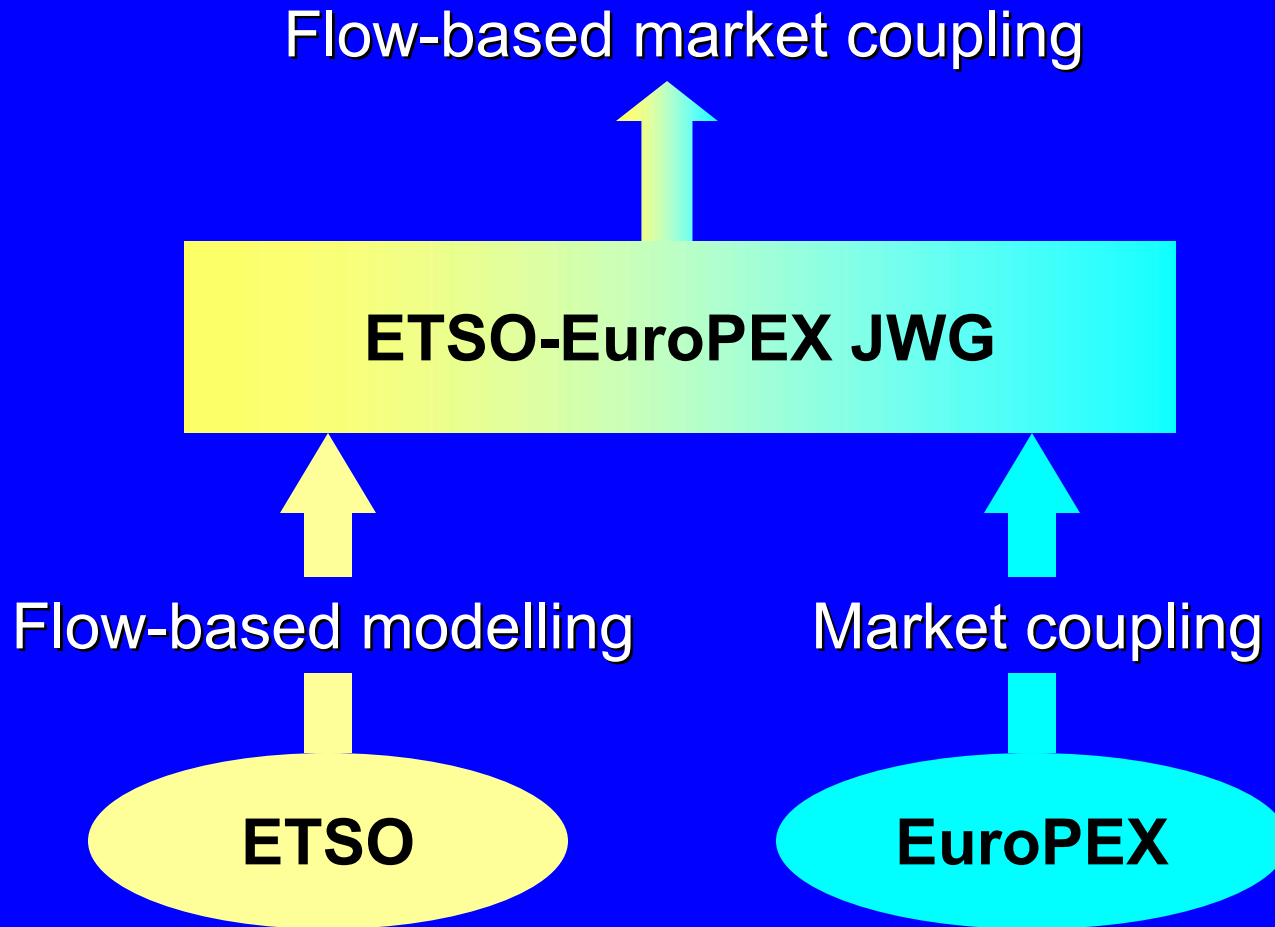


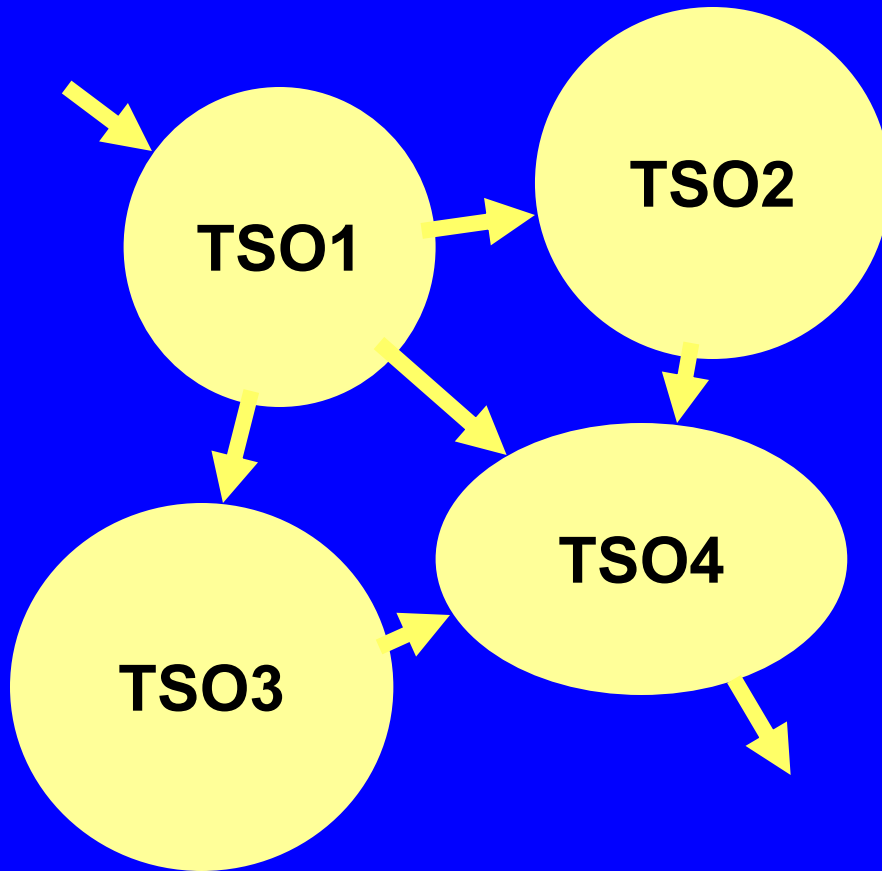
# Flow-based Market Coupling (FMC)

