Intraday cross-zonal capacity pricing

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- Introduction

- Problem identification

- Possible options

- Assessment

- Further analysis

- Conclusion

- Substantial progress in European electricity markets in recent years

  – Increase of international trading activities

  – Integration of European power exchanges

  – Establishment of market coupling in CWE and NWE region

  – Move from bilateral market coupling to flow-based market coupling

- Development of international intraday trading lacking behind

- For integration of RES → cross-zonal intraday trading of major importance

- Objective of the study

  – Identify **options to use and price intraday cross-zonal capacity efficiently**

  – Considering requirements of

    - **European Target Model**

    - Draft network code **CACM**

Problem identification

Article CACM	Objectives / requirements
Article 3.1 (a)	Promoting effective **competition** in the generation, trading, and supply of electricity
Article 3.1 (b)	Ensuring **optimal use** of the **transmission** infrastructure
Article 3.1 (h)	Respecting the need for **fair and orderly market and price formation**
Article 3.1 (j)	Providing a **non-discriminatory** access to cross-zonal capacity
Article 49.1 (a)	**maximising Economic Surplus** for the single intraday coupling per Trade
Article 49.1 (e)	Intraday cross-zonal capacity pricing should be **repeatable and scalable**
Article 53.1	Intraday cross-zonal capacity shall be priced in a manner which **reflects Market Congestion** and is based on actual orders
clause (13) of the preamble	Capacity traded in the day-ahead and intra-day time frames should be **allocated implicitly**

Relevant cases for capacity pricing

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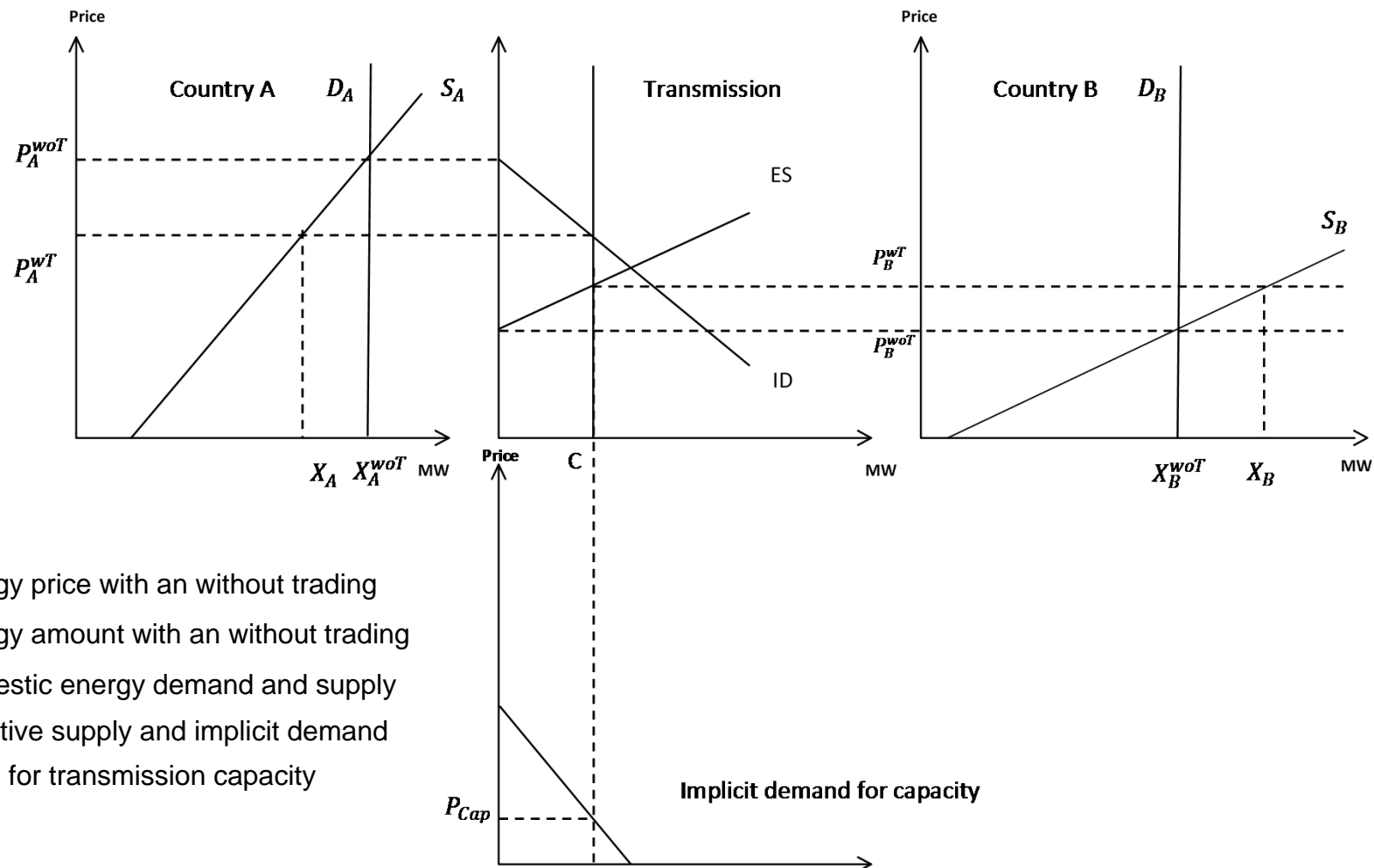PROF. DR. CHRISTOPH WEBER
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Problem identification

