UNLOCKING THE OFFSHORE WIND POTENTIAL IN THE BALTIC SEA: ROLE OF POLICY AND REGULATION

Riga – 16 May 2017

Lasse Sundahl, Project Manager
## Content

1. Introduction to DONG Energy
2. Cost of offshore wind
3. Offshore wind industry shifting gear
4. Levers for unlocking offshore wind potential
5. Baltic Sea compared to North Sea
6. Key messages

Source: dong energy
DONG Energy at a glance

- Headquarters in Denmark
- 6,200 employees (including Oil & Gas)
- Revenue in 2016 DKK 61.2 bn
- EBITDA in 2016 DKK 19.1 bn
- Phase out the use of coal by 2023

80%* Wind Power
- Develops, constructs, owns and operates offshore wind farms in Denmark, Germany, the Netherlands and the UK.
- Development projects in Taiwan and the USA

4%* Bioenergy & Thermal Power
- Generates and sells power and heat to customers in Denmark and Northwestern Europe

4%* Oil & Gas (discontinued operations)
- Produces oil and gas from fields in Denmark, Norway and the UK

12%* Distribution & Customer Solutions
- Power distribution grid on Zealand and sale of power and gas to customers in Northwestern Europe

* Share of the Group’s capital employed
DONG Energy Wind Power geographical footprint

- USA
  - Bay State Wind
  - Ocean Wind
- Europe
  - Walney Extension
  - West of Duddon Sands
  - Isle of Man
  - Barrow
  - Burbo Bank Ext.
  - Burbo Bank
  - Gunfleet Sands 1 & 2
  - London Array
  - Hornsea 1 & 2
  - Race Bank
  - Hornsea 2 & 3 & 4
  - Hornsea 1 & 2
  - Gode Wind 1
  - Borkum Riffgrund 1
  - Gode Wind 2
  - Gode Wind 3 & 4
  - Gode Wind 2
  - Borkum Riffgrund 2
  - German Cluster
  - Anholt
  - Middelgrunden
  - Avedøre
  - Vindeby
  - Nysted
- Asia Pacific
  - Formosa 1.1
  - Formosa 1.2

Unparalleled experience and track record

- 25+ years of experience and track record in the offshore wind sector
- 21 offshore wind farms in operation
- 7 offshore wind farms under construction
- 3.6 GW Constructed capacity
- 2,000 Dedicated employees
- 3.8 GW under construction
- 7.5 million Europeans with clean electricity
- 3.3 GW World’s leading operator
- 14 Partnerships
DONG Energy Wind Power has built a strong integrated end-to-end business model

DONG Energy Wind Power core competencies

- **Develop**
  - Identify and mature projects
  - ~110 employees

- **Build**
  - Manage construction, sourcing and supply
  - ~1,150 employees

- **Operate**
  - Conduct life-cycle maintenance
  - ~640 employees

- **Own**
  - Attract capital through partnerships
  - ~100 employees

1. Ability to design and optimise projects with a ‘total life-cycle cost of wind farm’ mindset
2. Experience and expertise along the entire value chain allow for better understanding and management of risks
3. End-to-end model reduces LCoE through fast feedback and learning across the entire organisation

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1. Front-end engineering design
2. Excluding CT Offshore and A2SEA as of January 2017
Offshore wind shows rapidly declining costs for society

Levelised costs for society of electricity, incl. transmission costs
EUR/MWh\(^1\), 2016-prices, bid announcement year.

<table>
<thead>
<tr>
<th>Project</th>
<th>Year</th>
<th>Cost (EUR/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walney Extension 2014</td>
<td></td>
<td>156</td>
</tr>
<tr>
<td>Race Bank 2015</td>
<td></td>
<td>145</td>
</tr>
<tr>
<td>East Anglia 2015</td>
<td></td>
<td>124</td>
</tr>
<tr>
<td>Borkum Riffgrund 2015</td>
<td></td>
<td>122</td>
</tr>
<tr>
<td>Horns Rev III 2015</td>
<td></td>
<td>102</td>
</tr>
<tr>
<td>Borssele I &amp; II 2016</td>
<td></td>
<td>78</td>
</tr>
<tr>
<td>Kriegers Flak 2016</td>
<td></td>
<td>68</td>
</tr>
<tr>
<td>Borssele III &amp; IV 2016</td>
<td></td>
<td>68</td>
</tr>
<tr>
<td>Cluster 1 2017</td>
<td></td>
<td>62</td>
</tr>
</tbody>
</table>

