EU market integration

Summer School 'Economics of Electricity Markets' University of Ghent

26 August 2014

James Matthys-Donnadieu

Disclaimer: This slideshow provides general information that has, for education (illustration) purposes, been simplified for certain aspects. It may not be relied upon as such

Agenda

Short presentation APX Group

PART I : Some fundamentals of current EU market design

- **Liberalisation**
- **General principles balance management**
- **Different Market Venues**

PART II: EU market integration

- **Principles Interconnection Management & EU Target Model**
- **Day Ahead Market Coupling: Principles**
- **Day Ahead Market Coupling: Implementation Road Map**
- **Day Ahead Market Coupling: Auction Characteristics**
- **Day Ahead Market Coupling: Products & Algorihtm**
- **Day Ahead Market Coupling: Process & Operations**
- **Bidding Zone Review**
- **Flow Based Market Coupling**
- **Intraday Market Coupling**

Agenda

Short presentation APX Group

PART I : Some fundamentals of current EU market design

- **Liberalisation**
- **General principles balance management**
- **Different Market Venues**

PART II: EU market integration

- **Principles Interconnection Management & EU Target Model**
- **Day Ahead Market Coupling: Principles**
- **Day Ahead Market Coupling: Implementation Road Map**
- **Day Ahead Market Coupling: Auction Characteristics**
- **Day Ahead Market Coupling: Products & Algorihtm**
- **Day Ahead Market Coupling: Process & Operations**
- **Bidding Zone Review**
- **Flow Based Market Coupling**
- **Intraday Market Coupling**

APX Activities

UK

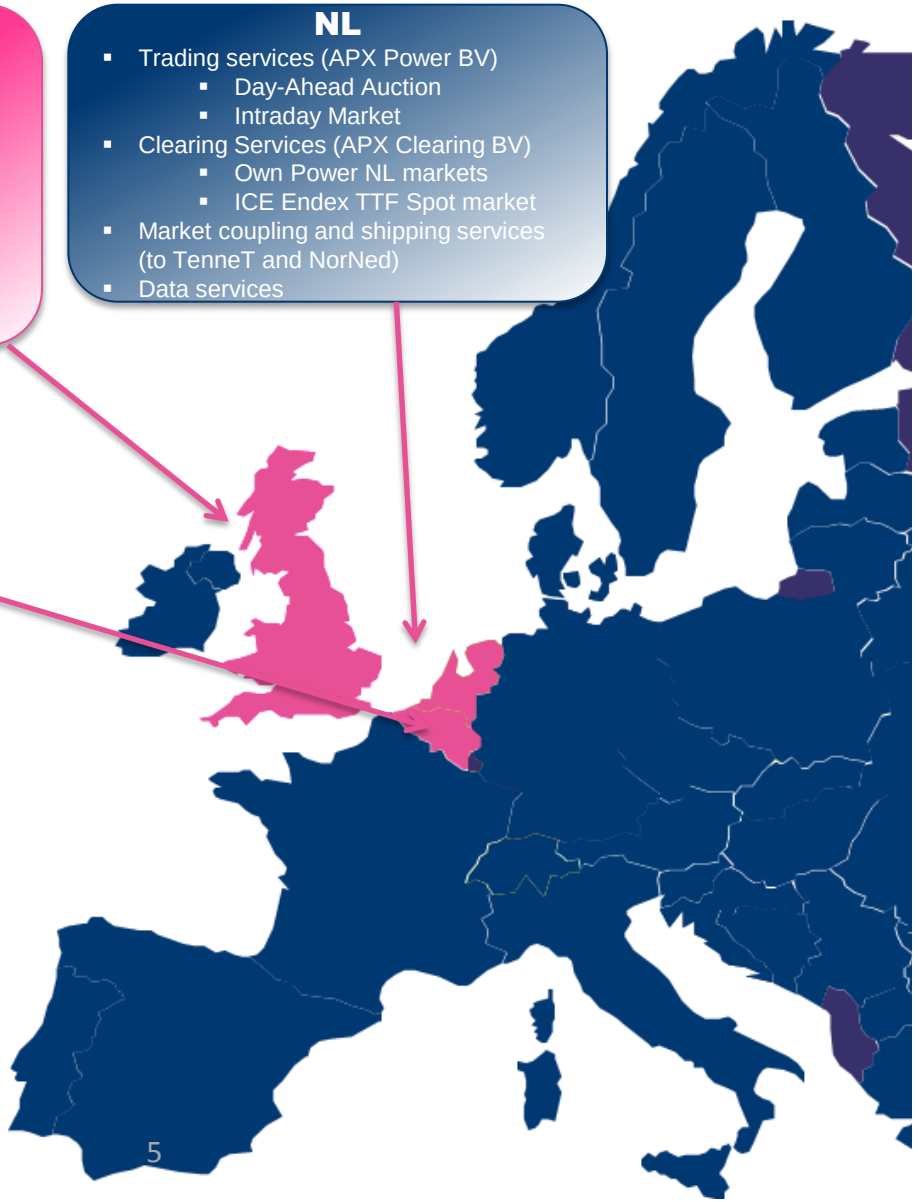
- Trading services (APX Com. Ltd)
  - Day-Ahead Auction
  - Prompt Market
  - Spot Market
- Clearing Services (APX Com. Ltd)
  - Own Power UK markets
  - ICE Endex OCM market
- Market Coupling and shipping services (To BritNed, Virtual Hub)
- Data services

NL

- Trading services (APX Power BV)
  - Day-Ahead Auction
  - Intraday Market
- Clearing Services (APX Clearing BV)
  - Own Power NL markets
  - ICE Endex TTF Spot market
- Market coupling and shipping services (to TenneT and NorNed)
- Data services

Belgium

- Trading services (Belpex NV)
  - Day-Ahead Auction
  - Intraday Market
- Clearing Services (APX Clearing BV)
  - Own Power BE markets
  - ICE Endex ZTP Spot market
- Market coupling and shipping services (to Elia)



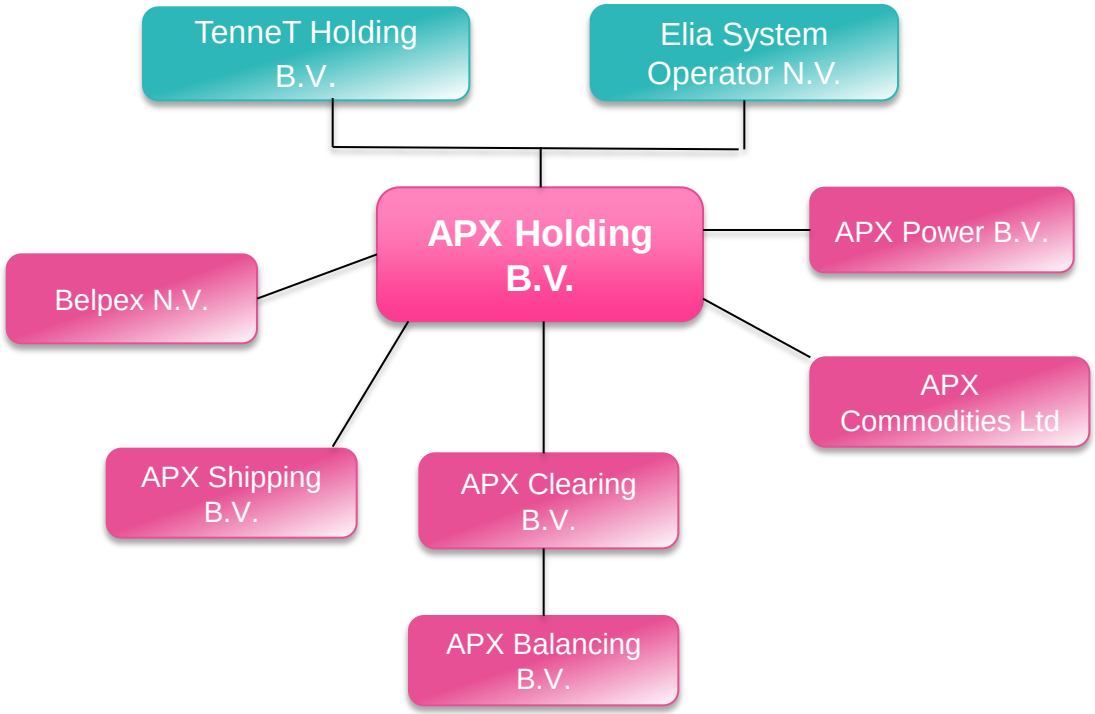
APX Group in Short

4 locations

- NL: Amsterdam
- Belgium: Brussels
- UK: London, Nottingham

Key financials 2013

- Revenue: €27.9 million
- EBIT: €5.29 million
- EBITDA: €7.86 million
- Equity: €29.36 million
- Total assets: €627.45 million
- Total value of cleared energy trades in 2013: €9 billion



History of APX Group

- 1999 Launch of the Amsterdam Power Exchange
- 2000 UKPX, UK's first independent power exchange, established
- 2001 APX UK spot market launched
- 2003 APX UK integrated to APX
- 2006 Belpex established. First market coupling initiative launched
- 2008 APX and ENDEX merge
- 2010 APX-ENDEX and Belpex merge
- 2013 APX and Endex demerge; Spot power exchange APX is launched
- 2014 Launch of PCR and NWE market coupling

Agenda

Short presentation APX Group

PART I : **Some fundamentals of current EU market design**

- **Liberalisation**
- **General principles balance management**
- **Different Market Venues**

PART II: **EU market integration**

- **Principles Interconnection Management & EU Target Model**
- **Day Ahead Market Coupling: Principles**
- **Day Ahead Market Coupling: Implementation Road Map**
- **Day Ahead Market Coupling: Auction Characteristics**
- **Day Ahead Market Coupling: Products & Algorihtm**
- **Day Ahead Market Coupling: Process & Operations**
- **Bidding Zone Review**
- **Flow Based Market Coupling**
- **Intraday Market Coupling**

Liberalisation EU electricity market

1st package (1996)

- Consumer >100 GWh/Y eligible as from 19.02.00
- Free production
- E-transport: natural monopoly (“Chinese wall”)
- Choice between NTPA et RTPA
- Freedom to choose supplier

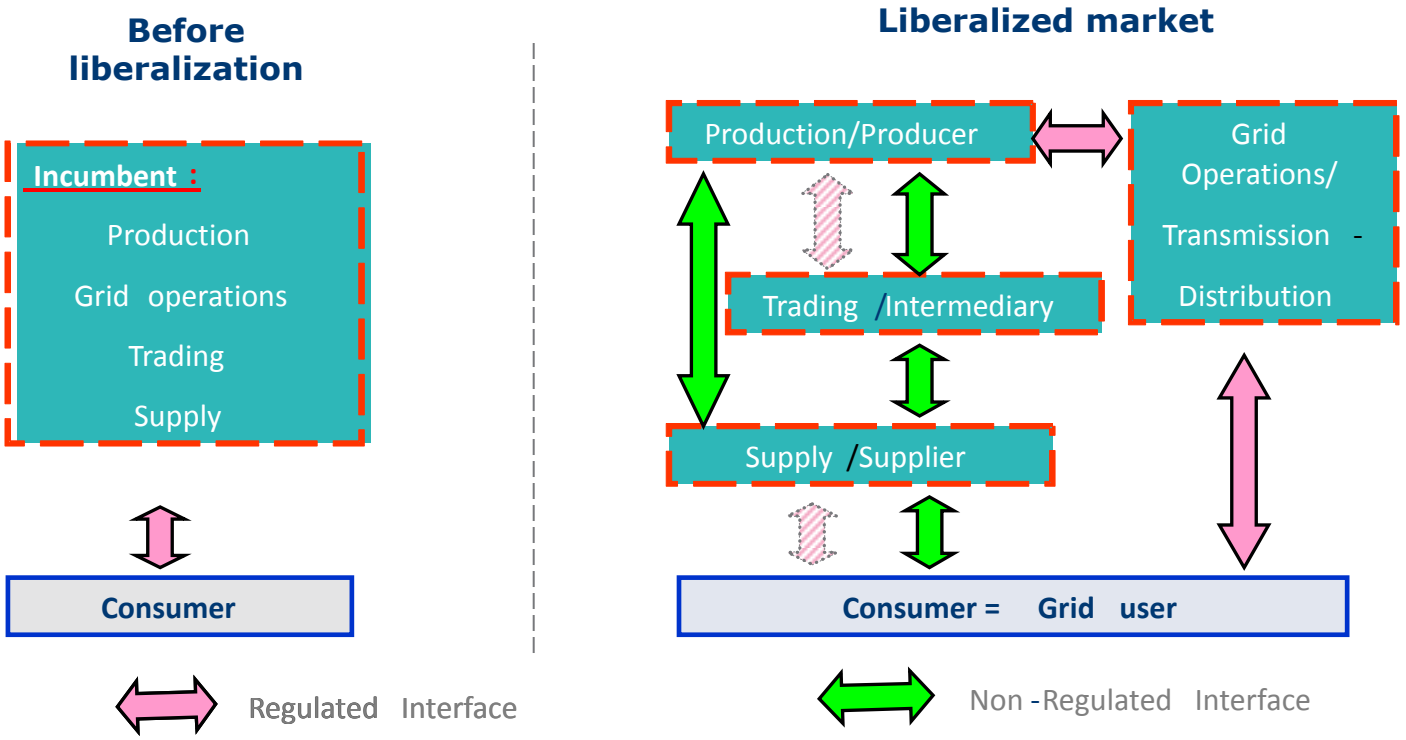
2nd package (2003)

- State responsibility to assure sufficient generation capacity
- Legal unbundling between TSO et DSO
- Mandatory RTPA
- Mandatory regulator
- Full market opening: 01-07-2007 latest
- Market based capacity allocation

3rd package (2009)

- Ownership unbundling (OU) or Independent System Operator (ISO+) or Independent Transmission Operator (ITO)
  - TSOs enhanced regional cooperation
  - ENTSO - Energy Networks of TSOs
  - Harmonisation & enhanced regulatory competences
- ACER (European agency regulators)
- EU network codes

Market Model



ROLE TSO

- Operation, maintenance, development high voltage grid
- Assure balance between injection and off-take within Belgian control area
- Assure non discriminatory access and grid connection (independent)

Agenda

Short presentation APX Group

PART I : **Some fundamentals of current EU market design**

- **Liberalisation**
- **General principles balance management**
- **Different Market Venues**

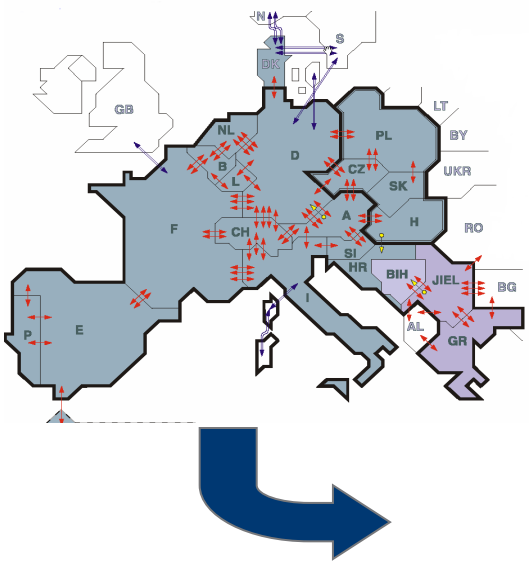
PART II: **EU market integration**

- **Principles Interconnection Management & EU Target Model**
- **Day Ahead Market Coupling: Principles**
- **Day Ahead Market Coupling: Implementation Road Map**
- **Day Ahead Market Coupling: Auction Characteristics**
- **Day Ahead Market Coupling: Products & Algorihtm**
- **Day Ahead Market Coupling: Process & Operations**
- **Bidding Zone Review**
- **Flow Based Market Coupling**
- **Intraday Market Coupling**

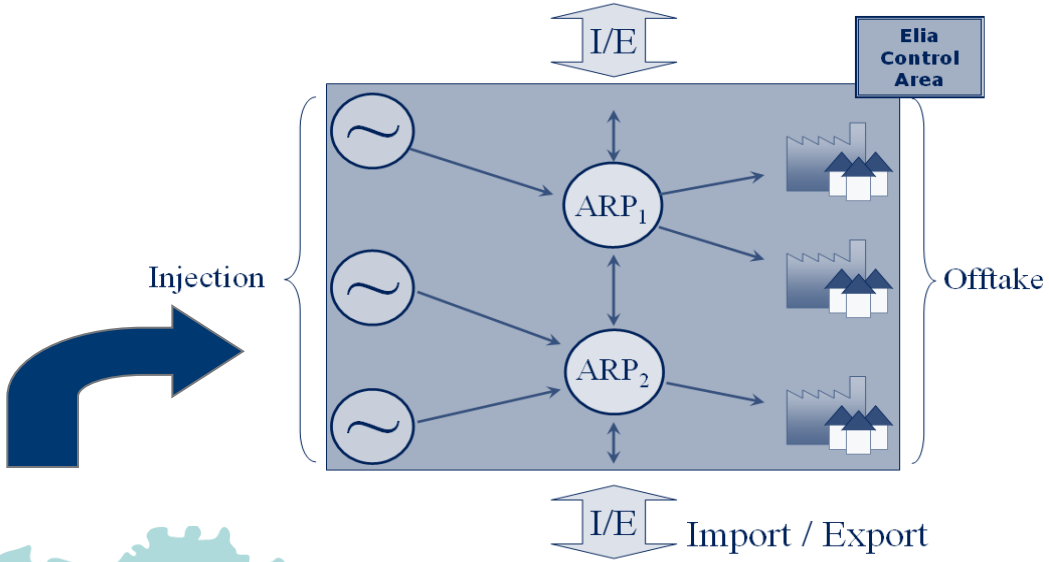
General Principles of Balancing Management

Electricity consumption = generation on interconnected network

Balance between electricity consumption and generation: coordination between TSO's



TSO ensures balance in its control area



Every BRP is responsible for maintaining ¼ h balance between total injections and total off-takes in his portfolio

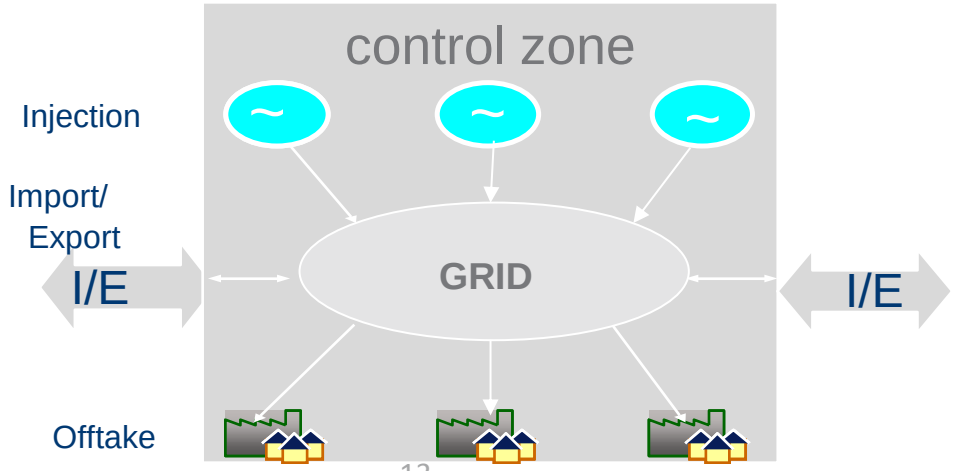
TSO Responsibility: Control Area Balance

Despite interconnected network, how to assure that control zone is balanced, i.e. how to make sure that no energy is unduly taken from neighbours?

- Measured flow is result: **Prod. + Real Import = off take + Real Export** (1)
- Balanced situation: **Prod. + Commercial Import = off take + Commercial Export** (2)

If 1 = 2 : OK

Automatic balancing mechanism based on difference between (1) et (2) => ACE signal
Real Exp. –Real Imp. –(Commercial Export – Commercial Import) = zone imbalance



Balancing Responsible Party (« BRP »)

- Within control zone: TSO “outsources” balance responsibility to Balance Responsible Parties (“BRP”)
- Every sale/purchase; import/export and injection/off-take must fall within perimeter/portfolio of BRP
- BRP portfolio must be balanced on Qh base => imbalances invoiced by TSO at balancing tariffs
- BPR must show day ahead balanced portfolio (“nominations” or “schedules”):
  - Commercial import / export
  - Sales / purchases with other BRP’s
  - Foreseen off-take of clients under its responsibility
  - Foreseen injection of generation under its responsibility

→ **If all BRP portfolio’s balanced: Control zone is balanced (Day Ahead Balance)**

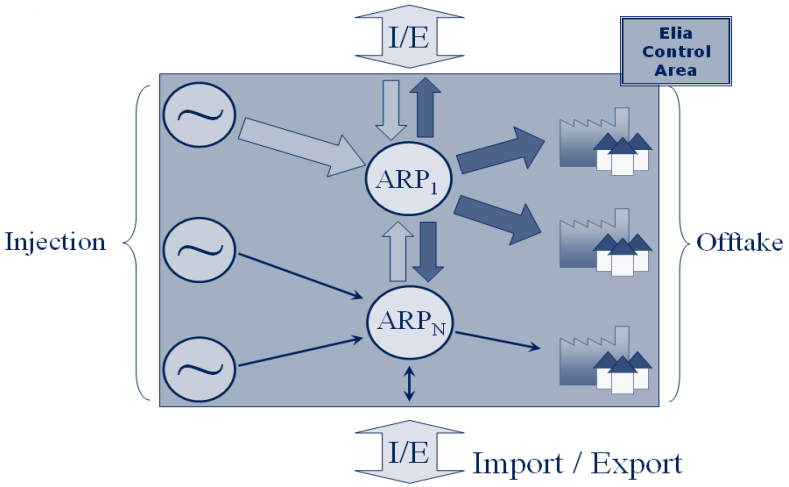
→ BRP can readjust portfolio based on any expected deviations between Day Ahead and Real Time **(Intraday Balance**)

However: Real-time injection and/or off take may differ from planned (T° , strike, wind…)

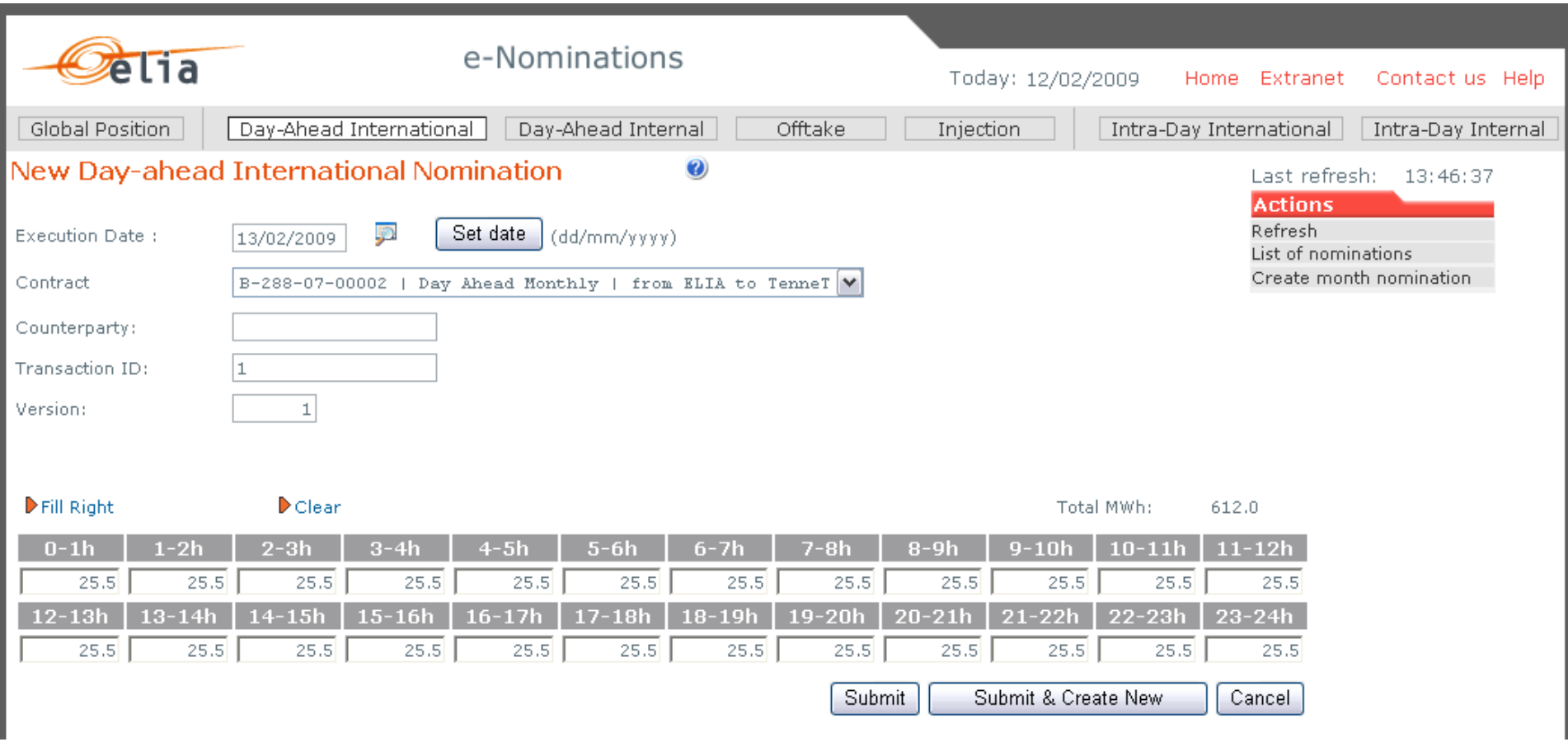
→ **TSO will inject differences (Real Time Balance)**

Once all metering is known, TSO calculates imbalance of each BRP based on **(Ex Post imballance settement)**:

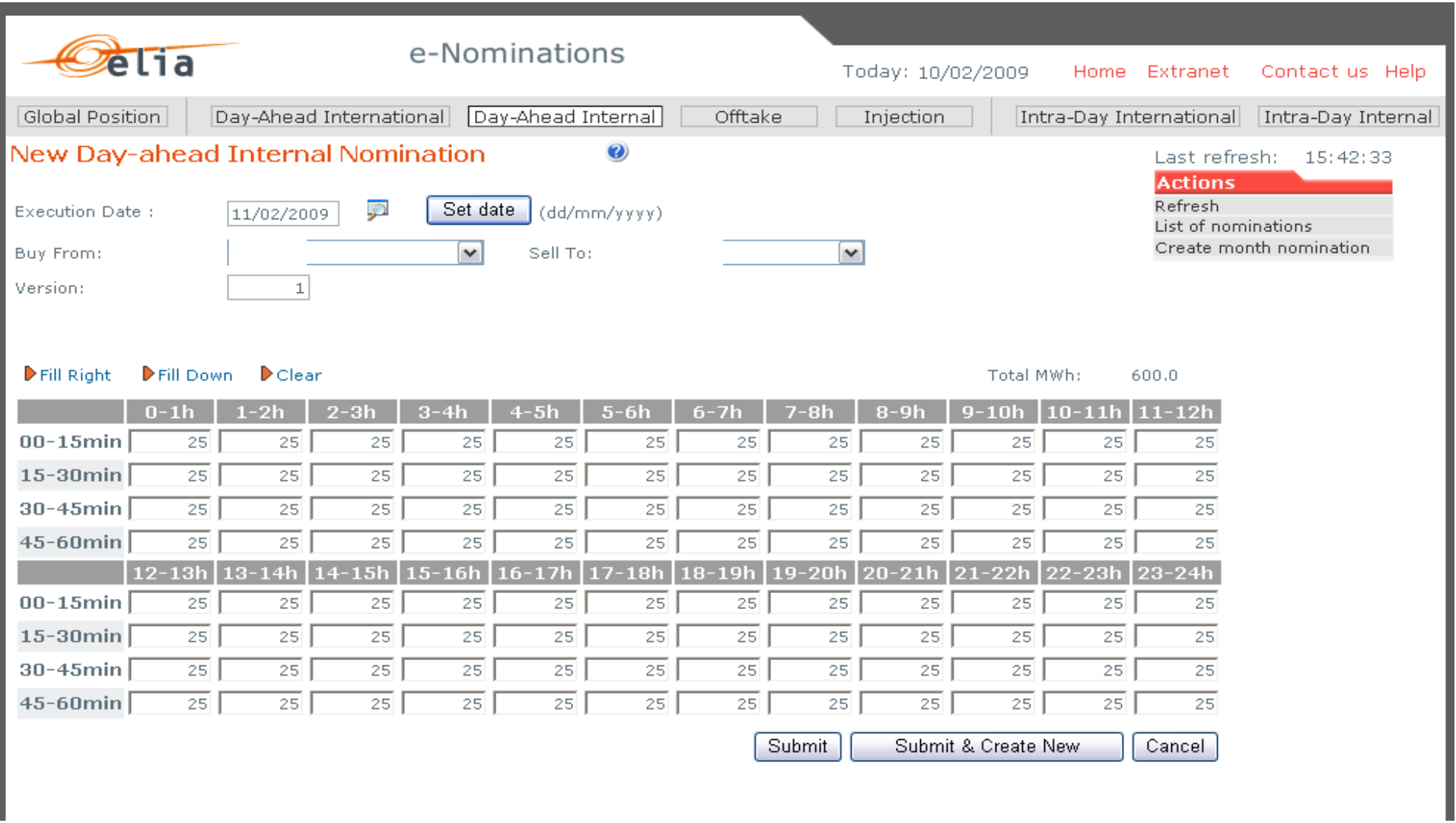
- Commercial import / export nominations
- Sales / Purchases nominations
- “real” off take
- “real” injection
- Imbalances are invoiced at “imbalance tariff”



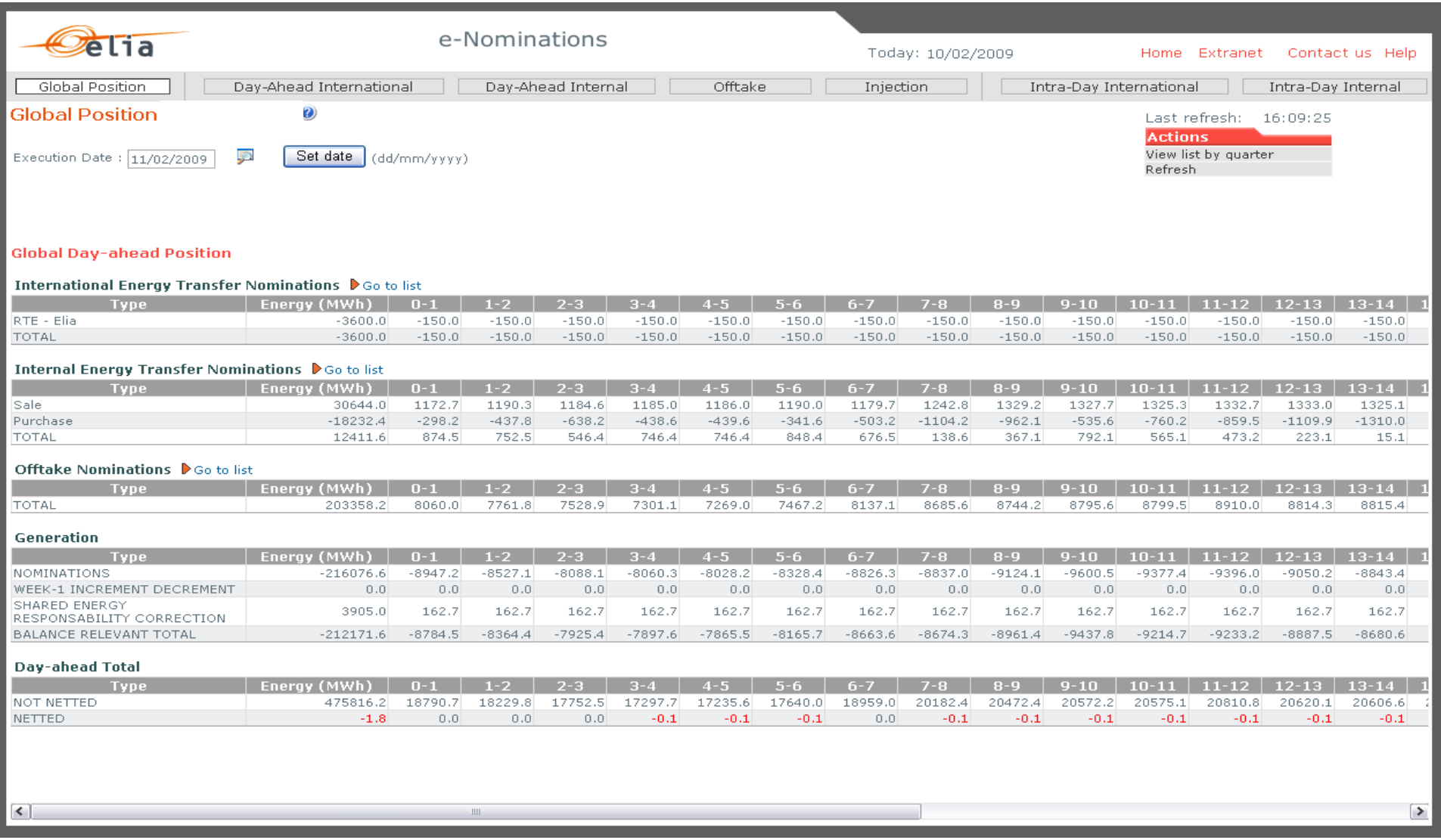
Example: international nominations (Elia)



