

Introduction

**Anders Plejdrup Houmøller
Houmoller Consulting ApS**

- **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.**

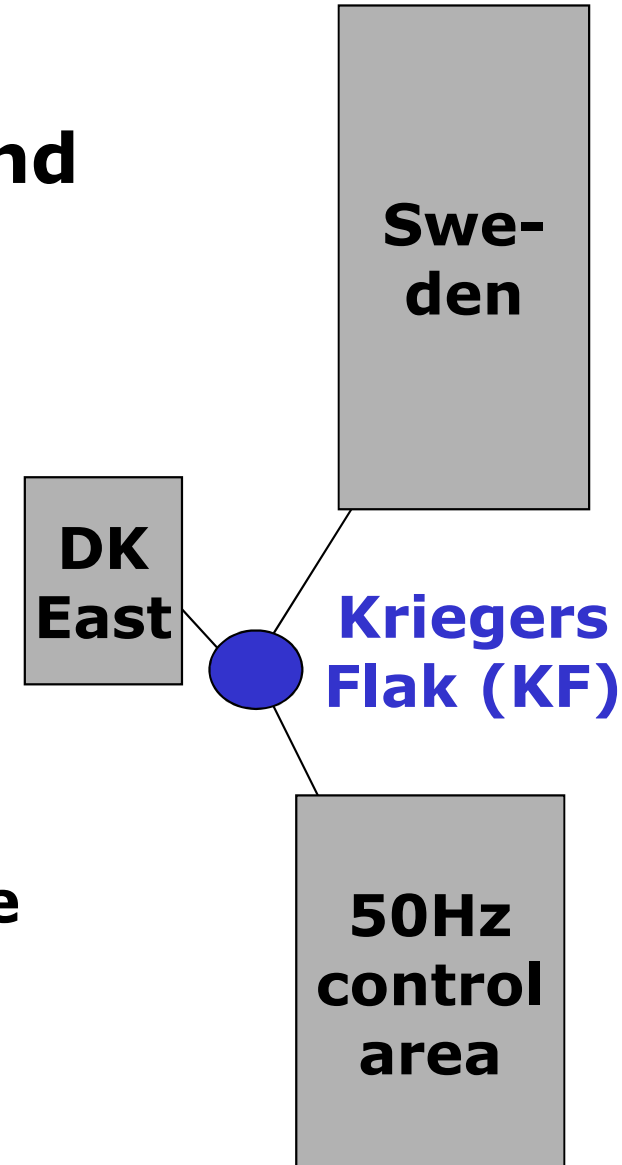
Kriegers Flak market coupling

- **This PowerPoint presentation shows how to establish day-ahead congestion management for the electrical energy produced by the wind turbines installed at Kriegers Flak in the Baltic Sea.**
- **In the presentation it's assumed Sweden participate in the Kriegers Flak project, although this is currently not the plan**
 - ✓ **However, by assuming this, you get a case with an off-shore wind farm connected to three different bidding zones.**
 - ✓ **The current project – with only Germany and Denmark participating – is just a simplified version of this case.**
- **Market coupling will do the following:**
 - ✓ **Calculating and publishing the spot prices for Kriegers Flak.**
 - ✓ **Producing the day-ahead plans for the energy flows on the links connecting Kriegers Flak to the neighbouring bidding zones.**

