



Cross-border interconnector capacity: investment hurdles and incentives

from a Transmission System Operator perspective

Summer School 2016 - Conference Day – Jacobs University

Bremen, 22/06/2016

Jonas Kraeusel

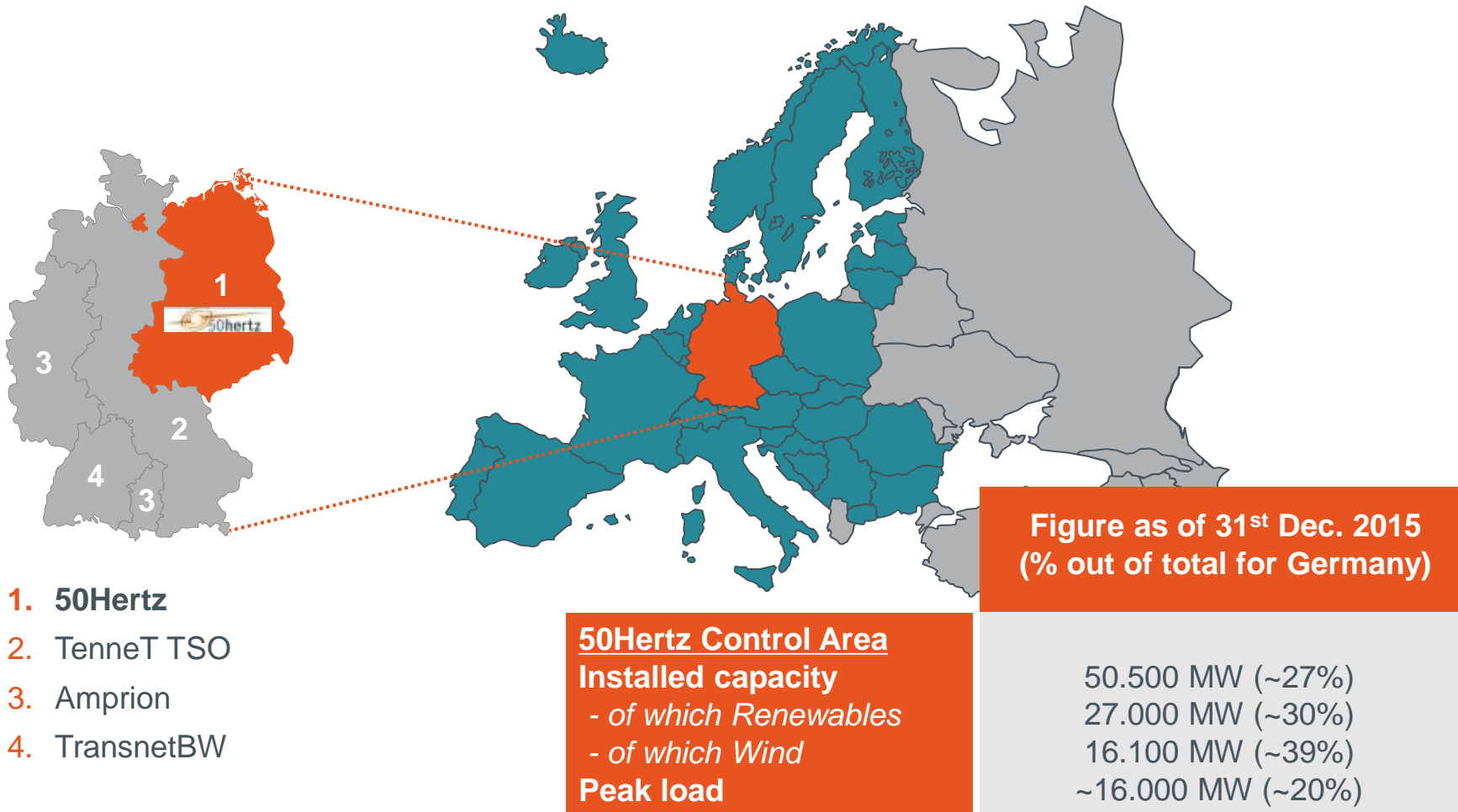


Agenda

1. Drivers for interconnectors in the 50Hertz control area
2. Potential barriers for the implementation of interconnector projects
3. Challenges in practice: Kriegers Flak Combined Grid Solution and Hansa PowerBridge

