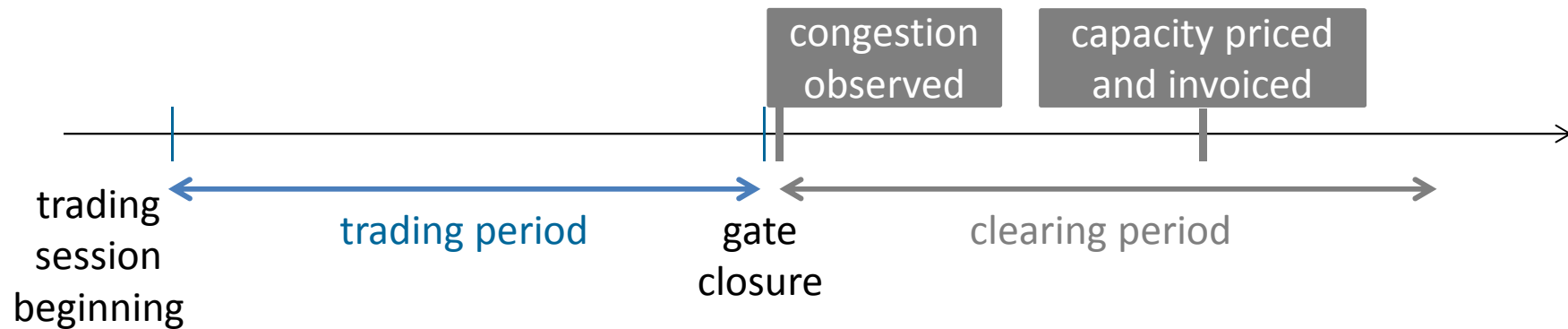
- Several variants exist to establish the reference price p_0 based on actual orders.

- Capacity price increases when remaining capacity decreases = when capacity becomes more scarce = when the opportunity cost increases.

- **Opportunity cost** paid by the collectivity = difference resulting from immediate capacity allocation to trades which do not need it instead future capacity allocation to trades which do need it
- **Option 1 is not a direct transposition of yield management techniques:**
 - ▷ **No attempt is made to reveal the highest willingness to pay** in order to maximise TSO's profit: **the only point is the minimisation of the opportunity cost** under uncertainty about congestion.
 - ▷ Capacity price is based on actual orders and parameters derived from market historical data; **no exogenous parameter or trading strategy is included in the option (like in yield management)**. In other words, **capacity price is implicit** and is not derived from the selling of capacity as a good as such.

- **The option is compatible with every requirement.** In particular:
 - It is compatible with the continuous nature of the intraday market and the possibility to trade as close to real-time as possible;
 - Price formation is fair;
 - Capacity price reflects capacity scarcity;
- **One drawback is the following:** possibly at the end of trading session, capacity has been priced although the interconnection is not congested (however capacity prices are in line with the likelihood of congestion; even though this likelihood might not materialize).

Option 2 (Ex-post calculation of capacity price) - Description



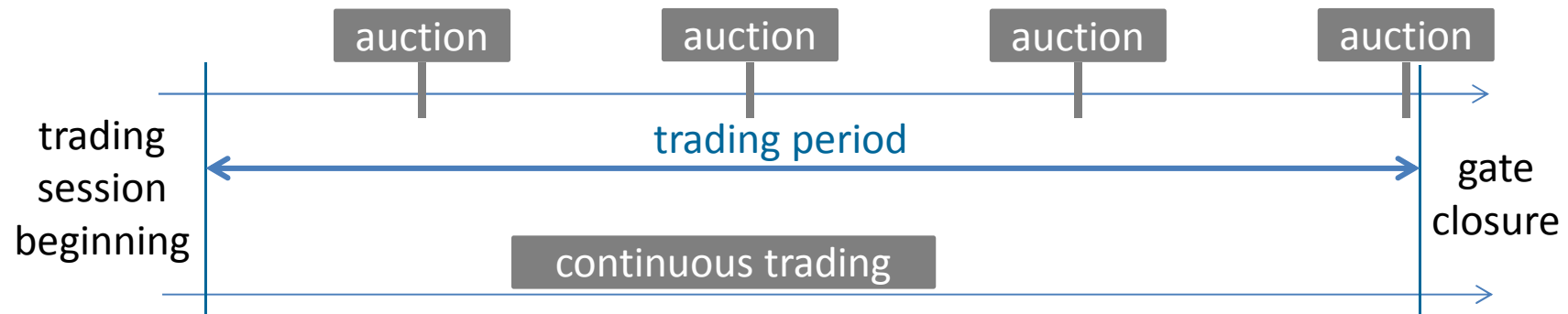
- Principle : keep the intraday trading session as today and **wait until gate closure to observe scarcity**. Indeed, actual scarcity can only be observed and determined when all trades have been executed.
- Capacity price is calculated after gate closure time and applies to every XB trade which has been executed during trading session.
- Capacity price should be the price difference between the two bidding zones. Several possible variants exist to define the price in each bidding zone; in each case, capacity price is implicitly derived from energy price.

