EPEX SPOT
EUROPEAN POWER EXCHANGE

# Market Coupling

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# Outline

- Day-ahead Auction
  - EPEX Day-ahead products
  - Determining Day-ahead Market results
- Market Coupling (MC)
  - How does it works?
  - Overview of the EU MC development
  - Impact assessment
  - Impact assessment examples

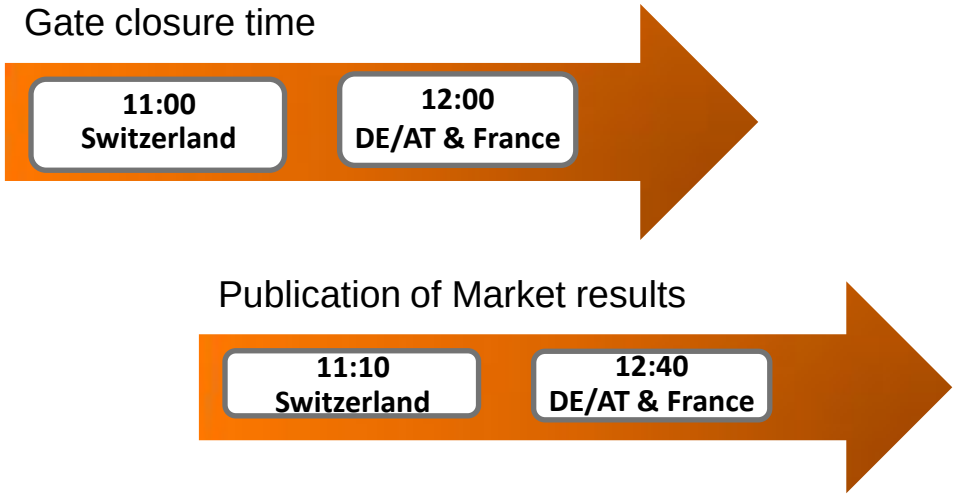
# Day-Ahead Auction

- Day ahead Auction
  - EPEX Day ahead products
  - Determining Prices and Volumes
- Market Coupling (MC)

## Day-Ahead Auction

| Market Areas | |
|---|---|
| | France |
| | Germany/Austria |
| | Switzerland |

- Blind auction, 7/7 days
- 24 hours of the next day
- Hours and blocks of hours
- Trading via EPEX Trading System – ETS
  Web based electronic system



# EPEX Day-Ahead products



- **Each participant can submit hourly and/or block orders**

- **Supply and Demand Hourly orders**
  - They take the forms of a piecewise linear curve for a given hour
  - For **each price**, the participant indicates the **volume** to buy/sell
  - These curves are aggregated into a single supply and a single demand curves for each hour

- **Supply and Demand Block orders**
  - They are defined by **volumes** on several hours and **one price limit**
  - They express the willingness of the participant to be either fully accepted on all hours or totally rejected

# Determining Day-ahead Market results (1)

- **Day-ahead Market results**
  - MCP: Market Clearing Price for each hour
  - MCV: Market Clearing Volume for each hour

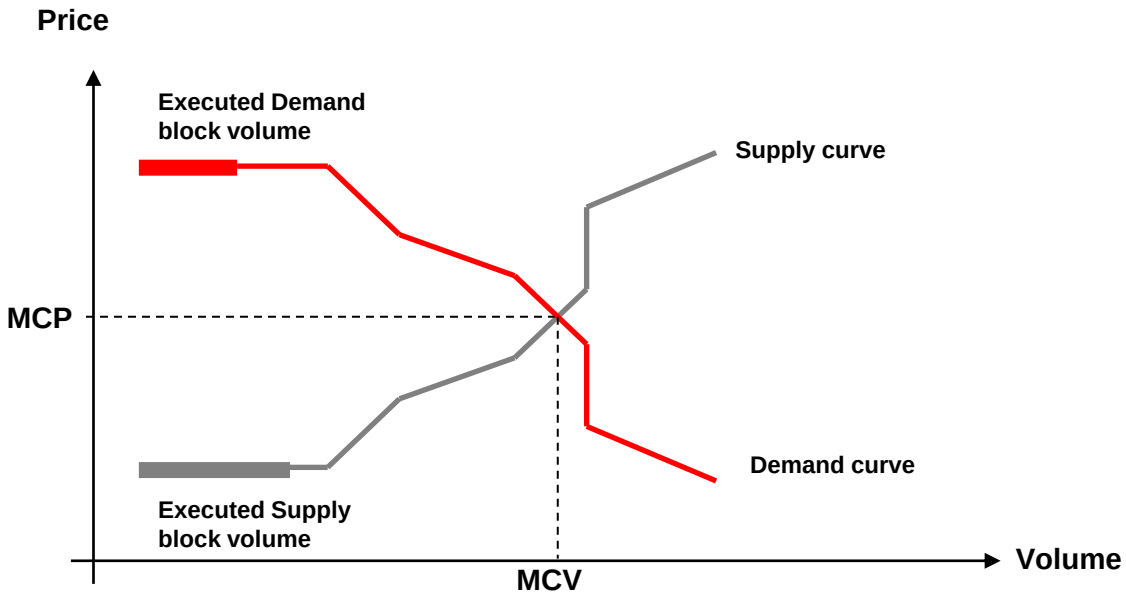
- **Supply and Demand Hourly orders**
  - Orders in-the-money are fully accepted
    - Supply at price < MCP
    - Demand at price > MCP
  - Orders out-of-the-money are fully rejected
    - Supply at price > Market Clearing Price (MCP)
    - Demand at price < Market Clearing Price (MCP)
  - Orders at-the-money can be curtailed