A Joint ETSO-EuroPEX Proposal  
for Cross-Border Congestion Management  
and Integration of Electricity Markets in Europe

# Origins of FMC

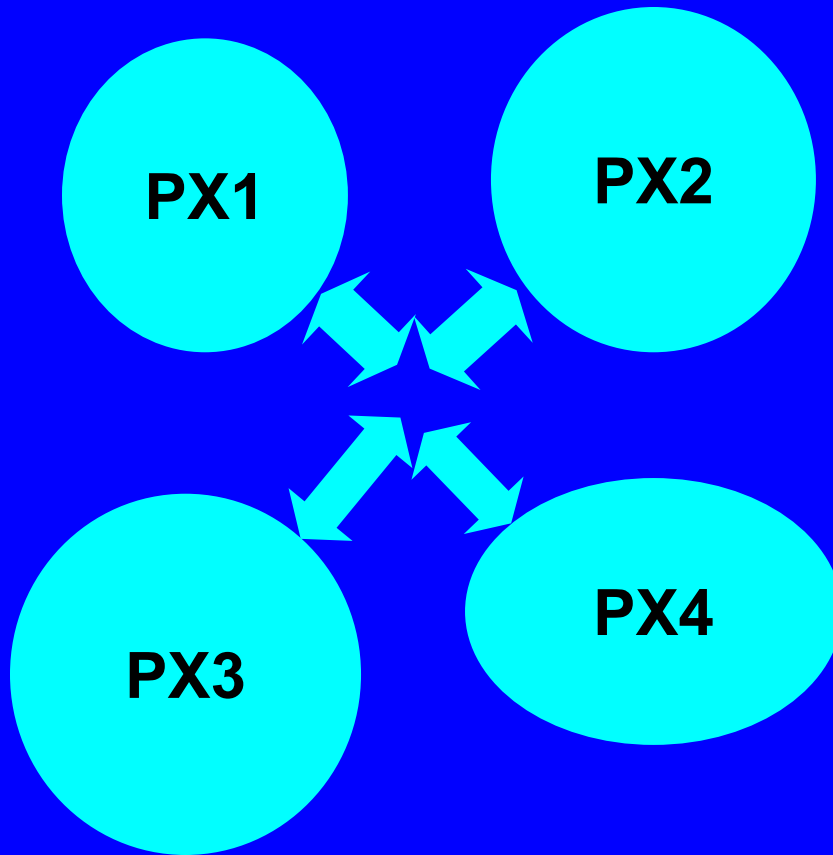


# Flow-based modelling



- All modelled electrical flow paths taken into account, not just 'contract path'
- Maximises use of inter-regional transmission capacity

# Market coupling

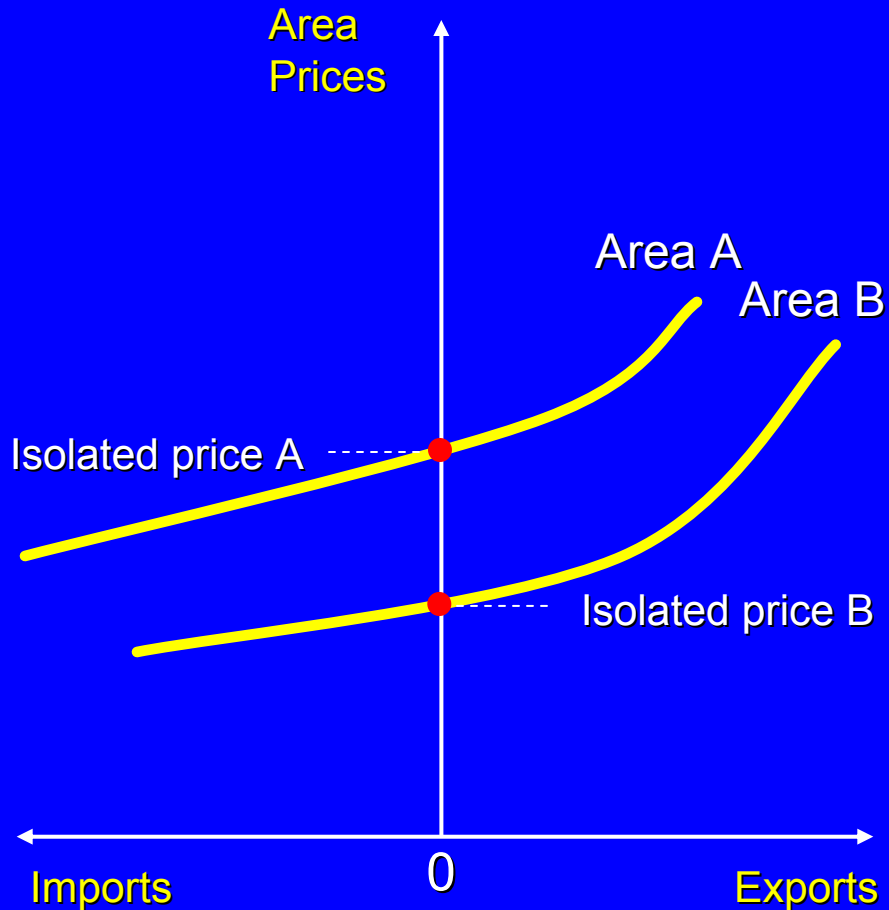


- Efficient trading between regional markets via power exchanges
- Maximises inter-regional market efficiency

# Why Market Coupling?

- A form of implicit auction similar to market splitting, with similar advantages:
  - Removes unnecessary risks of trading short-term capacity and energy separately
  - Encourages liquid, robust spot markets - promoting indices and derivative markets
  - Enables netting of schedules
  - Allows all spot market participants to benefit from cross-border access
  - Provides a transparent, rule-based, auditable methodology
- Market coupling links together separate markets in a region, whereas market splitting divides a regional market into price zones
  - Price differences minimised, convergence if sufficient capacity
  - Efficient use of interconnector capacity

