Electricity markets, cross-border capacity allocation and the role of RTE

Paris – 18th July 2014

Galileo BARBIERI – galileo.barbieri@rte-france.com

- What are the processes for scheduling for OTC, DAM and intra-Day markets ?
- What are the processes for scheduling cross-border power transactions ?
- Imbalance settlement system in France
- Cross border coordination for transmission capacity and scheduling
- How RTE role has changed with the market coupling ?

PLAN

1. An introduction to national power markets

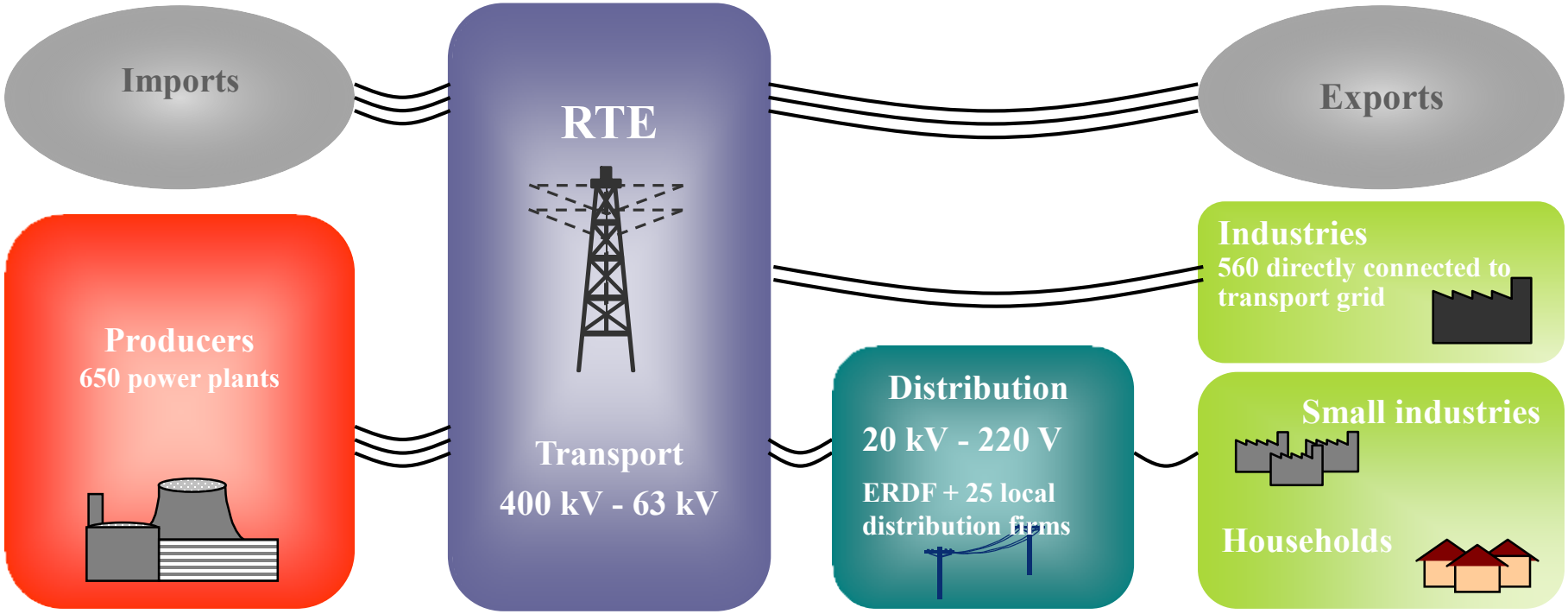
2. Interconnections: the cross-border capacity allocation

PLAN

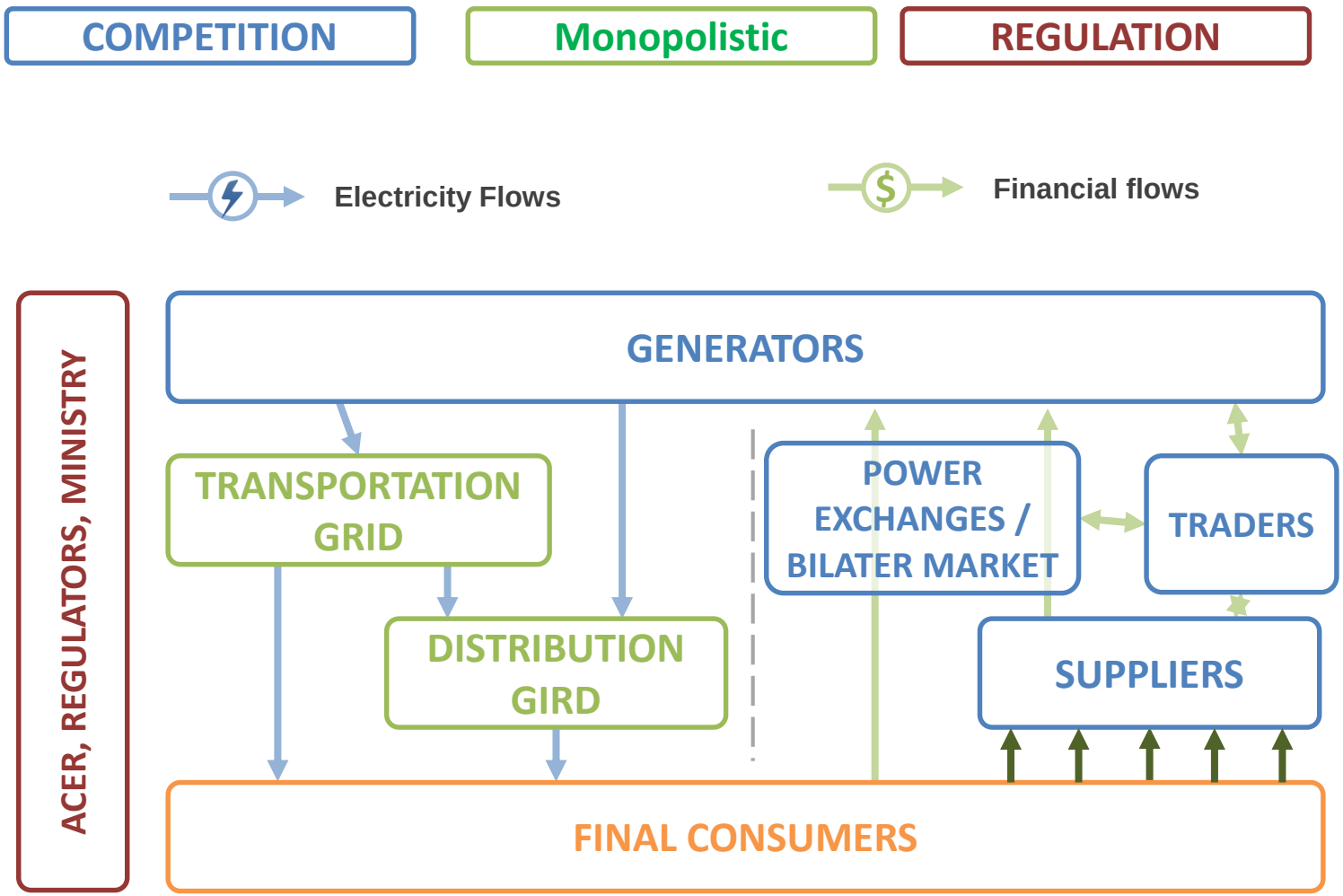
1. An introduction to national power markets

2. Interconnections: the cross-border capacity allocation

The **physical** players in France



The electricity **market** players



The liberalisation process

- Regulated activities (natural monopolies)
  - Transport
  - Distribution

- Activities open to competition
  - Production
  - **Gross electricity trade**
  - Electricity supply
  - **Access to interconnections**

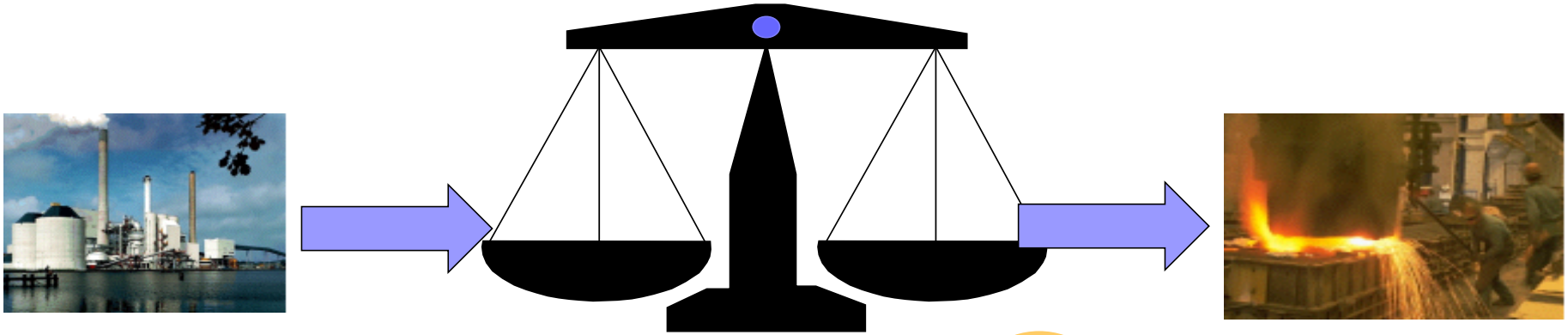
- … in Europe

→How to reconcile trading activities with the physical constraints of the electricity systems?

The Balance Responsible Party

- Balance Responsible Party mechanism : the needed link between the physical reality and the market

Eeach market party must ensure its own balance (in France: each ½ hour)



+	-
• Production	• Consumption
• Purchase	• Sales
• Imports	• Exports

= unbalances are financially penalized

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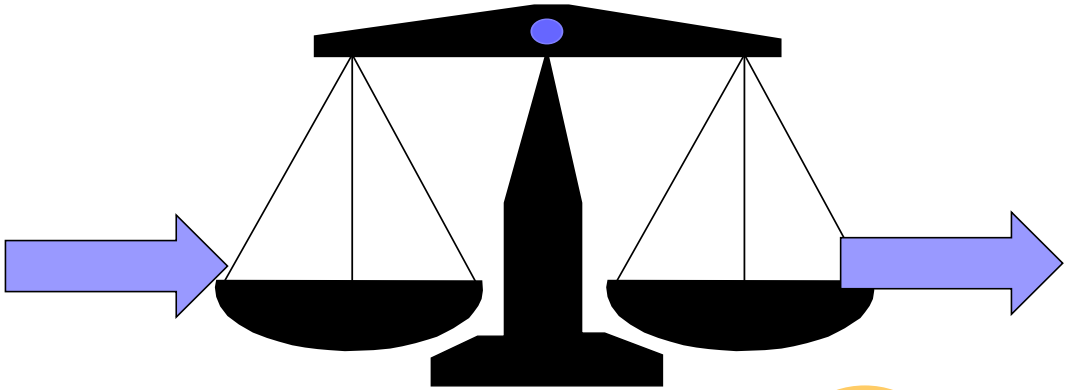

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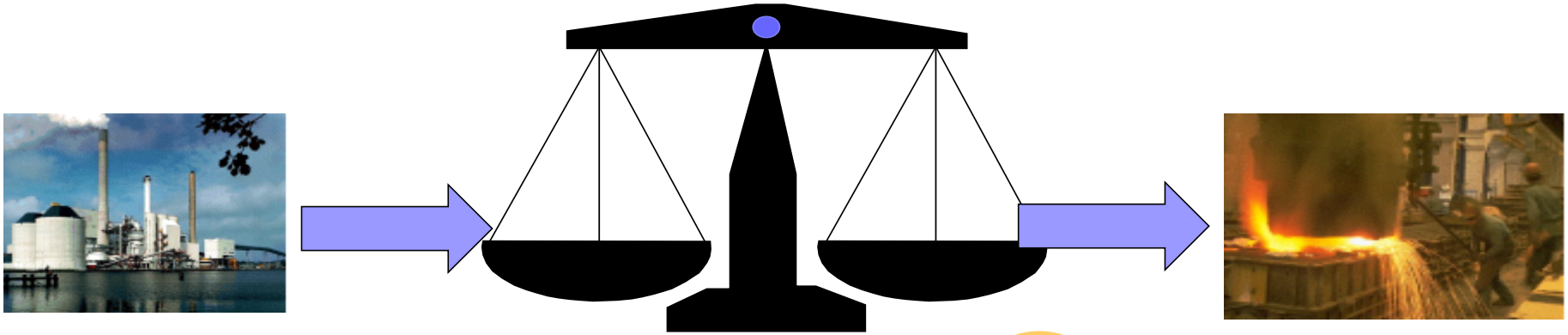


+	-
•Production •Purchase •Imports	•Consumption

= inbalances are financially penalized

The Balance Responsible Party

- ~150 Balance Responsible Parties in France
- Obligation to sign a Balance Responsible Party contract with RTE to participate to market mechanisms
- Production and load are metered, market activities (OTC, Power Exchange, Imports/Exports) are notified to RTE

Different markets

- Purchases / sales of electricity can be done :
  - Through **bilateral exchanges (OTC)**
  - Through **organized power exchanges (PXs)**
- Imports / exports can be done :
  - Acquiring **transmission rights** sold by TSOs (long term)
  - Indirectly, through **market coupling** (day-ahead)

Development of bilateral exchanges

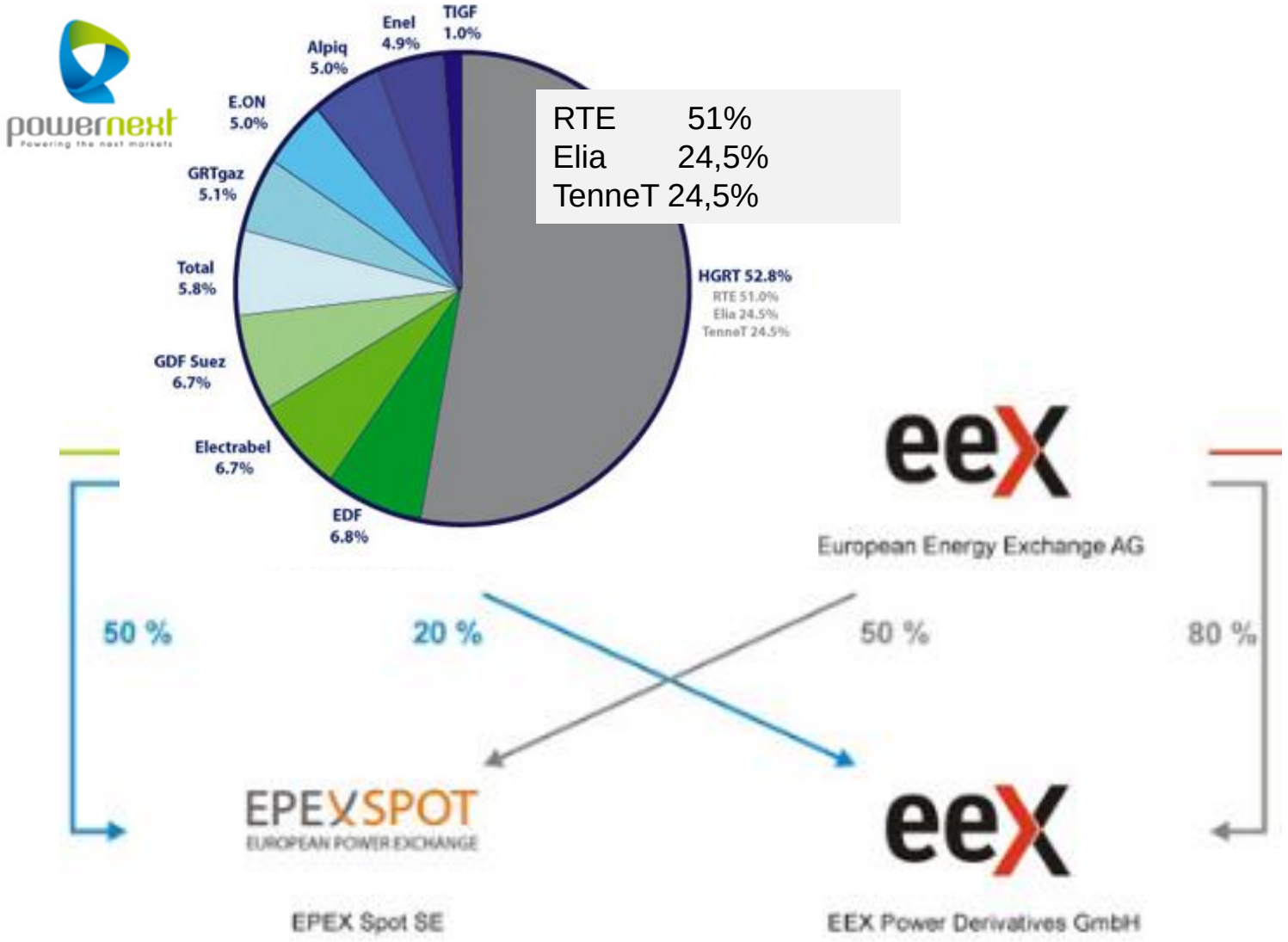
- Over The Counter (OTC)
- The first step for the creation of an electricity market
- Issues:
  - No transparency on prices !
  - Counterparty risks

The development of national Power Exchanges (PXs)

- The fixing of a reference price, transparency
- Standard products
- No counterparty risk

Electricity Power Exchanges in Europe

The role of RTE



The products avaliable on the electricity markets

- Long term products → price risk
  - Year (Y+1, Y+2, Y+3), quarter, month, week
  - Base (24h/24h) / peak (8am to 8pm)

EEX Power Derivatives GmbH

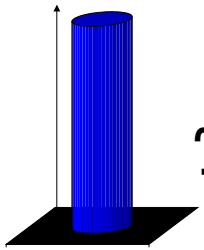
- Short term products → volume risk
  - **Day-ahead : base, peak and hourly products. The reference !**
  - Intraday

EPEX SPOT
EUROPEAN POWER EXCHANGE

- Why is the day-ahead market the reference ?

