

# Introduction

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- ⇒ **This PowerPoint presentation is animated**
  - ✓ **It's recommended to run the animation when viewing the presentation.**
- ⇒ **On most computers, you can start the animation by pressing F5.**
  - ✓ **Now the presentation moves one step forward, when you press Page Down. It moves one step backward, when you press Page Up.**

# **Structure of this PowerPoint presentation**

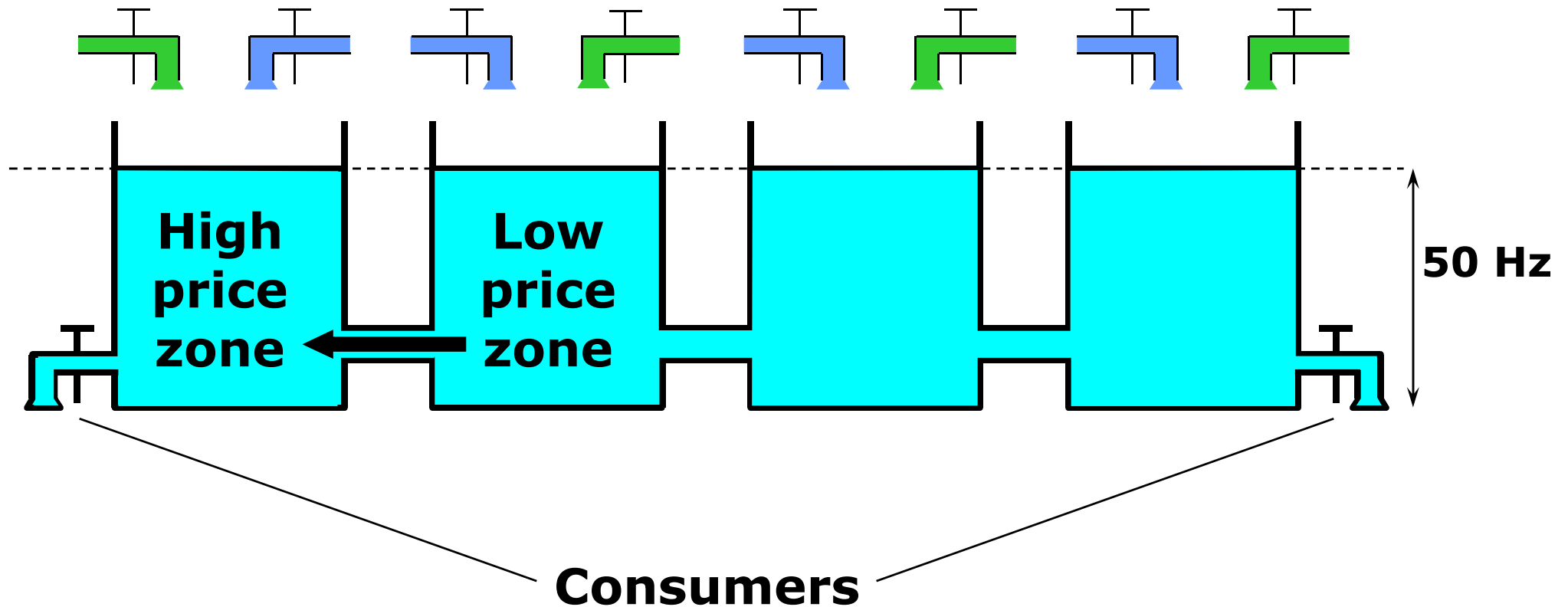
- ⇒ **This document first presents the EMCC volume coupling**
  - ✓ **And it's explained why the German-Danish volume coupling crashed in the autumn 2008.**
- ⇒ **Next, the lessons from the EMCC volume coupling are drawn up**
  - ✓ **And it's argued why we need a single spot price calculation in order establish The Single European Electricity Market.**
- ⇒ **A governance system for the European price coupling is proposed.**
- ⇒ **In appendix 1, you'll find an explanation of why block bids are the crucial bid form when the spot prices and the day-ahead plans for the cross-border energy flows are calculated.**
- ⇒ **In appendix 2, you'll find a list of the terms and acronyms used in this PowerPoint presentation.**

# The creation of The Single European Electricity Market

- ⇒ In order to create well functioning electricity markets, among other things, you need efficient cross-border competition.
  - ✓ In practice, this means good cross-border congestion management.
- ⇒ In the following, we will look at grid congestion management.
- ⇒ We will look at the day-ahead congestion management
  - ✓ How do you provide good day-ahead plans for the cross-border flow of electrical energy?

# How to couple electricity markets together

Producers



***Good congestion management will ensure the commodity moves towards the high price zone!***

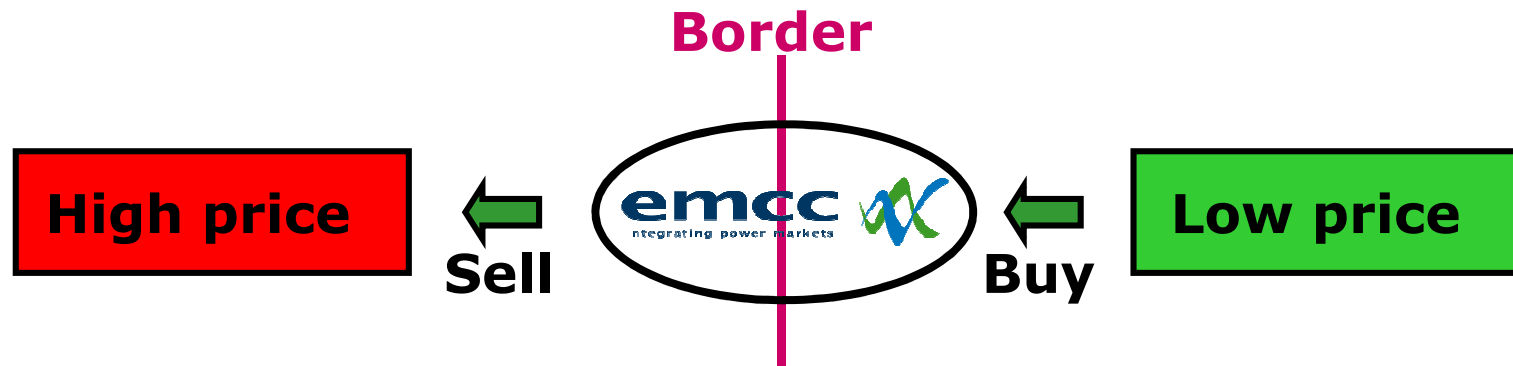
# EMCC European Market Coupling Company

- ⇒ **EMCC carries out the market coupling on the interconnectors between the Baltic-Nordic area and CWE**
  - ✓ **CWE Central Western Europe: Germany, France, Belgium, the Netherlands, Luxembourg.**

