The Evolved Flow-Based concept for integration of ALEGrO in Flow-Based Market Coupling

Introduction of EFB concept

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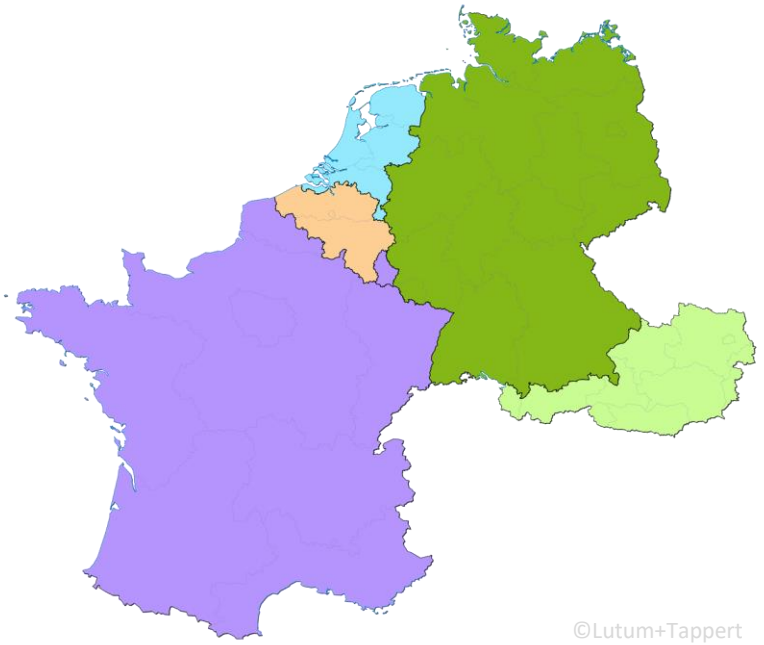
Status quo: CWE DA FB market coupling

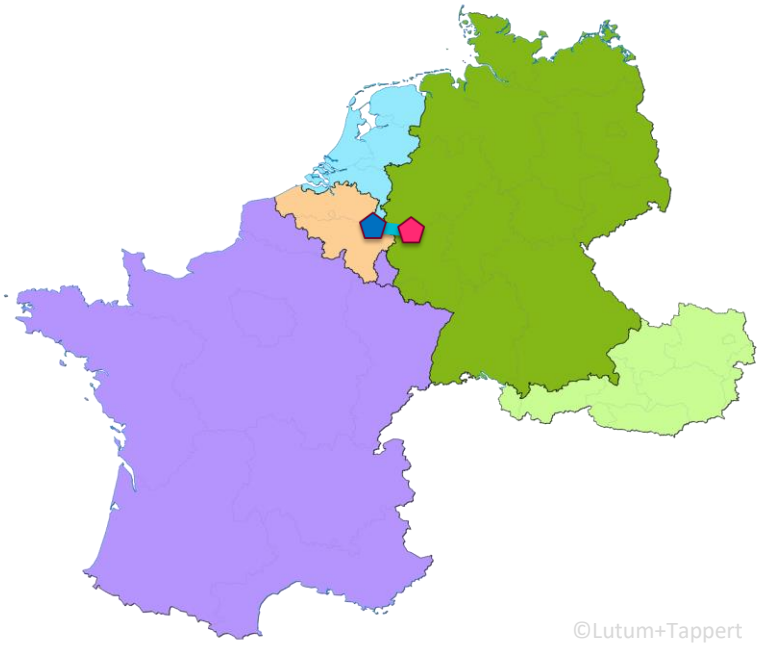
- Capacity is allocated in the DA market by a flow-based approach in the CWE area
  - 5 bidding zones (FR, NL, BE, DE/LU, AT)
  - The impact of commercial exchanges on load flows in the AC network is estimated as a function of the zonal net positions (by zonal PTDFs)
  - Main FB allocation parameters are 5 zonal PTDFs and 1 RAM value for each CBCO



PTDF: Power Transfer Distribution Factor
RAM: Remaining Available Margin
CBCO: Critical Branch Critical Outage combination