Example: HUB nominations (Elia)



Example: Global Day Ahead Position (Elia)



elia

e-Nominations

Today: 10/02/2009

Home Extranet Contact us Help

Global Position | Day-Ahead International | Day-Ahead Internal | Offtake | Injection | Intra-Day International | Intra-Day Internal

Global Position

Execution Date : 11/02/2009 Set date (dd/mm/yyyy)

Last refresh: 16:09:25

Actions

View list by quarter

Refresh

Global Day-ahead Position

International Energy Transfer Nominations

Go to list

Type	Energy (MWh)	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14
RTE - Elia	-3600.0	-150.0	-150.0	-150.0	-150.0	-150.0	-150.0	-150.0	-150.0	-150.0	-150.0	-150.0	-150.0	-150.0	-150.0
TOTAL	-3600.0	-150.0	-150.0	-150.0	-150.0	-150.0	-150.0	-150.0	-150.0	-150.0	-150.0	-150.0	-150.0	-150.0	-150.0

Internal Energy Transfer Nominations

Go to list

Type	Energy (MWh)	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14
Sale	30644.0	1172.7	1190.3	1184.6	1185.0	1186.0	1190.0	1179.7	1242.8	1329.2	1327.7	1325.3	1332.7	1333.0	1325.1
Purchase	-18232.4	-298.2	-437.8	-638.2	-438.6	-439.6	-341.6	-503.2	-1104.2	-962.1	-535.6	-760.2	-859.5	-1109.9	-1310.0
TOTAL	12411.6	874.5	752.5	546.4	746.4	746.4	848.4	676.5	138.6	367.1	792.1	565.1	473.2	223.1	15.1

Offtake Nominations

Go to list

Type	Energy (MWh)	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14
TOTAL	203358.2	8060.0	7761.8	7528.9	7301.1	7269.0	7467.2	8137.1	8685.6	8744.2	8795.6	8799.5	8910.0	8814.3	8815.4

Generation

Type	Energy (MWh)	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14
NOMINATIONS	-216076.6	-8947.2	-8527.1	-8088.1	-8060.3	-8028.2	-8328.4	-8826.3	-8837.0	-9124.1	-9600.5	-9377.4	-9396.0	-9050.2	-8843.4
WEEK-1 INCREMENT DECREMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHARED ENERGY RESPONSABILITY CORRECTION	3905.0	162.7	162.7	162.7	162.7	162.7	162.7	162.7	162.7	162.7	162.7	162.7	162.7	162.7	162.7
BALANCE RELEVANT TOTAL	-212171.6	-8784.5	-8364.4	-7925.4	-7897.6	-7865.5	-8165.7	-8663.6	-8674.3	-8961.4	-9437.8	-9214.7	-9233.2	-8887.5	-8680.6

Day-ahead Total

Type	Energy (MWh)	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14
NOT NETTED	475816.2	18790.7	18229.8	17752.5	17297.7	17235.6	17640.0	18959.0	20182.4	20472.4	20572.2	20575.1	20810.8	20620.1	20606.6
NETTED	-1.8	0.0	0.0	0.0	-0.1	-0.1	-0.1	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1

Agenda

Short presentation APX Group

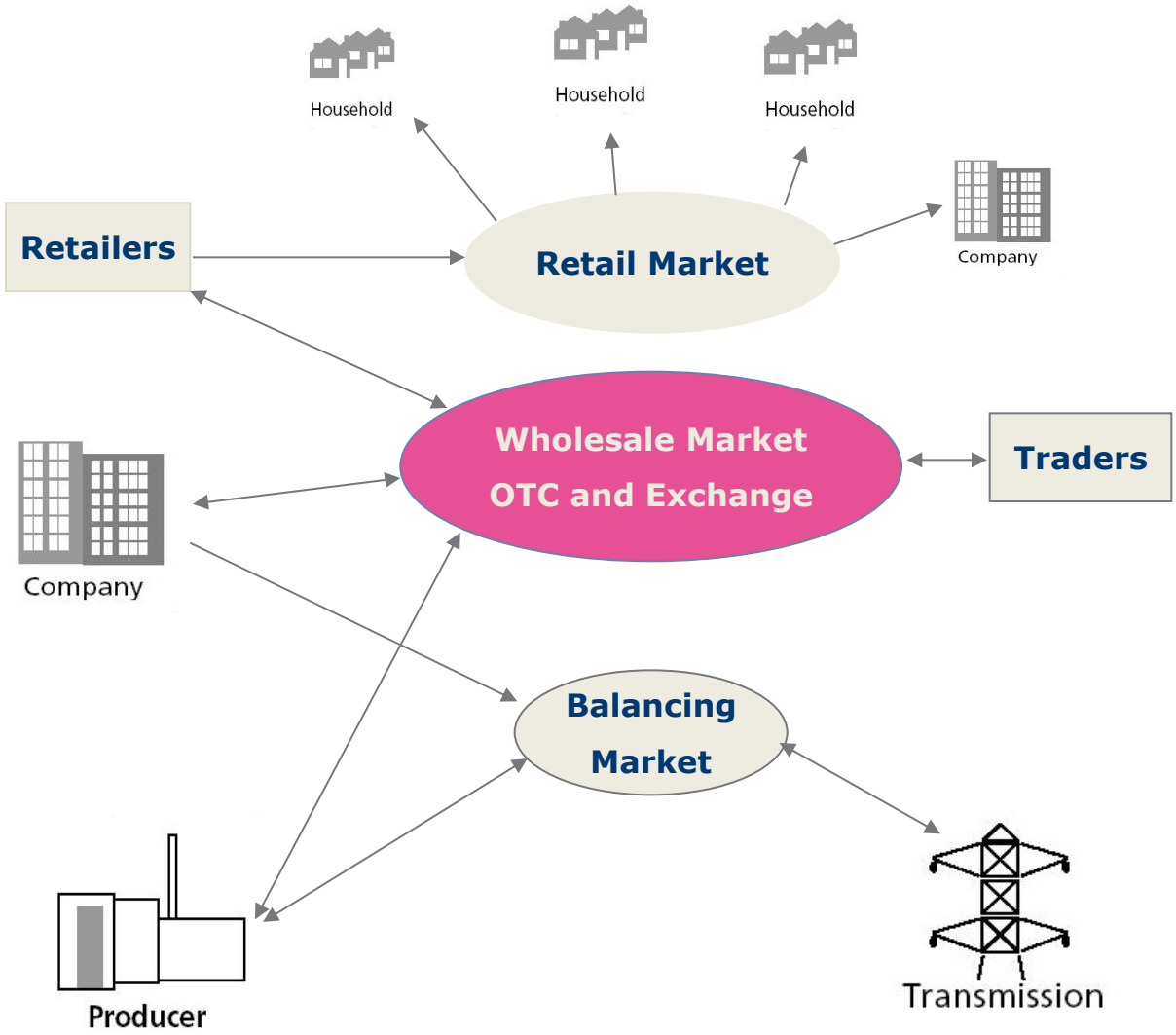
PART I : **Some fundamentals of current EU market design**

- **Liberalisation**
- **General principles balance management**
- **Different Market Venues**

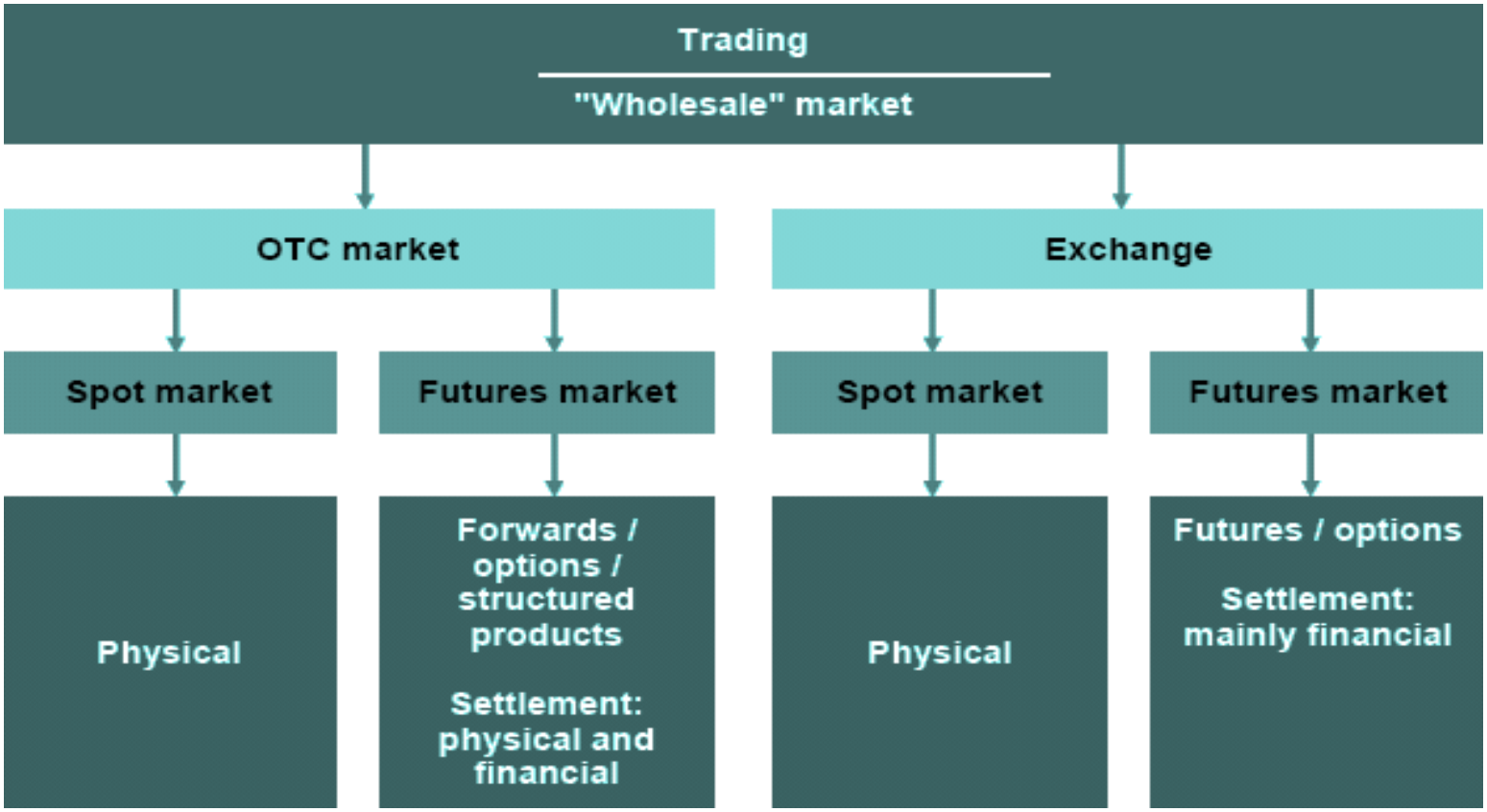
PART II: **EU market integration**

- **Principles Interconnection Management & EU Target Model**
- **Day Ahead Market Coupling: Principles**
- **Day Ahead Market Coupling: Implementation Road Map**
- **Day Ahead Market Coupling: Auction Characteristics**
- **Day Ahead Market Coupling: Products & Algorihtm**
- **Day Ahead Market Coupling: Process & Operations**
- **Bidding Zone Review**
- **Flow Based Market Coupling**
- **Intraday Market Coupling**

Different Market Segments



Wholesale Trading Venues

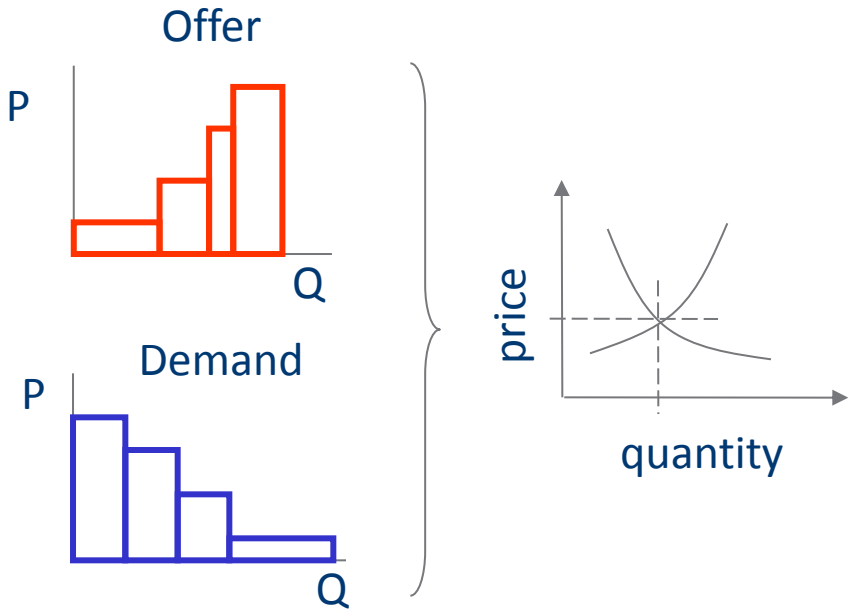


Auction versus continuous trading

Auction Trading

Mechanism

- Sellers introduce bids: 90MW@50€, 100MW@55€…
- Buyers introduce offers 90MW@60€, 100MW@55€…
- Aggregation of bids; aggregation of offers ➔ Supply and Demand curve
- Fixing: Intersection of Supply and Demand Curve ➔ determination of MCP, MCV and individual contracts



Features

- One price for one product
- Closed order book
- Marginal Pricing (however, subject for debate)

Continuous Trading

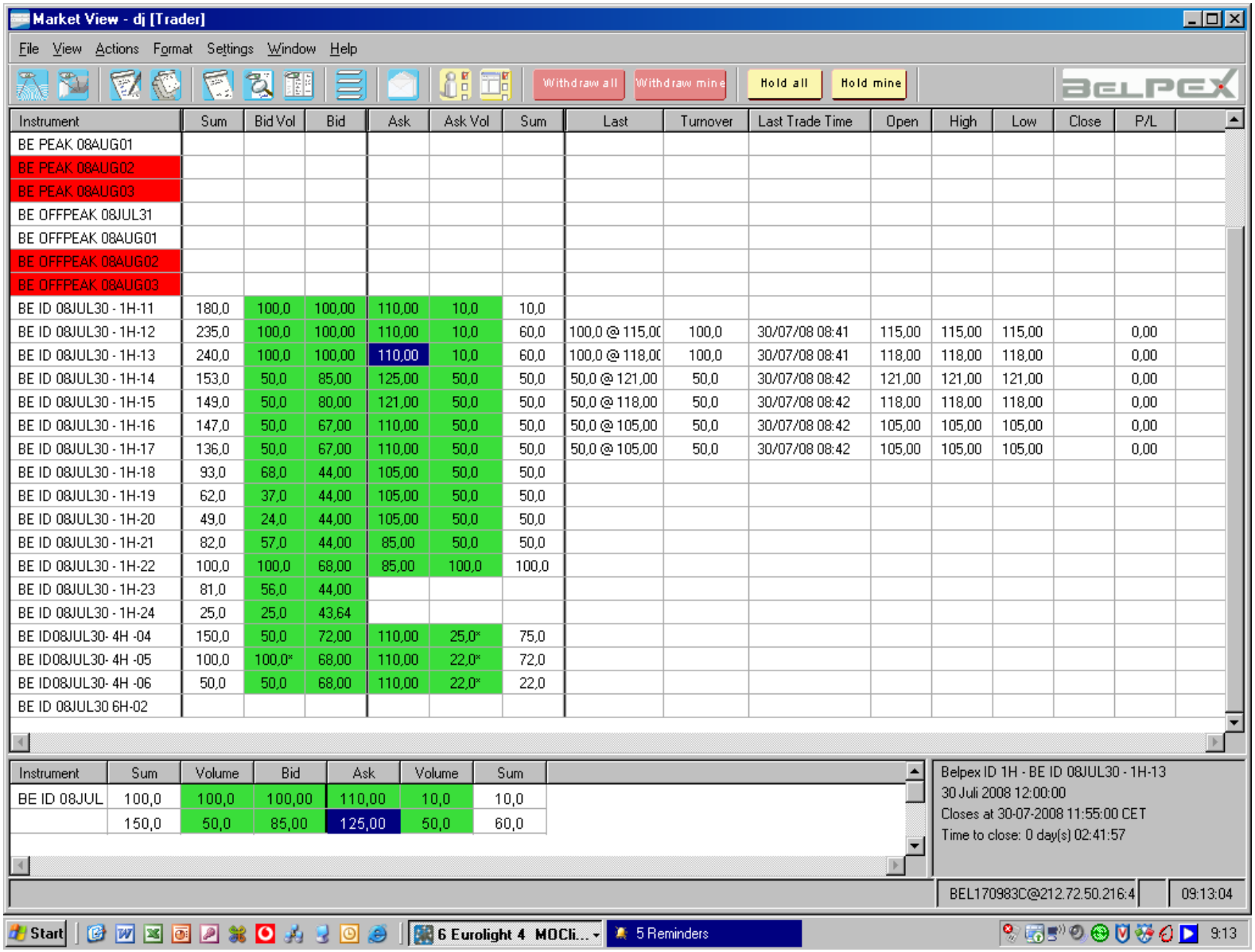
Mechanism

- Bids and Offers are matched immediately according to price/time priority

Features

- No single price
- Open order book
- Market pricing

Example: Screen Traded Market



Instrument	Sum	Bid Vol	Bid	Ask	Ask Vol	Sum	Last	Turnover	Last Trade Time	Open	High	Low	Close	P/L
BE PEAK 08AUG01														
BE PEAK 08AUG02														
BE PEAK 08AUG03														
BE OFFPEAK 08JUL31														
BE OFFPEAK 08AUG01														
BE OFFPEAK 08AUG02														
BE OFFPEAK 08AUG03														
BE ID 08JUL30 - 1H-11	180,0	100,0	100,00	110,00	10,0	10,0								
BE ID 08JUL30 - 1H-12	235,0	100,0	100,00	110,00	10,0	60,0	100,0 @ 115,0(	100,0	30/07/08 08:41	115,00	115,00	115,00		0,00
BE ID 08JUL30 - 1H-13	240,0	100,0	100,00	110,00	10,0	60,0	100,0 @ 118,0(	100,0	30/07/08 08:41	118,00	118,00	118,00		0,00
BE ID 08JUL30 - 1H-14	153,0	50,0	85,00	125,00	50,0	50,0	50,0 @ 121,00	50,0	30/07/08 08:42	121,00	121,00	121,00		0,00
BE ID 08JUL30 - 1H-15	149,0	50,0	80,00	121,00	50,0	50,0	50,0 @ 118,00	50,0	30/07/08 08:42	118,00	118,00	118,00		0,00
BE ID 08JUL30 - 1H-16	147,0	50,0	67,00	110,00	50,0	50,0	50,0 @ 105,00	50,0	30/07/08 08:42	105,00	105,00	105,00		0,00
BE ID 08JUL30 - 1H-17	136,0	50,0	67,00	110,00	50,0	50,0	50,0 @ 105,00	50,0	30/07/08 08:42	105,00	105,00	105,00		0,00
BE ID 08JUL30 - 1H-18	93,0	68,0	44,00	105,00	50,0	50,0								
BE ID 08JUL30 - 1H-19	62,0	37,0	44,00	105,00	50,0	50,0								
BE ID 08JUL30 - 1H-20	49,0	24,0	44,00	105,00	50,0	50,0								
BE ID 08JUL30 - 1H-21	82,0	57,0	44,00	85,00	50,0	50,0								
BE ID 08JUL30 - 1H-22	100,0	100,0	68,00	85,00	100,0	100,0								
BE ID 08JUL30 - 1H-23	81,0	56,0	44,00											
BE ID 08JUL30 - 1H-24	25,0	25,0	43,64											
BE ID08JUL30- 4H -04	150,0	50,0	72,00	110,00	25,0*	75,0								
BE ID08JUL30- 4H -05	100,0	100,0*	68,00	110,00	22,0*	72,0								
BE ID08JUL30- 4H -06	50,0	50,0	68,00	110,00	22,0*	22,0								
BE ID 08JUL30 6H-02														

Instrument	Sum	Volume	Bid	Ask	Volume	Sum
BE ID 08JUL	100,0	100,0	100,00	110,00	10,0	10,0
	150,0	50,0	85,00	125,00	50,0	60,0

Belpex ID 1H - BE ID 08JUL30 - 1H-13
30 Juli 2008 12:00:00
Closes at 30-07-2008 11:55:00 CET
Time to close: 0 day(s) 02:41:57

Market Business Timeline

12:00
DAM Auction

Years, quarters, months ahead, | Day Ahead | Delivery Day | Real Time

Forward/futures markets | Spot markets | Balancing markets

Quid portfolion position?
-Generation?
-Load forecast?
-LT contracts

14:00
Balanced DA portfolio towards Elia

Continuous portfolio follow up and rebalancing (ID market)

OTC Trading

Wholesale Market Places:

Spot Exchange

TSO

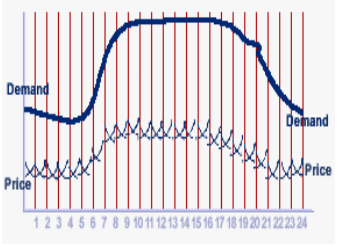
Continuous forward markets

Contract	Period Covered
3 Months ahead	From 00:00 am on the first day of the Month until 24:00 pm on the last day of the Month
4 Quarters ahead	From 00:00 am on the first day of the Quarter until 24:00 pm on the last day of the Quarter
3 Years (Calendars) ahead	From 00:00 am on the first day of the Calendar until 24:00 pm on the last day of the Calendar

Day-ahead market auction

Hourly products

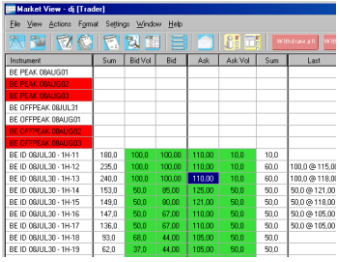
Multi-hourly products



Intraday market

Hourly products

Multi-hourly products



Real-time system balancing

Regulated market
15 Minutes trading periods

Balancing Market

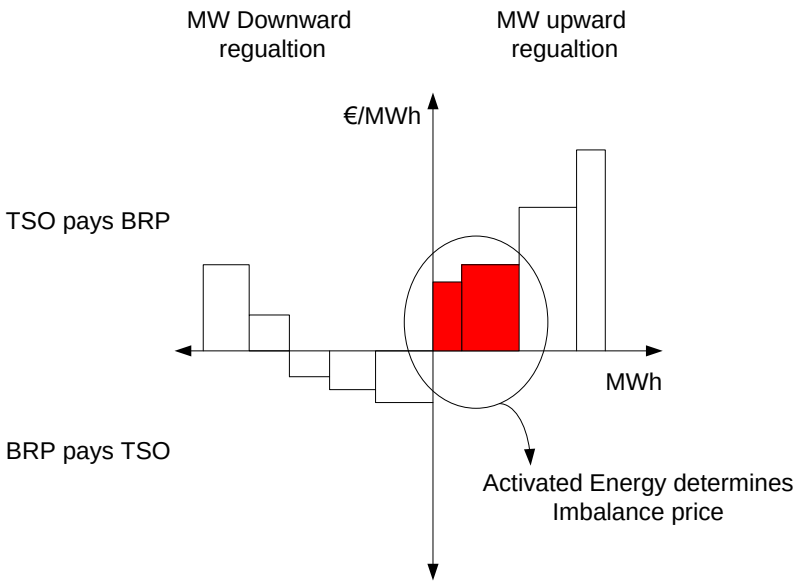
Sum of BRP portfolio imbalances: Control Area Imbalance

⇒ TSO must compensate Area Control Imbalance!

How does TSO compensate Area Control Imbalance? What means does TSO have to perform this task?

- Contracted reserves
- Spare generation capacity
- Schedeable load
- Inter-TSO reserve

Merit Order Curve



Example: Area Control is short

⇒ TSO activates necessary energy based on merit curve (red in example)

⇒ Activated bids will form basis imbalance price determination

⇒ Imbalance BRP having caused Area Control will be invoiced at the imbalance price

Agenda

Short presentation APX Group

PART I : Some fundamentals of current EU market design

- Liberalisation
- General principles balance management
- Different Market Venues

PART II: EU market integration

- Principles Interconnection Management & EU Target Model
- Day Ahead Market Coupling: Principles
- Day Ahead Market Coupling: Implementation Road Map
- Day Ahead Market Coupling: Auction Characteristics
- Day Ahead Market Coupling: Products & Algorihtm
- Day Ahead Market Coupling: Process & Operations
- Bidding Zone Review
- Flow Based Market Coupling
- Intraday Market Coupling

Internal Energy Market (“IEM”)

Goal :

- Competitive energy market for enlarged European Union
- Enable customers to choose their supplier
- “Electricity should flow between member states as easily as it currently flows within them”

Obstacle :

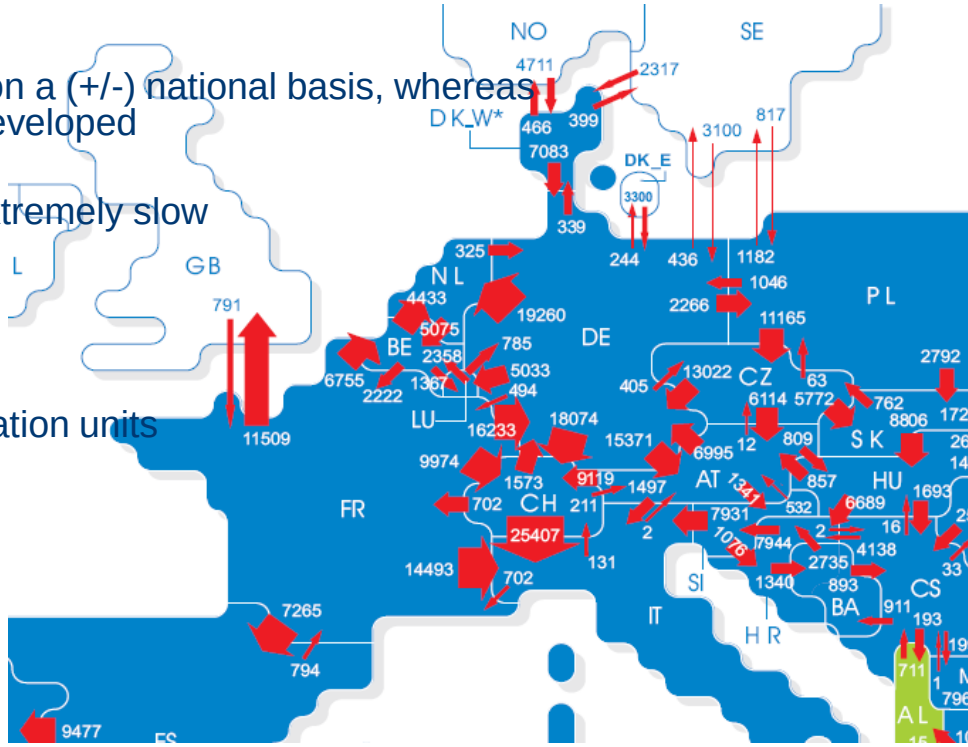
- Historically, markets were vertically integrated on a (+/-) national basis, whereas cross-border interconnectors have been less developed
- Congestion on cross border interconnections
- Building new transport capacity is costly and extremely slow

Long term structural solution :

- increase of capacity or new interconnectors
- incentivize appropriate locations for new generation units

On short term, with low cost impact :

Allocate/Use scarce transmission capacity via market-based mechanisms



Regulation 714/2009

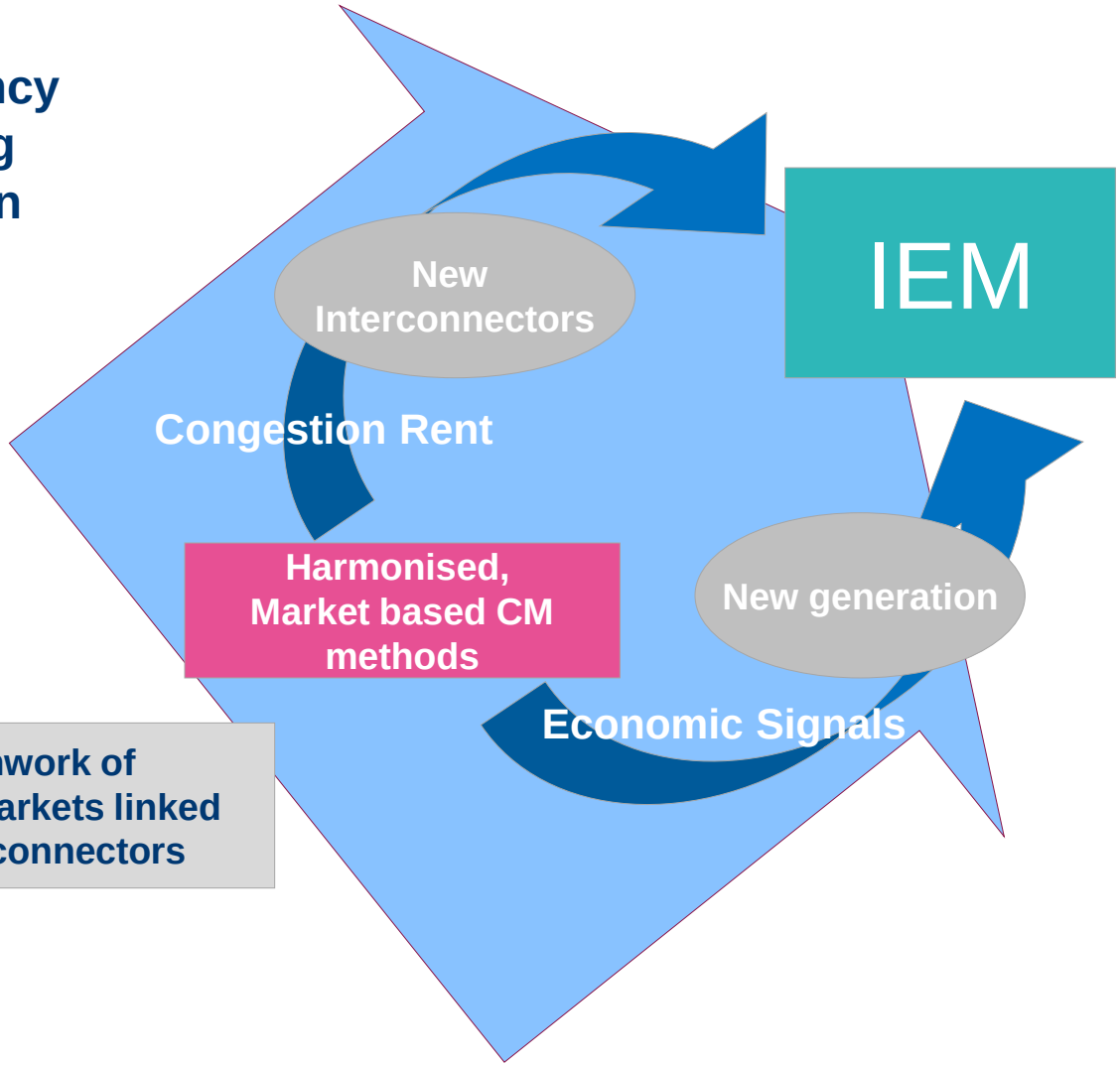
- Def. Congestion: situation in which an **interconnection linking national transmission** networks cannot accommodate all physical flows resulting from international trade requested by market participants, because of a lack of capacity of the interconnectors and/or the national transmission systems concerned
- Annex 1, 1.5 The methods adopted for congestion management shall give efficient economic signals to market participants and TSO's, promote competition and be suitable for regional and Community-wide application
- Annex 1, 2.1 **Congestion-management methods shall be market-based** in order to facilitate efficient XB trade. For that purpose, capacity shall be allocated only by means of explicit (capacity) or implicit (capacity and energy) auctions. […] For intraday trade continuous trading may be used;
- Annex 1, 1.7: When defining appropriate network areas in and between which congestion management is to apply, TSOs shall be guided by the principle of cost-effectiveness and minimisation of negative impacts on the internal market in electricity. Specifically, TSOs shall not limit interconnection capacity in order to solve congestion inside their own control area [except SoS]