Exchanged volumes by timeframe in France

Long term market

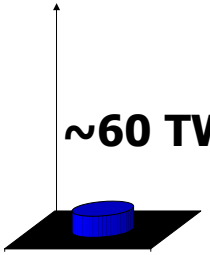


~600 TWh

Organized market / OTC

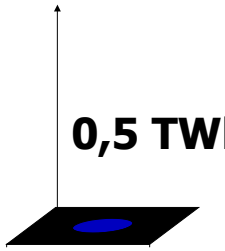
eex

Spot



~60 TWh

Intraday



0,5 TWh

Organized market / OTC

EPEX SPOT
EUROPEAN POWER EXCHANGE

Balancing

~4 TWh

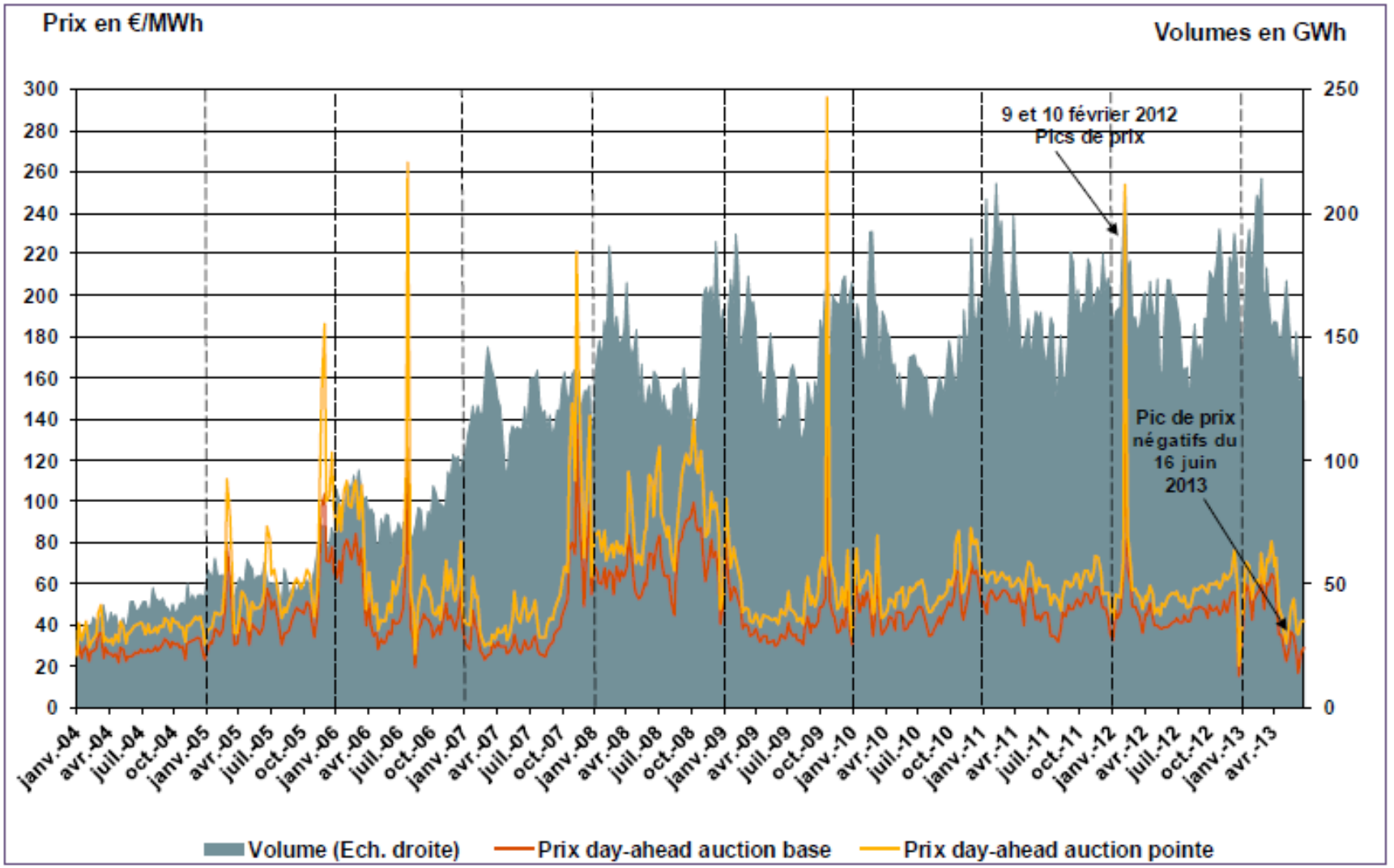
GRT:

RTE
Réseau de transport d'électricité

RTE International

Volumes and prices on Epex Spot

Graphique 14 : Evolution des prix spots en France (moyenne hebdomadaires des prix et somme des volumes)



Source : EPEX SPOT

The price fixing for the day-ahead market

For each product :

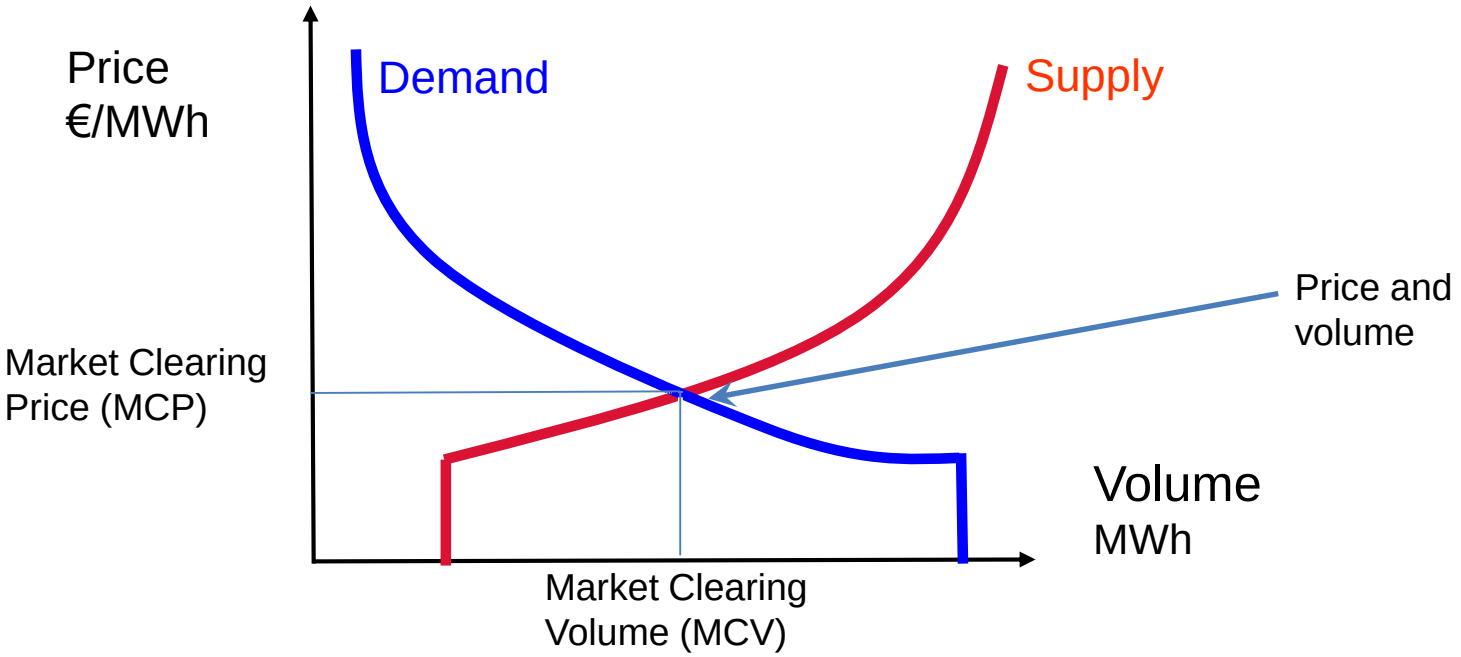
1. Collecting supply and demand bids*
2. Build Demand and Supply curves
3. Find marginal price
4. Find cleared volume

The price fixing

Sum of sale offers = **Supply curve**

Sum of purchase bids = **Demand curve**

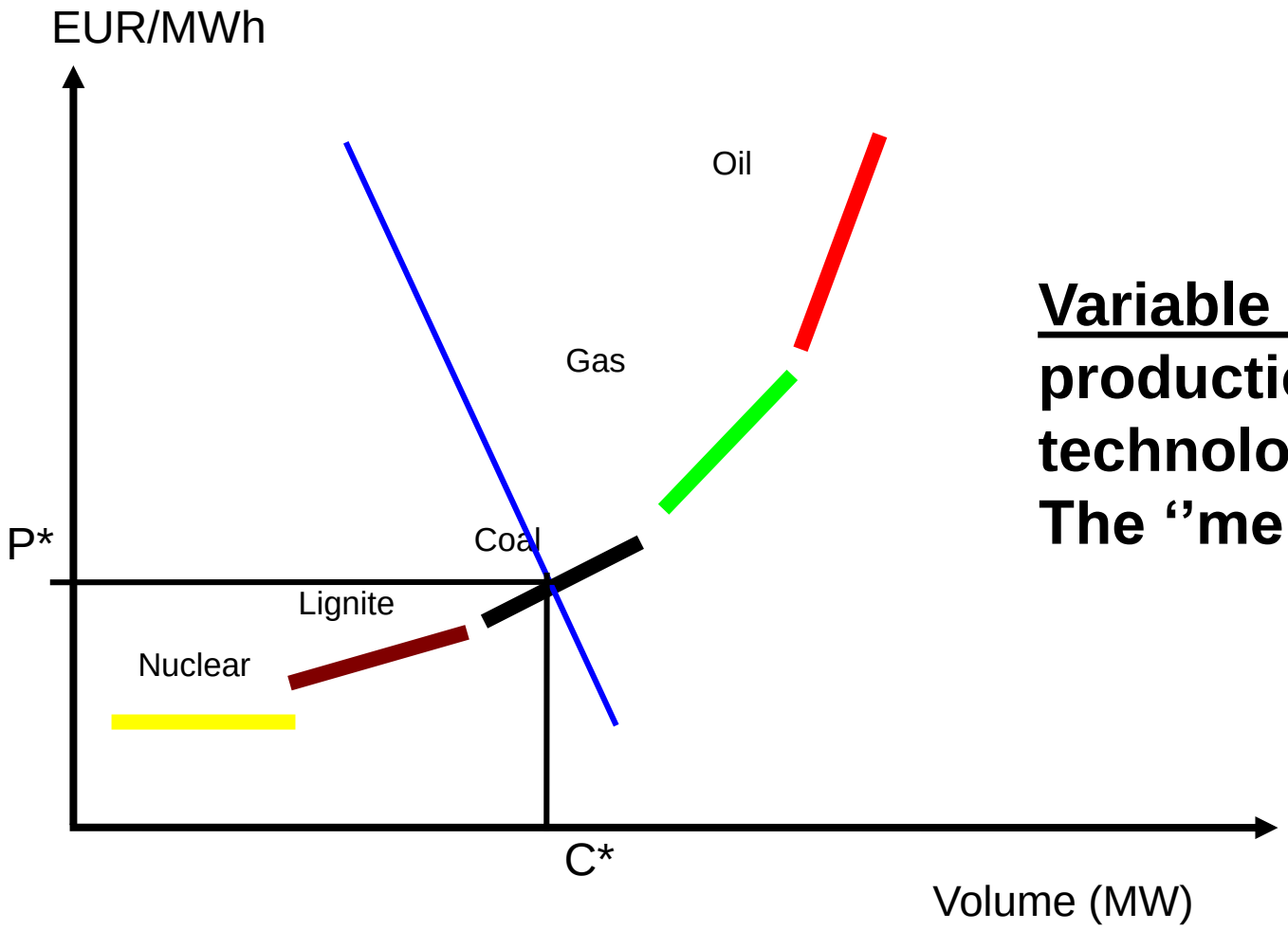
The intersection of the two curves gives the **clearing price and the cleared volume**



What lies behind the supply curve ?

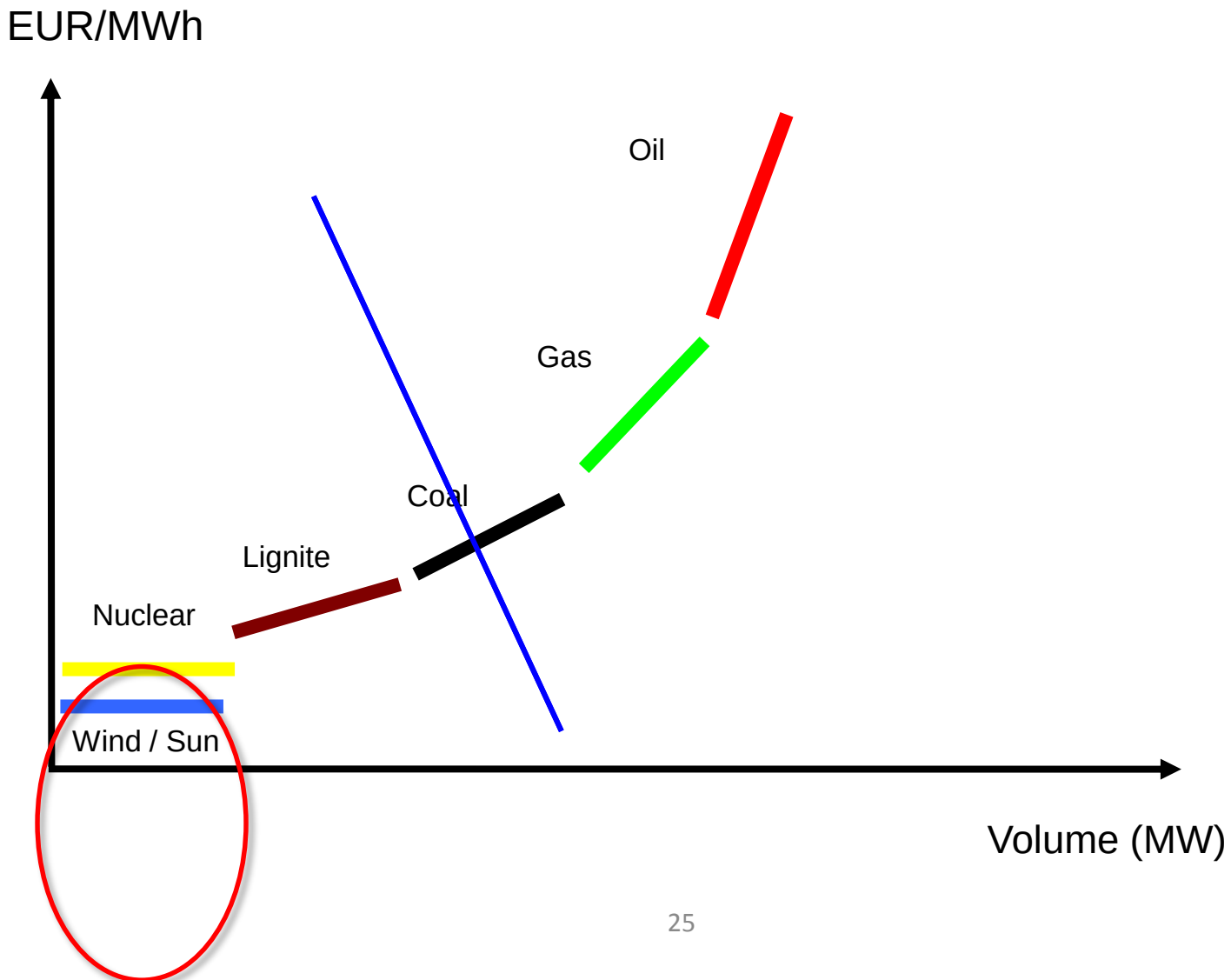
- Generation mix of each country

What lies behind the Supply curve ?

