Agenda

14:00 Welcome words by the Co-Chairmen
14:05 Overview of Market Coupling
14:25 CWE MC Project status and planning

Presentation of the CWE MC solution
14:50 Part 1:

> *Process & timing*
> *Coordinated ATC calculation*
> *Fallbacks*

15:30 Coffee Break
15:50 Part 2:

> *Price calculation*
> *Economic assessments*

16:25 Flow Based Market Coupling
17:00 Conclusions and next steps
**17:10 Cocktail**

Market Coupling: General overview

European electricity market

Through better capacity utilization, MC is going mitigate some of today's shortcomings, e.g.:

- Volatile prices
- Variable liquidity
- Transparency issues
- Inefficient use of capacity
- High level of market concentration in local market: market power issues

Market Coupling tomorrow:

→ **Better utilize existing capacity!**

— Explicit auctions

◯ Coupled market
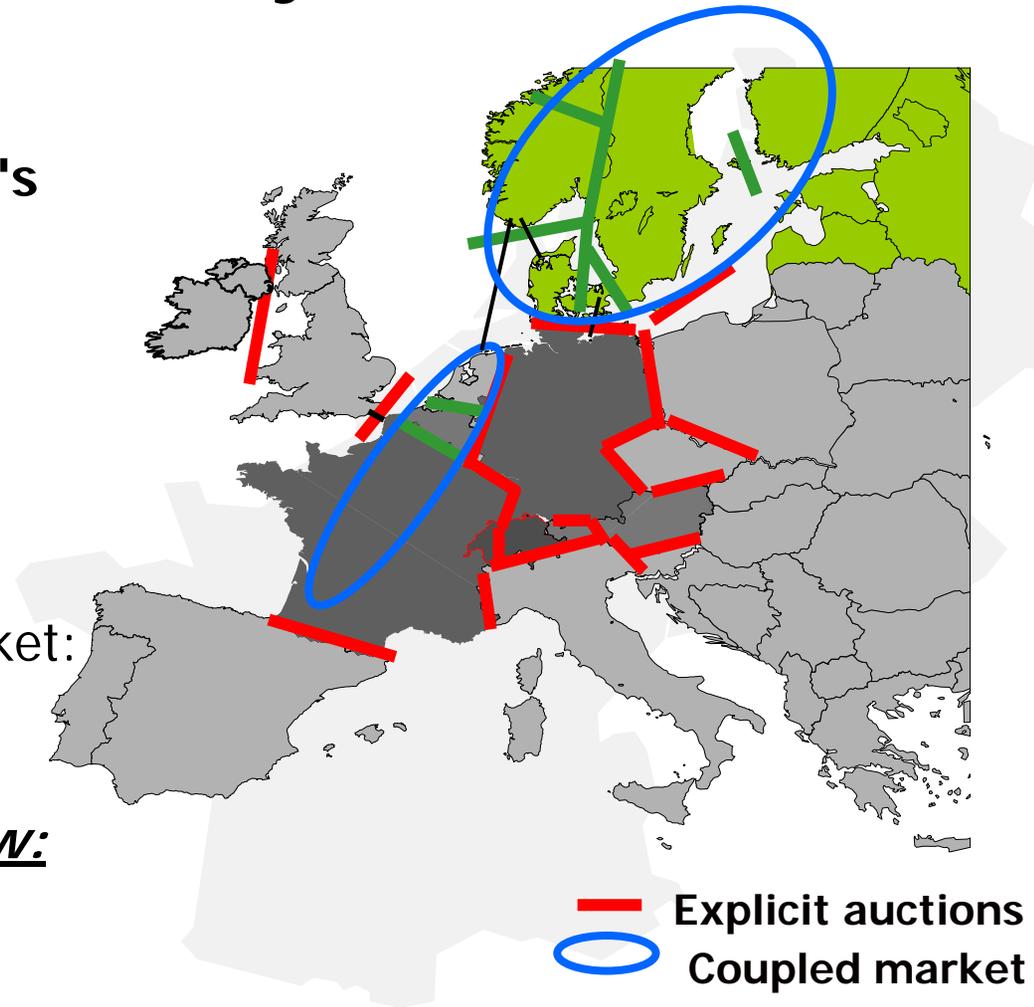
Short falls of day-ahead explicit auctions

- ▶ Risks of 2-step trading of capacity / energy

- ▶ Price of capacity not in line with power price spreads

- ▶ Im/exports not optimised to the maximum capacity

- ▶ Different rules for transfer of power across successive borders

- ▶ Limited market participants in cross border capacity auctions

- ▶ Area prices separate, even when there is no capacity constraint

→ Integrate by market coupling

≠
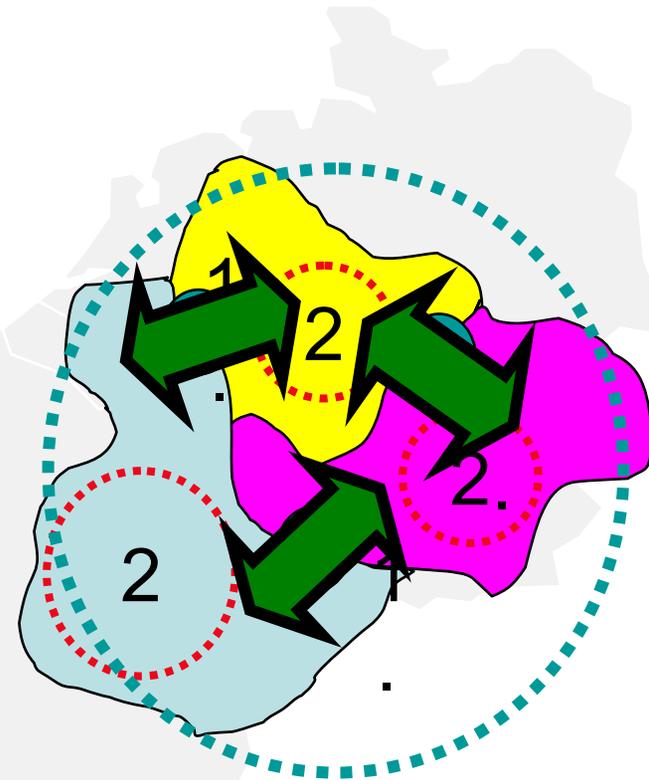
Advantages of market coupling

- Removes unnecessary risks of trading short-term transmission capacity and energy separately

- Guarantees the optimal utilization of transmission capacity

- Less prone to market abuse since capacity cannot be hoarded

- All market participants benefit from cross-border capacity

- Encourages liquid, robust spot markets
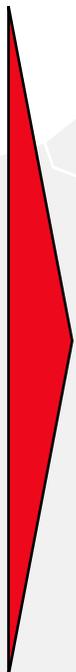
Optimal use of capacity (particularly when prices are close)

Single market (when there is sufficient capacity)

Market coupling design options

- Volume coupling
  - Sequential calculations
  - Common central calculation of the import/export flows
 - Local calculation of prices, PX only receive the volume to import/export
- Price coupling
  - Common central calculation of the import/export flows and of prices
  - Local PX receive both the volume to import/export and the price at which they have to clear
 - Preferred "European Target Model" (Florence Forum, June 2009)
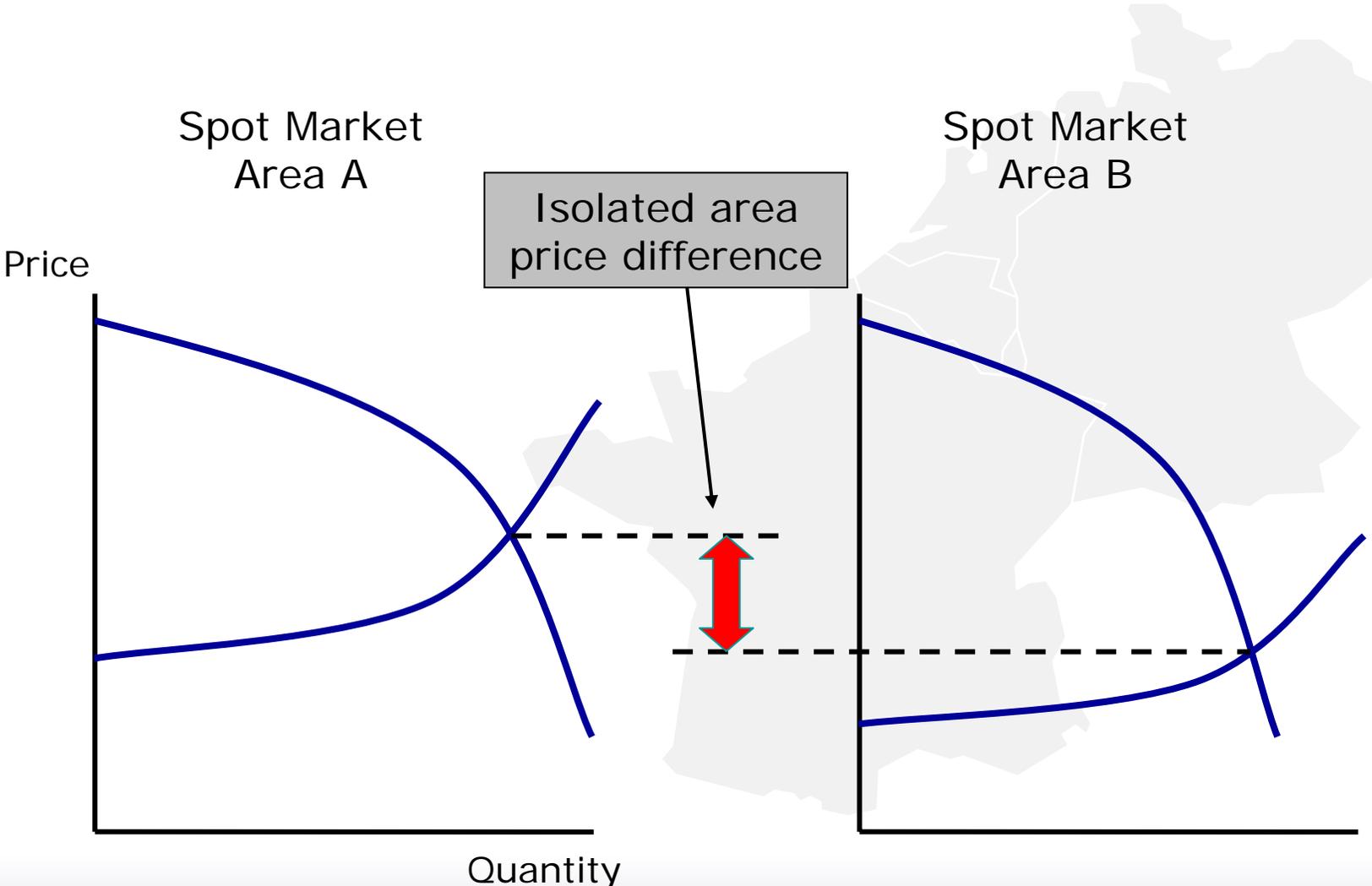
Basic price coupling