Network area = MS
CM between MS

More technical approach towards network areas

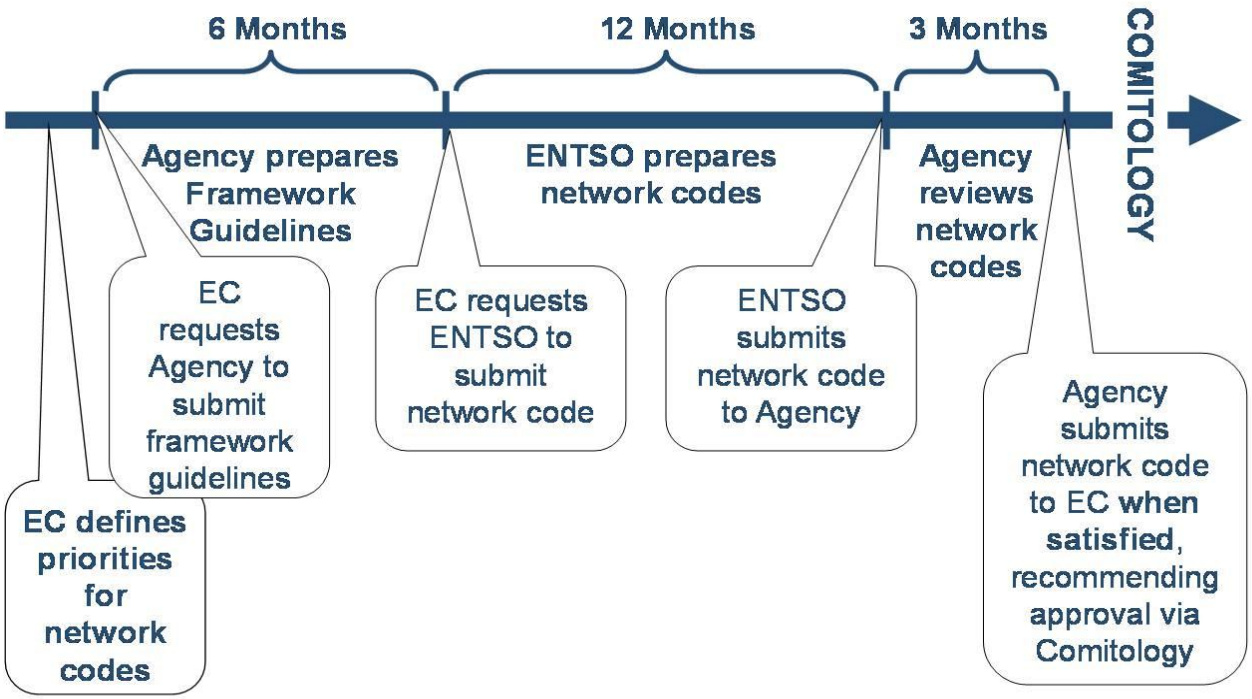
Market Integration Model

+ Transparency
+ Unbundling
+ Supervision



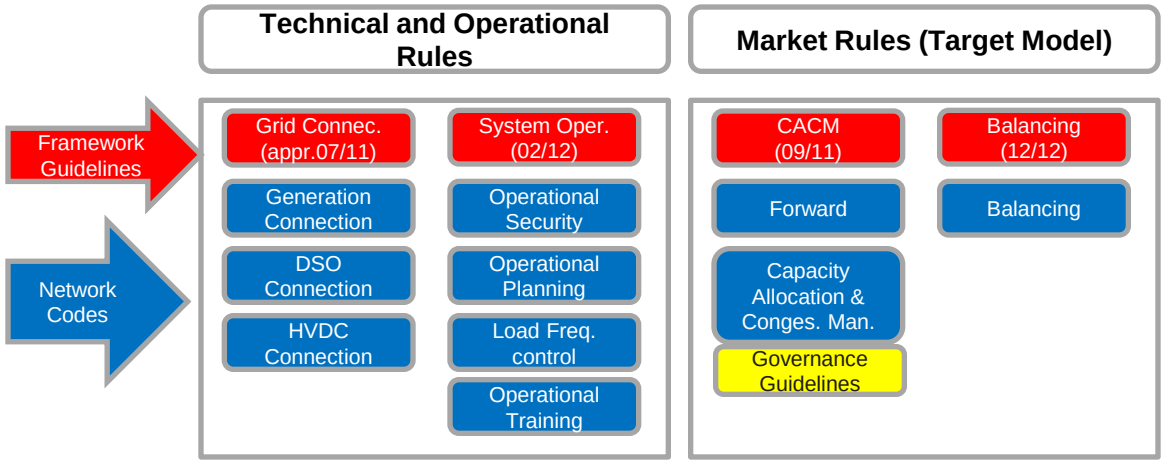
Framework: Network Codes

3rd E-package (Reg. 714/2009): high level principles to be detailed in EU Network Codes, to be developed according to a specified process



Framework: Network Codes

The themes to be covered by network codes are defined in the Regulation 714/2009



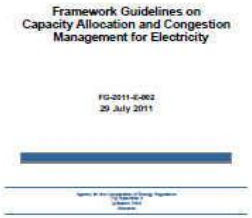
Content CACM NC:

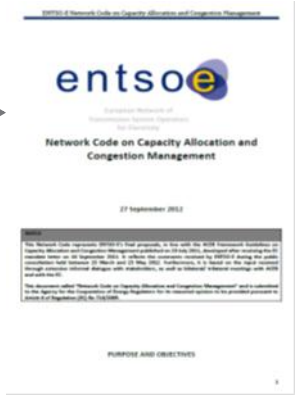
- Capacity calculation/Grid models/Bidding zones
- Algorithms development
- DA markets requirements
- ID markets requirements
- Capacity firmness
- (Governance Guidelines)

ACER

Drafting process NC CACM:

- Request of EC to ACER to draft FG CACM
- 29/7/2011: ACER delivers FG CACM
- 16/9/2011: EC requests ENTSO-E to draft NC CACM
- 27/9/2012: ENTSO-E submits NC CACM to ACER
- 12/12/2012: ACER invited ENTSO-E to amend NC CACM
- 8/2/2013: ENTSO-E declines amending NC CACM
- 14/3/2013: ACER recommends to EC to adopt NC CACM after amending it
- Since then: EC in the process of amending the text (incl. Governance)





General Concepts of Intercon. Management

Step 1: capacity determination

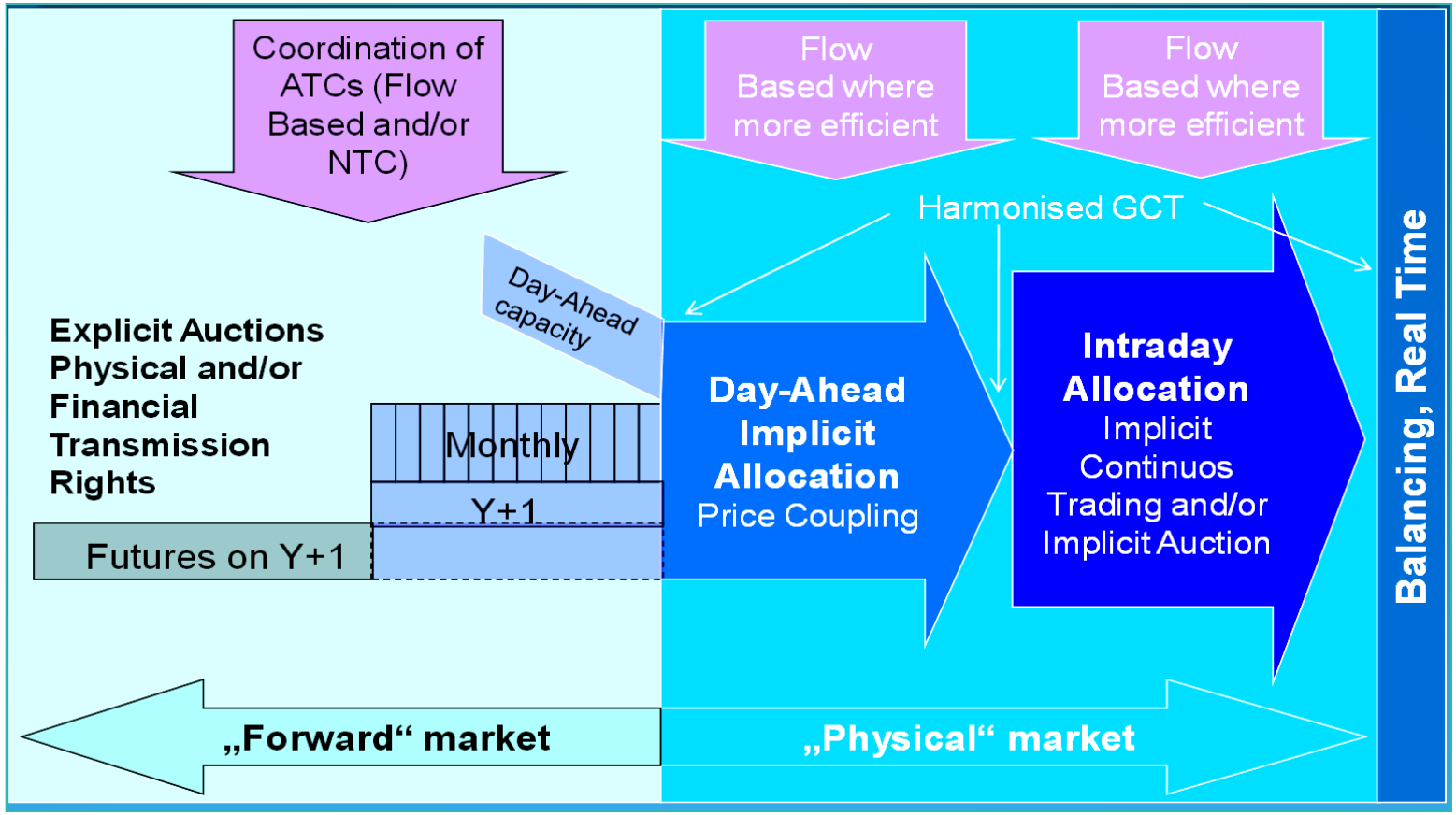
How much capacity can be put at the disposal of the market?

Step 2: capacity allocation

How will the available capacity be granted to the market?

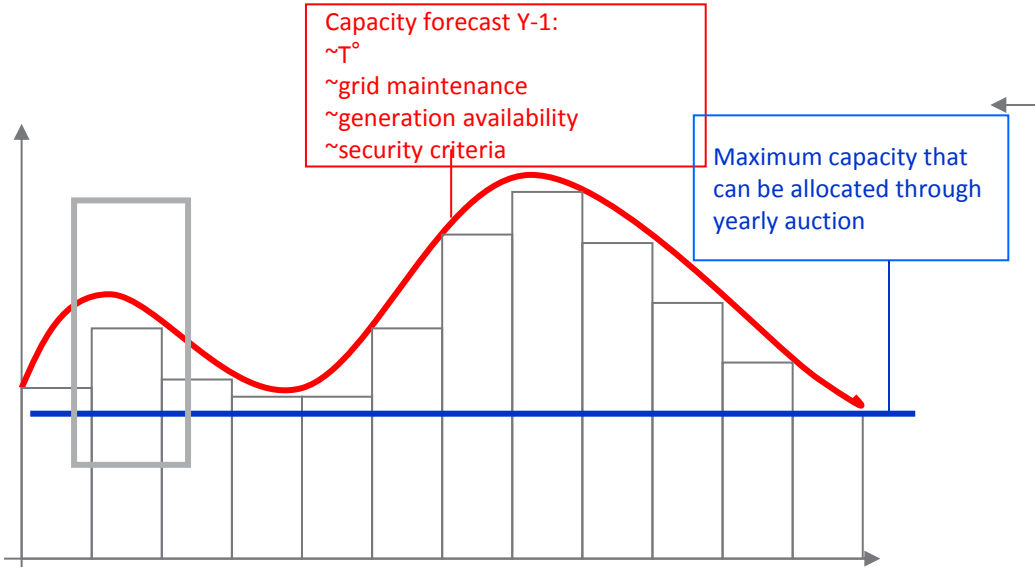
- Discriminatory or non-discriminatory
  - LT contracts
  - Third party access
- Market Based or non-market based
  - Pro-rata allocation; first come first served allocation
  - Auctions
- Implicit or explicit allocation
  - Explicit: allocate capacity rights only
  - Implicit: allocate capacity together with energy deal
    - Volume Coupling
    - Tight volume Coupling
    - Price coupling
- Border specific or regional
- ATC based or flow-based
- Nature of the product:
  - Long Term or Short Term rights
  - Financial or Physical rights
  - Options or Obligations

EU Target Model (as to be described in Market Codes)



+ « BIDDING ZONE » definition!

Determination of LT capacity (ATC method)



Yearly capacity

! Different values for each direction!

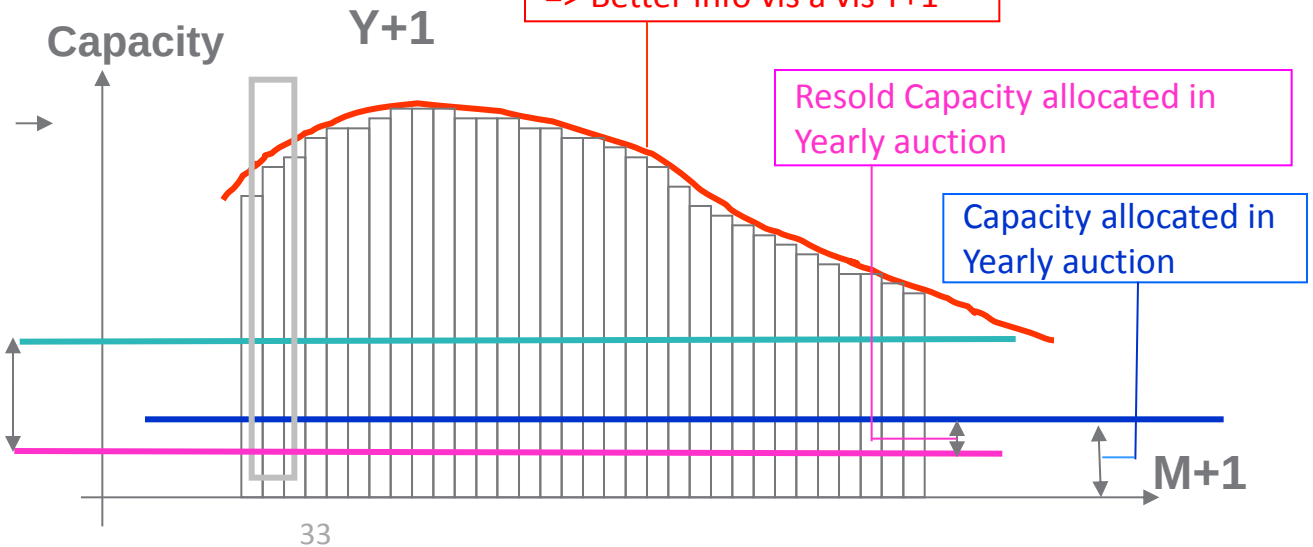
FR => BE

BE => FR

NL => BE

BE => NL

Capacity forecast M+1:
=> Better info vis à vis Y+1

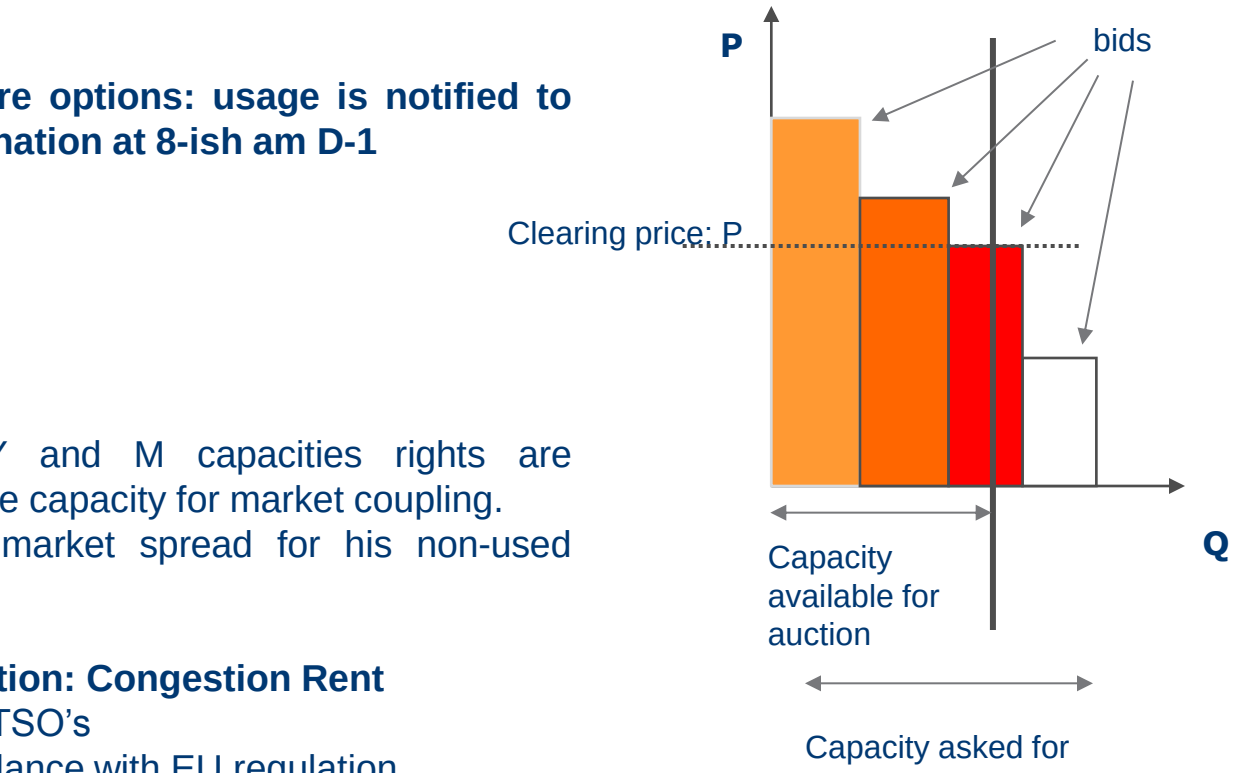


Monthly capacity

Maximum capacity that can be allocated through monthly auction

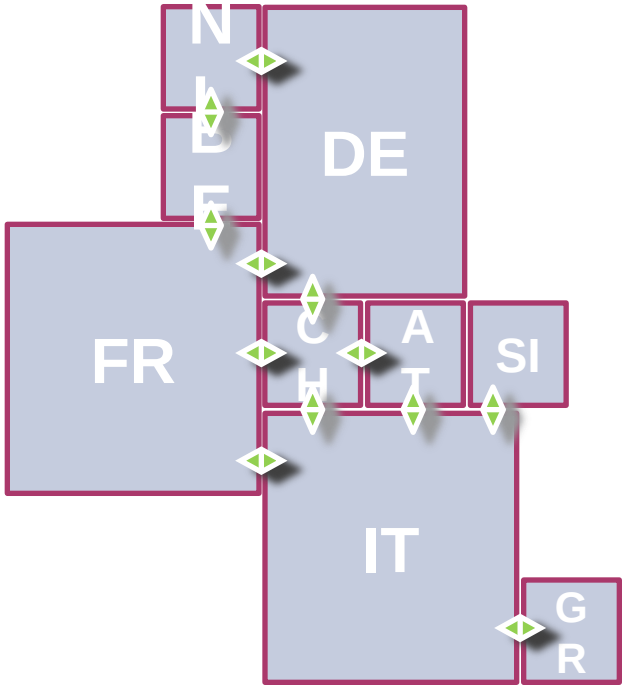
Explicit Capacity Allocation (Y and M rights)

- **Explicit auctioning of physical capacity rights**
  - Yearly rights through yearly auction (one value for the year)
  - Monthly rights through monthly auction (one value for the month)
- **Auctioned capacity rights are options: usage is notified to the TSO by means of a nomination at 8-ish am D-1**
- **Auction mechanism**
  - Single round
  - “paid as cleared”
- **“Use-it-or-sell-it" principle**
  - The non nominated Y and M capacities rights are automatically resold to the capacity for market coupling.
  - Market actors get the market spread for his non-used capacity rights.
- **Proceeds form Capacity Auction: Congestion Rent**
  - Captured by concerned TSO’s
  - Usage must be in accordance with EU regulation



Auction Office

As of 2012: one set of harmonised auction rules covering 12 borders



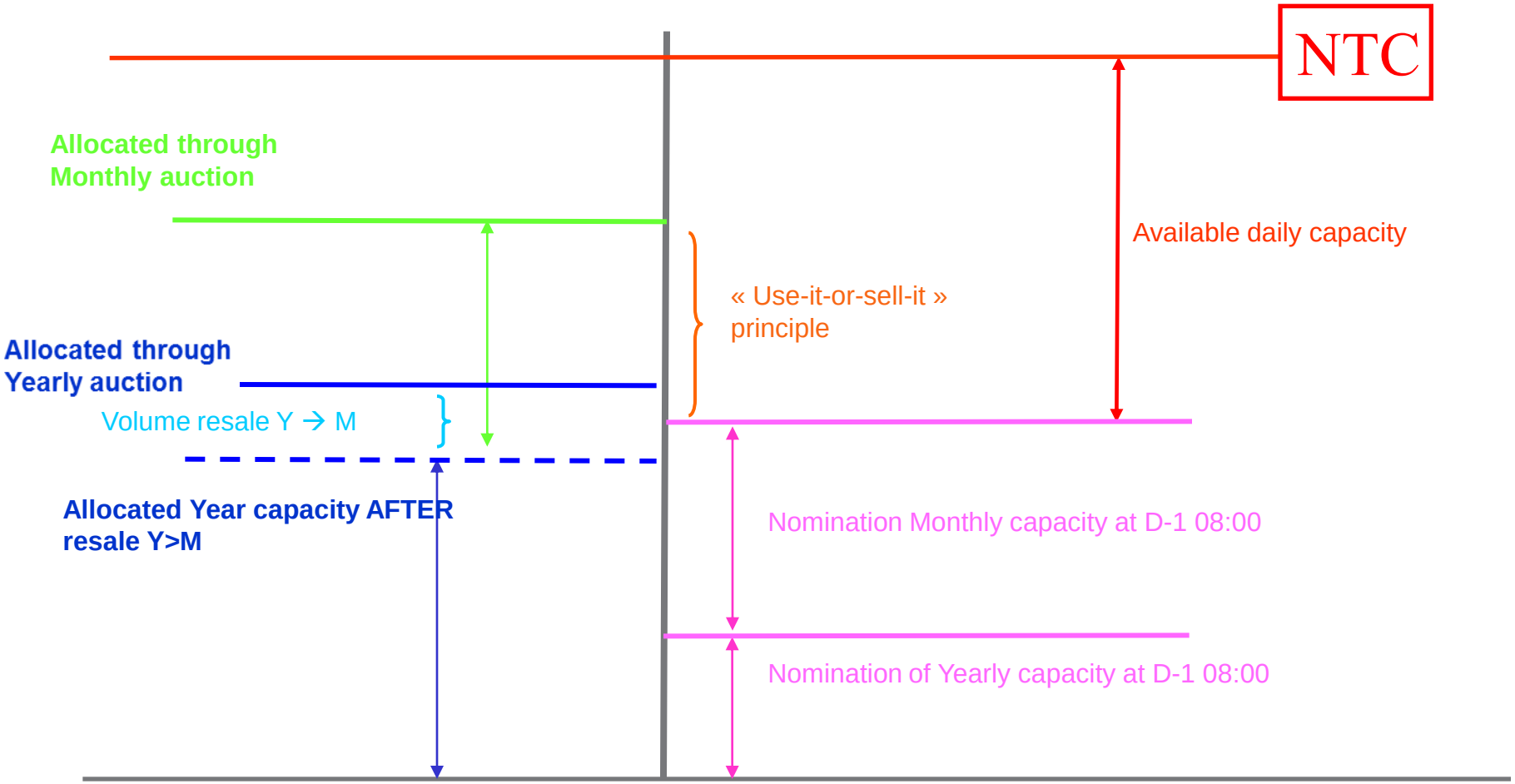
Already 12 shareholders

Creos (Luxemburg), **Elia** (Belgium) **TransnetBW** (Germany), **Tennet TSO GmbH** (Germany), **RTE** (France), **Amprion** (Germany), **Tennet TSO BV** (Netherlands), **APG** (Austria), **Swissgrid** (Switzerland), **ELES** (Slovenia), **HTSO** (Greece), **Terna** (Italy).

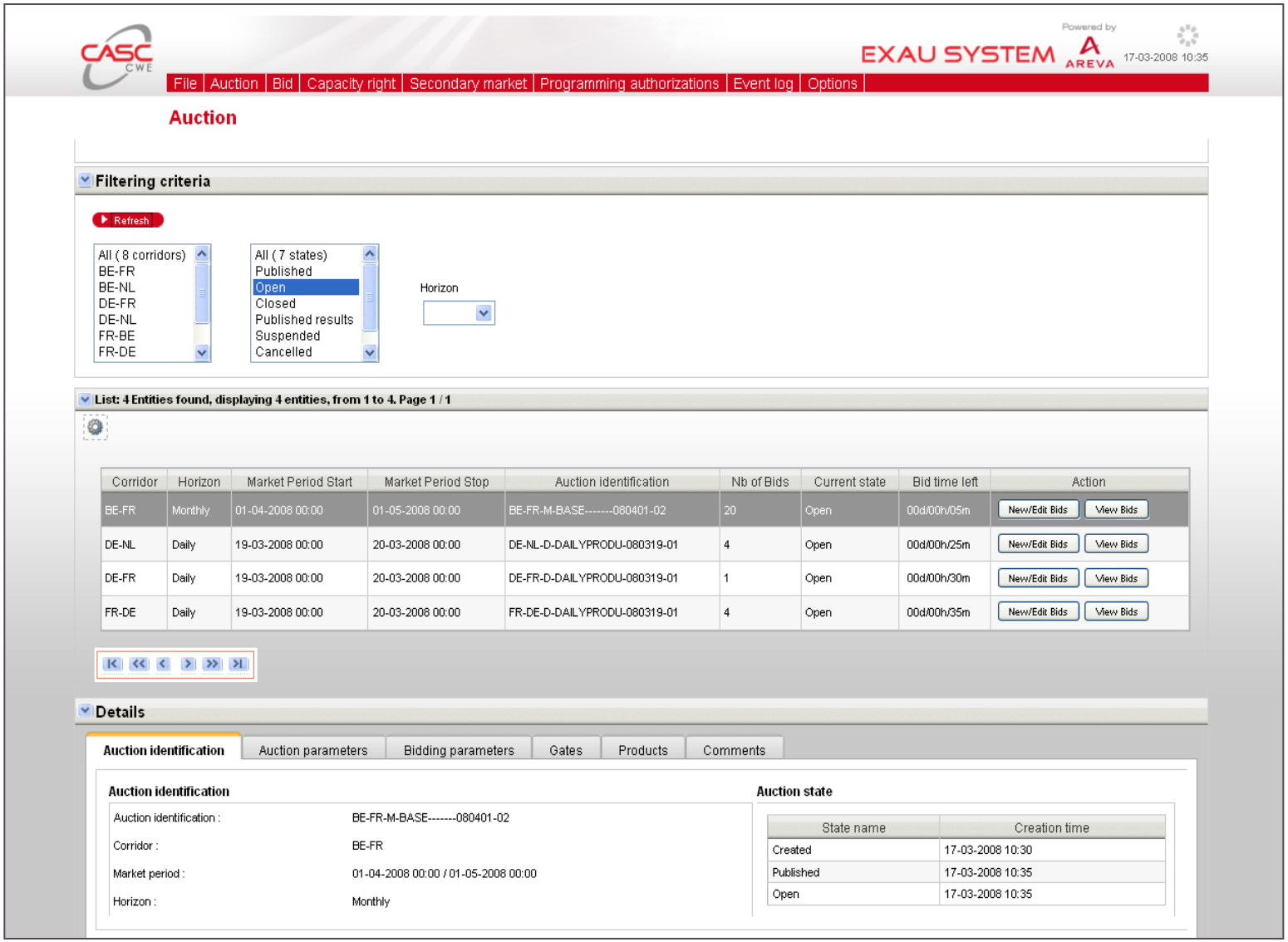
Already broad range of activities

- **Auction operator long term capacity rights**: CWE & CSE & CH borders ; DK-DE borders; ES-FR border
- **Auction operator daily auctions**: CSE region borders (excl. IT-SI border because of market coupling), CH borders
- **Auction operator intraday auctions** : North Italian borders
- **Operator for pre- and post-coupling tasks in implicit capacity allocations**
- **Shadow auction operator** (fall back of implicit auctions): CWE region borders; DE-DK-borders and NorNed

Y → M → D Available Capacity



Example: CASC's Auction Tool



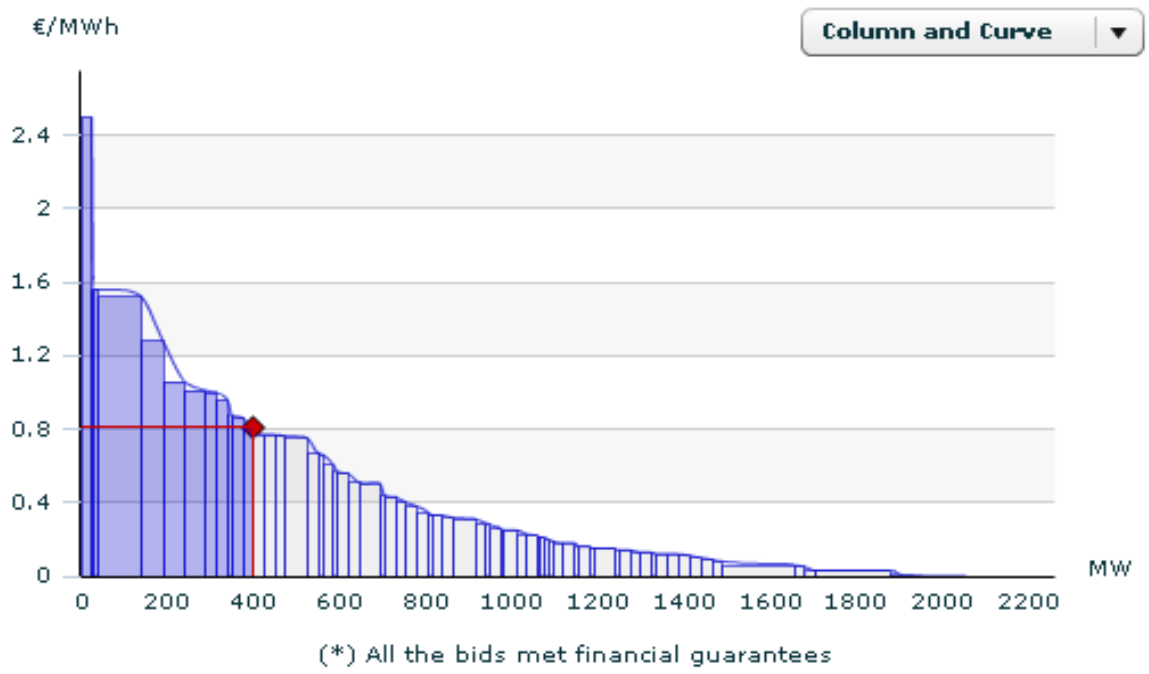
Example: CASC's Auction Tool

BE >> FR - 2009

Auction ID	Days	Timetable	Offered capacity (MW)	Requested capacity (MW)	Allocated capacity (MW)	Price (€/MWh)	Bid curve
BE-FR-Y-BASE-------090101-01	2009/01/01 2009/12/31	Every day 00:00-24:00	400	2055	400	0.81	

