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optimization solutions

CWE Day-Ahead Market Coupling

Towards the Implementation of Flow-Based Day-Ahead Market Coupling in the Central Western Europe Region

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Content

- Day-ahead market in the CWE region
- Flow Based theory
- Flow Based market impact analysis

The Central Western Europe Region

Belgium
France
Germany
Luxembourg
The Netherlands

http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_INITIATIVES/ERI/Central-West

CWE day-ahead market: Step #1

- 1999-2001: Creation of national day-ahead markets (Power exchanges).
  - No congestions within countries, i.e. one price zone per country.
- 2001-2002: Creation of long term to daily auctions to allocate cross-border transmission capacity.

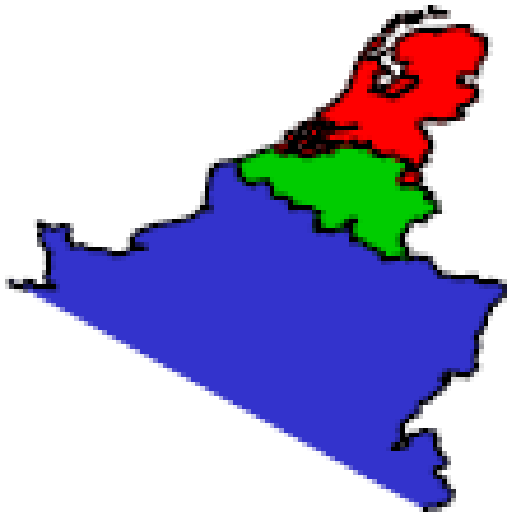
Step #1: Example

- A German company can produce 10 MW at 50 €/MWh
- Its trader wants to sell the production of the French Day-Ahead market because he/she expects a price of 60 €/MWh.
  - He/she bids for 10 MW of German to France cross-border capacity.
  - Let's assume the he/she obtains it for 5 €/MWh.
  - The trader nominates it so that he/she has to do the exchange
  - It offers 10 MW on the French market. The bid must be at the minimal price (-3000 €/MWh) so as to guarantee that the exchange will take place.
- If the French market clears at more than 55€/MWh, the transaction benefits to the company. If clears below, the company looses money because it must do the exchange.

CWE day-ahead market: Step #2

- 2006: Trilateral coupling of the Belgium, Dutch and French day-ahead markets:

- "Market Coupling" or "Implicit Auctions":
  - maximization of the total social welfare;
  - subject to constraints on flows between:
    - Belgium and France;
    - Belgium and the Netherlands.



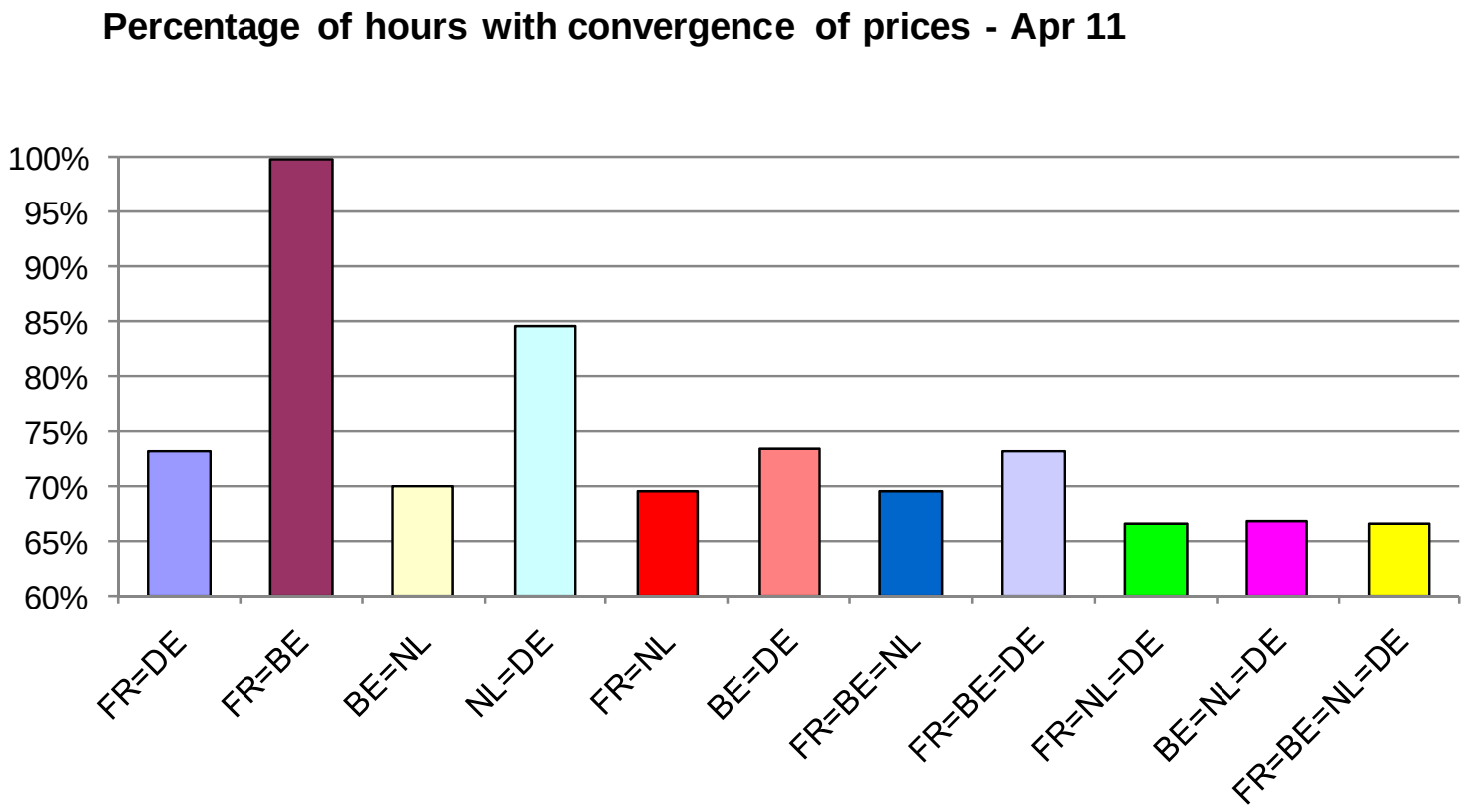
CWE day-ahead market: Step #3

- November 9th, 2010: CWE Market Coupling.

