

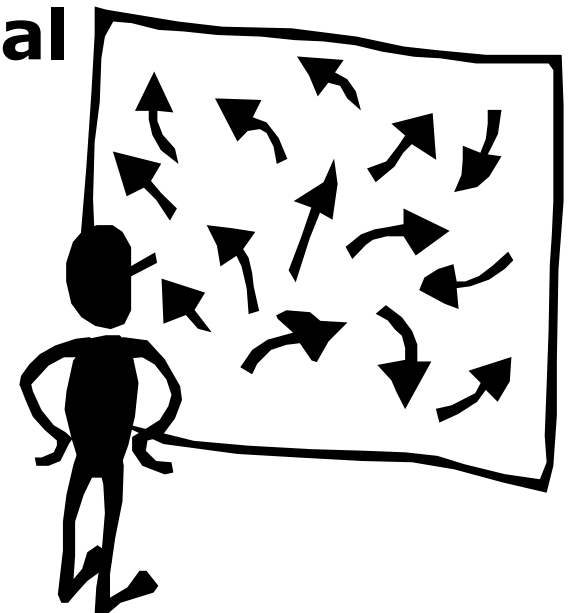
# Introduction

- **For the European Union's electricity market, this presentation discusses the calculation of spot prices and market coupling flows.**
- **In the appendix, you'll find a list of the terms and acronyms used in this presentation.**
- **Concerning the documents referred to in this presentation:**
  - ❑ **Unless otherwise mentioned, you can download the documents from <http://www.houmollerconsulting.dk/facts-findings/>.**
- **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.**



# Flow-based market coupling – 1

- **Flow-based market coupling considers the **spatial interdependency** of the power supply system**
  - ❑ **The allowed production surplus/deficit in one bidding zone is dependent on the production surpluses/deficits in all the other bidding zones.**
- **The so-called PTDF matrix describes a simplified, linear version of this spatial interdependency**
  - ❑ **PTDF Power Transfer Distribution Factor.**



# Flow-based market coupling – 2

The idea is to have a simplified, linear grid model included in the calculation of tomorrow's spot prices and market coupling flows.

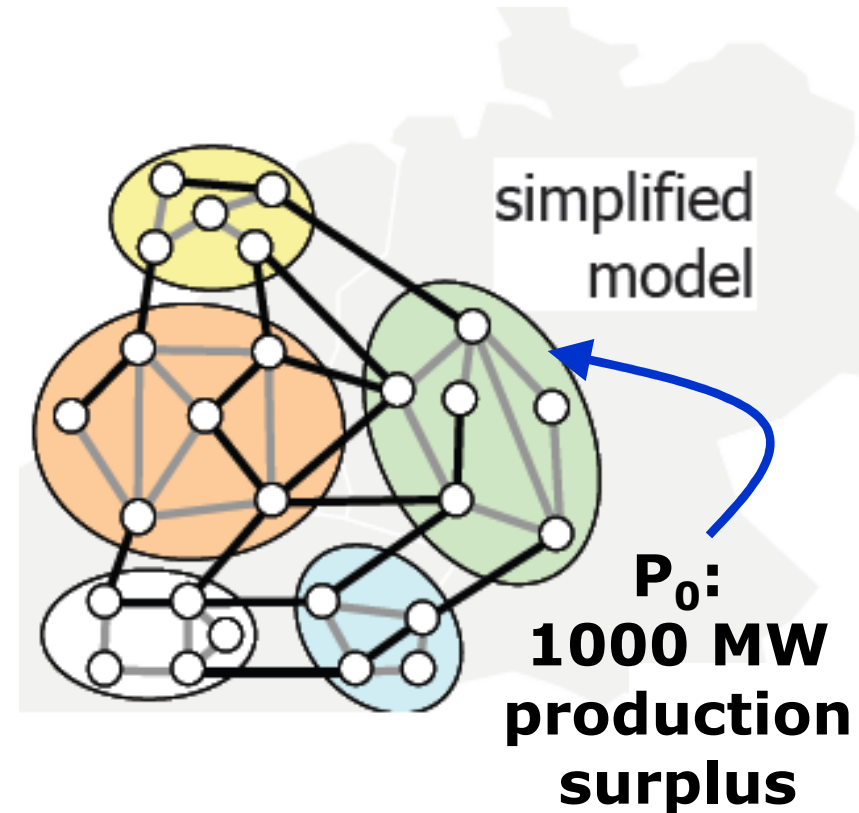
“Linear” means you have a starting point  $P_0$  for tomorrow's flows and production surpluses/deficits.

