

# First European Offshore Grid at the Baltic Sea? – Kriegers Flak: Techniques, Economics and Challenges –



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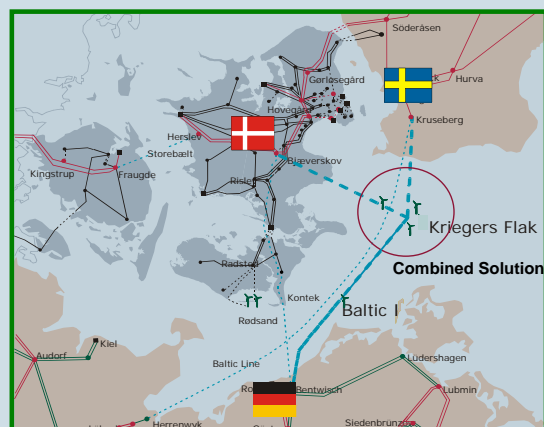
Joint Pre-feasibility Study



## Combining Wind Farm Connections to Make an Interconnector Grid in the Baltic Sea

### Contents

- Method
- Result: Technical concepts
- Result: Socio-economic benefit
- Result: Rough Cost-Benefit
- Challenges/barriers
- Summary



### Idea

Replacing of **three single** by one **common solution** offers considerable benefits involving technically advanced, three-legged interconnector for modest additional costs.

## Method and Background

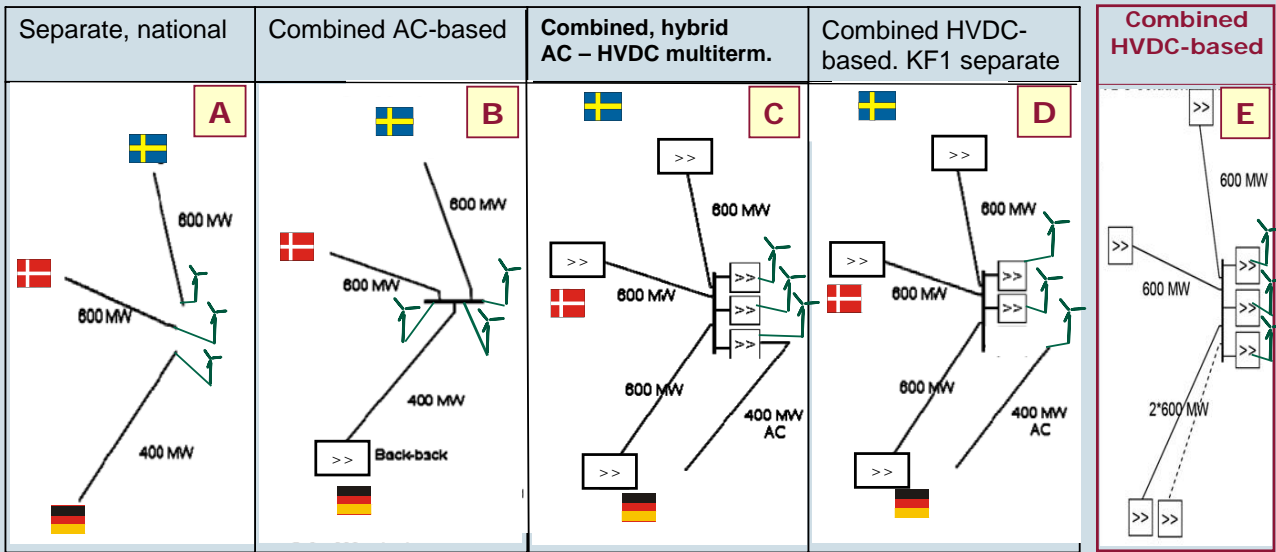
- **Assumption:**  
1600 MW wind power will be build at Kriegers Flak:  
(400+600+600) MW
- **"Business-as-usual"** is to connect these three wind power plants nationally by radial connections. This will cost a certain amount of money
- Is it **technically possible** to make a combined solution? (yes!)

## Method and Background

- **Investment Costs:**  
How much more expensive are combined solutions compared to separate, national solutions? What is the **best concept**?
- Can the **socio-economic benefit** from increased energy trade justify the additional expenses? (yes!)
- Are there **more Benefits? Security of Supply?**
- Is it possible (wrt **legal, regulatory and market issues**) to make a combined solution and reap the potential benefits?  
(challenges exist!)