- TLC + Germany.
- Same principles (Constraints on boundary flows).

Step #3

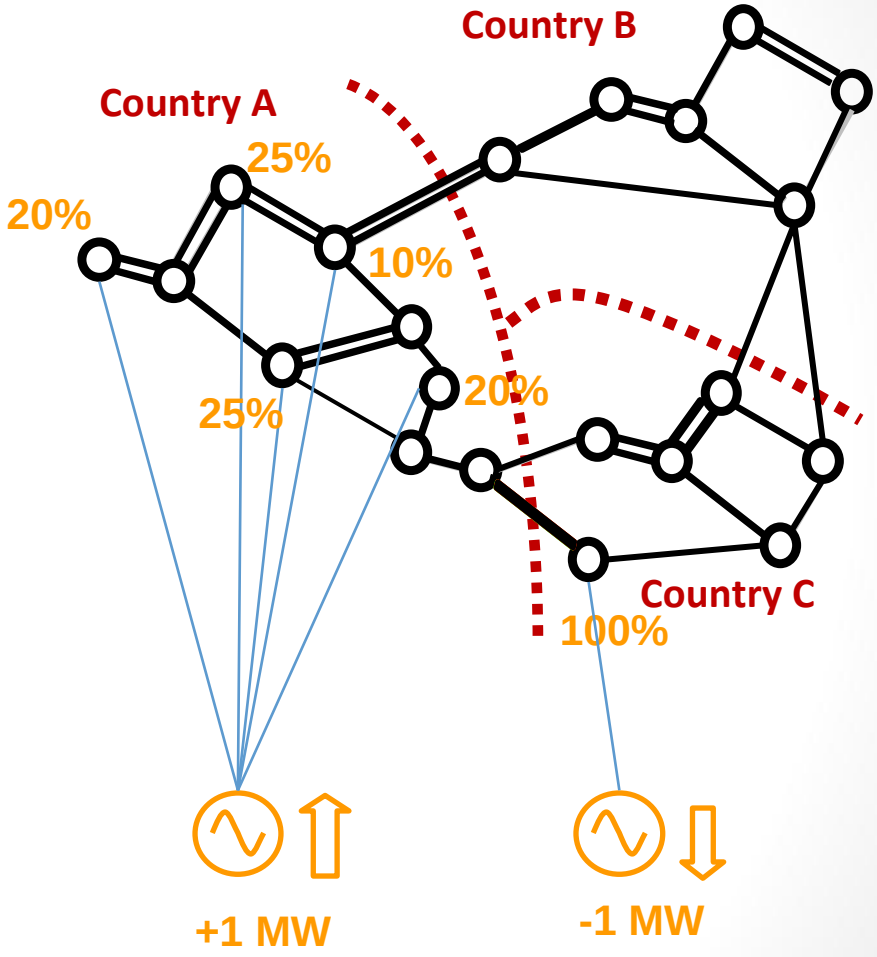
- First months gave good results. Example with convergence of prices in April:



Flow-Based theory

FB theory: zonal influence

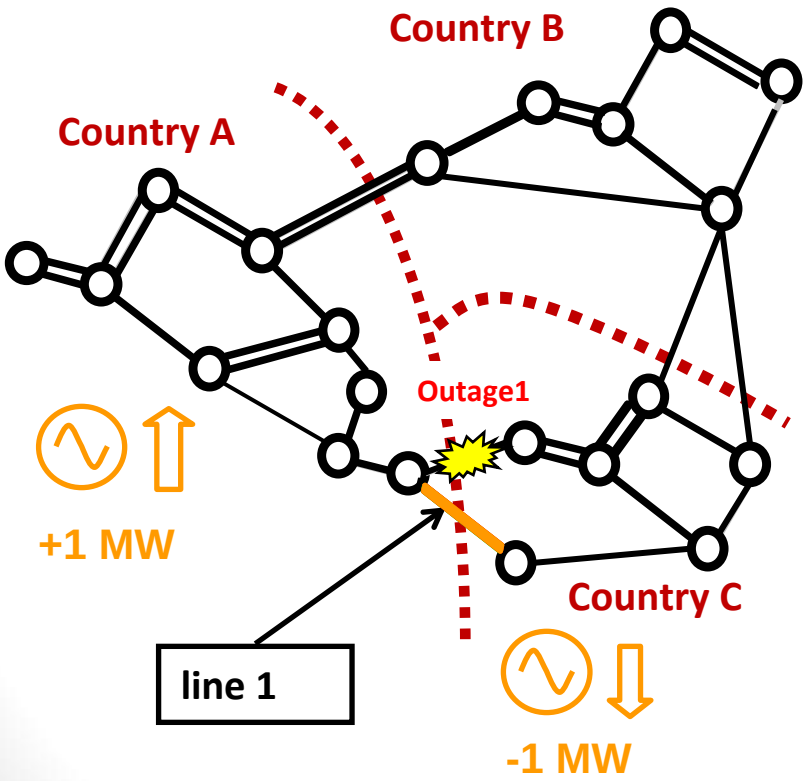
- Generation Shift Keys (GSKs)
  - Answer to the need to translate cross-border exchanges into nodal injections.
  - TSOs determine the key which maps linearly an import/export position in each country/price zone to a generation pattern.