Basic price coupling

Spot Market
Area A

Coupled area
price difference

Spot Market
Area B

Price

Export volume

Import
volume

Quantity

Basic price coupling

Spot Market Area A

Spot Market Area B

Price convergence

Price

Quantity

Import volume

Export volume
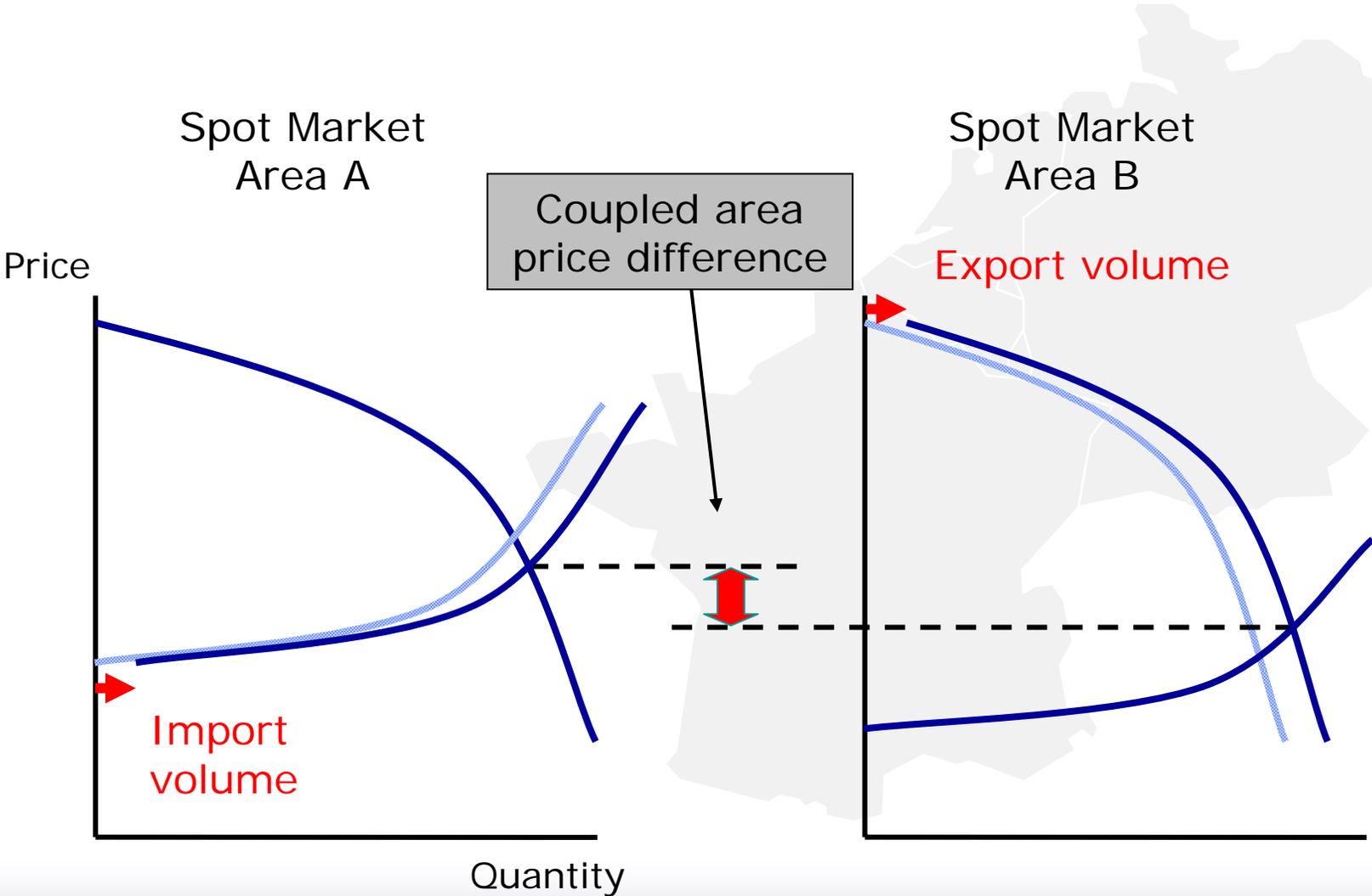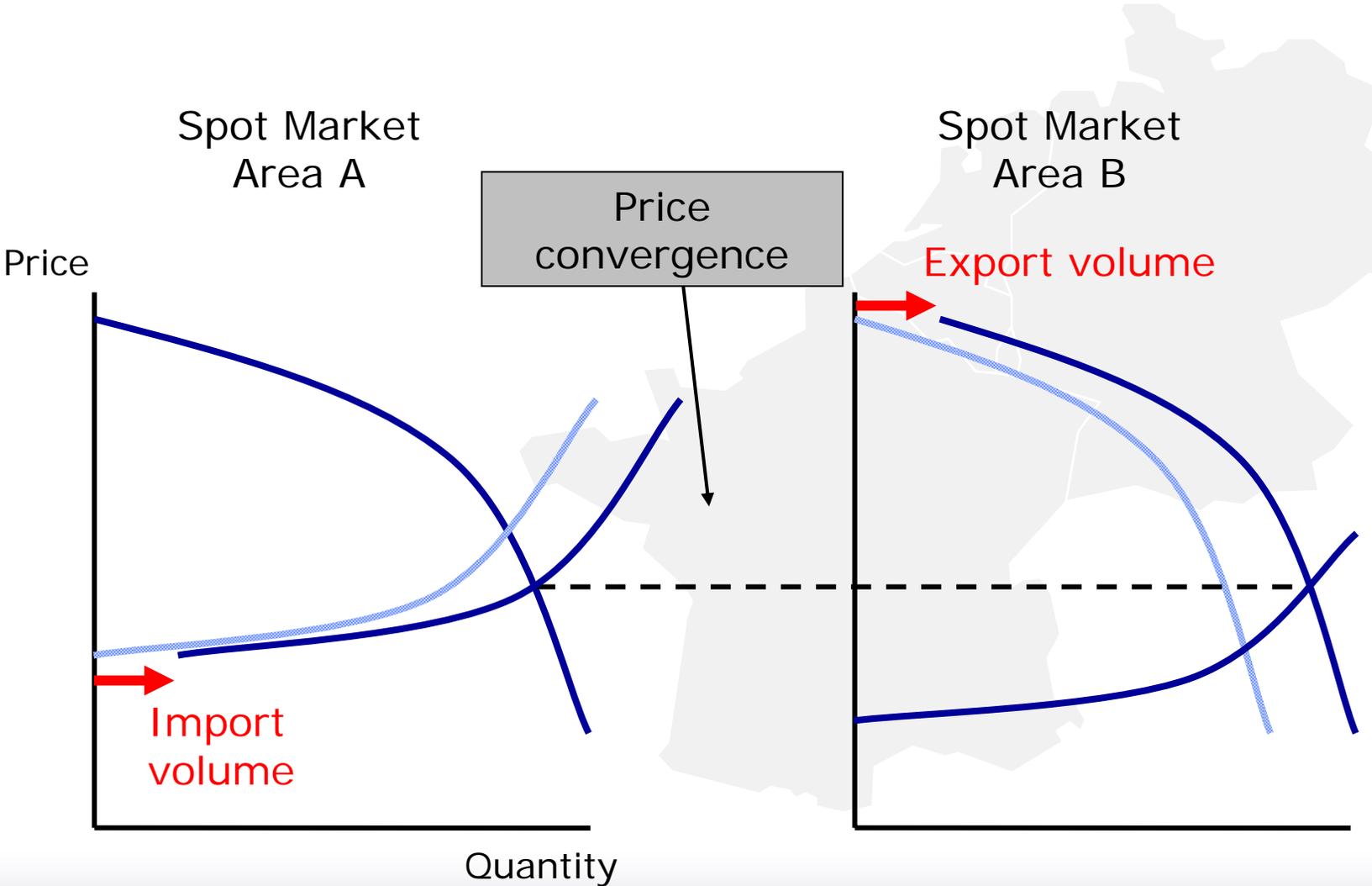
Example of achievements of price coupling: integration of price areas

1%

19%

14%

66%:
"Copper plate"
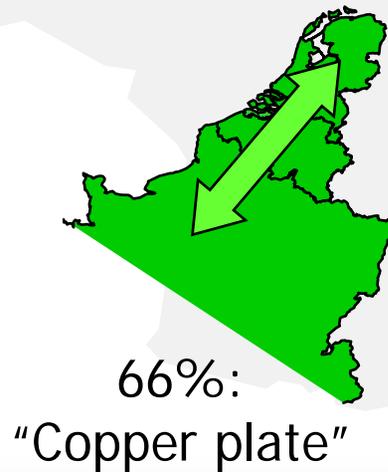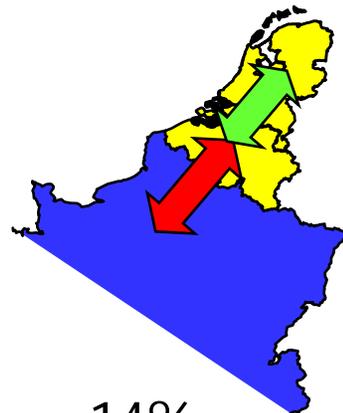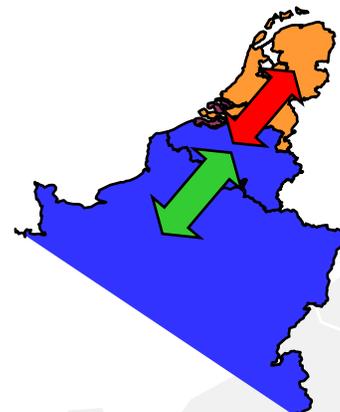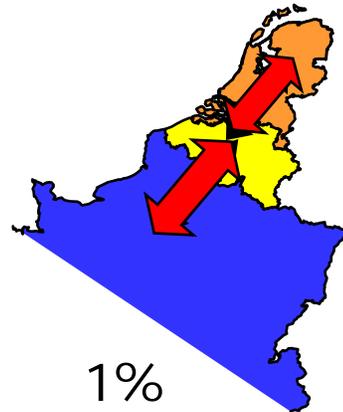
Either prices will converge 100%, or prices diverge –but then the transmission capacity used for 100%

→Better price index

→Better efficiency and better economic results

→Better basis for long-term contracts & investments

Shown are the data for the entire TLC history until July 2009
Percentages vary.

Prospective 2010 implicit auction market regions
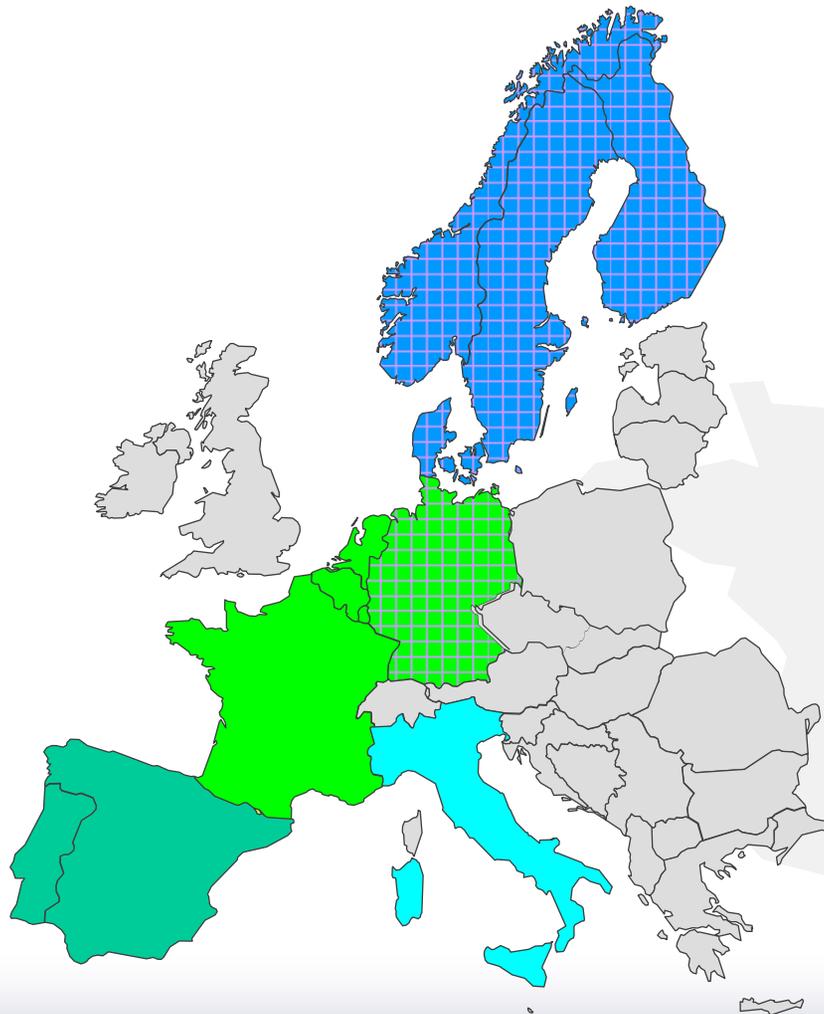
| REGIONAL IMPLICIT AUCTIONS		
	Nordic	Market splitting/ATC
	CWE	Price coupling/FB
	EMCC	Volume coupling/ATC
	Iberian Peninsular	Market splitting/ATC
OTHER IMPLICIT MARKET REGIONS		
	Italy	Market splitting (internal market boundaries)/ATC

No congestion (joint bidding areas):
- Austria – Germany
- Rep Ireland – N. Ireland

Project Status and Planning

The CWE MC Project

- The objective according to the MoU for CWE signed on 06/06/2007:

  Implement a flow-based Market Coupling solution in CWE Region

- Accomplished so far:
- Design phase : Finished in September 2008
  - TSO preliminary study (10/07/07)
  - Project plan
  - Orientation Study (Pentalateral Energy Forum, 14/02/08)
  - Market Parties Consultation (May 2008)
  - Progress report (Pentalateral Energy Forum, 15/05/08)
  - Decision to launch ATC based Market Coupling First and organise a parallel run test to validate Flow Based Market Coupling (07/2008)
  - Implementation Study (08/2008)
  - Addendum Implementation Study (09/12/2008)

- Implementation phase: Ongoing
  - Organizational setup/Specification : (Sept – Dec 2008)
  - System development (Reaching completion)
  - System Testing (Component testing initiated)
  - Drafting of the detailed operational procedures (Reaching completion)
  - Contractual negotiations between the CWE MC parties (Ongoing)

The CWE Market Coupling Solution
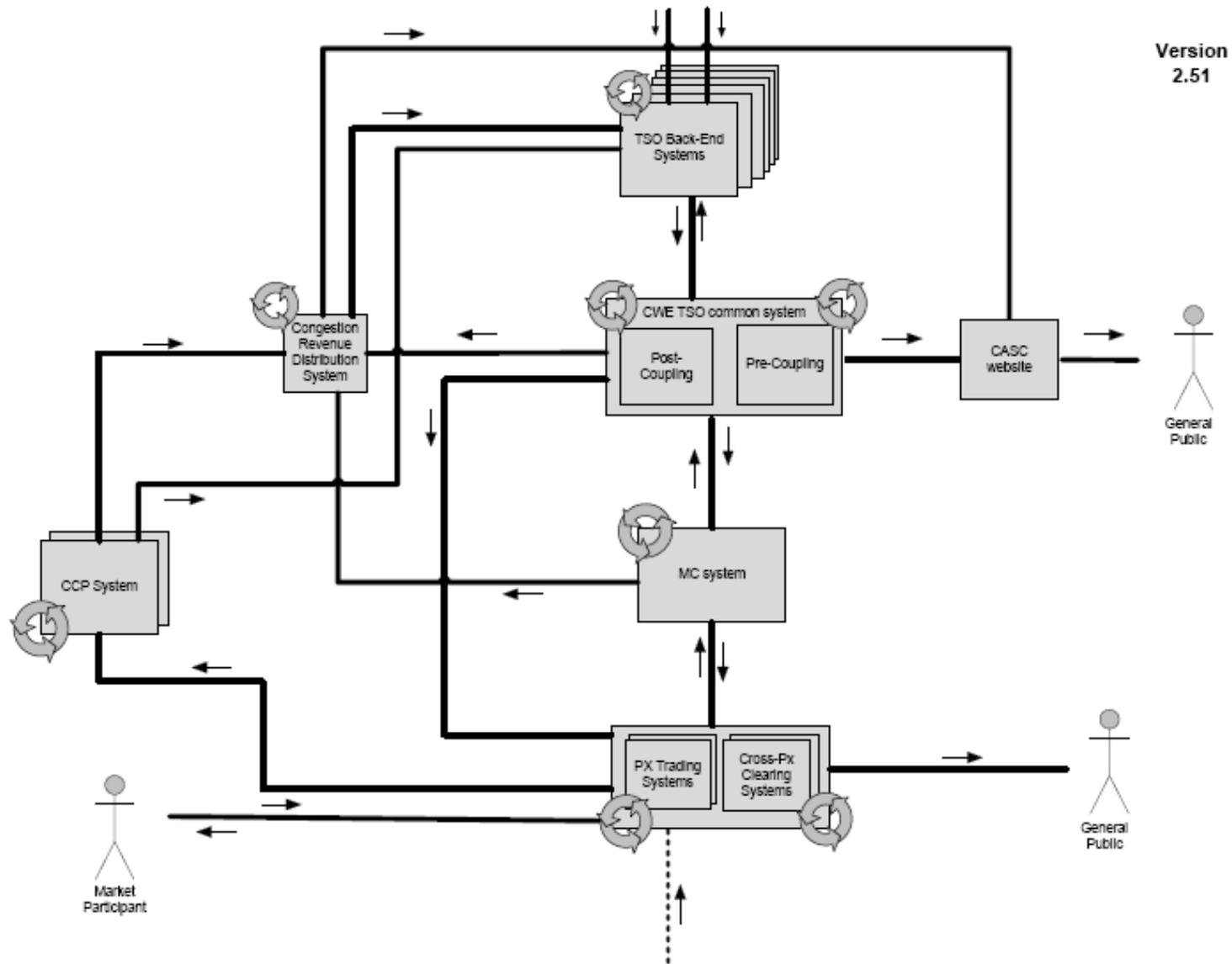
Operational responsibilities