- Identification of relevant cases → **stylized two-country model**

- Starting point: **theory of efficient markets** (cf. Fama 1970)
  - **New trades** if and only if **new information** becomes available

- **Two** exemplary **time steps** → discrete number of cases

Day-ahead market	**Information arrival** →	Intraday market
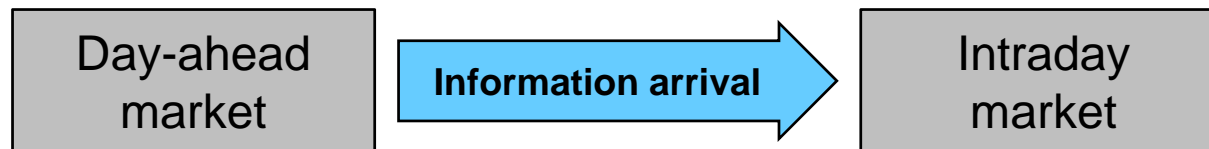
- **Pricing crucial** only when **capacity becomes scarce** in the intraday market

  - Day ahead: **demand > capacity**
    - Pricing when the **level of scarcity changes** due to a **change in available capacity**
    - Pricing when capacity **becomes scarce** after a **flow reversal** on the interconnector
  - Day Ahead: **demand < capacity**
    - Pricing when **intraday demand > capacity**
  - In all other cases
    - Market efficiency unaffected by intraday capacity pricing

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Two-country model

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Problem identification

P_A^{wT} P_A^{woT}	Energy price with an without trading	
X_A X_A^{woT}	Energy amount with an without trading	
D_A S_A	Domestic energy demand and supply	
ES ID	Effective supply and implicit demand	
P_{Cap}	Price for transmission capacity	

Problem identification

- **Explicit** and **implicit capacity allocation**

  - **Explicit:** separate markets for energy and transmission capacity

  - **Implicit:** capacity is traded along with energy, e.g. by market coupling

    → Capacity prices are given implicitly in efficient trading arrangements if energy prices in both countries and the available transmission capacity are known

    → **Any deviation of actual prices from implicit prices** (e.g. by explicitly traded capacity)
      → **inefficient** market results

- **Trade-off** between **information efficiency** and **simultaneous pricing efficiency**

  - **Information efficiency**: immediate use of new information and translation into transactions

  - **Simultaneous pricing efficiency**: Capability of the mechanism to reflect the coupling of energy prices with scarce transmission capacities demand.

- **Arrival of new information**

  - The frequency of information updates can affect mechanisms dissimilar fashion

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Problem identification

- **OTC integration**
  - High share of electricity traded through OTC market
  - Perceived as being necessary by some affected actors

- **Incomplete regional implementation**
  - Possibility of a partial implementation and further expansion to be considered
  - Solution preferably compatible to other approaches at the fringes

- **Move from NTC-based to Flow-based market coupling**
  - Increase of complexity and computational burden
    as cross-zonal capacity highly interdependent

- **Intra-zonal congestion**
  - Efficiency losses as prices will not reflect all congestions in the system
    → Bidding zone configuration

