Integrated Baltic Offshore Wind Electricity Grid Development - The Challenges of Offshore Wind: A Grid Operators‘s Perspective

The Baltic InteGrid I Kick-off Conference

The Challenges of Offshore Wind: A Grid Operators‘s Perspective

Berlin, 22/03/2016

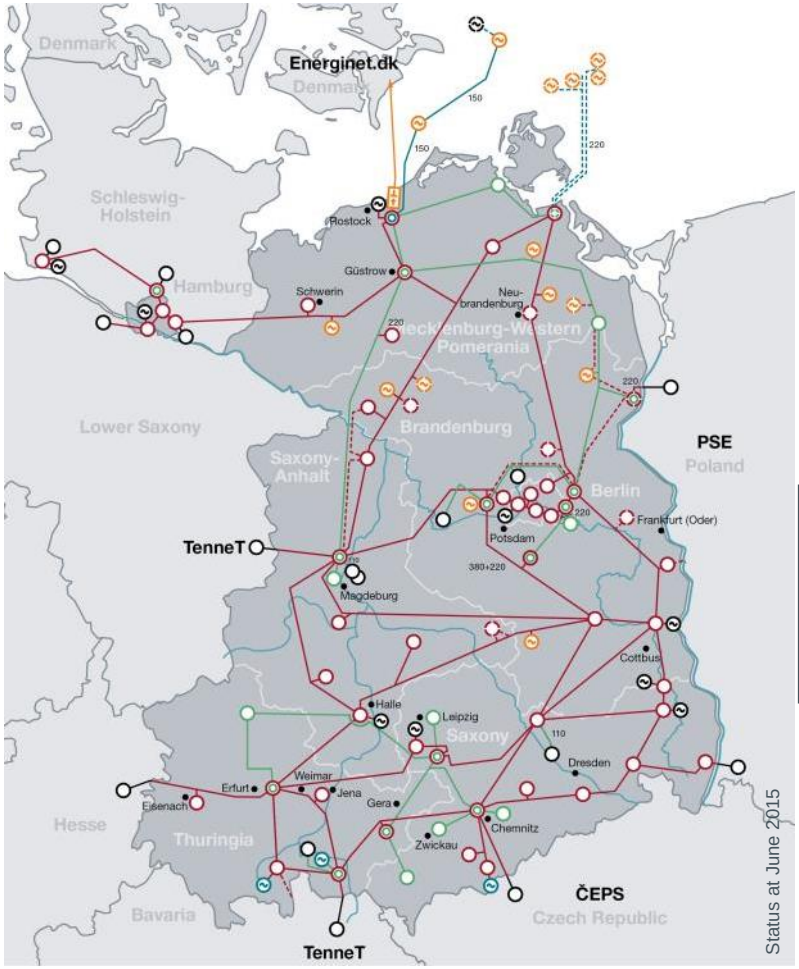
Nadja Ballauf

Agenda

1. 50Hertz Company Profile
2. Offshore Wind Grid Connection Projects in the German Baltic Sea
3. On the Way to a Transnational Offshore Grid
4. Conclusion