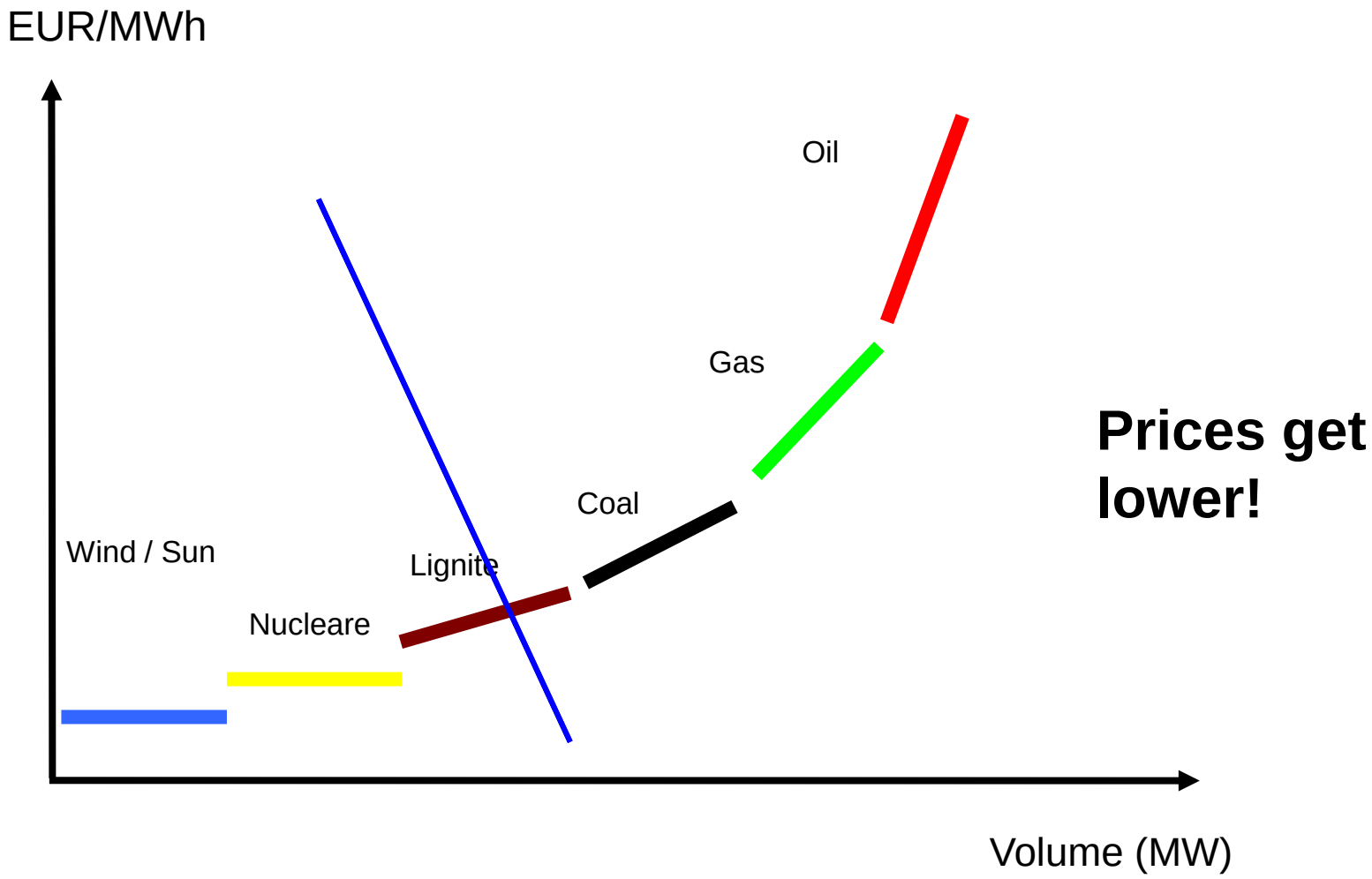


<u>Variable costs</u> of production technology: The ‘’merit order”

Impact on short-term prices of renewable generation (wind, solar…)



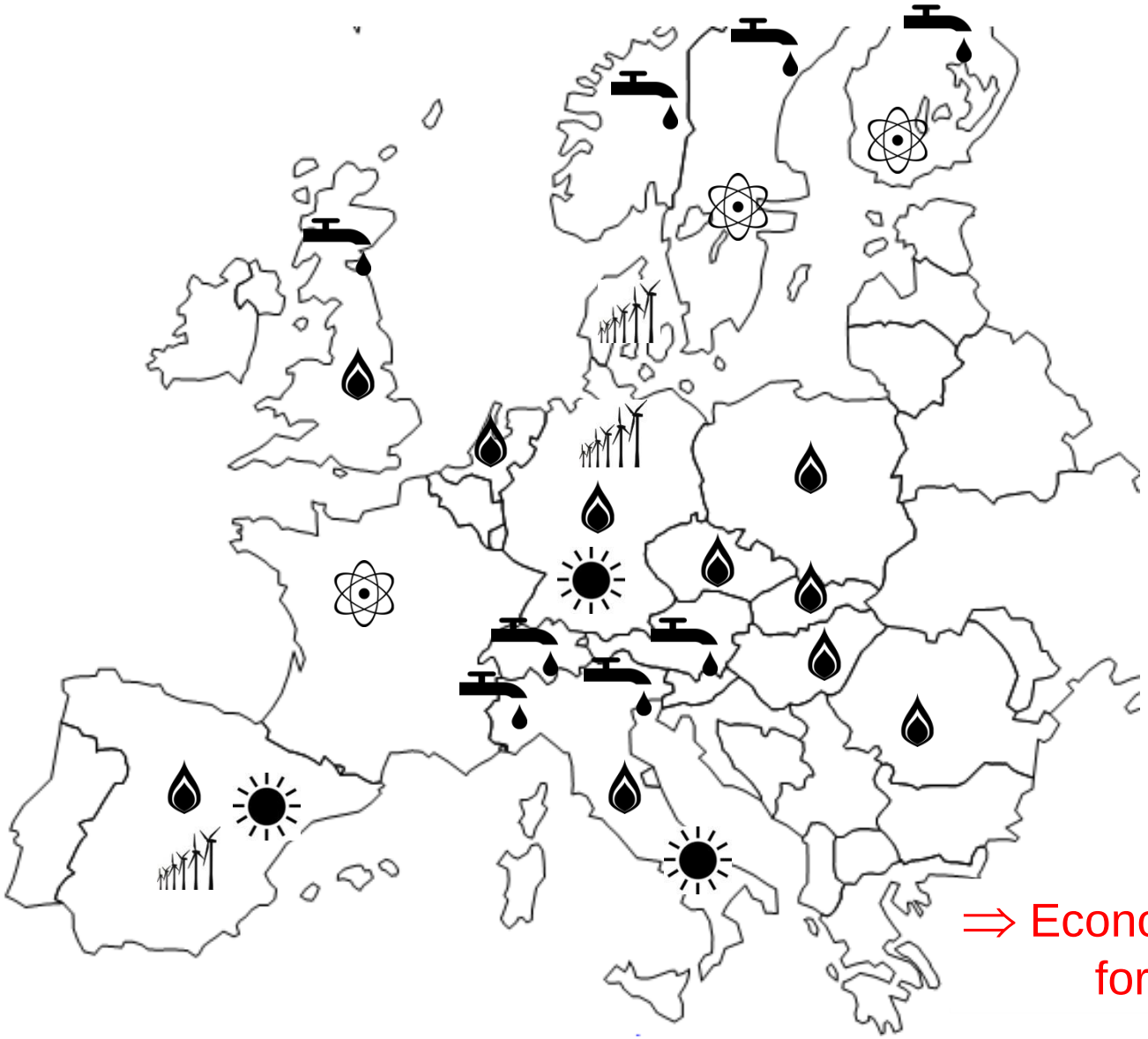
Impact on short-term prices of variable generation (wind, solar…)



Electricity prices in Europe

- The Demand and Supply curves of each country are different and change overtime
- Different prices and spreads between countries can be observed from hour to hour !

Production in Europe



hydro

thermique

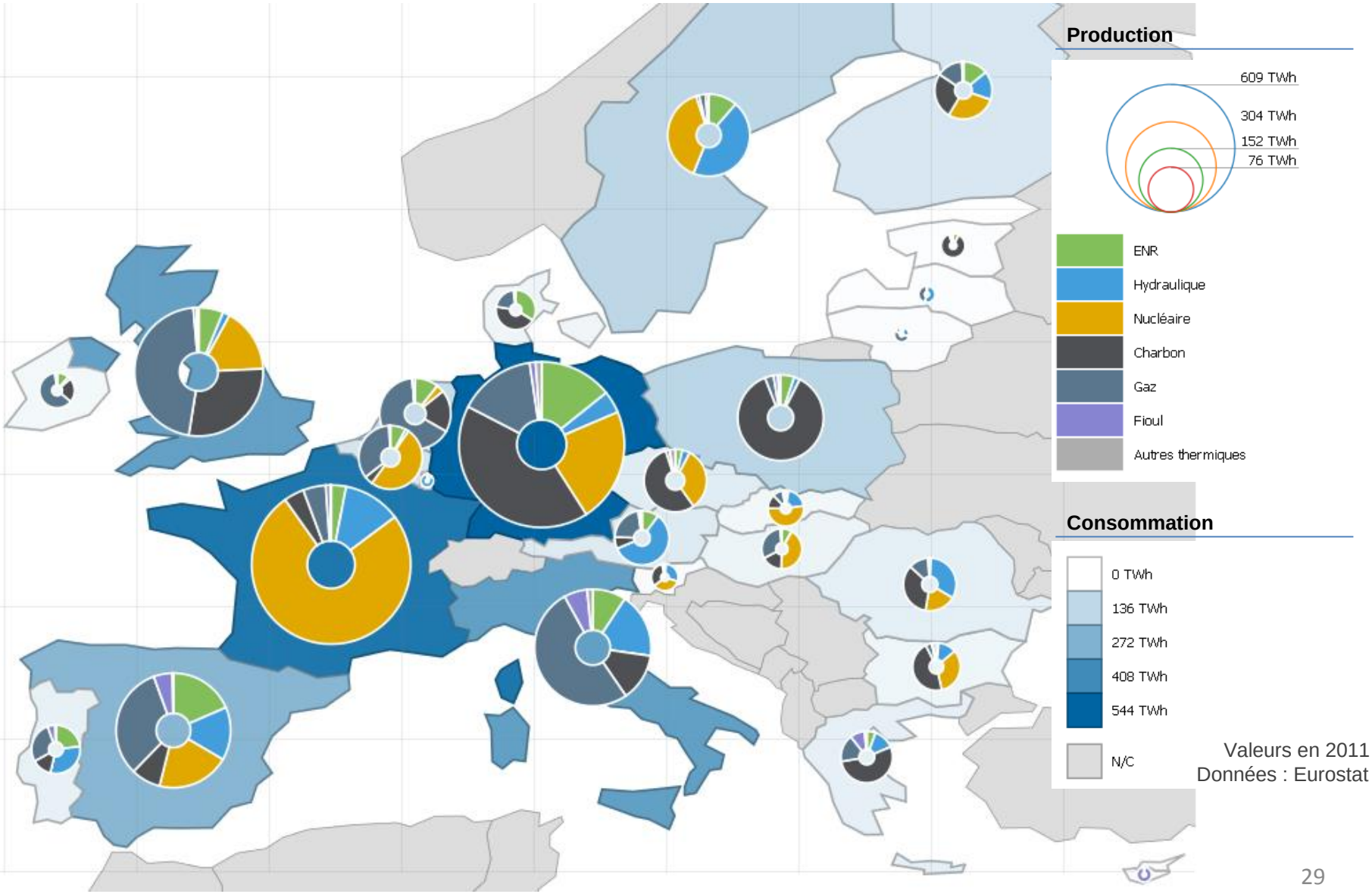
nucléaire

éolien

solaire

⇒ Economic interest for trade

Production and load in Europe



Valeurs en 2011
Données : Eurostat

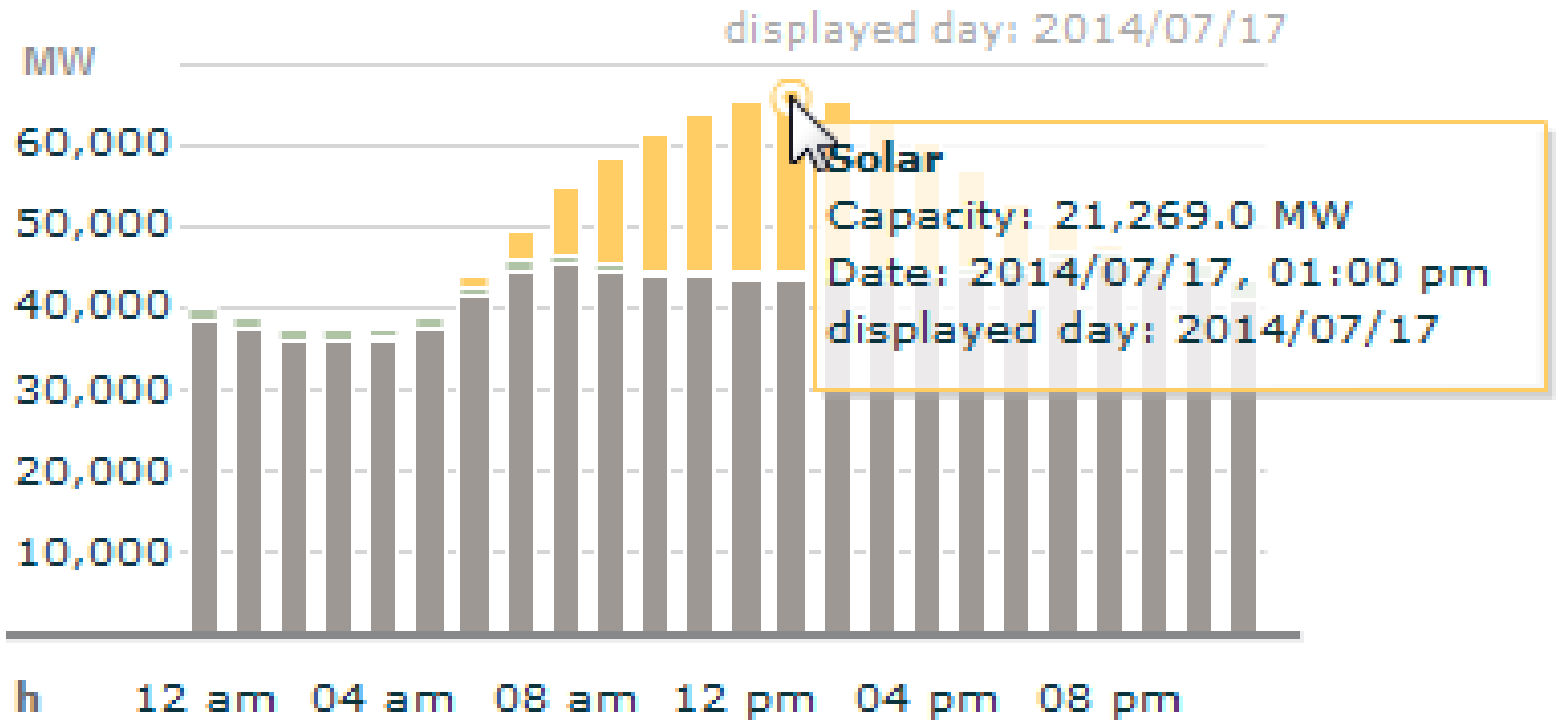
The energy transition in Europe: increasing need for trades

Energiewende … *Energy Tran*sition …
…*Transition énergétique* … Transizione energetica…

- 20-20-20 targets
  - Renewables
  - Energy efficiency
  - Reduction of CO2 emissions

- Germany
  - 36,5 GW of photovoltaic capacity
  - Photovoltaic increase of ~7 GW per year on the last 3 years !!