# EMCC daily tasks – 1

## What does the EMCC do?

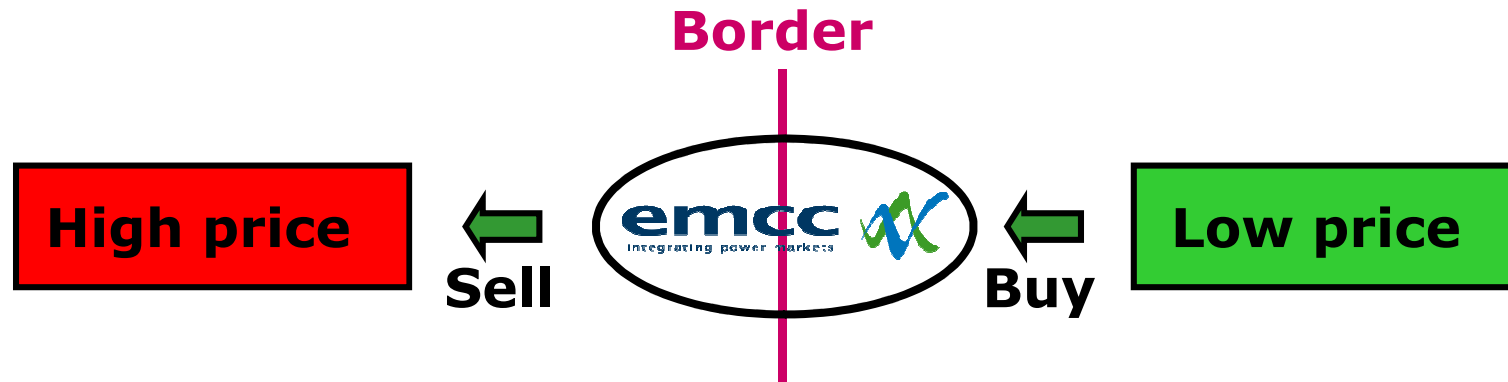
- The EMCC has two daily tasks
- ✓ **First:** for the CWE-Baltic-Nordic region, calculate the day-ahead prices for all price zones and day-ahead plans for flows on all links connecting the price zones in the region.



- ✓ **Second:** To be the cross-border trader for CWE-Nordic links
  - Buying low from one exchange and selling high to the other exchange.
  - Thereby, the EMCC will automatically collect the congestion rent (the arbitrage revenue).

# EMCC daily tasks – 2

What does the EMCC do?



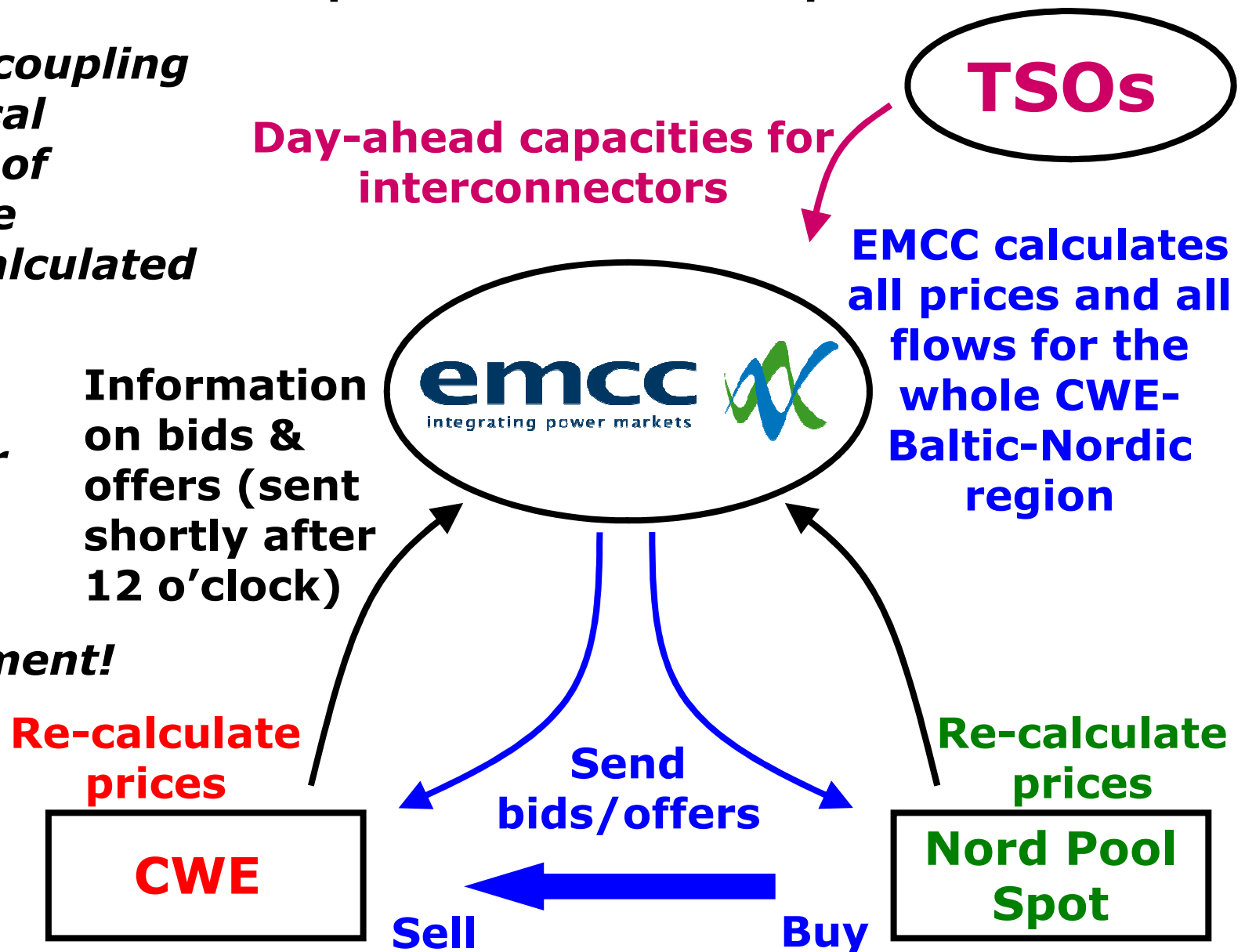
- ⇒ **The EMCC sends the congestion rent to the capacity owners.**
- ⇒ **For the capacity owners, the EMCC carries out a day-ahead congestion management service.**