The day-ahead energy flow plan

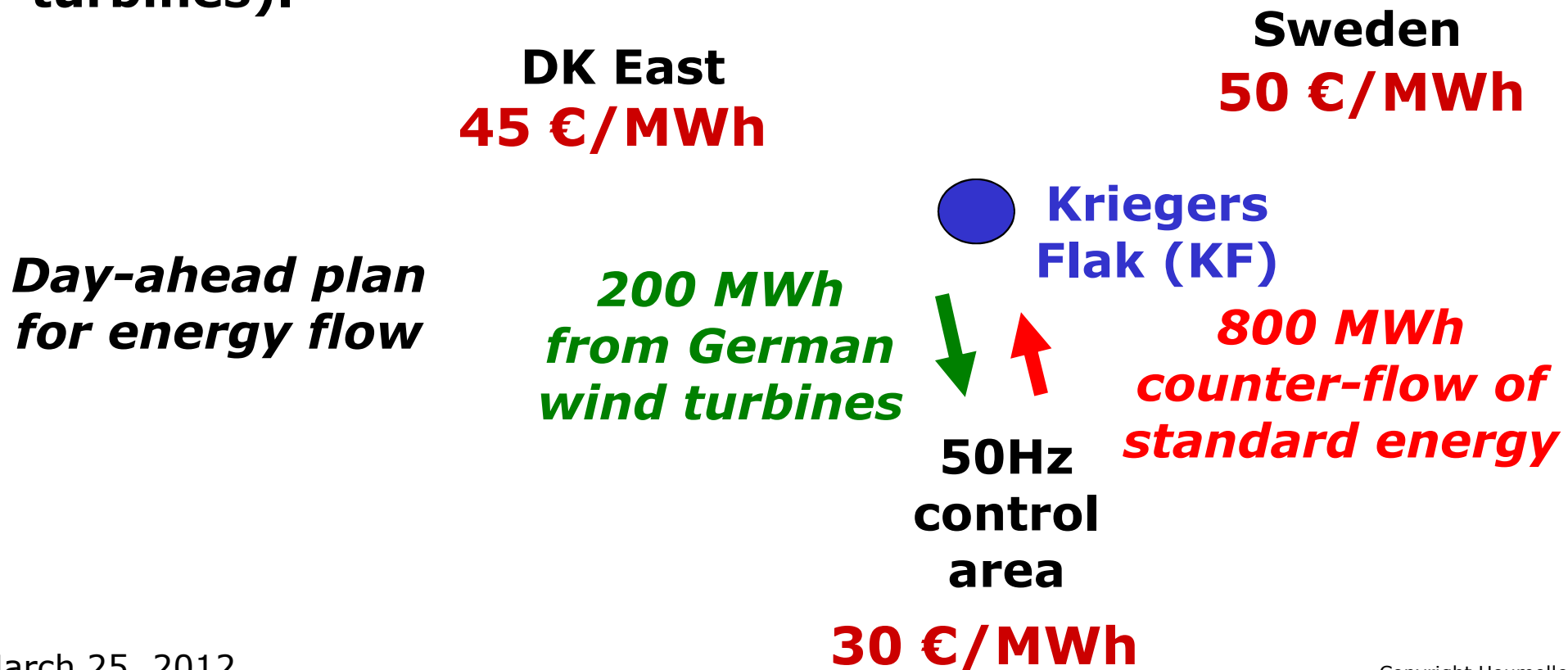
For one hour of tomorrow for an off-shore bidding zone

- **Simplifying assumptions:**
- **Assume each of the links between Kriegers Flak and Germany, Sweden and Denmark has capacity 600 MW.**
- **For the day-ahead energy flow plan:**
- **If the forecasted KF production is 600 MWh or less**
 - ✓ **Send all the energy to the high-price zone.**
- **Forecast between 600 and 1,200 MWh**
 - ✓ **Send 600 MWh to the high-price zone. The rest to the zone with the next-highest price**
- **Forecast higher than 1,200 MWh**
 - ✓ **Send (Forecast) – 1,200 MWh to the zone with the lowest price.**



Different wind energy subsidies in different countries?

- Assume, energy from German-owned wind turbines must be shipped to Germany in order to get the German subsidies.
- Assume each of the links between Kriegers Flak and Germany, Sweden and Denmark has capacity 600 MW.
- Assume, the forecast for one hour of tomorrow for the Kriegers Flak production is 500 MWh (200 MWh from the German wind turbines).