- Individual TSO:
    - Provision of the day-ahead transmission capacity (ATC-data) to the common TSO system
- Joint TSO:
    - In shift: Common TSO system - Operation of the coordinated ATC module
    - Via CASC-CWE:
        - Common TSO system : Operation Net position validation and bilateral exchange calculation modules
        - Fall back: Operation of the shadow auction
        - Operation Congestion Revenue Distribution system
- Individual PX:
    - Provision of local order book to the Market Coupling System
    - Local Matching
- Joint PX:
    - In shift: Operation of the central market coupling unit
- Clearing houses:
    - Cross PX clearing - Cross border nomination to TSOs
    - Congestion revenue collection and transfer to CASC

Planning ATC based launch

- Testing has started on several components already

- Testing will go on in Q1 of 2010

- Fully integrated solution will be available for Market Party Simulation by end of March 2010

- Precise launch date will be communicated when full integration test has been accomplished

- In January 2010 an intermediate update on progress will be communicated

- Expected readiness to launch will be towards the end of April 2010

- Parallel run Flow Based starts after ATC launch

Minor impact for market parties in ATC based market coupling

- Contracts: minor changes, no new contracts

- Platform interface:

  - PX: roll-out of new trading platforms

  - TSO: no changes

- Clearing and settlement interface: no changes

- Auction rules:

  - Modifications in local rules to allow for the implicit (capacity + energy) allocation mechanism
  - Decoupling: Shadow Auction Rules → CASC-CWE

→ For each change, you will be kept informed timely of the appropriate procedure by your concerned counter party

Subjects for consultation

▶ Process implementation

- ▶ Cross PX harmonized/fixed publication time
- ▶ Request for quote procedure
- ▶ Level of negative prices

The CWE exchanges will consult via a joint questionnaire their respective member bases on these issues in the near future.

Process and timings

Daily schedule & market timings

- Main working assumptions

    - GCT of CWE PXs harmonized at 12:00 (PLEF, 23/08/07)

    - 20 minutes left to calculate interregional exchanges (such as for Norned cable and DE-DK cables), before start of CWE MC calculation

    - Use timings based on TLC experience

    - Coupling solution : price coupling
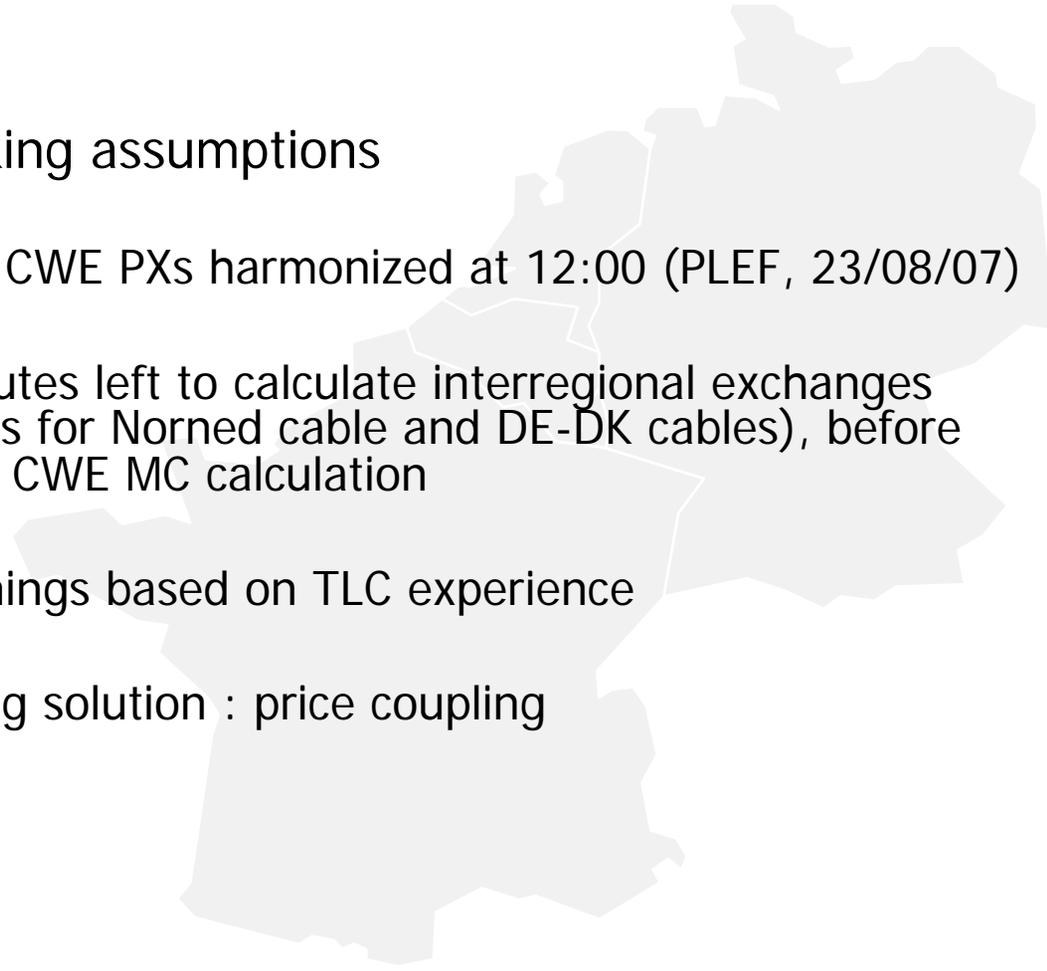
Process steps : overview

1. Calculation by the TSOs of the ATC values

2. TSOs send ATC values to the central module

3. TSOs publish ATC values

4. Market Parties send orders to the PXs before the GCT

5. PXs send order data to the central module

6. Calculation by the central module of prices, net positions, selected blocks

7. Publication of the results
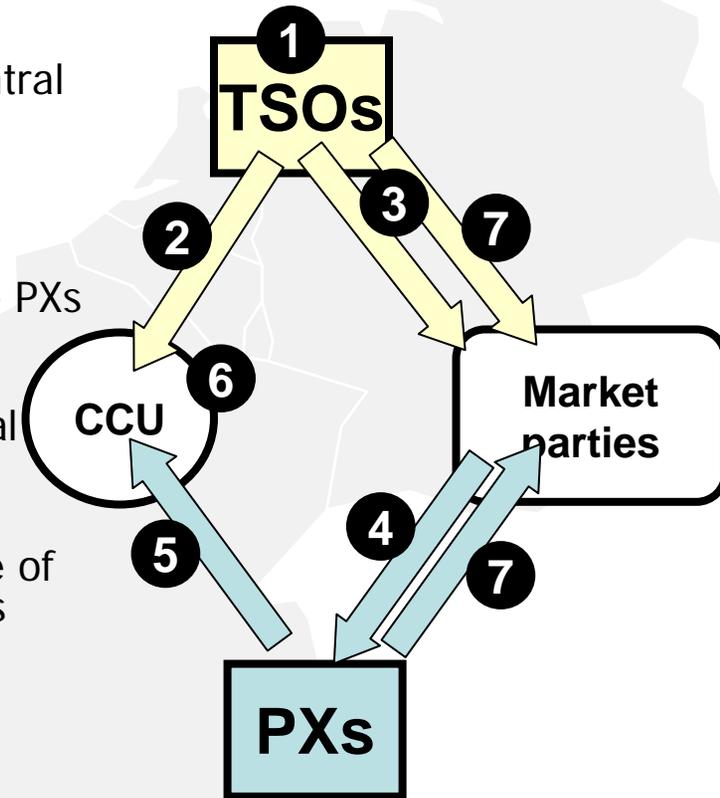
Current ATC Based time line

NETHERLANDS

LT capacity nominations	ATC published	PXs GCT	Market Results publication (TLC)	Final GCT physical positions notification
8:00	09:30-**10:00**	11:00	11:17-**11:45**	14:00

BELGIUM

LT capacity nominations				Final GCT generation schedules
8:00	09:30-**10:00**	11:00	11:17-**11:45**	14:00

FRANCE

LT capacity nominations				VPP nominations	Intended generation schedules	Final GCT generation schedules
8:00	09:30-**10:00**	11:00	11:17-**11:45**	12:00	14:30	16:00

GERMANY

LT capacity nominations	ATC published	PX GCT	Market Results publication	Final GCT generation schedules	Cut-off time
8:15	08:15-08:45	12:00	12:15	14:30	15:30

▸ Black timings are target timings
▸ Red timings are critical timings

Time schedule foreseen in CWE market coupling

LT capacity nominations	ATC values published	PXs GCT	Market Results publication		Final GCT physical positions notification	
9:00 (tbc)	10:30-11:15	12:00	12:40-13:05		14:00	**NETHERLANDS**

LT capacity nominations				Final GCT generation schedules	
8:00 (tbc)	10:30-11:15	12:00	12:40-13:05	14:30 (tbc)	**BELGIUM**

LT capacity nominations				Intended generation schedules	Final GCT generation schedules	
8:00	10:30-11:15	12:00	12:40-13:05	15:00	16:30	**FRANCE**

LT capacity nominations				Final GCT generation schedules	Cut-off time	
8:15	10:30-11:15	12:00	12:40-13:05	14:30	15:30 (tbc)	**GERMANY**

Given timings may be subject to confirmation and regulatory approval

▶ Black timings are target timings
▶ Red timings are critical timings

Coordinated ATC calculation
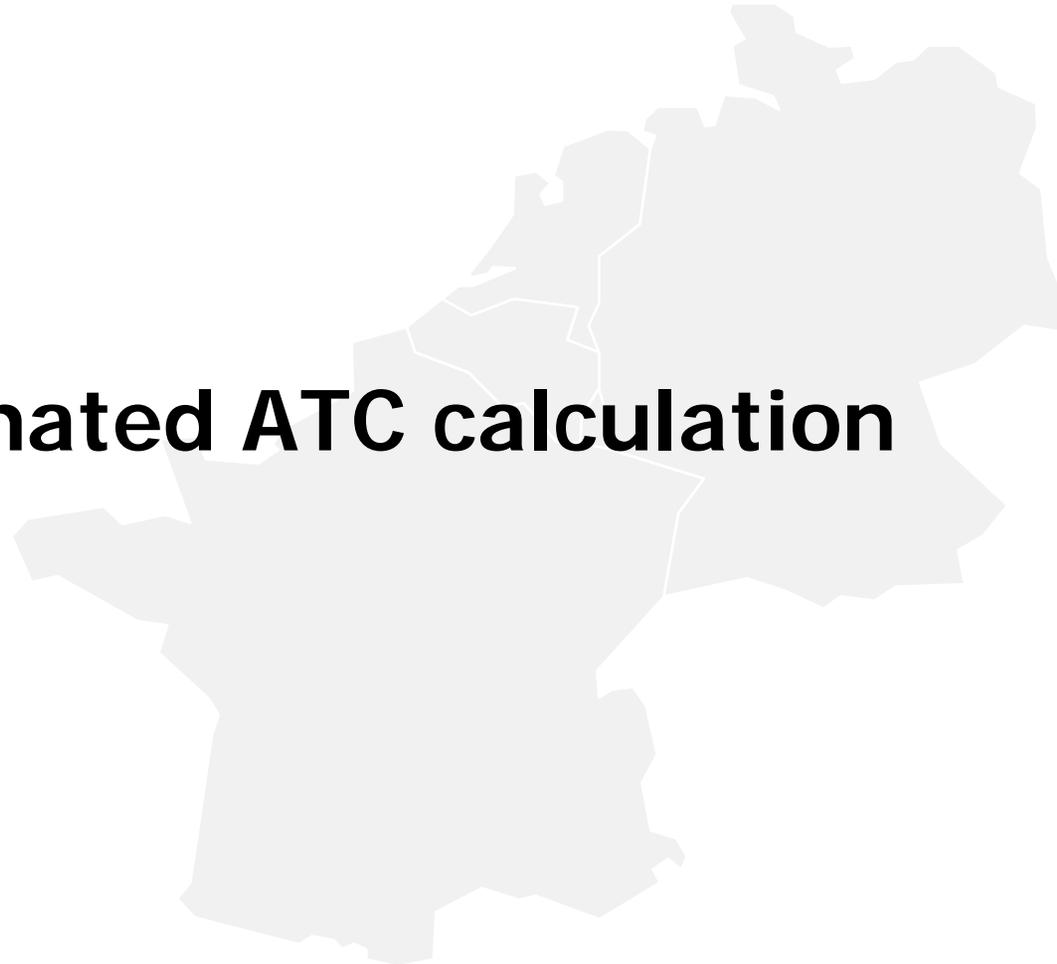
Objectives

- Enhance the way in which TSOs facilitate the market and safeguard the grid by striving for an increased level of coordination

- Increase coordination between TSOs in the allocation of capacity, using methodology as close as possible to what we have today, both for the market and for TSOs

- Perform a indispensable gradual step towards the introduction of a more advanced grid model for capacity allocation

Coordinated ATC calculation

Today:

bilateral coordination process where NTCs are shared between neighbouring TSOs

Partly "multi-border" co-ordination (e.g. Export D-NL/F/CH)

for CWE MC

we change to a regional coordination process where NTCs are shared and evaluated by all TSOs of the CWE region

from NTC to ATC:

ATC = NTC – NTF (Notified Transmission Flows) (ETSO Definition)