# Technical Concepts

theoretical



Rough cost estimate:

Sep. solution... + 130 mio.€ + 300 mio.€ + 245 mio.€

Capacity for north-south intraday trading depends on wind feed-in:

No exchange up to 400 MW up to 1000 MW up to 600 MW up to 1200 MW

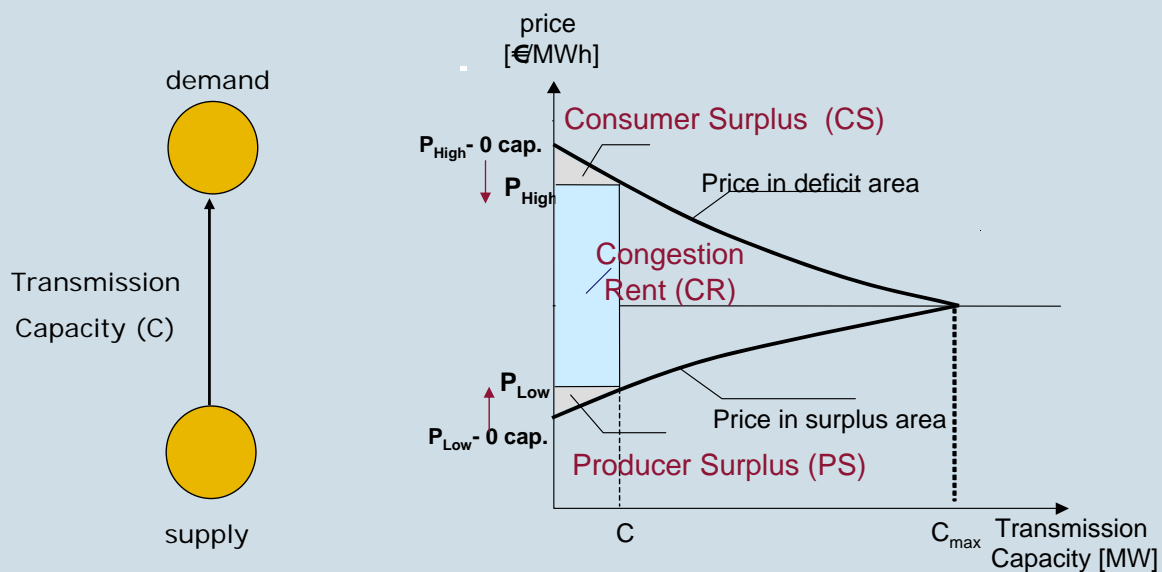
B1 and KF1 will be connected by AC solution

# Socio-economic Benefit from North-european Market Model

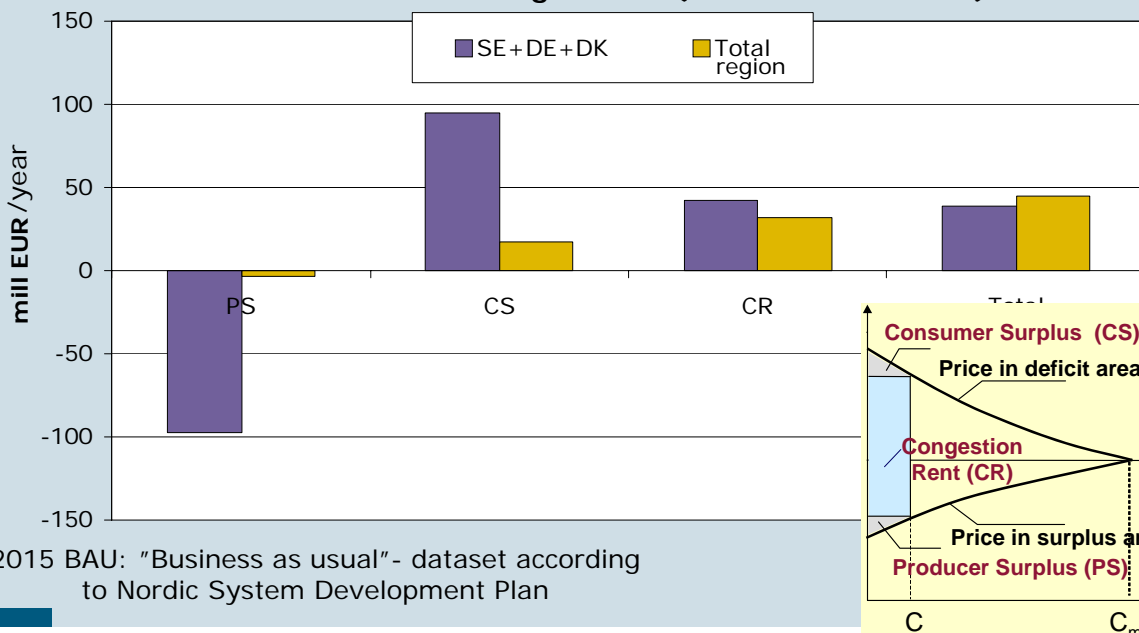
- Increased interconnector capacities between Germany, Sweden and Denmark is beneficial to the region. Socio-economic modelling is used to calculate how beneficial.
- Analyses using the EMPS Market Model (EFI's Multi Area Power Scheduling)
  - quantifies expected gain of combined vs. separate solution
  - calculates price cross in all price areas based on
    - production system
    - consumption
    - transmission capacities between areas
  - uses average of 51 years of inflow to hydro power in Nordic system