▸ Associated Auction Specifications

Bid curve



Characteristics

Number of participants	15
Participants who obtained capacities	7

Notice

Move the mouse pointer on the curve or bars to display offers values

Agenda

Short presentation APX Group

PART I : Some fundamentals of current EU market design

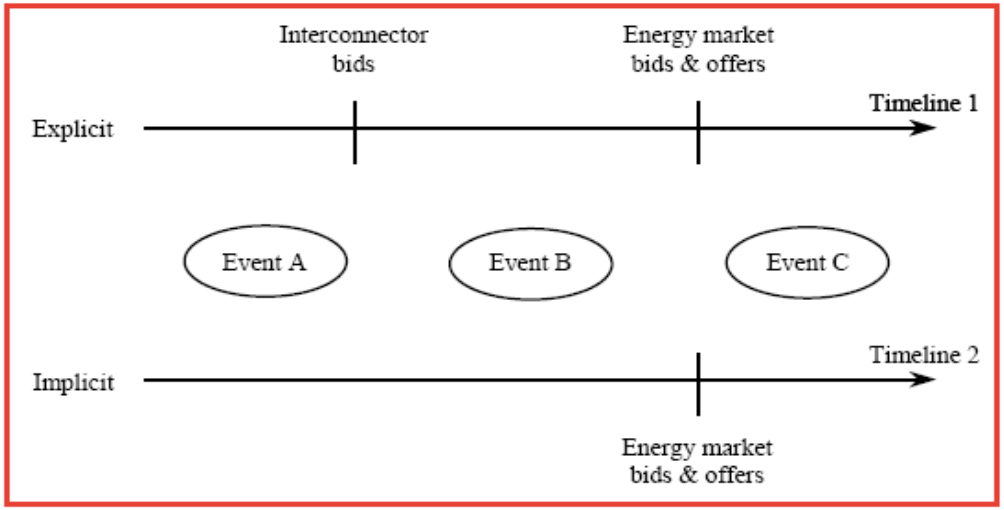
- **Liberalisation**
- **General principles balance management**
- **Different Market Venues**

PART II: EU market integration

- **Principles Interconnection Management & EU Target Model**
- **Day Ahead Market Coupling: Principles**
- **Day Ahead Market Coupling: Implementation Road Map**
- **Day Ahead Market Coupling: Auction Characteristics**
- **Day Ahead Market Coupling: Products & Algorihtm**
- **Day Ahead Market Coupling: Process & Operations**
- **Bidding Zone Review**
- **Flow Based Market Coupling**
- **Intraday Market Coupling**

Shortcomings Explicit Auctions

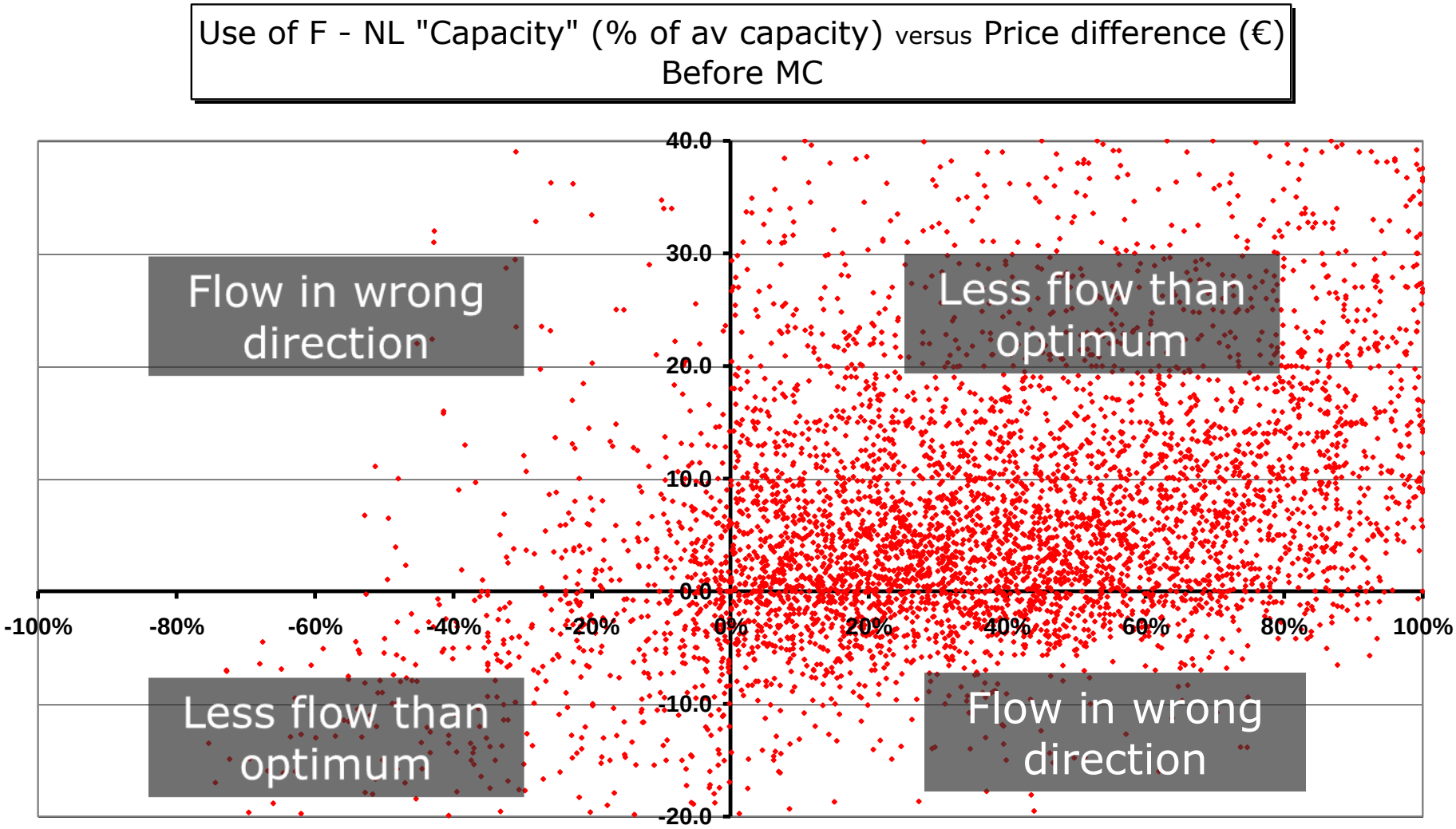
Explicit method
sequential capacity and energy market



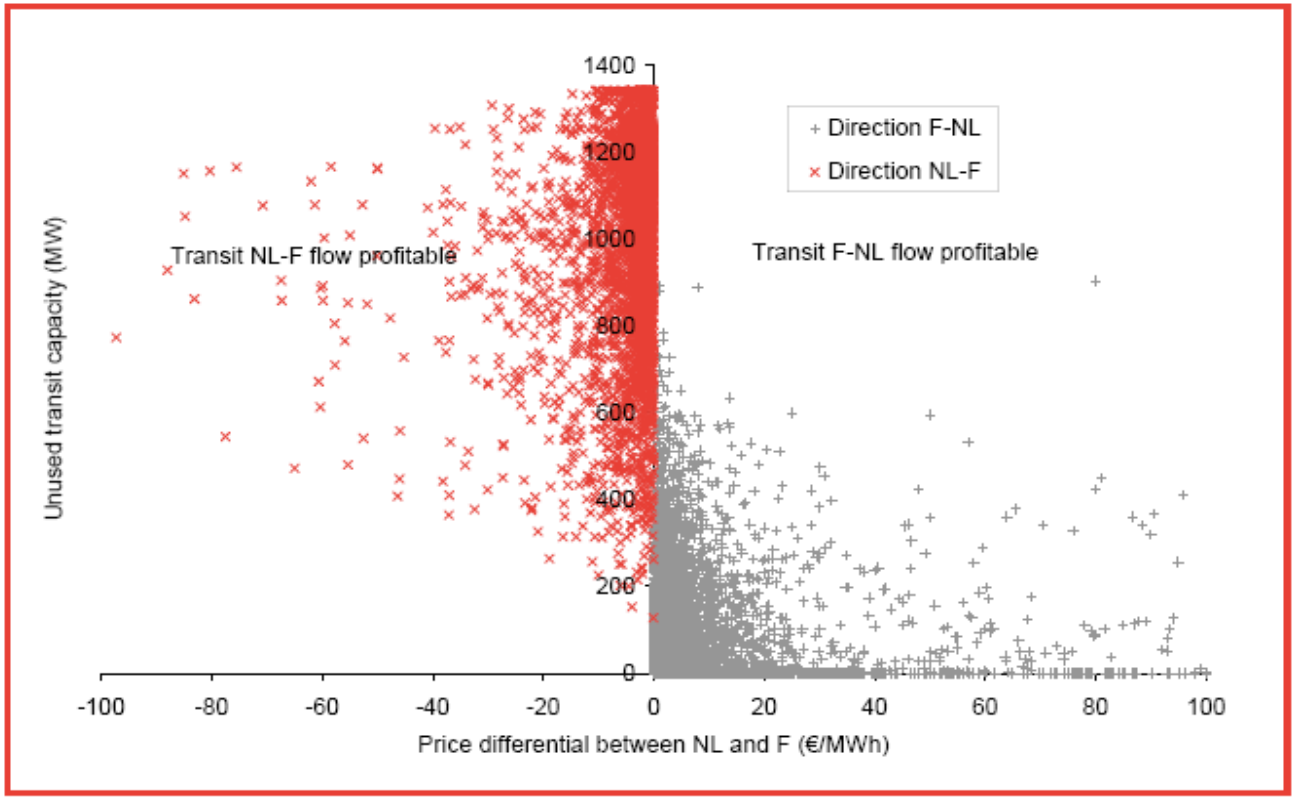
Three types of inefficiencies

- **Non rational use**
  - Power scheduled in the opposite direction than energy market prices would suggest
- **Under utilization**
  - Even if economically sound, not all the capacity is used
  - Netting of opposite flows is not possible (because options)
- **Wrong valuation**
  - Price paid for capacity does not reflect through market value

Example – Non Rational Use



Example – Under Utilization



Unused transit capacity in the profitable direction vs. price spread, 2005

Source : Frontier Economics, based on data's from Elia, APX and Powernext

What is Market Coupling

Market coupling is

- a way of linking separate day-ahead (auction-style) spot markets using available cross-border transmission capacity
- an "implicit auction" – meaning daily transmission capacity allocation is integrated with the trading of energy ("explicit auctions" allocate capacity separately)

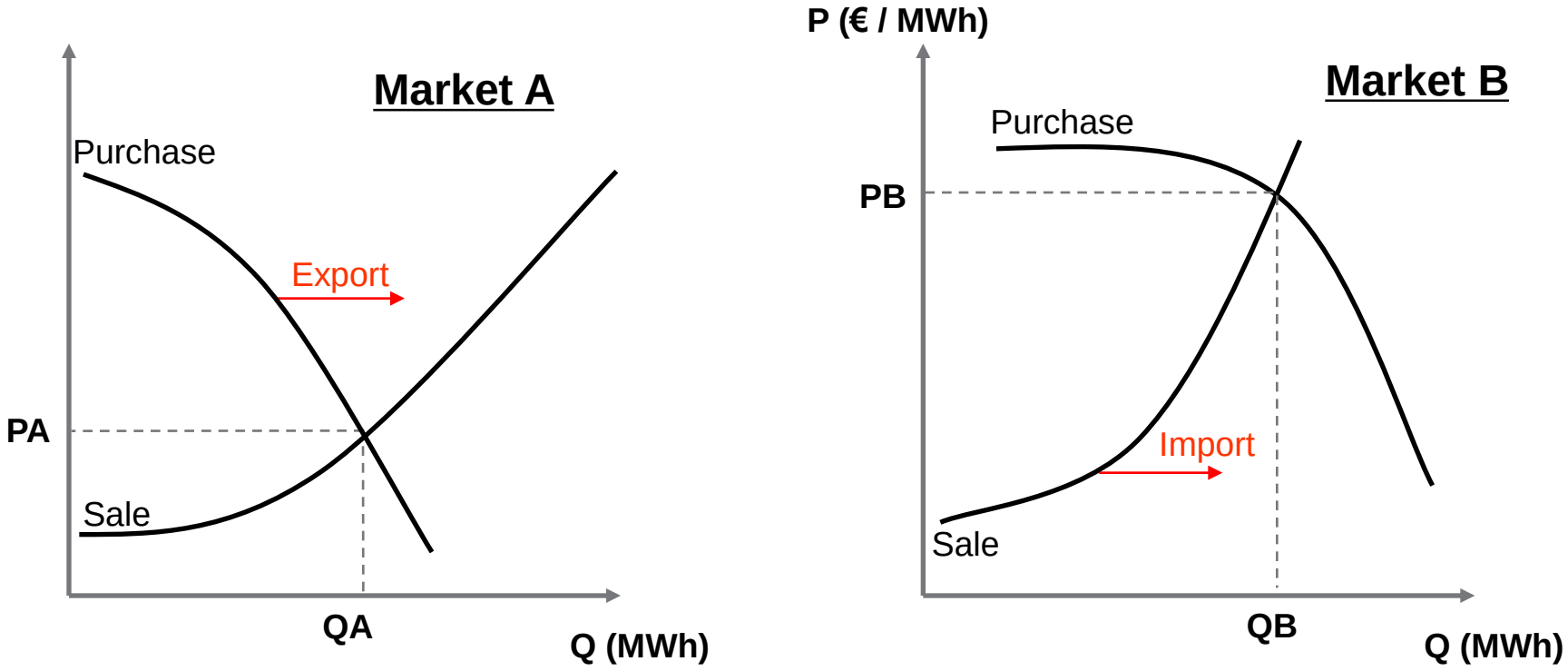
The implicit congestion price is equal to

- cost of using a scarce resource
- price-difference between markets.

With simplified network models (ATC):

Maximising the overall surplus
=
minimising price differences (in ATC)

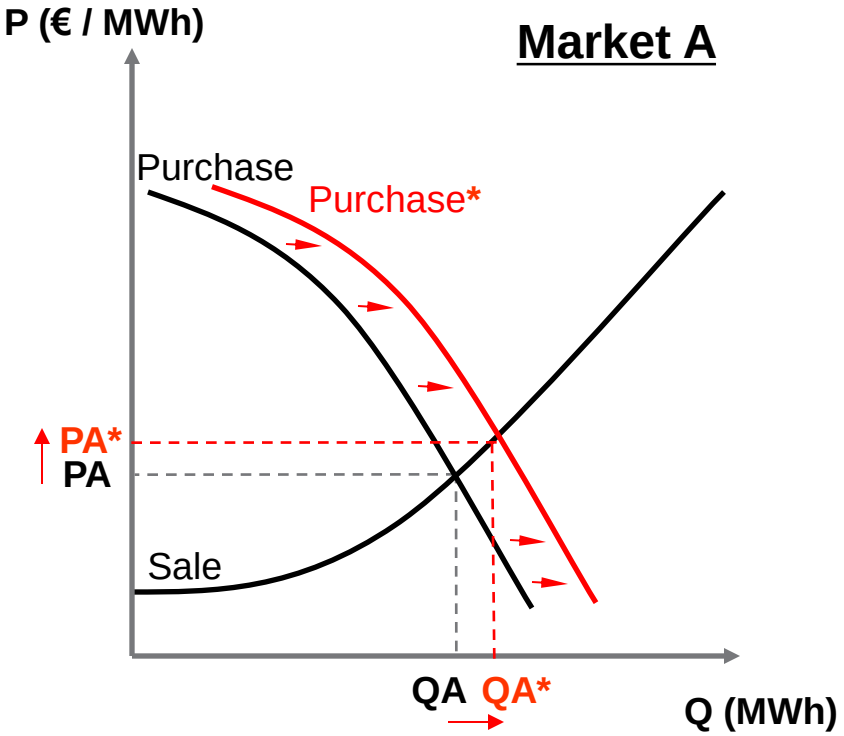
Market Coupling: Uncoupled Markets

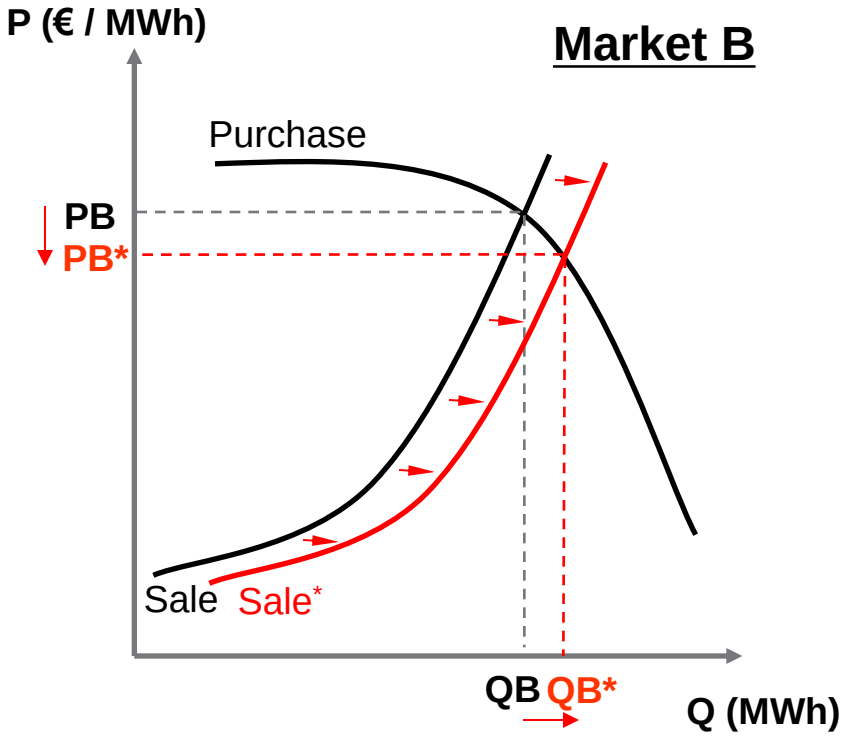


Isolated price Market A > isolated Price Market B

Market A can export to market B (purchase- and sale curve shift)

Market Coupling: Congested Case

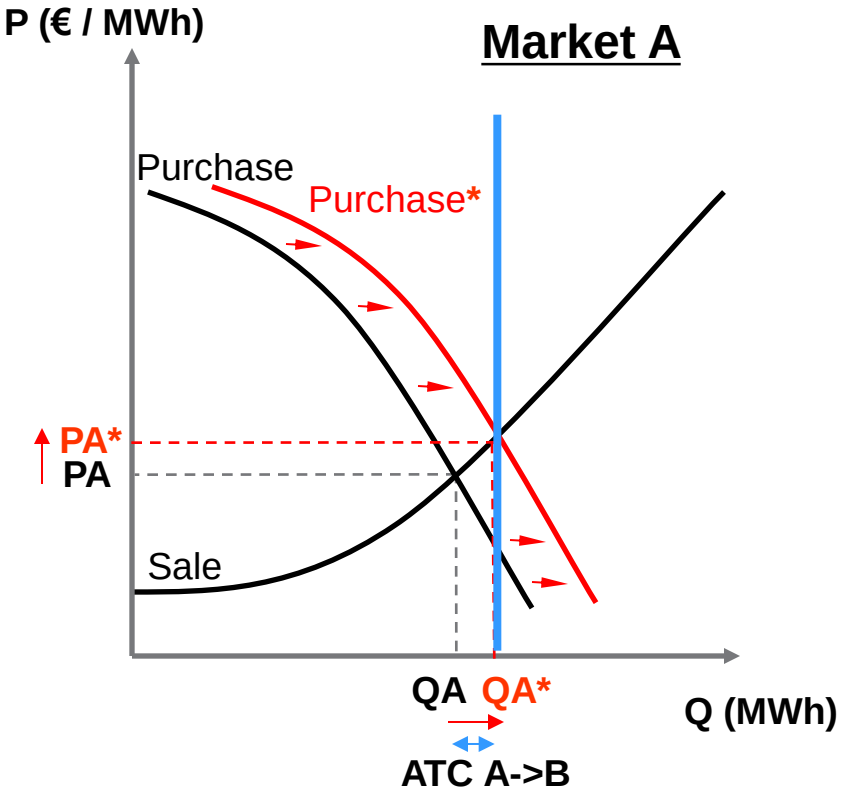


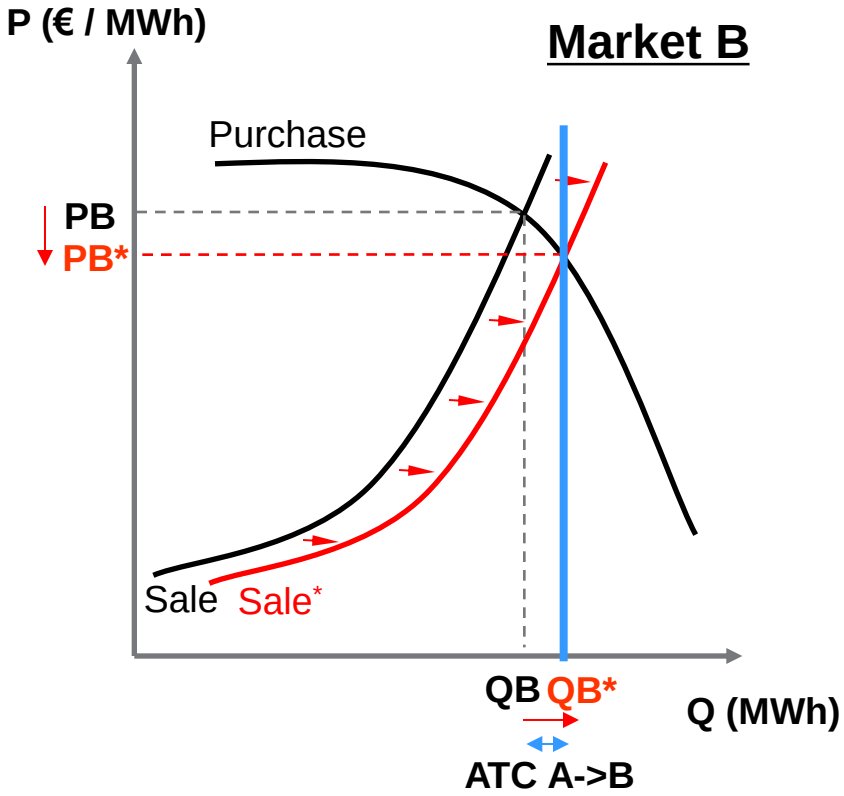


Isolated price Market A > isolated Price Market B

Market A can export to market B (purchase- and sale curve shift)

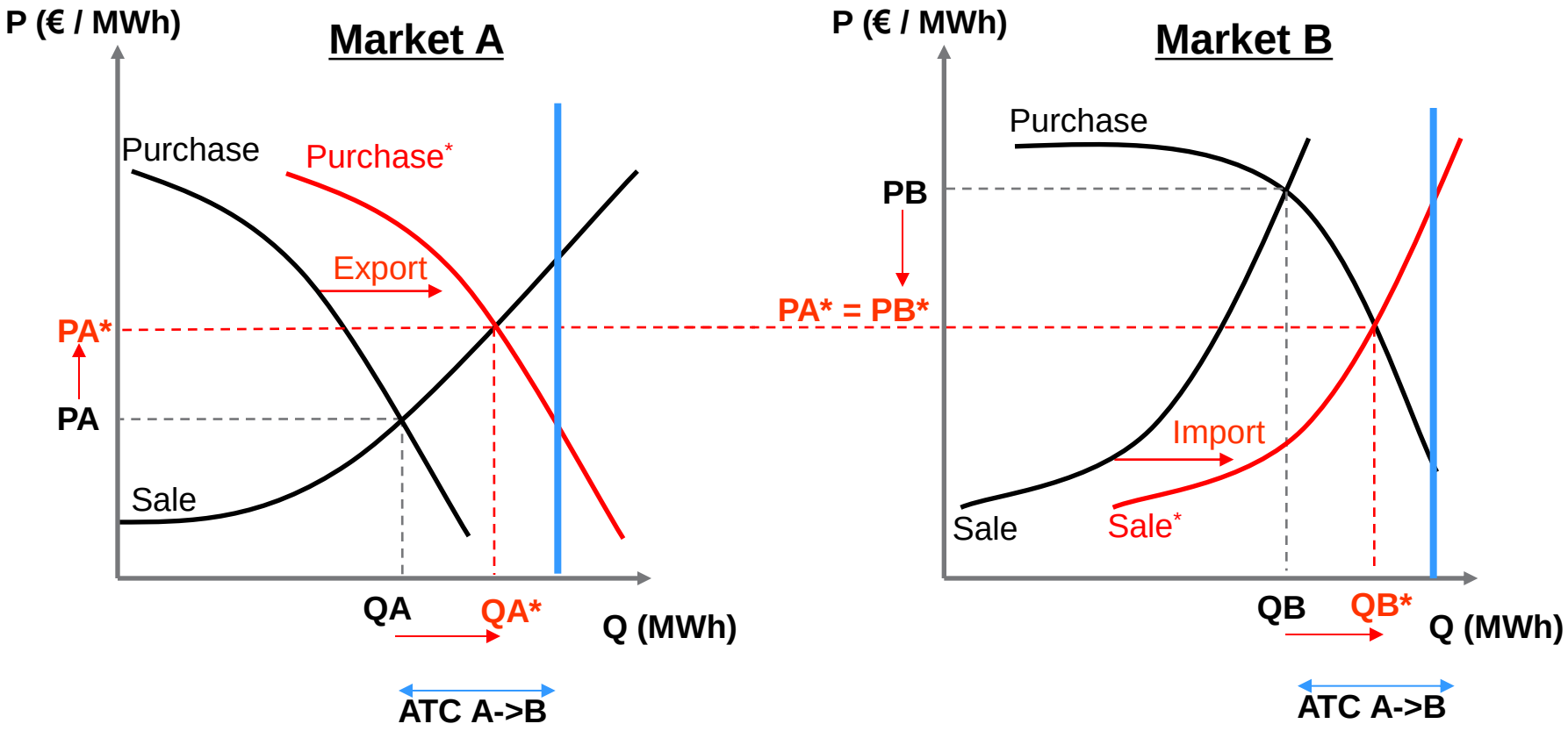
Market Coupling: Congested Case





Isolated price Market A > isolated Price Market B
Market A can export to market B (purchase- and sale curve shift)
The export (and therefore price convergence) is limited by the availability of the cross border capacity

Market Coupling: Uncongested Case

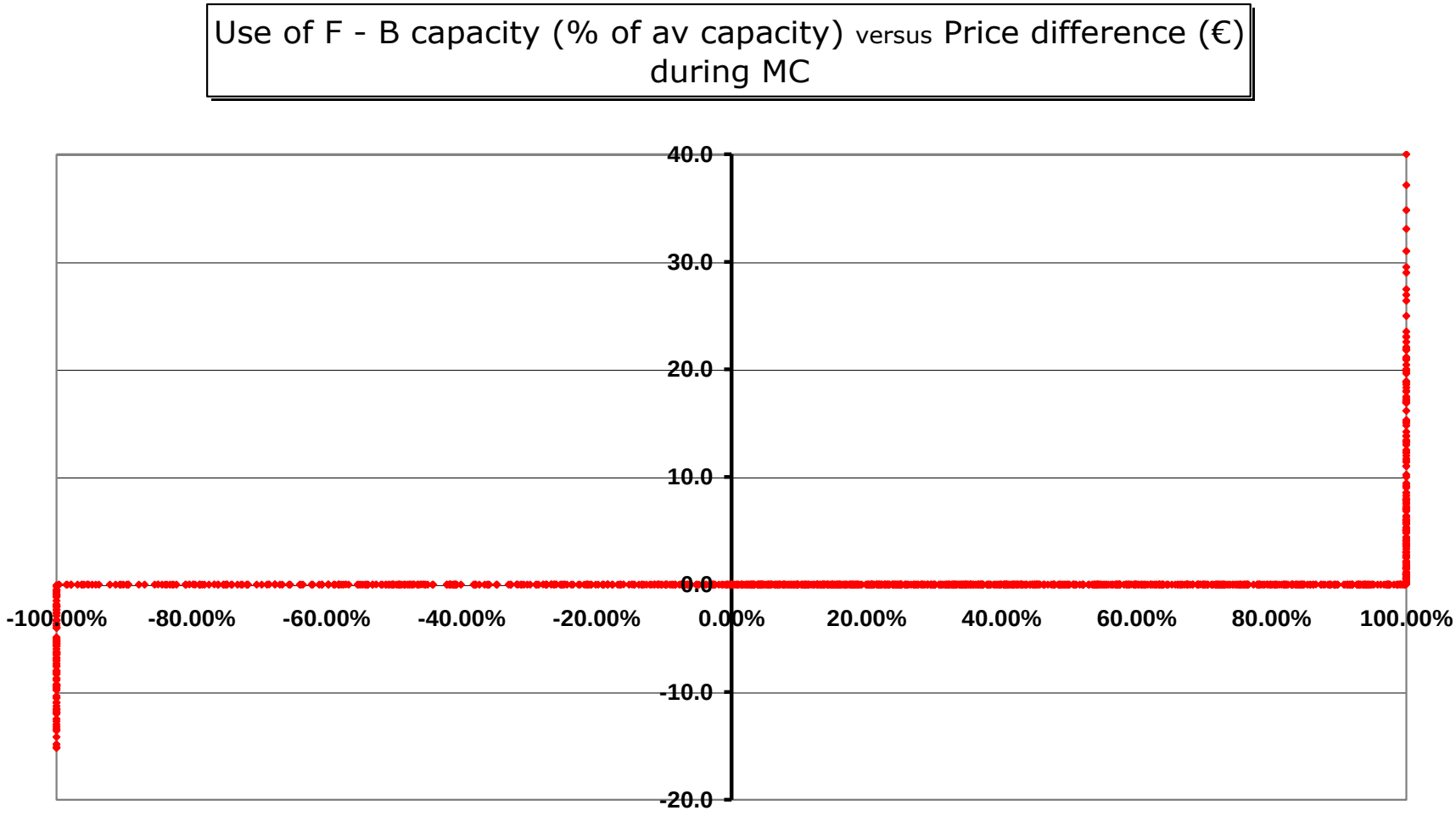


Isolated price Market A > isolated Price Market B

Market A can export to market B (purchase- and sale curve shift)

Prices market A and B converge till price market A = price market B

Example: Capacity Usage with MC

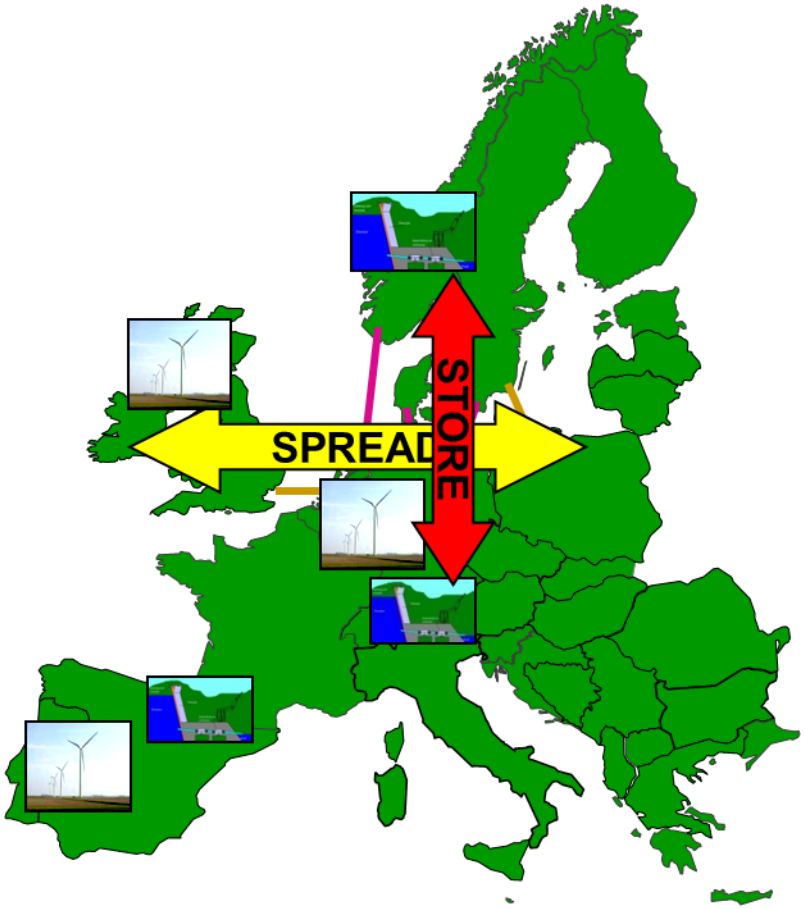


Main Benefits of Market Coupling

- Facilitates development of **liquid** commodity **markets** and fosters competition
- Removal risk of trading transmission and energy separately and **reduction risk of market abuse** since transmission capacity cannot be hoarded
- Market prices convergence, ultimately **towards a single market** price if sufficient capacity is available
- **Optimum use of cross-border capacity** and optimization of the use of the generation global portfolio. The more differences in local production mixes, the larger the social welfare increase resulting from such optimization
- **Mitigation of price volatility** by 'absorbing' local variations in production thanks to the activation of flexible means in other areas, which **contributes to SoS** and will be of increasing importance with the development of intermittent RES

"the benefits of market coupling, if fully implemented across Europe, will be of the order of €2.5 – €4 billion per year".