FB theory: PTDFs

- Flow Based Power Transfer Distribution Factors

  = Sum over nodes n in country A of (Nodal PTDF(n) . GSK(n))

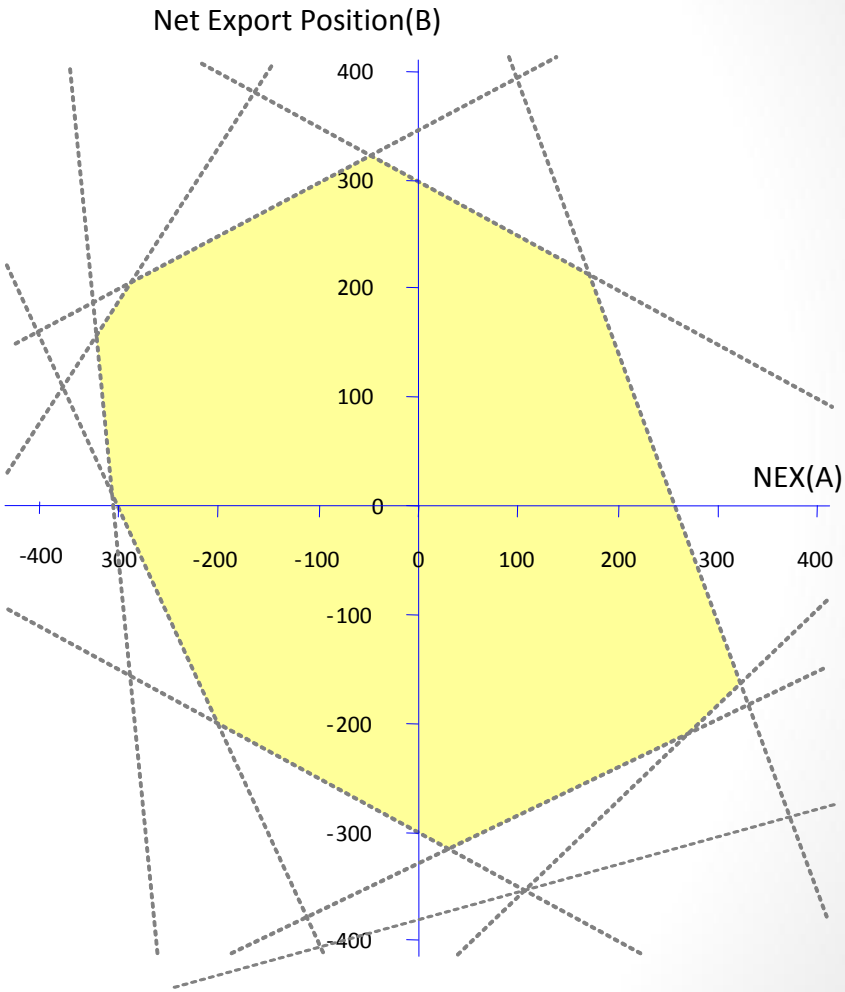


Monitored lines	Outage scenario	Margin left (MW)	Influence of exchange on lines (PTDF)		
			A	B	C
Line 1	No outage	150	10%		
	Outage 1	120	20%		
	…				
Line 2	…				
	…				
Line 3	…				
	…				

FB theory: SoS domain

- The set of constraints define the FB SoS (Security of Supply) domain.
- For 3 countries, the domain is a surface because NEX(A)+NEX(B)+NEX(C)=0
- For 4 countries, it is a volume.

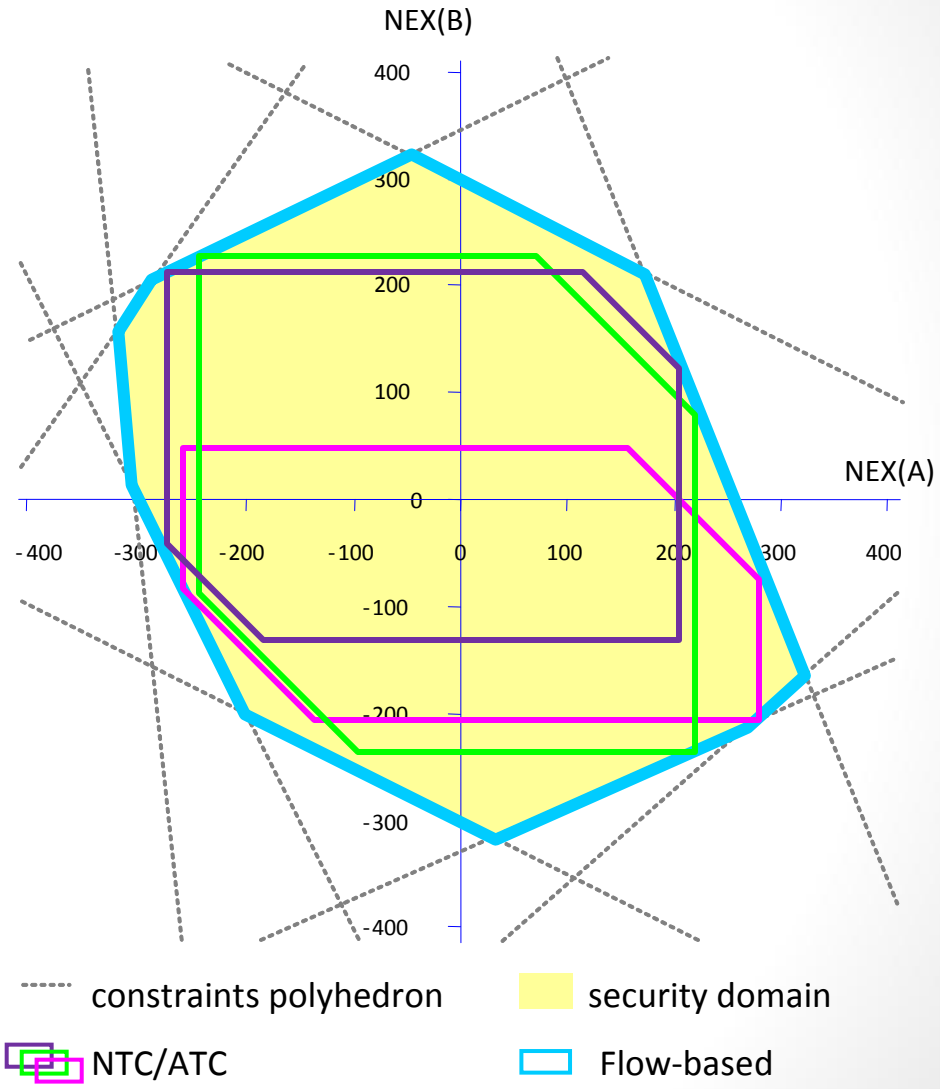
Monitored Lines	Outage scenario	Margin left (MW)	Influence of exchange on lines (PTDF)		
			A	B	C
Line 1	No outage	150	1%	10%	0%
	Outage 1	120	5%	20%	0%
	Outage 2	100	6%	25%	0%
Line 2	No outage	150	-2%	0%	0%
	Outage 3	100	-12%	0%	0%
Line 3	No outage				
	Outage 4				