# The daily operation

Example: all Baltic-Nordic price zones are low-price zones

*This is volume coupling as there are local re-calculations of prices that have already been calculated*

*Note: we have price coupling today. However the price coupling prices are not used in the spot settlement!*





# The local re-calculations can produce wrong prices!

**Nord Pool Spot re-calculation:  
sub-optimization for the Baltic-Nordic area only**

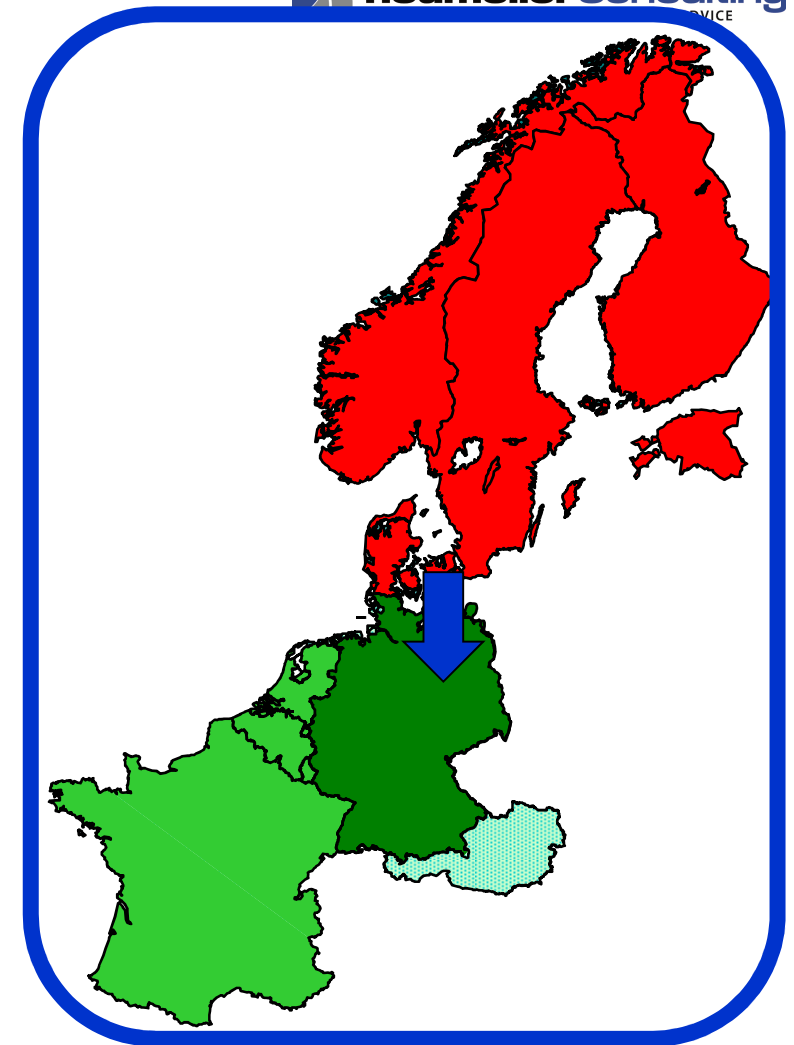
**CWE re-calculation:  
sub-optimization for  
CWE only**

**For 12 Oct. 2011: EMCC calculated prices in Eastern Denmark lower than the prices in Germany (also when EMCC's own bids were taken into account).**

**EMCC duly sent the energy south – buying in Eastern Denmark, selling in Germany.**

**BUT: for some hours, Nord Pool Spot's re-calculation of the prices in Eastern Denmark gave wrong prices – much higher than the German prices.**

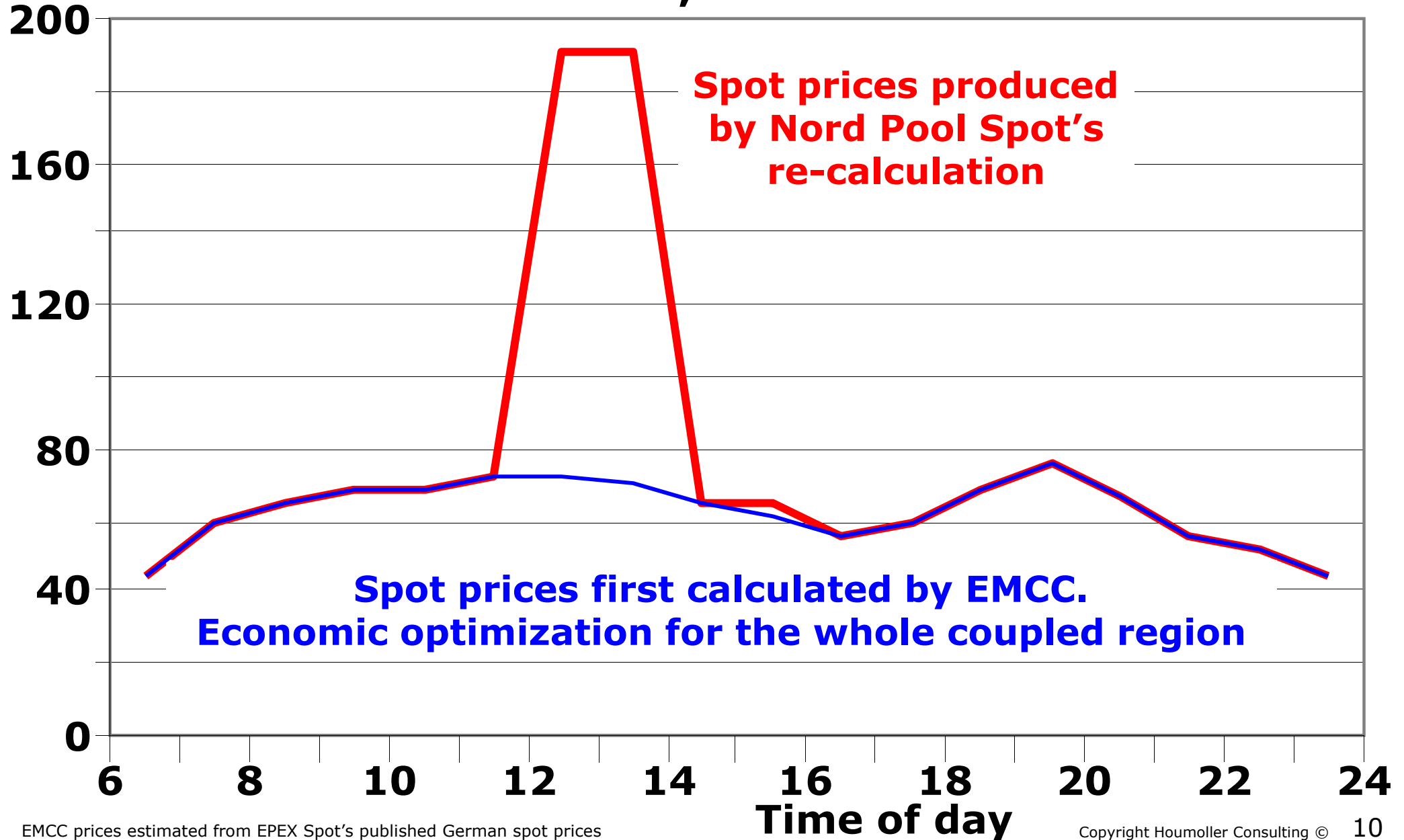
**The exchanges call it "adverse flow", when prices and flows do not fit. However, it is the exchanges' re-calculated prices that are wrong...**



