The significance of a meshed offshore grid in the North Sea from an energy-economic perspective - The German experience

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NorthSeaGrid Workshop:
Interconnected Offshore Grid – Barriers & Solutions Bremen, 18 June 2014
Side Event of WINDFORCE 2014
Overview

1. Stiftung OFFSHORE-WINDENERGIE

2. Status of Offshore Wind Energy Development in Germany

3. New Regulatory Regimes for Offshore Grid Connection
   - EnWG
   - BFO
   - O-NEP

4. Conclusion
German Offshore Wind Energy Foundation

- Founded in 2005 as an independent, non-profit organisation to promote the utilization and research of offshore wind
- Acquisition of ownership rights (permit) of alpha ventus (Sep. 2005) – moderated/accompanied process
- Platform for offshore wind/maritime industry, incl. trade associations, policy-makers and research
- Offices in Varel and Berlin (since Q4/2011)
- Initiator of studies/initiatives
  - cost reduction study (Prognos-Fichtner, 2013)
  - energy system benefits study (Fraunhofer IWES, 2013)
  - Collaborative WG between maritime industry and the offshore wind sector
- Involved in various projects, e.g. OffWEA - consultation, support and moderation
- PR and public acceptance work

International (EU) Projects
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German Offshore Wind Farms Operational and grid-connected (Q1/2014)

**alpha ventus (DOTI)**
- Fully online since 04/2010
- 12 turbines, 60 MW total capacity
- Annual electricity production appr. 250 GWh
- 30 m water depth, 45 km distance to shore

**Baltic 1(EnBW)**
- Fully online since 05/2011
- 21 turbines, 48 MW total capacity
- 18 m water depth, 15 km distance to shore
- Annual electricity production appr. 190 GWh

**BARD Offshore 1 (BARD/Ocean Breeze)**
- Fully online since 08/2013
- 80 turbines, total capacity: 400 MW
- 40 m water depth, 90 km distance to shore
- 120 km HVDC sea cable

**Riffgat (EWE)**
- Fully online since 02/2014
- 30 turbines, 108 MW installed capacity
- 20 m water depth, 15 km distance to shore
- Grid connection delays (OWF completed in 08/2014)
Overview German Offshore Wind Farms (Status Q1/2014)

- 616 MW operating (online)
- 2324 MW under construction – meanwhile 2,647 MW (6/2014)
- 872 MW investment decision made – meanwhile 582 MW (6/2014)
## Overview German Offshore Wind Farms (Status Q2/2014)

### Operational
- alpha ventus
- Baltic 1
- Bard Offshore 1
- Riffgat

### Under Construction
- Borkum West 2*
- Meerwind Süd/Ost*
- Global Tech 1
- Nordsee Ost
- Dan Tysk
- Borkum Riffgrund 1
- Baltic 2
- Amrumbank West
- Butendiek

### FID made
- Gode Wind I & II

### FID open
- Veja Mate
- Deutsche Bucht
- Albatros I
- MEG Offshore 1
- Nordergründe
- Sandbank
- Nordsee One
- Borkum Riffgrund 2
- Borkum Riffgrund West 1
- Wikinger
- Arkonabecken Südost
- Trianel Windpark Borkum (2.BA)

### 616 MW
- *OWF construction completed – waiting for grid connection*

### 2,647 MW

### 582 MW

### 3,341 MW

### 3,650 MW

### Commissioning
- 2010 - 2014
- 2014 - 2015
- 2015 - 2016

20+ offshore wind farms fully permitted – appr. 7 GW additional capacity
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**Offshore Grid Connection** - a long line of delays, regulatory uncertainty and system change

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec. 2006</td>
<td>§17 (2a) EnWG: TSOs obliged for grid connection (in time!)</td>
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<tr>
<td>Oct. 2009</td>
<td>Position Paper by regulator est. criteria for offshore grid connection</td>
</tr>
<tr>
<td>Since 2010/11</td>
<td><strong>Grid connection delays</strong> – up to 50-60 (+) months instead of 30 months (as envisaged by PP of 2009); TenneT letter to the government (7 Nov. 2011), raising liability and financing issues</td>
</tr>
<tr>
<td>Q1/2012</td>
<td><strong>WG Accelerated Grid Connection</strong> (moderated by: SOW) - recommendations to govt. on how to overcome delays</td>
</tr>
<tr>
<td>Q3-4/2012</td>
<td>Draft bill for change of EnWG (on system change/liability issues) proposed by govt. in summer, adopted by Parliament in late 2012</td>
</tr>
<tr>
<td>Jan. 2013</td>
<td><strong>New EnWG enters into force, i.e. regulatory system change</strong> → Implementation Guidelines (BNetzA) on liability issues and capacity transfer consulted during 2013/14,</td>
</tr>
<tr>
<td>April 2013</td>
<td><strong>ONEP 2013 (OGDP) draft issued for consultation by TSOs</strong></td>
</tr>
<tr>
<td>Sep. 2013</td>
<td>Federal Election</td>
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<tr>
<td>Jan. 2014</td>
<td><strong>ONEP 2013 published – enters into force</strong></td>
</tr>
<tr>
<td>April 2014</td>
<td><strong>Start of consultation on ONEP 2014 (with TSOs) and on grid capacity allocation (with regulator)</strong></td>
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</tbody>
</table>
EnWG 2013 – System Change for Offshore Grid Connection