# Market Coupling

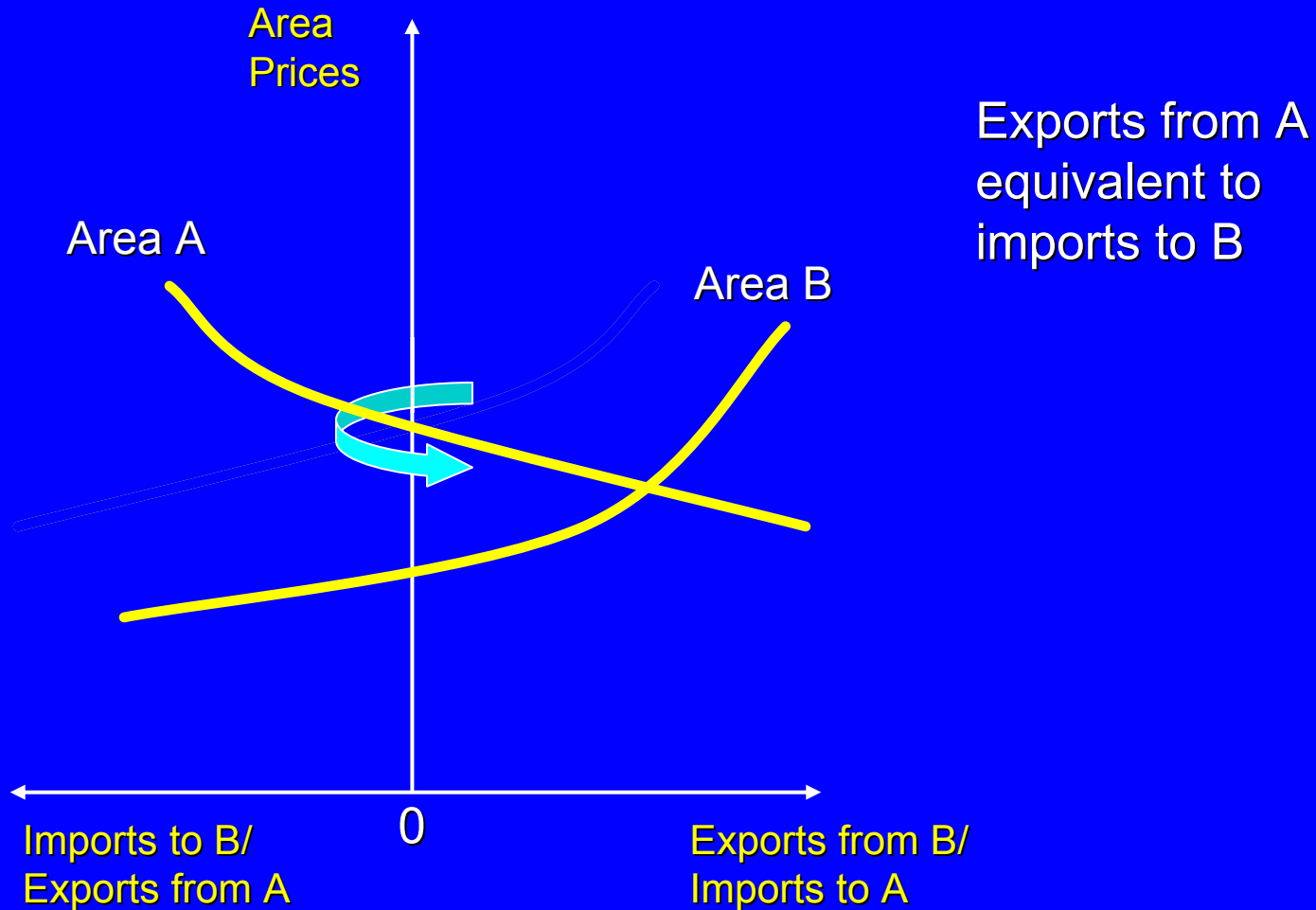


## Import/export Curves

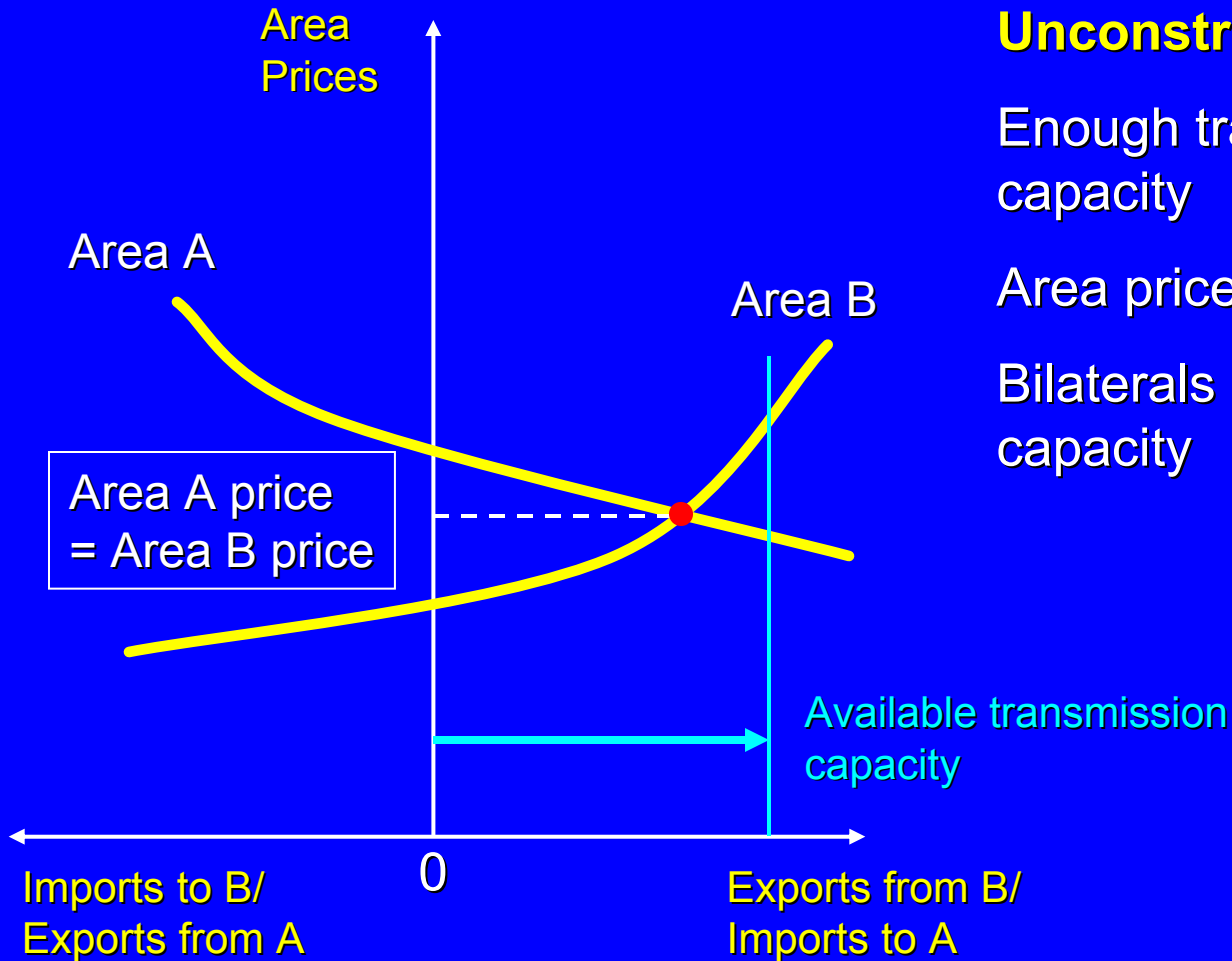
Impact on area price of imports to/exports from each individual area