1. 50Hertz Company Profile

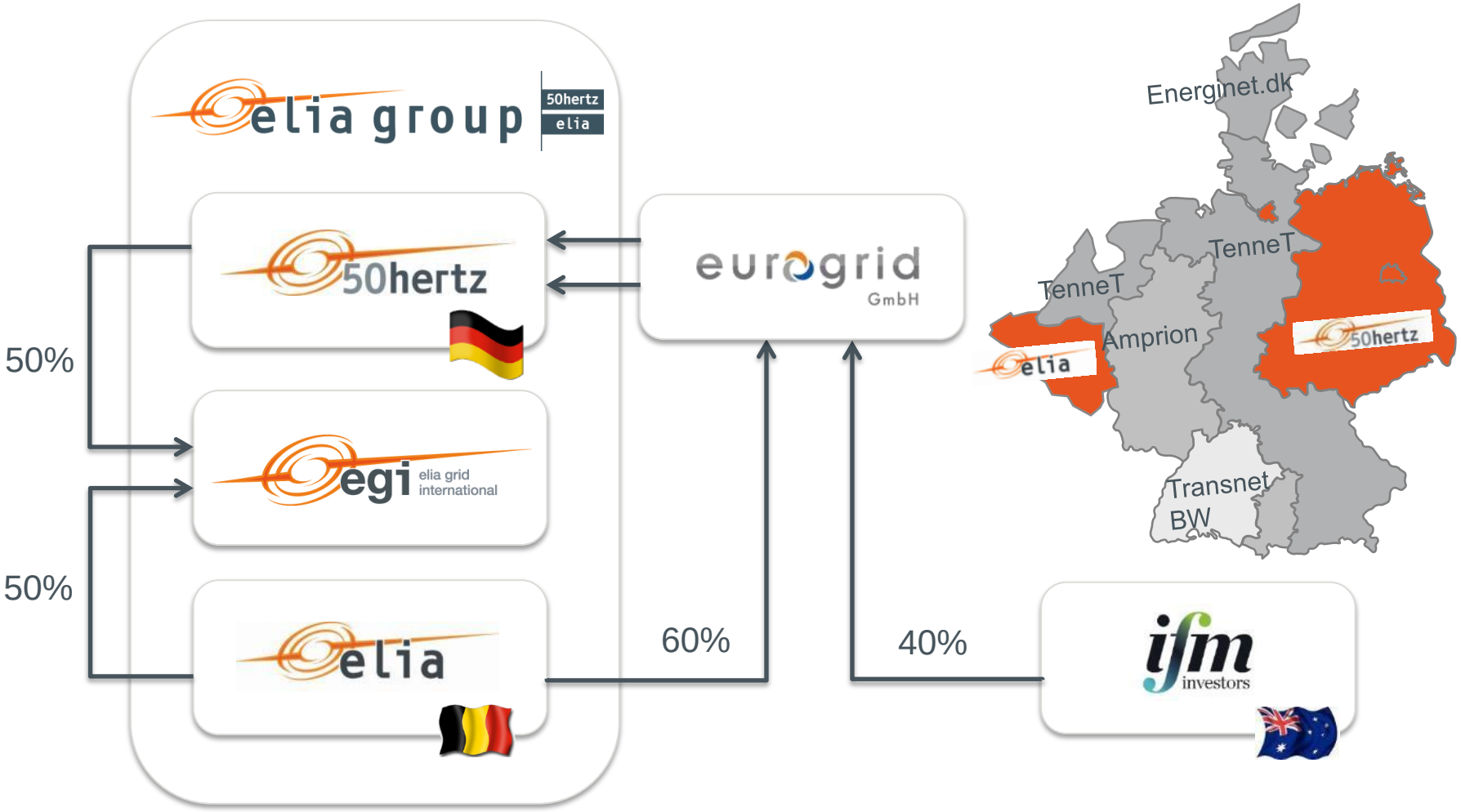
50Hertz at a glance



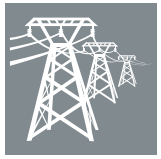
	Value (Share in DE) Situation in late 2014
Area	109,360 km² (31%)
Total length of lines	9,855 km (29%)
Maximum load	~ 16 GW (21%)
Energy consumption (based on electricity supplied to final consumers in acc. with the EEG)	~ 95 TWh (20%)
Installed capacity: - of which Renewables - of which Wind	48,080 MW (~24%) 25,216 MW (~29%) 14,797 MW (~38%)
Workforce	893
Turnover - of which grid	8.569 billion € 0.976 billion €

Source: 50Hertz

50Hertz as a part of an international group



Transmission grids are the technical backbone of the energy supply in Germany and in Europe



Owner of the transmission grid

In charge of operation, maintenance and the development of **extra-high-voltage lines** and **power junctions** (substations) and as well for the connection of **large-scale generators** and **consumers** (including offshore)

System operator

Responsible for **system stability** of the transmission system around the clock: frequency control and voltage regulation, congestion management.

Market developer

Catalyst for the **development of the energy market**, especially in Northern and Central-Eastern Europe.