Numbers are for illustration only

FB theory: FB vs ATC SoS domain

- In a meshed grid, ATCs are interdependent.
- With ATC model, TSOs choose ex-ante the best set of ATC:
  - Need to anticipate the market results.
- With FB model, TSOs simply give the FB SoS domain:
  - It is up to the market how to use it.



FB theory: Clearing model

- Control variables: Net Export Positions (NEX)
- Objective function: Maximization of social welfare

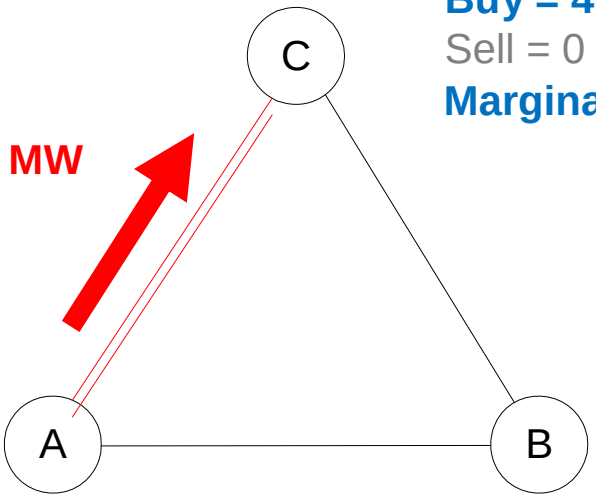
- Constraints:
  - Balancing constraint: $$\sum_{z \in Z} \mathrm{NEX}_z = 0$$
  - FB capacity constraints: $$\sum_{z \in Z} \mathrm{PTDF}_l^z \cdot \mathrm{NEX}_z \leq \mathrm{RAM}_l$$

FB theory: Non-intuitiveness

- Example of non-intuitive situation

Accepted:

Buy = 400 ≤ 1000 MW @ 90€
Sell = 0 MW
Marginal Price = 90 €



Fmax=100 MW

Accepted:

Buy = 100 ≤ 100 MW @ 45€
Sell = 0 ≤ 1000 MW @ 40€
Marginal Price = 10 €

The cheapest zone imports !

Accepted:

Buy = 0 MW
Sell =500 ≤ 1000 MW @ 50€
Marginal Price = 50 €

FB theory: conclusions

- FB offers more trading opportunity than ATC with the same SoS:
  - No more capacity splitting.
- FB is closer from the reality of the grid:
  - Inter-dependency of cross-border exchanges is reflected.
  - Direct allocation of physical margins.

- From the trader perspective, FB is more complex.
- Non intuitive situations may occur.

FB experimentation: Step #4

- Go live of FB market coupling is planned in 2013.