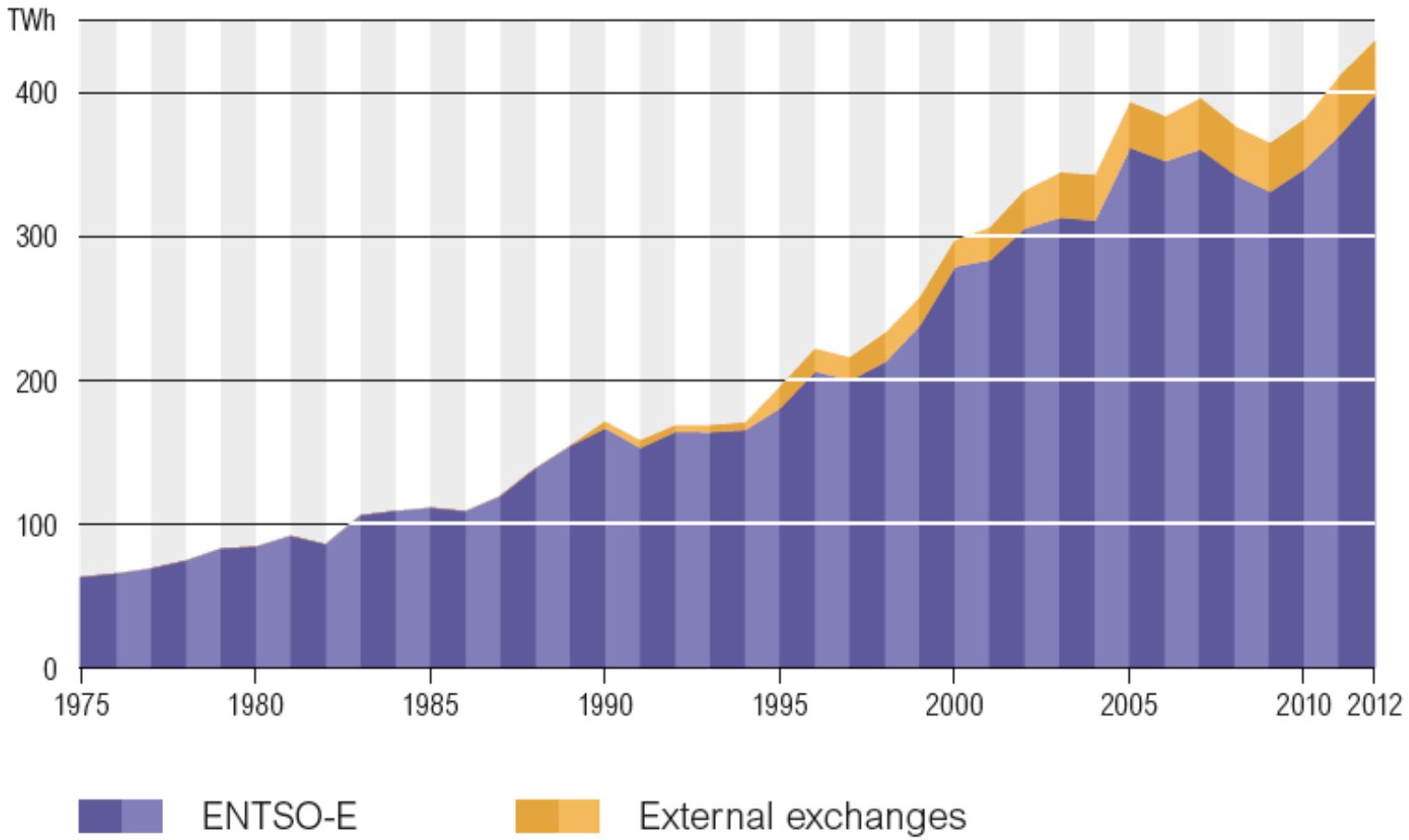
Solar power generation in Germany



www.transparency.eex.com

Cross-border exchanges in Europe

Development of overall cross-border exchanges of ENTSO-E member TSOs' countries since 1975



Conclusion

1. National markets are a necessary first step to have reference prices in each country
2. Different generation and demand conditions give raise to different wholesale national electricity prices
3. There is an economic interest to optimize electricity trades at European level
4. …but Capacity is a scarce resource!

- Need of introducing market mechanisms to allocate (=sell) capacity, which are:
  - **Flexible**
  - **Efficient**
  - **Secure**

PLAN

1. An introduction to national power markets

2. Interconnections: the cross-border capacity allocation

European Regulation

Network Codes

- Capacity Allocation and Congestion Management (CACM) Network Code
- Forward Capacity Allocation (FCA) Network Code

Role of TSOs : drafting Network Codes.

See ENTSO-E website

The Capacity Allocation, main principles

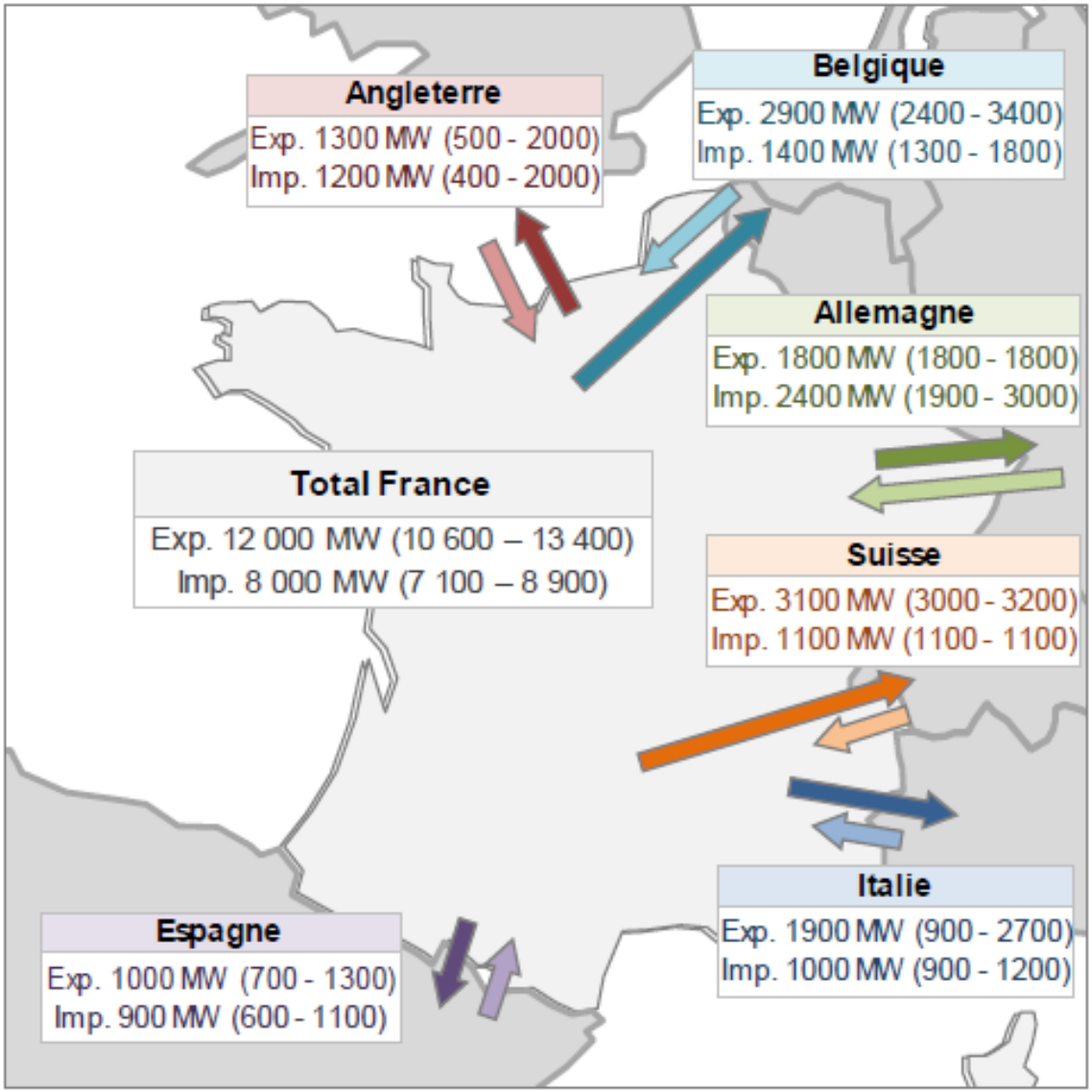
- **Each country is a "bidding area"** and has its own electricity prices (exception: Scandinavian countries and Italy)

- A simplification : Countries are linked by "pipelines" of **limited capacity**

- **Limited capacities between zones are allocated** (=sold) via market mechanisms **by TSOs** (in collaboration with power exchanges) at different timeframes

Cross border capacities of France

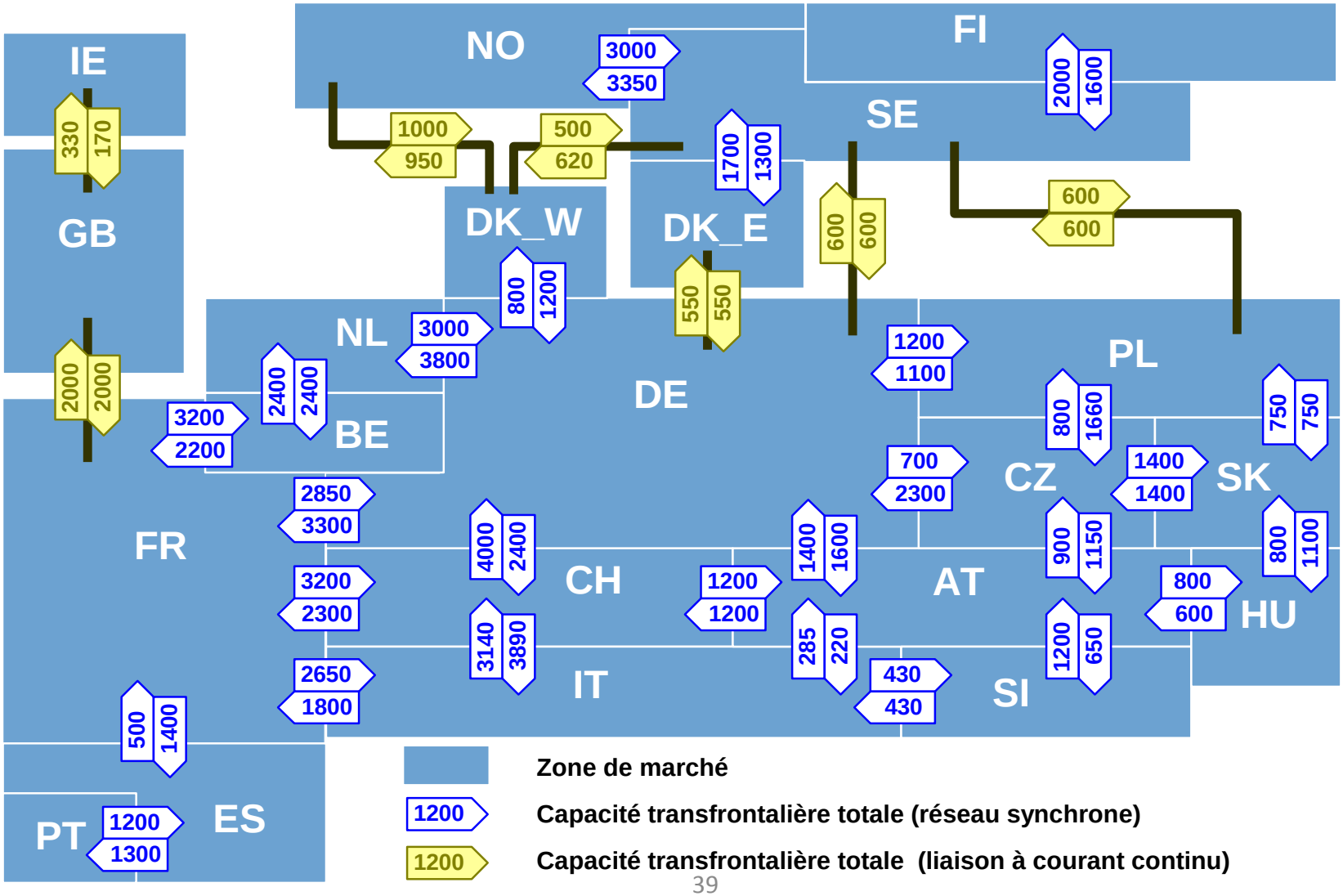
Graphique 8: Capacité des interconnexions en 2012, NTC[4] moyenne calculée en J2