Sources: DECC; Danish Energy Agency; Energinet.dk; NEV (Dutch Energy Scenarios), Bundesnetzagentur

1. Levelised revenue (price) of electricity over the lifetime of the project used as proxy for the levelised cost to society. It consists of a subsidy element for the first years and a market income for the whole lifetime. Discount rate of 3.5% used to reflect society’s discount rate. Market income based on country specific public wholesale market price projections at the time of contracting where available else an average of 5 analytics is used. For comparability across projects and because there is no transparency round the TSO costs of transmission a generic scope adjustment (incl. transmission and extra project development costs) have been applied. Due to the specific DC transmission set up in Germany cost estimates from the Offshore Netzentwicklungsplan 2017 have been applied.
We need to urgently adopt to the new reality

123 €/MWh
It is all about scale


Boeing 747-8
Length: 76m

160m
8MW

2003
2009
2012
2014
2016
2020

200m
13-15MW

1991
2000
2003
2012
2014
2016
2020

Public
Never before was offshore wind more affordable, but ironically we see declining commitment.

Data shows currently politically decided offshore wind energy pipeline, April 2017.

Sources: BNEF and DONG Energy
An offshore turbine a day turns subsidies away
Electricity market regulation and design essential for subsidy-free offshore

High and stable price
Decommissioning of fossil based generators
Enhanced transmission grid
Electrification
Improved market design

Generation capacity and grid adjusted to decarbonisation and flexibility targets
The Northern Seas has great potential for offshore wind

* SOURCE: ECOFYS AND NAVIGANT, ESTIMATED AS NECESSARY BY NORTH SEA COUNTRIES TO JOINTLY ACHIEVE 230GW OF OFFSHORE CAPACITY BY 2045 TO FULFIL THE PARIS AGREEMENT REQUIREMENTS
Key levers to unlock potential in any sea

**Volume** to continuously drive costs reductions through scale and competition

**Grid** development to access demand and drive cost reductions through competition and innovation

It is all about scale

Extend scope to enhance innovation and competition and to reduce total costs to society

- Offshore wind farm
- Transmission
- Hub
- Interconnectors
- Osehore grid
Prices for the transmission does not show a declining price trend across markets

EUR/MWh, 2016-prices

Kriegers Flak
COD 2018

Borssele 1&2
COD 2019/2020

Borssele3&4
COD 2020/2021

BRW2 + OWP
COD 2024

11
14
14
16

1 Transmission cost: Stated by the Danish Ministry as a written answer in Parliament. EFK spm 45, 25/11-2016
2 Transmission cost: Stated by TennT in July 2016 after Borssele 1&2 winning bid as an average for the five 700 MW tenders
3 Transmission cost: Derived from data in Offshore Network Development Plan 2017 – assumption that the 900 MW HVDC substation for cluster 1,3, and 7 will be fully utilised in the future. If not, higher costs apply.
Competitive pressure should be applied to the entire wind farm

**CAPEX component breakdown of an offshore wind farm**

Removing transmission assets from developer’s scope removes the solicitation’s competitive pressure from 15%-20% of project CAPEX

<table>
<thead>
<tr>
<th>Segment &amp; % of total CAPEX¹</th>
<th>Onshore Substation</th>
<th>Export Cables</th>
<th>Offshore Substation</th>
<th>Installation</th>
<th>Array Cables</th>
<th>Foundation</th>
<th>Wind Turbine</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4%</td>
<td>7%</td>
<td>6%</td>
<td>17%</td>
<td>3%</td>
<td>10%</td>
<td>39%</td>
</tr>
</tbody>
</table>

**Competition has helped drive down the costs of transmission assets**

- In the UK developers build transmission assets then divest them in the OFTO regime
- A large study found that this system had created significant savings for UK ratepayers
  - Competition had helped move industry to efficiency frontier faster
  - Competition created savings equivalent to a LCoE reduction of up to **EUR4.5/MWh**

**Total savings created by competition in OFTO regime 2009-12²**

<table>
<thead>
<tr>
<th></th>
<th>Low (EURm₁₄)</th>
<th>High (EURm₁₄)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>244</td>
<td>305</td>
</tr>
</tbody>
</table>

¹. Other costs account for 14% of total CAPEX and include contingencies, management reserves, resource costs, insurances and construction management. Data is average of select wind farms built towards 2020.