FB Market Impact Analysis

- Objective: assess the impact of FB capacity calculation on markets

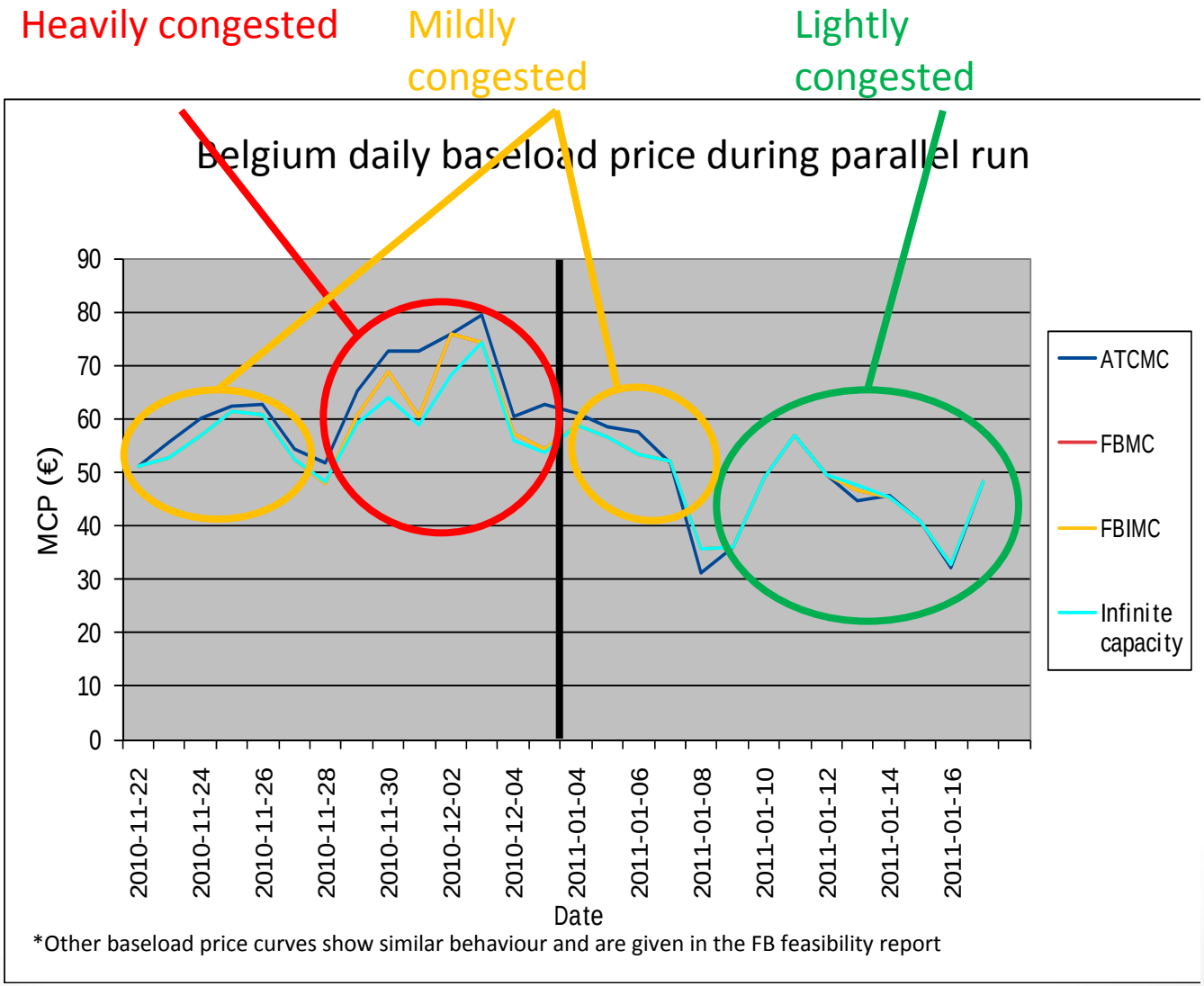
- Means: simulation of market clearing with FB constraints
  - On 2 times 2 weeks:
    - From 22-11-2010 to 05-12-2010
    - From 04-01-2011 to 17-01-2011

  ⇒ *No possible extrapolation to 1 year.*

- Results: evolution of indicators (welfare…) between historical **ATC Market Coupling (ATCMC)** and:
  - **Flow-Based MC (FBMC)**,
  - **Flow-Based Intuitive MC (FBIMC)**, enforcing intuitiveness
  - **Infinite MC,** i.e. 'copper plate': no capacity constraints thus identical price in every area.