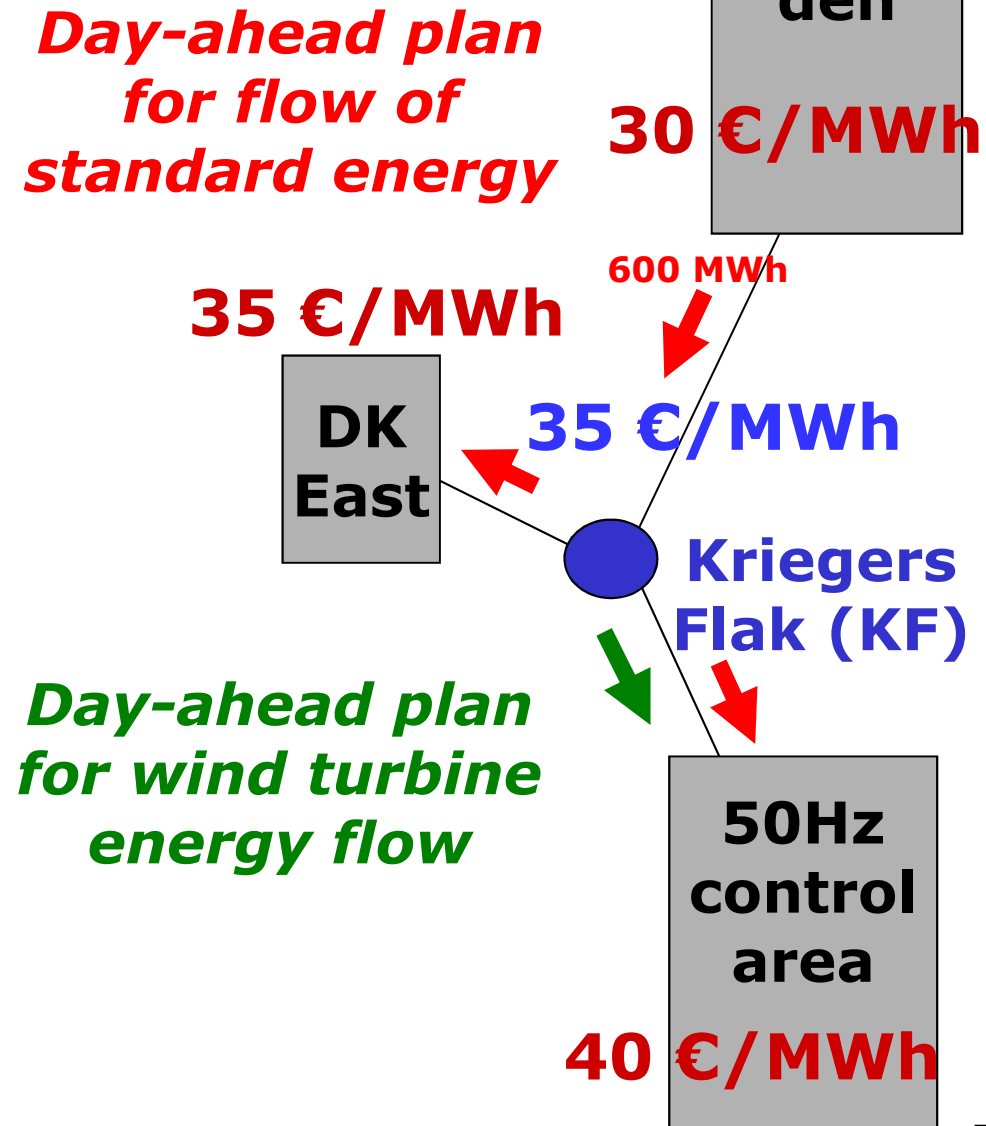


The day-ahead energy price

For one hour of tomorrow. KF is Kriegers Flak.

E_{KF} is the expected wind turbine energy production for this hour

- $0 < E_{KF} < 600 \text{ MWh}$
 - ✓ The wind energy is sent to Germany.
 - ✓ The remaining DC grid capacity is used to send standard energy from Sweden to Denmark & Germany.
 - ✓ As the link KF-DK_{EAST} is uncongested, the KF price becomes 35 EUR/MWh
 - When the link is uncongested, you can regard KF as an integrated part of DK_{EAST}.