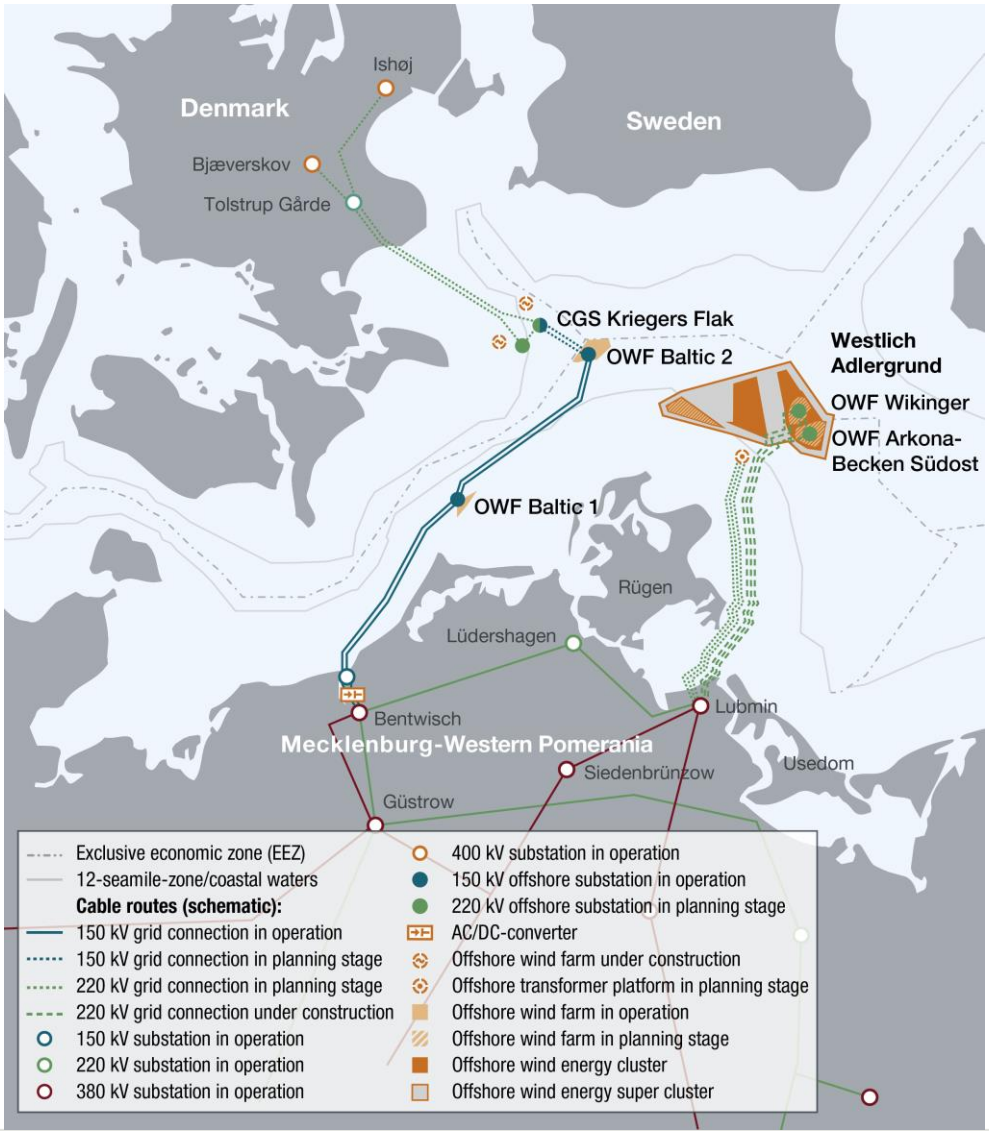
"Trustee" for performing EEG processes

Responsible for the **financial management of renewable energies (EEG)**.

Source: 50Hertz

2. Offshore Wind Grid Connection Projects in the German Baltic Sea

Offshore Grid Development Projects - Overview



Grid Connection Baltic 1

- since 03/2011 successfully in operation

Grid Connection Baltic 2

- since 09/2015 successfully in operation

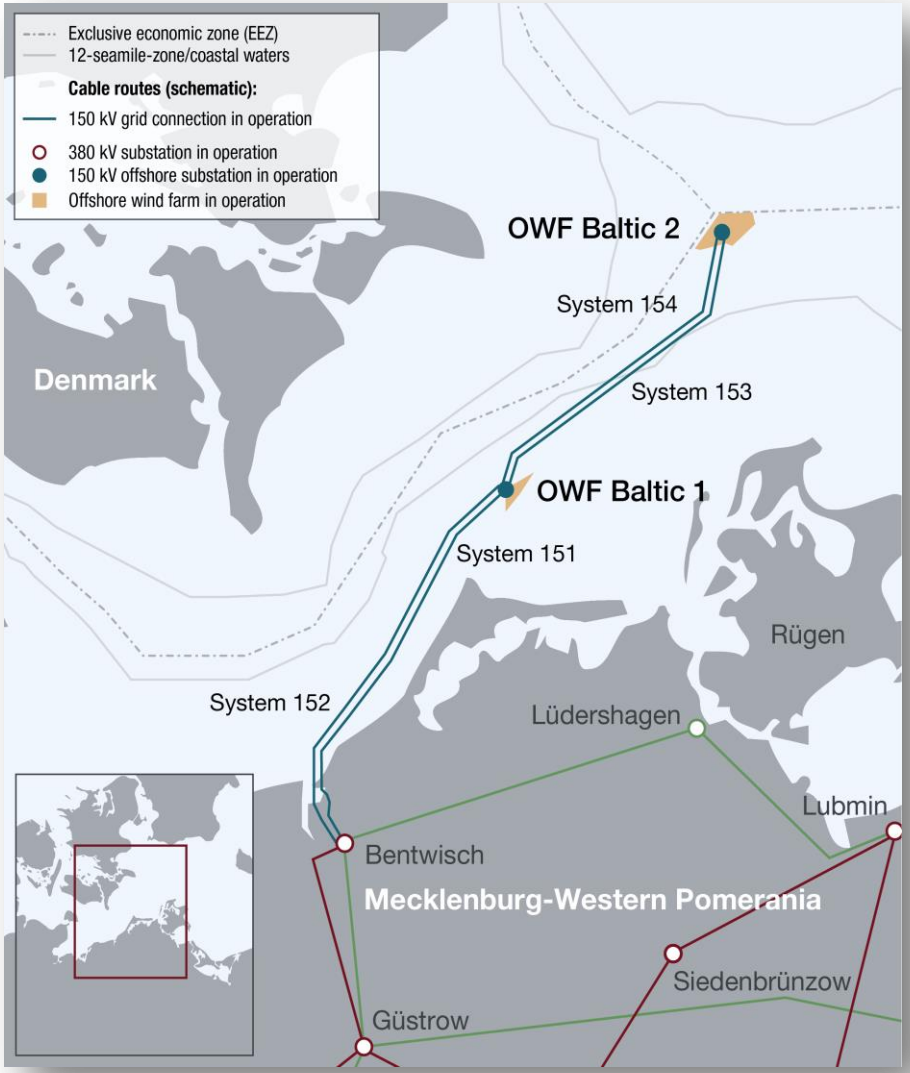
Grid Connection Cluster Westlich Adlergrund