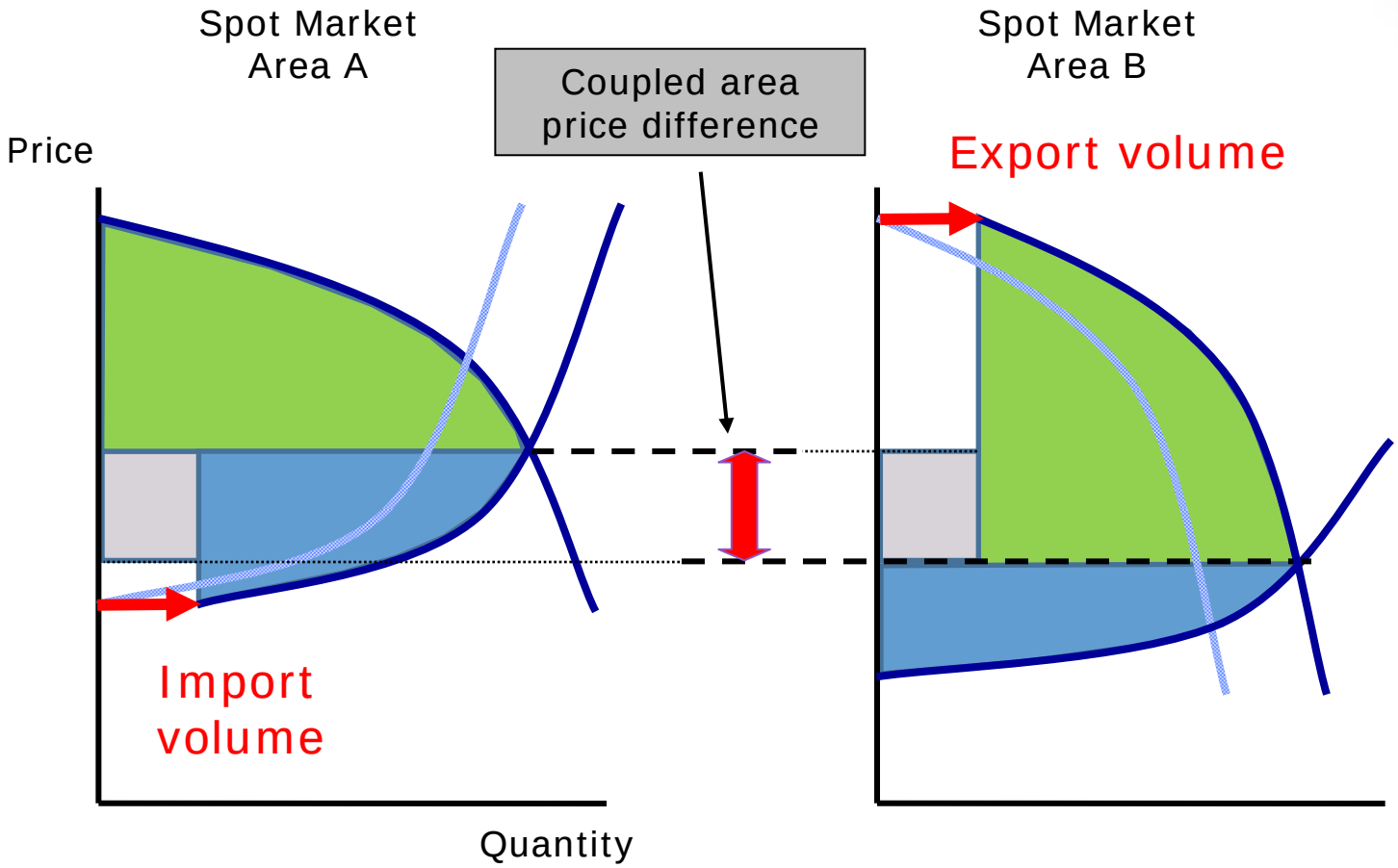
FB MIA: general analysis

- Different market conditions over the weeks:



*Other baseload price curves show similar behaviour and are given in the FB feasibility report

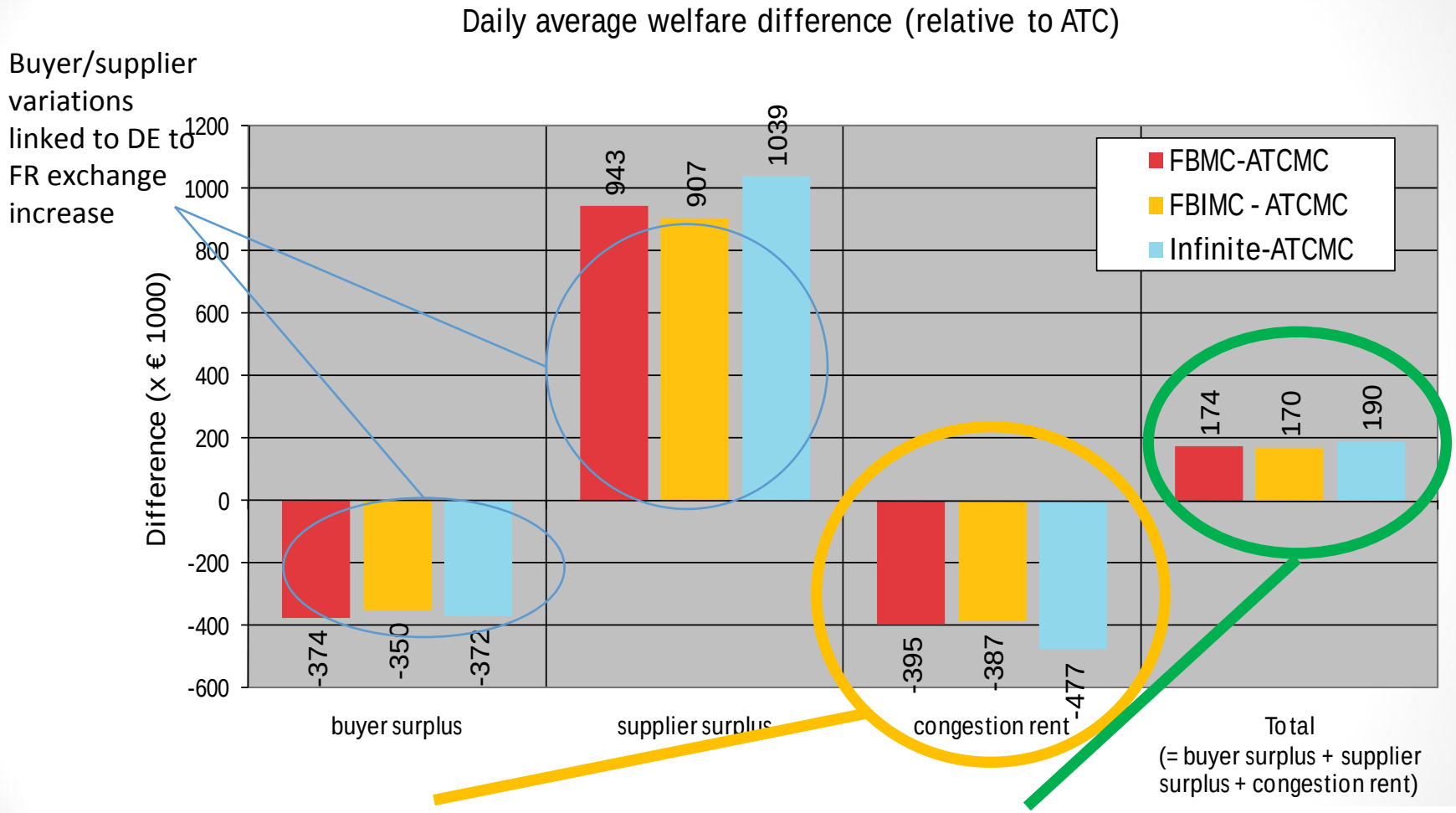
FB MIA: reminder on welfare



Supplier surplus | Buyer surplus | Congestion rent (x2*)