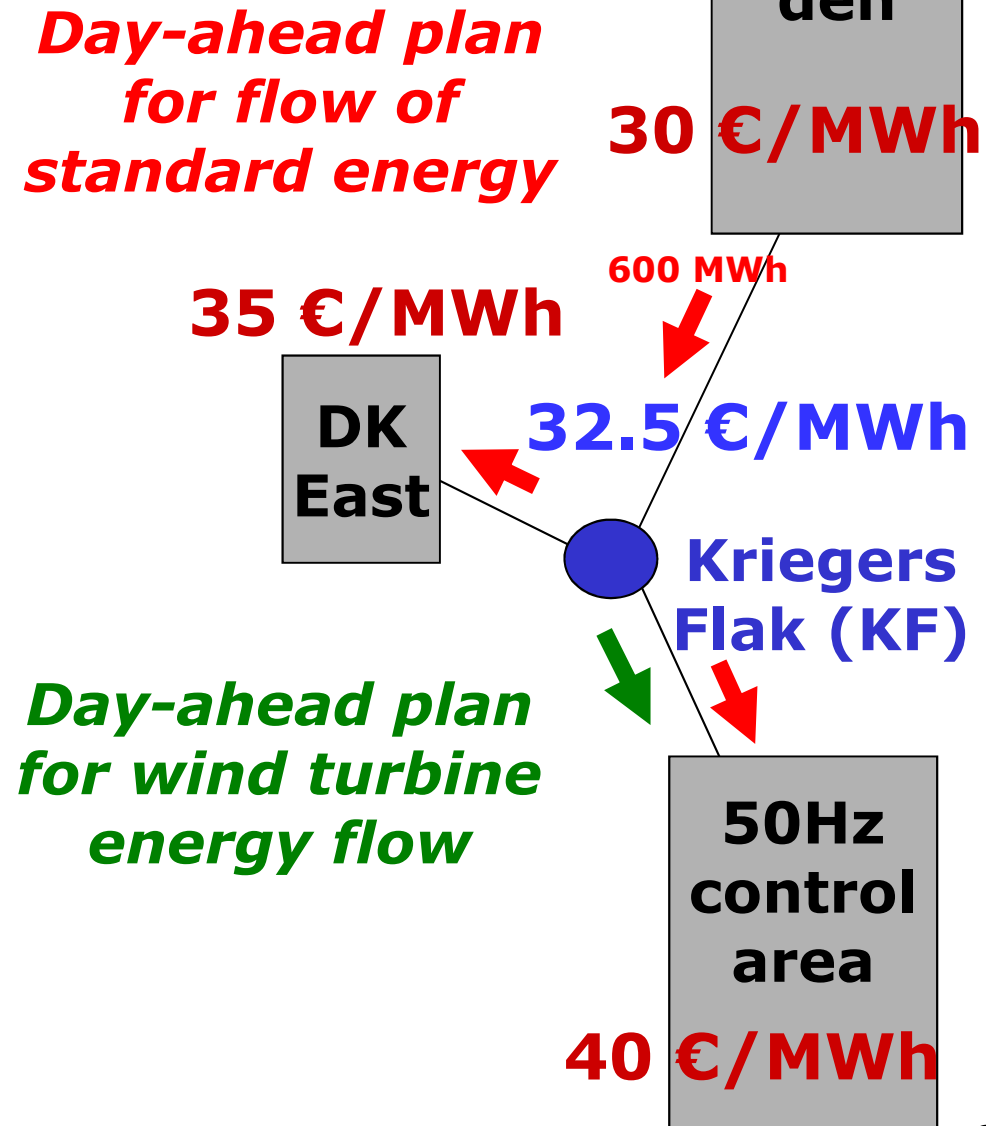


The day-ahead energy price

For one hour of tomorrow. KF is Kriegers Flak.

E_{KF} is the expected wind turbine energy production for this hour

- $E_{KF} = 600 \text{ MWh}$
 - ✓ The wind energy is sent to Germany.
 - ✓ The remaining DC grid capacity is used to send standard energy from Sweden to Denmark & Germany.
 - ✓ For the Kriegers Flak spot price, you can choose any price in the interval 30 – 35 €/MWh.
 - For example, you may choose the mid-price.



The day-ahead energy price

For one hour of tomorrow. KF is Kriegers Flak.