From « benefits of an integrated European Energy Market » sttudy from Booz&CO, Prof. D. Newberry, et al, prepared for DG Ener



Consistency of energy policies is important

Agenda

Short presentation APX Group

PART I : Some fundamentals of current EU market design

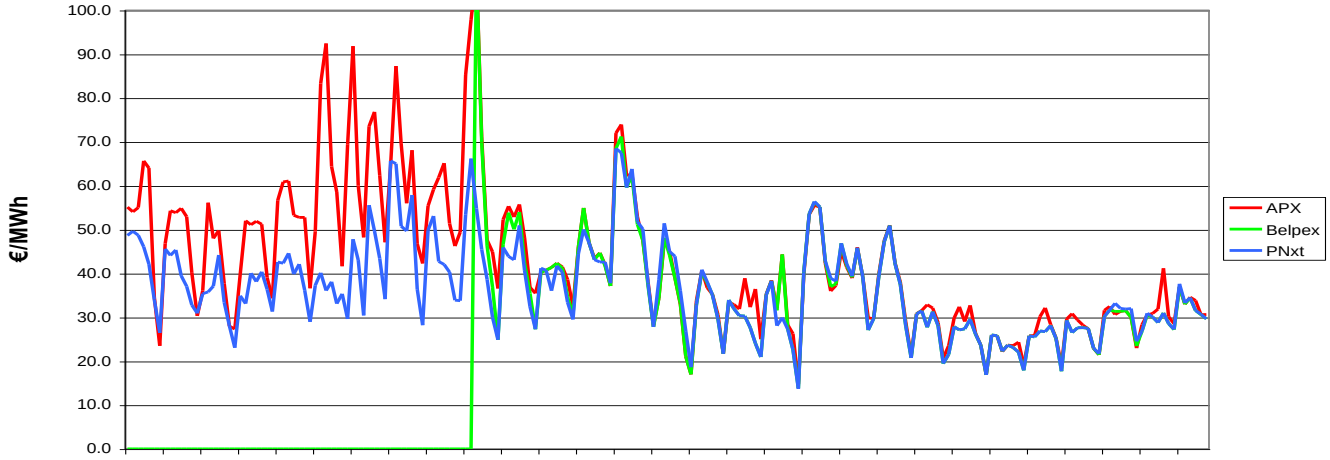
- Liberalisation
- General principles balance management
- Different Market Venues

PART II: EU market integration

- Principles Interconnection Management & EU Target Model
- Day Ahead Market Coupling: Principles
- Day Ahead Market Coupling: Implementation Road Map
- Day Ahead Market Coupling: Auction Characteristics
- Day Ahead Market Coupling: Products & Algorihtm
- Day Ahead Market Coupling: Process & Operations
- Bidding Zone Review
- Flow Based Market Coupling
- Intraday Market Coupling

Example Market Coupling Benefits: TLC project

Key features (Launched 2006)	
Achievement	Coupling of NL, Be and FR sport markets through MC
Parties	PX and TSOs of BE, FR and NL
Concept	MC is a service provided by PX to TSO
Control	All party contract, joint SC, unanimous decisions
Regulation	Local regulation of TSO, TLC jointly approved by NRA's
MC system	Partially decentralized, iterative, heuristic-based, price coupling
Transmission model	ATCs, no loops
XB shipping	Bilateral TSO-TSO

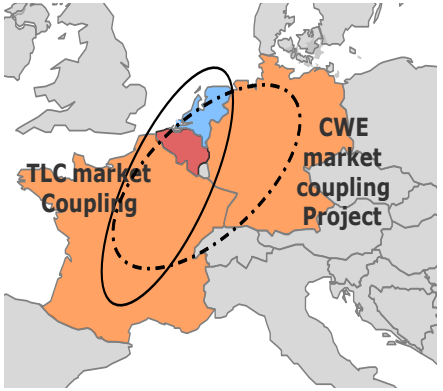


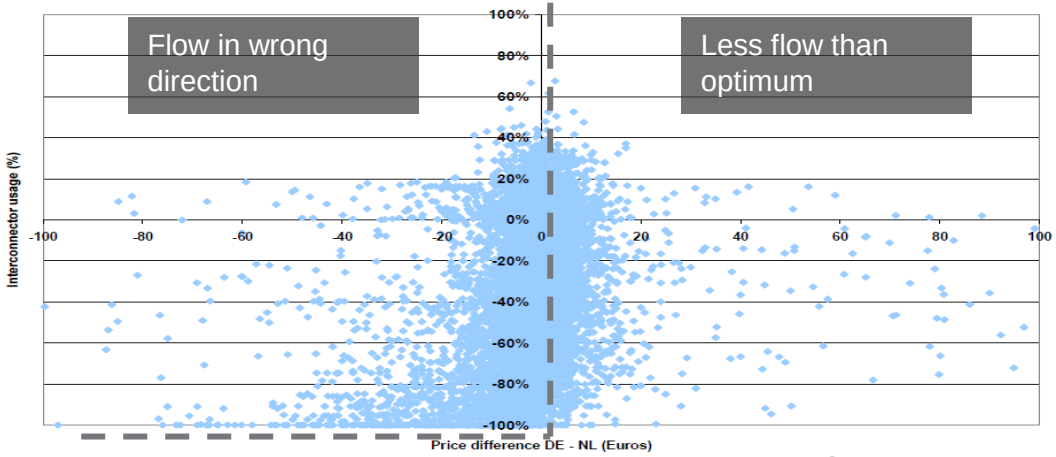
Price Evolution before – after market coupling implementation

Daily average prices 9-'06 until 3-'07

Example Market Coupling Benefits: CWE project

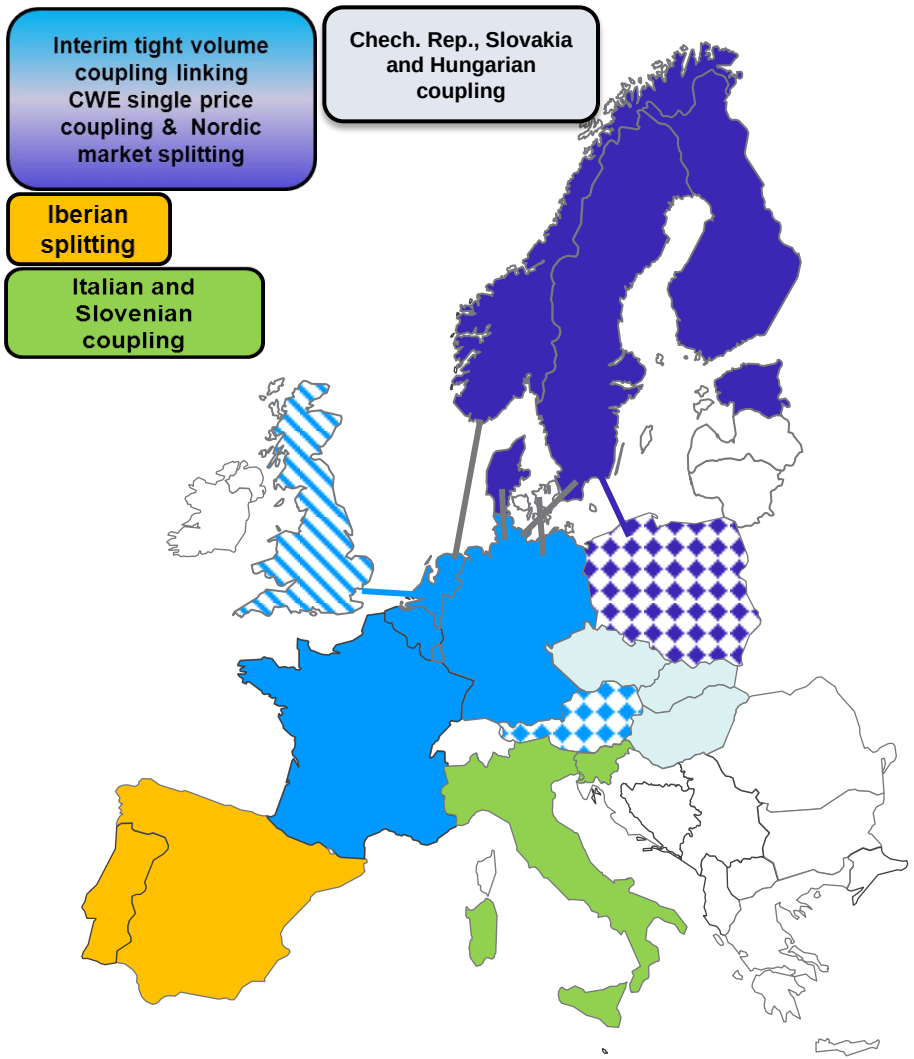
Key features (Launched 2010)	
Achievement	Coupling of NL, Be, FR and DA sport markets through MC
Parties	PX and TSOs of BE, FR, NL and DE
Concept	MC is a service provided by PX to TSO
Control	All party contract, joint SC, unanimous decisions
Regulation	Local regulation of TSO, TLC jointly approved by NRA's
MC system	Partially decentralized, iterative, heuristic-based, price coupling
Transmission model	ATCs, with loops (new Algorithm: COSMOS)
XB shipping	CCP to CCP





Capacity utilisation NL-DE border before CWE market coupling Go-Live ; 2007 data

Status EU Market Coupling January 2014



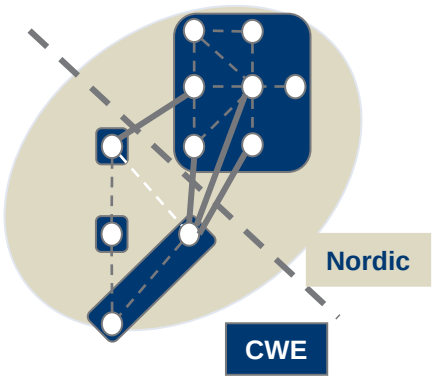
- Coupling of CWE region and Nordic region through "Tight Volume Coupling" ("ITVC")
- Tight Volume coupling; sequential process
  - Step 1: regional order collection
  - Step 2: determination of inter-regional flows based on regional order books and capacity information
  - Step 3: regional price coupling taking into account inter-regional flows as price taking orders
- GB coupled through "embedded" solution (APX)

⇒ Organic growth ; maximum reach achieved
⇒ Unfit as EU solution: Different algorimths, products, gate closure times,..

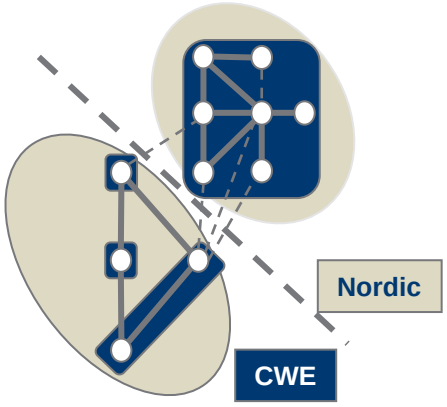
New approach was needed:

Price Coupling of Regions (PCR)

Multi regional Tight Volume Coupling

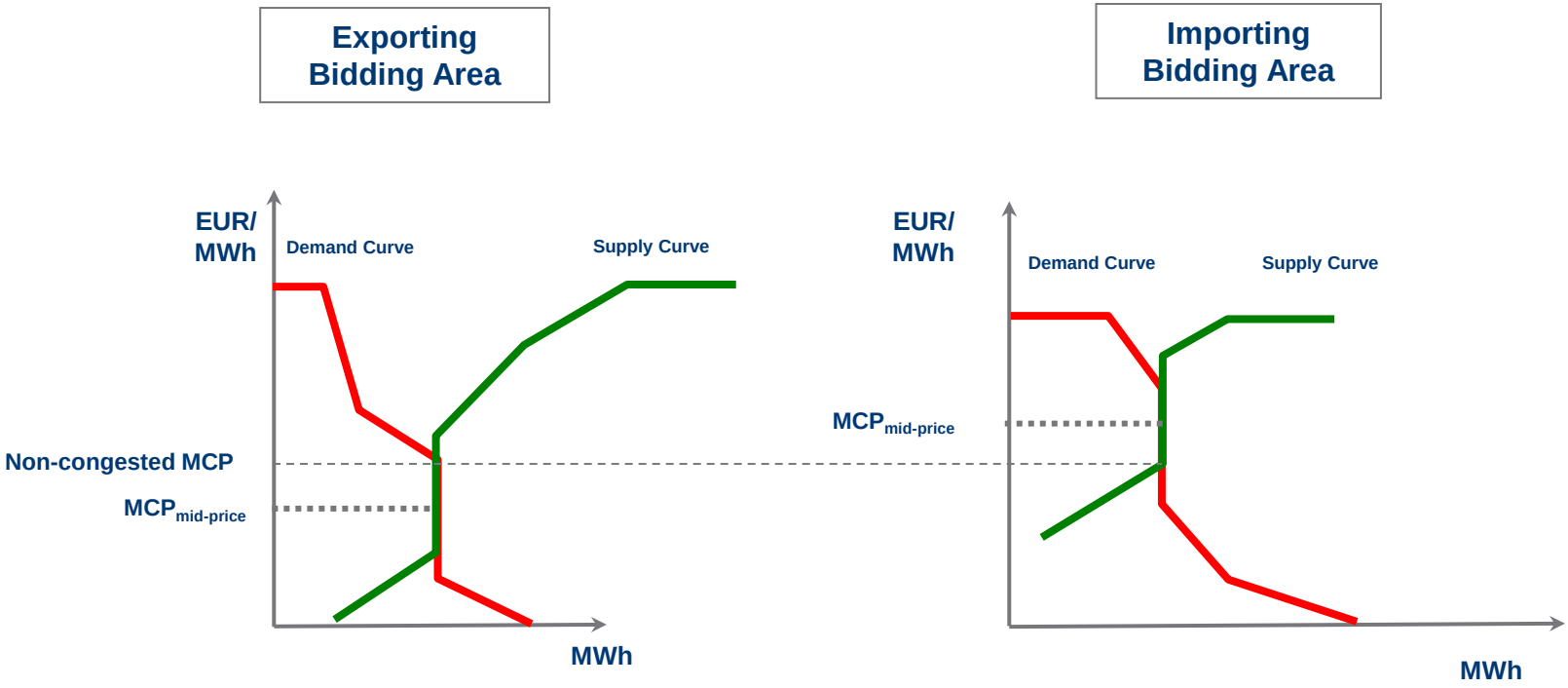


- **First Step**
  - **Joint matching of the Nordic market and the entire CWE region**
  - **Result:**
    - **Volumes on the interregional interconnectors**



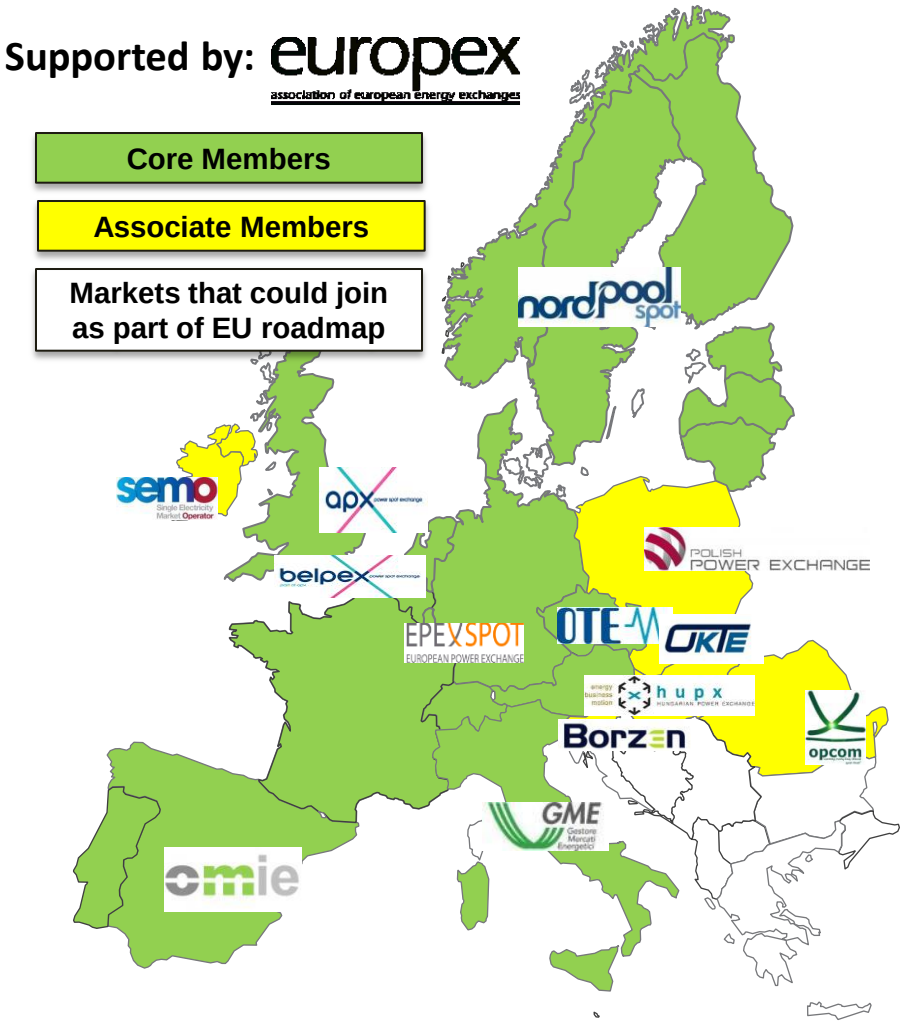
- **Second Step**
  - **Parallel matching of the CWE region and the Nordic market**
  - **Result in each region:**
    - **Prices and net positions of each Bidding Area**
- **Possible Problem: different algorithms**

Example of tight volume coupling inefficiencies



Despite no congestion, price discrepancies remain because of different algorithms/price determination rules

Price Coupling of Region (PCR)



- Joint PX project focused on the delivery of a common European price coupling solution (with associated algorithms, systems, procedures and inter-PX co-operation arrangements)
- Solution can be implemented in a variety of local regulatory/governance settings
- Philosophy: build on the existing contractual, regulatory and operational solutions, while establishing the necessary harmonization and governance principles at the European level

→ **One single algorithm**

→ **Harmonized procedures**

→ **Decentralized operation**

→ **Decentralized governance**

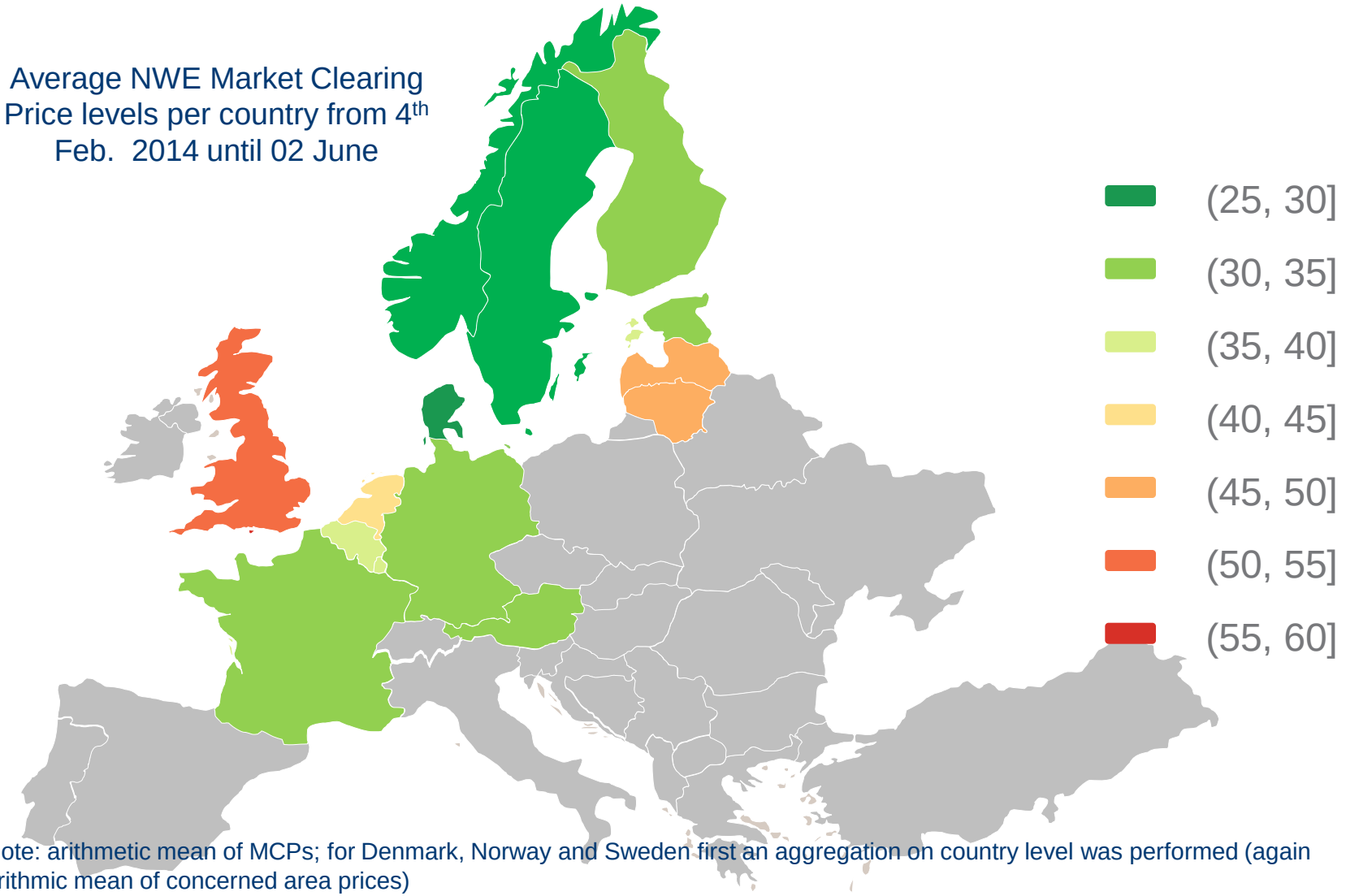
Status EU coupling 2015

- NWE went live on February 4, 2014. SWE also started in common synchronized mode, using PCR.
- SWE full coupling started May 13th, 2014
- NWE-SWE now called MRC
  - NWE and SWE jointly developed a common Operational Agreement
  - This agreement is regarded as the basis for further extensions
- MRC has proven to be operationally robust
- Daily >3,5TWh cleared for value of > 200M€

EXPANSION OF MRC		
	NWE, Baltic	Feb 2014
	Austria, Poland	Partial solution, Feb 2014
	SWE	May 2014 Full Coupling
	Italian Borders	End 2014
	4M	Separate PCR solution, Q4 2014

NWE price development

Average NWE Market Clearing Price levels per country from 4th Feb. 2014 until 02 June



Note: arithmetic mean of MCPs; for Denmark, Norway and Sweden first an aggregation on country level was performed (again arithmic mean of concerned area prices)

Source: own computation based on data from APX, Belpex, EPEX Spot, N2EX and NordPoolSpot

Key Features Multi Regional Coupling

- Decentralized solution; each PX has system (PMB) in place to perform the central calculation
- Central coordination (calculation role) role switches every 2 weeks, is performed by all PX
- Back Up coordinator who takes over in case of issues at Central Coordinator, role switches every 2W
- Back Up Coordinator runs a // shadow central calculation. 0ther PMB operator can run // calculation
- If issues: Incident Committee is triggered by confer. call, allowing for central incident management

Governance -Market Coupling principles/mechanism: NRA approval

-Contracts:

-PX-TSO (one): Day Ahead Operational Agreement (DAOA): R&R PX vs TSOs

-PX-PX (one): Cooperation Agreement PCR & co-ownership agreement

-TSO-TSO agreements: pre & post coupling arrangements

-PX or CCPs-TSO agreements: shipping contracts

-PX-TSO local/regional agreements: agreements supplementing DAOA to account for local/regional features

Management -TSO-PX ; TSO-TSO and PX-PX steering committees and operational committees

-Regular reportings to EU and National autorities and NRAs

Next Steps /WiP

- Management of further extentions
- Set up of EU-wide stakeholder committee
- Change procedures / consultation / decision making process / issue resultion

From TLC to MRC – Success Factors

- Initially bottom up – now mixture of bottom up and top down
- Subsidiarity and respect of each others' interest
- Harmonisation not as mantra, only when required to achieve overall goal
- Realism/pragmatism: solve problems as they come along, out of the box thinking
- Regulatory/political flexibility
- Team work ; confidence ; transparency

Agenda

Short presentation APX Group

PART I : Some fundamentals of current EU market design

- Liberalisation
- General principles balance management
- Different Market Venues

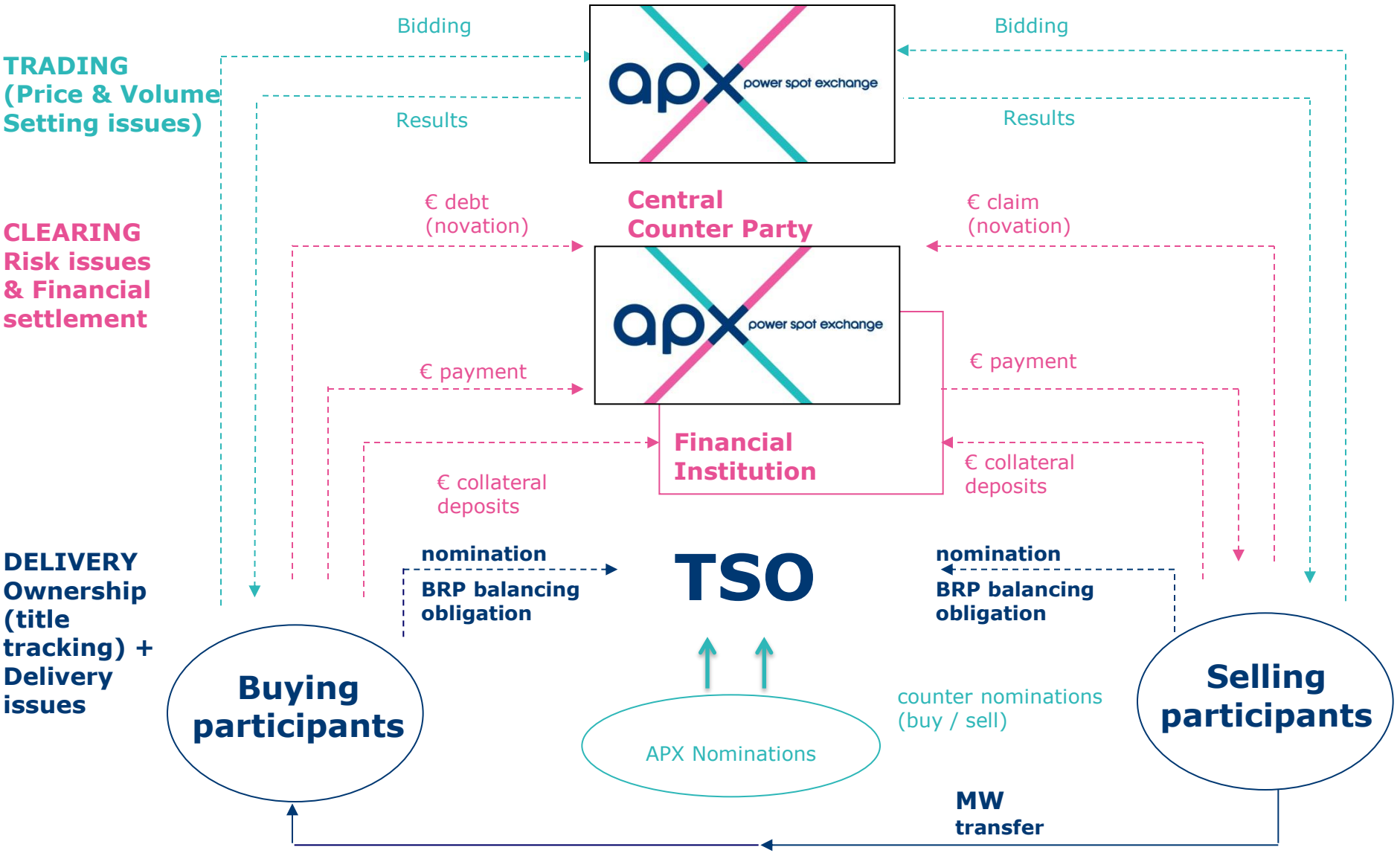
PART II: EU market integration

- Principles Interconnection Management & EU Target Model
- Day Ahead Market Coupling: Principles
- Day Ahead Market Coupling: Implementation Road Map
- Day Ahead Market Coupling: Auction Characteristics
- Day Ahead Market Coupling: Products & Algorihtm
- Day Ahead Market Coupling: Process & Operations
- Bidding Zone Review
- Flow Based Market Coupling
- Intraday Market Coupling

Auction Characteristics

- **Anonymous trading**
- **Short term, physical trading**
  Day Ahead Market: trade today for delivery the next day
- **Closed order book (no pre-closing information)**
  Avoid “squeezing”
- **Fixing of contracts via a double-sided blind auction**
  concentrate liquidity
  Set uniform price
- **Clearing and settlement facilities provided by central counterparty**
  Collateralization of trades
  Daily invoicing and settlement
- **Delivery on the hub via the TSO nomination system**

Trading, Clearing, Nomination



Agenda

Short presentation APX Group

PART I : Some fundamentals of current EU market design

- **Liberalisation**
- **General principles balance management**
- **Different Market Venues**