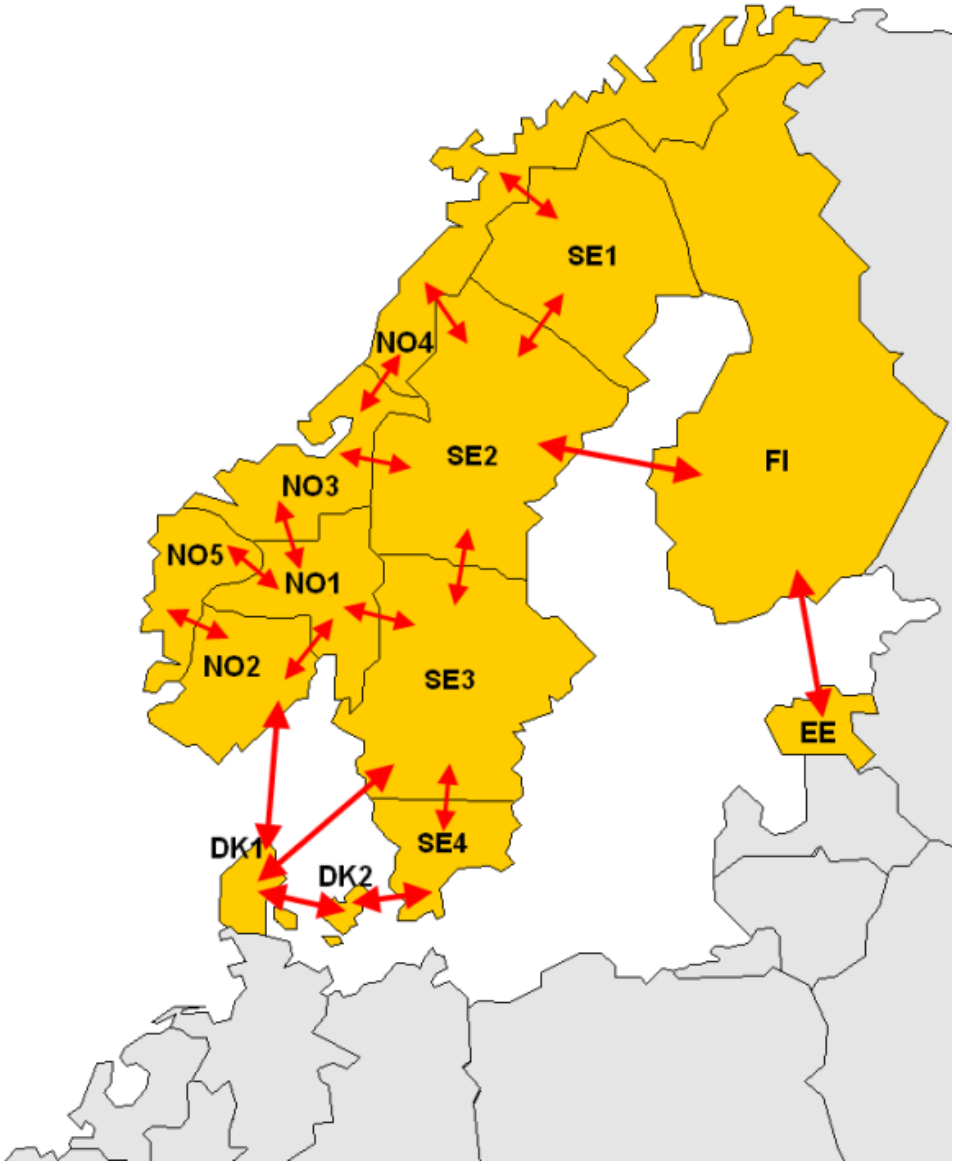


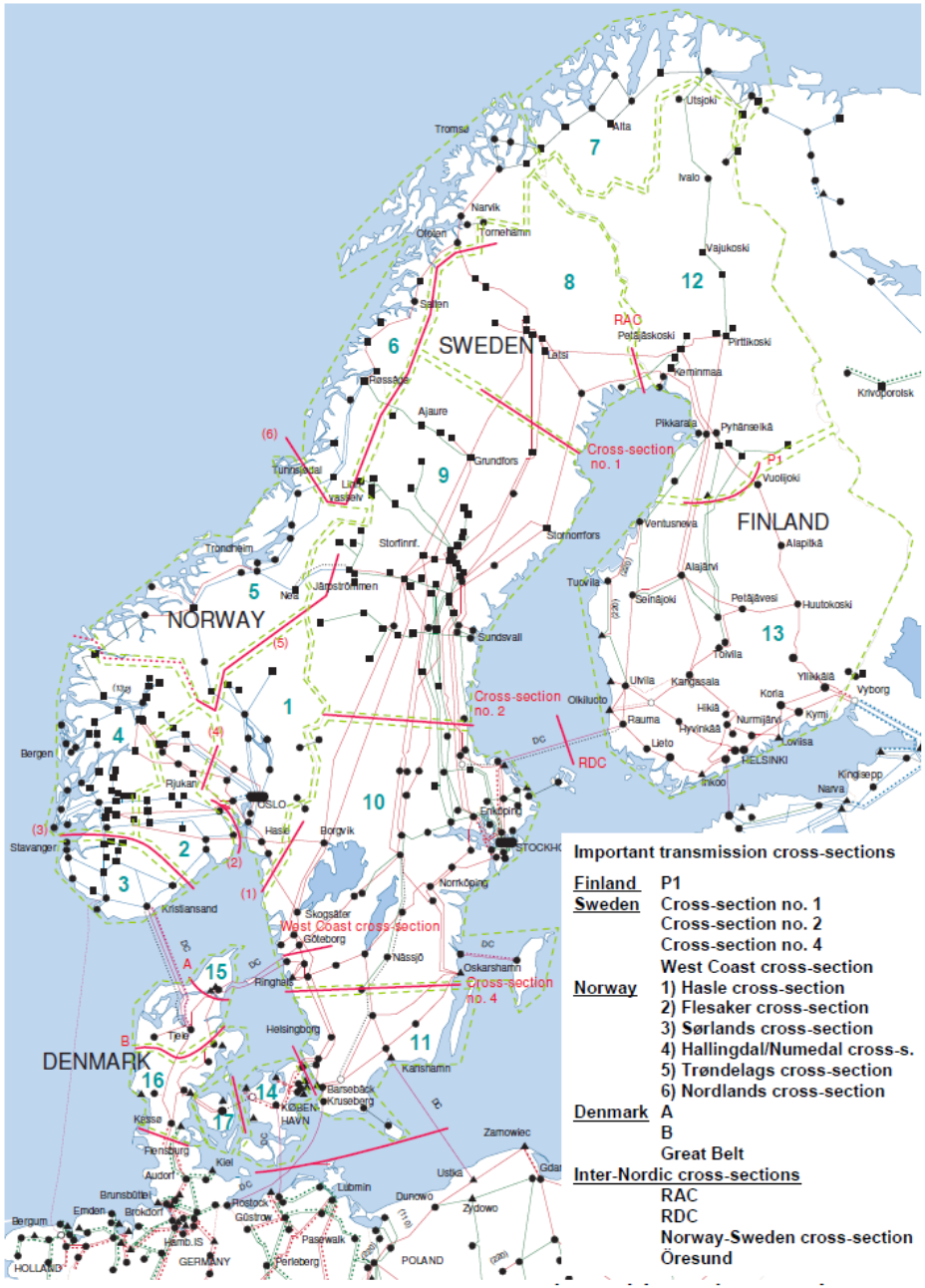
Source : RTE – Analyse : CRE

Note : Les valeurs entre parenthèses représentent respectivement les 1er et 9ème déciles.

Trade capacities in Europe (MW)

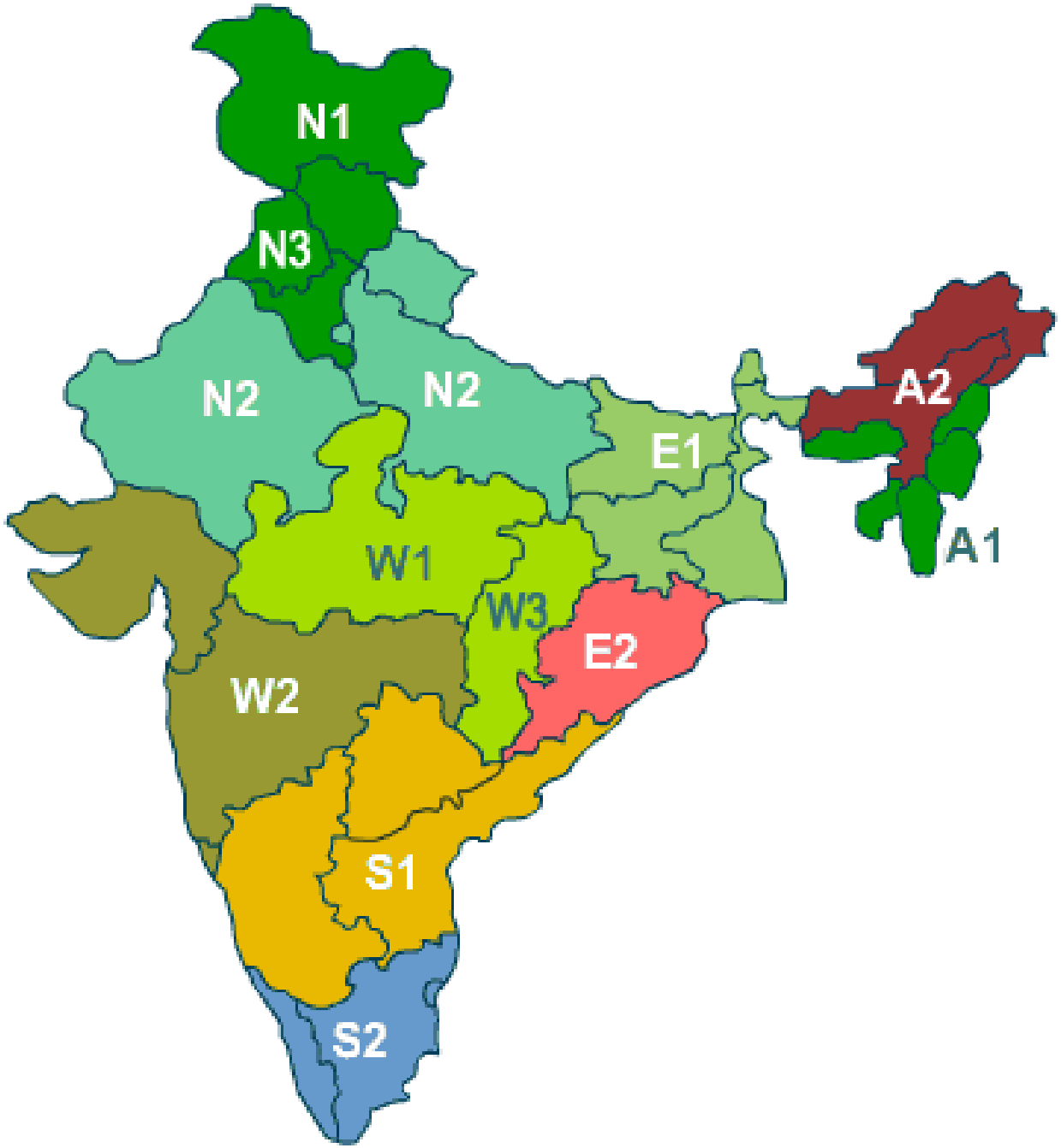






NORDPOOL : Countries splitted in several zones

Bidding zones in Italy


N1
N3
N2
N2
A2
E1
A1
W1
W3
E2
W2
S1
S2

Timeframes for Capacity Allocation

- Transmission Rights roughly cover **the same timeframes as energy products**

- Long term products → price risk
  - Year (Y+1), Month
  - Base (24h/24h) / peak (8am to 8pm)
- Short term products → volume risk
  - **Day-ahead : base, peak and hourly**
  - **Intraday**

The capacity allocation

- Main allocation mechanisms:
  1. Explicit allocation (explicit auctions) – Long Term
  2. Implicit allocation (implicit auctions, market coupling) – Day-ahead
  3. (Continuous allocation - Intraday)

The capacity allocation

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Long term allocation → Explicit Auctions of PTRs

- **Physical Transmission Rights (PTRs) with Use It or Sell It (UIOSI) provision**

- They give the right to import or export electricity over an interconnection *(Use It)* or receive positive market spread *(Sell It)*

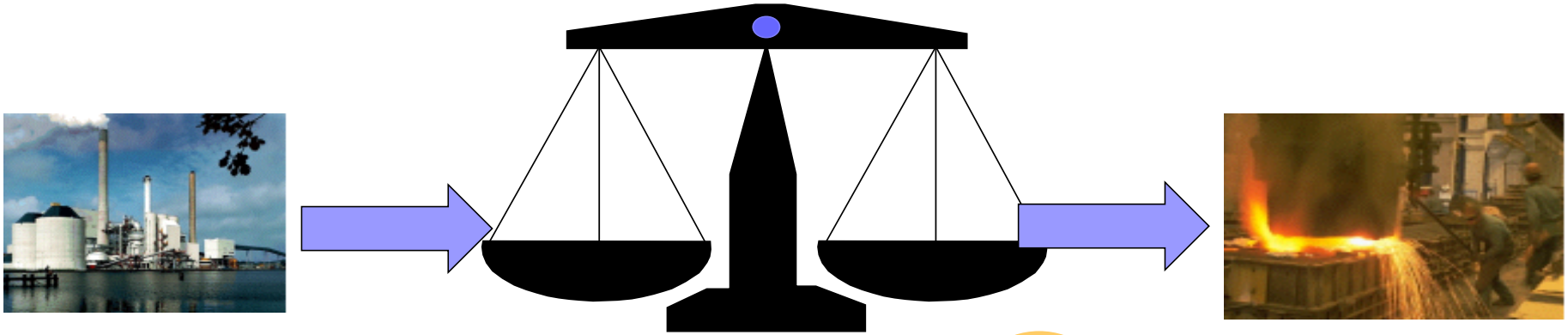
- Sold by TSOs, through a central allocation platform (CASC.EU, CAO)

- Sealed auction, single round

- Settlement at the Marginal price
  - price of the last accepted bid

- Products offered
  - yearly, (seasonal, quarterly), monthly, base, peak / off peak

Balance Responsible Party for imports



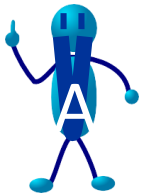
+	-
• Imports	• Consumption • Sales • Exports

Explicit auctions

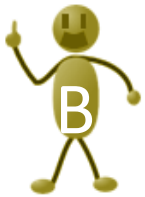
1. Capacity calculation and publication by TSOs (yearly, monthly)
2. Submission of bids from market parties
3. Auction results
   - Marginal price
4. Settlement

Exemple of explicit auction

1. Available capacity : 150 MW
2. Market parties bids:



- 100 MW
- 18 €/MWh

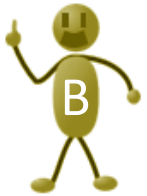


- 175 MW
- 17 €/MWh

- 125 MW
- 15 €/MWh

Exemple of explicit auction

- 100 MW h
- 18 €/MWh



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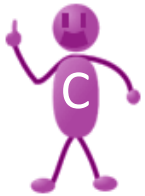
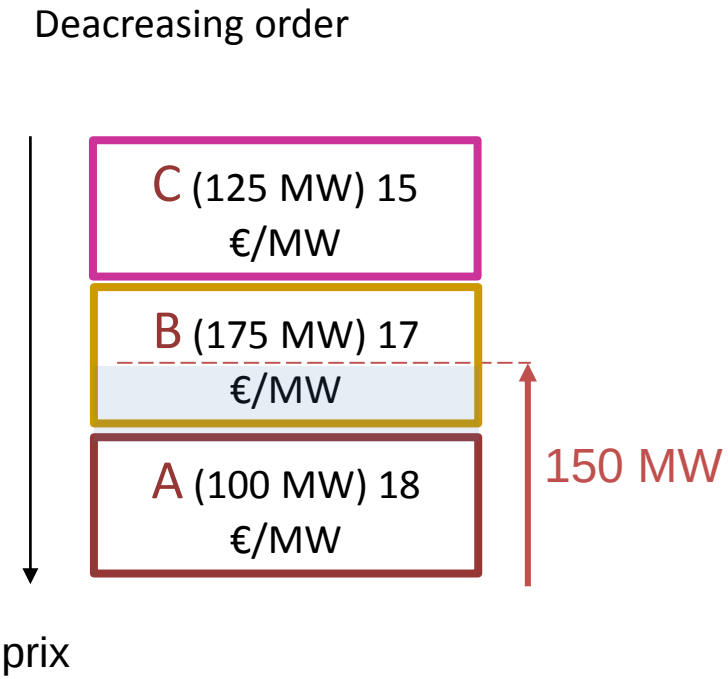
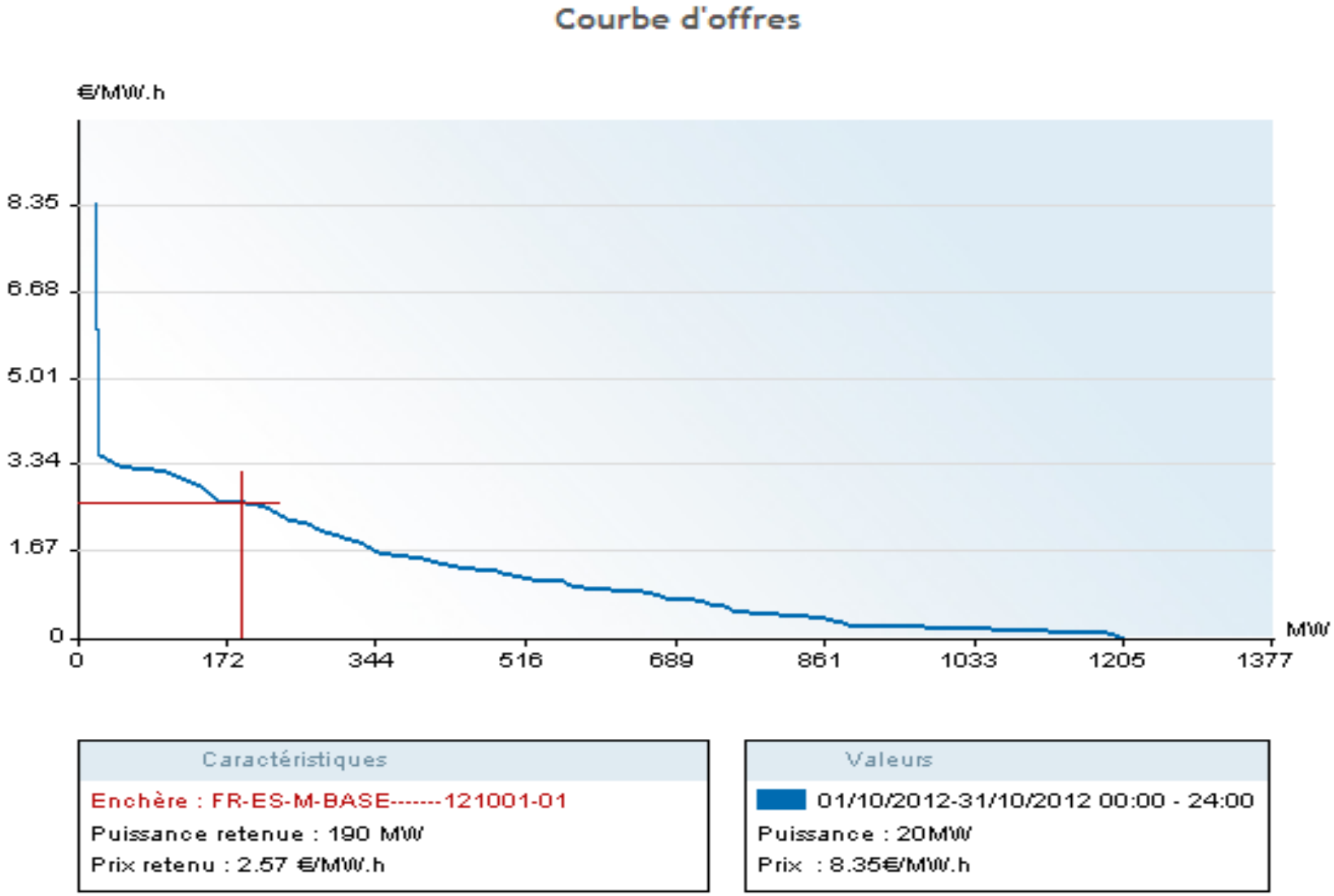


- 125 MW h
- 15 €/MWh

1. Sorting bids
2. Offered capacity = 150 MW
3. Marginal price = 17 €/MW
4. Settlement
   - A : Accepted
   - B : Partially accepted(50 MW)
   - C : Refused



