Flow-Based Market Coupling and Bidding Zone Delimitation: Key Ingredients for an Efficient Capacity Allocation in a Zonal System

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Dr. Pieter Schavemaker, Principal Consultant of E-Bridge Consulting B.V., has worked in the energy sector for 18 years. Pieter gained a varied experience working as assistant professor at the Delft University of Technology, with a large manufacturer of power system equipment, with a Transmission System Operator and as a consultant.

During the past years, Pieter was heavily involved in the international work on the boundary between system operations and the electricity market. Pieter is one of the founding fathers of the CWE Flow-based Market Coupling that is currently being implemented.

Pieter received his Didactic Qualification for University Education from Delft University of Technology.

‘There are two permissible approaches when calculating cross zonal capacity: Flow based or coordinated net transmission capacity based. The flow based approach is preferred over the coordinated net transmission capacity approach for day ahead and intraday capacity calculation where interdependencies of cross zonal capacity between bidding zones is high. Flow based should only be introduced after market participants have been consulted and given sufficient preparation time to allow for a smooth transition. The coordinated net transmission capacity approach may be applied in regions where interdependencies between cross zonal capacity are low and the added value of the flow based method cannot be proven.’
Flow-Based (FB): the ‘next-step’ coordinated capacity calculation method

After ETSO created the fundament of the flow-based methodology (based on flow gates), the current flow-based methodology (based on critical branches) was developed more or less independently in both CWE and CEE.
Current status of FB

Flow-based Market Coupling
- Public consultation: ongoing
- External Parallel run: ongoing

Flow-based
- Started FB development for FB explicit auctions
- Currently on hold
Flow-Based Market Coupling: a constrained optimization problem

- All the bids of the bidding zones are brought together in order to be matched by a centralized algorithm.

- Objective function: Maximize social welfare

- Control variables: Net positions

- Subject to: $\sum \text{net positions} = 0$

**FB grid constraints**
Flow-Based Market Coupling and Bidding Zone Delimitation: Key Ingredients for an Efficient Capacity Allocation in a Zonal System

- Flow-based market coupling provides an efficient allocation mechanism in which all exchanges that are subject to the allocation mechanism compete with one another for the use of the scarce capacity.

- Exchanges that are subject to the allocation mechanism are all competing for the scarce capacity made available within the allocation mechanism.

- Exchanges that are outside the allocation mechanism are all exchanges of which the impact is taken into account before the allocation mechanism itself, i.e. exchanges that receive a ‘priority access’ and that are exempted from the competition element within the allocation mechanism.

- Thus, the key question in zone delimitation is which exchanges need to be subject to an allocation mechanism, and which exchanges can be left outside the allocation mechanism.
Zone delimitation

Zone delimitation is one way to manage congestions in the transmission network. Three systems may be distinguished:

- the uniform system, where no exchanges are subject to an allocation mechanism;

- the nodal system, where exchanges between all nodes are subject to an allocation mechanism;

- the zonal system, where only exchanges between zones are subject to an allocation mechanism.

Source: website Nordpool Spot
Zone delimitation: an example

Flow caused by exchange not under allocation
Flow caused by exchange under allocation
Zone delimitation: an example

Flow caused by exchange not under allocation
Flow caused by exchange under allocation
Zone delimitation: an example

Flow caused by exchange not under allocation
Flow caused by exchange under allocation
Zone delimitation: an example

- Flow caused by exchange not under allocation
- Flow caused by exchange under allocation
Sources, sinks and flows

- the grid interconnects the sources and sinks
- the flows fan out in the grid in accordance to Kirchoff’s laws

Source: ENTSO-E
Loop flow and transit flow

- A geographical concentration of sources and/or sinks can have a strong impact on the physical flows
  - transit flows
  - loop flows

Transit flow: sink and source in different countries

Loop flow: sink and source in same country
Allocated and unallocated flows (1)

- A loop flow is by definition an unallocated flow: it is not subject to an allocation mechanism
Allocated and unallocated flows (2)

- A transit flow can be either an allocated or an unallocated flow
  - A transit flow is an unallocated flow when the exchange, causing the transit flow, is not subject to the same cross-border allocation mechanism as the zone facing the transit flow
  - A transit flow is an allocated flow when the exchange, causing the transit flow, is subject to the same cross-border allocation mechanism as the zone facing the transit flow
Exchanges and flows

Subject to the same regional allocation mechanism?

Flows
- Intrazonal flows
- Loop flows
- Interzonal flows (transit flows)
- Interzonal flows (a.o. transit flows)

Exchanges
- Unallocated
- Allocated

Intrazonal

Interzonal
From unallocated to allocated flows

Subject to the same regional allocation mechanism?

Flows
- Intrazonal flows
- Loop flows
- Interzonal flows (transit flows)
- Interzonal flows (a.o. transit flows)

Zone delimitation

Extent the scope of the regional allocation
Key message in this presentation

- Only with a flow-based approach, a true competition between all relevant exchanges for the scarce capacity can be established.

- Bidding zone delimitation defines which exchanges are subject to the allocation mechanism.

- With a combination of these two, key ingredients are at hand to establish an efficient allocation mechanism for the European integrated electricity market.
Questions?
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