- efficient 3-cable-solution foreseen to connect wind farms Wikinger and Arkona-Becken Südost
- all permissions received
- all construction measures have been started

Kriegers Flak Combined Grid Solution

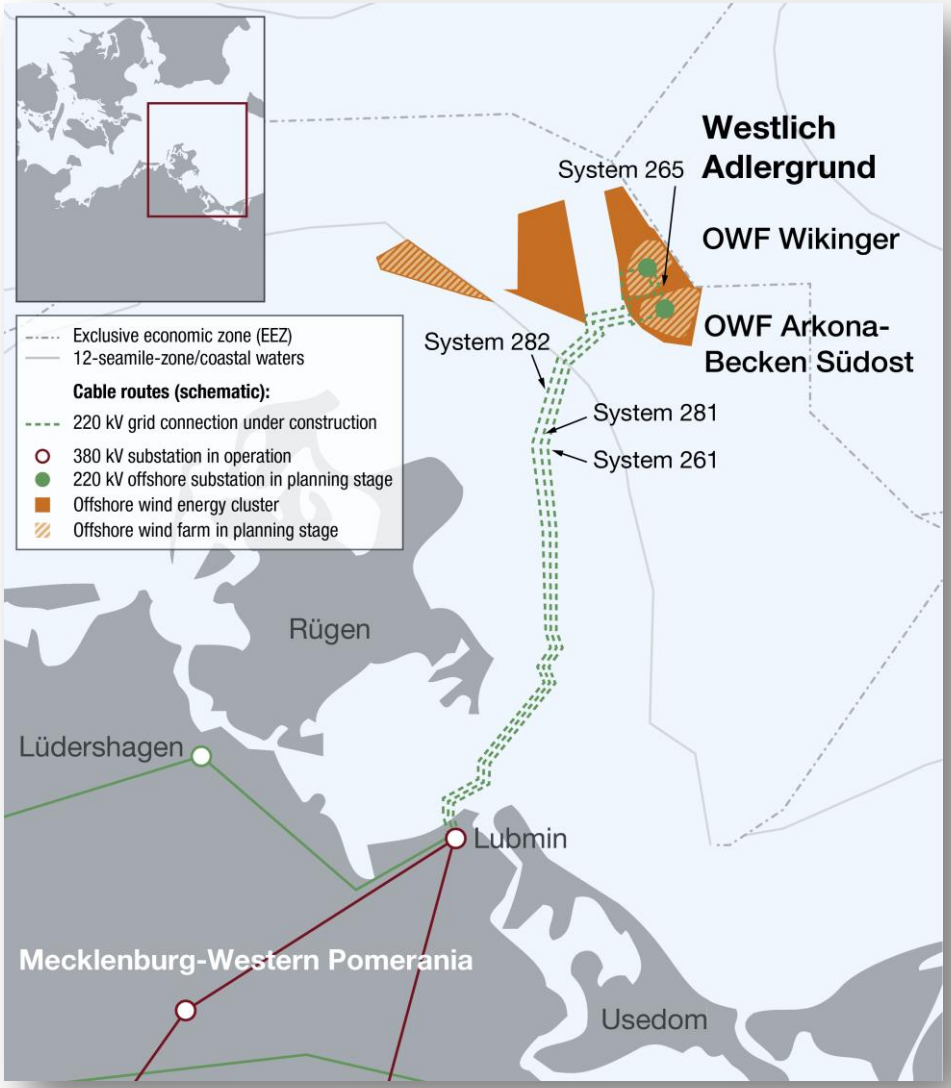
- innovative combination of OWF grid connections and interconnector between Denmark and Germany
- realization and cooperation between Energinet.dk and 50Hertz agreed in January 2015
- support by European Commission granted, subsidies of up to 150 million €
- The activities have been started