Coordinated NTC approach
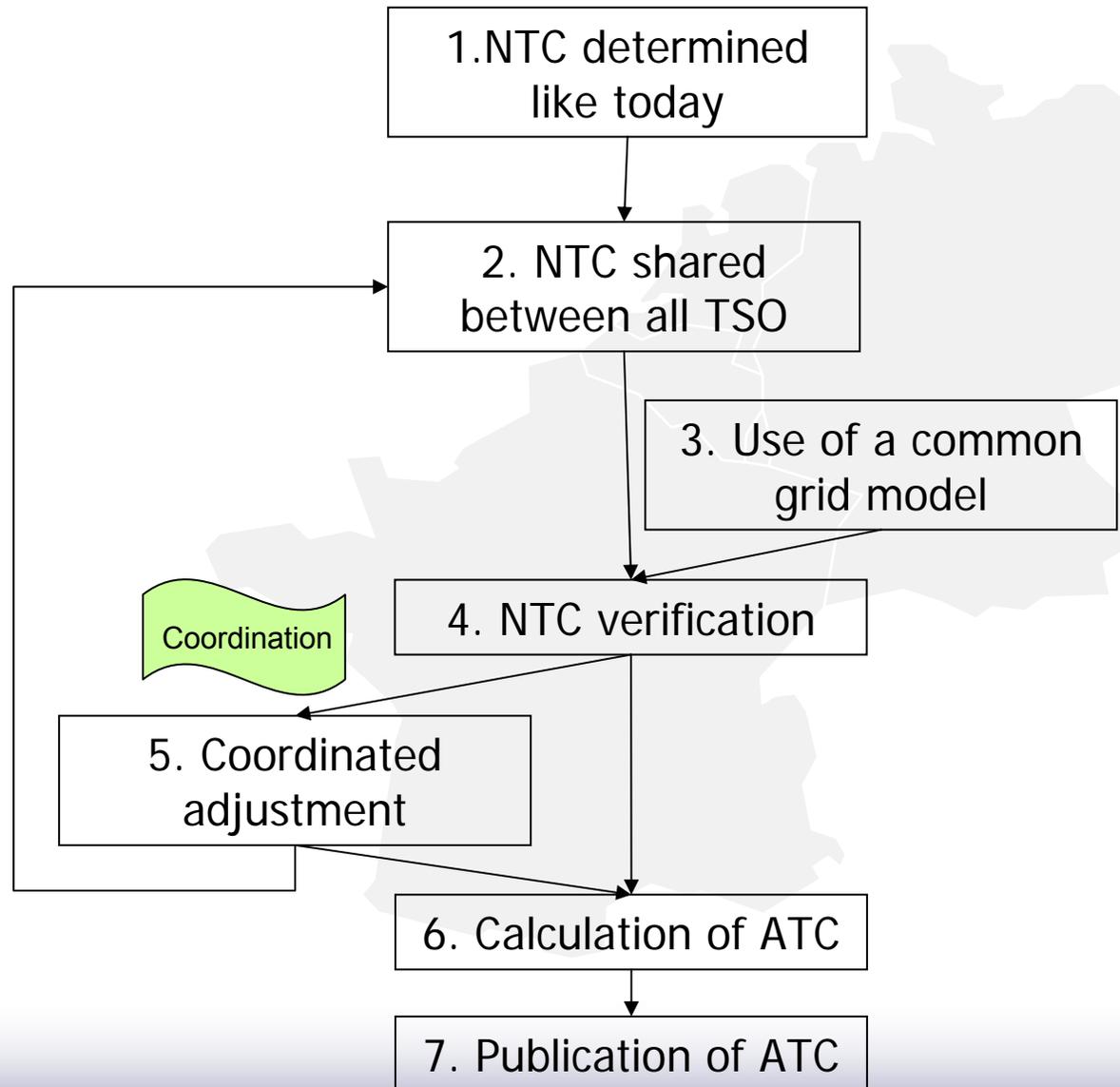
D-2CF base case: merging

▶ the models of the TSOs and non-participating TSOs are merged centrally:
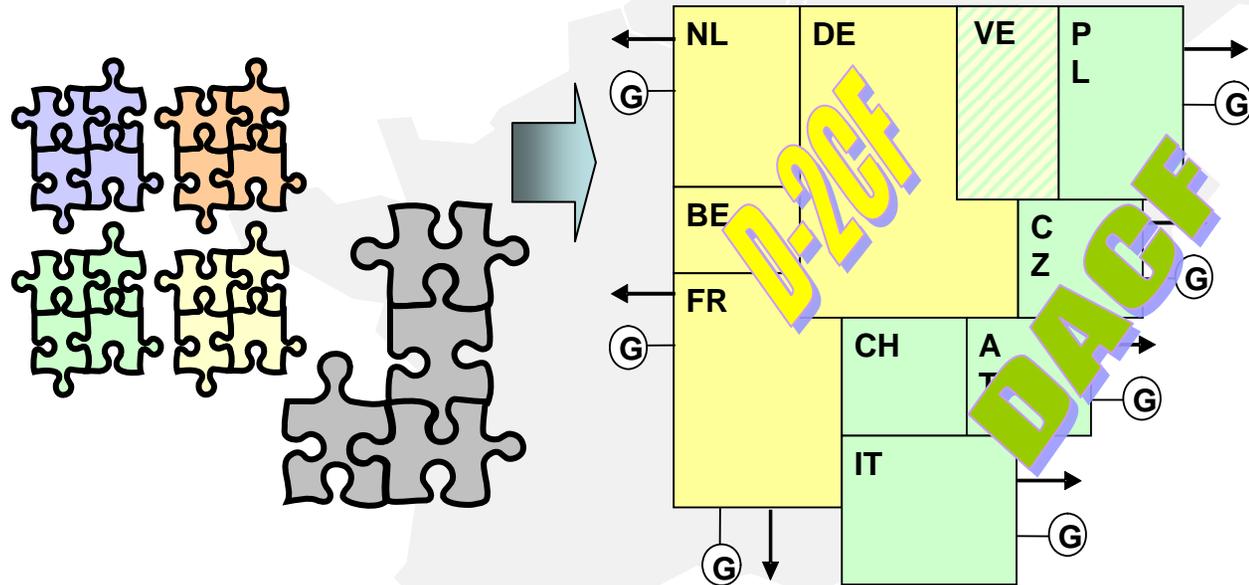
Similar to the Flow Based method
Time Frame: peak and off-peak

16 NTC combinations

- 4 electrical borders
- 4 country-to-country NTCs
- in both directions

- 16 (=2^4) corners of the NTC space, in which the grid security should not be violated
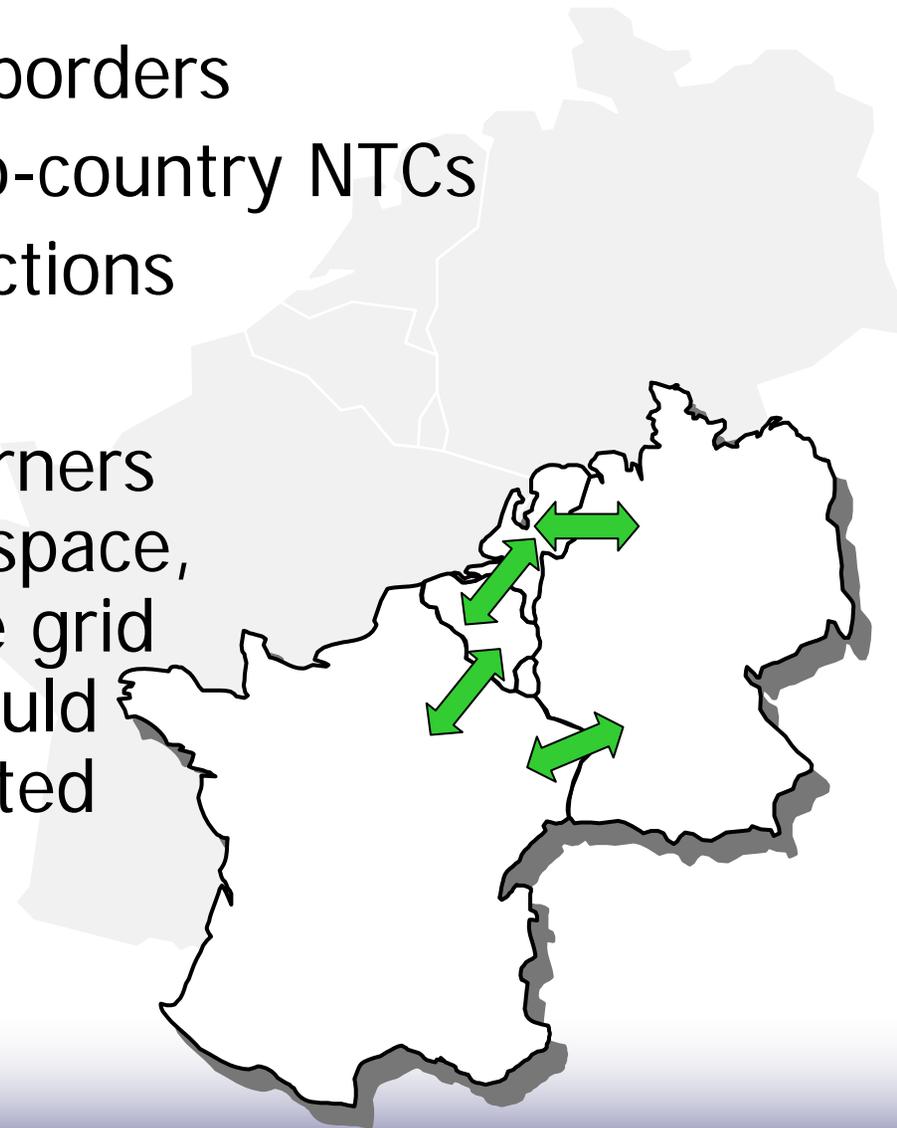
NTC verification & adjustment

- 32 cases to be potentially checked
  - 16 NTC "corners"
  - common grid model (peak / off-peak)

- Each TSO can select the most meaningful ones for its grid and make a grid security analysis
- Assessment done via a coordinated and harmonized procedure
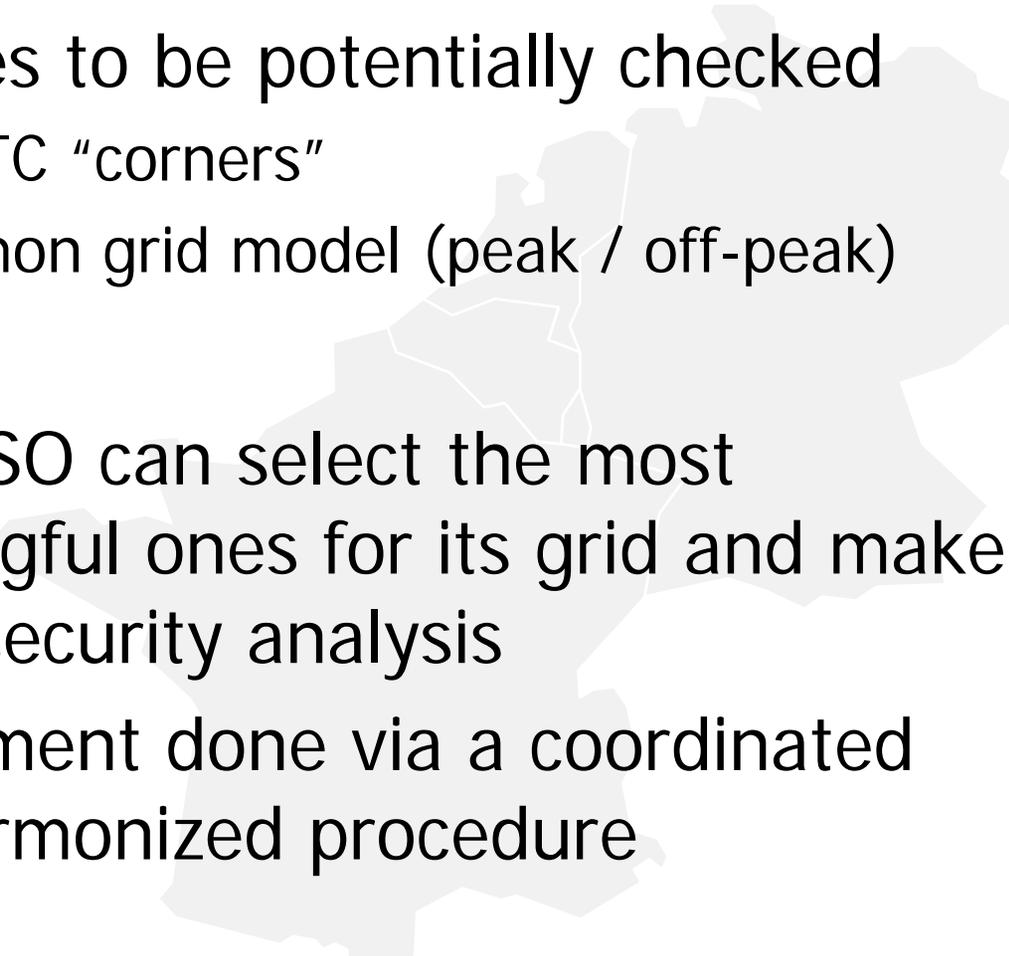
Advantages

- Improved regional view between TSOs
  - TSOs share regional data and coordinate on potential problems on a daily basis
  - Harmonised approach

- Better reflection of actual grid conditions:
  - NTCs are expected, where grid conditions are comparable, to be similar to today on most days (i.e. non-stressed days)
  - NTCs can be lower in stressed cases, maintaining required security of supply

- Results will be discussed with regulators and presented at the PLEF

- Step towards the Flow Based target
  - Daily use of a common base case is a key element of the fine-tuning of the Flow Based method