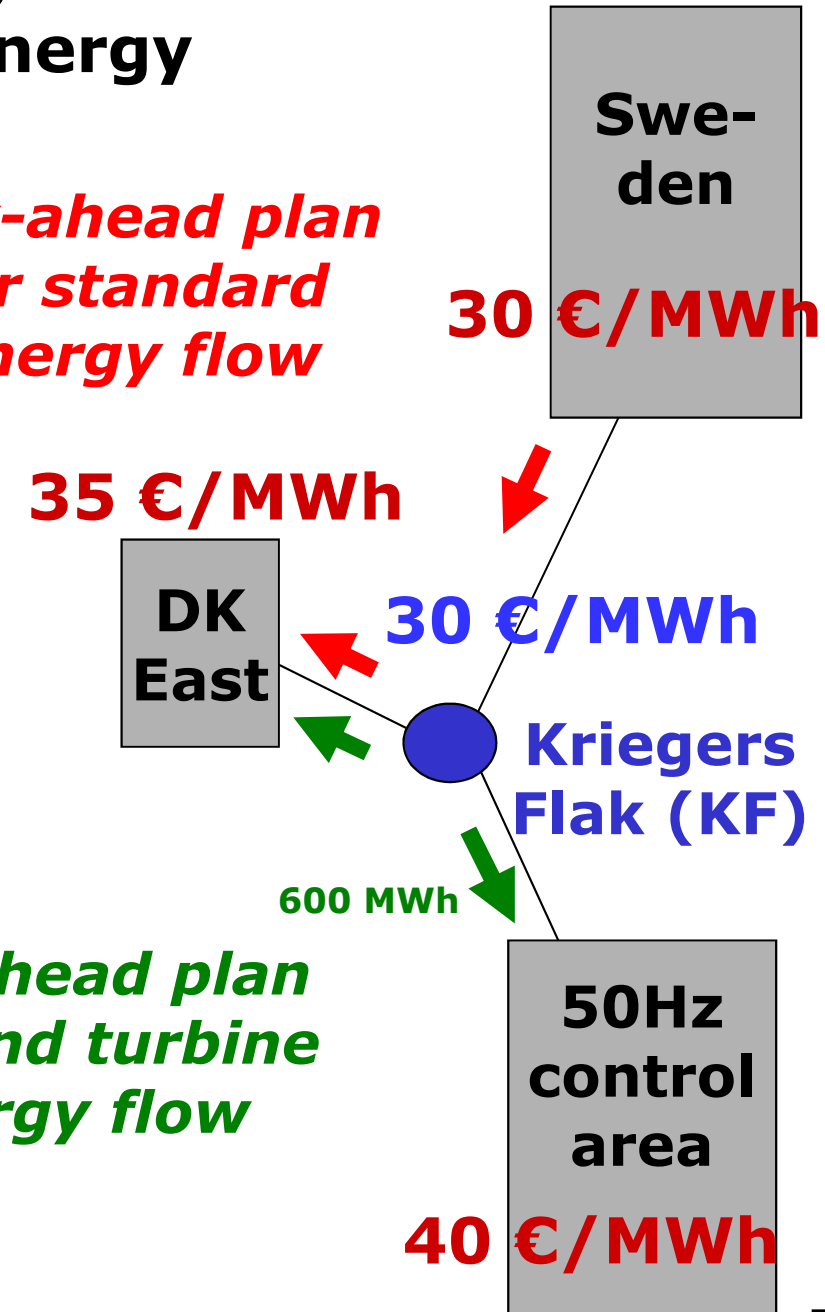
E_{KF} is the expected wind turbine energy production for this hour

➤ $600 \text{ MWh} < E_{KF} \leq 1,200 \text{ MWh}$

- ✓ The wind energy is sent to Germany and DK_{EAST}.
- ✓ The remaining DC grid capacity is used to send standard energy from Sweden to Denmark.
- ✓ As the link KF-Sweden is uncongested, the KF price becomes 30 EUR/MWh
 - When the link is uncongested, you can regard KF as an integrated part of Sweden.