Next, you assume deviations from  $P_0$  gives a linear response.

Thereby, the software can see, how big production surpluses/deficits we can have per bidding zone without overloading any interconnector.

Also, the software can ensure, we run according to the “*n-1 criterion*”

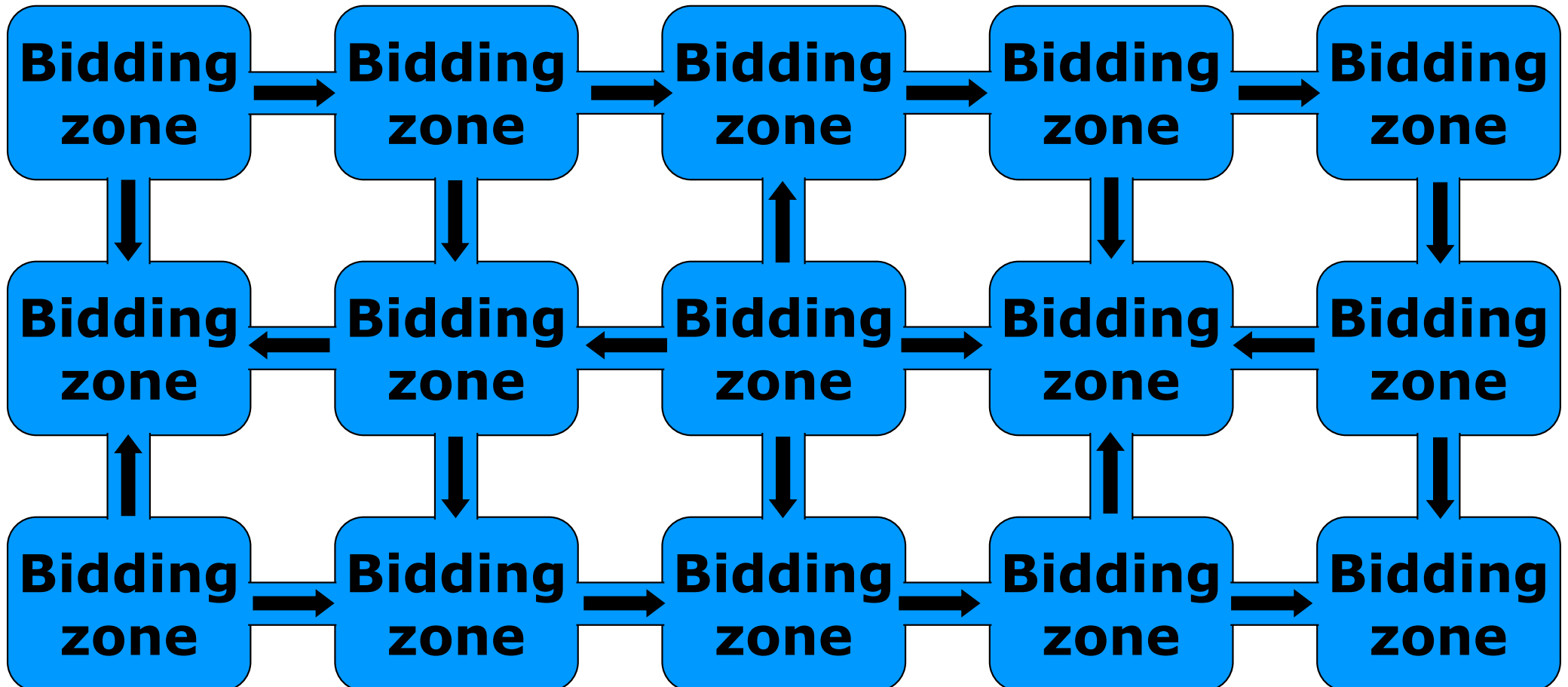
ie, the system can cope with the unplanned outage of one big production unit or one important power line.