Drivers for interconnectors in the 50Hertz control area

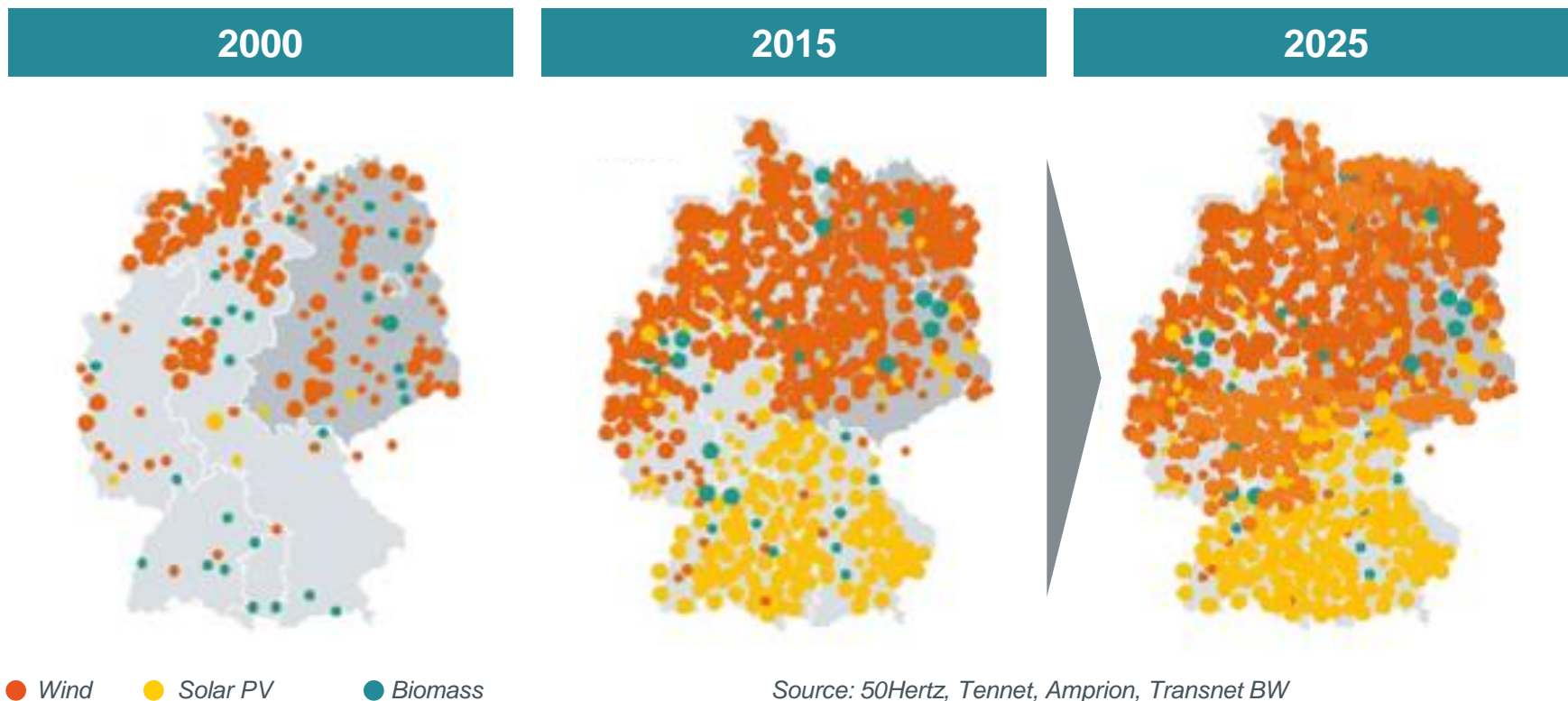
50Hertz as part of the European Electricity System



- 1. 50Hertz
- 2. TenneT TSO
- 3. Amprion
- 4. TransnetBW

50Hertz Control Area
Installed capacity
- of which Renewables
- of which Wind
Peak load