- However, no additional operation is required by market participants: **capacity has been automatically purchased** when trades have been executed (even though its price was not certain). **Capacity purchase was implicitly performed when trades were executed.**
- A **price cap is defined beforehand** in order to allow market participants to control the risk that the actual final price of a trade does not correspond to their willingness to pay. **The price cap is not arbitrary and would depend on capacity reference prices.**

- Capacity price is based on actual market conditions and actual orders; it reflects scarcity.
- **Fairness requirement is not fully satisfied:**
 - Orders are subject to capacity payment only if trade was a XB trade, though order books cannot distinguish between local orders and cross-border orders;
 - Final execution price is not known during trading session but at the end of trading session only;
- The non-fulfilment of fairness requirement can be mitigated:
 - Capacity price can be seen as an additional transaction cost, with a known average value and with a known maximum value;
 - In addition to the capacity price cap, mitigation measures can be taken in order to help market participants to control the risk that the final execution price is not beyond their willingness to pay;

Option 3 (Auctions during trading session) - Description

- Capacity price is the result of intraday auctions in addition, in parallel or in replacement of current continuous intraday trading.



- Variants 3.a; 3.b; 3.c; 3.d correspond to different combinations between continuous trading session and the sequence of auctions.
 - ▷ Variant 3.a: auctions parallel to continuous trading
 - ▷ Variant 3.b: parallel auctions interrupt continuous trading
 - ▷ Variant 3.c: auction for XB trading / continuous trading local only
 - ▷ Variant 3.d: auctions only

- **In variants 3.c, capacity price has the same required properties as in day-ahead** (implicitly derived from energy prices, welfare maximising, reflecting scarcity).
- **Variants 3.c does not deteriorate liquidity** compared to existing intraday markets.
- **Crucial questions for further analysis:**
 - How many auctions to perform (for each market product; and therefore how to organize the auctions during trading session?)
 - How much capacity to make available in each auction?
 - What is the overall complexity of the intraday trading resulting from the combination of continuous and auction trading?
 - What is the resulting liquidity?

- **Variant 3.a is not compliant**
 - **Compliance of variant 3.b depends** how the option is put in place in practice (e.g. a huge complexity of intraday trading could be discriminatory for small market participants)
 - **Variant 3.d is almost compliant** in the non restrictive interpretation of “continuous”; however trading “as close to real-time as possible” is not easy to achieve.
 - **Variant 3.c is fully compliant** and has advantages:
 - ▷ Capacity price is an auction-based price: implicit price, reflecting scarcity as benefit from possessing marginal quantity.
 - ▷ Continuous (local) trading is still possible.
- In practice, variant 3.c should be assessed further in order to identify the best organization of the trading process.

Summary Assessment

#	Requirements	Options	1	2	3			
					a	b	c	d
1	CACM - Article 3 - Objectives of cacm cooperation (a) promoting effective competition in the generation, trading and supply of electricity;		✓	✓	✗	x/✓	✓	✓
2	CACM - Article 3 - Objectives of cacm cooperation b) ensuring optimal use of the transmission infrastructure;		✓	✓	✗	x/✓	✓	✓
3	CACM - Article 3 - Objectives of cacm cooperation d) optimising the calculation and allocation of cross-zonal capacity;		✓	✓	✗	x/✓	✓	✓
4	CACM - Article 3 - Objectives of cacm cooperation (g) contributing to the efficient long-term operation and development of the electricity transmission system and electricity sector in the Union;		✓	✓	✓	✓	✓	✓
5	CACM - Article 3 - Objectives of cacm cooperation (h) respecting the need for a fair and orderly market and fair and orderly price formation;		✓	x	✓	✓	✓	✓
6	CACM - Article 3 - Objectives of cacm cooperation (j) providing non-discriminatory access to cross-zonal capacity;		✓	✓	x	x	✓	✓
7	CACM - Article 49 - Objectives of the continuous trading matching algorithm (a) aims at maximising economic surplus for single intraday coupling per trade for the intraday market timeframe by allocating capacity to orders for which it is feasible to match in accordance with the price and time of submission;		✓	✓	✓	✓	✓	✓
8	CACM - Article 49 - Objectives of the continuous trading matching algorithm (e) is repeatable and scalable;		✓	✓	✓	✓	✓	✓
9	CACM - Article 53 – Pricing of intraday capacity 1. The intraday cross-zonal capacity charge shall reflect market congestion and shall be based on actual orders.		✓	✓	✓	✓	✓	✓
10	CACM - Article 53 – Pricing of intraday capacity 2. This mechanism shall ensure that the price of intraday cross-zonal capacity is available to the market participants at the time of matching the orders.		✓	✓	✓	✓	✓	✓
11	FGs – 5. Intraday Capacity Allocation The key feature of the intraday market is to enable market participants to trade energy as close to real-time as possible in order to (re-)balance their position.		✓	✓	✓	✓	✓	x
12	FGs – 5. Intraday Capacity Allocation The pan-European intraday target model supporting continuous implicit trading, with reliable pricing of intraday transmission capacity reflecting congestion (i.e. in case of scarce capacity).		✓	✓	✓	✓	✓	✓