Conclusions

- Launch of the coordinated ATC calculation together with CWE MC

- Improved coordination
  - From bilateral to regional

- Step towards Flow Based
  - Common grid model
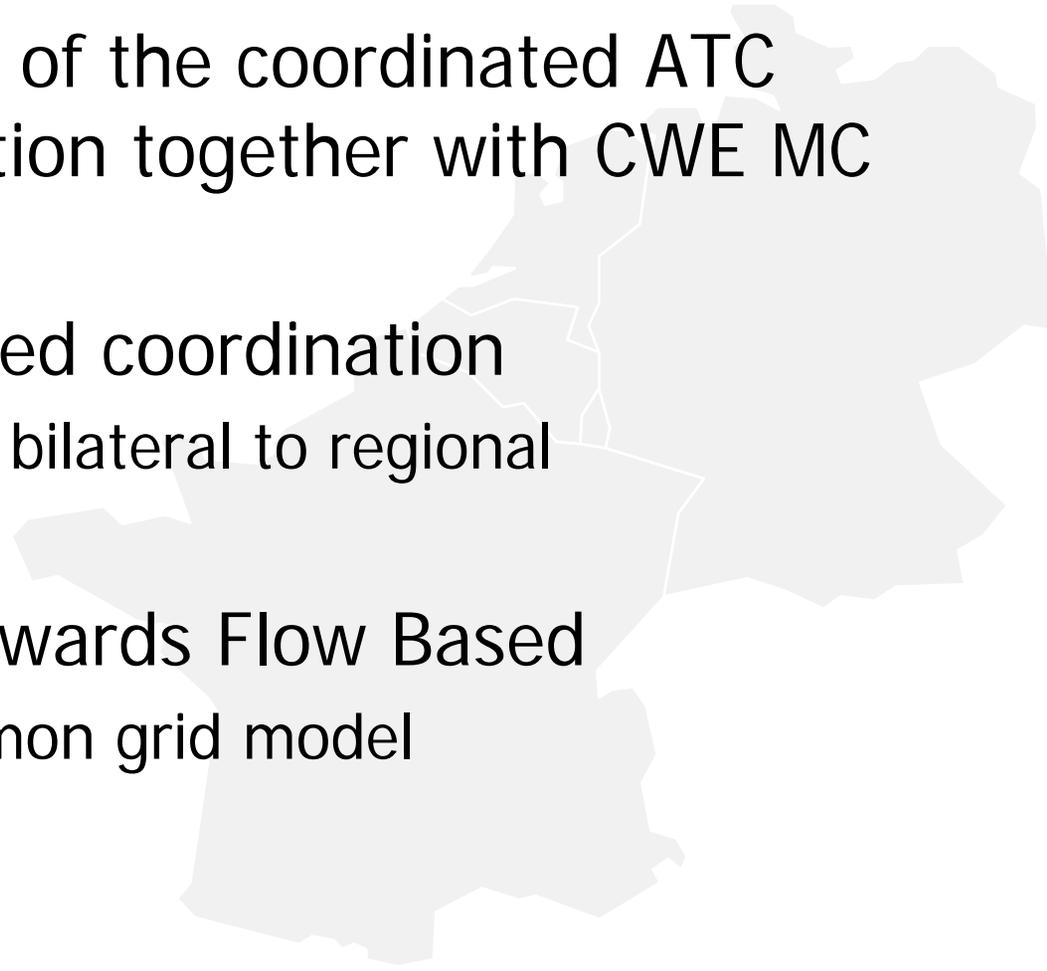
Fallback

Fall back solution

Fallback

- **Fallback situations are likely to be rare**

- Fallback is ...
    - When *Market Coupling fails and does not provide results before critical deadline*

- Chosen solution: Shadow explicit auctions

    Option presented by some market parties in May 2008 has become the fall-back mechanism

Fallback arrangement

1) "shadow explicit auction" of capacity
2) Isolated fixing of the PXs

Shadow explicit auction:
- Permanent database of capacity bids
- All pre-registered market parties may add, modify or withdraw bids for capacity
- In normal operation, these bids are not used
- In fallback situation : database is frozen at time of announcement of fall back
- Fallback explicit auction is performed according to merit order defined by the bids

Isolated fixing of the PX's:
- Reopening of order books
- Orderbooks are closed after capacity allocation
- Local matching
- Publication of results

Advantages of the chosen solution

- ▶ Common procedure for all borders via CASC CWE
- ▶ Favour energy trading to capacity trading
- ▶ Flexibility to adjust capacity bids whenever you like
- ▶ Clear position on each market and the interconnections
- ▶ Market based mechanism
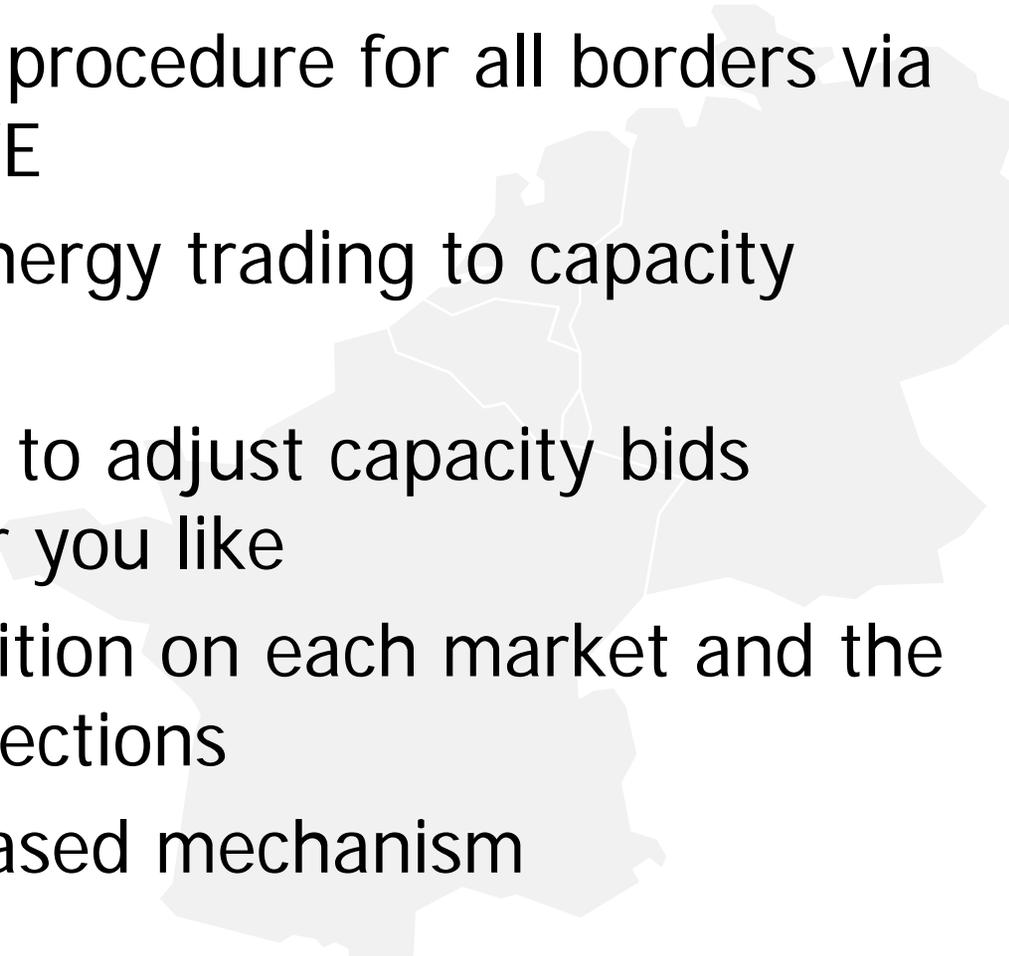
Price calculation
Economic assessments
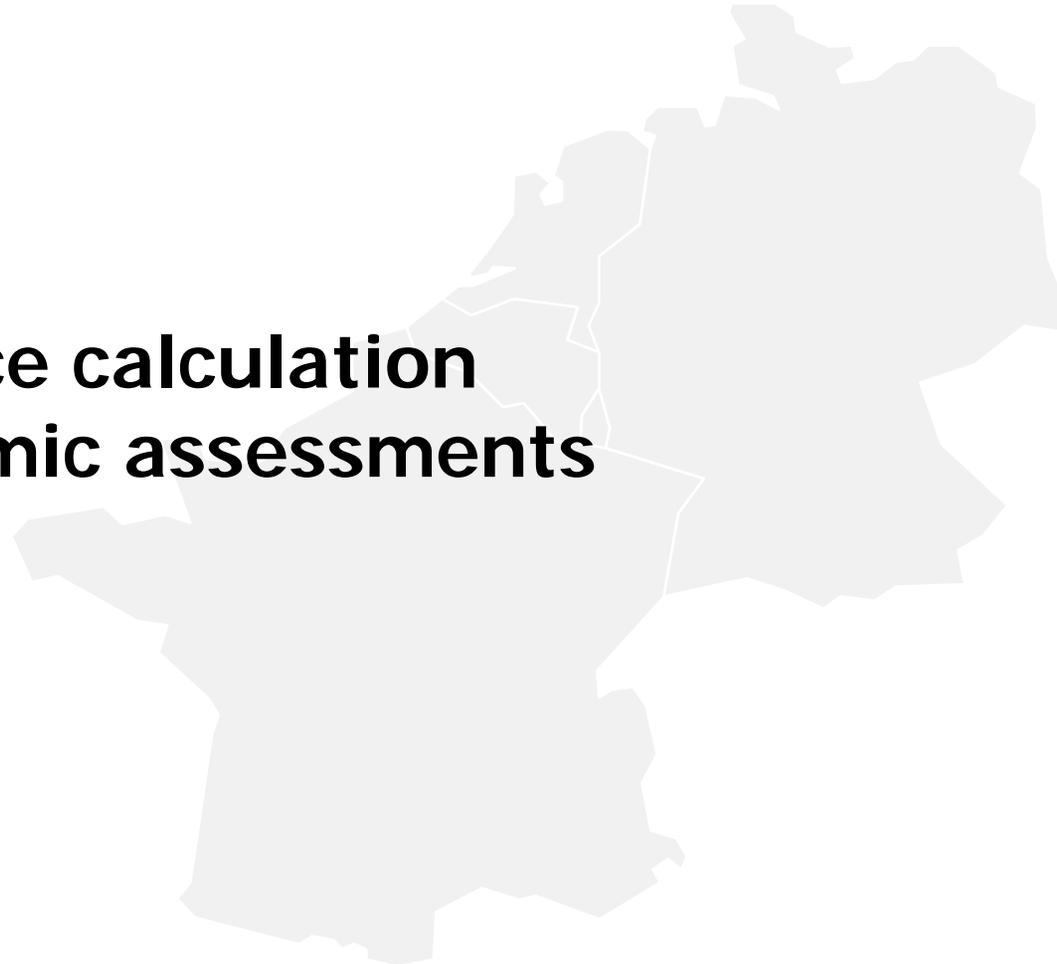
Price calculation

Price calculation

- Determination of hourly prices and volumes of the different hubs
- Taking into account
  - interconnections
    - ATC

    OR

    - Flow-based
  - order books of the PX's
    - Hourly orders

    AND

    - Block orders
- With existing local rules in terms of price ticks, volume ticks, price boundaries,...
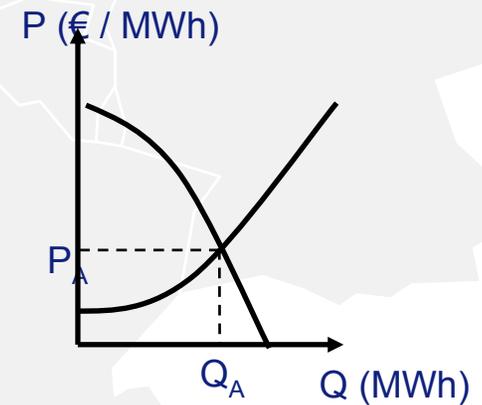
New coupling algorithm: Cosmos

Common CWE partners selection process
1. Determination of requirements for an enduring algorithm
2. Evaluation of different algorithms of the partners
3. Cosmos is unanimously chosen by internal and external experts as fixing algorithm for CWE market coupling
4. Cosmos is owned jointly by all CWE PX's

Coupling Of Spot Markets with Optimal Solutions

Flexibility in handling grid models

- Cosmos is based on a clear and sound understanding of the problem and properties of its feasible solutions
- Technical constraints of the electricity grid can be taken into account:
  - Ramping constraints
  - Grid losses
  - Commercial cables
  - ...
- Cosmos facilitates both ATC and Flow-based models
- Allows for geographical expansion

Flexibility in order book handling

▶ Cosmos supports current order types offered by the CWE PX's

▶ And other order types*

Simple hourly orders

Profile block orders
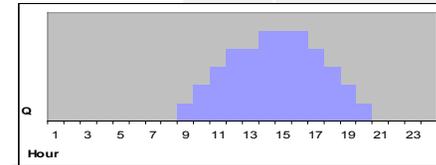
Linked block orders
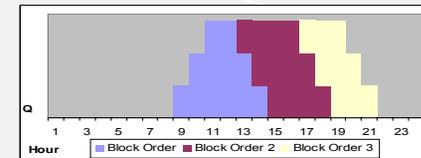
Block orders

Volume flexible block orders

Flexible hourly orders

Exclusive orders

*Introduction of new order types depends on the functionalities offered by the local trading platforms

Performance

Cosmos:

- ▶ ... uses robust mathematical concepts and state-of-the-art solving methods to solve problems with "fill or kill" conditions
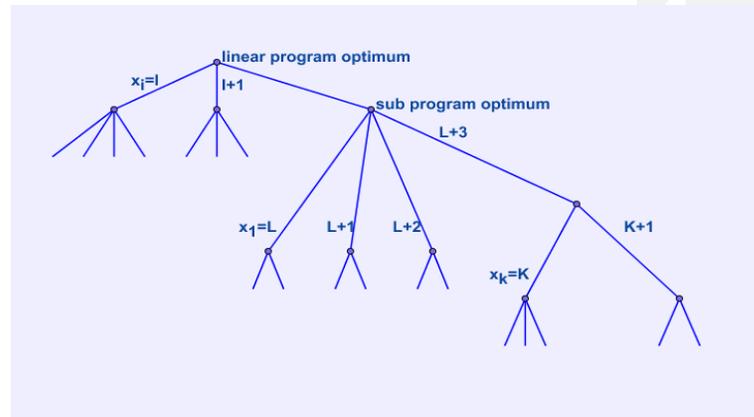
- ▶ ...finds quickly a very good solution in all cases (i.e. less than 10 sec. even with problems with 350000 hourly orders and 1800 blocks) and improves it whenever possible

- ▶ Transparency:
  - ▶ The algorithmic concepts have been validated by a panel of external experts
  - ▶ a detailed description of Cosmos' calculation will be provided by the CWE PX prior to the launch of CWE