Calculated in each area based on local area energy bids/offers

# Market Coupling



# Market Coupling



## Unconstrained Case

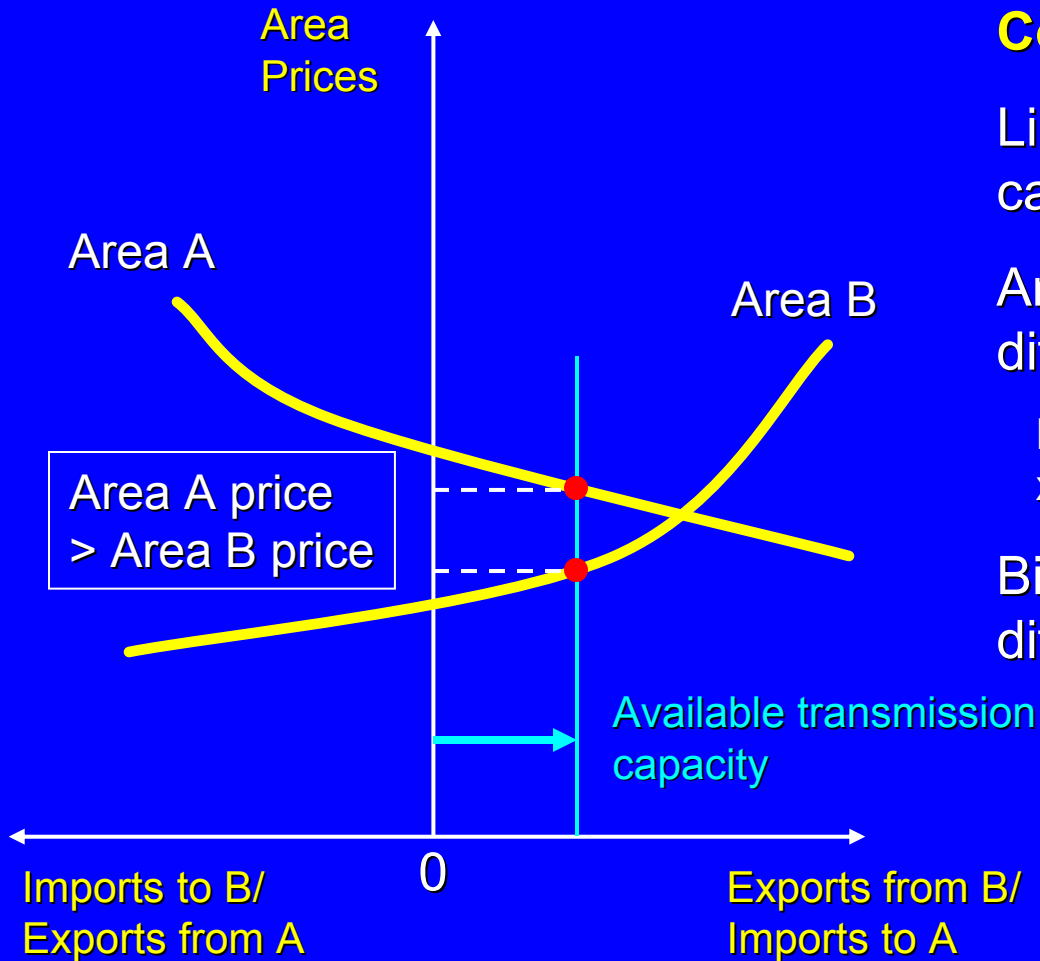
Enough transmission capacity

Area prices converge

Bilaterals pay zero for capacity



# Market Coupling



## Constrained Case

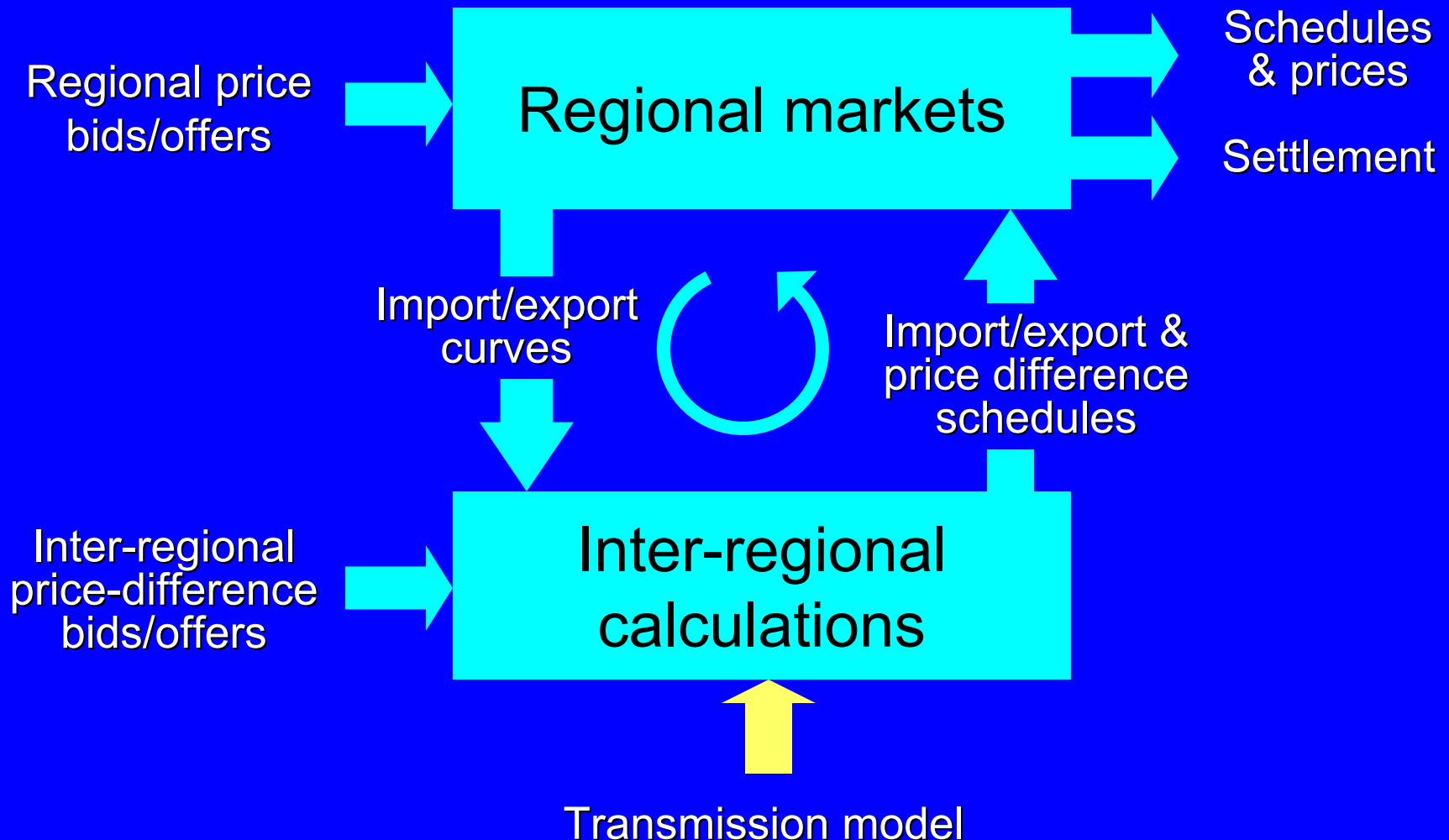
Limited transmission capacity

Area prices converge, but difference remains

$$\text{Price diff} \times \text{volume} = \text{congestion revenue}$$

Bilaterals pay same price difference for capacity

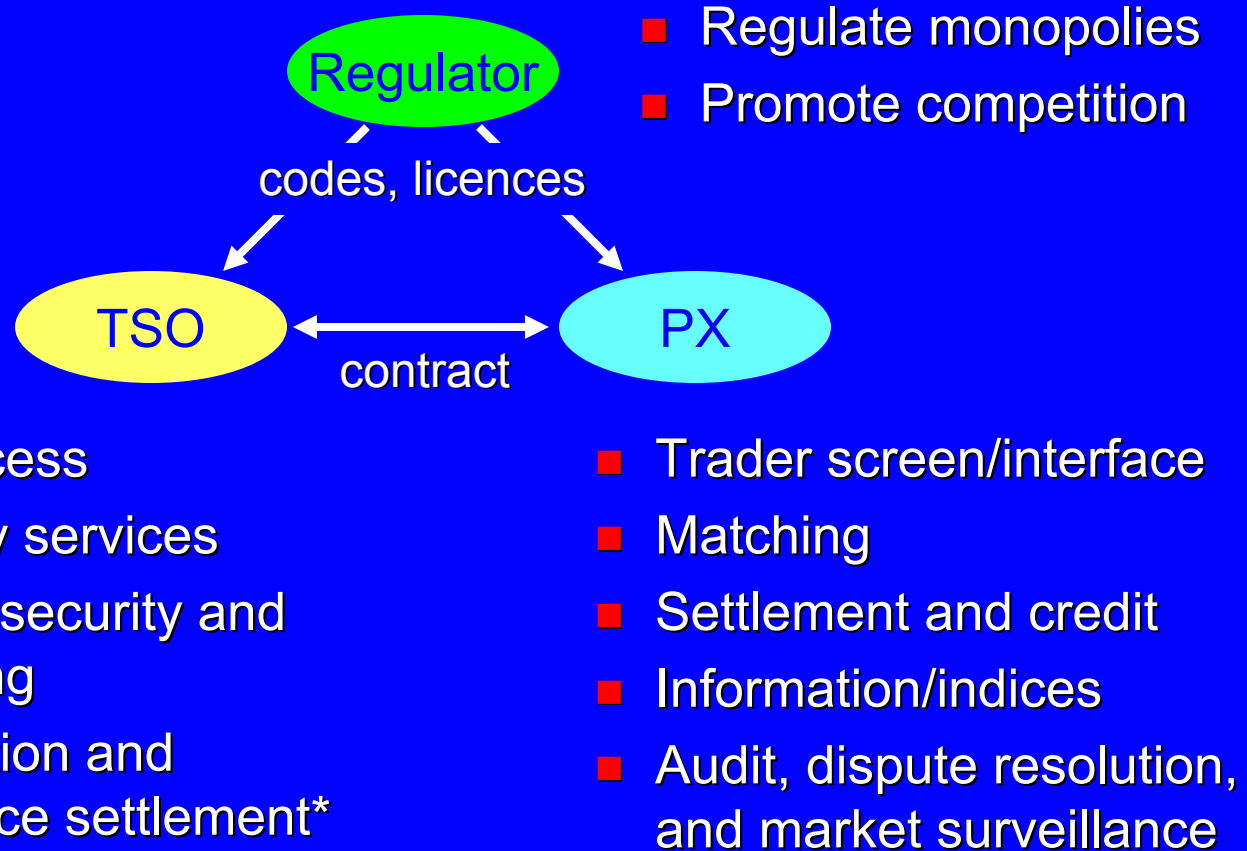