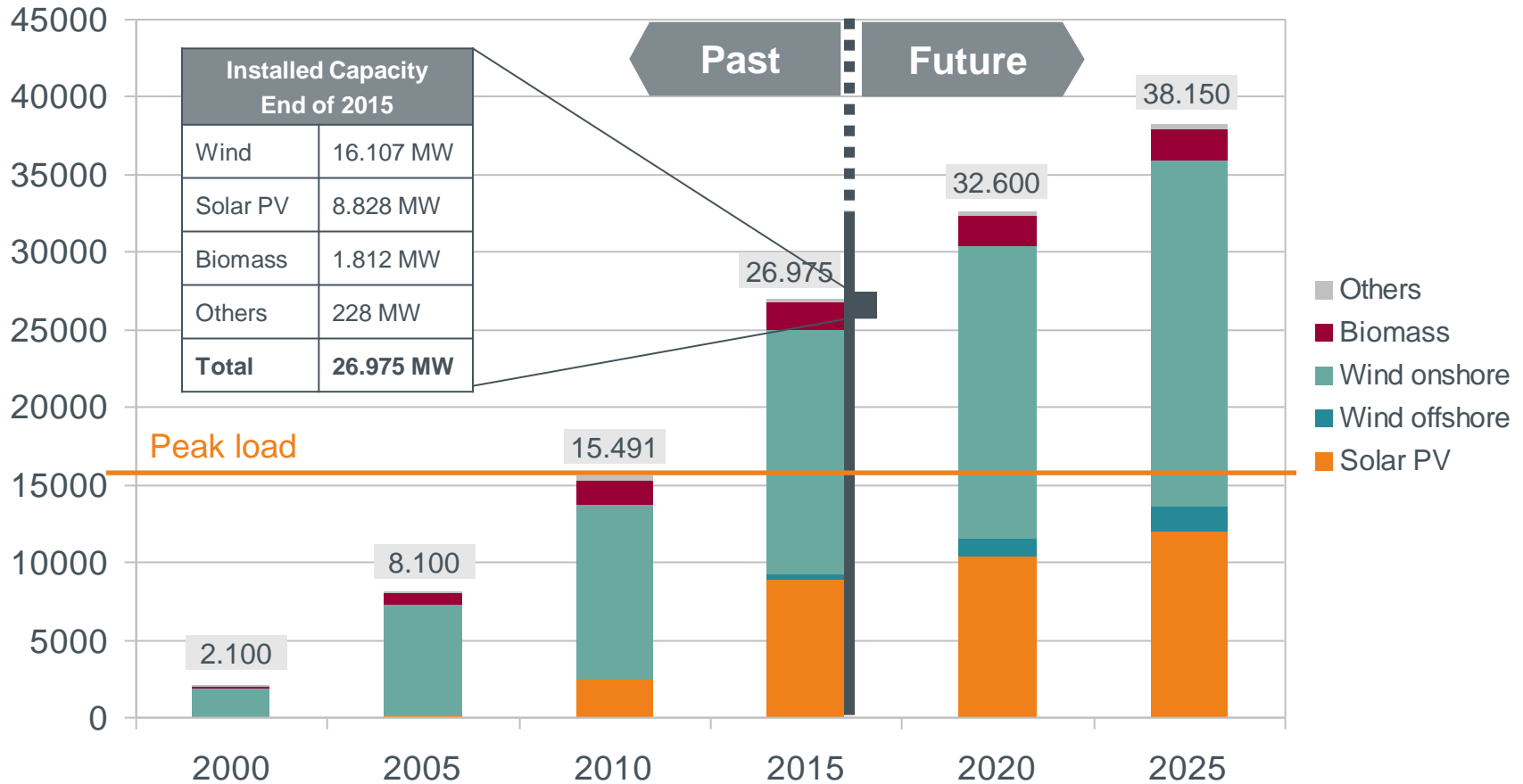
Development of renewables in Germany as a highly visible aspect of the ‘Energiewende’



Over the next ten years the share of RES in Germany will continue to grow – with further windfarms in the North and solar parks in the South.