- **Market power**
  - Dominant firms → Strategically block cross-border capacity
  - Small players → Deterrance from market entry due to costs of market entry (direct or indirect)

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Overview on possible options

Possible Options

Solution	Description	auction-based or continuous trading	implicit or explicit trading	congestion pricing	CACM compatibility
Continuous 1 (C1)	**no congestion prices, fully implicit**	continuous	implicit	no	yes
Continuous 2 (C2)	**explicit congestion prices** through **separate capacity pricing mechanisms**	continuous	explicit	yes	no
Continuous 3 (C3)	**explicit congestion prices** through **exogenous specification**	continuous	Implicit	indirectly	yes
Auction 1 (A1)	**auction-based solution**	auction-based	implicit	indirectly	only with broad interpretation
Auction 2 (A2)	**hybrid implicit-explicit allocation**	auction-based	both	yes	only with broad interpretation
Hybrid 1 (H1)	**hybrid model**	both	implicit	indirectly	yes

Possible options

C1: Fully implicit trading without congestion prices

- Energy-only order book → no price for transmission capacity arises

- Trading and price settling at first-come, first-served principle

- Bids are continuously matched and cross-border capacity are automatically updated after each executed trade

- **Several existing applications:**

  – ELBAS Trading System for Nordic and Baltic region, Germany and BeNeLux

  – FITS (Flexible Intraday Trading Scheme) implicit continuous cross-border trading btw. France, Germany, Austria and Switzerland

- Compliance with the Target Model/CACM: **yes**
  implicit allocation of cross-border capacity (no separate trades on capacities) but no implicit price

Possible options

C2: Explicit congestion prices through separate trading mechanism

- Used for long-term capacity allocation in interconnections among European countries
    - 1st stage: capacity sold by uniform pricing (or pay as bid) auction
    - 2nd stage: decision which share of transmission capacity to use for energy exchange

- Analogous to forward trading:
  separate trading mechanism via separated order books
    - With DA market serving as a reference and being the starting auction
    - → Resulting capacity prices should reflects market congestion
    - → **Separation of energy and capacity trading**
        - → danger that capacity prices diverge from efficient implicit value

- Compliance with the Target Model/CACM: **no**
  Explicit allocation of capacity departs from the Target/CACM requirement of implicit allocation of cross-border capacity

Possible options

C3: Explicit congestion prices through exogenous specification

- Exogenously specified capacity prices
  - Scarcity of transmission capacity reflected
  - function of remaining available capacity and possibly further information on relevant scarcity at the respective instant of time
    - i.e. of probability of future congestion and expected WTP
  - Parameters need to be set by NRAs or TSOs
  - Price formation based on market-based components but not purely market-based
    → **risk of divergence from efficient prices**
- Implicit trading of capacity
- Compliance with the Target Model/CACM: **yes**

Possible options

A1: Intraday Auctions with implicit (or explicit) capacity pricing

- **Enhance liquidity** → Implicit capacity pricing

- **Existing implementations** in markets with zonal pricing:
  Italian and Iberian markets

- Contemplated in LMP markets in the U.S. (e.g. PJM, NE-ISO, CAISO or ERCOT)
  - Multi-day forward energy market
  - Re-run every hour with new bids and offers → consider the arrival of new information (semi-continuous)

- Intraday auctions also allow for an explicit allocation
  - Reveal true willingness of market participants to pay for capacity
  - Problematic → Exertion of market power and incomplete information

- Compliance with the Target Model/CACM: **yes (in broad interpretation)**
  - Sequence of (rapidly) repeated auctions satisfies the objective of continuous trading
  - **True for implicit capacity pricing** at least in broad interpretation of requirements
  - Explicit capacity pricing not compatible with requirements

Possible options

A2: Hybrid implicit-explicit capacity allocation

- Capacity can be traded both
  - Implicitly through an EOM
  - Explicitly through capacity auctions
- Implicit demand and explicit demand compete for the available capacity
- Execution of orders across both markets
  - Maximization of the value of cleared energy and capacity bids
- Compliance with the Target Model/CACM: **yes (in broad interpretation)**
  - Same argumentation as previous model

Possible options

H1: Continuous, implicit trading interrupted by auctions

- Implies use of different pricing mechanisms
  - Continuous trading: no capacity price
  - Auctions: capacity price based on price difference

- Expected behavior of participants
  - Larger participants: participate in continuous trading to avoid payment of congestion rent and use auctions where continuous trading did not achieve an efficient result
  - Smaller participants: prefer auctions where liquidity is aggregated and the outcome efficient
  - → distributional impacts: no congestion rent incurred during continuous trading

- ACER proposal:
  - Continuous trading starting at DA gate closure until ID gate closure
  - Auctions: bids and offers collected for final (or possibly several) auction(s)
  - Key design question: suspend continuous trading during auctions?