**EMCC calculation:  
economic optimization of the whole  
coupled region**

# Spot prices in Eastern Denmark

EUR/MWh      **October 12<sup>th</sup>, 2011**



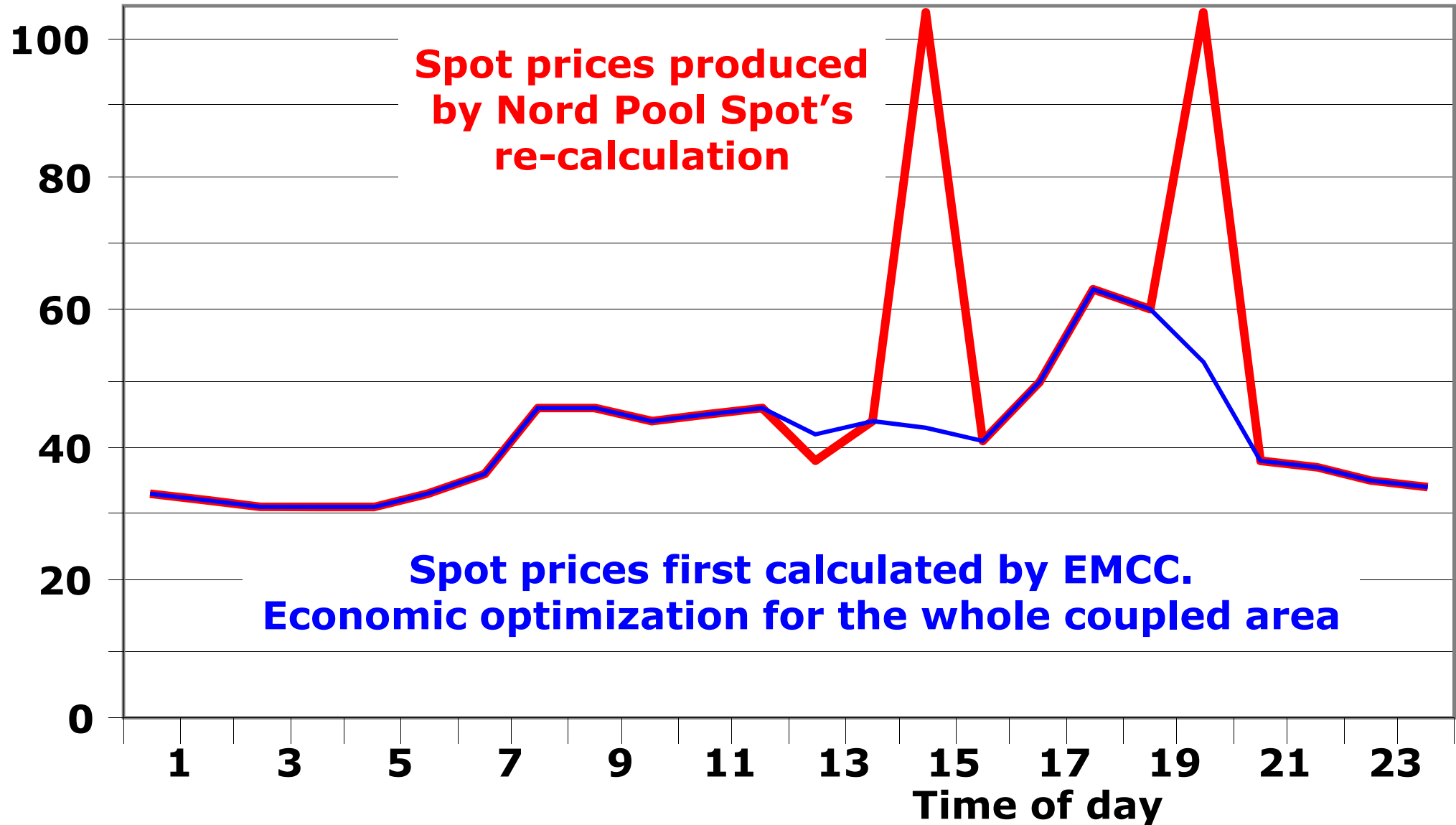
# More unreliable spot prices

⇒ **Also for 1 December 2009, Nord Pool Spot's re-calculation of the spot prices failed spectacularly.**

# Spot prices in Eastern Denmark

Dec. 1<sup>st</sup>, 2009

EUR/MWh



# The EMCC volume coupling – 1

- ⇒ **September 29<sup>th</sup>, 2008, the EMCC volume coupling was first launched as a coupling between Germany and Denmark.**
- ⇒ **After only 10 days, the volume coupling had to be stopped due to repeated, severe mismatch between the published spot prices and the market coupling flows.**
- ⇒ **However, the EMCC's market coupling software performed as planned!**
- ⇒ **The problem: Nord Pool Spot's re-calculations went awry again and again**
  - ✓ **Failing to reproduce the centrally calculated EMCC prices.**