RES in the 50Hertz grid area: Present situation and forecast of installed capacity

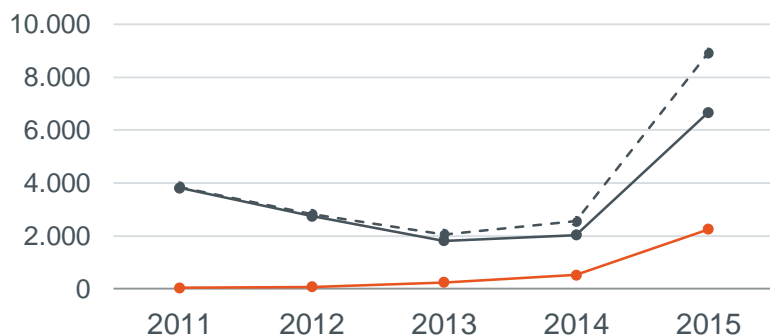
Installed capacities in MW



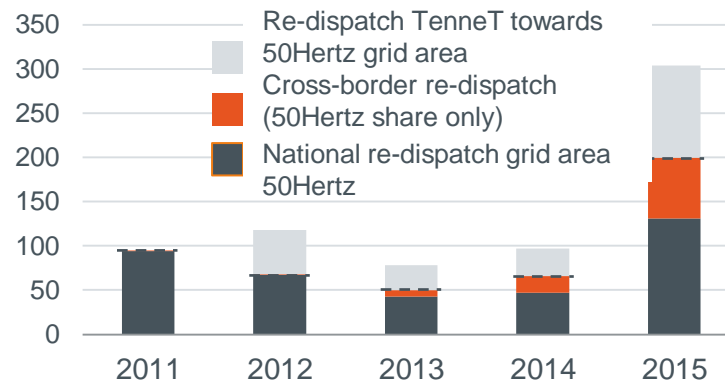
Congestion management: record high of interventions to stabilize grid in 2015

Electricity volume and costs for redispatch

volume in GWh

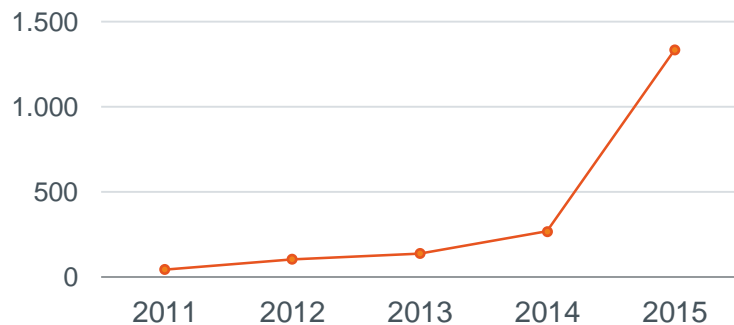


costs in Mio €

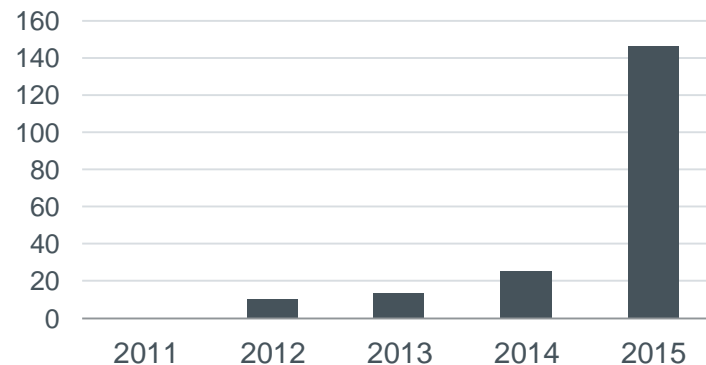


Electricity volume and cost for curtailment of wind in-feed

volume in GWh



costs in Mio €



Fast grid expansion is very beneficial for grid users as it would lower the costs for interventions in the grid, increase security of supply and enhance use of RES.

The interconnector potential between Germany and Scandinavia is not yet fully exploited

New “storage links“
under development



* Maximum available storage capacity of water reservoirs in 2011

- Increasing volatile surpluses in Germany due to renewables in-feed require flexible and abundant storage capacities
- World Energy Council (2012) study showed potential of 7 to 12 GW of additional interconnections between Germany and Nordic countries.
- Capacity for Alpine hydro storage and potential for new technologies like power-to-gas and batteries likely to remain at a much lower level.