- Compliance with the Target Model/CACM: **yes (in broad interpretation)**

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Assessment

Evaluation criteria

Legally required properties

Criteria	Sub-criteria
Efficiency and competition	Information efficiency
	Simultaneous pricing efficiency
	Liquidity
	Sensitivity to exercise of market power

Evaluation of considered models

Information efficiency

- High information efficiency: market prices update instantaneously on new information
  - Very limited time of inconsistent prices
- Execution speed paramount
  - Continuous trading better suited than auctions
- Exogenous pricing C3 → potentially delayed updates

low ——— C3 ——— A1 A2 ——— H1 C2 ——— C1 ⟶ high

Simultaneous pricing efficiency

- Simultaneous pricing efficiency: consistency between energy and capacity prices
- Continuous mechanisms fit orders successively
  - May not fully reflect the interdependencies between scarcity in capacities and energy prices
- Auction-based mechanisms clear all orders simultaneously
 - Results in consistent prices for both energy and capacity

low ——— C3 ——— C1 C2 ——— H1 A2 ——— A1 ⟶ high

Evaluation of considered models

Liquidity

- High liquidity supports the overall market efficiency

- Auctions aggregate orders → increased liquidity

- Continuous trading → increased information costs
    - Could act as entry barrier to small actors

low ——— C2 ——— C1 C3 ——————————————— H1 A2 A1 ——▶ **high**

Avoidance of market power exercise

- Market power may be used to block capacity
    - Explicit trading of capacity particularly at risk

- Vulnerable when market concentration is high
    - Continuous mechanisms disadvantageous due to information costs (cf. above)

low ——————————————— C1 C2 C3 ——— H1 A2 ——— A1 ——▶ **high**
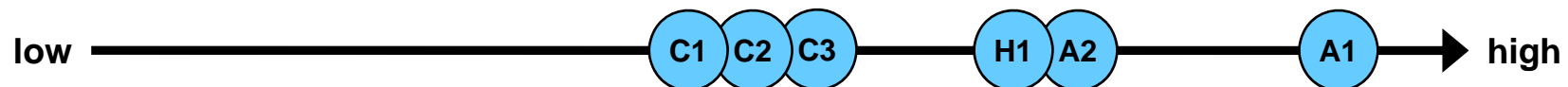
Evaluation criteria

Desirable properties

Criteria	Sub-criteria
Compatibility	Compatibility with flow-based market coupling (FBMC)
	OTC integration
	Compatibility with incomplete regional implementation
	Consistency between timeframes
	Sensitivity to intra-zonal congestion
Distributional and transitional effects	Distributional effects (on TSO, large and small market participants)
	Transition costs

- High degree of **pricing efficiency** and competition
  → **auction-based solutions** (A1 and A2) and **hybrid solution** H1

  - Pricing efficiency → inextricably linked with liquidity & with simultaneous pricing of capacity and energy

  - Auction-based mechanisms increase liquidity and reduce information asymmetry

  - Auction-based solutions only compliant in a broader sense

- High degree of **information efficiency**
  → **continuous pricing mechanisms** (C1 and C2)

  - Immediate execution of orders upon reception by market participants

  - Difficult implementation → Increase of complexity through FBMC and intraday capacity pricing

- Frequency and structure of **information arrival** of primordial importance for selection of efficient option

  - Capability to cope with **frequent and/or late information updates**

- **Solution C3** at first sight close to achieving continuous, implicit congestion pricing

  - External pricing mechanism → Not equivalent to a market-determined price

  - Potential divergence of prices → **Efficiency questionable**

- **Mechanism H1** apparently an **attractive combination** of the advantages of both the **auction-based and** the **continuous trading** approaches

  - **Closing auction → Increase of simultaneous pricing efficiency** also at the **continuous trading stage**

  - **Key challenge** → Ensure utilization of latest available information
    → Final auction sufficiently close to real time

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Many thanks!