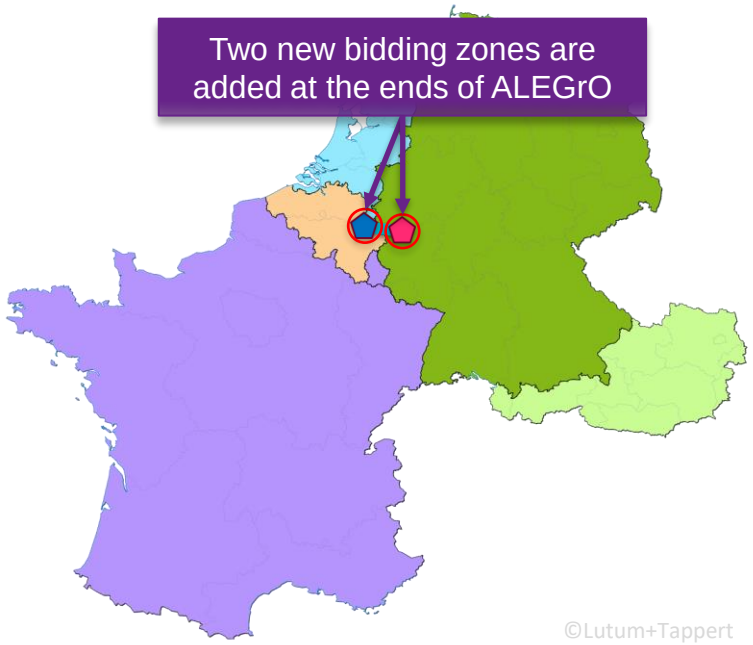
New step: integration of an HVDC link

- ALEGrO requires the integration of a controllable HVDC link within the FB coupled area
- Approach: Evolved Flow-Based (EFB) concept
  - Model the impact of the exchange over the HVDC link on the CBCOs in the AC network
  - Determine the optimal exchange over the HVDC link as part of the day-ahead market welfare optimization („EUPHEMIA“ algorithm)



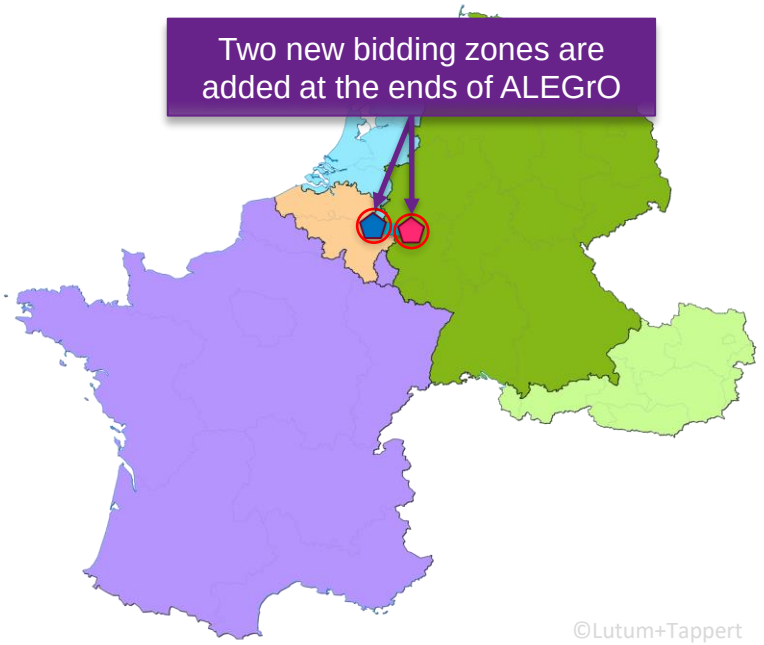
Implementation of EFB by adding two virtual bidding zones

- At the two connection points of the HVDC link two new „virtual“ bidding zones are modelled in FBMC
  - The net positions of these virtual bidding zones are equal to the injection/extraction of power at the connection nodes of the HVDC link
  - Assuming no losses of the HVDC link, the net positions (NP) of the two virtual bidding zones are balanced:
    - $NP_{BE}^{ALEGrO} = -NP_{DE}^{ALEGrO}$