Combined Grid Connections OWFs Baltic 1/ Baltic 2



Grid Connection for OWF	EnBW Baltic 1 GmbH & Co. KG EnBW Baltic 2 GmbH
Installed Capacity	48,3 MW (Baltic 1) 288 MW (Baltic 2)
Grid Connection	2 x 150 kV AC cable connection (combined connection Baltic 1 and Baltic 2)
Length of Grid Connection	ca. 60 km sea cable to Baltic 1 ca. 60 km additional sea cable to Baltic 2 15 km land cable
Substation	150/380 kV Bentwisch
Status	Grid Connection Baltic 1: in operation since 03/2011 Grid Connection Baltic 2: in operation since 09/2015

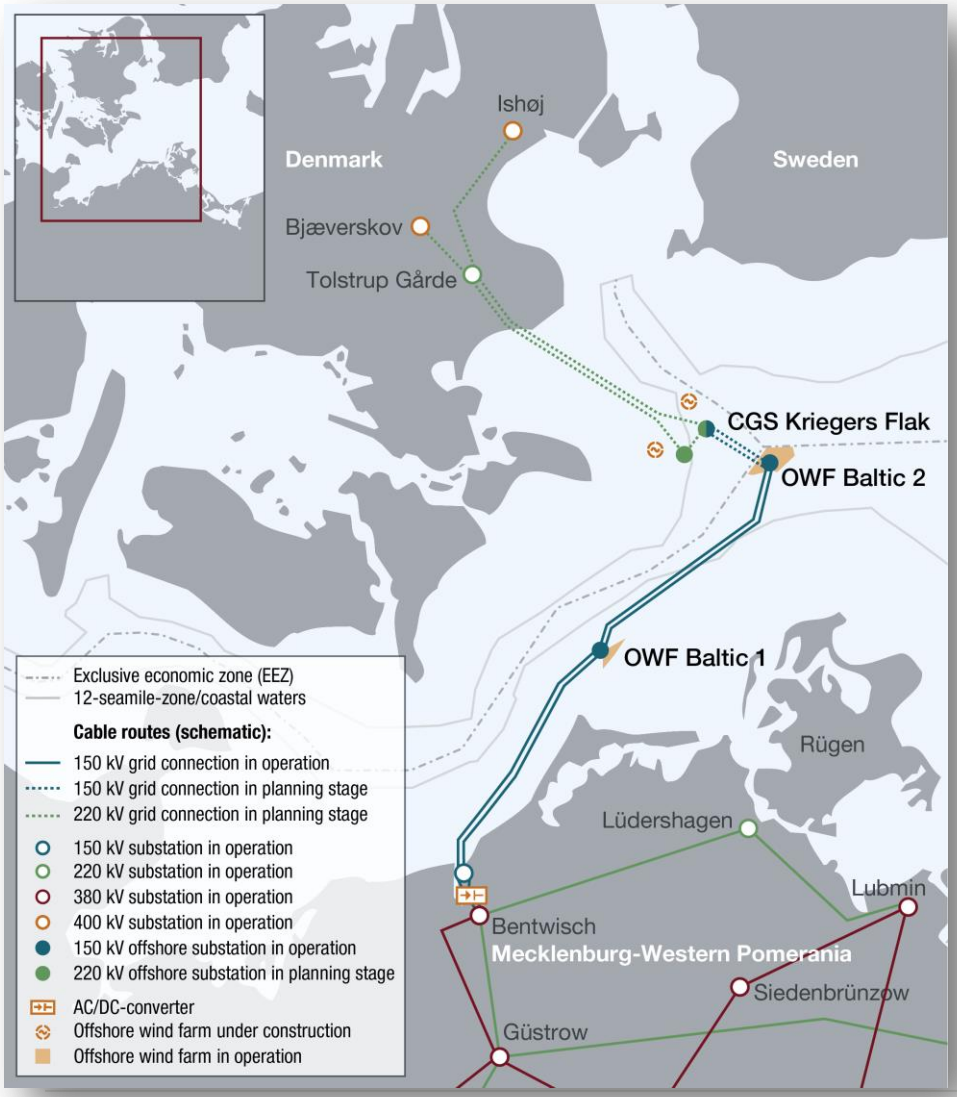
Grid Connection Ostwind 1 (**C**luster **W**estlich **A**dlergrund)