* Each purple square represent the full congestion rent

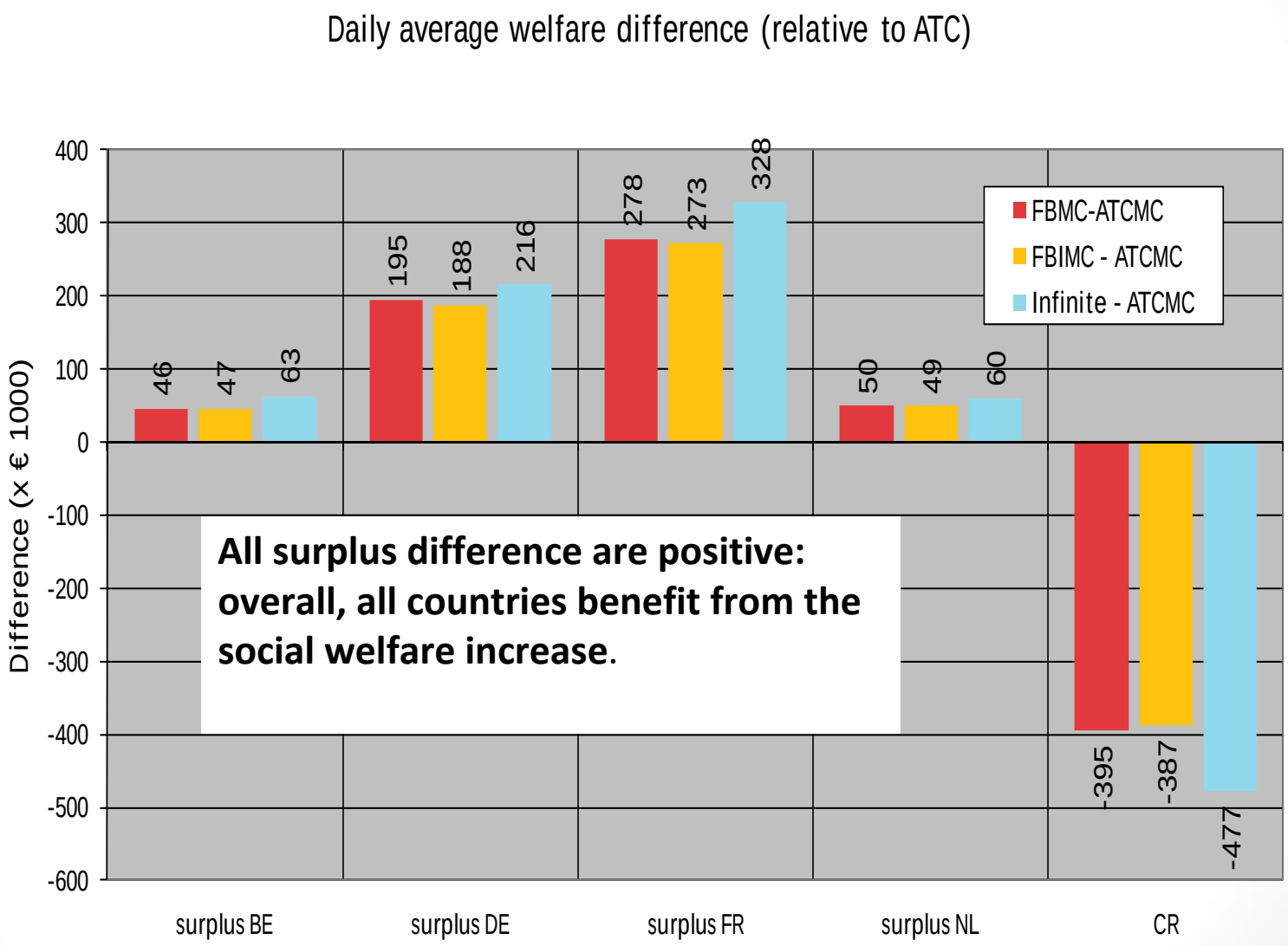
FB MIA: Welfare impact



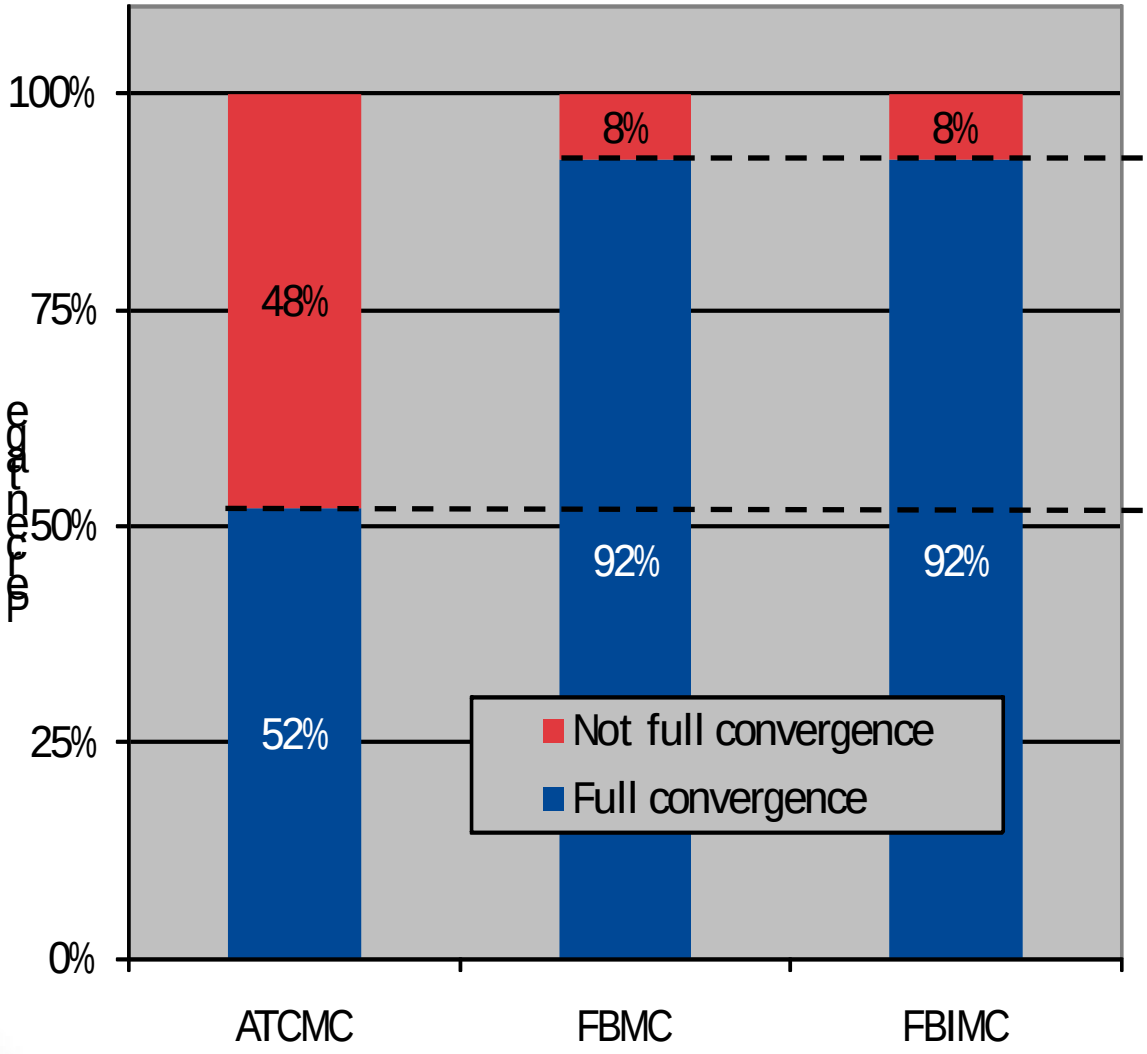
FB ⇔ More than 81% decrease of congestion rent