Wind integration triggers interconnectors

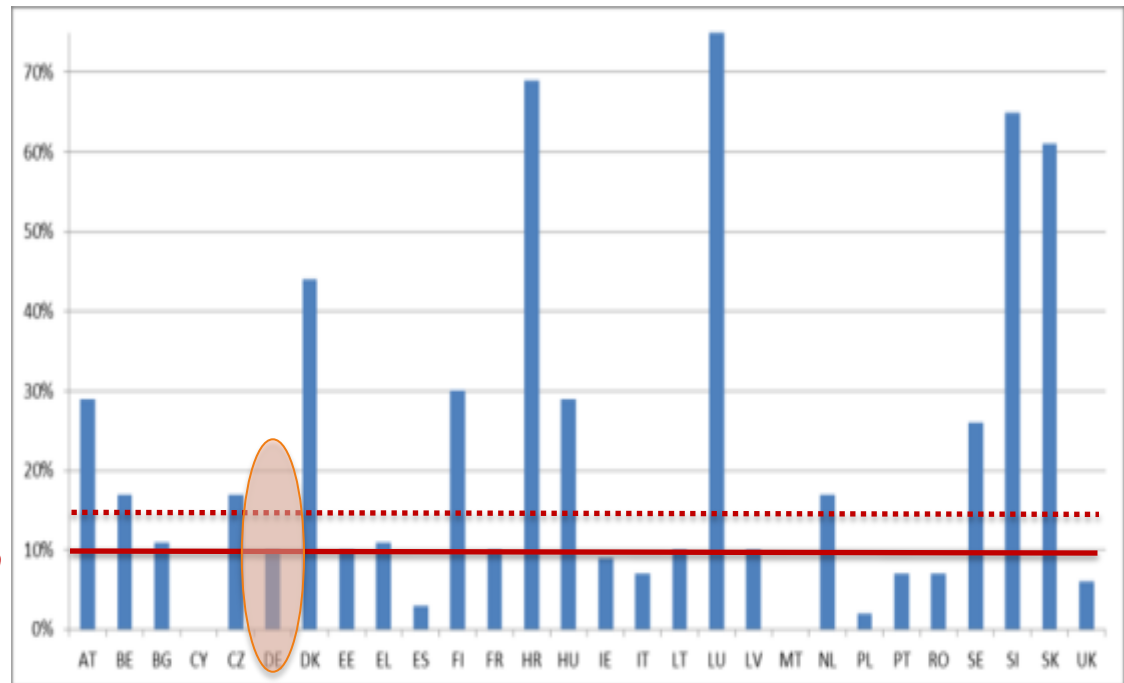
- A rising share of renewables in Germany requires internal grid extension, operational and market-based measures and interconnectors.
- Drivers for interconnectors:
 - Comparison of **spot price levels** (yearly average of spot prices) between two markets has been a good indicator for promising interconnector projects and trigger investment.
 - With a growing share of **volatile energy sources**, **flexibility** (hourly price differences) becomes more and more important. Interconnectors to regions with sufficient storage capacities may play an important role for systems with high shares of fluctuating RES generation.
 - Other drivers such as **energy trade in shorter time frames** (hours and shorter), use of interconnectors for **balancing purposes**, the consideration of interconnectors for cross-border **capacity markets** and **security of supply** are likely to gain importance.

European goals on interconnector capacity

- 10-15% goal in ratio of interconnector capacity to total installed capacity
- Goals strengthen TSO position when interconnectors face approval from regulatory and spatial permission authorities
- Differentiation and refined definition necessary?

15% goal by 2030

10% goal by 2020



Status 2014 / Source: EC, based on ENTSO-E „Scenario and Adequacy Forecast 2014“

Potential barriers for the implementation of interconnector projects

Financial incentives for interconnectors

National regulation follows cost-based approach for all new transmission lines, whether or not it is an interconnector

Regulatory approval for socializing costs for measures (§ 23 ARegV (1)) if considered necessary for general system stability or for the integration in the national or international joint grid

Although the initial financial incentive for an interconnector is independent from the expected congestion rent income, the required proof of necessity for the integration in the international grid triggers only projects which are reasonable from an economic and operational viewpoint.

50Hertz paradigm: Grid expansion to the extent necessary to ensure system security and the integration of renewables and to the extent accepted by society.