France-Spain capacity, monthly product october 2012



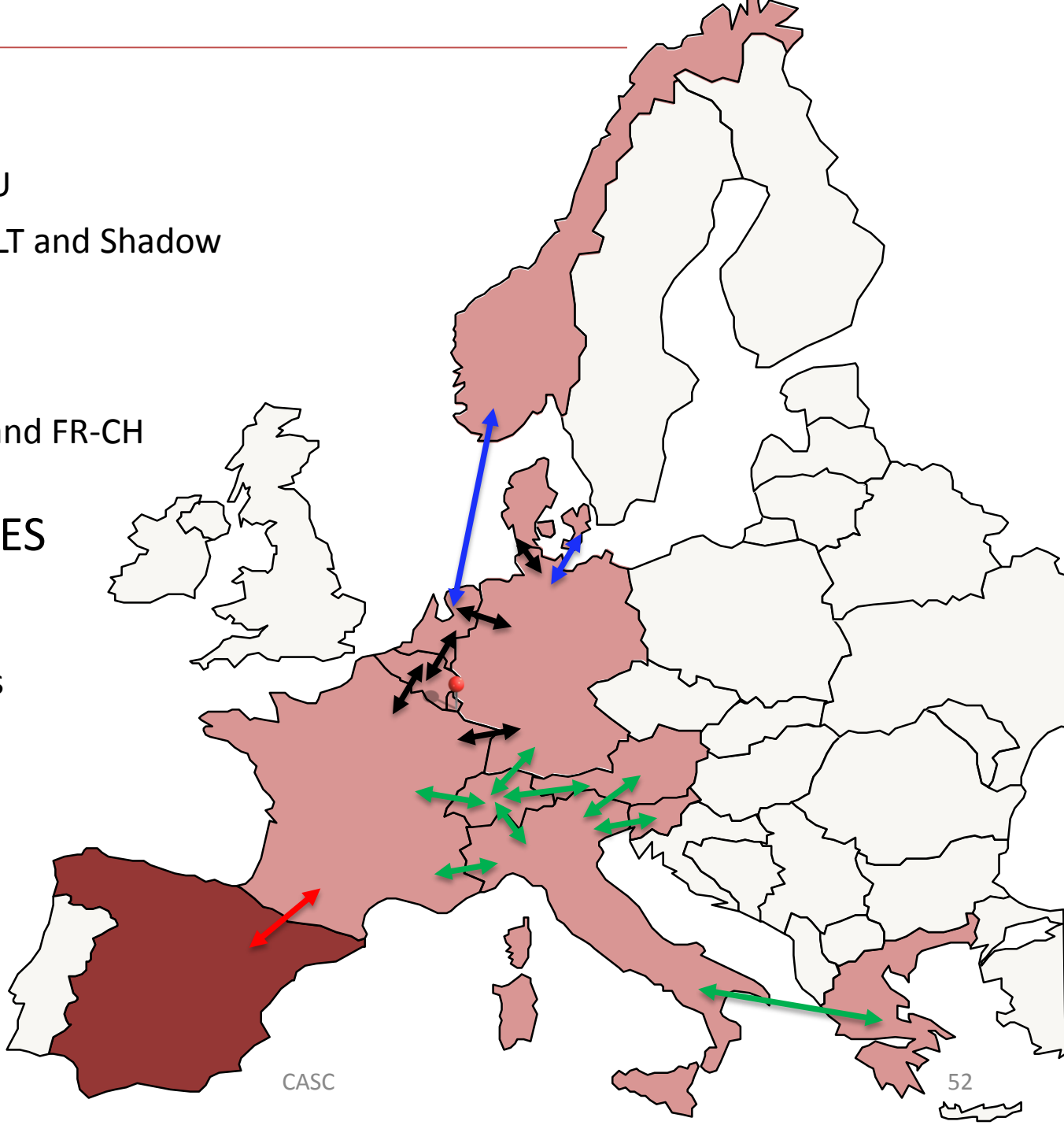
CASC.EU

Working Area CASC.EU

- CWE and DE-DK1 LT and Shadow Auctions
- ITVC Shadow Auctions
- CSE, Swiss North and FR-CH border

NEW border FR-ES April 2014

- FR- ES LT Auctions



EXPLICIT

CASC.EU for the explicit allocation of PTRs

Capacity Allocation Service Company (http://www.casc.eu/en)

- Created in October 2008 by the CWE TSOs.
  - –Since November 10th, 2010, twelve (12) shareholders: **Tennet B.V and GmbH, ELIA, RTE, TERNA, IPTO, ELES, APG, Swissgrid TransnetBW, AMPRION and CREOS**
  - –October 2013: **Energinet.dk** and **Statnett** become CASC.EU Shareholders

- Its main objective is to manage the allocation of capacities on borders on behalf on TSOs
  - –**Single point of contact** for Market Participants
  - –**Unique set of Rules** for Explicit Allocations on all borders
  - –**Harmonized format of exchanges** (ETSO standard – ECAN)

Rte International

EXPLICIT

Another allocation platform:

CAO, Central Allocation Office

(http://www.central-ao.com)

Countries covered: Germany, Poland, Czech Republic, Slovakia, Austria, Slovenia, Hungaria

cao
Central Allocation Office GmbH

	CASC	CAO
Legal form	Public Limited Liability Company (S.A.)	Private Limited Liability Company (GmbH)
Registered Office	Luxembourg-Hamm	Freising, Germany
Share/nominal Capital	3,990,000 EUR	100,000 EUR
Shareholders	14 (equal shares: 7.14 %)	8 (equal shares: 12.5 %)
Governance	1 Tier	2 Tier
Management	BoD	MD
BoD	BoD approves CEO transactions (Unanimity)	N/A
Daily Management	1 CEO, appointed by BoD	1 MD, appointed by GA
Representation	2 Board Members or CEO	MD
Supervision	N/A	SB approves certain MD transactions
General Assembly	Unanimity	Unanimity or 75%
FTEs	14	14 (incl. Capacity Calculatio

EXPLICIT

- ACER Framework Guidelines and resulting Network Codes stipulate that **TSOs should provide a single platform** (single point of contact) for the allocation of long-term transmission capacity at EU level
- A merger of CAO and CASC would therefore be a logical first step towards a European single platform

- On 26 June 2013 we – 17 TSOs – signed a MoU with the intention to merge CAO and CASC
  - Energinet and Statnett joined the MoU recently
- A project was set up to elaborate how to merge the functions currently existing in CASC and CAO
  - The Capacity Calculation – a peculiarity of CAO – should be given a new home (preferably within TSC) which is condition precedent
- The resulting Joint Auction Office (JAO) should
  - **pave the way to a possible European single auction platform**
  - **be open to new shareholders and non-shareholding customers**
  - **continue to offer its services at cost-reflective modest prices**
  - **improve the overall efficiency in the long-run**
- The design of JAO should be agreed until end of June
- The implementation JAO should be in place by the end of 2014

The capacity allocation

- Main allocation mechanisms:
  1. Explicit allocation (explicit auctions) – Long Term
  2. **Implicit allocation (implicit auctions, market coupling) – Day-ahead**
  3. (Continuous allocation - Intraday)

Implicit auctions / Market coupling

- Used **only for day-ahead**, on some borders (UK, Spain, Germany, Belgium)
- More efficient, as **market parties only bids on the national Power Exchanges**
- The optimal trades and prices are found through a simple algorithm (same as market splitting) whose inputs are:
  1. Available capacities between bidding areas (countries)
  2. Market parties bids in each bidding area (country)

IMPLICIT

Market coupling principles

–Implicit allocation of Capacity simultaneously with energy allocation aiming at optimizing the use of cross border capacities in line with the Markets results.

–Simultaneous interconnection capacity allocation and the associated energy:

- More liquidity on the power exchanges
- Best price convergence between countries
- Less price volatility

–Best capacity utilization

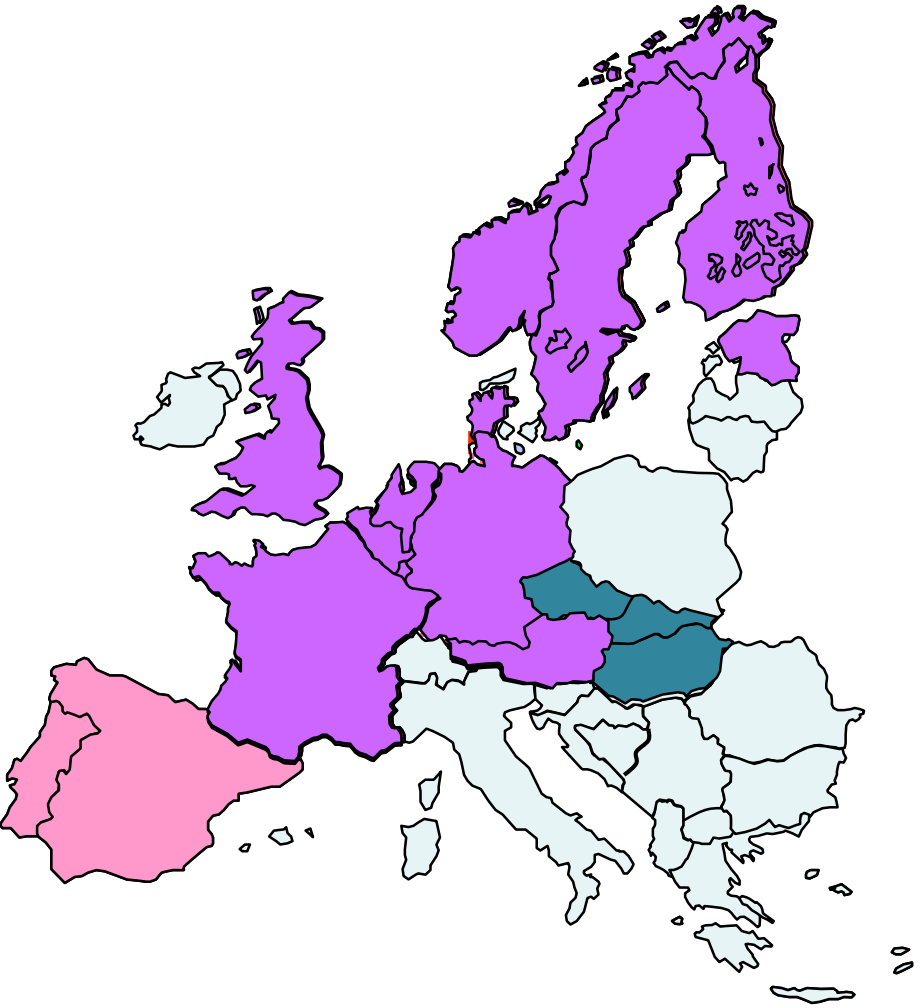
- Remove adverse flows (flow from the most expensive to cheapest countries)
- Simplify the allocation process and capacity utilization

Impact of trade on prices

1. Prices in importing country gets lower
2. Prices in exporting country gets higher
3. …if enough capacity is available, prices reach an equilibrium, otherwise prices are different

4. The global Social welfare of the two countries is maximised

The European market coupling until february 2014



(1) Nordic Coupling (splitting) - 1993

(2) Trilateral coupling France, Belgium, Netherlands - 2006

(3) Iberic coupling, Spain and Portugal - 2007

(4) Partial coupling between Germany and nordic countries – 2009

(5) Coupling CWE – Nordic - 2010

Estonia - Finland via Estlink

(6) Coupling Hungary – Czech Republic - Slovak- 2012

(7) Nord-West Europe Coupling – begin 2014

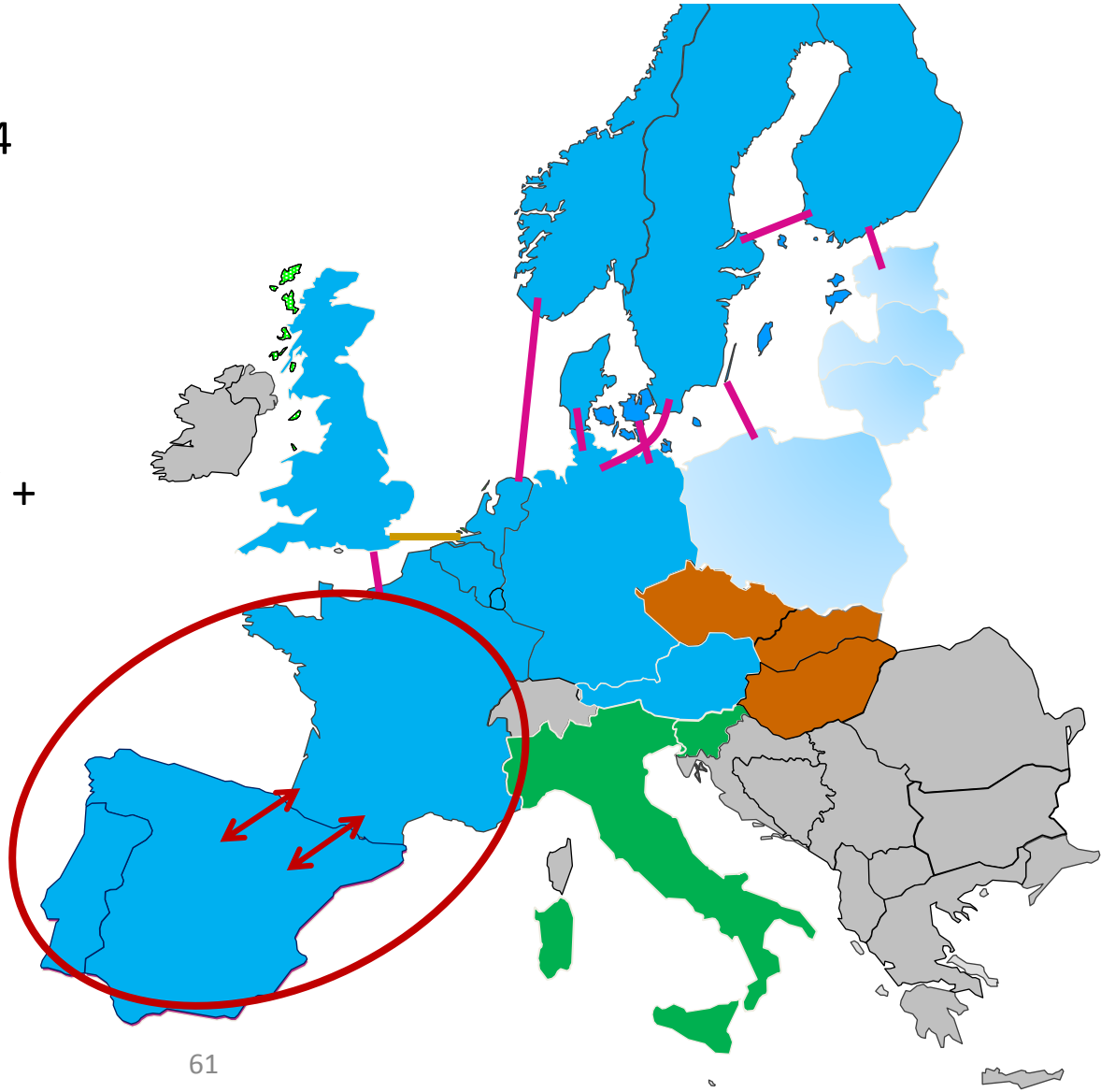
Current status of market coupling in Europe + Next extensions

Project NWE + SWE : may 2014

Mibel/OMIE

Italie-Slovénie

Czech – Slovak / + Hongrie

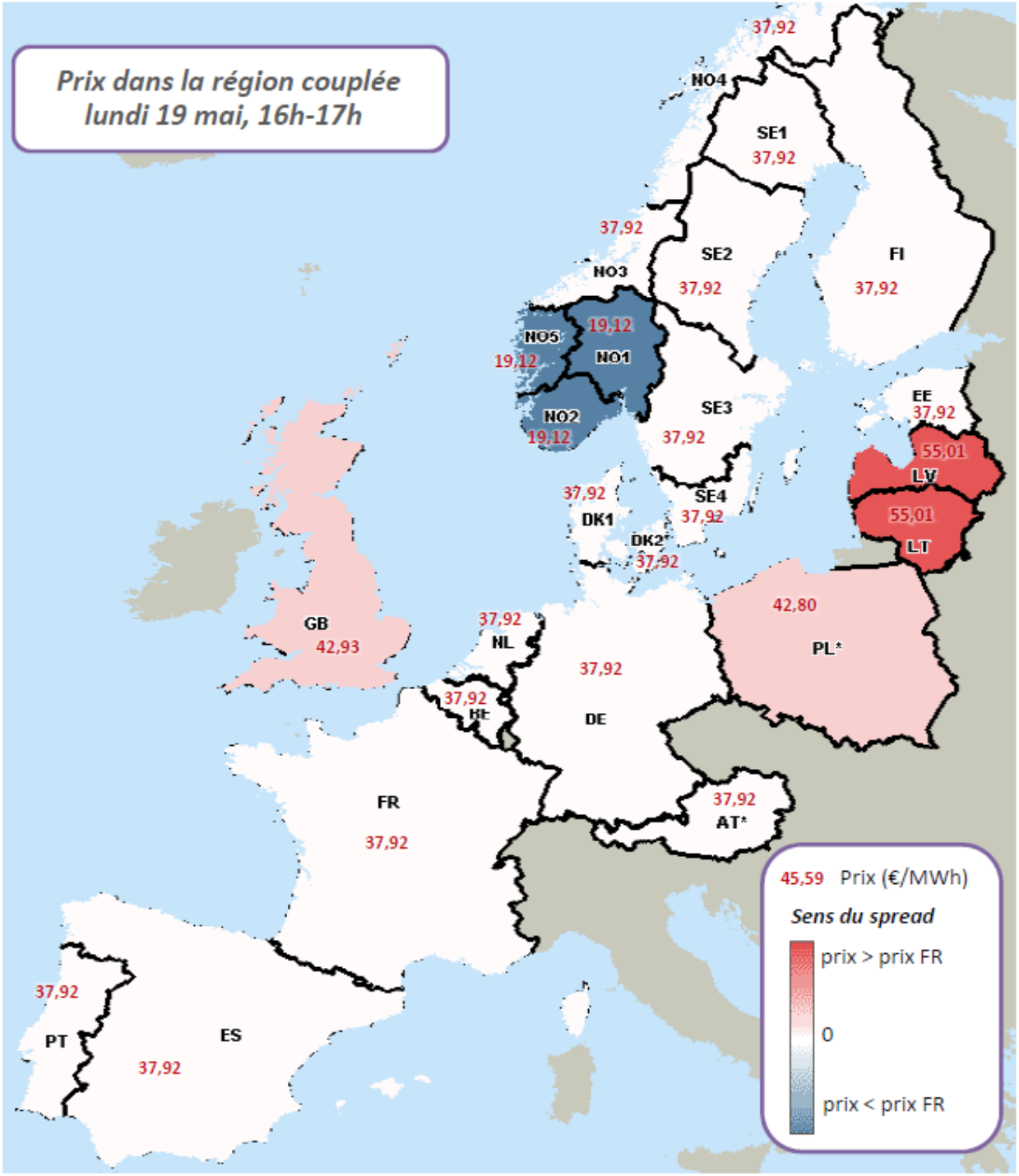


Project SWE = Portugal, Spain, France

Projects NWE+SWE = 2500 TWh/an (75% conso ENTSO-E)