- **Supply and Demand Block orders**
  - Block orders that are accepted are in-the-money
    - Weighted average of the published MCPs is above limit price for a supply block
    - Weighted average of the published MCPs is below limit price for a demand block
  - Block orders in-the-money can be rejected (Paradoxically rejected Block PRB)


- **Day ahead Auction**
  - **EPEX Day-ahead products**
  - **Determining Day-ahead Market results**
- **Market Coupling (MC)**

# Determining Day-ahead Market results (2)

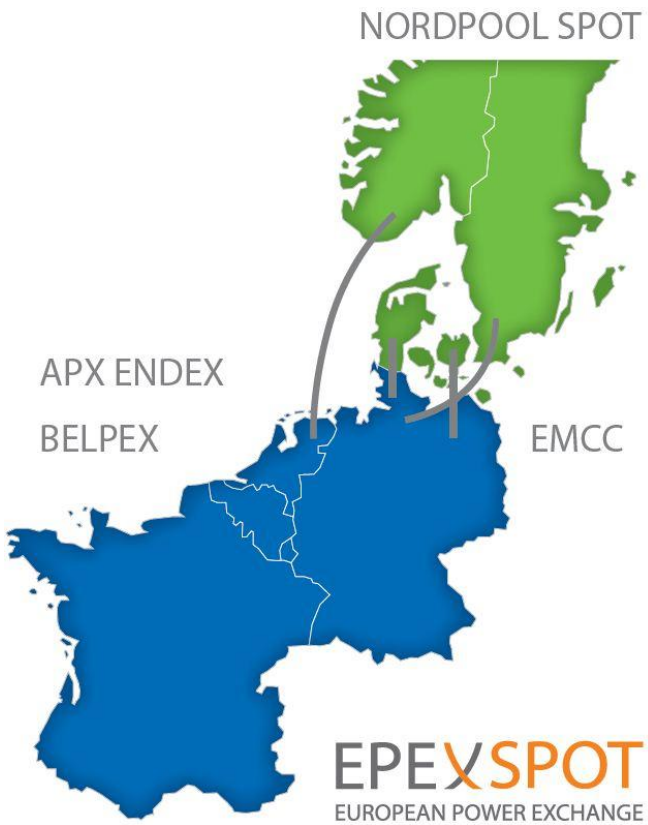
- Algorithm optimizing the WELFARE
  - The algorithm search for a partition of executed block orders optimizing the welfare,
  - For each hour, the executed supply (resp. demand) block order volumes are added to the supply( resp. demand) curve,
  - Price and volume are determined by the intersection of the aggregated demand and supply curves.