Festlegungsverfahren gemäß § 17d (5)
• Aufstellung
• Umsetzung
ONEP

30. November 2012
Februar 2013
3. März 2013
vsl. Herbst 2013

Entwurf
Beschlussfähigkeit

Szenariorahmen
2013
gemäß § 12a

Bundesfachplan
Offshore
Offshore-BFP
gemäß § 17a

ÜNB
BSH

BNetzA
BNetzA

Öffentlichkeit
Öffentlichkeit

Offshore-Netzentwicklungsplan
ONEP
gemäß § 17b und 17c

ÜNB
BNetzA

Öffentlichkeit
Öffentlichkeit

Bundesbedarfs-
plan
BBP
gemäß § 12e

Bundesregierung
(BMWi, BMU,...)
Ausführung

BT/BRat
Zustimmung

Öffentlichkeit
Beteiligung

Onshore-Netzentwicklungsplan
NEP
gemäß § 12b

ÜNB
BNetzA

Öffentlichkeit

BSH Bundesamt für Seeschifffahrt und Hydrographie
BNetzA Bundesnetzagentur
ÜNB Übertragungsnetzbetreiber
BMWi Bundesministerium für Wirtschaft und Technologie
BMU Bundesumweltministerium
BT Bundestag
BRat Bundesrat
Offshore Grid Development Plan (ONEP) ‘Start Grid‘ according to ONEP 2013
OWF cluster connection – a step in between radial grid and meshed grid design

Approach so far: individual (DC) grid (cluster) connections - Contains substantial risk to energy system stability and economics
Aim:
Create a „flexible“ offshore grid - applied consumer protection!
• Minimising grid interruptions and delays in grid connection
• Continuously ensuring system safety and stability
• Risk mitigation
→ Can/should be implemented in the short/medium-term
Risk mitigation strategies are available (acc. to state of the art) - have to be considered by TSOs (part of O-NEP):

- **Realisation Schedules** (part of O-NEP, acc. para 17d EnWG), incl. option to prioritise certain grid connections
- **Grid connection management** and temporary grid connection measures require technical implementation and cost allowance by the regulator
- **Meshed grid** (connection of various OWF clusters/converter stations) – ensures system stability in case of damage/failure of a DC cable/platform (see BET study on economic benefits)

**Objective:** Optimise system economic and technical solutions and reduce potential liability exposure.
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Energy System Benefits of Offshore Wind

Key assumptions/study results

1. German Energiewende requires 800 TWh coming from wind and solar (by 2050) – *can only be realized with large offshore wind capacities!*

2. Offshore wind leads to **reduced cost for flexibility measures** → least-cost option by 2050

3. Offshore wind has considerable **power plant characteristics** – important for security of supply (provision of balancing power, high schedule reliability, etc.)

4. **Stable and continuous expansion** of offshore wind capacities **required** to harvest energy system benefits and cost reduction potentials

5. Further significant cost savings can be achieved by the European collaboration on a North Sea offshore grid for BE, DE, DK, GB, N, and the NL. Making use of cross-border balancing capacity and increased electricity trade **decreases the total residual load for all of the North Sea countries by 16 percent** → from 98 GW to 82 GW

More information at:

Study launched in Nov. 2013, (EWEA Offshore 2013, Frankfurt)
Realising cost reduction potentials requires active commitment and participation of all stakeholders

Recommendations for:
→ Policy and Regulatory Environment
  ▪ Stable legal and policy frameworks to ensure dynamic market development → key requirement/prerequisite
  ▪ Common standards for components and for grid connection
  ▪ Simplified criteria for certification and permitting