Consumer Surplus + Producer Surplus + Congestion Rent = **Socio-economic Benefit**



**Socio Economics - 2015 BAU**  
 Common solution at Kriegers Flak compared to individual solutions  
 Common solution at Kriegers Flak (600 - 600 - 400 MW)



2015 BAU: "Business as usual"- dataset according to Nordic System Development Plan

## A Rough Cost-Benefit Analysis

Results are preliminary and sensitive to key assumptions like cable prices, future production system (energy balances), fuel prices, utilization period etc. Cost of onshore grid reinforcements are not included

- Cost of Construction:
  - additional cost for a combined solution compared to separate solution:
    - With 400 MW to Germany: ~130 mio.€ (A->B)
    - With 1000 MW to Germany: ~300 mio.€ (A->C)
  
- Total Socio-economic benefit (DE+SE+DK):
  - With 400 MW to Germany: ~36 mio.€ /year
  - With 1000 MW to Germany: ~103 mio.€ /year
  
- At 6% interest and 20 years,
  - 130 mio.€ corresponds to ~11 mio.€ /year
  - 300 mio.€ corresponds to ~26 mio.€ /year

Effects of changes in maintenance costs and losses are not included,  
full capacity to DE has been considered (no priority feed-in of wind power energy)

→ Further investigations are required with detailed handling of barriers and challenges

Barriers:

## Overall Coordination and Uncertainties

- The investment decisions about Wind farms at Kriegers Flak
  - How much installed wind power capacity can we expect?
  - When can we expect it?
  
- Coordination
  - complex
  - circumstances will change

### The Challenge:

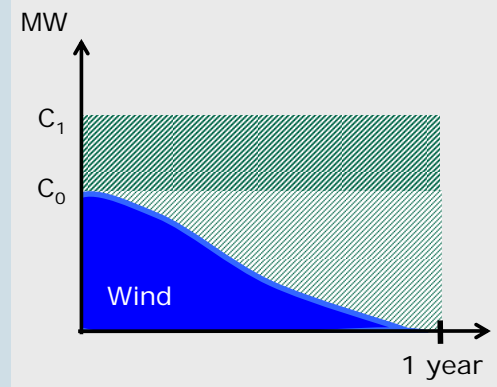
If we must wait for all investment decisions,  
a common solution might only be possible step by step.

We cannot plan and build a common connection for all possible wind farms up front.

Barriers:

## Current Rules and Guidelines

- Priority feed-in of wind power energy in DE limits/blocks day-ahead trade
- Different rules for balancing and trade of system services make these products not tradeable
- Different support schemes for renewables (physical delivery)
- Different responsibilities for offshore grid connection / building transformer platforms increases the effort for coordination and makes costs sharing difficult



Barriers:

## Other Tasks

- Necessary onshore grid expansion
  - How to handle Kriegers Flak in the electricity market?  
(Implicit auction is the ambition with EMCC as the respective service provider - How can it be done practically?)
  - Costs and benefit sharing for a combined connection
  - Environmental studies and permissions
  - Kriegers Flak as a part of a large offshore grid?
  - A standard for VSC-Technology in future?  
(VSC-grid-technology / standard DC voltages / plug and play concept)
- > Further studies are required

## Summary

- Clear potential for combined Offshore Grid at Kriegers Flak
- Most important assumption is that KF1-3 are erected
- Many barriers have to be determined and evaluated yet

# Thank you !