Exemple of price convergence in Europe

19th May 2014



The role of Power Exchanges

- The PCR (Price Coupling of Regions) initiative
- To ensure coordination among National Power Exchange
- Implementation and (shifts) operation of a common algorithm for day-ahead markets

Price Coupling of Regions (PCR), a PX project

•PCR project is an initiative of seven PX: **APX, Belpex, EPEX Spot, GME, Nord Pool Spot, OMIE** and **OTE** covering the electricity markets in Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Italy, Latvia, Lithuania, Luxemburg, the Netherlands, Norway, Poland, Portugal, Spain, Slovenia, Sweden and the UK

PCR Organization

- All **PXs are connected to each other** through MPLS using secure channels.
- Each **PXs is connected to the related TSOs** for receiving capacity information and sending the required information (nominations, clearing info,…) as today.
- This is responsibility of **each particular/regional PX**
- A data sharing solution is created based on the implementation at each PX of a **PMB** (PCR Matcher Broker) which is responsible of interfacing the PX systems with the rest of the PXs.
- Together, all the PXs' PCR PMBs form the **PCR Cloud.**
- Each PMB is in continuous connection to the other PMBs, access to the internal PX market information, validates it, and publishes it to the PCR Cloud.
- The PCR ensures that each PX runs the **same common algorithm (Euphemia)** with the same data and the same configuration parameters.
- PCR results are provided by the **Coordinator** PX. Operator PXs may verify results through a shadow matching for internal and validation purposes.
- **Hot Backup Coordinator** takes over the operations in case of failure of the Coordinator.

Market coupling: Role of TSOs

Implementation role

- **Defining market design and rules** with regulators, PXs and other stakeholders
- **Promoting market coupling extensions and evolutions** (e.g. FLOW BASED)

Operational role

- **Daily calculation and submission of cross-zonal capacities** to power exchanges (PXs)
- Daily **validation of results** (compatibility between results and capacities)
- **Matching and scheduling** of final cross-border exchanges
- Receive congestion rent
- Monitoring of Balance Responsible perimeters

Gain of Social welfare

- Assuming no congestions, 50-200 M€ of social welfare gain each year on the CWE area (France, Belgium, Netherlands, Germany) thanks to market coupling

- Social welfare monthly report :
- http://www.epexspot.com/fr/couplage/documentation_cwe

Conclusions on Capacity Allocation

Two main capacity allocation mechanisms:

- **Explicit auctions** (long term rights)
- **Implicit auctions/market coupling** (day-ahead allocation)

These mechanisms ensure:

- **Flexibility**: well functioning markets allow to cope with variability of load and generation (renewables) *day by day, hour by hour*
- **Efficiency**: the cheapest resource are used first, as long as there are no congestions - Scarce interconnection capacities are correctly priced
- **Security**: market parties are balance responsible parties

- Developing market mechanisms takes time !

Thank you for your attention !

Galileo BARBIERI – RTE

galileo.barbieri@rte-france.com

ANNEXES

Neighbouring TSO Coordination: data exchange, capacity calculation, grid monitoring

- For each calculation timeframe, TSOs exchange some data on the part of their main assets influencing their respective neighbours (**topology, consumption, generation pattern**…)

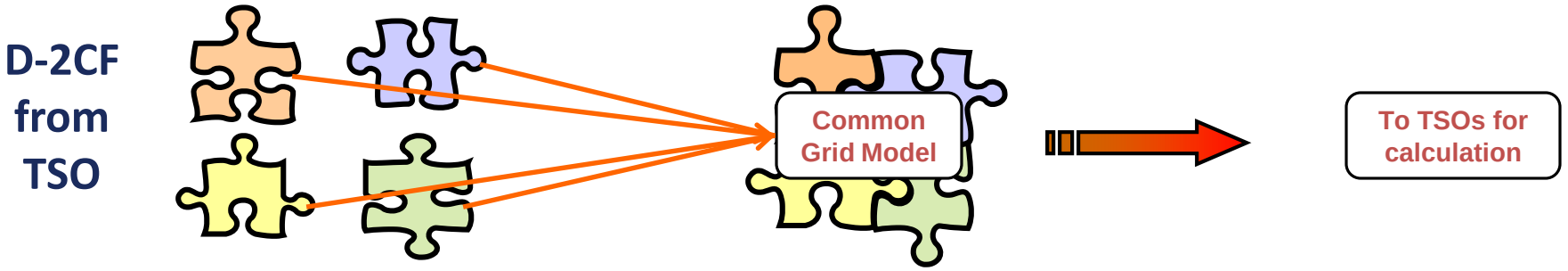
- This exchange enables to increase the coherency between the hypothesis taken into the calculations made on both side of the border

- However, a even higher level of coordination is already in place in Central Western Europe region (France, Germany, Belgium, the Netherlands) for Day Ahead capacity calculation with the activity performed by **Coreso**.

Actions performed by coreso

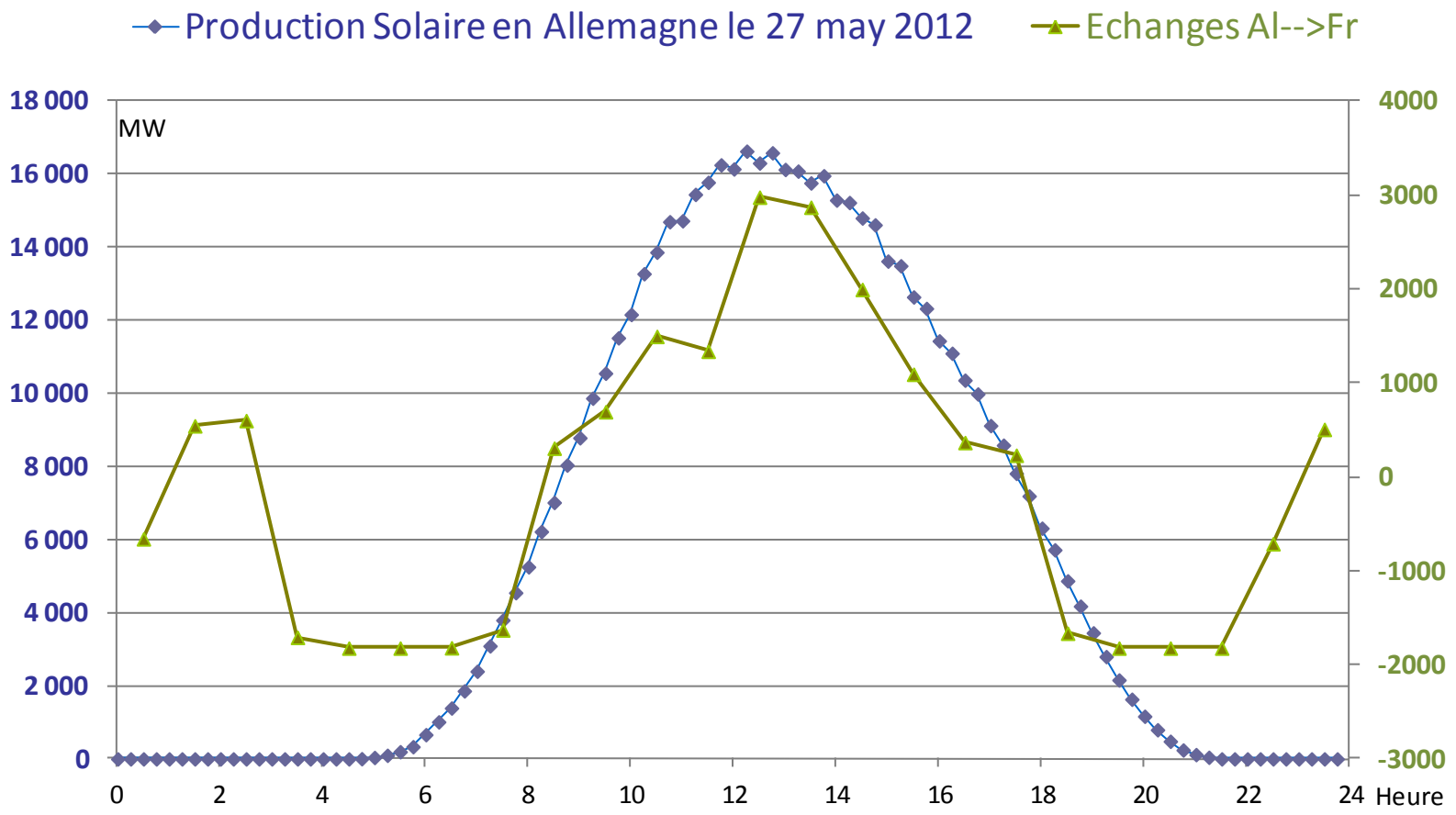
(COoRdination of Electricity System Operators)

- Entity created on the 19th of December 2008 by RTE and ELIA in order to improve the management of congestions. National Grid (UK) joined Coreso in March 2009. Terna and 50Hertz joined Coreso in November 2010.
- Activity performed for capacity calculation **: <u>Creation of a common grid model / common base case for Central West Europe (CWE) for capacity calculation</u>**



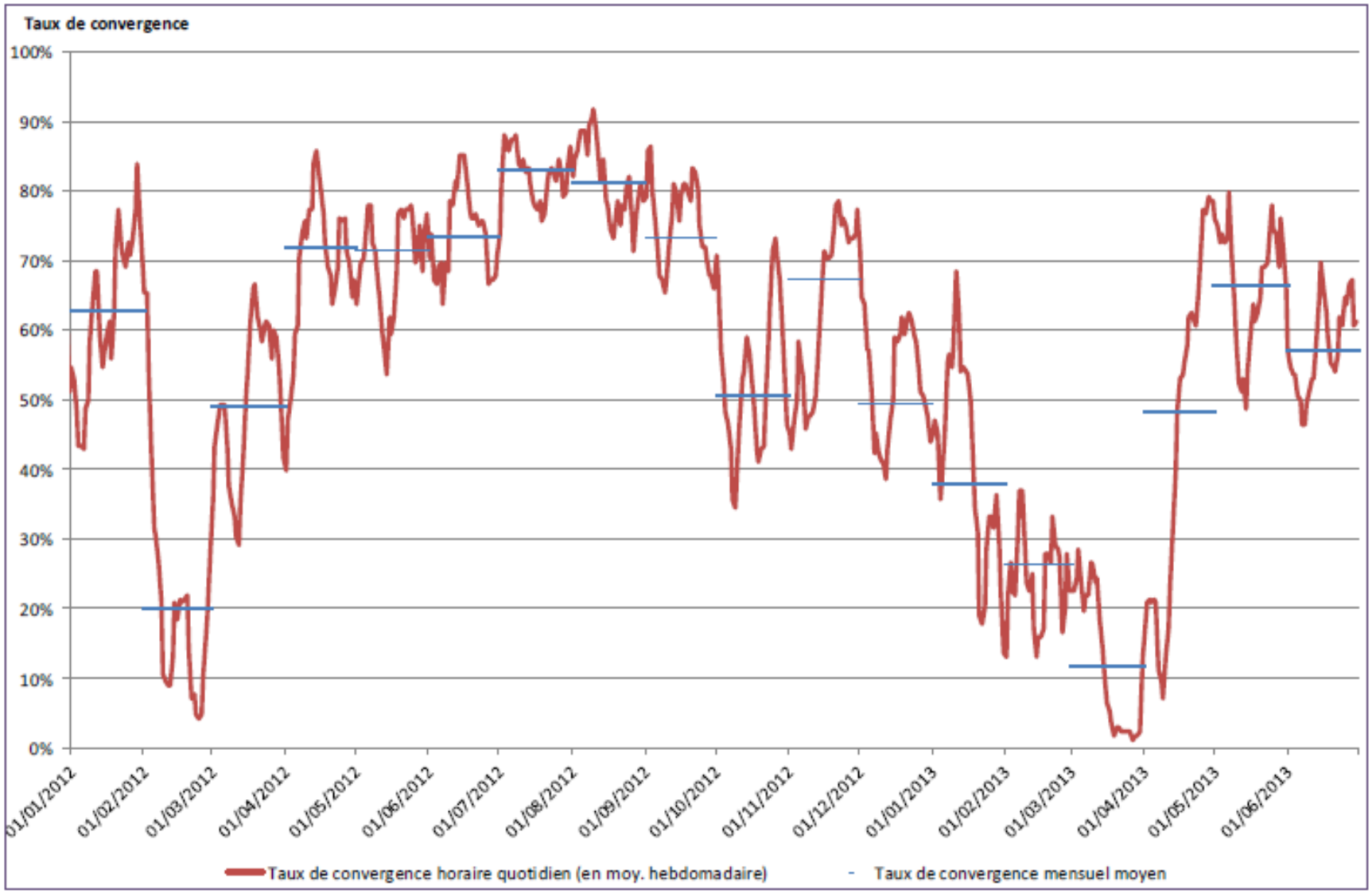
- **Additional activities in real time (24h/24 and 7days/7)**
  - **Real time follow up of contraints on the network and provide some recommendations for congestion management to France and Belgium**
  - **Provide some recommendations to the United Kingdom regarding the congestion management linked to the DC Cable.**

Exemple: solar production and trades between France and Germany



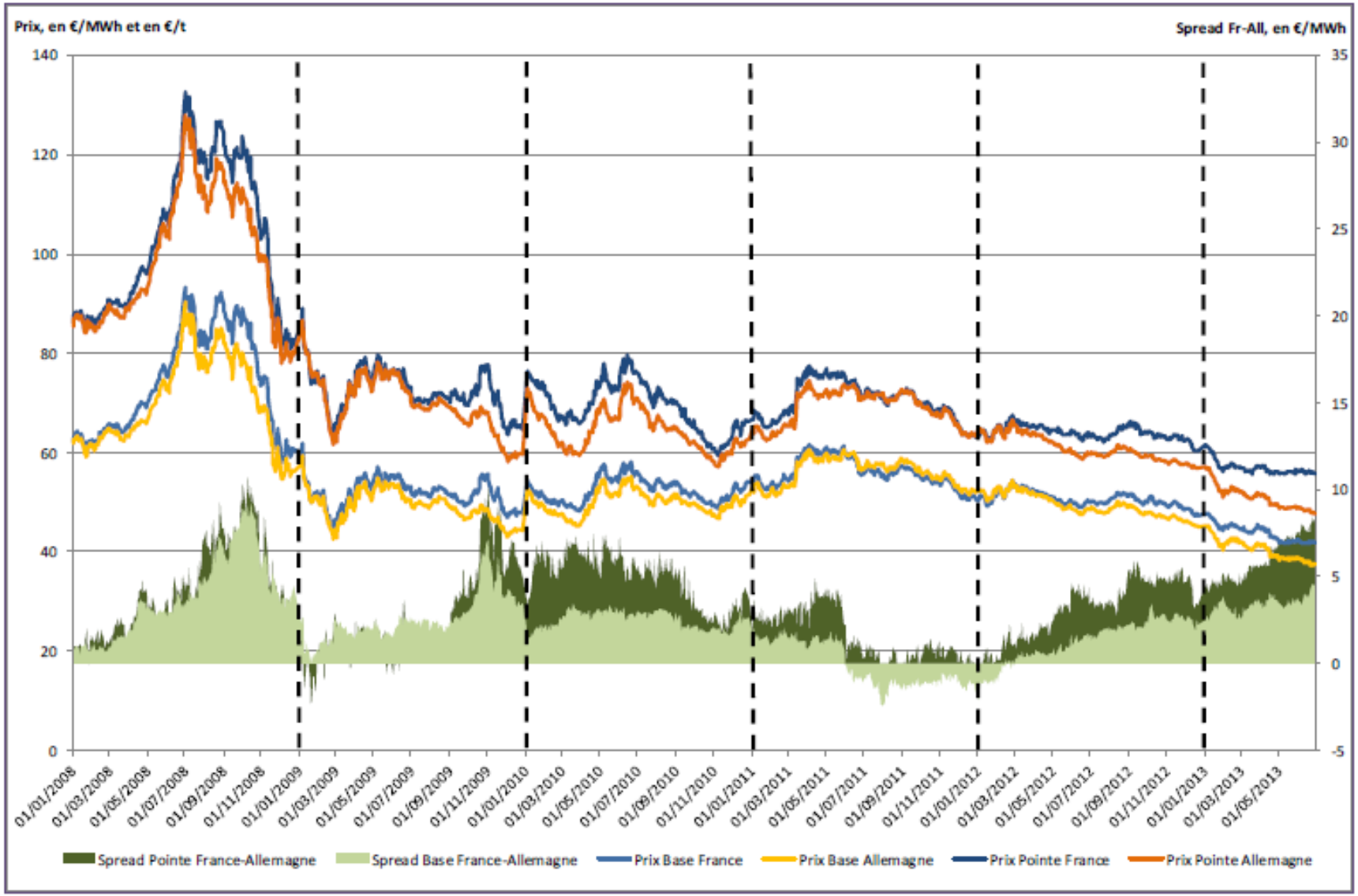
Day- head Price convergence between France and Germany