Grid Connection for OWF	Iberdrola Renovables Deutschland GmbH (OWF Wikinger) and Arkona Windpark Entwicklungs GmbH (AWE / affiliate of E.ON) (OWF Arkona-Becken Südost)
Allocated Grid Capacity	735 MW (350 MW Iberdrola, 385 MW AWE) 3 cable systems à 220 kV
Length of Grid Connection	93 km offshore, 3 km onshore
Substation	Lubmin

3. On the Way to a Transnational Offshore Grid

Kriegers Flak Combined Grid Solution



Idea

- creation of link between grid connections of OWFs in the Kriegers Flak Area Baltic 2 (Germany) and Kriegers Flak III (Denmark)
- usage of linked grid connections for cross-border electricity trade
- option to realize further leg to Sweden at a later stage

Aims and benefits

- ✓ integration of renewable energy and achievement of EU climate protection goals
- ✓ extension of cross-border electricity trade capacity/ integration of markets
- ✓ improvement of security of supply

Project of European Energy Programme for Recovery

Pilot project for cross-border offshore grid!

Legal and Contract-related Background

European Framework

- Project is supported by the EU and listed as a PCI-project (Projects of common interest)
- EU funding of up to 150 Mio by the European Programme for recovery (EEPR)

→ Grant Agreement (GA) between EU / ENDK / 50Hertz

German Framework

- „Bundesbedarfsplangesetz 2015“
- „Network development plan 2024

→ Implementation of legal requirements by 50Hertz!