Curtailment and
negative price boundaries

Curtailment sharing principle
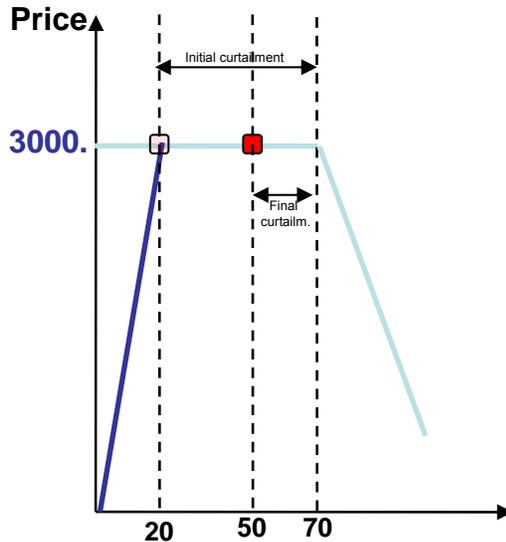
ATC = ∞
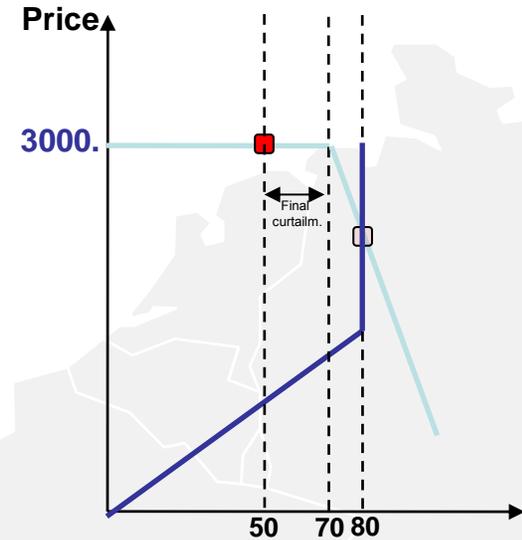
Isolated situation

50 MW curtailment   no curtailment

Market coupling convergence

p=3000; import >= 10 MW   p=3000; export >= 10 MW

Total non-solvable curtailment: 40 MW

• Equal sharing rule   • Equal sharing rule
  final curtailment: 20 MW   final curtailment: 20 MW

Equal sharing curtailment rules aims at minimizing curtailed volume
or equivalently maximizing the acceptance of price taking orders
while apportioning curtailment on a equal sharing basis

(the exact rules to unambiguously apportion curtailed volumes shall be provided in written later on)

Price boundaries harmonization

- Current situation
  - TLC markets do not allow negative prices
  - Negative prices are possible in Germany
- Target situation
  - All markets have harmonized price boundaries
- Possible temporary situation
  - It is likely that some markets will launch negative prices shortly after CWE-MC go-live
  - This would imply that Cosmos might have to temporarily manage non-harmonized price boundaries
  - The difficulty is to avoid supply orders which are not allowed to be negative to be discriminated against negatively priced orders
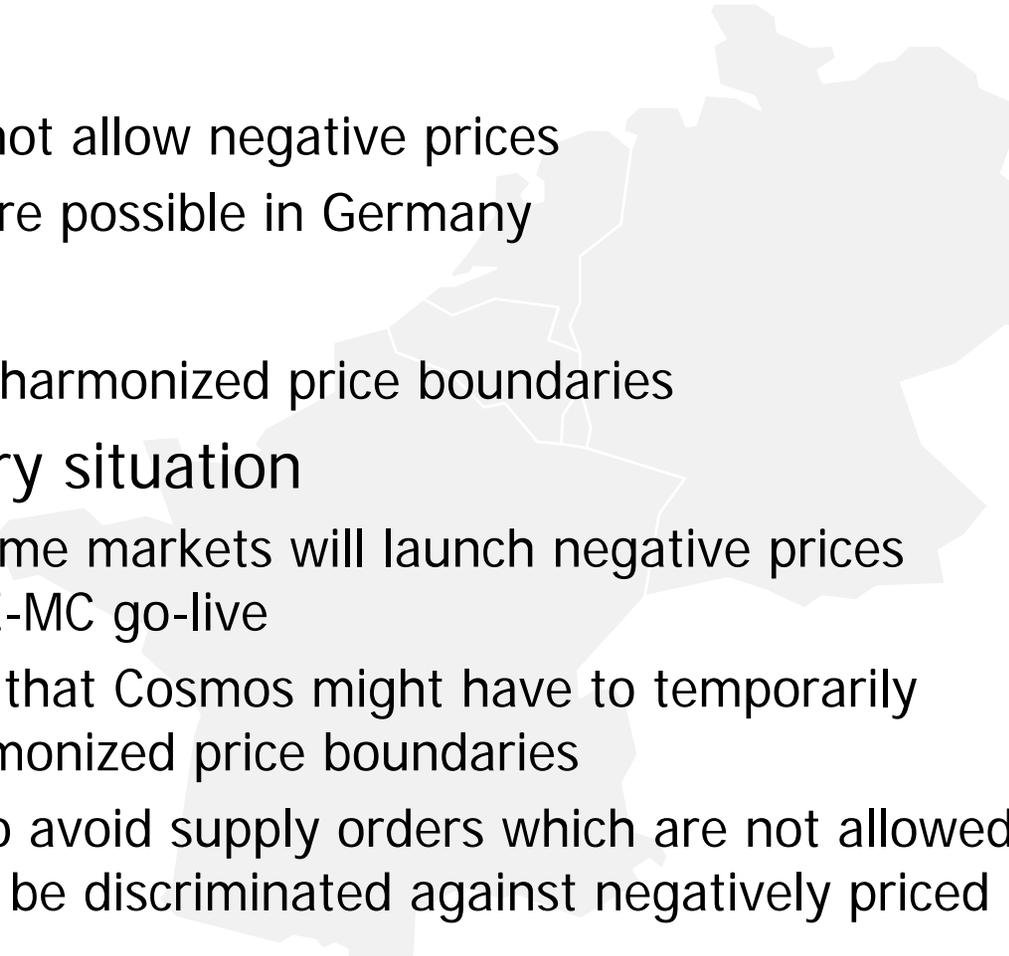
Description of the issue

- ▶ Markets where participants can not expressed their negative marginal costs are disadvantaged because price taking orders in these markets are substituted by negatively priced orders

ATC = ∞
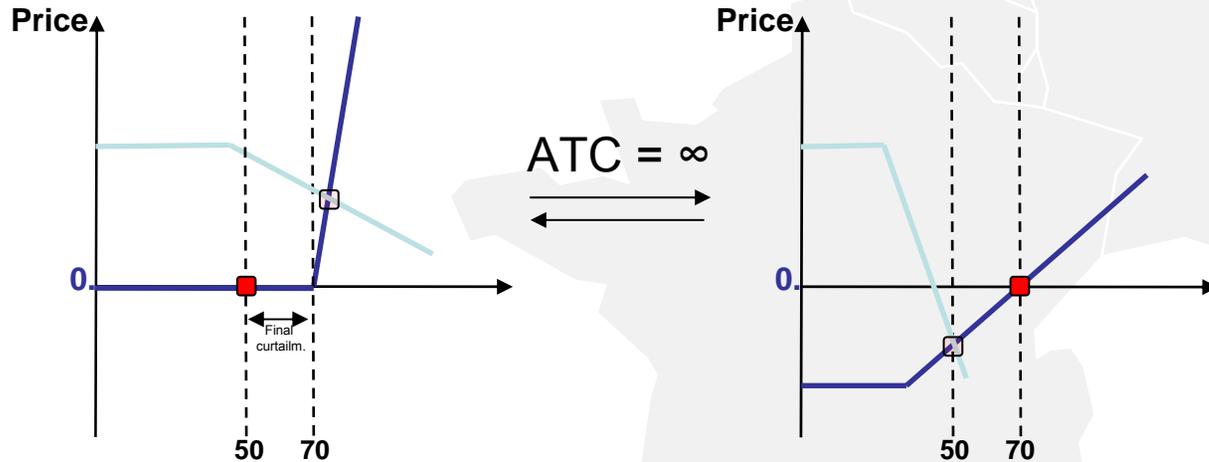
- ▶ This might be seen as discriminatory since curtailment might prevent participants to close their position
- ▶ Therefore specific rules have been implemented in Cosmos

Non-harmonized boundaries rules

- The principles of curtailment sharing (see above) still apply
- However, the algorithm enforces the acceptance of price taking orders at the most restrictive price boundaries:

  price taking orders at 0.01 €/MWh are forced to be accepted (if hourly demand orders allows it)
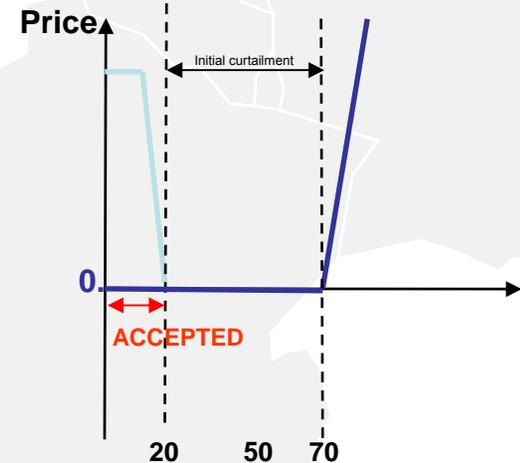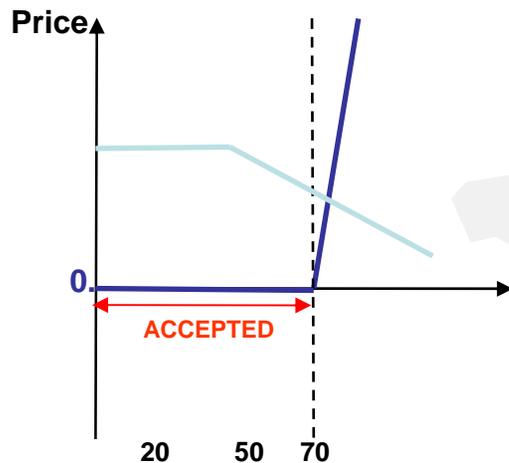
- The objective is to avoid that price taking orders in markets that do not allow negative prices are substituted by negatively priced orders

Example with COSMOS

▶ In practice, this means that markets which do not allow negative prices will not see their curtailment increasing with market coupling


ATC = ∞
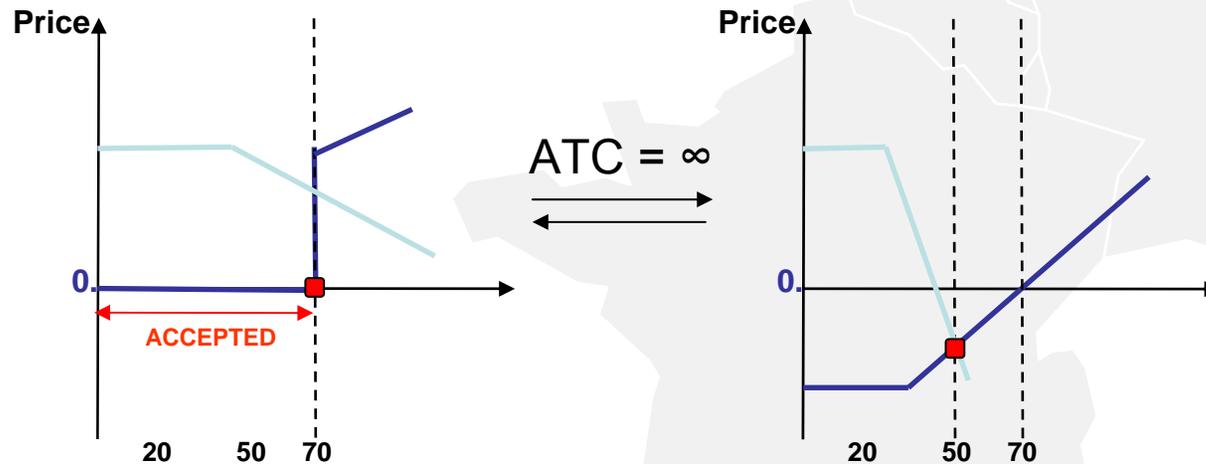
▶ Technical consequences :
  ▶ Price differences might exist even with no congestion
  ▶ Curtailment sharing no longer applies on orders at 0.01 €/MWh

Economic assessments

Effect on the prices

- Increased convergence
- Smaller markets experience larger impact
- Annual baseload prices 2007 below:
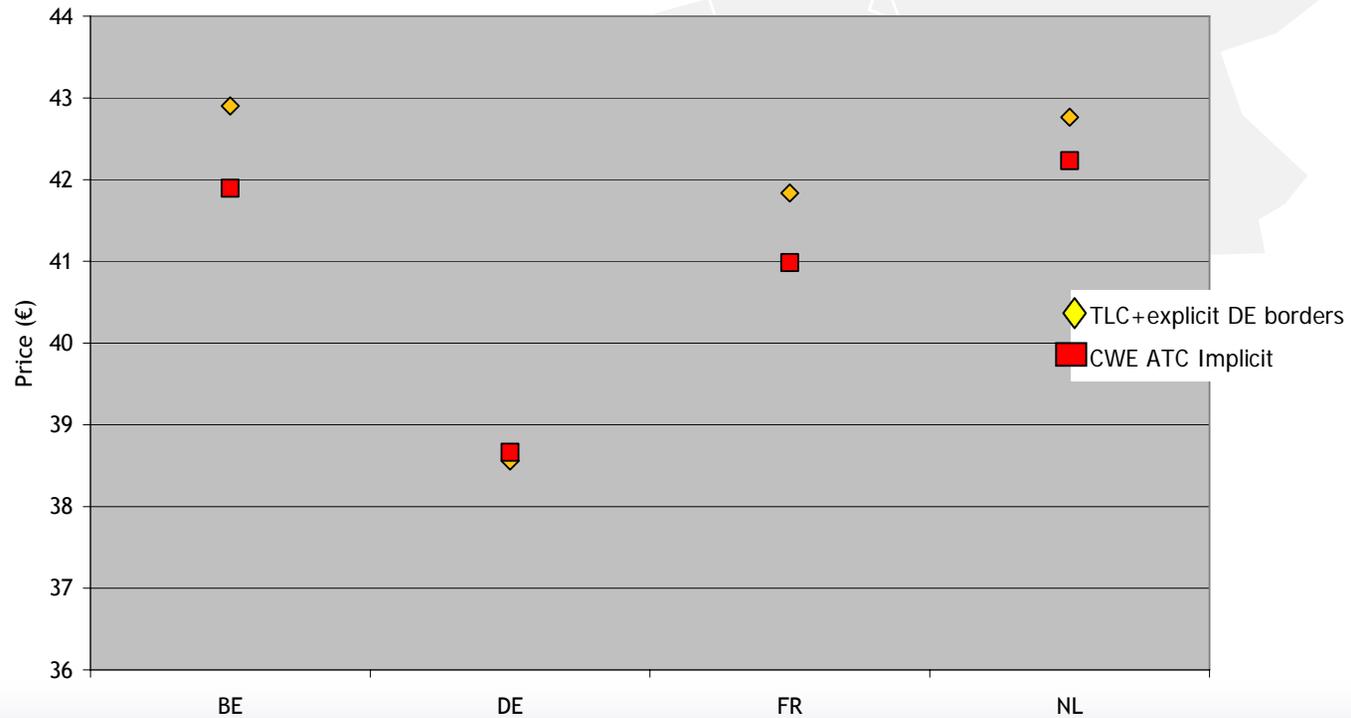
Convergence scenarios