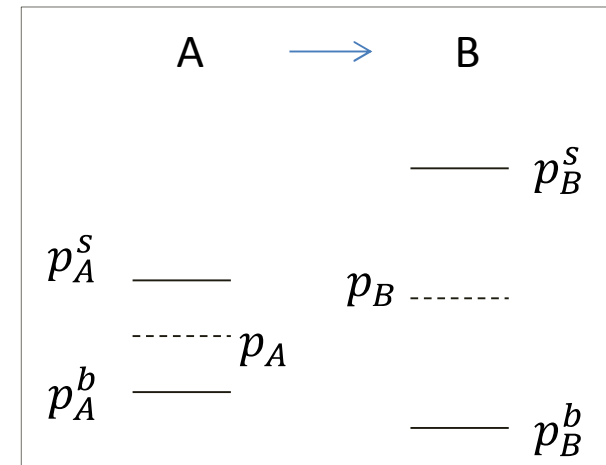
- Option 1 (Congestion forecast) and option 3.c (Auctions combined with continuous local trading) fully compliant.

- **Two option types: decision between intraday auctions or strictly continuous capacity pricing**
- Implementation issues
 - ▷ Specific implementation issues related to each option
 - ▷ Changes in trading systems
- Economic assessment
 - ▷ Quantitative analysis of the preferred option (based on historical data): e.g. resulting prices, impact on the market.
 - ▷ Assessment of implementation costs
- Future developments of intraday markets
 - ▷ Flow-based
 - ▷ Balancing

Annex

Option C (Capacity price as difference between middle of price spreads) - Description

- Capacity price calculated as the **difference between the middle of price spread** in each bidding area.
- Capacity price** between two bidding areas A and B should reflect the **price difference** between A and B.
- However, in a continuous market, prices in A and B are not defined at any moment (we only have matching prices for each trade); the idea is to define the **real-time price** in A (resp. in B) as the **middle of the spread** between the best ranked buy and sell orders.
- If $p_A < p_B$ then the capacity from A to B will have a positive price : $p_C = p_B - p_A$

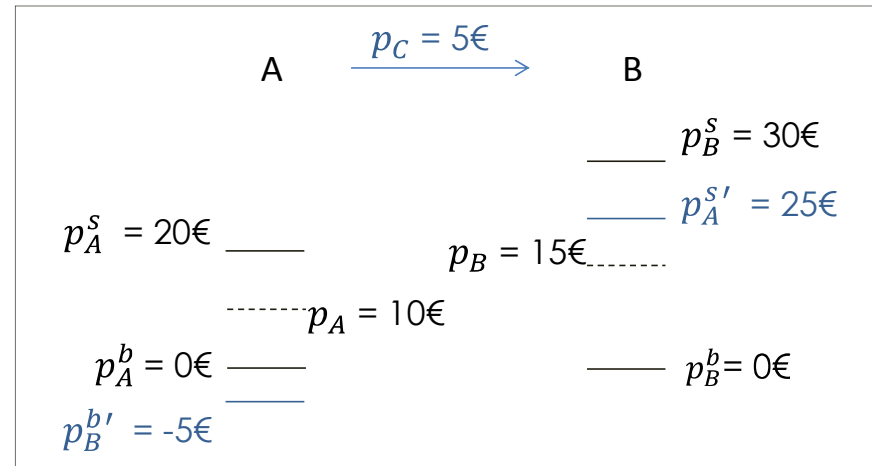


$$p_A = \frac{1}{2} (p_A^s + p_A^b)$$

$$p_B = \frac{1}{2} (p_B^s + p_B^b)$$

Option C (Capacity price as difference between middle of price spreads) - Assessment

- Assume best buy order in B starts to negotiate with best sell order i.e. sell order at the apparent price of 25€, which is the sell order from A.



- More precisely, assume the trader gradually increases the price by 1€ over time: then the middle of spread in B gradually moves up, and so does the capacity price and also therefore the local apparent price in B of the sell order in A.
- The example shows that the **negotiation process** under this capacity pricing mechanism **is not compatible with cross-border matching**.
- In addition, in such options **congestion rent is paid even if capacity is abundant**: capacity price does not reflect actual scarcity or predictable scarcity i.e. opportunity cost.