Partnership Agreements

- Energinet.DK / 50Hertz
- Cooperation Agreement (CA)
- 50:50 ownership & costs

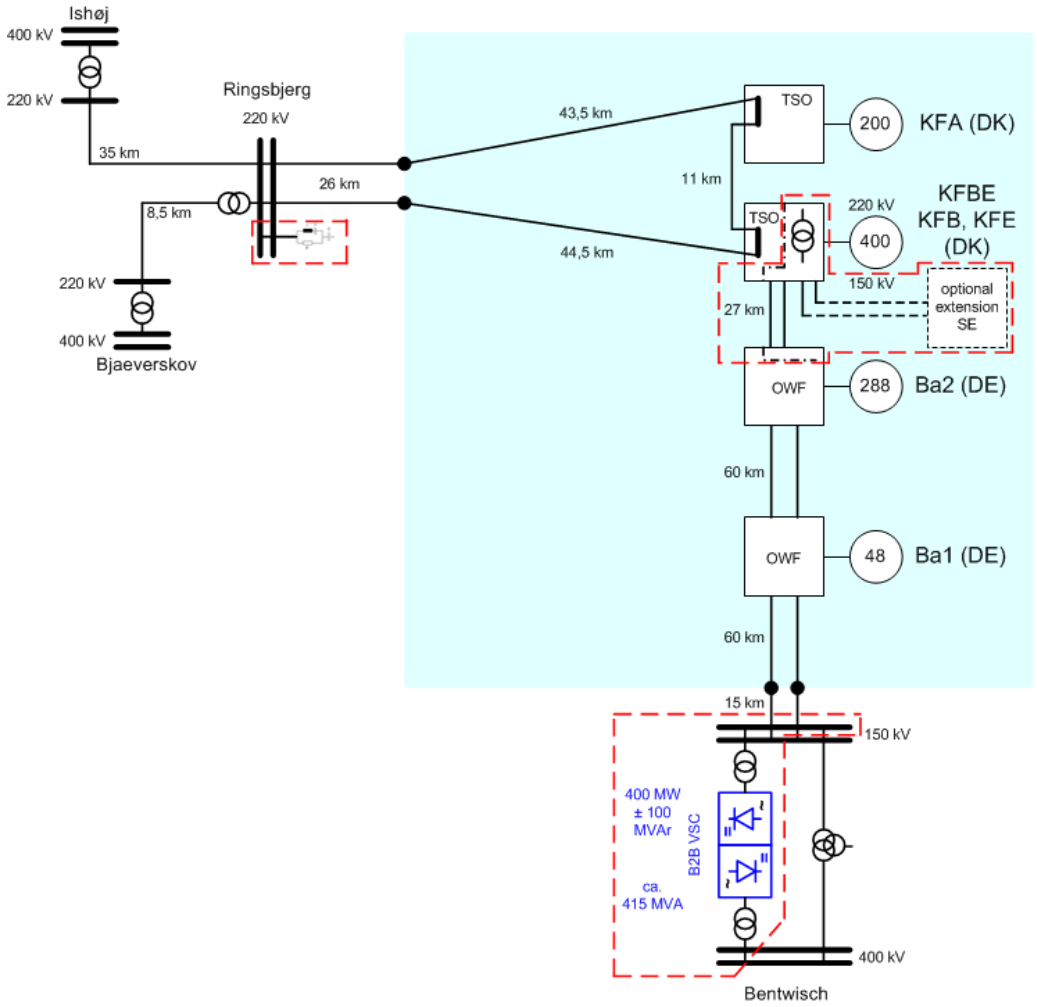
→ common project team/ common decisions

International Contractors

- International FIDIC (International Federation of Consulting Engineers) contracts

→ challenging in organisational matters

KF CGS - Technical Concept

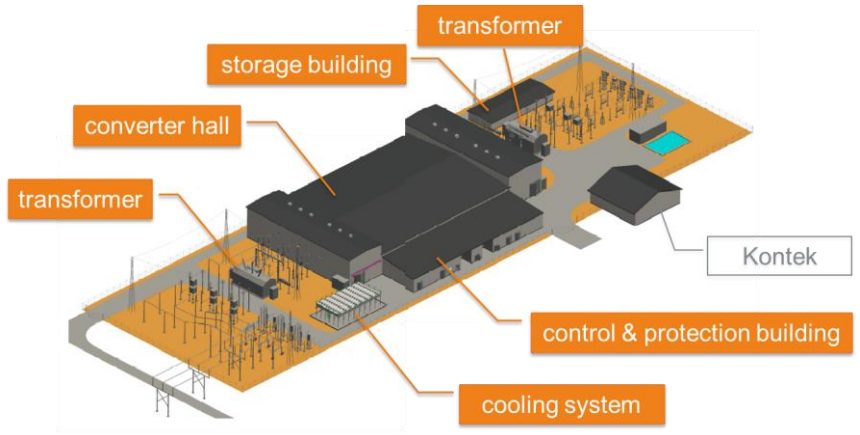


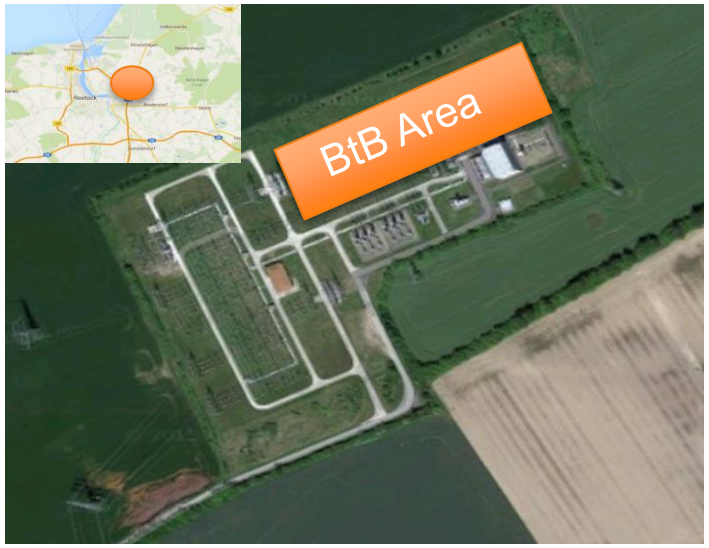
Main components

- **HVDC onshore B2B converter station Bentwisch**
  including **M**astercontroller for **I**nterconnection **O**peration (MIO)
- **HVAC offshore Substation Kriegers Flak E (KFE)**, extension of the existing OSS KFB by erection of a daughter platform on a common foundation KFBE
- **HVAC sea cable connection**
  OSS Baltic 2 – OSS Kriegers Flak E, 2 x 150-kV-sea cables
- **HVAC Onshore Substation**
  extension SS Bentwisch
  extension SS Tolstrup Gårde
- **C-Type-Filter** in Tolstrup Gårde (MSCDN)