Day-ahead plan for standard energy flow

Day-ahead plan for wind turbine energy flow

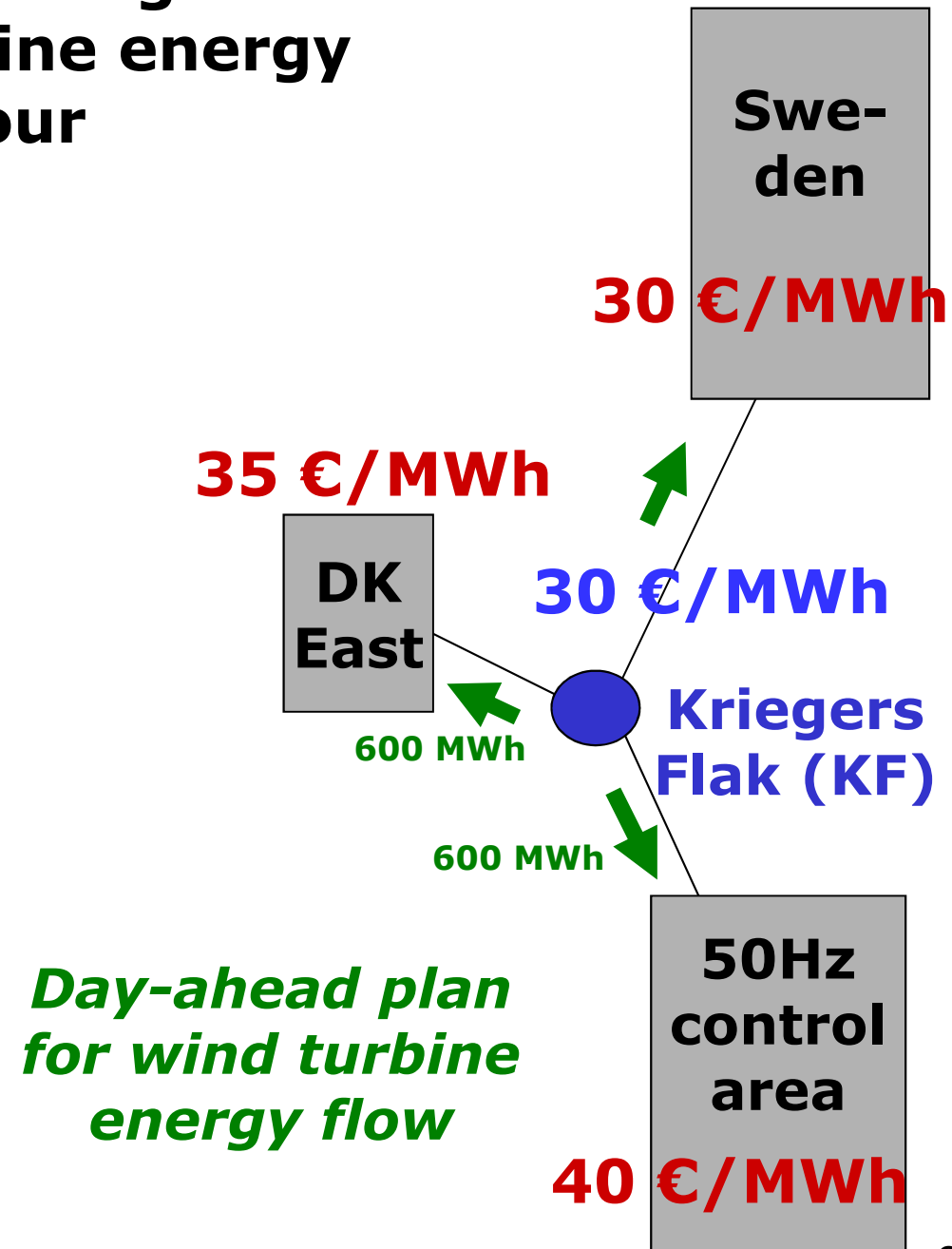


The day-ahead energy price

For one hour of tomorrow. KF is Kriegers Flak.

E_{KF} is the expected wind turbine energy production for this hour

- **$1,200 \text{ MWh} < E_{KF}$**
 - ✓ The wind energy is sent to Germany, DK_{EAST} and Sweden
 - ✓ As the link KF-Sweden is uncongested, the KF price becomes 30 EUR/MWh
 - When the link is uncongested, you can regard KF as an integrated part of Sweden.



Thank you for your attention!

Anders Plejdrup Houmøller
CEO

Houmoller Consulting ApS

Tel. +45 28 11 23 00

anders@houmollerconsulting.dk

Web houmollerconsulting.dk