# Spot calculation - 1

Every day, shortly after noon Central European Time, the spot software calculates the spot prices and the market coupling flows for the coupled area.

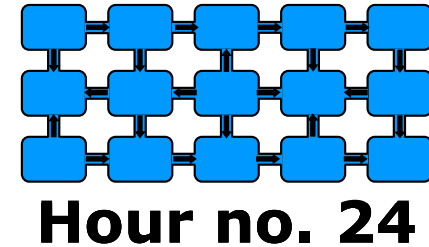
All bidding zones and all interconnectors in the coupled region are included in the calculation.



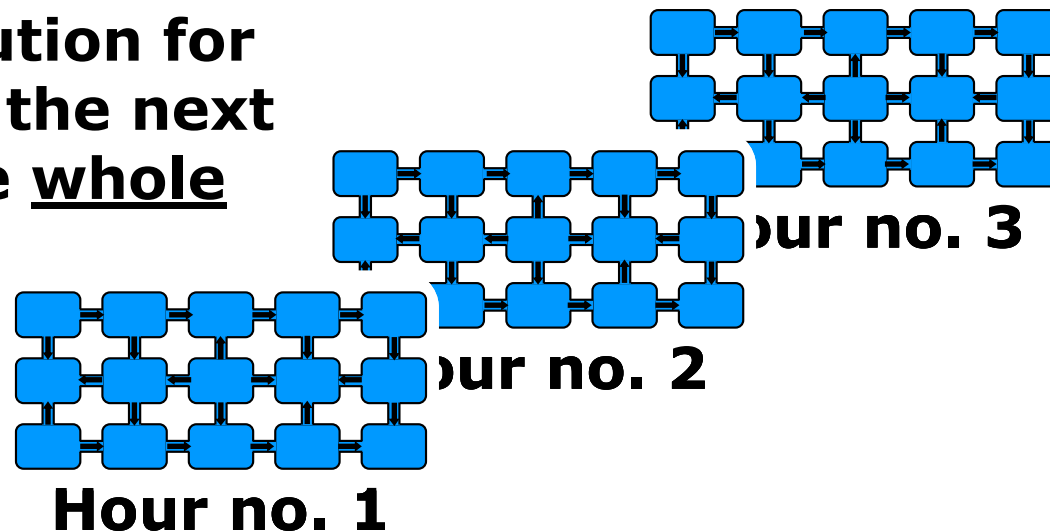
# Spot calculation – 2

## The effect of block bids

- The block bids create a **time inter-dependence** between the 24 hours of the next day.
- You cannot calculate the prices and the flows for one hour only.
- And it does not make sense to optimize the solution for one hour only.
- In one go, you must calculate spot prices and market coupling flows for all bidding zones, all interconnectors and all 24 hours of the next day