Modelling of HVDC link by FB parameters

- By adding the two virtual bidding zones, the the impact of the injection/extraction at the HVDC links‘ ends (= net position of the virtual bidding zones) on flows in the AC network can be modelled by two new zonal PTDFs for the corresponding net positions
  - ➢ From 5 to 7 zonal PTDFs per CBCO
- Further, the outage of the HVDC link needs to be considered as a new critical outage (CO) in the CBCO list
  - ➢ New CBCOs for the CO “outage of ALEGrO“



Example: FB parameters in case of EFB

Status quo (without ALEGrO):
PTDF matrix with 5 columns

	PTDF FR	PTDF DE	PTDF BE	PTDF NL	PDF AT	RAM
CBCO 1	-0.3	0.16	-0.2	-0.1	0.05	…
CBCO 2	…	…	…	…	…	…
…	…	…	…	…	…	…

EFB (with ALEGrO):
PTDF matrix with 7 columns
and additional CBCOs

Two new PTDF-columns for the two virtual zones

	PTDF FR	PTDF DE	PTDF BE	PTDF NL	PTDF AT	PTDF HVDC-BE	PTDF HVDC-DE	RAM
CBCO 1	-0.3	0.16	-0.2	-0.1	0.05	-0.2	0.2	…
CBCO 2	…	…	…	…	…	…	…	…
…	…	…	…	…	…	…	…	…
New CBCOs for CO = outage of HVDC link						0	0	…

New CBCOs for HVDC outage

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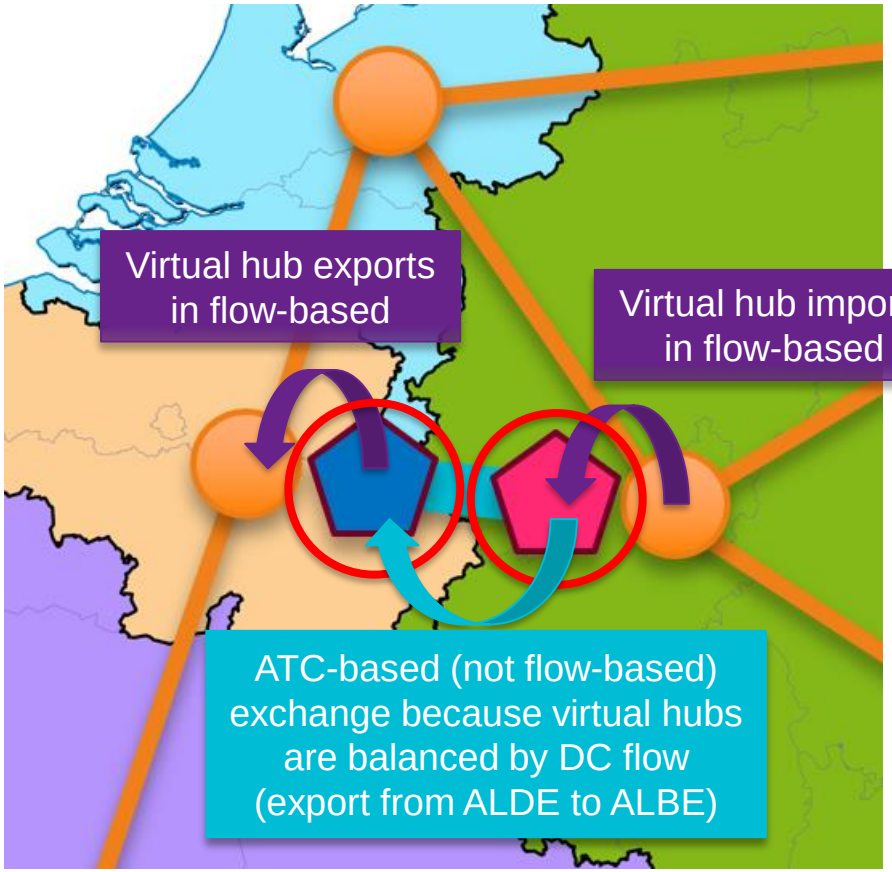
Modelling of an ATC link balancing the virtual hubs