Main Components CGS - Infrastructure

Back-to-Back Converter Station Bentwisch





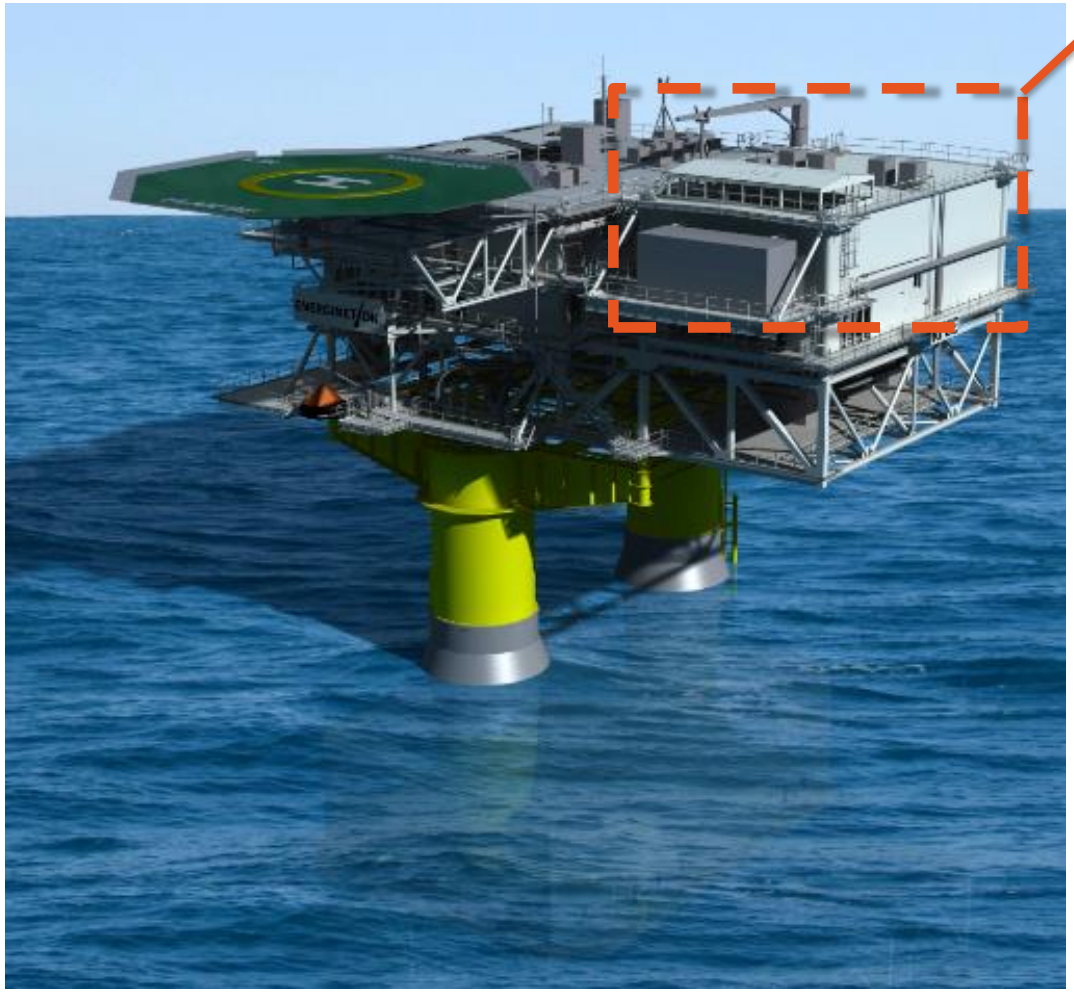
Location:

- East of Rostock on the premises of substation Bentwisch

Area Needs:

- approximately 1,5 hectare

Offshore Substation KFE



extension of the existing OSS KFB

KFB/E Topsides

- Area: approx. 42 x 32 m; KFE: approx. 15 x 32 m
- Height: 35 m
- Total Weight: approx. 2400 t KFE: approx. 750 t

KFBE Gravity Based Substructure

- Height of foundation: 34 m; underwater: 16 m

Approx. 60km off the coast of Denmark

4. Conclusion

Conclusion

1. Lessons learned and implemented concerning technical issues
   - cable production & logistics, cable laying/ subsoil conditions; bad weather; interfaces to OWF project
2. Current framework for offshore wind and grid connections seems rather sound
   - but: next step in the evolution already ahead (tender procedures…)
3. Potential for cost savings and increase of efficiencies to be realized
   - permission requirements (e.g. laying depth), further synergies with OWFs in construction and operation
4. Clarification / establishment of standards concerning maintenance, repair and insurance of grid connections
   - identification of justifiable and efficient standard of repair storage (cables, joints, transformers, shunt reactors, vessels?)
   - availability of insurance for damages of lost feed-in tariff caused by delayed or interrupted grid connection?
5. Close Partnership between TSO and OWFs concerning grid system management
   - cooperation with regards to forecasts of in-feed

Thank you for your attention!

Nadja Ballauf

50Hertz
Eichenstraße 3A
12345 Berlin

030 – 5150 – 0
info@50Hertz.com

www.50Hertz.com

Berlin, 22.03.2016