# The EMCC volume coupling – 2

- ⇒ **After the failure of the volume coupling in the autumn 2008:**
- ⇒ **Naturally, the obvious solution would be to use the EMCC prices**
  - ✓ **Stop re-calculating prices already calculated...**
- ⇒ **Unfortunately, instead the Nord Pool Spot re-calculation still takes place**
  - ✓ **Now with some information on the German and Dutch bids feed to the Nord Pool Spot software.**
  - ✓ **This is the so-called Iceberg solution**
    - **"Iceberg" as the German/Dutch market situation is only partly visible for the Nord Pool Spot software.**
  - ✓ **The doctoring took place in the Nord Pool Spot software, as Nord Pool Spot's re-calculation was the problem.**

## The EMCC volume coupling – 3

- ⇒ **It took more than one year to develop the Iceberg solution.**
- ⇒ **As was demonstrated 1 December 2009 and 12 October 2011, the "solution" does not always work...**
- ⇒ **Conclusion: in order to always calculate reliable Danish prices, the calculation system needs full information on the bids in all the neighbouring countries**
  - ✓ **Local calculations or re-calculations will always be risky**
    - **Especially for price zones, which constitute border areas between different calculation regimes.**
- ⇒ **Therefore: you should not have local calculations**
  - ✓ **As this inevitably would leave some price zones as border areas.**

# Lessons learnt

## From the EMCC volume coupling

- ⇒ **Due to the redundant re-calculations yielding wrong spot prices:**
  - ✓ **December 1<sup>st</sup>, 2009, the buyers in Eastern Denmark paid **EUR 220 000** too much for electricity.**
  - ✓ **October 12<sup>th</sup>, 2011, the buyers in Eastern Denmark paid **EUR 457 000** too much.**
- ⇒ **These are huge daily losses for an area, where the consumption is 14 TWh/year!**
- ⇒ **Volume coupling can only be a temporary measure**
  - ✓ **Local calculations or re-calculations do have an added value**
    - **But the added value is negative, and can be numerically huge...**
- ⇒ **We **need to go to price coupling****
  - ✓ **True price coupling: no local calculation or re-calculation of spot prices**
    - **A central computer's calculation is the only calculation.**
- ⇒ **For the whole, coupled area in Europe, we must have a single computer doing the spot price calculation.**



# Transparency lacking

- ⇒ **After the accident 1 December 2009, Nord Pool Spot promised to introduce an emergency procedure**
  - ✓ **Whenever the re-calculation goes awry, Nord Pool Spot will intervene manually in the price calculation in order to try to remedy the situation.**
- ⇒ **At a meeting for market players 4 March 2010, this was presented orally**
  - ✓ **However, the promise was not kept, as was demonstrated 12 October 2011.**
- ⇒ **Now Nord Pool Spot claims, an emergency procedure has been introduced.**
- ⇒ **However, in contrast to the normal process used when other emergency procedures have been introduced, there has been**
  - ✓ **No public consultation.**
  - ✓ **No documentation of the procedure in Nord Pool Spot's rule book.**
- ⇒ **This ditching of transparency and due diligence is regrettable.**

# PCR Price Coupling Regions – 1

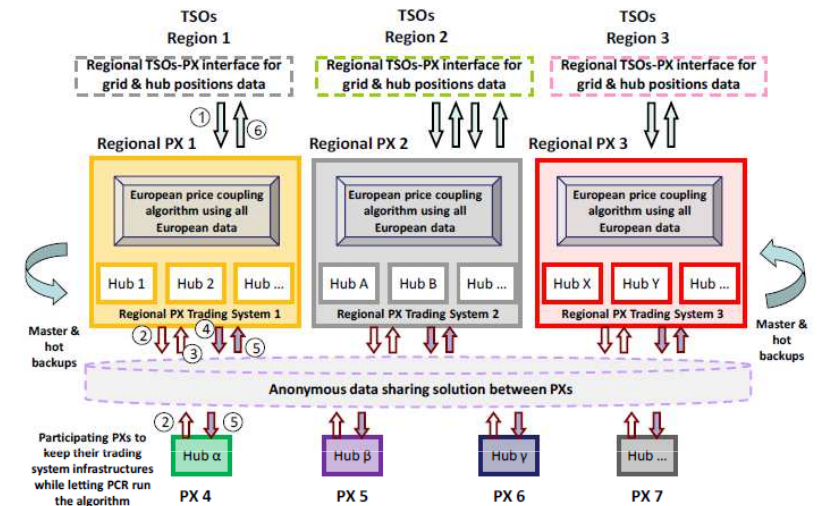
- ⇒ **This is a market coupling scheme proposed by some European spot exchanges.**
- ⇒ **The scheme foresees one algorithm for the price calculation.**
- ⇒ **Unfortunately, the scheme also foresees a lot of redundant staff, computers and software installations!**
- ⇒ **In the Nordic area, for more than 12 years, there has been price coupling between four countries with one staffed calculation site and one unstaffed disaster site**
  - ✓ **Where is the added value of the PCR's so-called "hot backup"?**
  - ✓ **Probably, even the American nuclear missile system does not have this much redundancy...**
- ⇒ **Is the PCR scheme proposed of concern for the market?**

# PCR Price Coupling Regions – 2

⇒ The costly and risky complexity of PCR clearly illustrates the absence of competitive pressure

✓ At companies exposed to throat-cutting competition, opportunities to cut costs and increase quality by outsourcing are eagerly seized.

⇒ In PCR, you witness active opposition towards decreasing costs and increasing quality by outsourcing the price calculation.