# FMC day-ahead market



# Why a Decentralised Approach?

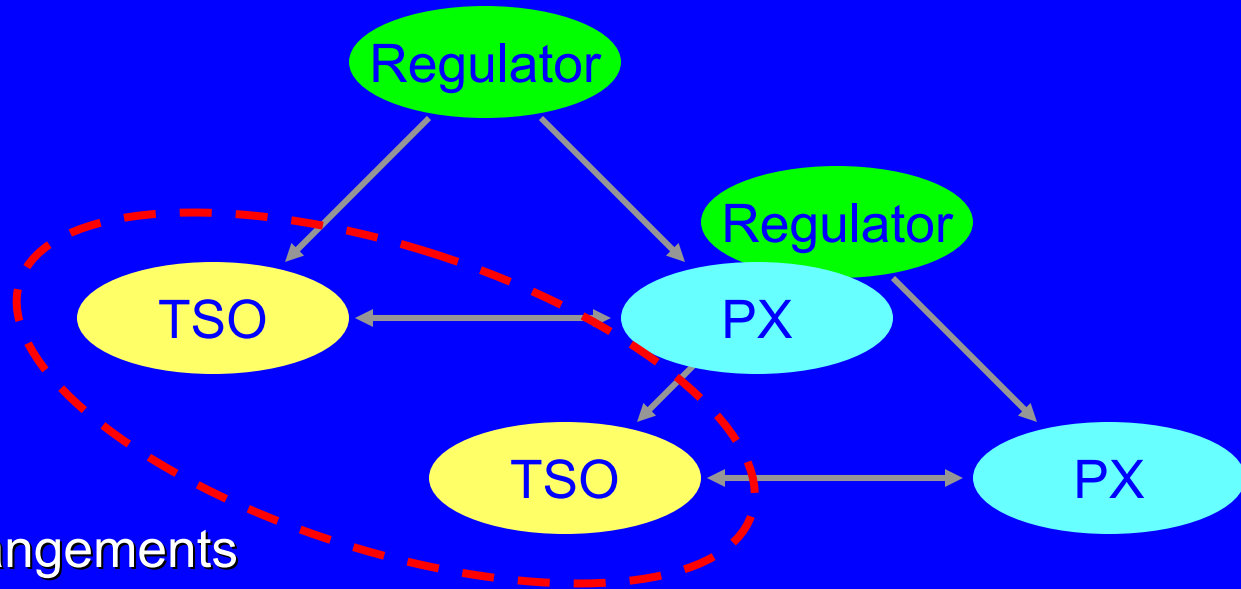
- Minimizes the degree of standardization/centralization required
  - Avoids change to local procedures and arrangements
  - Minimizes governance complexity
- Supports local market variations
  - Compatible with financial and physical hedging instruments
  - Can combine explicit auctions and implicit auctions
  - Maintain local products (e.g., block bids) to suit local needs
- Builds on existing trading arrangements