# How does it work?

- Several market areas with a PX of their own
- Goal of Market Coupling is the optimal use of cross border capacities (ATCs) provided by TSOs
- The ATC at the interconnections are used in an optimal way by implicit allocation of electricity and capacities over the exchange
  - The access to the market becomes easier and fairer
  - The realisation of transactions become more efficient
  - Less price volatility
  - Prices converge over the market areas when sufficient cross-border capacity is available



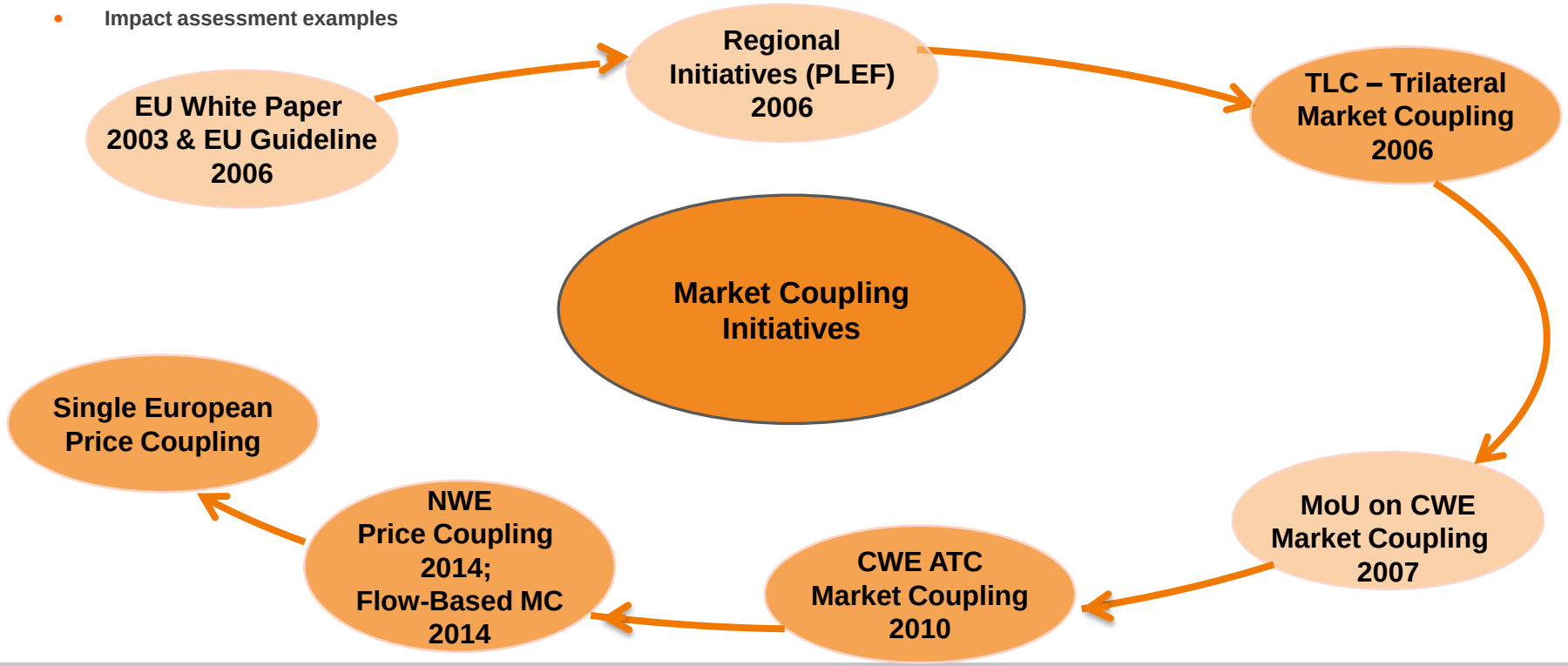


# Initiatives

- Day-ahead Auction
- Market Coupling (MC)
  - How does it works?
  - Overview of the EU MC development
    - Initiatives
    - Coupling achievements
    - Algorithm achievements
  - Impact assessment axes
  - Impact assessment examples