- Large overall convergence
- Two major blocks:
  - FR-BE
  - DE-NL


Legend:
- Full price convergence
- FR=BE=NL <> DE
- FR=BE <> NL <> DE
- BE=DE=FR <> NL
- BE=FR & NL=DE
- BE=NL<>DE<>FR

historic:
- BE=NL&DE<>FR; 9,47%
- 26,26%
- 62,81%
- Full price convergence; 0,17%

CWE:
- BE=FR&DE<>NL; 4,67%
- BE=FR&NL=DE; 14,90%
- 9,68%
- BE=DE=FR<>NL; 4,98%
- 61,07%
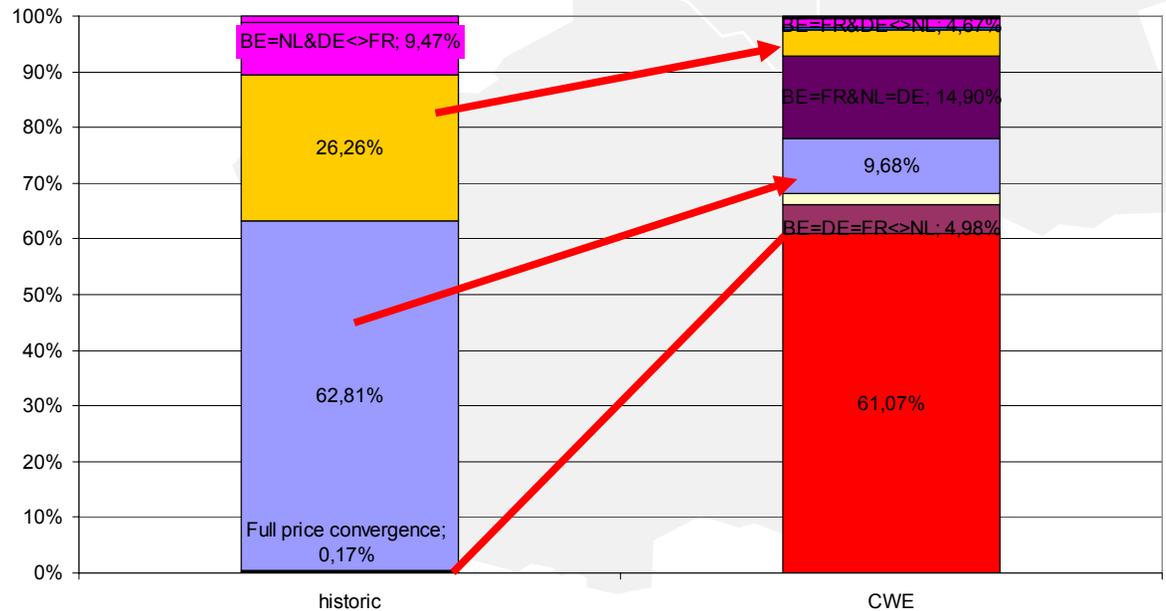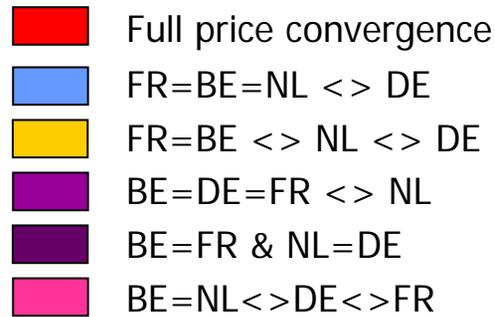
Optimisation Use of Interconnectors

FR - DE Interconnector usage (2007)

28% negative spread flows

NL - DE Interconnector usage (2007)

37% negative spread flows
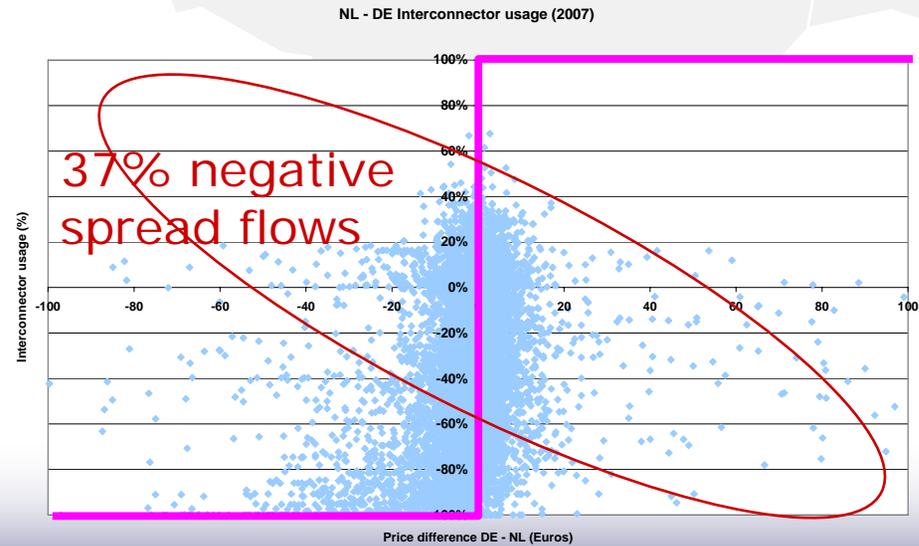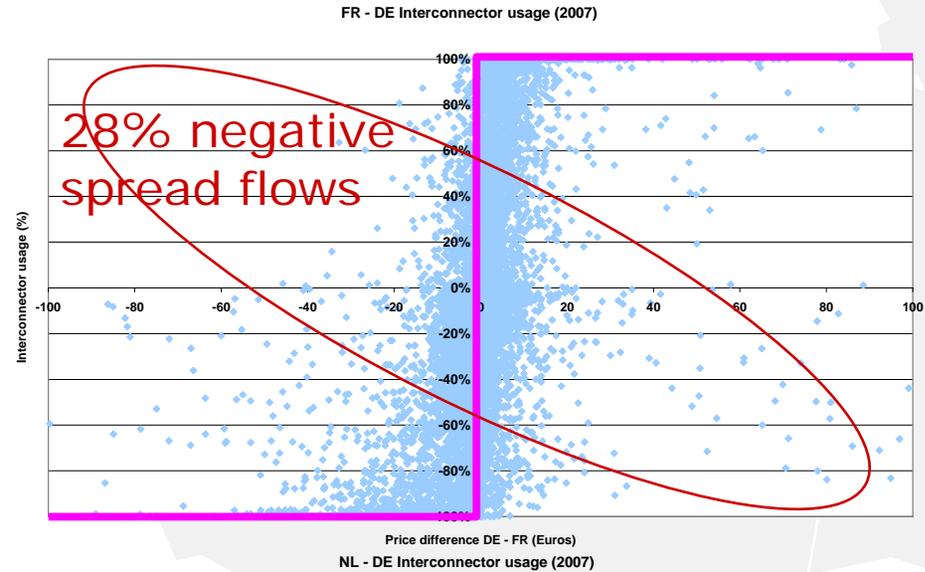
# Price convergence

- Increased price convergence
- Reduced volatility
- Structural differences remain
- Spikes are leveled

Price divergence
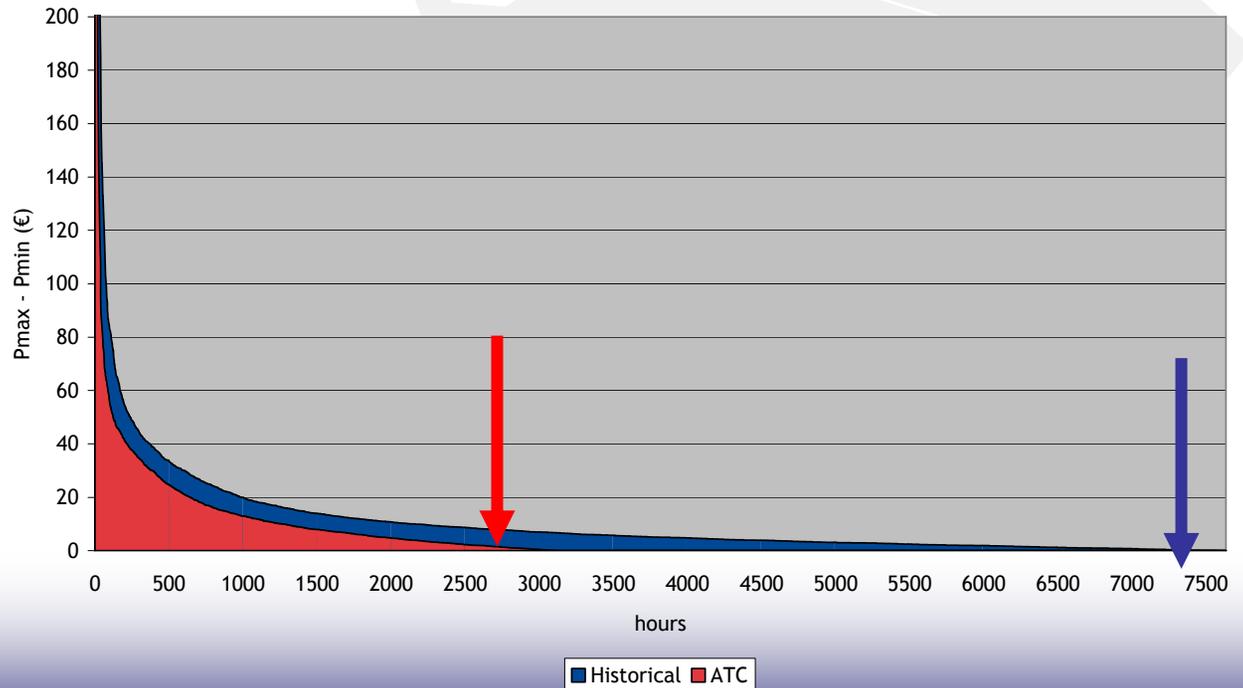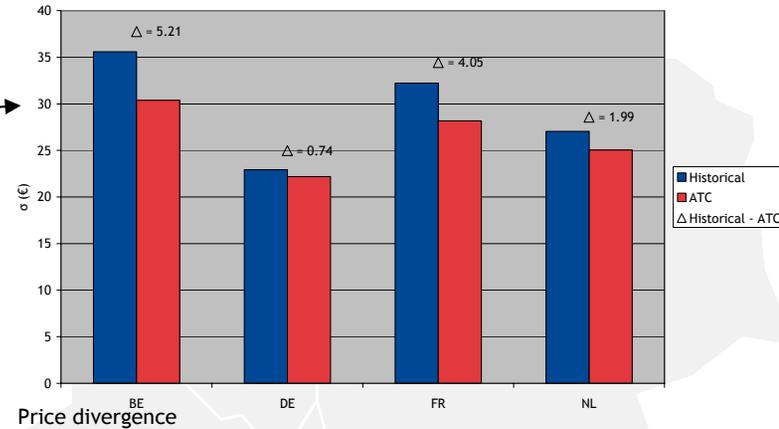
Main facts

- ▸ Full price convergence between the CWE countries in over 50% of the time
- ▸ Reduced volatility
- ▸ Efficient use of the capacity
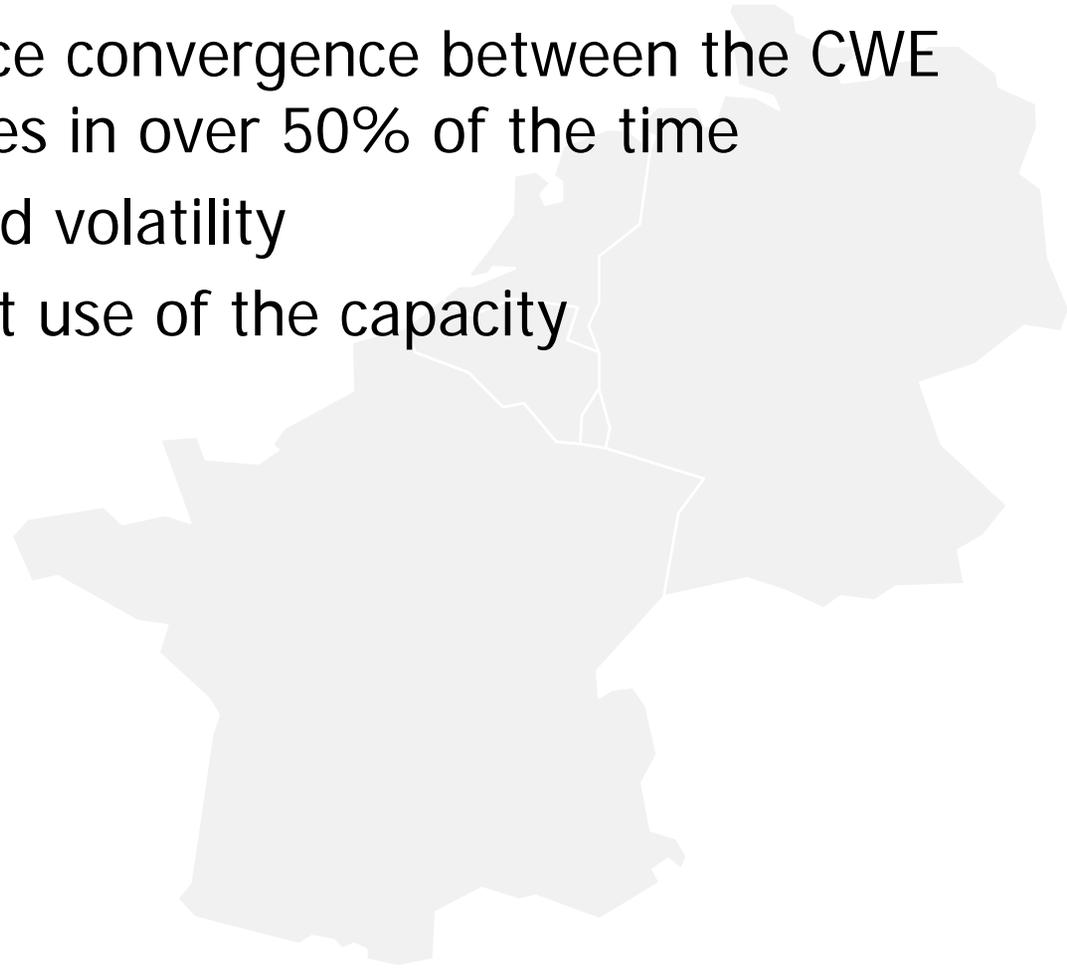
Flow-based Market Coupling