PART II: EU market integration

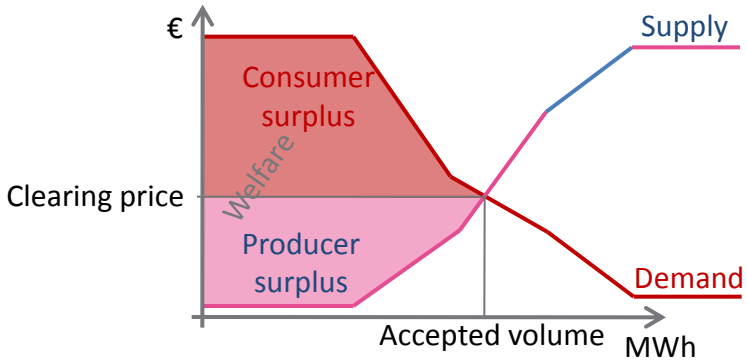
- **Principles Interconnection Management & EU Target Model**
- **Day Ahead Market Coupling: Principles**
- **Day Ahead Market Coupling: Implementation Road Map**
- **Day Ahead Market Coupling: Auction Characteristics**
- **Day Ahead Market Coupling: Products & Algorihtm**
- **Day Ahead Market Coupling: Process & Operations**
- **Bidding Zone Review**
- **Flow Based Market Coupling**
- **Intraday Market Coupling**

Algortithm Euphemia

- **EUPHEMIA is an algorithm that solves the market coupling problem on the PCR perimeter.**

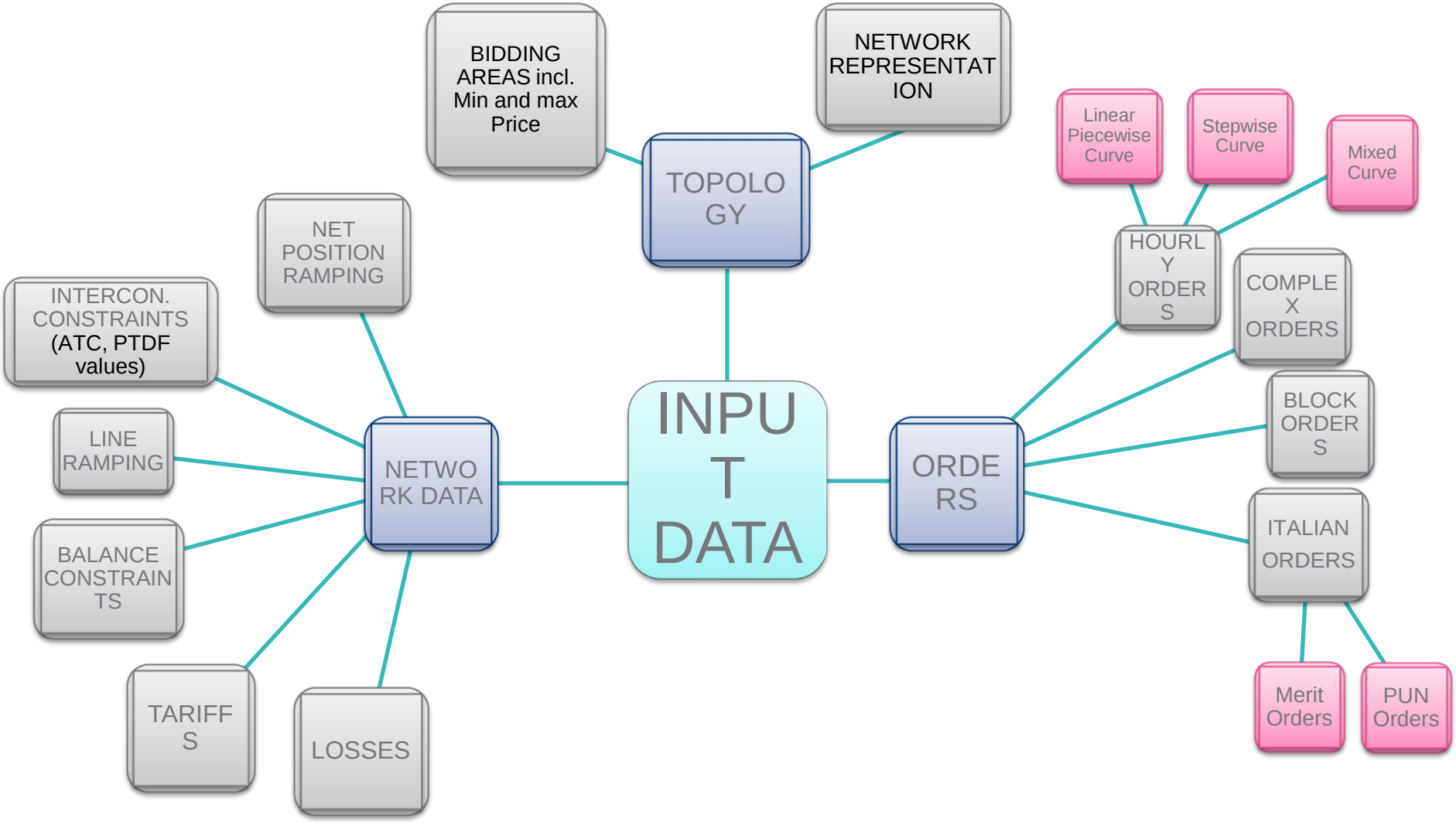
  EUPHEMIA stands for: EU + Pan-european Hybrid Electricity Market Integration Algorithm**.**

- **It maximizes the welfare of the solution**
  - Most competitive price will arise
  - Overall welfare increases
  - Efficient capacity allocation



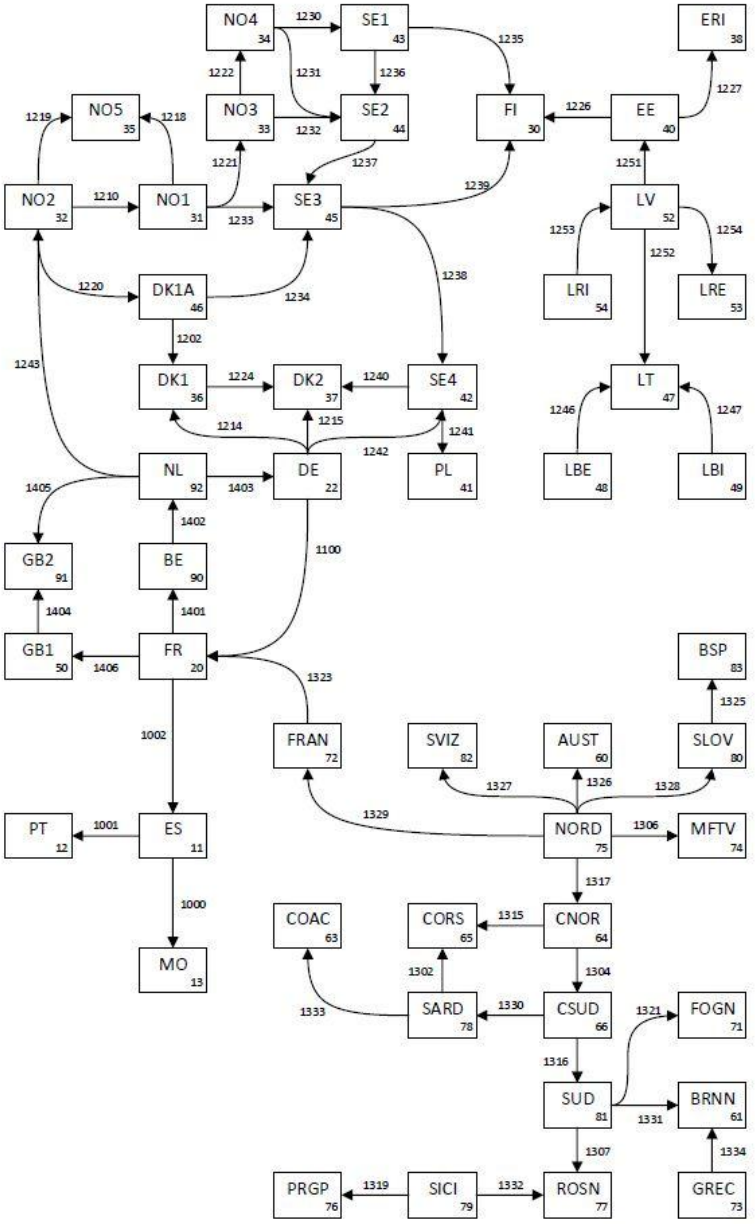
Algorithm has been tested using real 2011/2012/2013/2014 daily order books (around 50 bidding areas and 60 ATC lines)

INPUT DATA


BIDDING AREAS incl. Min and max Price
NETWORK REPRESENTATION
TOPOLOGY
NET POSITION RAMPING
INTERCON. CONSTRAINTS (ATC, PTDF values)
LINE RAMPING
BALANCE CONSTRAINTS
TARIFFS
LOSSES
NETWORK DATA
INPUT DATA
ORDERS
Linear Piecewise Curve
Stepwise Curve
Mixed Curve
HOURLY ORDERS
COMPLEX ORDERS
BLOCK ORDERS
ITALIAN ORDERS
Merit Orders
PUN Orders

MARKET DATA

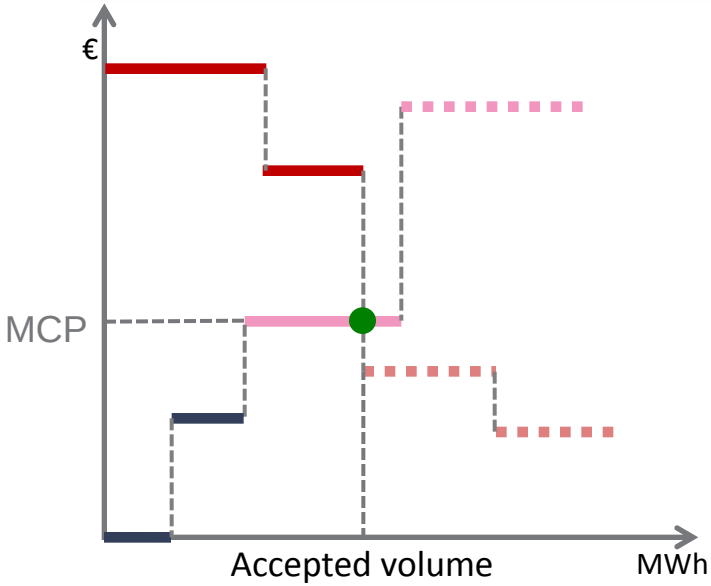
- Each PX (Market) operates several bidding areas.
- All bidding areas are matched at the same time.
- A different price can be obtained for each bidding area.
- The price for the bidding area must respect maximum and minimum price market boundaries.



HOURLY STEP ORDERS (general rule)

- Hourly step orders are defined by
  - A type (buy or sell)
  - A volume
  - A limit price

- EUPHEMIA provides solutions such that
  - Orders in-the-money are fully accepted
    - Supply at price < MCP
    - Demand at price > MCP
  - Orders out-of-the-money are fully rejected
    - Supply at price > MCP
    - Demand at price < MCP
  - Orders at-the-money can be curtailed

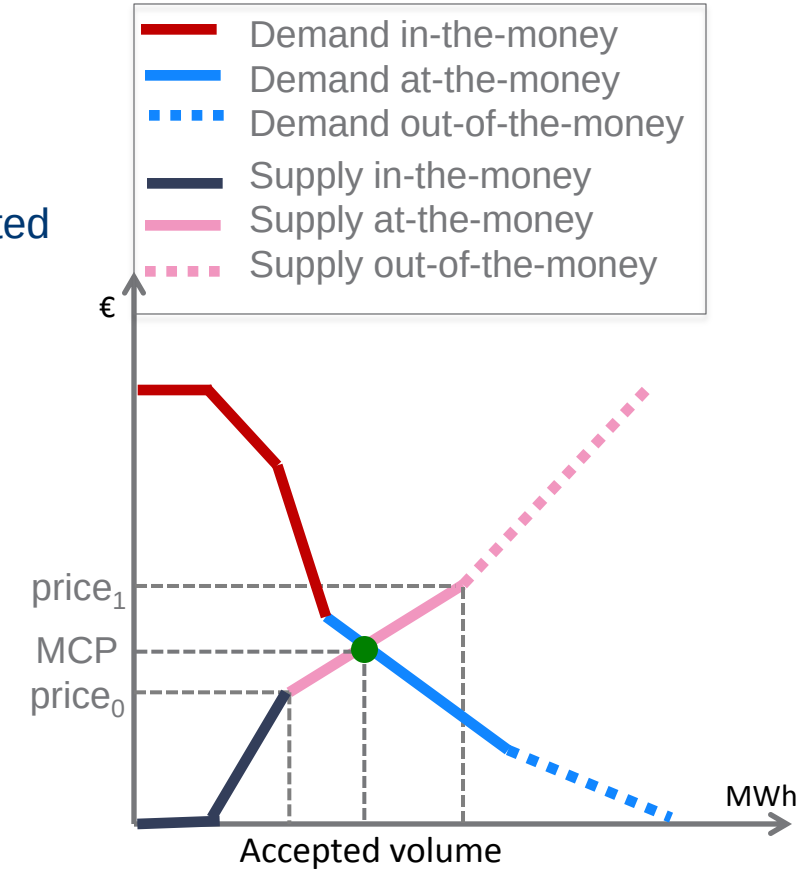


OMIE, APX, Belpex, GME and OTE use this kind of orders.

HOURLY LINEAR PIECEWISE ORDERS (gen.rule)

- Hourly piecewise orders are defined by
  - A side (buy or sell)
  - A volume
  - price0: at which the order starts to be accepted
  - price1: at which the order is totally accepted (price1 > price0)
- EUPHEMIA provides solutions such that
  - Orders in-the-money are fully accepted
    - Supply where price1 < MCP
    - Demand where price1 > MCP
  - Orders out-of-the-money are fully rejected
    - Supply where price0 > MCP
    - Demand where price0 < MCP
  - Orders at-the-money are accepted to the corresponding proportion

    Acceptance ratio = (MCP-price0) / (price1-price0)



NORDPOOL and EPEX use this kind of orders.

REGULAR BLOCK ORDERS

Regular Block orders are defined by

- Type (buy or sell).
- one single price.
- one single volume.
- Period: consecutive hours over which the block spans.

A regular block order <u>cannot</u> be accepted partially. It is either totally rejected or accepted (Fill-or-Kill condition).

PROFILE BLOCK ORDERS

Profile Block orders are defined by

- Type (buy or sell).
- one single price.
- Minimum Acceptance Ratio.
- Period: hours over which the block spans.
- Volume for each hour

The Profile Block orders can only be accepted with an acceptance ratio higher or equal than the minimum acceptance ratio.

Examples :

Type	PERIOD	PRICE	VOLUME
BLOCK BUY	Hours 1-24	40 Euros	200 MWh
BLOCK SELL	Hours 8-12	40 Euros	50 MWh

Type	PERIOD	PRICE	MIN. ACCEPT. RATIO	VOLUME
BLOCK SELL	Hours 1-7 Hours 16-24	40 Euros	**50%**	80 MWh 220 MWh

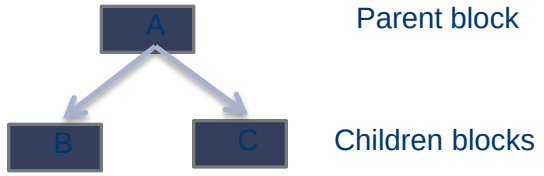
Acceptance Criterion :
a regular or profile block order out-the-money cannot be accepted

EXCLUSIVE BLOCK ORDERS

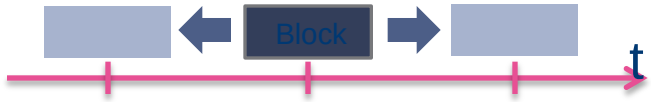
- Exclusive Group = Set of Block Orders in which the sum of the accepted ratios cannot exceed 1.
- Acceptance rules of Block Orders totally apply.

LINKED BLOCK ORDERS

- Several Block orders may be linked together in a parent-child relationship
- The acceptance of a child Block Order is conditional to the acceptance of its parent.
- However a loss giving parent can be saved by a child as long as the combination of accepted block orders is not making a loss.



FLEXIBLE HOURLY BLOCK ORDERS



- A Flexible Hourly Order is a Regular Block Order which lasts for only one period.
- If accepted, the block will be executed once and the period is determined by the algorithm such as the welfare is maximized.
- Acceptance rules of Regular Block Orders apply fully.

COMPLEX ORDERS & MIC ORDERS

MIC (Minimum Income Orders) are Stepwise Hourly Orders under an economical condition defined by two terms:

- FT: Fixed Term in Euros which shows the fixed costs of the whole amount of energy traded in the order.
- VT: Variable Term in Euros per accepted MWh which shows the variable costs of the whole amount of energy traded in the order.

The same acceptance rules for Stepwise Hourly Orders are applied to MIC Orders and the revenue received by an activated MIC must be greater or equal to the Fixed Term plus Variable Term times the energy matched.

SCHEDULED STOP CONDITION

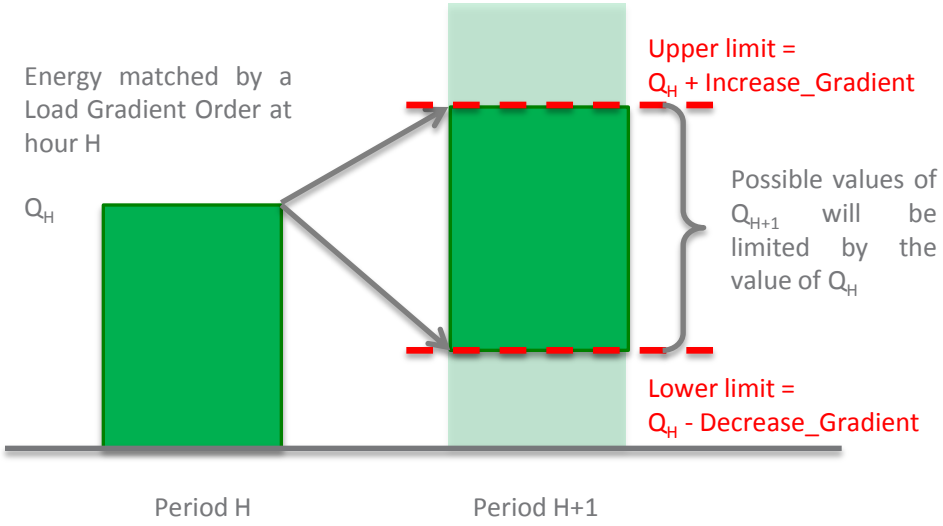
- It only applies to deactivated MICs.
- It applies to periods declared as Scheduled Stop by the MIC.
- A MIC order can declare a maximum of three periods as Scheduled Stop interval. (Periods 1, 2 or 3).
- The hourly sub-orders in the periods declared as Scheduled Stop interval must have decreasing energy as period increases.
- The first hourly sub-order will remain active (although the MIC is deactivated).
- For a deactivated MIC, its active hourly sub-orders corresponding to Scheduled Stop periods will be accepted if they are in/at the money (as any other hourly order).

COMPLEX ORDERS & LOAD GRADIENT

The load gradient condition limits the variation between the accepted volume of an order at a period and the accepted volume of the same order at the adjacent periods.

A Load Gradient Order (LG) is defined by the next terms:

- ***Increase Gradient:*** Maximum increase gradient in MWh.
- ***Decrease Gradient:*** Maximum decrease gradient in MWh.



PREZZO UNICO NAZIONALE (PUN) REQUIREMENT

- National demand of Italy (with the exception of storage pumps) is matched to a single purchase price (PUN), regardless of its location
- Expenses coming from the consumers paying the PUN must be equal to the expenses that would have come from consumers with zonal prices (minimum tolerance accepted)
- Acceptance/rejection of buying bids subject to PUN must respect the following conditions
  - Buying bids in-the-money (Offered price > PUN) are fully accepted
  - Buying bids out-of-the-money (Offered price < PUN) are fully rejected
  - Buying bids at-the-money (Offered price = PUN) can be curtailed
- In order to respect the aforementioned requirements, PUN and bidding area prices must be calculated simultaneously (PUN cannot be calculated ex-post)

- Supply Merit orders are selling offers. They are cleared at their bidding area price.
- Non-PUN demand orders (pump plants and buying bids on cross-border long term capacities) : Buying Bids from pump plants and buying bids in non-Italian national zones* are demand Merit Orders. They are cleared at the price of their bidding area.
- PUN Merit Orders : the rest of the buying bids (the ones related to national consumption) are cleared at the common national PUN price (which is different from their bidding area price).

This PUN price is defined as the average price of GME marginal market prices for its bidding areas, weighted by the purchase quantity assigned to PUN Orders in each bidding area (subject to a tolerance, ϵ). That is:

$$P_{PUN} * \Sigma_z Q_z = \Sigma_z P_z * Q_z + \epsilon$$

NETWORK DATA AND BALANCE CONSTRAINTS

The energy balance concept is defined as : The global supply minus the losses must be equal to the global demand of all markets involved. Depending on the manner the interconnections are modeled, there are the following:

- ***ATC network model:*** The network is described as a set of lines interconnecting bidding areas. The nomination of the line can be made up to its Available Transfer Capacity (ATC).

- ***Flow-based network model:*** Also known as PTDF model, with all bidding areas connected in a meshed network. It expresses the constraints arising from Kirchhoff's laws and physical elements of the network in the different contingency scenarios considered by the TSOs. It translates into linear constraints on the net positions of the different bidding areas.

- ***Hybrid network model:*** Some bidding areas are connected using the Flow-based network model; the remaining using the ATC network model.

NETWORK DATA AND RAMPING LIMITS

- EUPHEMIA supports a wide range of network restrictions:
  - Ramping limit for individual or sets of lines between consecutive hours.
  - Line tariffs.
  - Line losses.
  - Hourly and daily net position ramping limits for bidding areas.

EUPHEMIA USES BRANCH-AND-CUT

- Branch-and-Cut method is a way to
  - Search among all block and MIC selections in a structured way
  - Find feasible solutions quickly
  - Prove early that large groups of these selections cannot hold good solutions

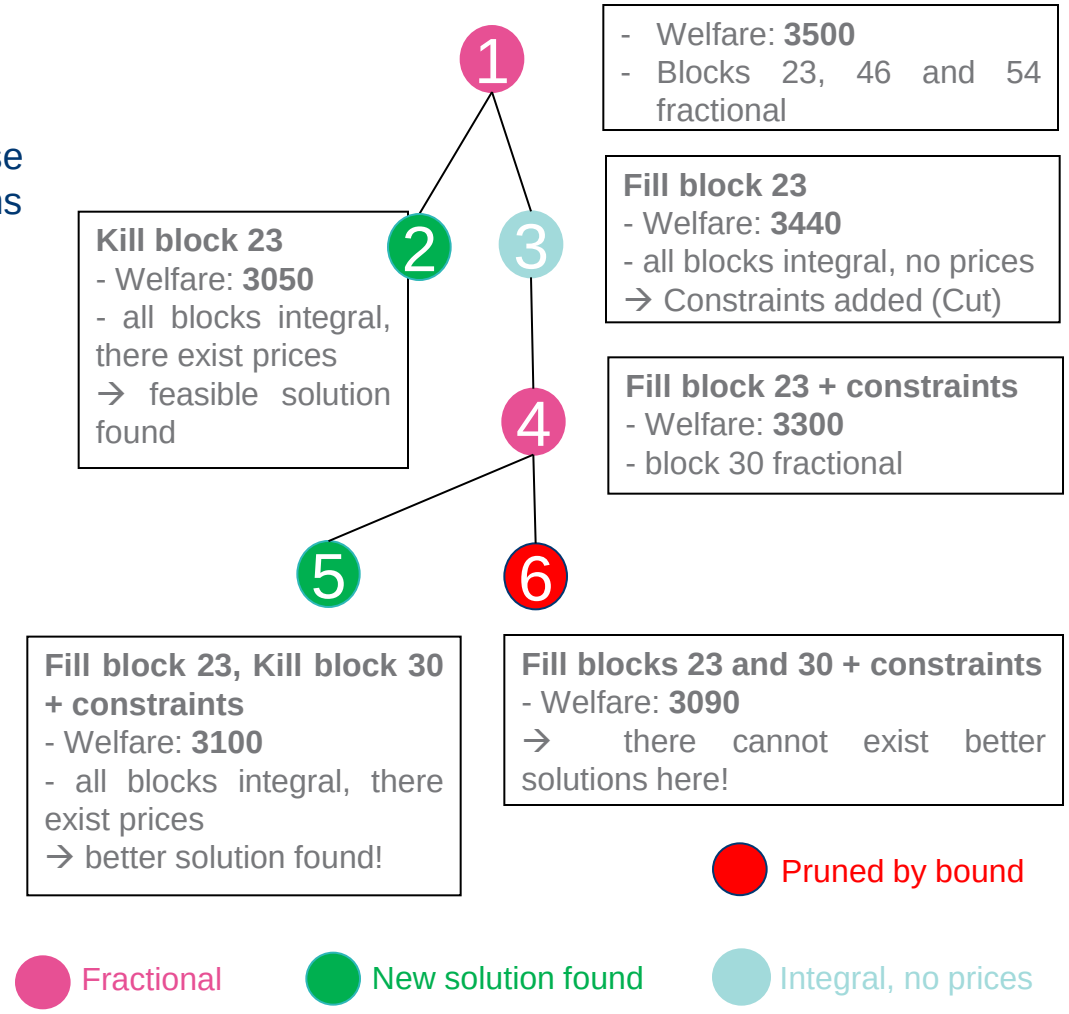
- The idea is as follows
  - Try first without the fill-or-kill requirement
  - If the solution happens to have no partially accepted block ➔ OK
  - If it has, then

    Select one block which is partially accepted

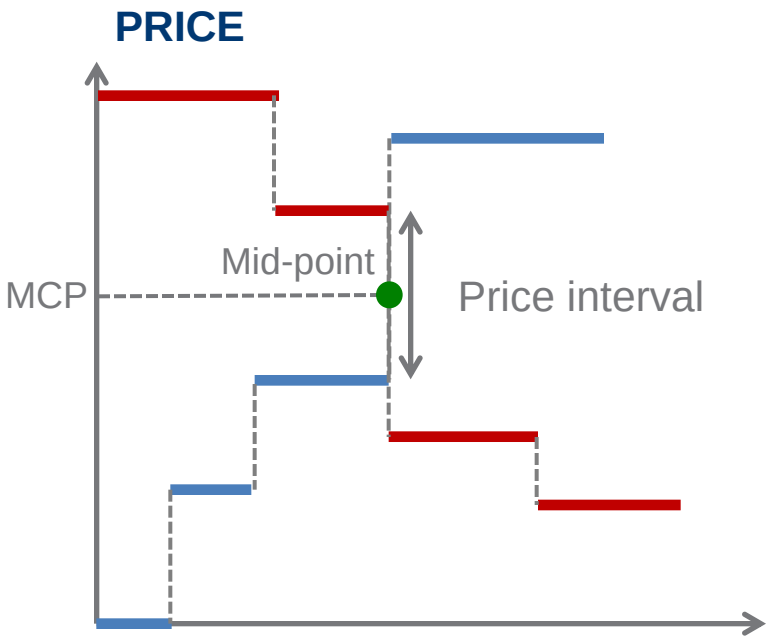
    Create two sub-problems (called branches)

    One where the block is killed

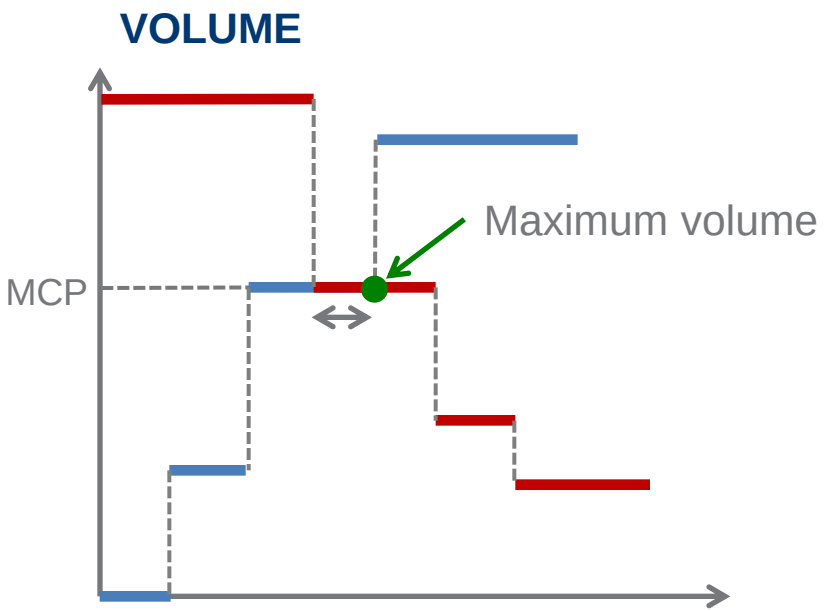
    One where the block is filled
  - Continue to explore until there is no unexplored branch



PRICE AND VOLUME INDETERMINACY RULES (general rule)



Minimize the distance to the middle of the price interval



Maximize traded volume

STOPPING CRITERIA

In production, the algorithm will stop calculating whenever one of the following situations is reached:

- The algorithm has explored all nodes.
- The time limit has been reached.