**For the price coupled region, to establish The Single European Electricity Market, instead of a cartel we need a well-regulated and well-governed single price calculation.**

# PCR Price Coupling Regions – 3

## The extreme PCR redundancy is dangerous!

- ⇒ **A general IT safety rule: For IT systems, where reliable operation is crucial, you don't have a number of semi-autonomous systems running simultaneously.**
- ⇒ **For example, one of the dangers of such a configuration was illustrated 10 November 2009, when the calculations for the following day were carried out:**
  - ✓ **Due to a technical problem, EMCC's calculation was delayed – but not more than what was agreed acceptable**
    - **At EMCC, the problem was solved and the EMCC calculation was ready within the agreed deadline.**
  - ✓ **However, in Paris EPEX Spot did not wait the agreed time for the EMCC result**
    - **Instead, EPEX Spot started its calculation of the German spot prices with the EMCC market coupling flows set to zero – and published the resulting prices**
      - **Thereby inflicting losses on market players, who were left with unreliable spot prices.**

# PCR Price Coupling Regions – 4

## The extreme PCR redundancy is dangerous!

- ⇒ **In contrast to the case mentioned on the previous slide:**
- ✓ **In the Nordic region, for more than 12 years, there has been price coupling between four countries with one staffed calculation site and one unstaffed disaster site**
    - **This configuration makes it impossible for one country/region to cut-and-run**
      - **Everybody must stay with the agreements.**

# The mission of exchanges

- ⇒ **In 1981, when Janne Carlsson became CEO for the airline SAS, he had to fight the old SAS machine-orientation**
  - ✓ **Carlsson: *"SAS flies people – not airplanes"*.**
- ⇒ **The mission of exchanges is to provide price transparency**
  - ✓ **The mission is not to have local computers calculating prices...**

# Unbundling

- ⇒ **The spot exchanges must unbundle**, when implicit auction becomes the day-ahead congestion management system
- ✓ **As they get a monopoly**: Only the spot exchanges can carry out day-ahead cross-border power trading
    - Naturally, you may install a system granting the players the opportunity to compete with the spot exchanges for cross-border capacity
      - However, even with such a system in place, the spot exchanges are granted a special status.
  - ✓ Hence, **the spot exchanges become regulated entities** (like the TSOs).

# Governance for the price coupling

- ⇒ **With one algorithm for the price calculation, you need central governance**
  - ✓ **As features of the algorithm have consequences for all market players, producers, end users and TSOs in the whole coupled region.**
- ⇒ **You need to establish a price coupling council**
  - ✓ **Where all the price coupling area's stakeholders are represented: market players, producers end users and TSOs.**
- ⇒ **The council will govern the price coupling.**
- ⇒ **The regulators will supervise the price coupling**
  - ✓ **Probably, the regulators will be spearheaded by ACER.**



## Price coupling governance principles

- ⇒ **By being a centre for the price calculation for a large region, the PCSC can afford to have technical experts, which understand both electricity trading and linear optimisation**
  - ✓ **Mathematical experts, computer experts and economic experts**
    - **In contrast: each spot exchange can/should not afford such a team of experts.**
- ⇒ **Note: the PCSC must not take one, single decision concerning the calculation algorithm or the procedures used in the daily price calculation**
  - ✓ **It's truly a service centre – servicing the market**
    - **With the council and the regulators as the primary references.**
- ⇒ **All decisions must be taken in the price coupling council.**
- ⇒ **The task of the PCSC's experts is to explain the various options and their consequences for the council and the regulators**
  - ✓ **And then leave the decisions to the council and the regulators.**

# Transparency introduced

**For the present EMCC volume coupling  
and the future PCSC Price Calculation Service Centre**

- ⇒ **The prices calculated by EMCC must be published daily**
  - ✓ **Making it possible for all stakeholders to understand the market coupling flows.**
  - ✓ **And see the difference between the centrally calculated EMCC prices and the local, re-calculated prices.**
- ⇒ **The PCSC will be governed by the price coupling council and supervised by the regulators.**
- ⇒ **Every feature of the PCSC calculation algorithm must be public.**
- ⇒ **Every procedure (potentially) applied in the daily PCSC price calculation must be documented in the PCSC's rule book.**

# Single price calculation – 1

## Simple and easy geographic expansion of the coupling

- ⇒ **For each participating spot exchange, implicit auction boosts the liquidity enormously**
  - ✓ **Because (a lot of) the cross-border energy flows go via the exchange.**
- ⇒ **Therefore, market coupling/splitting can create a liquid spot exchange overnight**
  - ✓ **This is how liquid spot exchanges were established in Belgium and the Nordic area, respectively.**
- ⇒ **By having two-sided (or multiple-sided) coupling to neighbouring countries, new entrants to the price coupling can over-night have liquid spot exchanges.**
- ⇒ **By having a single spot price calculation, this can be done easily: new entrants need not spend time & money on installing a new, local calculation system**
  - ✓ **All they need is a settlement system – and domestic laws furthering exchange trading of electrical energy.**

# Single price calculation – 2

## Flexible solution

- ⇒ **In EU, for the software calculating the spot prices, we must agree on common specifications in order to have a level playing field for the competition in The Single European Market.**
- ⇒ **However, a country C outside EU may want only loose coupling to The Single European Electricity Market (at least initially)**
  - ✓ **The country C may want volume coupling – accepting the draw-backs of this approach**
    - **The country C may have a local re-calculation using other specifications than the ones used in EU.**
- ⇒ **With a single calculation, this is easy to achieve**
  - ✓ **The single calculation will calculate all spot prices in the coupled EU area and the day-ahead plans for the flows inside the coupled EU area**
    - **And the day-ahead plans for the flows on the links between C and the coupled EU area.**
- ⇒ **Every day, after having received the flow plans, C can proceed with it's local re-calculation.**

# Appendix 1

## Block bids

# Block bids – 1

⇒ **An example of a block sales offer:**

✓ ***“Tomorrow, to the power exchange, I’ll sell 200 MWh during the hours from 7 am to 3 pm, if the exchange’s average price is at least 50 EUR/MWh”***

- **Therefore, the production facility’s start-up costs are distributed over the eight hours from 7 am to 3 pm.**
- **The block’s offer price = (the facility’s marginal production costs) + (the facility’s start-up costs distributed over eight hours).**

⇒ **In the calculation of the spot prices: for each of the eight hours from 7 am to 3 pm, the 200 MWh are inserted as a price-taking sales offer**

- ✓ **ie, an offer where the seller is willing to sell 200 MWh even at the minimum price.**
- ✓ **Because: during a single hour, the seller is actually willing to sell at the minimum price**
  - **Only the average price during the eight hours is of interest for the seller.**