  - PX membership: credit, settlement, trader interface
  - Trading patterns: indices, OTC/bilateral flexibility
- Can evolve over time, step by step – e.g., geographic scope and methodology

# FMC builds on existing arrangements



\* responsibility of the PX in some countries

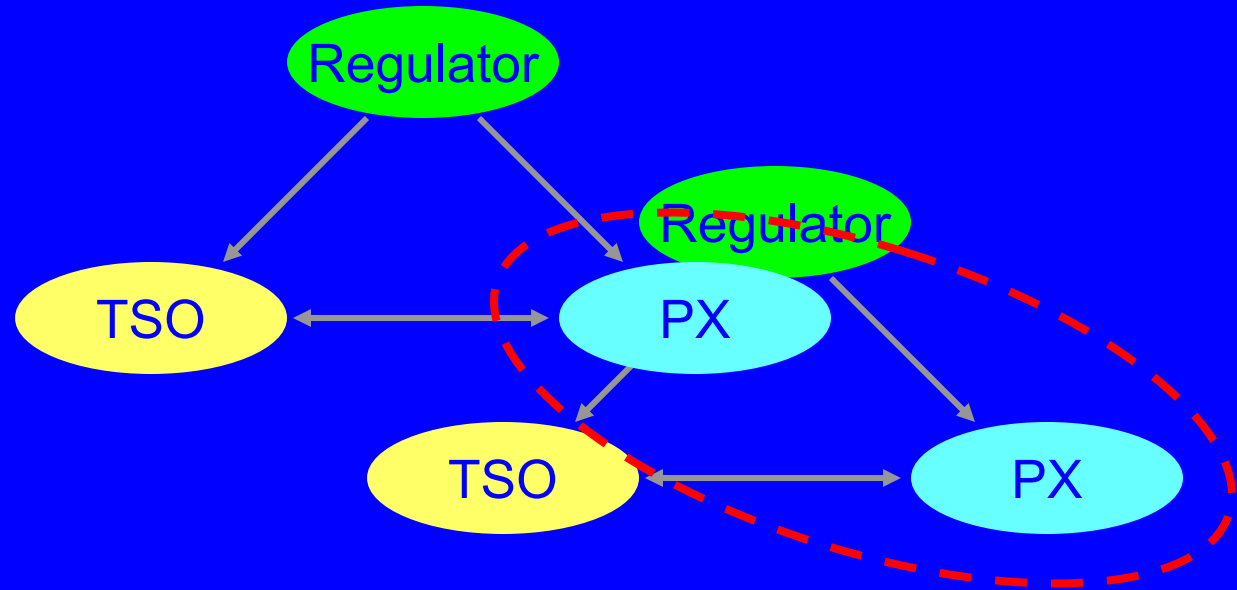
# New requirements for FMC: inter-TSO coordination



## Inter-TSO arrangements

- Calculate bottleneck capacities and flow factors
- Co-ordinated actions to ensure firmness

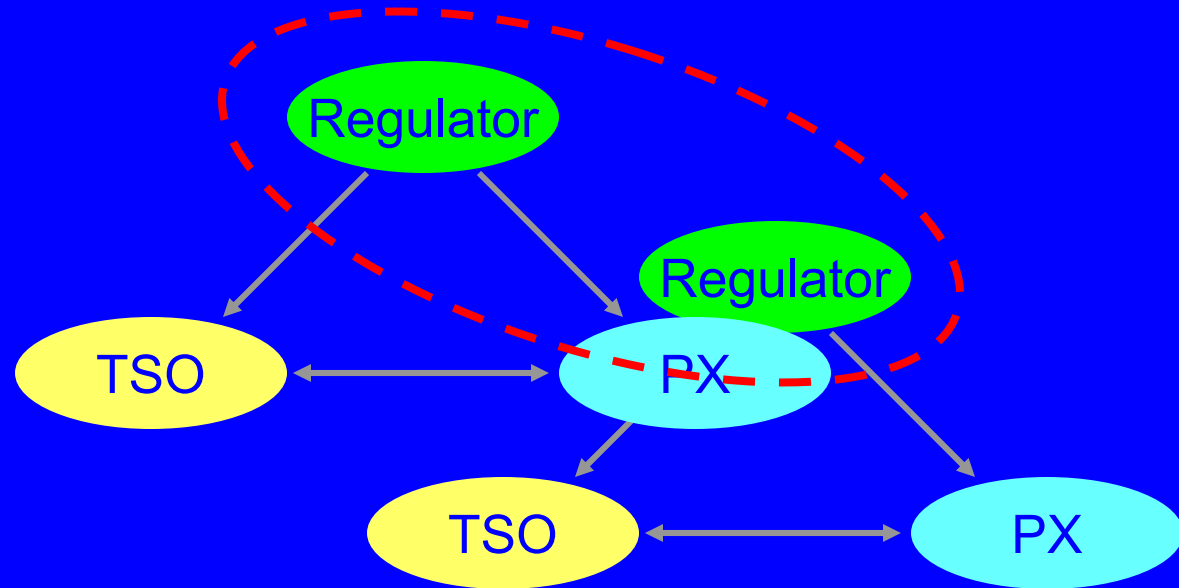
# New requirements for FMC: inter-PX coordination