Why Flow based -1

▶ In a meshed grid like CWE's one, ATC's are interdependent

▶ With ATC model, TSOs chose ex-ante the « best » set of ATC

  ▶ Need to anticipate market player's preferences among an infinity of possible choices

▶ With FB model, the TSOs simply provide the available margins of the grid

  ▶ It is up to the market how to use it

➔ **Maximizing the economic surplus in coupled region compared to ATC and co-ordinated ATC based**

Exchange$_{A=>C}$

400

Operational point of the reference case

300

200

100

0

Exchange$_{A=>B}$

-400   -300   -200   -100   0   100   200   300   400

-100

-200

-300

-400

········ constraints polyhedron   security domain

☐ NTC   ☐ Implicit flow-based
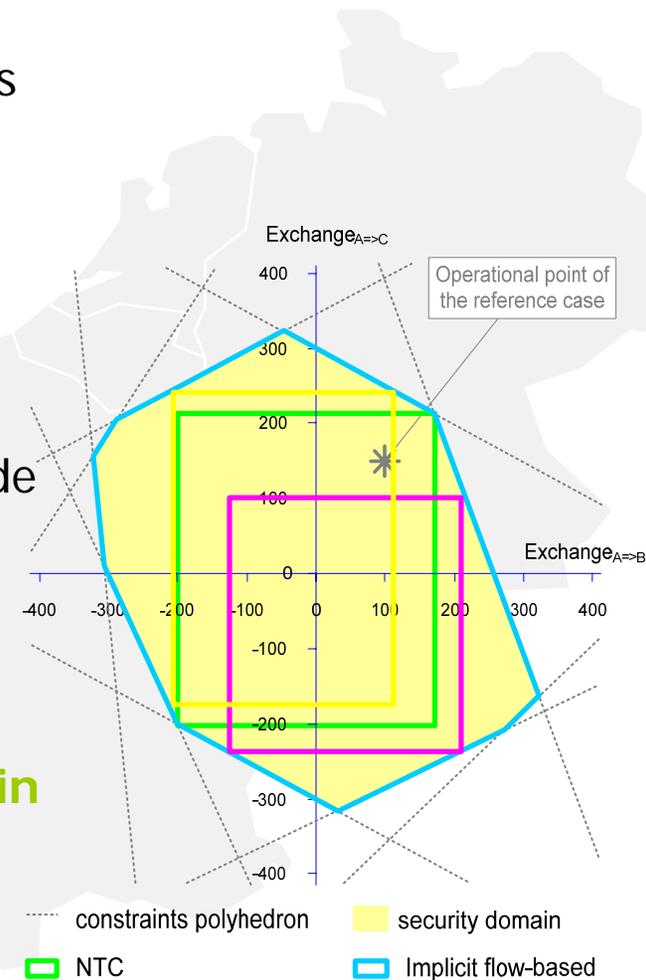
Why Flow Based -2

- For a transaction from DE to FR, only a portion of the power will flow via the DE-FR border,
  the rest flowing via the DE-NL-BE-FR loop
  (or via DE-CH-FR, DE-AU-IT-FR,...)

- The apportioning of these flows is determined by physical laws (Kirchhoff)

30

30

30

100

+100

35

24

21

-100

⬆ **commercial flows**
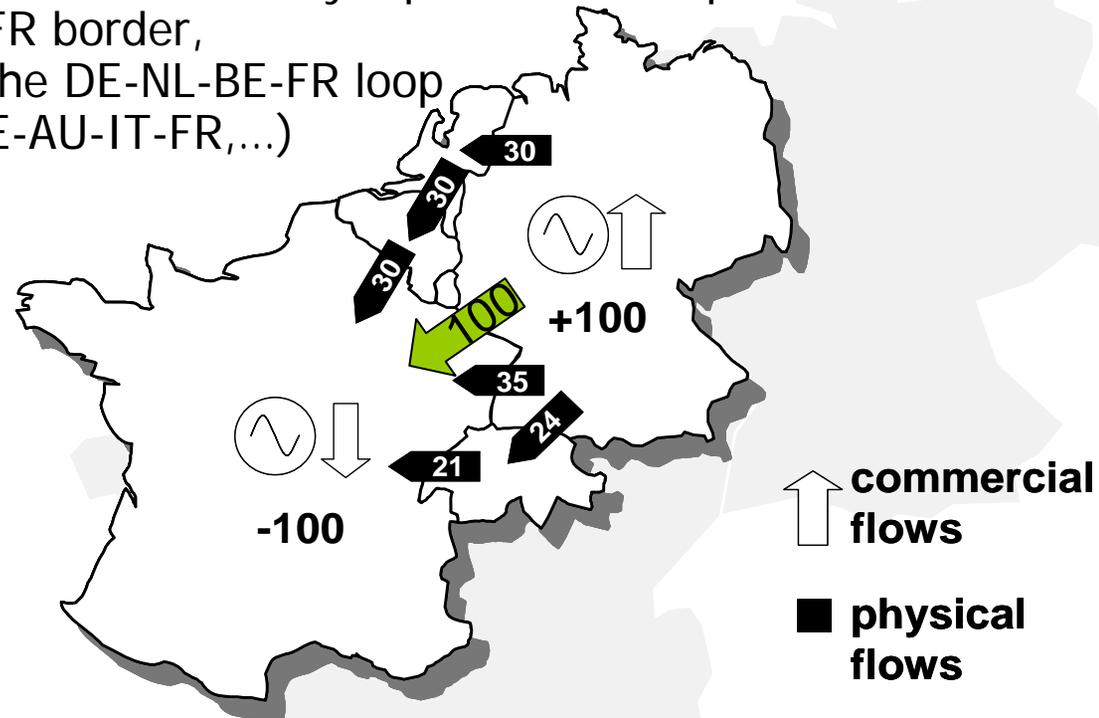
■ **physical flows**

- Bilateral ATC does not take into account loop flows
- Whereas FB uses a physical grid model

➔ **Grid security safeguarded, while taking into account loop flows**

Why Flow based -3

▶ FB uses a physical grid model (i.e. it refers to real physical elements)

▶ The congestions and hot spots in the grid are clearly identified

➔ **Enhanced use and development planning of grid infrastructure**
➔ **Enhanced information provided**
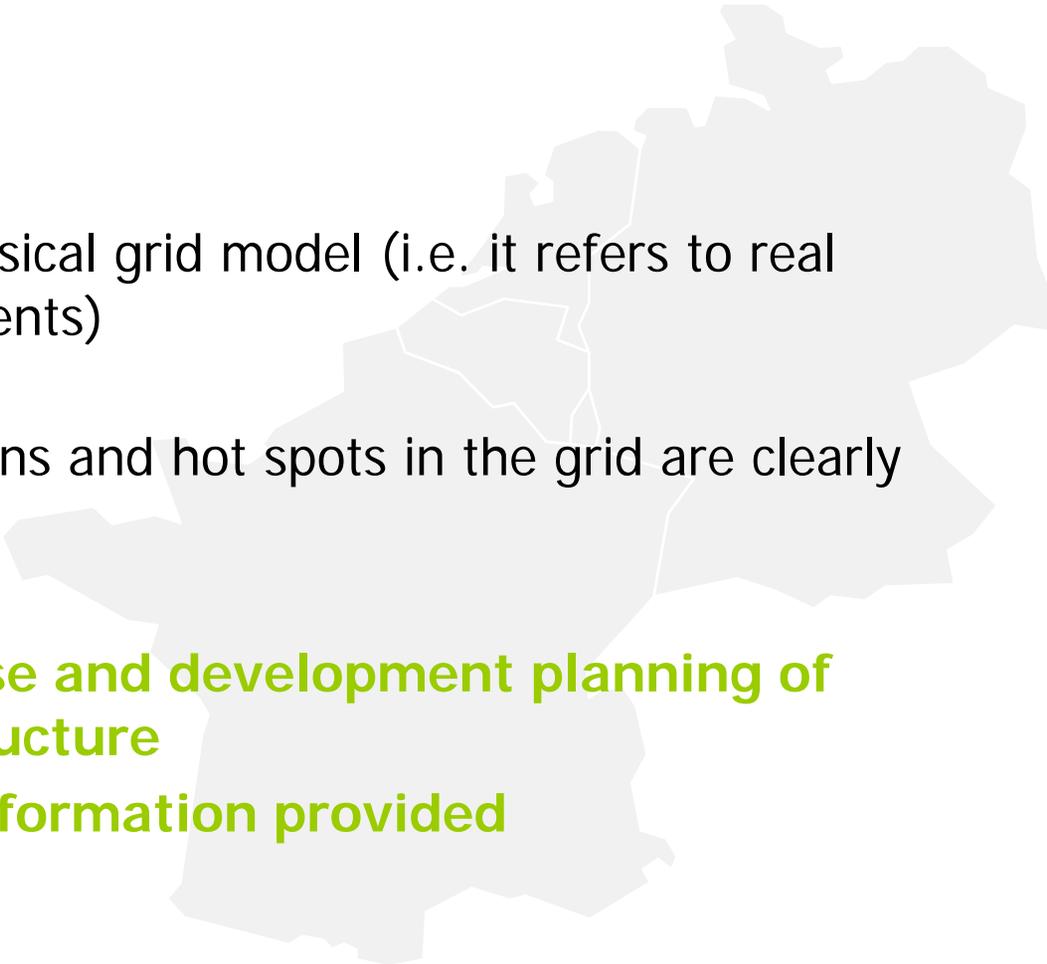
Flow-based principle


real model
(D-2 base case)
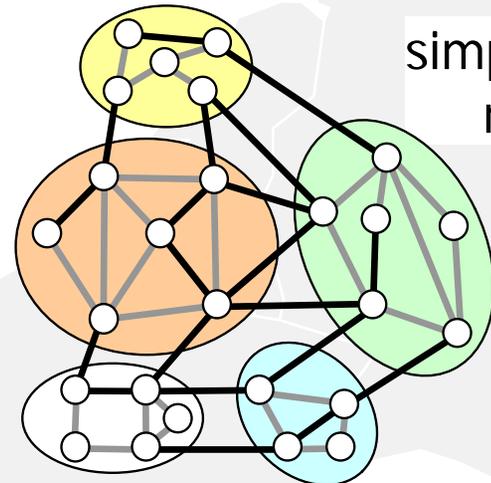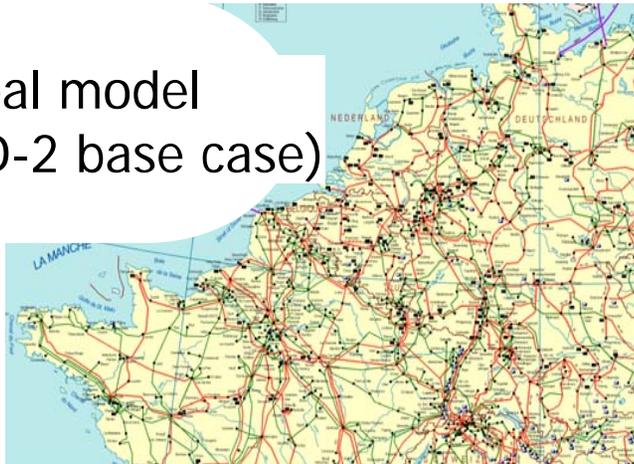
simplified
model

Flow-based parameters

TSOs

MC
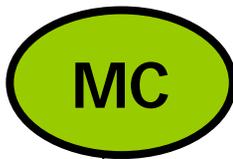
Bids are allocated within
security margins by
optimising
the market value
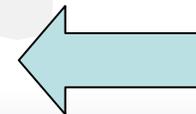
Bid data

PXs

Flow-based market coupling

control variables: net export positions

objective function: maximize social welfare

$$\sum (\text{net export positions}) = 0$$

subject to:

flow   = $_{\text{hub}}$PTDF * (net export positions)
          ≤ Physical margin

linearized 'grid model'
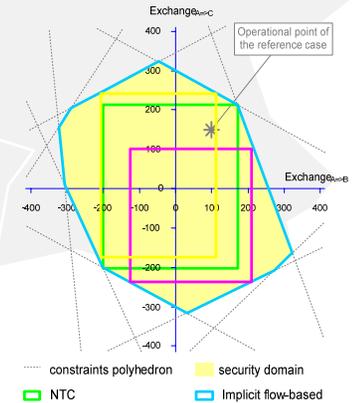
Issues : Pre-congestions

- Issue: The physical margin on some critical branches can be small or zero
- Congestions occur before taking into account market coupling trades

  - Pre-congestions never block the regional trades
  - Pre-congestions limit the net flows induced by the regional trades to the maximal flows

- In fact, precongestions can be relieved by the market coupling in case the economic flow opposes the pre-defined flow
- To be studied further during Flow Based parallel run

Issues : Counter-intuitive results

- Issue: N cheapest zones may be collectively importing, or N most expensive zones exporting
  - Lowest supply bid may be rejected because of network constraints
  - The corresponding flows are "counter-intuitive" or "adverse" flows
- "Non-intuitive" flows are considered as such from a local perspective
- This result optimises social welfare

- If needed, the coupling algorithm could include a constraint to prevent counter intuitive results, but it would be detrimental to social welfare
- To be studied further during Flow Based parallel run

Parallel run

- FBMC market analysis was performed based on non-operational FB data
- The frequency of issues detected could be mainly due to the quality of the data
- Decision
  - to start with an ATC MC as an intermediate facilitation of the market
  - to perform a FB MC in parallel
- // run starting after ATC launch :
  - get a grip on issues detected, and quantify their impact based on operational data
    - Reports after 3 months and 6 months
  - Allow the market parties to get to know FB
  - Tests & training with MPs during last months
  - Consultation of market parties before FB MC go-live

Agenda

14:00 Welcome words by the Co-Chairmen
14:05 Overview of Market Coupling
14:25 CWE MC Project status and planning

Presentation of the CWE MC solution
14:50 Part 1:

Process & timing
Coordinated ATC calculation
Fallbacks

15:30 Coffee Break
15:50 Part 2:

Price calculation
Economic assessments

16:25 Flow Based Market Coupling
17:00 Conclusions and next steps
17:10 Cocktail