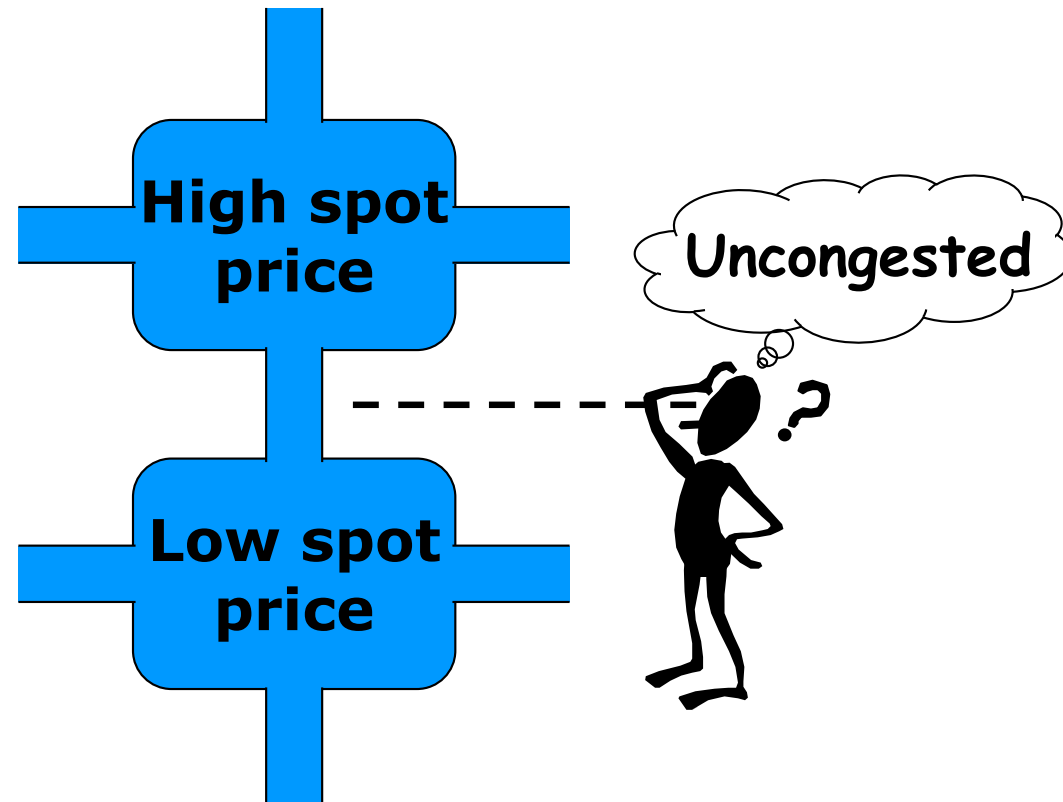


- ❑ The algorithm must search for an optimal solution for all 24 hours of the next day and for the whole coupled area.



# The optimal solution - 1

- **Even if we do not use flow-based market coupling:**
  - ❑ **Due to the block bids, the optimal solution will normally have hours where an interconnector is not fully utilized, although it connects two bidding zones with different spot prices.**



# The optimal solution - 2

➤ The truly optimal solution in a meshed grid defies intuition

❑ As this solution will often have flows towards the low price for some interconnectors

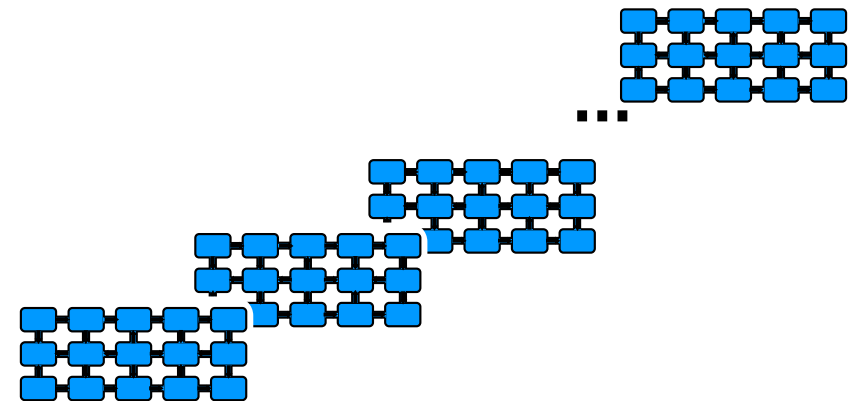
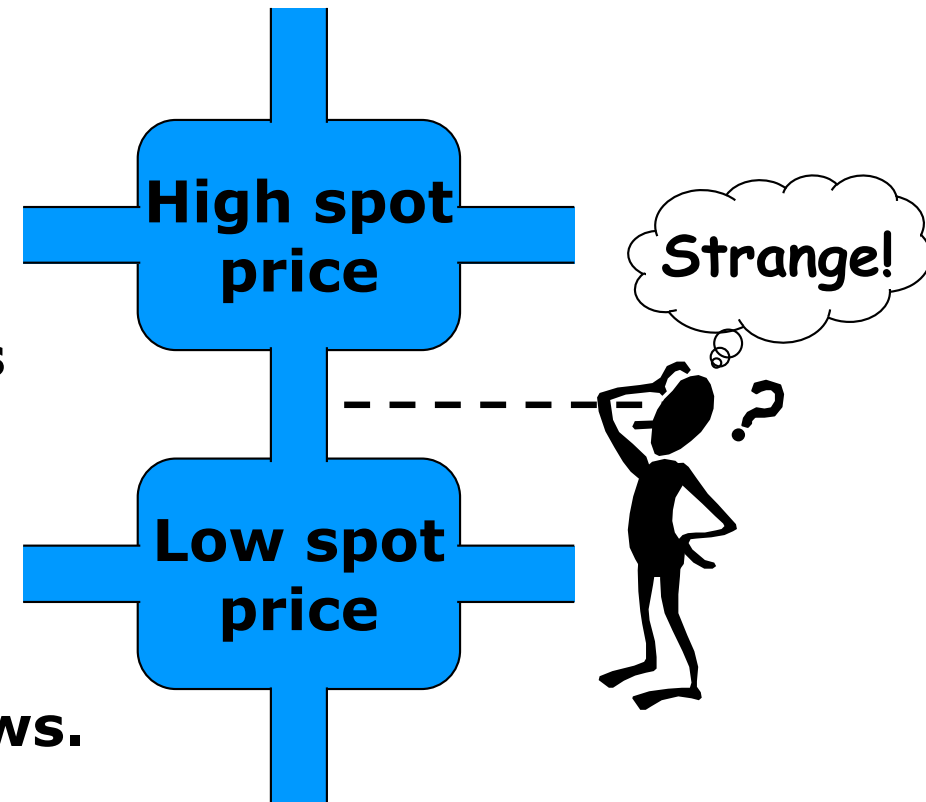
- In order to ship as much energy as possible to some high-price zones.