## Inter-PX arrangements

- Calculate cross border flows, including operations, audit and dispute resolution
- Settle and notify Price Difference contracts

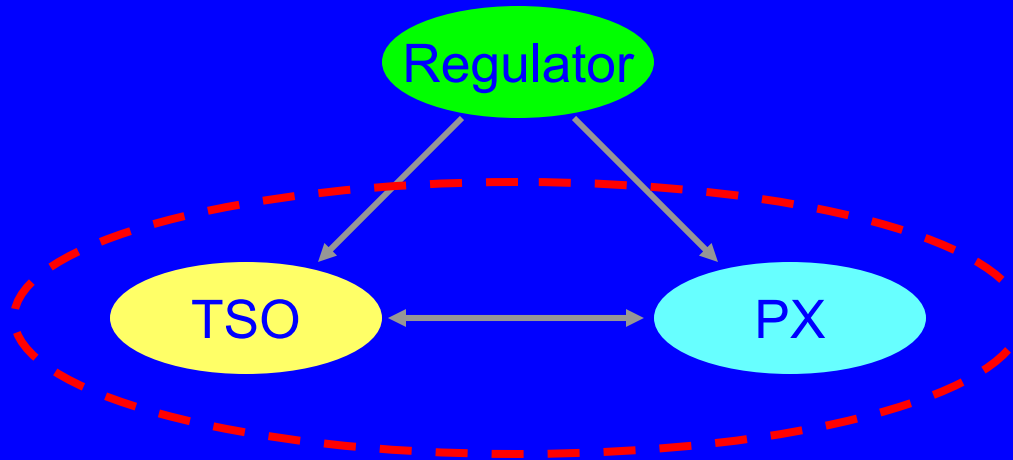
# New requirements for FMC: inter-Regulator coordination



## Inter-Regulator arrangements

- Regulation of FMC (e.g., rules, market surveillance, information)
- Splitting of aggregate congestion revenues

# New requirements for FMC: TSO - PX coordination



## TSO-PX arrangements

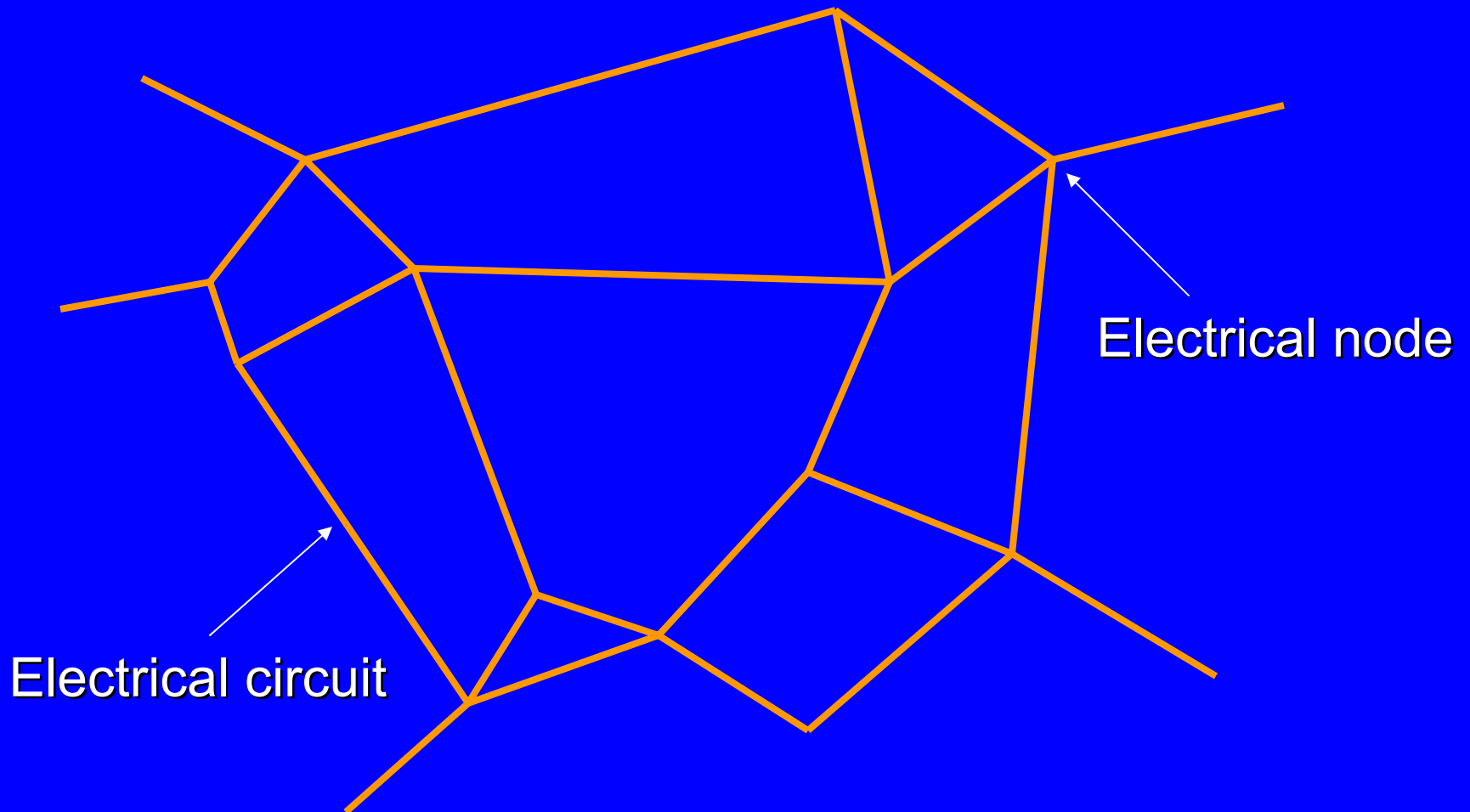
- TSOs: provide firm capacities and flow factors
- PXs: calculate aggregate schedules; collect and return congestion revenue
- TSOs: accept aggregate schedule and congestion revenue