Regulatory approval process for interconnectors



- Only regulatory approval secures investment
- Requirements include:
 - agreement with partner-TSO on the rationale of an interconnection despite differing financial and system-related incentives
 - common project description in TYNDP, which performs cost-benefit-analyses
 - adaptation of interconnection in national grid development plan
- Regulatory approval of interconnector project with efficient cost recovery

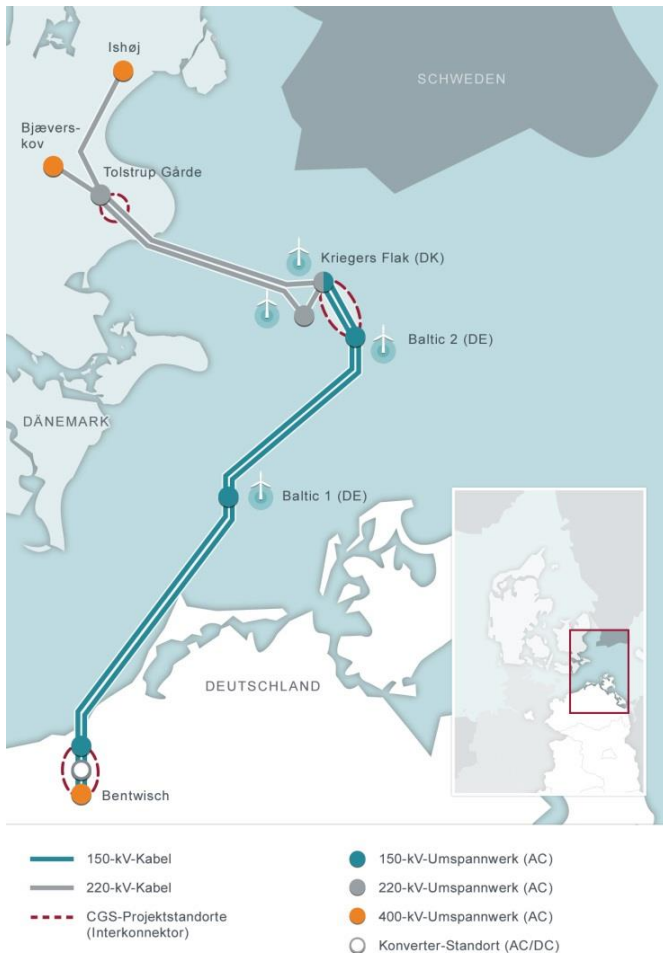
Potential barriers during project implementation

- **Planning**
 - Specialists available for such a huge project?
 - Interaction with other projects?
 - Stable political, economic, system-related drivers for partner-TSOs?
 - Well-established partnership between affected TSOs?
- **Spatial permission**
 - Conflicts in spatial plans?
 - Land acquisition feasible?
 - Correct choice of connection points?
 - Does a status as European Project of Common Interest speed up the permission process?
- **Construction**
 - cost estimates fit suppliers offer and real costs?
 - Chosen technical solution appropriate?



Challenges in practice: Kriegers Flak Combined Grid Solution and Hansa PowerBridge

Kriegers Flak Combined Grid Solution (Interconnection to Denmark)