➤ Because flow-based market coupling aims at this truly optimal solution:

❑ The best flow-based solution will often have such counter-intuitive flows.

➤ This illustrates that it does not make sense to ask if the solution is optimal during one hour and/or for one interconnector only.

➤ For more information on the optimal solution, see the PowerPoint presentation "Welfare criterion".



# Appendix

## Terminology and acronyms





# Terminology and acronyms – 1

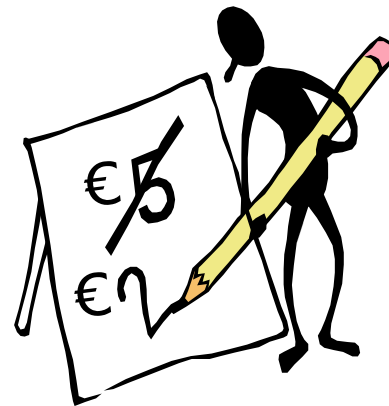
- **Bidding zone** A geographical area, within which the players can trade electricity day-ahead without considering grid bottlenecks.
- **Block bids** Please refer to the PowerPoint presentation “Market coupling – European price coupling”.
- **Border** A border between two bidding zones. Hence, it need not be a border between two countries. It may be a border between two bidding zones in the same country.
- **Coupled area** For EU, you’ll find a map of the coupled area at [https://www.entsoe.eu/network\\_codes/cacm/implementation/sdac/](https://www.entsoe.eu/network_codes/cacm/implementation/sdac/)  
However, market coupling and spot trading is also used in India, for example. See <https://www.iexindia.com/>.
- **Interconnector** In this document, this is a power line connecting two bidding zones.
- **Market coupling** A day-ahead congestion management system, where the plans for tomorrow’s cross-border energy flows are calculated using:  
The purchase bids and sales offers sent by market players to spot exchanges.  
The day-ahead cross-border trading capacity for each interconnector.  
For more information, see the PowerPoint presentation “Maximizing the economic value of market coupling and spot trading”. You may also refer to the PDF document “The Liberalized Electricity Market”.

# Terminology and acronyms – 2

- **Spot calculation** The simultaneous calculation of tomorrow's spot prices and market coupling flows.

For more information, see the PowerPoint presentation "Maximizing the economic value of market coupling and spot trading". You may also refer to the PDF document "The Liberalized Electricity Market".

- **Spot exchange** See the PowerPoint presentation "Maximizing the economic value of market coupling and spot trading". You may also refer to the PDF document "The Liberalized Electricity Market".
- **Spot price** See the PowerPoint presentation "Maximizing the economic value of market coupling and spot trading". You may also refer to the PDF document "The Liberalized Electricity Market".
- **Spot software** The software performing the spot calculation. In EU, the algorithm used is called Euphemia.



# **Thank you for your attention!**

**Anders Plejdrup Houmøller**  
***Houmoller Consulting ApS***

**Tel. +45 28 11 23 00**

**anders@houmollerconsulting.dk**

**Web houmollerconsulting.dk**