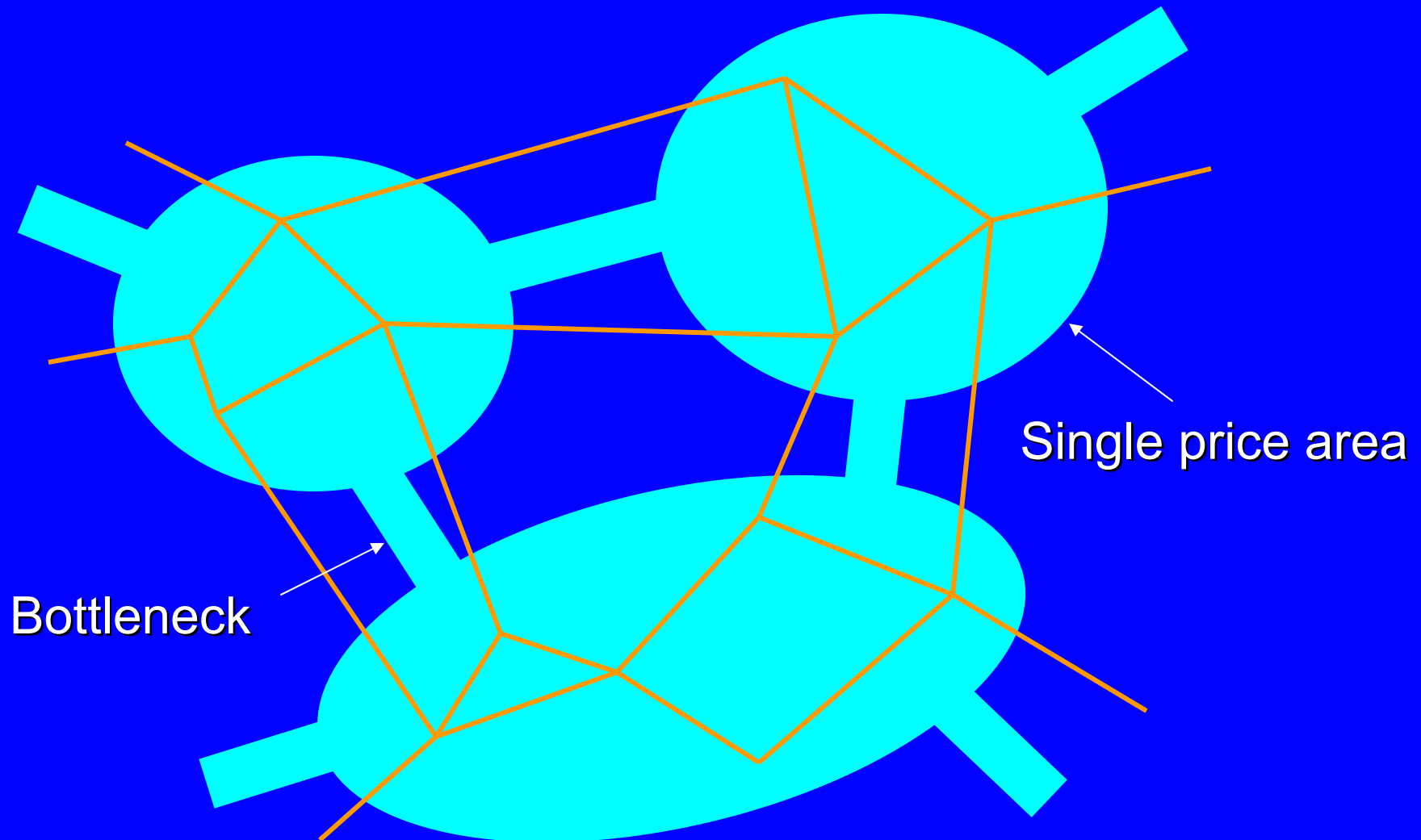
# TSO support for the markets

- Transmission model (essential)
- Firmness of cross-border commercial exchanges (essential)
- Allocation of transmission rights (optional for FMC)

# Operational transmission model



# Simplified transmission model for FMC



# Transmission model (1)

- Linearisation
  - based on reference state with given generation, load and switching patterns
  - model consists of relationships between variations from the reference state
- Flow factors
  - FF matrix links variations in physical bottleneck flows to variations in area balances (i.e. sum of commercial exchanges)
- Bottleneck capacities
  - BCs are operational limits on variations in physical bottleneck flows
  - not the same as current NTCs

# Transmission model (2)

- Bottleneck capacities and flow factors depend on the generation pattern, loads and network switching assumed in the reference state
- The ‘chicken and egg’ problem
  - the generation pattern is required to determine the parameters of the transmission model ...
  - but the transmission model is needed for the trading that determines the generation pattern!

... but less severe than with NTC modelling
- Transparency
  - publication of methods and results

# Firmness of cross-border commercial exchanges

- TSO action (e.g. re-dispatch, counter-trade) will be necessary to deal with:
  - 'internal' constraints
  - transmission model simplifications
  - the 'chicken and egg' problem
  - prediction uncertainties
  - production/consumption imbalances
  - production/consumption/transmission failures
- Costs of TSO action
  - socialised/targeted recovery
  - possible use of congestion income
  - allocation between intra-area and inter-area users

# Allocation of cross-border transmission rights

- Transmission rights can be allocated by explicit auction before the FMC implicit market
- Availability of rights may be needed to enable users to manage transmission access price risk
- Physical or financial
  - nearly equivalent, differences depend on implementation details and market maturity
- Options
  - day-ahead notification to TSOs transforms options into firm obligations

# Regulatory/contractual arrangements

- Power exchanges' 'institutional' role needs to be designated and held accountable to Regulator or TSO (some already are)
- Harmonisation is needed for inter-regional transmission modelling, data transfer, publishing formats, etc.
- General structure and content of regulatory/contractual arrangements has been identified



# Benefits of FMC

## Congestion management

- Flow-based approach and netting of schedules maximises use of inter-regional transmission network

## Market efficiency

- Integrating transmission access and energy trading eliminates unnecessary pricing risk and concentrates liquidity
- Inherent cross-border access for all market participants
- Variety of trading options: bilateral/exchange, blocks

## Feasibility

- Builds on existing trading infrastructure and liquidity
- Can evolve over time

# Development issues

- Technical development
  - market coupling mechanism
  - transmission model
  - TSO actions to ensure firmness of cross-border commercial exchanges
- Regulatory and contractual matters
- Compatible Regional development

# Current regional initiatives

- Iberia (Spain, Portugal, Morocco)
- Spain – France
- France – Belgium – Holland
- Holland – Norway
- Denmark – Germany
- ex-Yugoslavian countries