# Block bids – 2

- ⇒ **An example of a block sales offer:**
  - ✓ *“Tomorrow, to the power exchange, I’ll sell 200 MWh during the hours from 7 am to 3 pm, if the exchange’s average price is at least 50 EUR/MWh”*
- ⇒ **Everything is OK, if the price calculation yields an average price for the eight hours of 50 EUR/MWh or higher.**
- ⇒ **Otherwise the block is rejected, and the price calculation is repeated without the block sales offer.**
- ⇒ **Problem: with the block rejected, the price calculation may yield an average price for the eight hours higher than 50 EUR/MWh!**
  - ✓ **However: you can’t fix this by re-inserting the block offer in the price calculation...**
  - ✓ **Hence, this gives a PRB – Paradoxically Rejected block Bid.**

# Block bids – 3

⇒ **An example of a block purchase bid:**

- ✓ *Tomorrow, from the power exchange, I'll buy 100 MWh during the hours from 8 am to 11 am, if the exchange's average price is at most 45 EUR/MWh during the three hours.*

⇒ **In the calculation of the spot prices: for each of the three hours from 8 am to 11 am, the 100 MWh are inserted as a price-taking purchase bid**

- ✓ **ie, a purchase bid where the buyer is willing to buy 100 MWh even at the maximum price.**
- ✓ **Because: during a single hour, the buyer is actually willing to pay the maximum price**
  - **Only the average price during the three hours is of interest for the buyer.**

⇒ **"Block bids" is the common term for block sales offers and block purchase bids.**



# How to select the block bids to be included in the exchange trading?

- ⇒ Every day, at each exchange, there are lots of block bids.
- ⇒ How to select the block bids, which will be included in the spot trading?
- ⇒ Example – two competing block sales offers, where a one hour overlap creates a situation, where only one bid can be included in the trading:

*Which block should be rejected?*



**Blok bid A**  
**Offer price 47 EUR/MWh**  
**From 3 am to 8 am**  
**15 MWh/hour**

**Block bid B**  
**Offer price 50 EUR/MWh**  
**From 7 am to 3 pm**  
**200 MWh/hour**

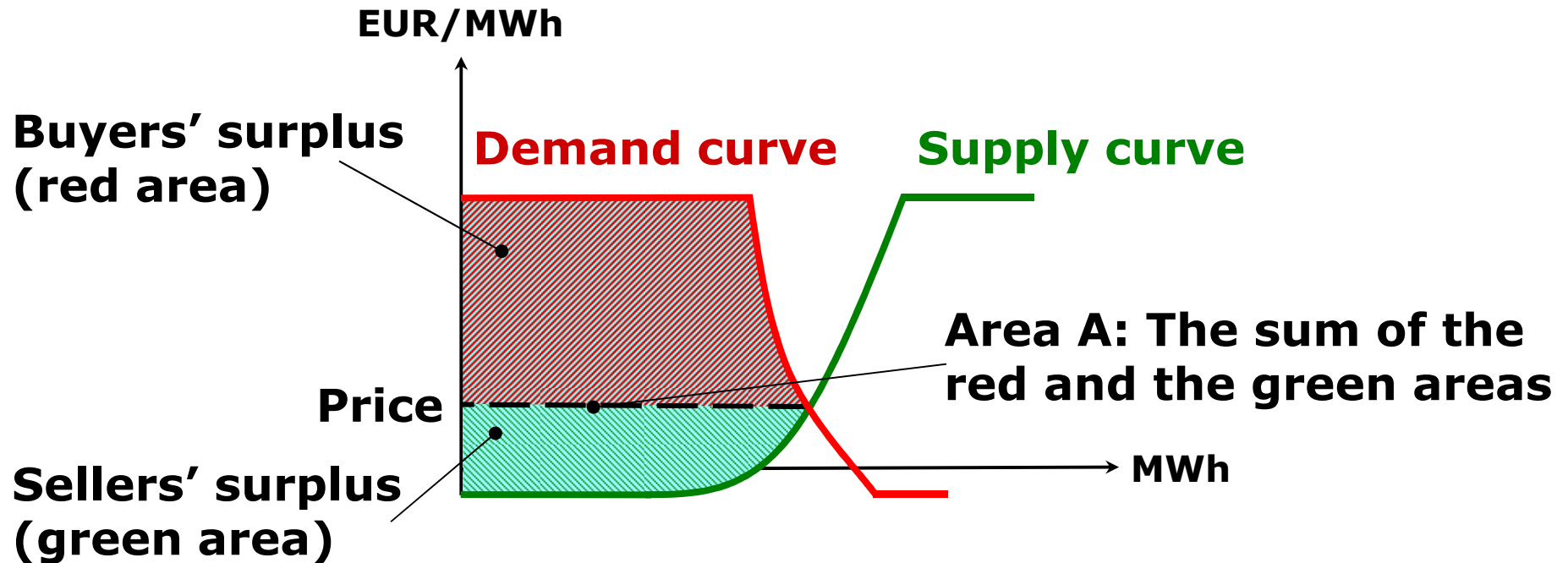
# **It's all about selecting the block bids!**

## **When the spot prices are calculated**

- ⇒ **If there were no block bids, there would be only one solution to the spot price calculation**
  - ✓ **ie, only one set of valid spot prices per price zone and only one set of valid day-ahead plans for the cross-border energy flows.**
- ⇒ **A "valid solution" is a solution fulfilling all the requirements**
  - ✓ **For each hour for each price zone: the spot purchase price is equal to the spot sale price.**
  - ✓ **For each hour for each interconnector: the day-ahead plan for the cross-border energy flow must not exceed the interconnector's capacity.**
  - ✓ **Ect...**
- ⇒ **With block bids: there are millions (perhaps billions) of valid solutions!**
- ⇒ **Therefore: with block bids, you need a criterion for selecting the preferred solution among all the valid solutions!**

# The traders' surplus

One hour one price zone. No import or export of energy



For one hour for one price zone: the buyers' and the sellers' total surplus from the spot trading is the area between the exchange's supply curve and the exchange's demand curve (the red/green area A).

# Value created by the spot trading

- ⇒ **For one hour of the next day: consider two neighbouring price zones with different prices  $P_{low}$  and  $P_{high}$ .**
- ⇒ **If the market coupling system sends the energy  $E$  from the low-price zone to the high-price zone, the so-called congestion rent (or congestion revenue) is**
  - ✓  $E * (P_{high} - P_{low})$ .
- ⇒ **Normally, the congestion rent is given to the capacity owners.**
- ⇒ **Actually, the total value created by the spot trading is the sum of the following two components:**
  - ✓ The sum of all the red/green areas (the traders' surplus).
  - ✓ The congestion rent (the capacity owners' gain).