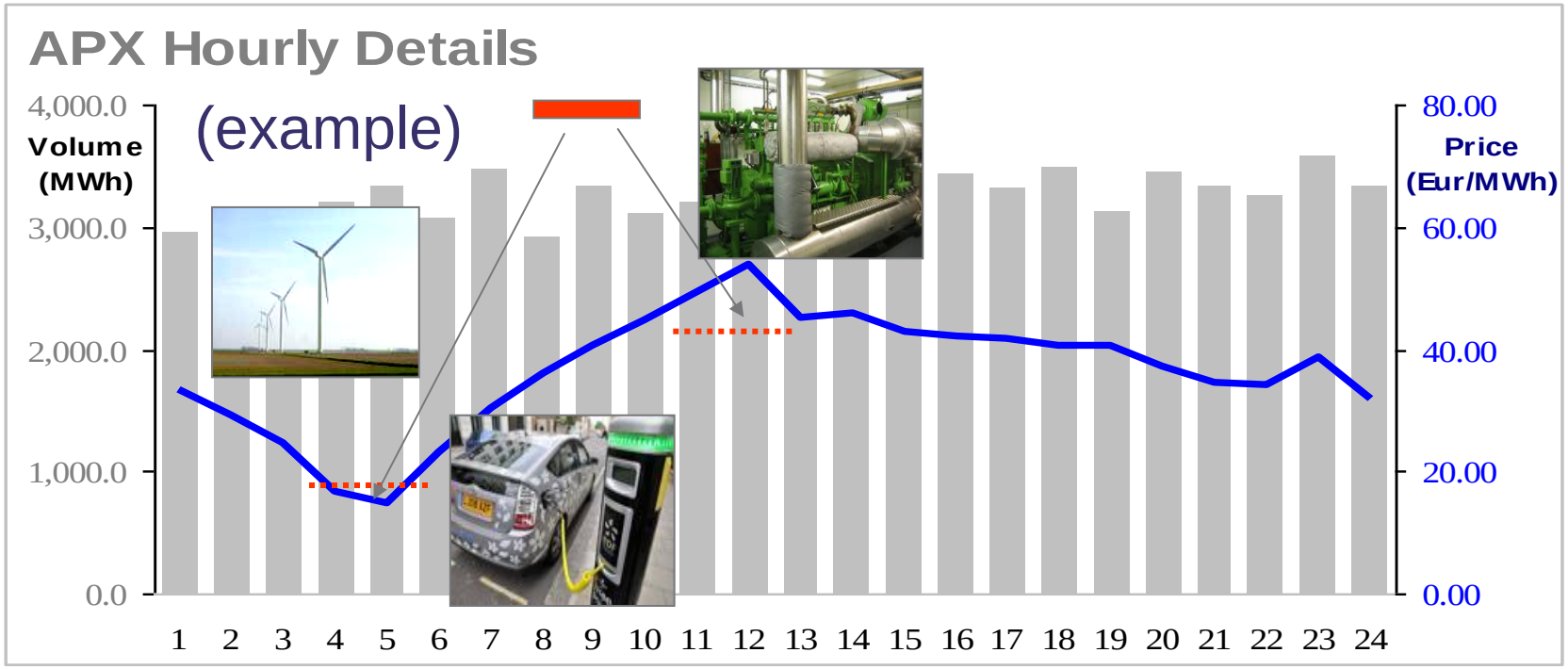
OUTPUT DATA

EUPHEMIA results:

- Price per bidding area
- Net position per bidding area
- Flows per interconnection
- Matched energy for block, MIC and PUN orders

Smarter Markets

- **New “smart” order types allow “Peak Shaving” and “Valley Filling”**
- **“Peak shaving”**: Cogeneration, flexible load
- **“Valley filling”**: e.g. electrical cars, plug-in hybrids, flexible load
- Thermal Power optimization



Agenda

Short presentation APX Group

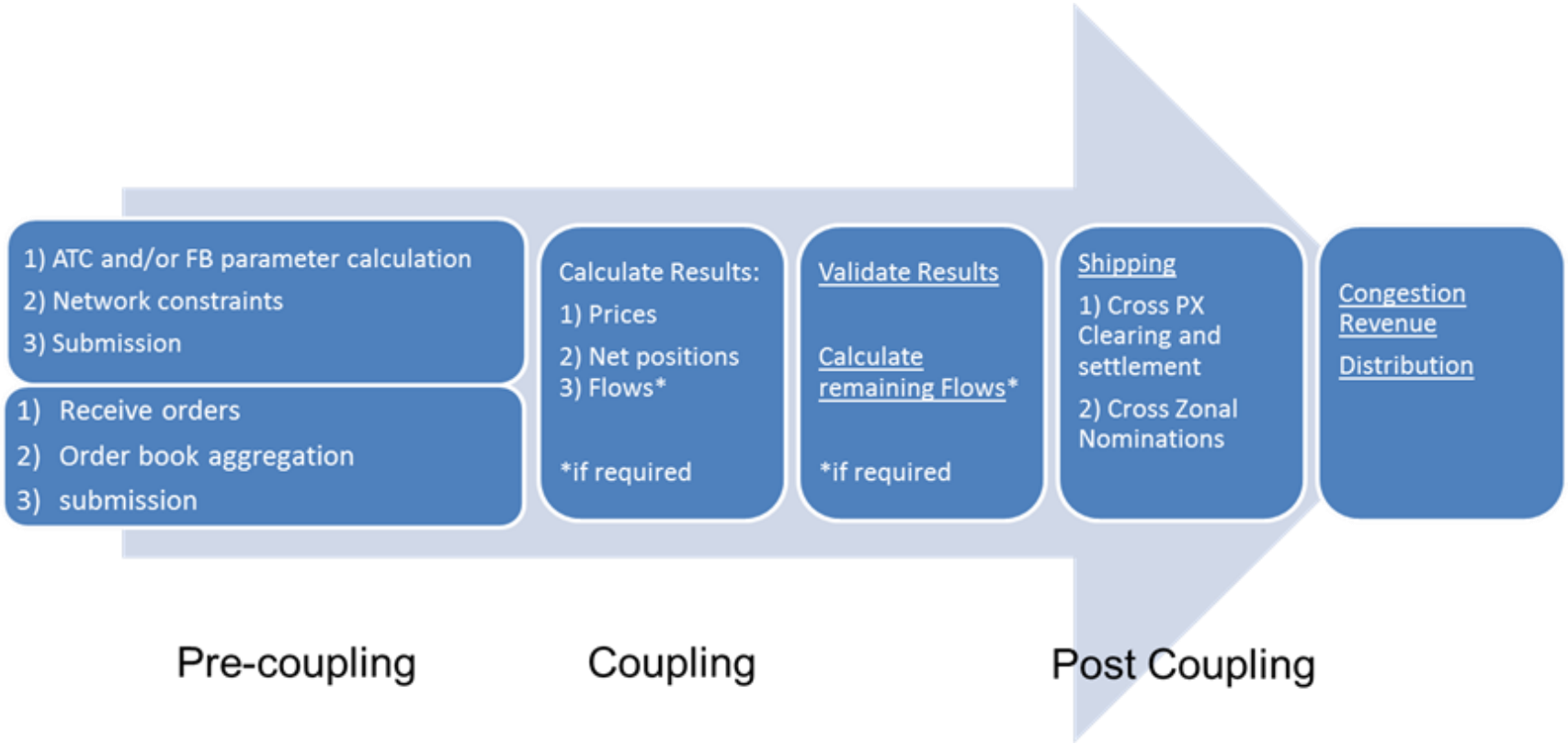
PART I : Some fundamentals of current EU market design

- **Liberalisation**
- **General principles balance management**
- **Different Market Venues**

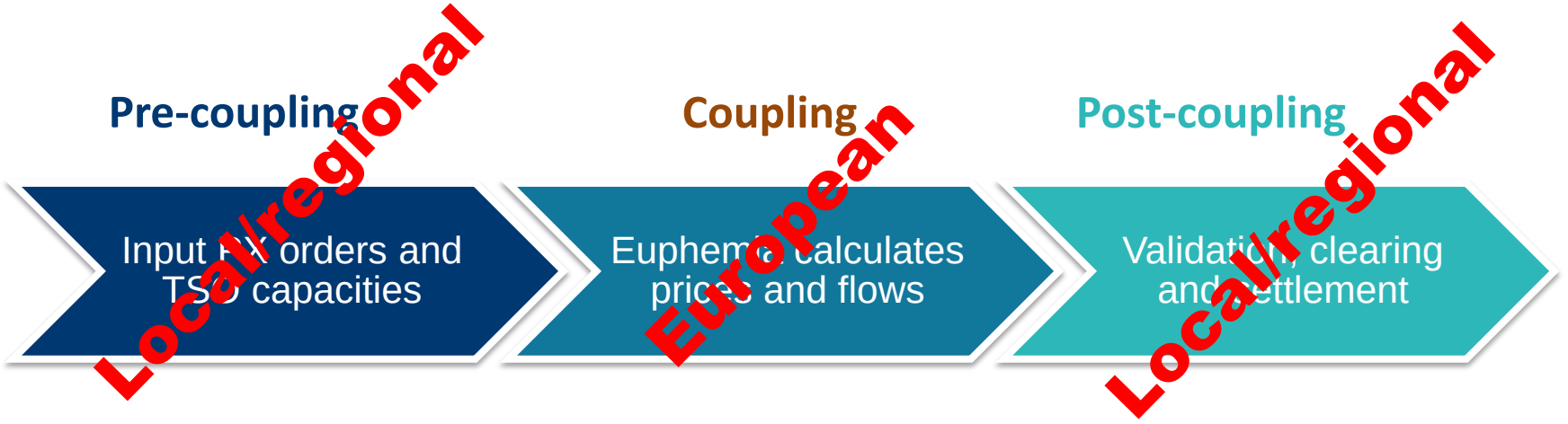
PART II: EU market integration

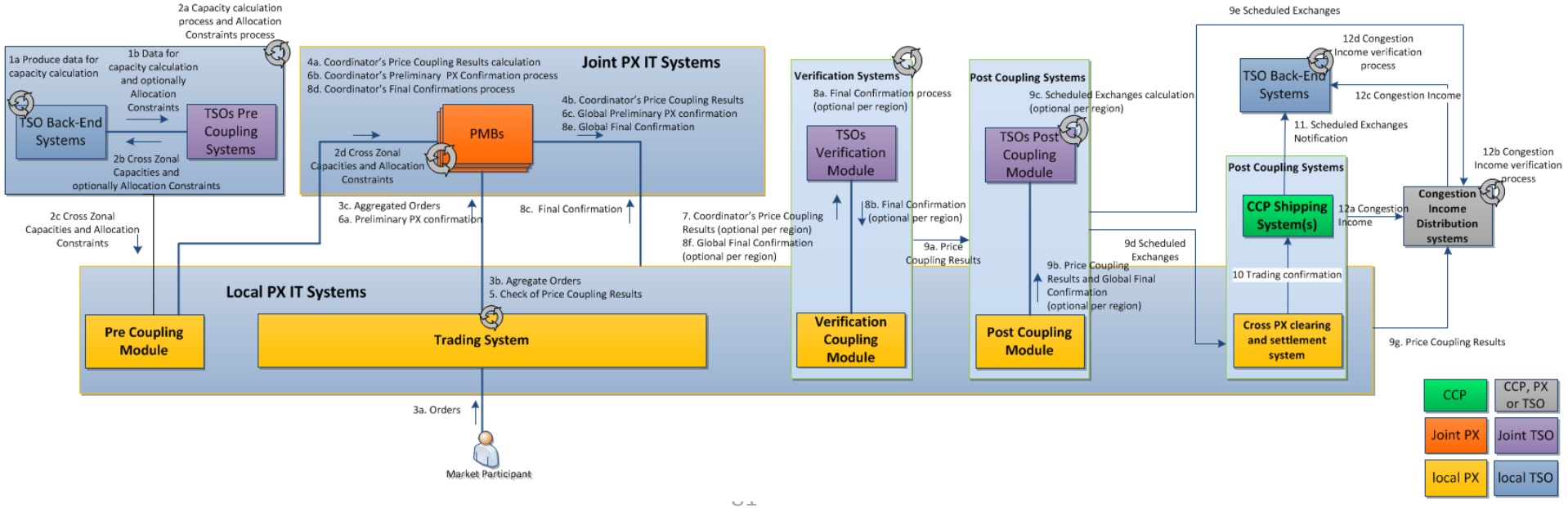
- **Principles Interconnection Management & EU Target Model**
- **Day Ahead Market Coupling: Principles**
- **Day Ahead Market Coupling: Implementation Road Map**
- **Day Ahead Market Coupling: Auction Characteristics**
- **Day Ahead Market Coupling: Products & Algorihtm**
- **Day Ahead Market Coupling: Process & Operations**
- **Bidding Zone Review**
- **Flow Based Market Coupling**
- **Intraday Market Coupling**

MRC- Price Coupling Process

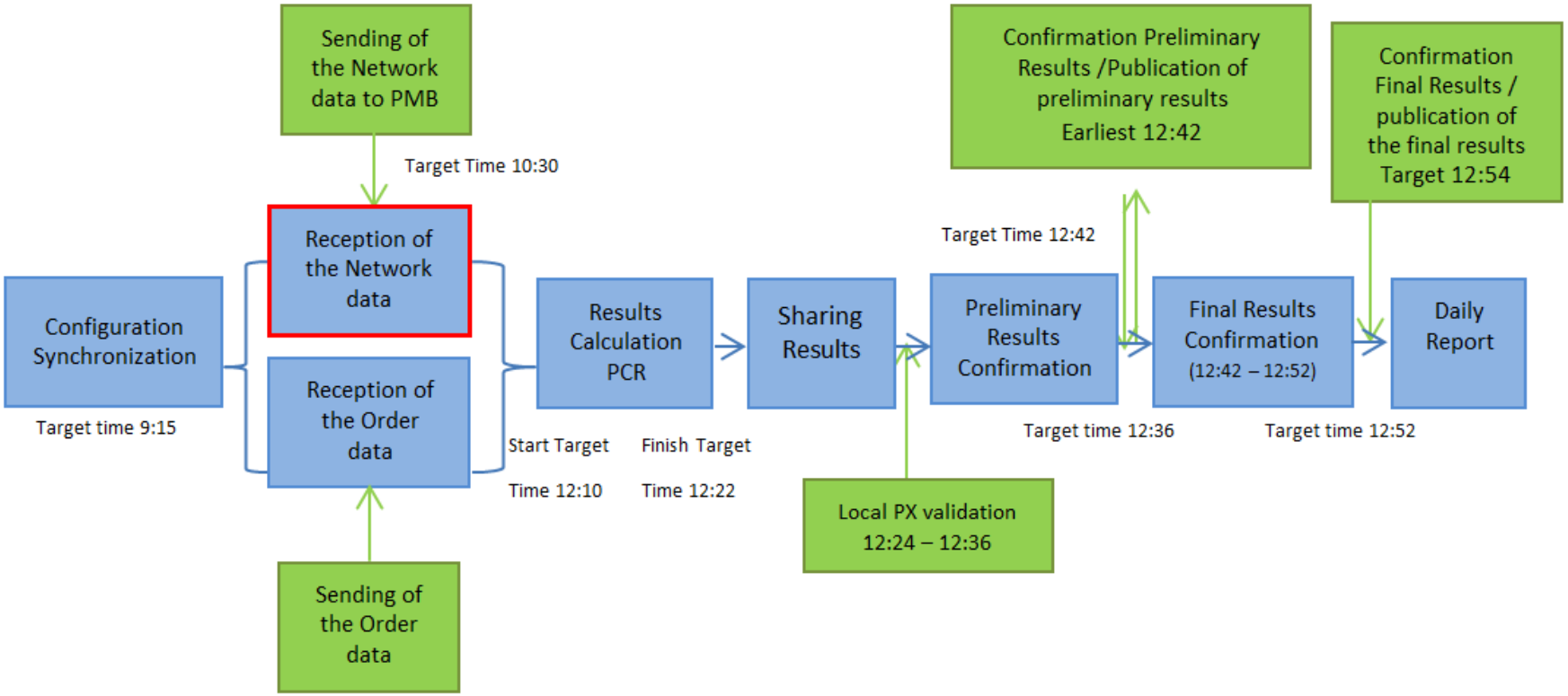


MRC – Decentralized approach





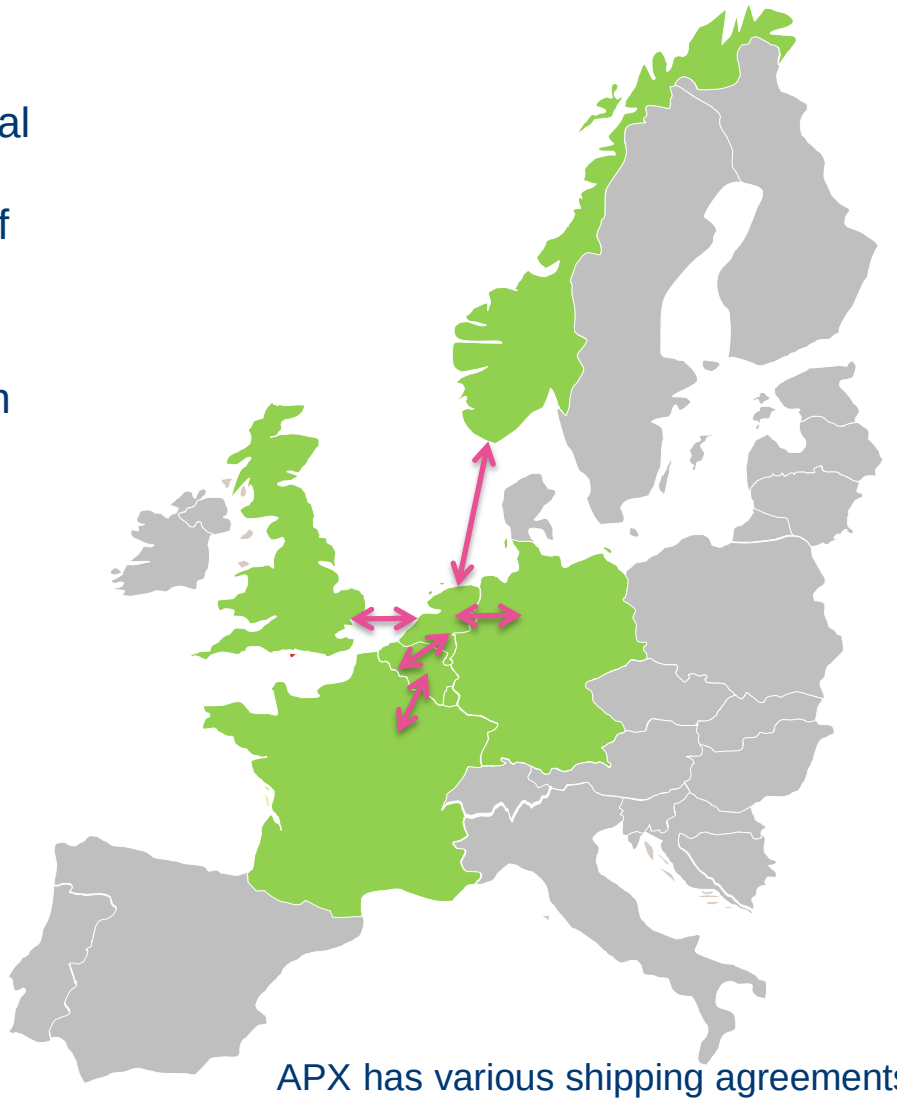
MRC – Target Operational Timeliness



PCR in blue /Own PX in green

Post Coupling: Shipping

- Shipping arrangements cover the financial and physical arrangements to transport power between price zones as a result of the MC results.
- Each border has a local shipping solution
- Shipping agreements are multi-party, cross-functional, covering different countries
  → COMPLEX!



APX has various shipping agreements across the MCR region.

Shipping Solutions

TSOs will appoint a service provide to assist in the shipping and/or manage the pre and post-coupling arrangements.

There are options wrt to the design. E.g.

1.Direct Clearing Link

Central counter parties have a direct link

Areas that need to be addressed:

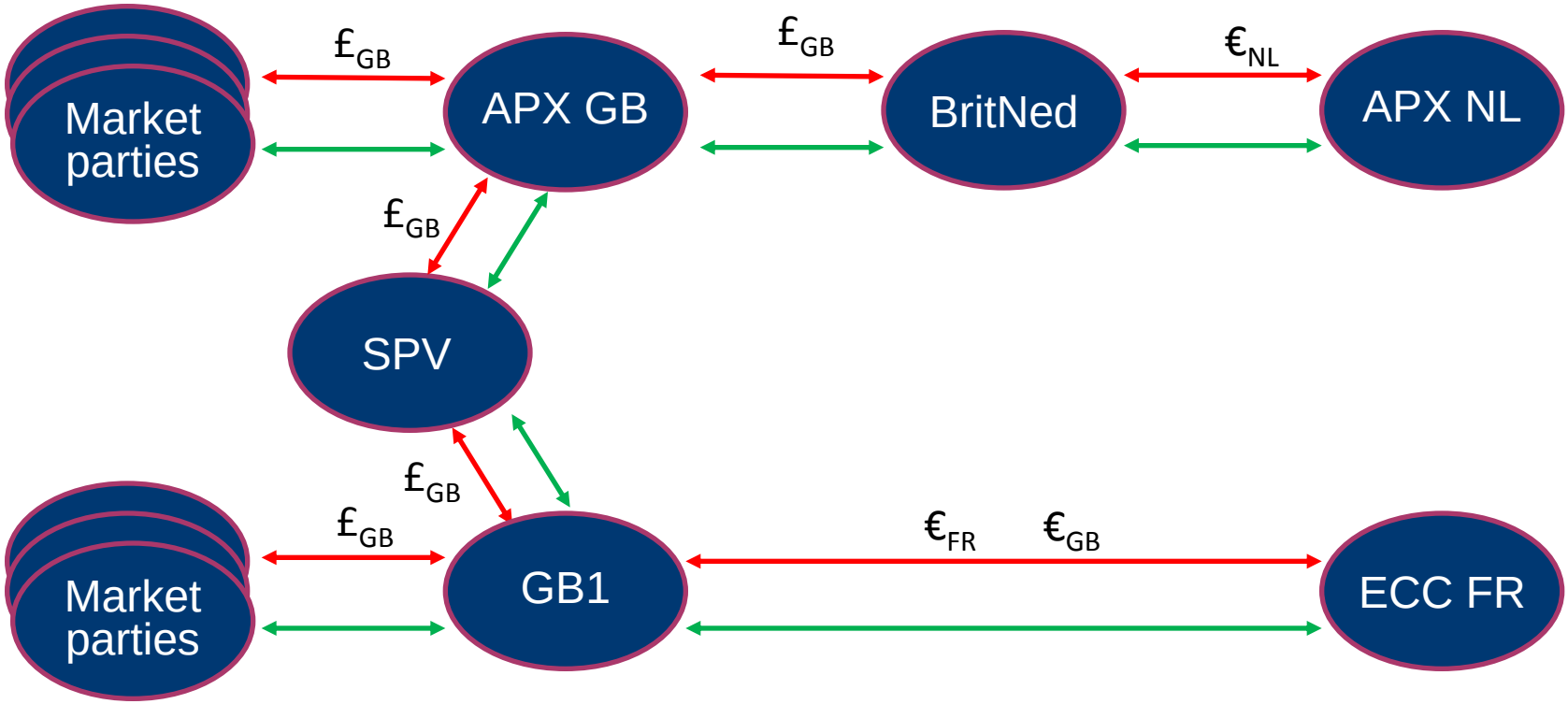
1. Contracts (direct between CCPs)
2. Nominations
3. Finance processes (e.g. Collateral, pre-financing, settlements, tax arrangements, FX)
4. Congestion revenue

2. Shipping Entity

Separate entity sits between the markets and is responsible for the trading and settlements of power between markets

1. Set-up entity
2. Contracts (PXs, SPV)
3. Financing (e.g. collateral, pre-financing, settlements, tax arrangements, FX) are the SPVs responsibilities
4. Congestion revenue

E.g. GB shipping arrangements



Financial settlement

Physical settlement/ nomination

- SPV sits between GB exchanges (not visible to market parties)
- Exchanges are treated as 2 price zones with infinite capacity between them in the PCR algorithm
- SPV enables the pooling of GB liquidity resulting in single hourly price formation

Agenda

Short presentation APX Group

PART I : Some fundamentals of current EU market design

- **Liberalisation**
- **General principles balance management**
- **Different Market Venues**

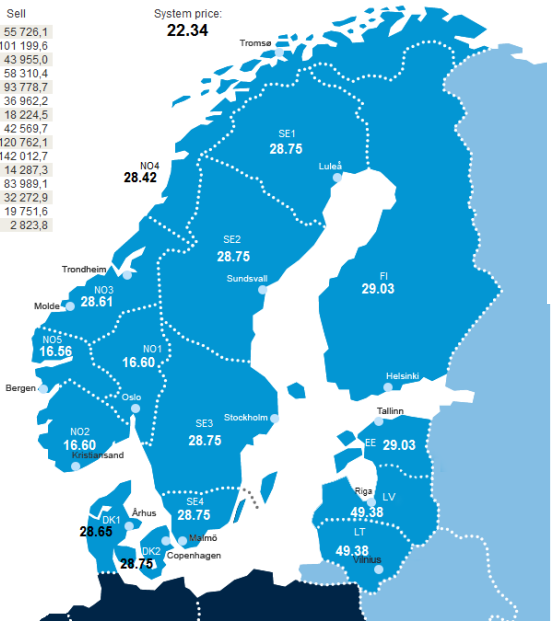
PART II: EU market integration

- **Principles Interconnection Management & EU Target Model**
- **Day Ahead Market Coupling: Principles**
- **Day Ahead Market Coupling: Implementation Road Map**
- **Day Ahead Market Coupling: Auction Characteristics**
- **Day Ahead Market Coupling: Products & Algorihtm**
- **Day Ahead Market Coupling: Process & Operations**
- **Bidding Zone Review**
- **Flow Based Market Coupling**
- **Intraday Market Coupling**

Bidding zones: an ongoing discussion

Elspot volumes

	Buy	Sell
NO1	62 591,4	55 726,1
NO2	101 433,2	101 199,6
NO3	51 655,9	43 955,0
NO4	38 183,5	58 310,4
NO5	41 579,8	93 778,7
DK1	43 314,2	36 962,2
DK2	38 536,5	18 224,5
SE1	24 647,7	42 569,7
SE2	33 522,3	120 762,1
SE3	183 309,4	142 012,7
SE4	63 368,9	14 287,3
FI	126 373,1	83 989,1
EE	17 579,7	32 272,9
LT	27 041,2	19 751,6
LV	13 488,9	2 823,8



EEX warns on German-Austrian price zone split

Splitting the integrated German/Austrian power market price zone could have "unforeseeable" risks for the derivatives market, Germany-based energy exchange EEX said Wednesday.

"Any splitting of the German-Austrian price zone entails unforeseeable risks for the power market," the chairman of EEX's exchange council, Peter Heydecker, said in a statement.

"Energy trading and, specifically, the derivatives market might be permanently harmed by such a serious intervention in the market," EEX CEO Peter Reitz added.

Platts European Power Daily, 20140612

ACER **Market Report on Bidding Zones**

Conclusions: Existing zones are affecting:

a) The efficient dispatch of generation and social welfare

b) The distribution of social welfare (potential discrimination of market participants located at different areas)

c) The signals and incentives to invest in both transmission and generation

d) Market liquidity in particular in the forward market

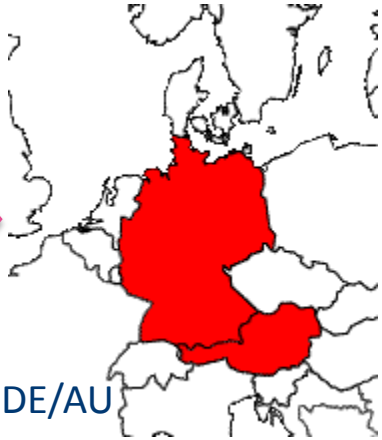
Bidding zone review is needed:

➔ This does not automatically imply a change of zones

26th Florence Forum

ACER, 26th Florence Forum

Different approaches in EU



Single DE/AU price zone

Arguments for and against bidding zones

ewi

Congestion-based bidding zones can be beneficial

Pros	Cons
• Internalization of external costs of grid expansion, congestions are identified	• Smaller bidding zones raise illiquidity and potential market power
• Possible incentives for investment (power plants and infrastructure)	• Volatile design of bidding zones leads to market uncertainty
• Different prices only in situations with congestion	• Transaction costs of implementation and maintenance are currently unknown

Dr. Christian Growitsch, Biding Zones in the Internal Market , 26th Florence Forum

Agenda

Short presentation APX Group

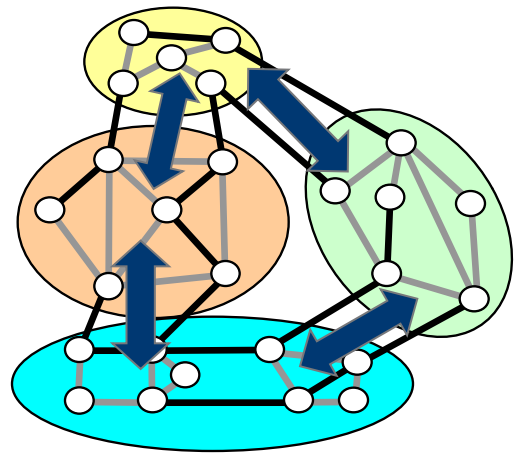
PART I : Some fundamentals of current EU market design

- Liberalisation
- General principles balance management
- Different Market Venues

PART II: EU market integration

- Principles Interconnection Management & EU Target Model
- Day Ahead Market Coupling: Principles
- Day Ahead Market Coupling: Implementation Road Map
- Day Ahead Market Coupling: Auction Characteristics
- Day Ahead Market Coupling: Products & Algorihtm
- Day Ahead Market Coupling: Process & Operations
- Bidding Zone Review
- Flow Based Market Coupling
- Intraday Market Coupling

Difference between ATC and Flow Based



ATC: “virtual tunnels”

ATC

- “Virtual tunnel” of how much capacity can flow from point A to B, based on (conservative) assumptions grid model and assumptions regarding production
- “Single route”, not Kirchhoff law
- Commercial exchanges always flow from “cheap price areas” to “high price areas”. This is a property naturally valid under ATC models but not necessarily valid under FB models

Flow Based allocation

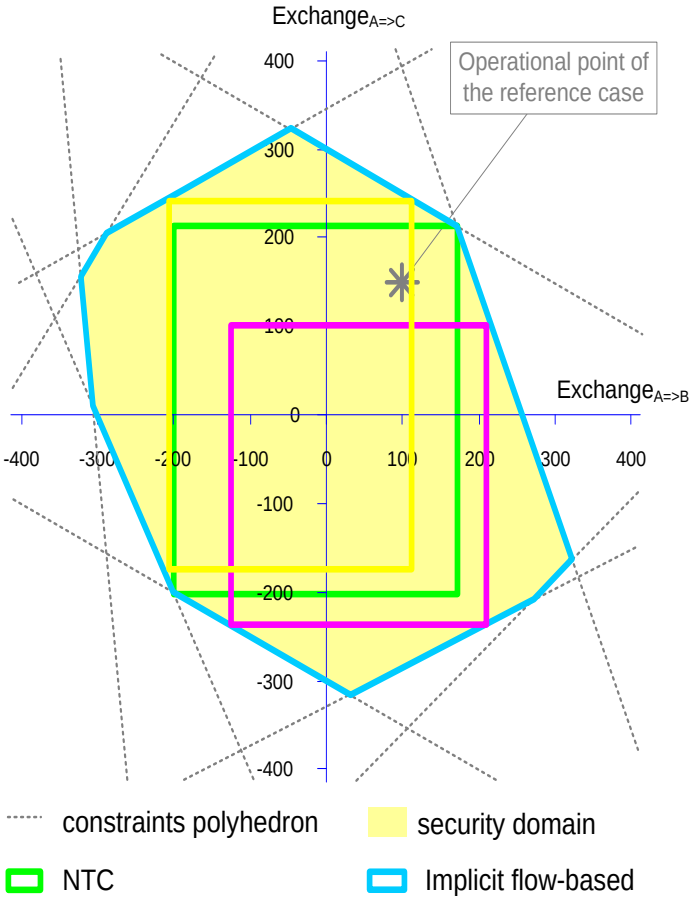
- Kirchhoff law; model accounts for true impact in line of an import/export in an area

Rational Flow Based versus ATC based

- In a meshed electricity grid, flows on all lines are interdependent
- With ATC models, TSOs have to chose ex-ante the « best » set of ATC
  - Not possible to represent possibilities very precisely (rectangle instead of polyhedron)
  - Need to anticipate market's preferences. (which rectangle to choose?)

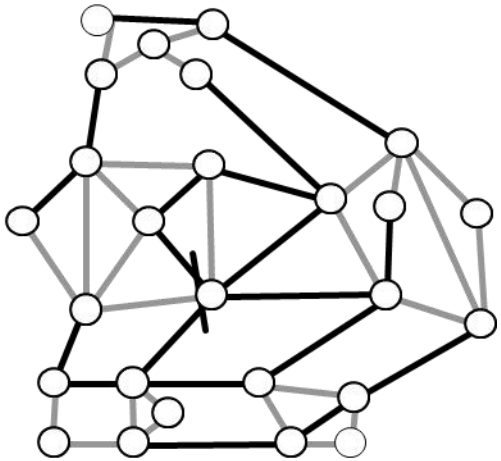
  Priorities are set by TSOs according to expected commercial flows (= suboptimal in case anticipations are wrong)
- With FB models, TSOs can express more precisely the expected behaviour of the power flows
  - No need to anticipate market's preferences Priorities are set according to economic signals (= optimally assigned by the coupling algorithm)

⇨ **With flow-based, market's preferences are directly taken into account and priorities on borders are set according to merit order**

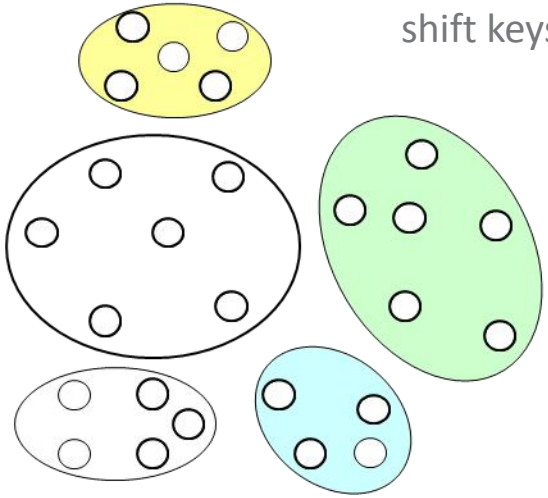


PTDF Model

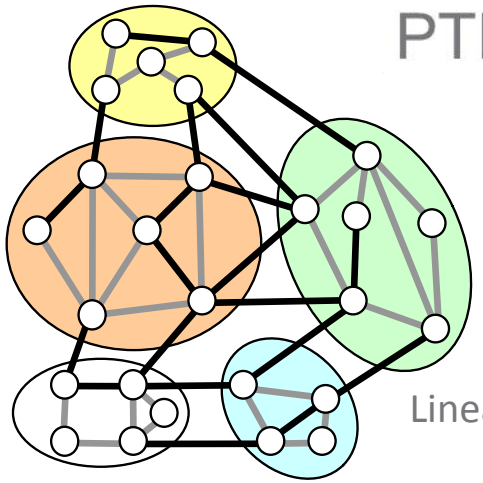
Determination of a linear load-flow model (node-to-node PTDF)



Linearization of the variations in national net positions (i.e. generation shift keys)



PTDF Constraints



Linear hub-to-hub PTDF contraints

ATC versus Flow Based

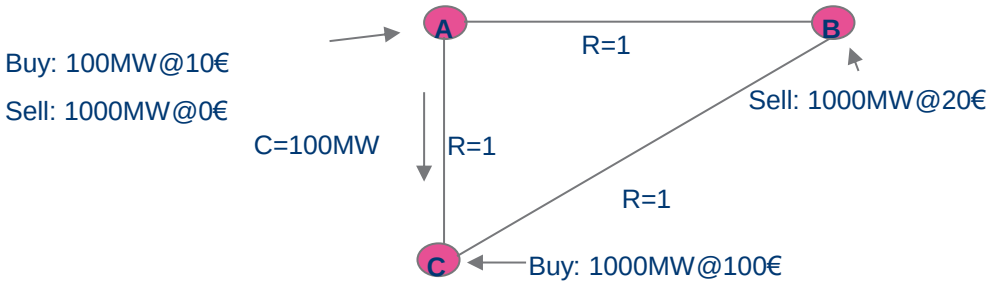
(zonal) ATC	(nodal) Flow-Based
• Price convergence • Bounded prices • No adverse flows • Intuitive price formation • Less optimal allocation/usage of infrastructure • Market outcome does not indicate where to invest • #different prices = #congested borders+1	• May cause price divergence • May cause out of bound prices • May cause adverse flows • Price formation is less intuitive • More optimal allocation/usage of infrastructure • Market based investment signals • Higher welfare than ATC for given security level • Single congestion can cause all prices to be different

However: CWE = Zonal Flow Based; unique in the world

Challenges

- Estimation of linear generation shift keys
- Application in lager price areas and/or price areas with different sizes
- Integration of volatile renewable energy sources?
- How to manage congestions within a price zone when they happen?
- Are non-intuitive results (= the cheapest zones are importing) acceptable?