Graphique 21 : Taux de convergence journalier des prix horaires France-Allemagne



Y+1 electricity prices

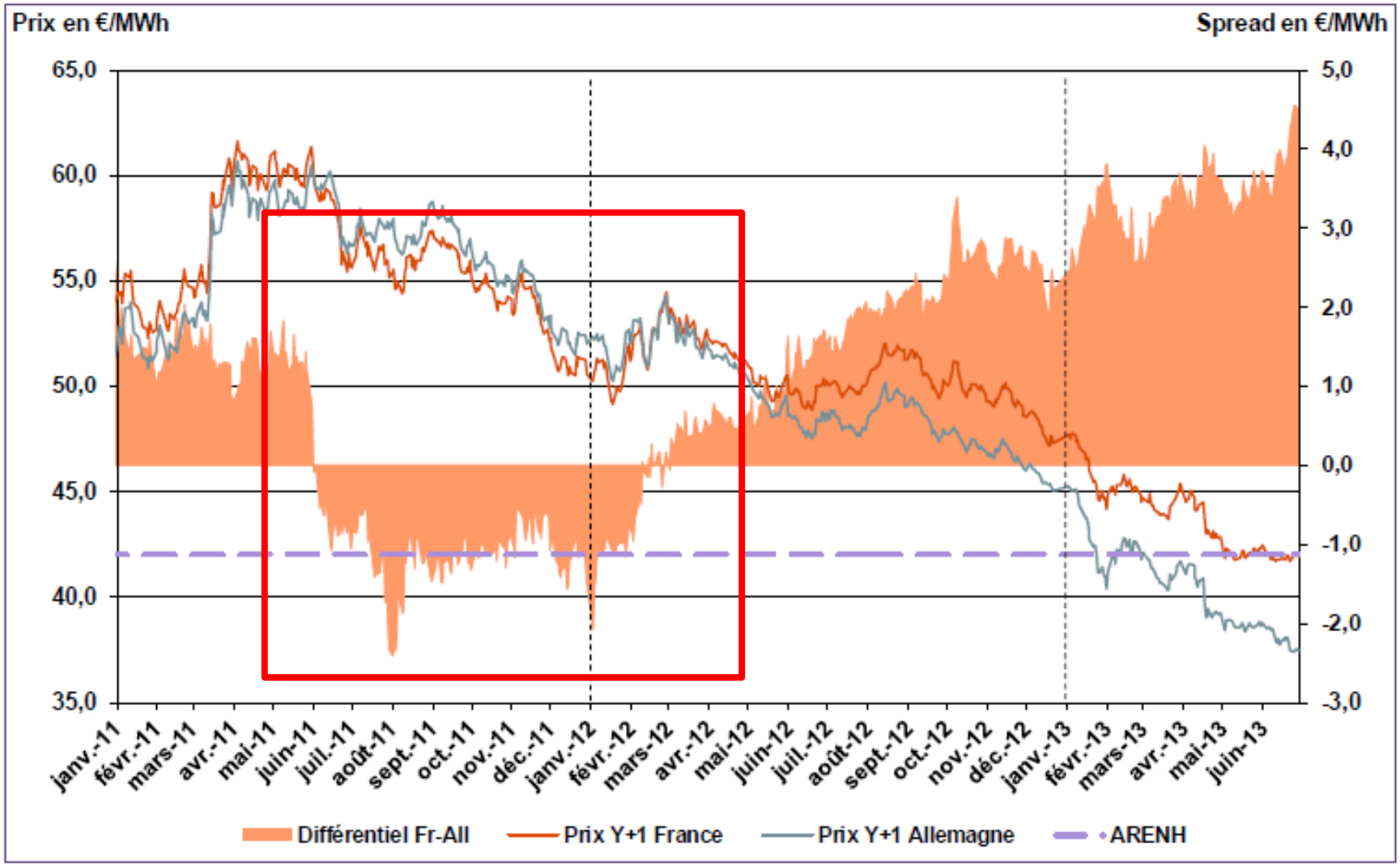
Graphique 24 : Prix des produits calendaires Y+1 France et Allemagne



Source : EEX Power Derivatives – Analyse CRE

Y+1 price spread between France and Germany

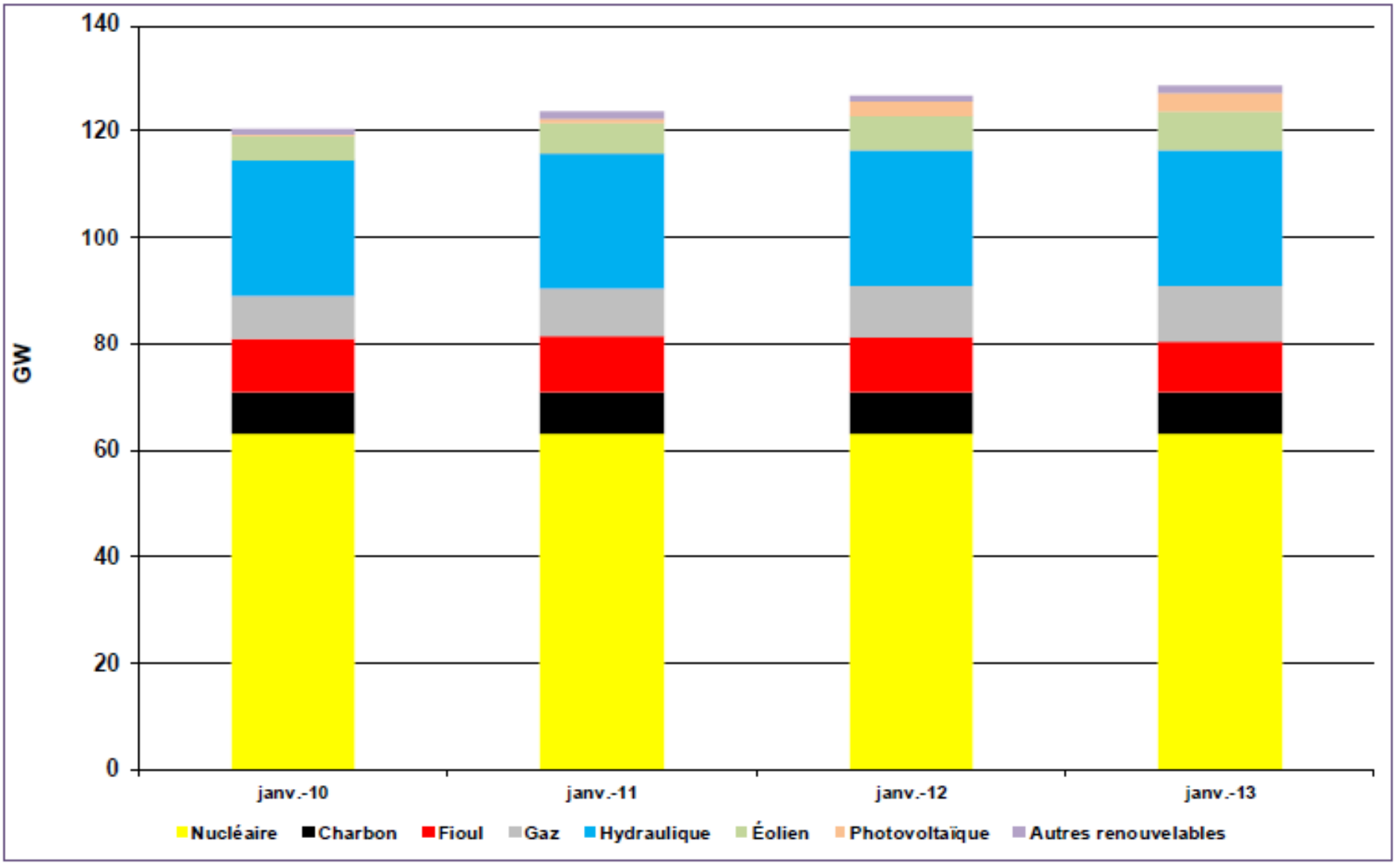
Graphique 28 : Prix Y+1 et *spread* France - Allemagne



Source : EEX Power Derivatives – Analyse : CRE

Generation capacity in France

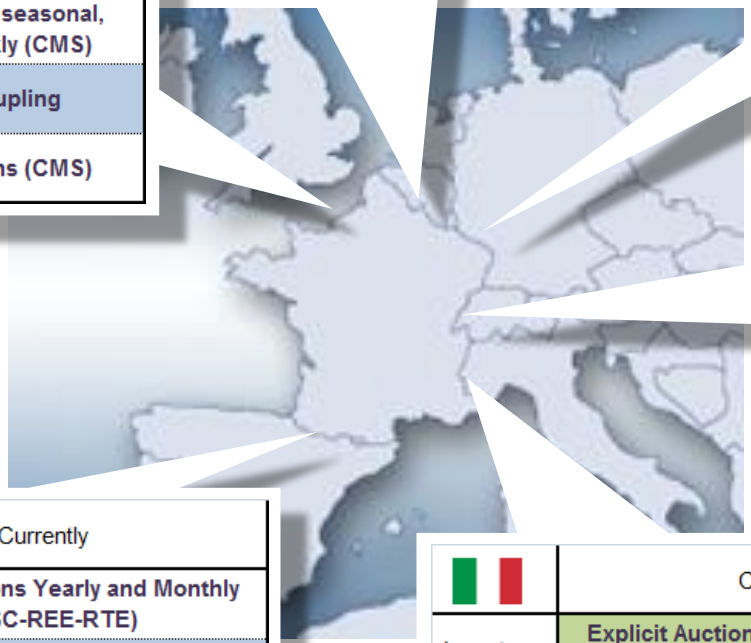
Graphique 31 : Parc de production électrique français (niveaux des différents parcs)



Overview of the allocation mechanisms on French borders

	Currently
Long term	Explicit Auctions Yearly and Monthly (CASC)
Daily	MCR D-1 Market Coupling
Intraday	Explicit allocation (pro-rata)

	Currently
Long term	Explicit auctions: yearly, seasonal, quaterly, monthly, weekly (CMS)
Daily	MCR D-1 Market Coupling
Intraday	Explicit Intraday auctions (CMS)



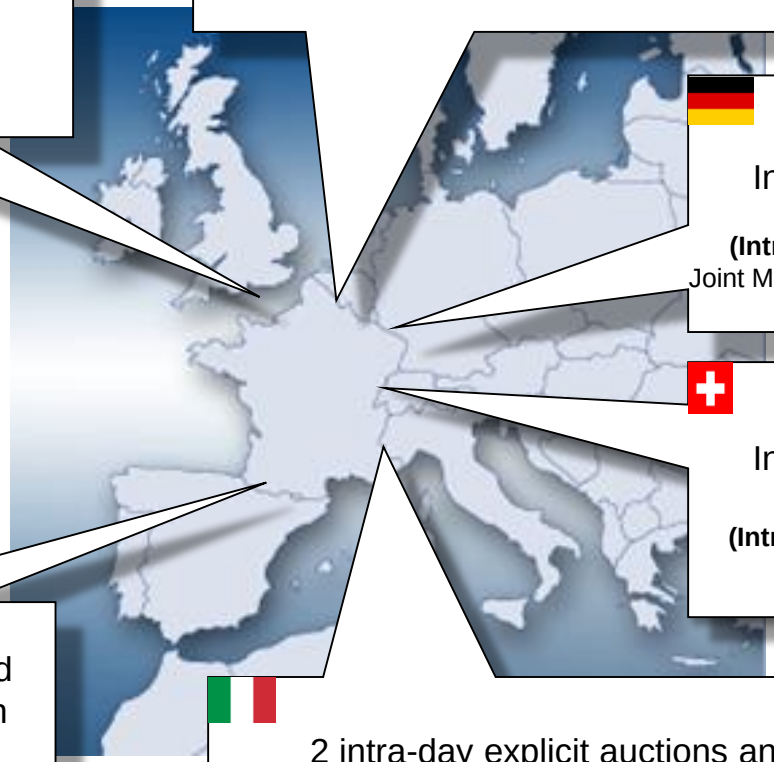
	Currently
Long term	Explicit Auctions Yearly and Monthly (CASC)
Daily	MCR D-1 Market Coupling
Intraday	Implicit and Explicit continuous allocation

	Currently
Long term	Explicit Auctions Yearly and Monthly (CASC)
Daily	Explicit Daily Auctions (CASC)
Intraday	Implicit and Explicit continuous allocation

	Currently
Long term	Explicit Auctions Yearly and Monthly (CASC-REE-RTE)
Daily	MCR D-1 Market Coupling
Intraday	Explicit Intraday auctions (REE)

	Currently
Long term	Explicit Auctions Yearly and Monthly (CASC)
Daily	Explicit Daily Auctions (CASC)
Intraday	Explicit Intraday auctions (CASC)

Access to intra-day capacity



2 intra-day explicit auctions and
6 nomination gates
-
(IFA access Rules Issue 8.0)
Joint Mechanism with NG

12 explicit allocations on a pro-rata basis
followed by nomination
-
(Intraday Capacity Allocation Rules IFB Rules V2.0)
Joint Mechanism with ELIA

Explicit* and Implicit
Intraday continuous Allocation
-
(Intraday Capacity Allocation Rules V2.3)
Joint Mechanism with AMPRION and TransnetBW

Explicit and Implicit
Intraday continuous Allocation
-
(Intraday capacity Allocation Rules V1.2)
Joint Mechanism with Swissgrid

2 intra-day explicit auctions and
2 nomination gates
-
(Rules for Intraday Capacity Allocation by Explicit Auctions V1.0 on North Italian Borders)
Joint mechanism with TERNA,Swissgrid, and ELES

2 intra-day explicit auctions and
6 opportunities for nomination
-
(IFE Rules V3.0)
Joint Mechanism with REE

EUPHEMIA, the PCR algorithm

•Need to set up of an unique price coupling algorithm to replace several algorithms used locally:

- **EUPHEMIA**, for Pan-European Hybrid Electricity Market Integration Algorithm

•This unique algorithm, developed based on COSMOS algorithm, includes all the local specificities of local markets.

•EUPHEMIA:

- handles standard and sophisticated orders
- Manages network constraints to compute the result
- Issues prices, net positions of hub, and possibly commercial flow between hubs (Scheduled Exchanges)
- no hard limit on number of markets,

IMPLICIT

EUPHEMIA

the Market Orders

The algorithm can handle a large variety of orders at the same time

Aggregated Hourly Orders (linear or stepwise curves)

Complex Orders

- MIC (minimum income condition) orders
- Load Gradient orders

Block Orders

- Profiled Block Orders
- Linked Block Orders
- Exclusive Groups of Block Orders
- Flexible Hourly Orders

Merit Order and PUN (Prezzo Unico Nazionale) orders

the Network Constraints

•EUPHEMIA receives information from the TSOs which are modelled in form of constraints to be respected in the final solution

•Bidding Area

- net position ramping (hourly and Daily)

•Available Transmission Capacity (ATC) model

- ATC
- Losses
- Tariffs
- Hourly flow ramping limit on individual Lines
- Hourly flow ramping limit on line sets

•Flow Based Model

EUPHEMIA Public Description

PCR Organization