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Evaluation criteria

Legally required properties

Criteria	Sub-criteria	Description
Efficiency and competition	Information efficiency	Arrival of new information is instantaneously translated into market adjustments.
	Simultaneous pricing efficiency	Capability of the mechanism to reflect the coupling of energy prices with scarce transmission capacities demand.
	Liquidity	A high liquidity is advantageous for the overall efficiency. High liquidity means a high number of market participants and high trading volumes.
	Sensitivity to exercise of market power	In case of scarce capacities firms with market power might strategically block cross-zonal capacity in order to raise prices.

Further desirable properties

Evaluation criteria

Desirable properties

Criteria	Sub-criteria	Description
Compatibility	Compatibility with flow-based market coupling (FBMC)	Flow based market coupling increases the transmission capacity available for trades by using realistic load flows in the grid calculations. While this increases the solution complexity, mechanisms compatible with FBMC are preferred for efficiency reasons.
	OTC integration	Given the high share of OTC trades in Europe, the capacity pricing mechanism should allow for an integration into the power exchanges or capacity platform. Competition between power exchanges and OTC trading puts efficiency pressure on all trading platforms.
	Compatibility with incomplete regional implementation	During the transitional period, the combination of the proposed market arrangement with other mechanisms at the fringe should be possible in order to avoid blockings.
	Consistency between timeframes	Information efficiency states that market prices should only be influenced by the arrival of new information. Consequently, a market mechanism should be consistent between timeframes to avoid pure time/mechanism driven ("endogenous") price changes.
	Sensitivity to intra-zonal congestion	Intra-zonal congestions affect the efficiency and effectiveness of the considered solution. Therefore the sensitivity to intra-zonal congestions of the capacity pricing mechanism should be minimized.

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Further desirable properties

Evaluation criteria

Desirable properties

Criteria	Sub-criteria	Description
Distributional and transitional effects	Distributional effects (on TSO, large and small market participants)	Depending on the trading arrangement, incentives for participation and thus rents may vary for different user groups. Moreover rents may be allocated to different stakeholders even when the incentives at the margin are efficient In particular adverse distributional effects on small market participants should be avoided, since these put competitive pressure on the large players.
	Transition costs	Costs of implementing a new pricing mechanism should be minimized.

section	solution	models	Efficiency			
			information efficiency	simultaneous pricing efficiency	liquidity	sensitivity to exercise of market power
3.2.1	CONTINUOUS 1	no congestion prices, fully implicit	++	0	-	0
3.2.2	CONTINUOUS 2	explicit congestion prices through separate capacity pricing mechanisms	+	0	--	-
3.2.3	CONTINUOUS 3	explicit congestion prices through exogenous specification	-	-	-	0
3.3.1	AUCTION 1	auction-based solution	0	++	++	++
3.3.2	AUCTION 2	hybrid implicit-explicit allocation	0	+	++	+
3.4	HYBRID 1	hybrid model	+	+	++	+

section	solution	models	Compatibility				
			OTC integration	Consistency btw. timeframes	Incomplete regional implementation	Flow-based market coupling	Sensitivity to intra-zonal congestion
3.2.1	CONTINUOUS 1	no congestion prices, fully implicit	+	-	0	0	0
3.2.2	CONTINUOUS 2	explicit congestion prices through separate capacity pricing mechanisms	++	-	0	0	0
3.2.3	CONTINUOUS 3	explicit congestion prices through exogenous specification	+	-	0	0	0
3.3.1	AUCTION 1	auction-based solution	0	++	0	+	+
3.3.2	AUCTION 2	hybrid implicit-explicit allocation	0	0	0	+	+
3.4	HYBRID 1	hybrid model	0	+	0	0	0

section	solution	models	Distributional and transitional effects	
			distributional effects (focus on small market participants)	transition costs
3.2.1	CONTINUOUS 1	no congestion prices, fully implicit	-	++
3.2.2	CONTINUOUS 2	explicit congestion prices through separate capacity pricing mechanisms	-	-
3.2.3	CONTINUOUS 3	explicit congestion prices through exogenous specification	-	+
3.3.1	AUCTION 1	auction-based solution	++	-
3.3.2	AUCTION 2	hybrid implicit-explicit allocation	+	--
3.4	HYBRID 1	hybrid model	+	+