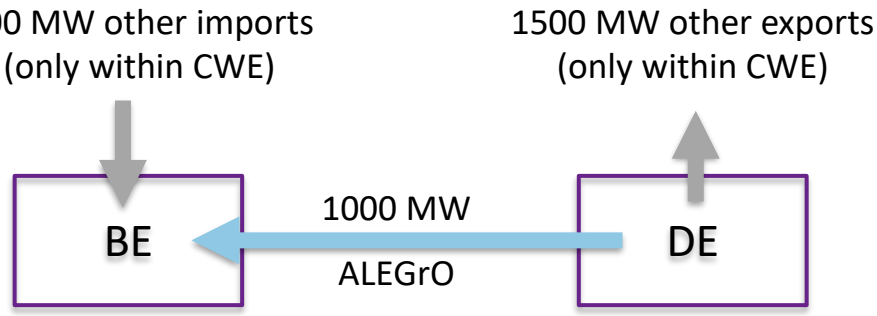
- The virtual hubs do not contain any bids by generation or load
  - ➢ MRC net positions of virtual hubs (considering flow-based and ATC-based exchanges) need to be 0
- The energy exported/imported by a virtual hub in the flow-based system is in fact the energy that is received from/provided to the HVDC link
- ➢ This balancing is modelled in the market algorithm by adding an ATC exchange between the two virtual hubs (being equal to the flow over the interconnector)



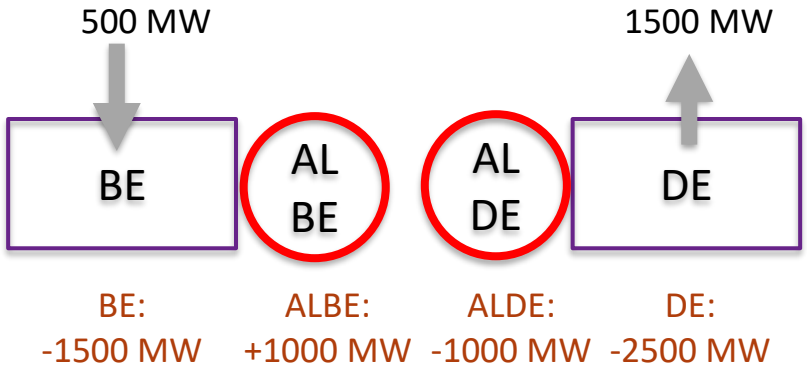
Exemplary situation for export from DE to BE via ALEGrO

Numerical example

Physics:
1000 MW over HVDC line from BE to DE
Like 1000 MW generation at BE grid node
and 1000 MW load at DE grid node

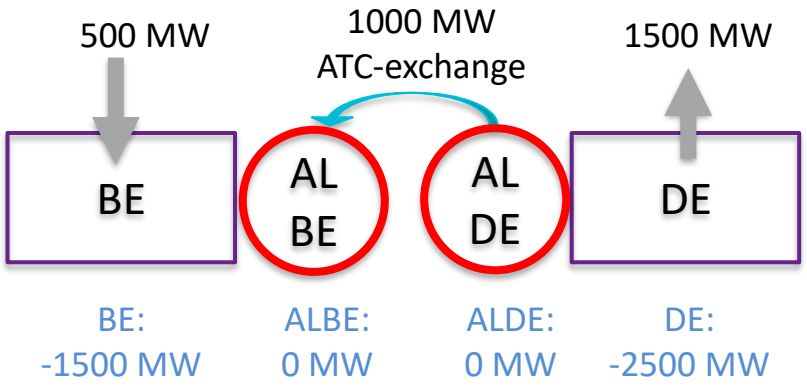


Flow-based view:
1000 MW exported from ALBE, injected at BE grid node
1000 MW imported from ALDE, extracted at DE grid node



MRC view:
The injections/extractions at the HVDC nodes are due to an exchange between ALBE and ALDE and not due to supply/demand bids

- Balance by ATC-link
- 1000 MW ATC exchange between ALBE and ALDE



Thank you very much!

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