². Based on BDO&CEPA report. Low and high figures from counterfactuals 3 and 5 relating to savings of £205m-£256m due to developer involvement. Calculated by dividing total savings with total MW built in OFTO tender round 1, and adding this figure to CAPEX in GRA LCoE model on a 2023 CoD OWF.

Source: EWEA; Bladt Industries; DONG Energy; Ofgem; BDO & CEPA ‘Evaluation of OFTO Tender Round 1 Benefits’
Centralised model – Authority driven site selection process

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
<th>Potential Issues</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Authorities chose <strong>single site</strong> for OSW development</td>
<td>✗ Authorities may not be best to assess optimal possible sites with a focus on cost reduction</td>
<td>1. Danish Energy Agency</td>
</tr>
<tr>
<td></td>
<td></td>
<td>✗ Analysis of previous DEA¹ site rankings suggest a risk of using sub-optimal sites²</td>
<td>2. In DEA index ‘Stor-skala havmølleparker i Danmark’, April 2011’ Renne Banke was identified as best site after Kriegers Flak. Analysis of site characteristics suggest at least 3 sites were better (they contributed up to ~4,5€/MWh cost reduction compared to Renne Banke based on DEA’s data on wind speed, distance to shore, water depth and size of wind farm)</td>
</tr>
<tr>
<td>2.</td>
<td>Authorities do <strong>extensive</strong> site investigation work</td>
<td>✗ Letting developers do detailed site investigations would save DEA expensive consultancy services</td>
<td>3: CPT: Cone Penetration Test</td>
</tr>
<tr>
<td></td>
<td>✓ EIA prepared &amp; consulted on to secure consent</td>
<td>✓ Authorities ensure an approved EIA prior to auction, this removes risk of winning projects being cancelled</td>
<td></td>
</tr>
<tr>
<td></td>
<td>✓ Geophysical survey</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>✓ 3D geophysical model</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>✓ Geotechnical investigation (10%-20% of site locations)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>✓ Integrated geological model</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Developers compete in auction for <strong>site and support</strong></td>
<td>✗ The site has a large impact on cost, and in a “single site auction” the choice of site is not exposed to competitive pressure</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dev. A</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dev. B</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dev. C</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Dev. D</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹ DEA: Danish Energy Agency
² DEA: Danish Energy Agency

Site + support

Ronne Banke was identified as best site after Kriegers Flak. Analysis of site characteristics suggest at least 3 sites were better (they contributed up to ~4,5€/MWh cost reduction compared to Renne Banke based on DEA’s data on wind speed, distance to shore, water depth and size of wind farm)
### Decentral model – Developer driven site selection and site investigation to increase competition

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Advantages</th>
</tr>
</thead>
</table>
| 1. Authorities chose **multiple sites** for development | ✓ This allows market players to use expertise in identifying best sites, reducing costs  
✓ This introduces competitive pressure to site selection | |
| 2. Authorities carry out **very limited** site investigation work | ✓ This is sufficient for developers to do concept selection, installation concept and preliminary design  
✓ Authorities should still ensure EIA for site has been prepared and consulted on to avoid post-auction cancellations | ✓ EIA prepared and consulted on to secure consents  
✓ Geophysical survey  
✓ Small geotechnical pre-investigation (1 borehole or 2 CPTs per site) |
| 3. Developers compete in **“multi site auction”** for site and support | ✓ Detailed site investigation done once as only winner carries these out  
✓ Smaller players can still participate as there are consultancies capable of detailed site investigations  
✓ Non-winning sites can be used again in later auctions | Dev. A  
Dev. B  
Dev. C  
Dev. D |

1: CPT: Cone Penetration Test

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**Public**
In the Baltic sea, shore is never far away…

Max 400 km. from shore.

Max 150 km. from shore.
Key messages

- Offshore wind on track to subsidy free
- Baltic Sea has potential to benefit from subsidy free offshore, but countries in the region need to act
- Prepare for competition in site selection and investigation
- Combine offshore wind parks and transmission assets in projects to reduce costs through innovation and competition
- Facilitate market driven engagement of developers in offshore grid development in general
- Grand master plans risk locking in solutions and technology
- In the Baltic Sea, shore is never very far away…
Thank you for your attention!