Prerequisites

Projects



# Coupling achievements

- Day-ahead Auction
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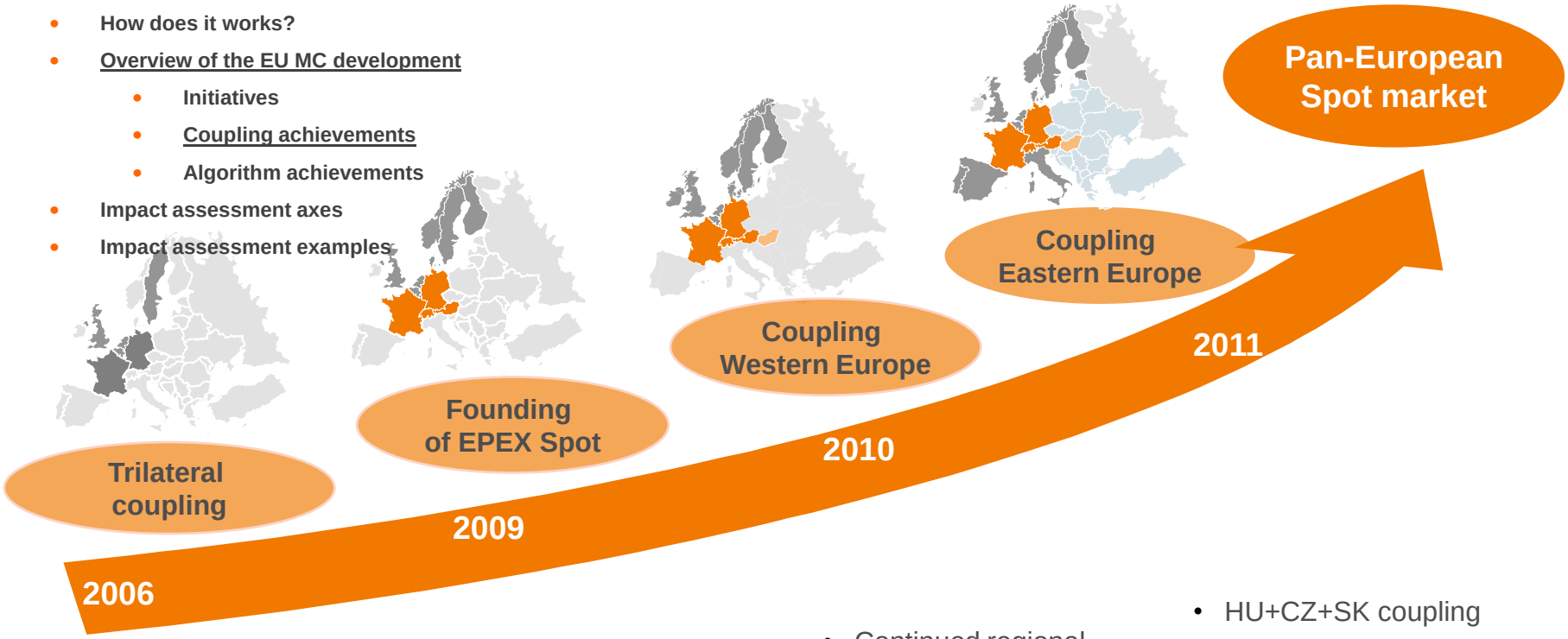


- POWERNEXT co-initiator of TLC
- 3 PXs, 3 TSOs involved

- EEX and POWERNEXT Spot business under one roof
- Geographically including AU, CH, DE and FR

- Continued regional coupling (CWE)
- 3 PXs, 7 TSOs involved
- Coordinated with Nordic (ITVC)
- Cooperation EPEX-HUPX

- HU+CZ+SK coupling
- 3 PXs, 3 TSOs involved
- Cooperation
  - EPEX
  - HUPX
  - OKTE
  - OTE

# Algorithm achievements

- Day-ahead Auction
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    - Initiatives
    - Project achievements
    - Algorithm achievements
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**TLC project BE+FR+NL**

**CWE project**

**PCR project**

**Pan-European Spot market**

**Vision**

**2006**

**2010**

**2013**

**Design and assessment of the TLC MC algorithm**

- TLC dedicated

**Design and assessment of the CWE MC algorithm : COSMOS**

- "Generic"
  - ATC/FB/FBI/Hybrid MC
  - Loss/tariff/ramping
  - Smart blocks
  - Negative prices…
- "Unlimited" (nb of markets)
- Welfare optimization

**Design and assessment of the PCR algorithm : EUPHEMIA**

- Based on CWE algorithm
- SWE (ES+PT) markets
- CSE (IT) markets
- Flow calculation
- …

# Algorithm achievements (2)

- Day-ahead Auction
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- TLC algorithm
  - Greedy algorithm

http://static.epexspot.com/document/4360/Algorithme%20du%20TLC

- COSMOS algorithm
  - Branch and Bound algorithm

http://static.epexspot.com/document/20015/COSMOS_public_description.pdf

- EUPHEMIA algorithm
  - Heuristic algorithm combining B&B and Heuristics

http://static.epexspot.com/document/24867/Euphemia%20-%20public%20description%20-%20Nov%202013

# Impact assessment

- Day-ahead Auction
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TLC project