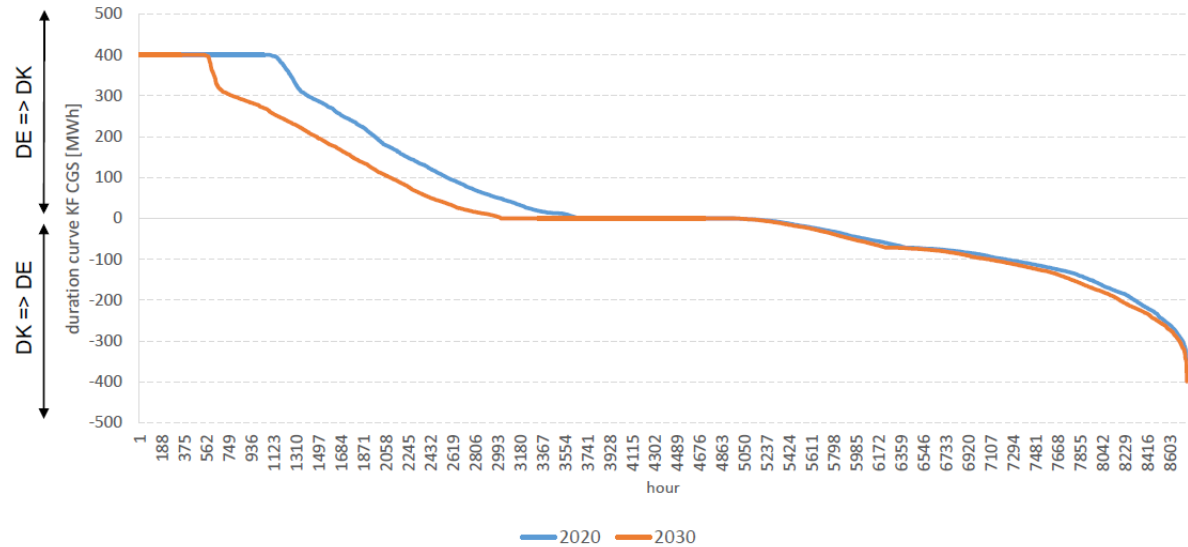


Project	Interconnection DK - GER
Installed capacity	400 MW HVDC (B2B converter) 400 MW HVAC (cable)
Length	≈54 km HVAC subsea cable (2 x 27 km)
Substation onshore:	Substation Bentwisch (GER), B2B converter station
Substation offshore:	Substation Bjæverskov (DK), filter OSS Baltic 2 (extension) (GER) OSS Kriegers Flak E (DK)
Envisaged commissioning	2018
Peculiarities	<ul style="list-style-type: none"> ▪ Unique combination of offshore wind farm connection and interconnector ▪ Status as European Project of Common Interest ▪ Partly funded by European Union
Social Economic Welfare (modelled for 2020)	Ca. 10 Mio € per year

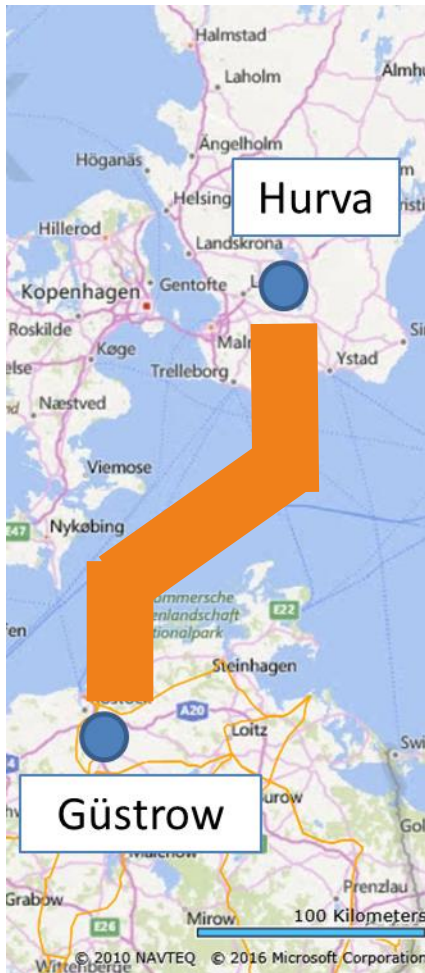
Complex and innovative project character in combination with slight decrease in trade

- Market simulations for CGS show
 - German market prices more and more influenced by offshore wind production
 - Initial plan of HVDC hub with SE, DK and DE had to be adapted due to Swedish offshore wind regulation and high DC technology price offers
 - Important financial EU support for innovative character

The importance of CGS for system adequacy rises, impact of volatility will relatively become more important than an annual average price level.