# The criterion

- ⇒ **When selecting the preferred solution, the price calculation software aims at maximising the value created by the spot trading.**
- ⇒ **With reference to the previous slides: the software aims at maximising the sum of**
  - ✓ **The traders' surplus (all the red/green areas).**
  - ✓ **The congestion rent.**
- ⇒ **The maximization runs over all links, all price zones and all 24 hours of the next day.**
- ⇒ **Hence, the software aims at maximising the following sum:**

$$\sum_{\text{24 hours}} \left[ \sum_{\substack{\text{All links} \\ \text{between} \\ \text{price zones}}} (\text{congestion rent}) + \sum_{\substack{\text{All} \\ \text{price} \\ \text{zones}}} (\text{traders' surplus}) \right]$$

# An economic optimization

- ⇒ **Therefore, it implies making an economic optimization, when the spot prices and the day-ahead plans for the cross-border energy flows are calculated.**
- ⇒ **As it means making an economic optimal selection among the valid solutions**
  - ✓ **Among the valid solutions: select the solution maximizing the value of the spot trading.**

# Appendix 2

## Terms and acronyms

# Terminology and acronyms – 1

## As used in this presentation

- ⇒ **ACER** Agency for the Cooperation of Energy Regulators. An EU body established in 2010.
- ⇒ **Border** means a border between two price zones
  - ✓ Hence, it need not be a border between two countries. It may be a border between two price zones inside a country.
- ⇒ **Congestion rent** The arbitrage revenue earned by implicit auction. In implicit auction, for each interconnector, some body must buy energy on the interconnector's low-price side and sell the energy on the high-price side. Normally, this body is appointed by the interconnector's capacity owners; and the arbitrage revenue is collected by the capacity owners. The amount of energy traded cross-border is calculated by means of market splitting or market coupling.
- ⇒ **Customers** In this document, the "customers" of the price coupling are the market players, the end users of electricity, the producers of electricity and the TSOs.



# Terminology and acronyms – 2

## As used in this presentation

- ⇒ ***CWE*** Central Western Europe: Belgium, France, Germany, Luxembourg and the Netherlands.
- ⇒ ***Double auction*** A calculation method whereby an exchange's price is set by calculating the intersection between the exchange's supply curve and the exchange's demand curve.
- ⇒ ***EMCC*** European Market Coupling Company.
- ⇒ ***EU*** European Union.
- ⇒ ***Implicit auction*** The common term for market coupling and market splitting.
- ⇒ ***Market coupling*** A day-ahead congestion management system, you can have on a border, where two spot exchanges meet. The day-ahead plans for the cross-border energy flows are calculated using the two exchanges' bids and information on the day-ahead cross-border trading capacity.

# Terminology and acronyms – 3

## As used in this presentation

- ⇒ ***Market splitting*** A day-ahead congestion management system, you can have on a border, where you have the same spot exchange on both sides of the border. The day-ahead plans for the cross-border energy flows are calculated using the exchange's bids and information on the day-ahead cross-border trading capacity.
- ⇒ ***Nordic and Nordic area*** refer to the countries Denmark, Finland, Norway and Sweden.
- ⇒ ***PCR*** Price Coupling Regions. A market coupling system proposed by some European spot exchanges. Unfortunately, PCR would mean market coupling with a lot of redundant staff, computers and software installations – financed by captive costumers.

# Terminology and acronyms – 4

## As used in this presentation

- ⇒ **PCSC** Price Calculation Service Centre. For the price coupled region, this is a central body calculating all spot prices and all day-ahead plans for the cross-border energy flows. The price calculations is carried out using double auction. The calculation is based on information on
  - ✓ All spot bids in the price coupled region.
  - ✓ Information on the day-ahead cross-border trading capacity for all interconnectors in the price coupled region.
- ⇒ **Price coupling** In this document, this is a system, where there is one, single body calculating the spot prices and the day-ahead plans for the cross-border energy flows. No local calculations or re-calculations are taking place.
- ⇒ **Price zone** means a geographical area, within which the players can trade electrical energy day-ahead without considering grid bottlenecks.

# Terminology and acronyms – 5

## As used in this presentation

- ⇒ ***Spot bid*** A purchase bid or a sales offer submitted to a spot exchange.
- ⇒ ***Spot exchange*** In this document, a spot exchange is an exchange where
  - ✓ **Electrical energy is traded day-ahead.**
  - ✓ **The day-ahead prices are calculated by means of double auction.**
  - ✓ **Note: this document strongly recommends the price calculation is outsourced to a Price Calculation Service Centre (PCSC). The PCSC will calculate the spot prices and the day-ahead plans for the cross-border energy flows for the price coupled region.**
- ⇒ ***Spot price*** A price calculated by a spot exchange. Either by a calculation performed by the spot exchange itself, or by a calculation performed by a body, to which the calculation has been outsourced (refer to PCSC).

# Terminology and acronyms – 6

## As used in this presentation

- ⇒ **Volume coupling** A market coupling scheme, where a central body first calculates the spot prices and the day-ahead plans for the cross-border energy flows for the whole coupled region. However, the centrally calculated spot prices are not used. Instead, there are local re-calculations of the spot prices.
- ✓ If you have volume coupling, the prices and the energy flows may mismatch (energy flows apparently going from high-price zones towards low-price zones).
  - ✓ This can happen because the spot prices for each price zone are calculated twice. First, the central body calculates all spot prices for the whole coupled area. Next, for some interconnectors in the coupled area, the market coupler sends price-taking purchase bids to the price zone on the interconnector's low-price side; and corresponding price-taking sales offers to the interconnector's high-price side. After having received the market coupler's bids, the local spot exchanges re-calculate the local spot prices. However, the redundant, local re-calculations are economic sub-optimizations for sub-areas of the coupled area. Therefore, the local re-calculations may fail to reproduce the prices calculated in the global optimization performed by the central body. In turn, the wrong re-calculations may cause a mismatch between the prices and the energy flows. However, the glaring mismatch is not the most serious effect of the redundant re-calculations. By far, the most serious effect is the fact that the market is supplied with unreliable spot prices.
- ⇒ **TSO** Transmission System Operator.

# **Thank you for your attention!**

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