FB ⇔ More than 89% of possible welfare increase
Loss linked to enforcing intuitiveness in FBIMC is small (less than 2% of the increase).

FB MIA: Welfare impact



FB MIA: Convergence



(convergence ⇔ price difference below 0.002 €/MWh)

Copper plate occurrence increase:
⇒ *Congestion rent decrease.*

+40%

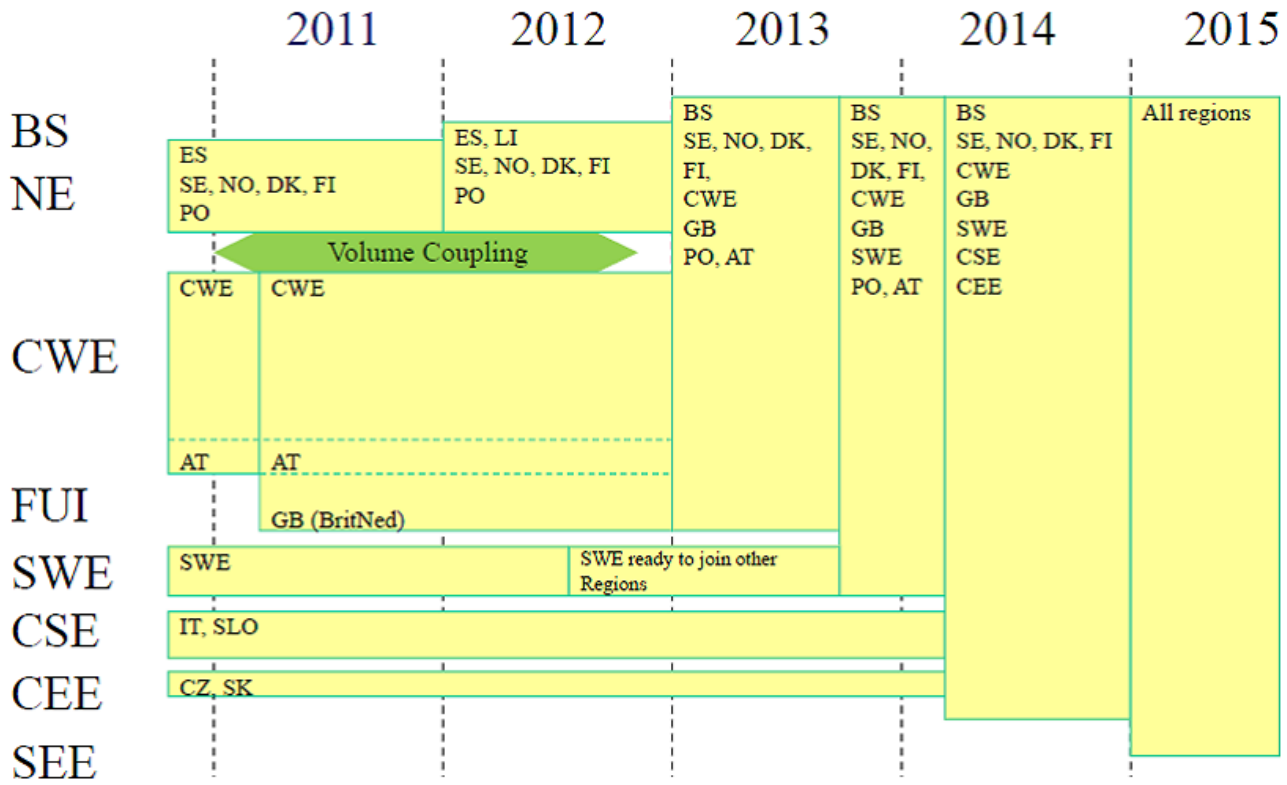
In FBMC, partial convergence in congested situations disappears.
Example: no congested situation with the same price in BE and FR and in DE and NL.

FB Conclusion

- On a limited simulation period, FBMC and FBIMC have a positive impact on the market compared to ATCMC.
- Non intuitive situations were found in FBMC. Using FBIMC removes these situations without unacceptable deterioration of the other indicators.
- More simulations are required to confirm current conclusions on a longer period of comparison (Up to go live).

Beyond FB: European integration

- Single european price coupling roadmap



Open planning issues: CEE, SEE, Ireland (SEM), CH and the joining of SWE to the other Regions

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