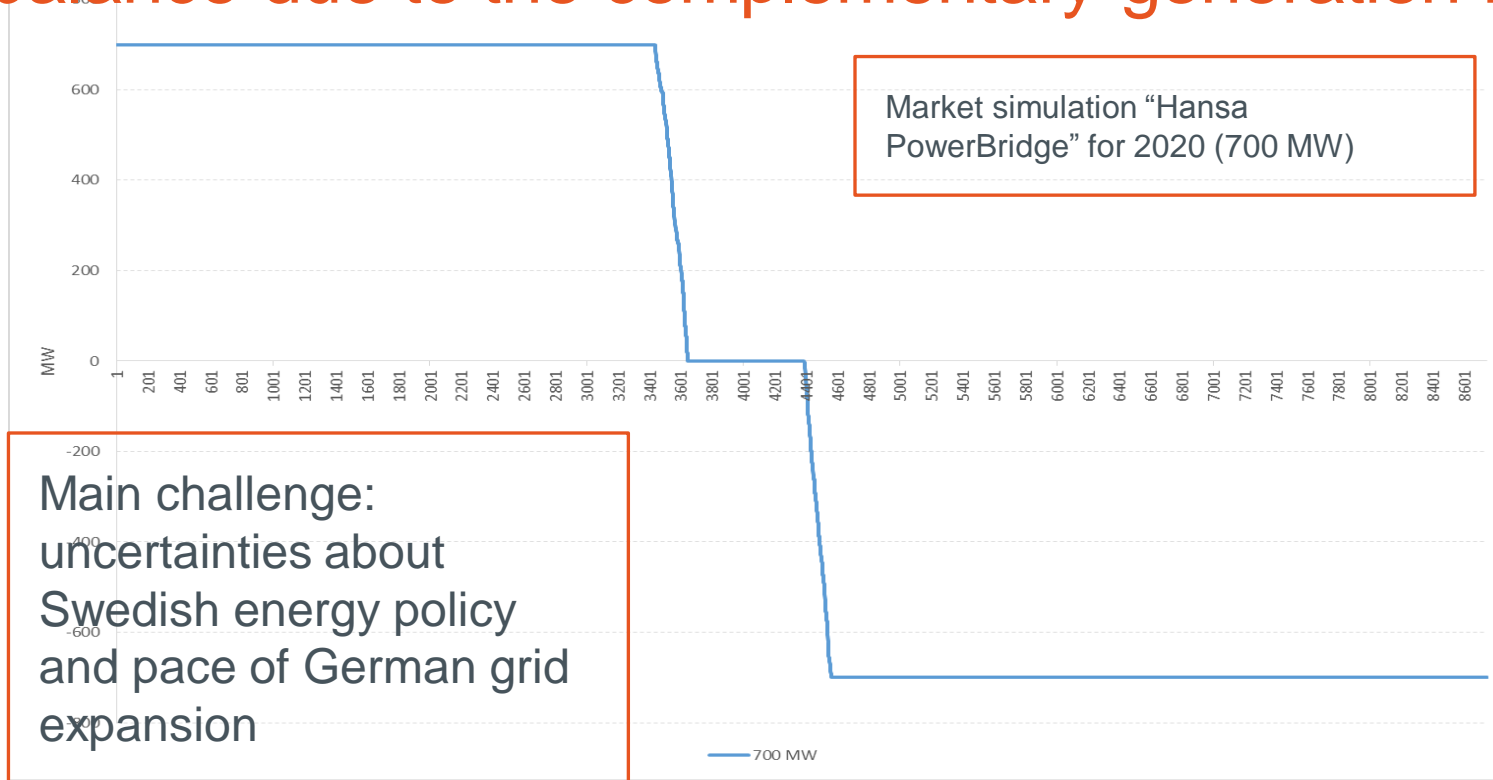


Hansa PowerBridge (Interconnection to Sweden)



Project	Interconnection SE- GER
Installed capacity	700 MW HVDC Potential of increase in the future
Length	≈300 km, incl. HVDC subsea cable
Routing	SE4 - Güstrow
Social Economic welfare (modelled for 2030)	Ca. 30-80 Mio € per year
Envisaged commissioning	2023-2025
Next steps	<ul style="list-style-type: none"> Verification of routing and technical details Signing of cooperation agreement on the implementation phase early 2017

Market simulation indicates an almost even trade balance due to the complementary generation mix



Volatility of hourly price differences makes Hansa PowerBridge a profitable project although the annual average price difference is low.

Drivers for interconnectors outweigh barriers

- The cost-based German regulatory framework usually provides sufficient financial incentives for interconnectors which are economically beneficial and ensure secure system operation
- Since regulatory frameworks differ, a stable financial incentive and political support in all other EU-countries is wishful
- Some other project-related risks such as lengthy permission procedures should be tackled by the authorities
- A sound and professional project management, close relations with the partner-TSO and suppliers and careful follow-up of developments in the European Energy Market are key success factors