CWE project

PCR project

Pan-European Spot market

2006

2010

Vision

- New market development (BE)
- Shift from Explicit to Implicit auction mechanism
- MC impact on Market results and algorithm performance

- Algorithms comparison on a given scope
- Negative prices development
- Network model development
  ATC vs FB vs FBI
- MC extension (CWE+NPS+UK+…)
- Volume coupling vs Price coupling
- …

- New product development
  - OMIE & GME products
- New products introduction
  Smart blocks on EPEX
- MC extension
  CWE → NWE → PCR
- Network model development
  - Tariff / losses on interconnectors
  - Flow calculation
- …

# What?

- Market result indicators
  - Welfare
  - Price (volatility, resilience, convergence…)
  - Volume
  - Block order
  - …
- Performance indicators
  - Calculation time
  - Solution quality (opimality)
  - …

➢ Same indicators for different purposes

- **Day-ahead Auction**
- **Market Coupling (MC)**
  - **How does it works?**
  - **Overview of the EU MC development**
  - **Impact assessment**
    - **What ?**
    - **How ?**
  - **Impact assessment examples**
    - **Market development**
    - **Algorithm development**

# How?

- Data
  - Historical data (order books, ATC, nominations…) collection
  - « Automated » tools to collect data
  - More than «30 years» of data depending on the purpose
  - … Data sharing agreements
- Hardware/DB

  Increasing number of production like environments with the development of MC projects
- Simulation software **embedding the MC algorithms**
  - CWE SF: web shared tool (CWE TSOs/PXs)
  - Pieces of home made software automating “exotic” simulations

- **Day-ahead Auction**
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  - **Impact assessment**
    - **What ?**
    - **How ?**
  - **Impact assessment examples**
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# Replacing EXPLICIT by IMPLICIT allocation mechanism

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  - Impact assessment examples
    - Market development
    - Algorithm development

- CWE vs TLC + DE
  - No more cross border arbitrage opportunities on DE borders
  - ➢ No more arbitrage orders in the order books

- It was questionable
  - In which extent the participant behavior will change?
  - Whether arbitrage orders are present in the orders books ?
  - What is the portion of arbitrage orders in the order books ?

- Simulating shift from EXPLICIT to IMPLICIT
  - 2 methodologies
    - Altering the ATC with the cross border nominations for the interconnectors that were allocated explicitly (DE-FR and DE-NL)
    - Removing arbitrage orders from the respective order books (DE, FR and NL)
  - For both methodologies, consider different levels of alteration resulting from different assumptions of the arbitrage orders portion in the order books

http://static.epexspot.com/document/4775/CWE_MC_Implementation_Study.pdf

# Negative prices development impact

- CWE PXs decided allowing negative prices on their markets for CWE MC launch

- It was questionable
  - In which extent the participant behavior will change?
    - Will order prices shift  to (very) negative values ?
    - Will all “price taking orders” remain ?
  - What is the impact of harmonized and non harmonized price limits ?
  - …

- Simulating Negative price development
  - Focus on delivery days where curtailment situations occurred  at minimal price
  - Replace  a portion of (sell) orders submitted at minimal price by orders at -3000€
  - Assume different portion of negative price orders



http://static.epexspot.com/document/4775/CWE_MC_Implementation_Study.pdf

# Smart blocks development on EPEX markets

- Smart blocks
  - LINKED blocks
    - Regular block execution conditions
    - \+ Execution dependency
      - father / child hierarchy
      - child can be executed only if his father is executed
  - EXCLUSIVE group of blocks
    - \+ Regular block execution conditions
    - \+ Execution condition
      - Only one block of the exclusive group can be executed

- It is questionable
  - How will participant behavior change?
  - What will be the portion of SB in the portfolios ?
  - What will be the additional complexity (combined with NWE launch)

- Simulations of smart blocks on CWE MC in NWE configuration
  - ⇨ Assuming different behaviors and different portions

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# Algorithm behavior comparison

- Day-ahead Auction
- Market Coupling (MC)
  - How does it works?
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- TLC vs COSMOS
- COSMOS vs ETS Matching Algorithm
- COSMOS vs ITVC (EMCC)
  - Initial validation → Initial benchmark
  - Each time one of the algorithms is changed/updated
    - ➢ Validation against the benchmark
- COSMOS vs EUPHEMIA
  - COSMOS vs EUPHEMIA on CWE scope under ATC/FB/FBI Market Coupling
- …

# Thanks for your attention!

# Questions?

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