→ Industry (developers/technology suppliers) to accelerate technology innovation:
  ▪ Optimised system (plant) technology to maximize energy yield/operational hours
  ▪ Optimised existing support structures & development of new foundation concepts
  ▪ Improve installation logistics
  ▪ Intensify R&D efforts

→ Industry to improve efficiency
  ▪ Develop joint concepts for installation/O&M (pooling)
  ▪ Accelerate serial production efforts (incl. automation)
Long lead times for OWF need to be reflected (large power plant schedules)

Idealized (!) Project Schedule for an OWF in Germany

- **Project development**
  - 4-6 Years
- **Construction Permit**
  - 1-2 Years
- **Financial Negotiations**
  - 2-4 Years
- **FID**
  - 2-4 Years
- **Commissioning**
  - 20 Years
- **Operational Phase**
  - 5 Years
- **Extension of operation**
  - 5 Years
- **Decomm.**
  - 1-2 Years

Total project lifetime: 27-37 years

→ Stable, **long-term political framework conditions** essential for investors, technology innovation and cost reduction!!!
Conclusion and open questions for debate

• **Financial barriers:**
  How can TSOs ensure a sustainable financing of grid investments? (both offshore and onshore, e.g. overlay-grid).
  Need of a strong and capable organisational structure – ensure system stability and proper management of the 'Energiewende', e.g. creation of a national O-TSO /European (North Sea) OFTO?

• **Regulatory and Technical barriers:**
  Systematic (step-by step) approach to accelerate implementation, e.g. *long-term grid planning incl. meshed grid, standardisation and implementation schedules* contribute to:
  - Substantial *reduction of risk exposure* in case of grid failures/damages
  - Creation of a *flexible and stable (offshore) grid* by common technical standards and regulatory provisions
  - Substantial *reduction of downtime/repair times* by spare parts management (studies by MARSH and Deutsche. WindGuard, 2012)
  → Helps creating *improved conditions for financing/insurance* for (offshore) grid connection systems (DC) and OWFs.

• **Demonstration projects** on a bilateral/trilateral basis needed (with EU support) to prove technical feasibility, identify and deal with regulatory barriers
  → take into account long lead times of offshore projects and resolve regulatory/financial barriers separately and more long-term
Many thanks for your attention!

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More news & information (German/English)
Support for renewable energy - specifies FIT, technology differentiation since 2000

**Issues in the past for offshore wind (prior to 2009)**

- No investments due to insufficient remuneration (9.1 ct/kWh)

**EEG of 2008** (entered into force on 1st Jan. 2009)

- Increase of initial Feed-in-Tariff (FiT) to 13.0 ct/kWh, plus starter bonus of 2 ct, granted for 12 years after commissioning (valid new OWF until 1st Jan. 2016)

**EEG of 2011** (entered into force on 1st Jan. 2012)

- Compressed FiT: Option to claim a higher initial rate of 19 ct/kWh – granted for 8 years, afterwards FiT drops to 3.5 ct/kWh
  Applied for new OWF until 2017
  → Important boost for investment decisions

**New challenges emerging in 2012/13:**

Grid connection issues and “Electricity price brake” debate (‘Strompreisbremse’) – Uncertainty about future of the Renewable Energy Act and RE targets

**EEG 2014 – Revised targets for OWE**  
(Govt. Proposal of April 2014)

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<th>Year</th>
<th>IECP* of 2007</th>
<th>§ 3 EEG 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>10 GW</td>
<td>6,5 GW</td>
</tr>
<tr>
<td>2030</td>
<td>25 GW</td>
<td>15 GW</td>
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* Integrated Energy and Climate Programme of German Govt.

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**Proposed degression of FIT for Offshore Wind**  
acc. to para 26 EEG 2014

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... **but** 2-year FIT-extension until Dec. 2019;

**NOTE:**
After 2020, new tendering system for OWE proposed –
For other RE tender in 2017, based on outcome of PV (greenfield) pilot tender

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**Degression of FIT**  
para 20 EEG 2012 | para 26 EEG 2014
---|---
Standard (base) model | 7 % annual degression after 2017 | in 2018: 0,5 €ct/kWh  
in 2020: 1,0 €ct/kWh  
Compressed FIT | No degression | in 2018: 1,0 €ct/kWh
Long lead times for OWF need to be reflected (large power plant schedules)

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Cost Reduction Potentials for OWE

Projection of levelized cost of energy (LCOE)

Site B, results in €cent/kWh, based on 2012 real terms

Learning Curve Effect caused by constant growth
→ economies of scale, increasing competition and growing turbine size

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