An illustration of counter intuitive results with FB



Welfare = Buyer Surplus
+ Seller Surplus
+ Congestion Rent

A) Supplying buyer C from A
- 2/3 over A->C and 1/3 over A->B->C
- Added Value: €100/MWh
- Congested line: A->C congested
- Possible delivery: 150MW
- Generated welfare: €15 000

B) Supplying buyer C from B
- 2/3 over B->C and 1/3 over B->A->C
- Added value: €80/MWh
- Congested line: A->C congested
- Possible delivery: 300MW
- Generated welfare: €24000

C) Supplying buyer A from A
- Added Value: €10/MWh
- Congested line: no influence
- Possible delivery: 100MW
- Generated welfare: €1000

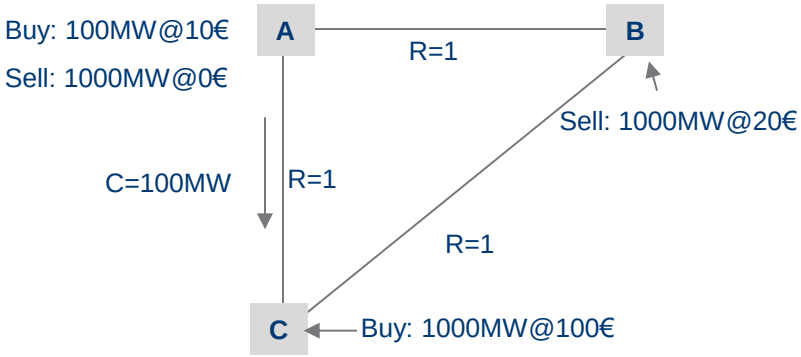
D) Supplying buyer A from B
- 2/3 over B->A and 1/3 over B->C->A
- Congested line: increases A->C capacity to 133MW
- Possible delivery: 100MW
- Generated welfare: -€1000

Several options/strategies to supply buyer in point C and A:

- A) + C) = €15000 + €1000 = €16000
- B) + C) = €24000 + €1000 = €25000
- A) + D) = €15000 - €1000 + **5000** = **€19 000**
- B) + D) = €24000 - €1000 + **€8000**= **€31 000**

Supplying A from B
allows additional supply to C from B

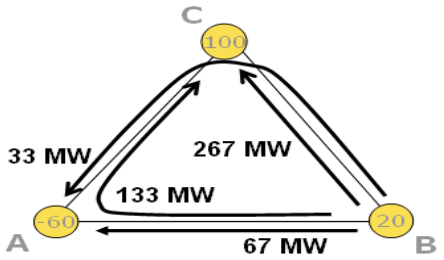
An illustration of counter intuitive results with FB



Initial situation

Welfare maximizing outcome

Market	Price	Net Position
A	**-60€**	**Import 100MW**
B	**20€**	**Export 500MW**
C	**100€**	**Import 400MW**



Pb: Sell offer only partially executed so **Pb=€20**

Pc: Purchase offer only partially filled so **Pc= €100**

Pa?

MW send from A->C uses 2*more capa of scarce A->C resource then MW send from B to C: should reap twice as much welfare when options compete!

(Pc-Pa) = 2 (Pc-Pb)

Pa= 2Pb – Pc = **- €60**

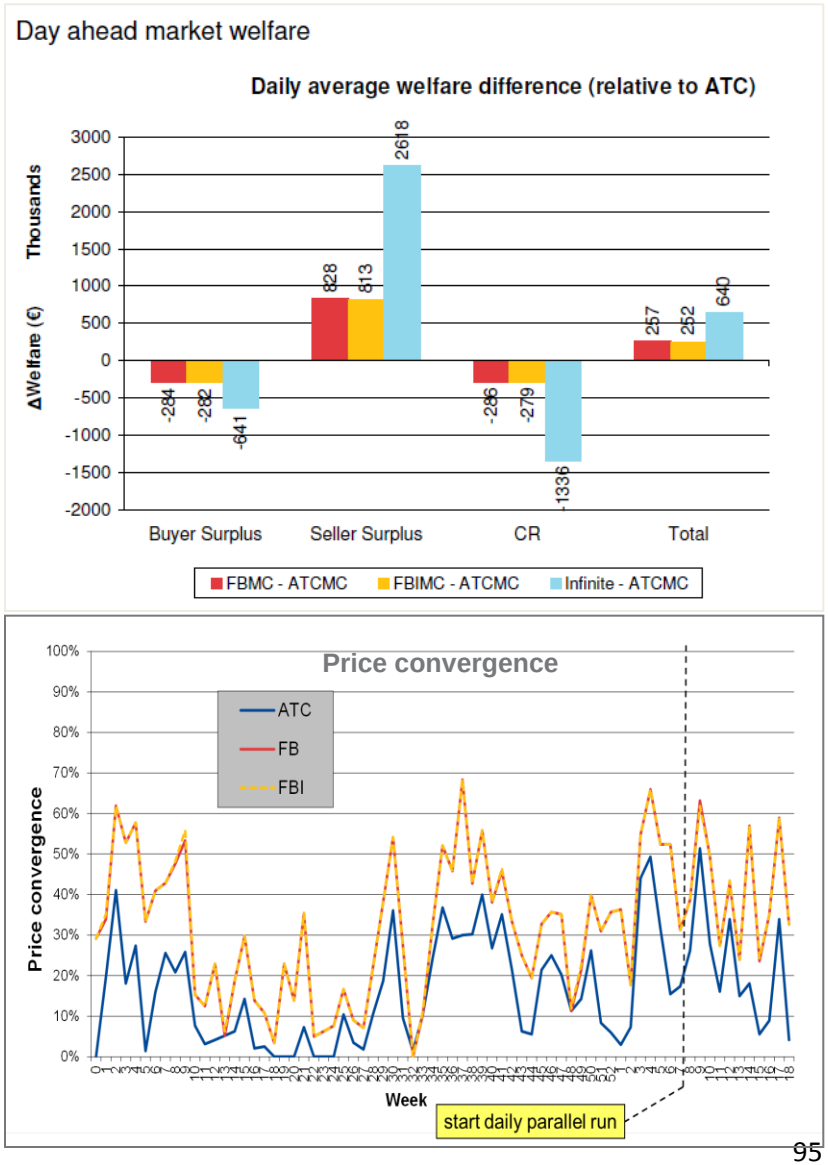
Summary, under flow-based

- Lowest supply bid may be rejected
- Prices may be out of bound
- Cheapest node may be importing

⇨ **COUNTER INTUITIVE!**

CWE Flow Based Project: status

- Objective: implement FB MC on inner CWE border
- Target Go-Live: Q4 2014 (subject to technical readiness, fullfilment Acceptance Criteria and NRA approval (project started in 2007)
- Challenges:
  - Fundamental change in capacity determination and TSO cooperation ; complex ans heavy change management and learning process
  - Stakeholder understanding and acceptance
  - Transparency
  - FB «intuitive» VS FB «plain»
  - Good/robust change control process to gurantyee Q of results in LT
- Results // run:
  - oveval welfare increase of 79M€ (307 days simulated) ;
  - Better grid utilisation
  - Everyday learning



95

Agenda

Short presentation APX Group

PART I : Some fundamentals of current EU market design

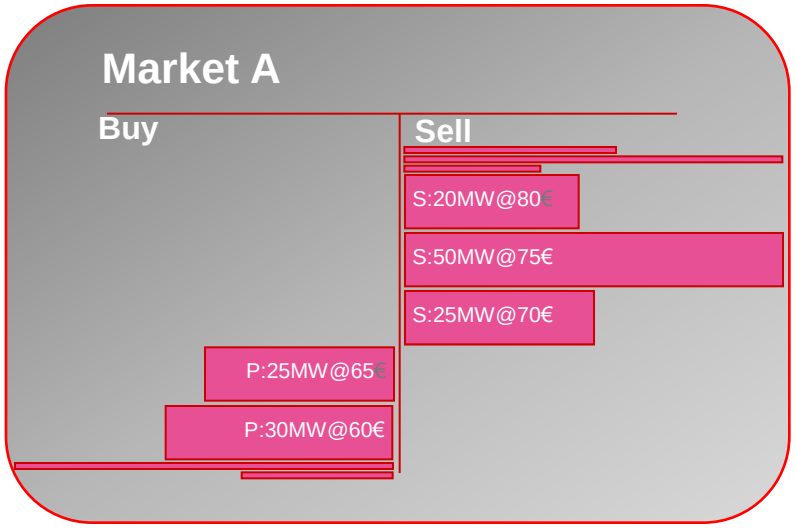
- Liberalisation
- General principles balance management
- Different Market Venues

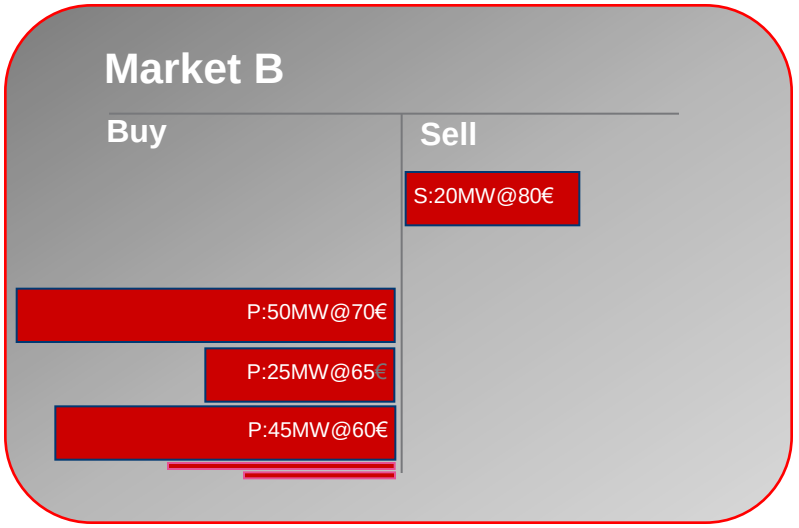
PART II: EU market integration

- Principles Interconnection Management & EU Target Model
- Day Ahead Market Coupling: Principles
- Day Ahead Market Coupling: Implementation Road Map
- Day Ahead Market Coupling: Auction Characteristics
- Day Ahead Market Coupling: Products & Algorihtm
- Day Ahead Market Coupling: Process & Operations
- Bidding Zone Review
- Flow Based Market Coupling
- Intraday Market Coupling

Continuous Implicit Capa. allocation: principle

No capacity



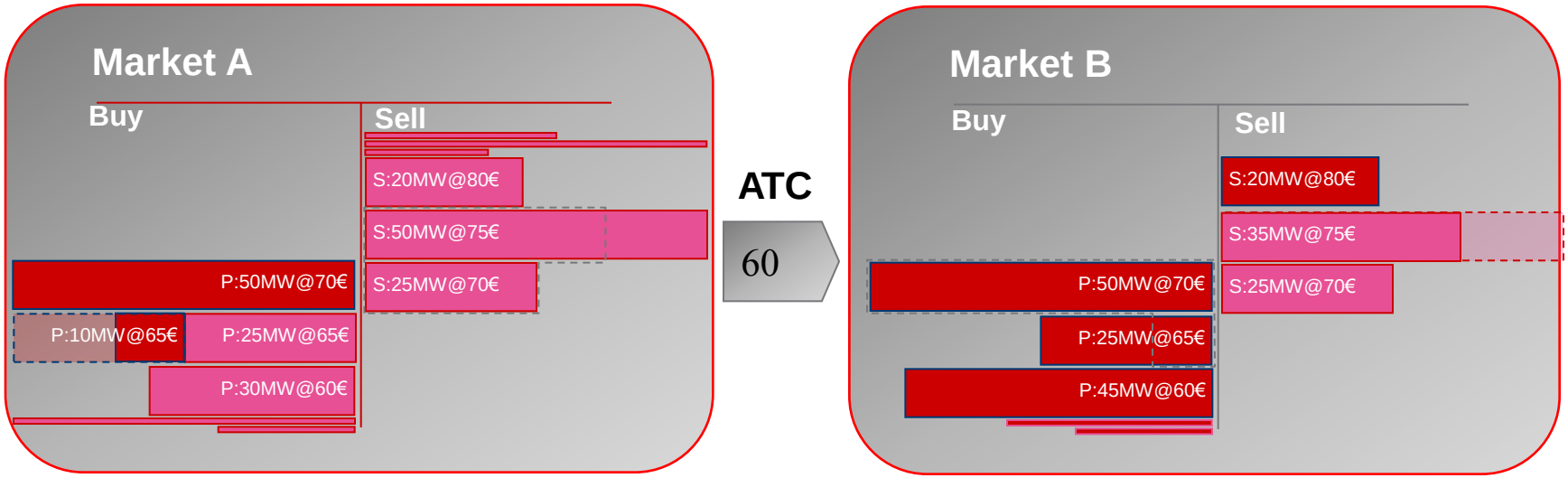


Market A: Liquid / low spread

Market B: few sell / high spread

Continuous Implicit Capa. allocation: principle

ATC A->B = 60 MW

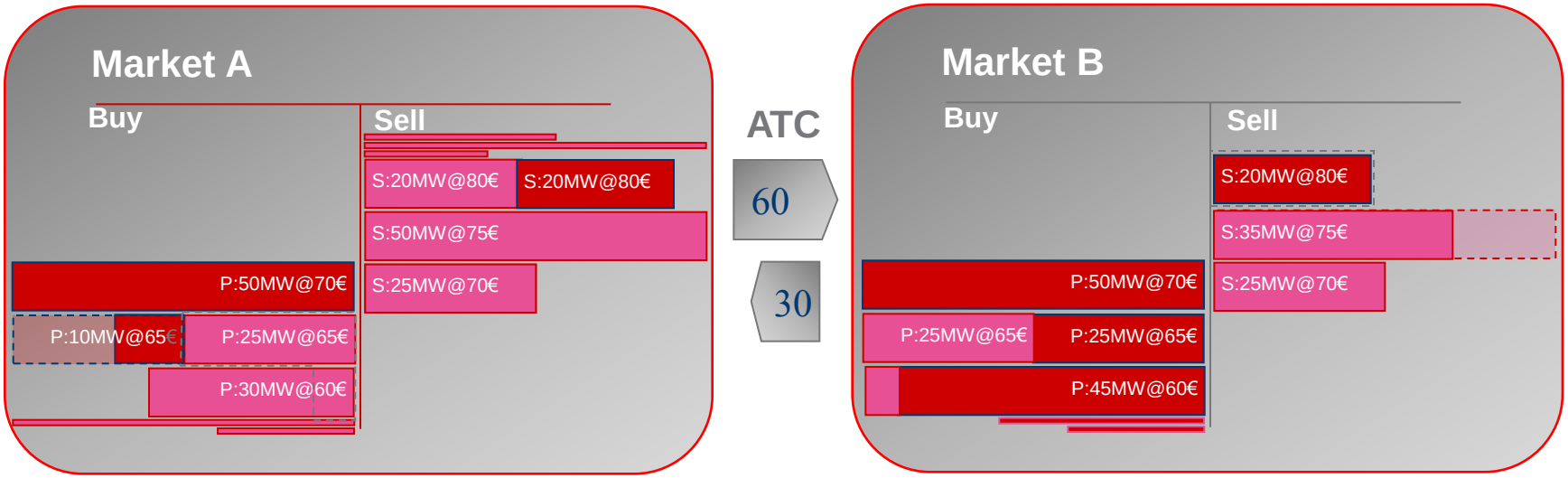


With 60 MW capacity from A to B

- 60 MW cheapest sell orders in A are shown in B
- 60 MW most expensive buy orders in B are shown in A

Continuous Implicit Capa. allocation: principle

ATC B->A = 30 MW

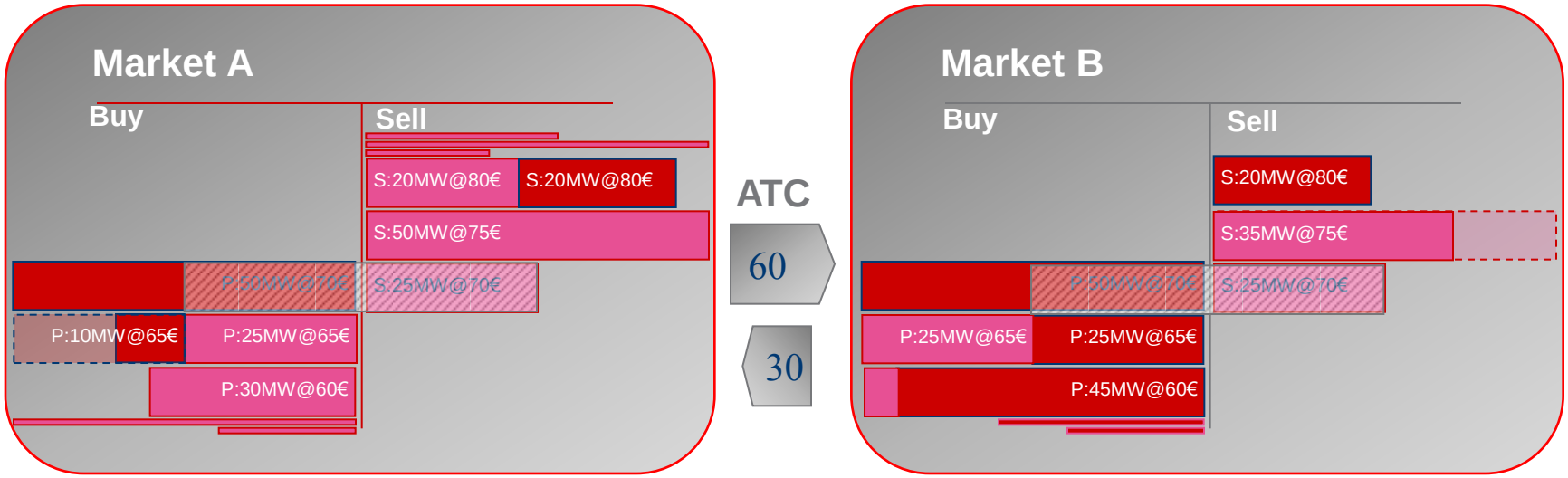


With 30 MW capacity from B to A:

- 30 MW most expensive buy orders in A are shown in
- 30 MW cheapest sell orders in B are shown in A (but only 20 MW available)

Continuous Implicit Capa. allocation: principle

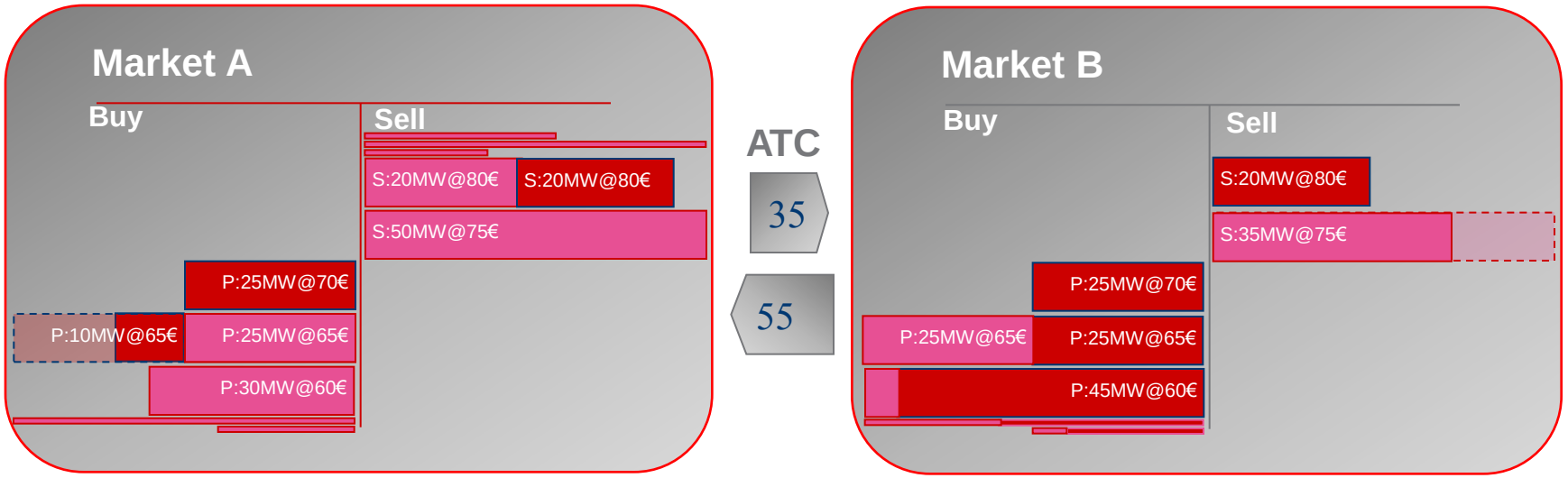
Matching



A sell order of 25 MW in market A can match a buy order in market B

Continuous Implicit Capa. allocation: principle

Netting



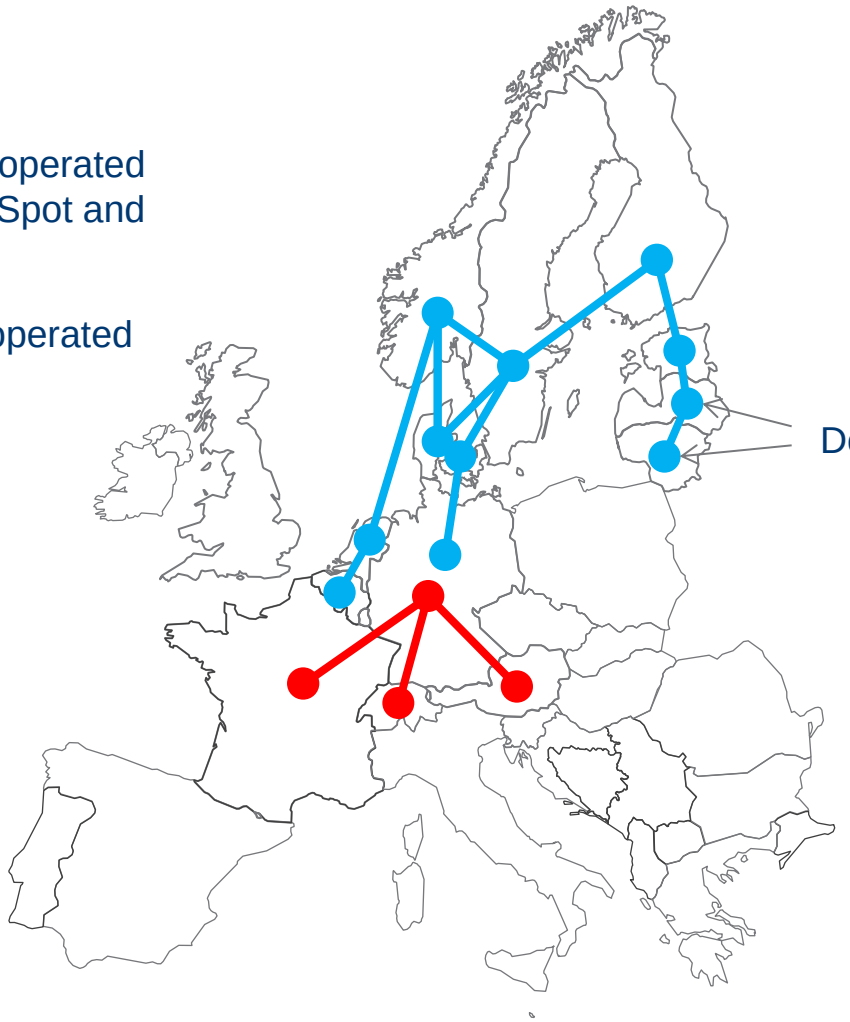
- 25 MW of capacity used in the direction A -> B (ATC A->B = 60 – 25 = 35)
- 25 MW can be netted in the direction B -> A (ATC B->A = 30 + 25 = 55)
- Order books are updated accordingly

Continuous implicit capacity allocation makes intraday markets more efficient and creates more opportunities for market players

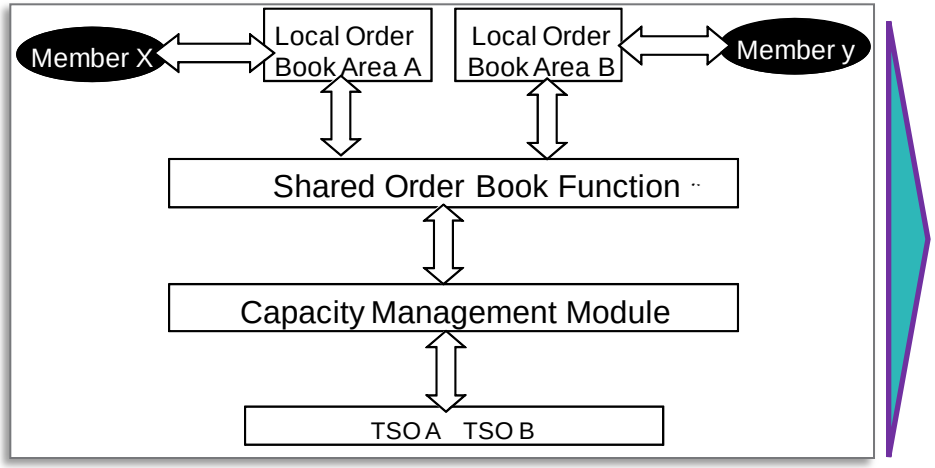
Cross Border Intraday Market: situation today

Elbas market operated by Nord Pool Spot and APX/Belpex

FITS market operated by EPEX



Cross Border Intraday Market: Target Model



⇨ **European intraday target model** for Inter-Regional cross-border intraday (XBID) capacity allocation and energy trading based on implicit continuous allocation (continuous trading)

⇨ Based on **Shared Order Book Function (SOB)** and Capacity Management Module (CMM)

Main principles

- The Sharied of Order Books (“SOB”) implies that one unique algorithm performs the matching
- This algorithm is provided with all bids of all participating PXs and takes into account all capacity data

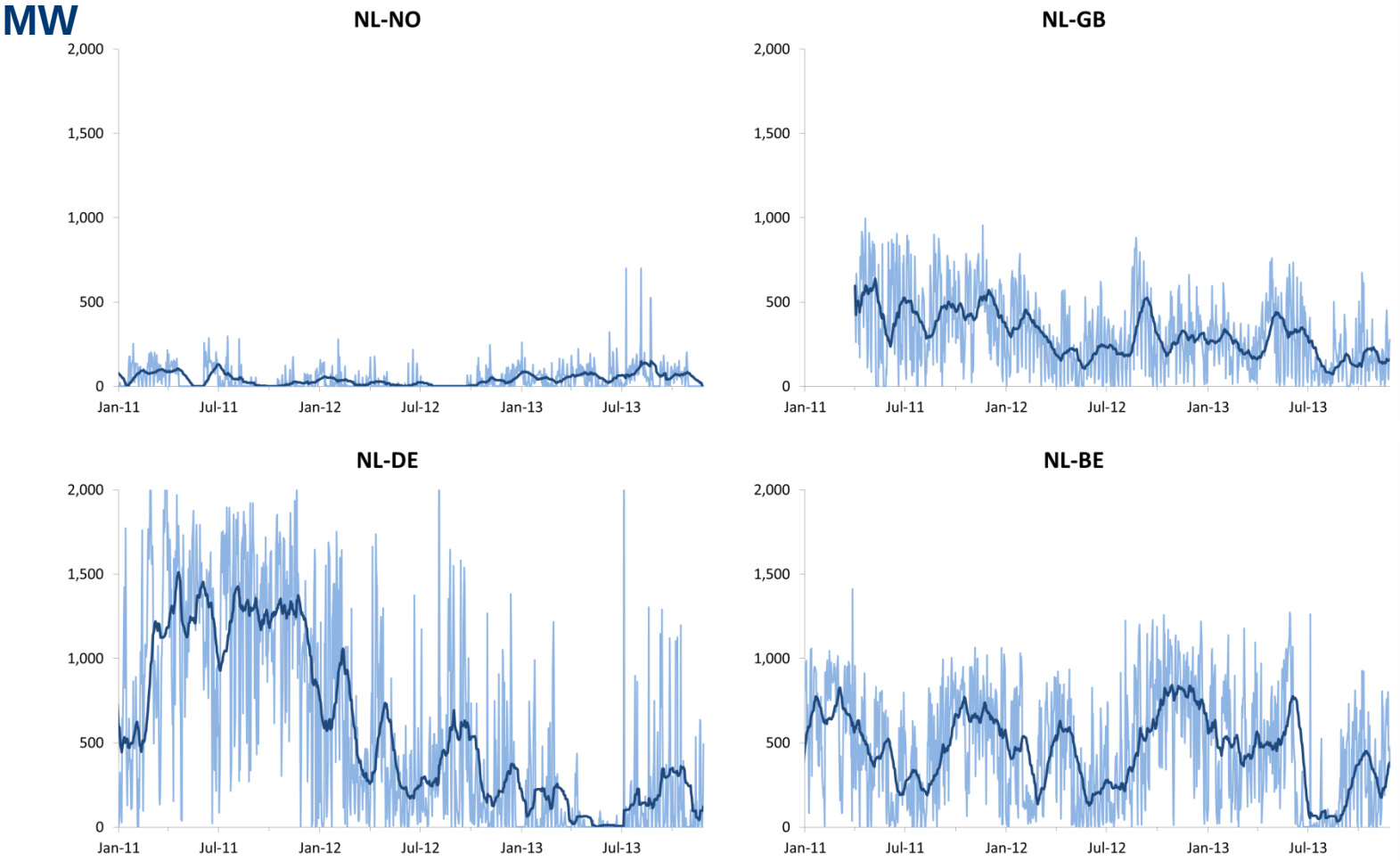
Status

- SOB/CMM: IT service vendor identified ; working under an early start agreement to progress work (at start NPS, EPEX, APX, Belpex, OMIE), cooperation open to other exchanges
- In // X-TSO project structures are being set up to implement the solution
- **Target Go-live: Q2 2015**

Cross Border Intraday: potential

Average daily unused DA capacity in active direction

MW



Thank you for your attention

j.matthys-donnadieu@apxgroup.com