Contents

A  Offshore market volume of EUR 130 bn by 2020
   Agenda 2020 – Markets – Trends – Competition  Page 3

B  Value chain evaluation for offshore
   Project development – Turbines – Foundation – Grid – Vessels – O&M  Page 8

C  Offshore potential to meet LCoE targets
   Utilities – Investors – Cost competitiveness – Saving potential – LCoE  Page 16

D  Conclusion
   Offshore on the pathway to cost competitiveness  Page 22
A. Offshore market volume of EUR 130 bn by 2020

Agenda 2020 – Market – Trends – Competition
Offshore wind energy is an essential element in meeting ambitious European climate and energy targets.

ADVANTAGES OF OFFSHORE WIND

- Wind energy is the most mature renewable energy technology in operation
- There is limited growth potential for onshore wind due to high population density in Europe
- Offshore wind provides higher and steadier energy yields – on average about 4,000 full load hours
- Offshore wind is a very young technology that offers further potential for substantial cost reductions
- Several European countries rely strongly on offshore wind to fulfill their energy and climate targets

EUROPEAN TARGETS 2020

- 35% of electricity from renewables
- 12% of electricity from wind energy
- 40 GW installed offshore capacity

Security of supply & sustainability
Politics & regulation

OFFSHORE WIND IS A KEY PILLAR OF THE EUROPEAN ENERGY TRANSITION

Source: European Commission; EWEA; BWE; Roland Berger
A. Offshore market volume of EUR 130 bn by 2020

Offshore wind energy will soon become a large sector – Global investments of EUR 130 bn by 2020

Global offshore market

Europe
- Capacity [MW p.a.]
- Investment [EUR bn p.a.]

Asia Pacific
- Capacity [MW p.a.]
- Investment [EUR bn p.a.]

North America
- Capacity [MW p.a.]
- Investment [EUR bn p.a.]

Risks to global development arise from challenges such as a lack of grid connections and the need to reduce the cost of energy.

COMMENTS

> Europe has ambitious growth rates and annual additions of 4.5 GW or EUR 14.4 bn in 2020
> Asia Pacific will catch up, with annual additions of 1.5 GW or EUR 4.8 bn in 2020
> North America follows, with lower levels
> ROW shows no relevant investment in offshore through 2020

Source: EER; BTM; Global Data; Roland Berger

Rationale: Investment costs per MW: 2013: EUR 3.9 m, 2016: EUR 3.6 m, 2020: EUR 3.2 m
The next generation of offshore wind farms will be constructed further away from the shore in deeper water.

**Trends in offshore**

**OFFSHORE WIND FARMS**

- **Distance to shore [km]**
  - 0
  - 20
  - 40
  - 60
  - 80
  - 100
  - 120

- **Water depth [m]**
  - 0
  - 20
  - 40
  - 60
  - 80
  - 100
  - 120

- **Average farm size [MW]**
  - 200
  - 300
  - 340

**TRENDS**

- **FURTHER**
  - Trend toward building wind farms further from shore
  - Environmental laws (GER) and limited space close to shore are a driver for greater distance

- **DEEPER**
  - Greater distance to shore usually leads to deeper water at site
  - Deeper water requires new foundation solutions

- **LARGER**
  - Larger wind farms allow improved fixed cost allocation
  - Average size of approved projects is at 340 MW

Source: EWEA; Roland Berger

A. Offshore market volume of EUR 130 bn by 2020
A. Offshore market volume of EUR 130 bn by 2020

Offshore turbine manufacturing will enter a phase of intense competition – Threat of future overcapacity

Competition between wind turbine manufacturers

NEW ENTRANTS

ESTABLISHED PLAYERS

DOMINANT PLAYERS

<5 WTG

6-100 WTG

>100 WTG

= Number of installed offshore wind turbine generators (WTG)

COMMENTS

> Large number of new market entrants in the last two years

> Big industrial players such as Alstom, Hyundai, Mitsubishi and Samsung see offshore wind as attractive

> Competition will increase significantly due to the large number of new entrants

> Siemens and Vestas are the dominant players, with more than 500 turbines installed

> Production overcapacity expected in the years to come

Source: EWEA; EER; manufacturers; press; Roland Berger
B. Value chain evaluation for offshore
Project development – Turbines – Foundation – Grid – Vessels – O&M
Offshore projects show significant potential for improvement across the entire project value chain

Value chain for offshore projects

1. PROJECT DEVELOPMENT
2. WIND TURBINE
3. SUPPORT STRUCTURE
4. GRID CONNECTION
5. LOGISTICS & INSTALLATION
6. OPERATION & MAINTENANCE

Source: Roland Berger
## Project development

### Initial planning
- Identify suitable area
- Evaluate wind potential
- Evaluate ground surface
- Develop wind farm layout

### Permission
- Apply to the responsible public authority
- Conduct required environmental studies

### Supplier management
- Identify suppliers
- Negotiate terms
- Allocate interface risks
- Develop installation and logistics concepts
- Develop O&M concept

### Financing
- Optimize project structure
- Prepare info memo and financial model for investors and banks
- Approach banks and investors
- Financial close

### Installation & construction
- Align suppliers’ timeframes with logistics concept
- Manage and mitigate interface risks
- Ensure timely commissioning

### Operations & maintenance
- Assure high level of turbine availability
- Regular service and quick troubleshooting
- Enable component change
- Ensure cost effectiveness of O&M concept

### AVG. of 7-10 years¹)

<table>
<thead>
<tr>
<th>Phase</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial planning</td>
<td>1-3 years</td>
</tr>
<tr>
<td>Permission</td>
<td>2-4 years</td>
</tr>
<tr>
<td>Supplier management</td>
<td>2-3 years</td>
</tr>
<tr>
<td>Financing</td>
<td>1-3 years</td>
</tr>
<tr>
<td>Installation &amp; construction</td>
<td>1-2 years</td>
</tr>
<tr>
<td>Operations &amp; maintenance</td>
<td>20+ years</td>
</tr>
</tbody>
</table>

¹) Years per phase not strictly cumulative as some phases overlap

### COMMENTS

> **Interface risks for investors**
- EPC contracts for offshore wind projects are not available
- Multi-contracting has major interface risks for investors

> **Improvement methods**
- Build strategic partnerships with a small number of partners
- Strengthen controls
- Hire experienced personnel from developers

> **Growing professionalism**
- Market entry by large players such as construction companies and utilities leads to growing professionalism in project development
B. Value chain evaluation for offshore

Larger turbines will improve total CAPEX, capacity factors and O&M costs – "Big is beautiful" as LCoE falls

Wind turbines – Size and LCoE

**LEVELIZED COST OF ENERGY (LCoE), OFFSHORE WIND**

<table>
<thead>
<tr>
<th>DRIVER</th>
<th>3 MW turbines</th>
<th>6 MW turbine</th>
<th>IMPROVEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAPEX [EUR m/MW]</td>
<td>1.35</td>
<td>1.55</td>
<td>+15%</td>
</tr>
<tr>
<td>[EUR m/MW]</td>
<td></td>
<td></td>
<td>-6%</td>
</tr>
<tr>
<td>Capacity factor [%]</td>
<td>43</td>
<td>48</td>
<td>+12%</td>
</tr>
<tr>
<td>O&amp;M costs [EUR '000/MW/year]</td>
<td>140</td>
<td>120</td>
<td>-14%</td>
</tr>
<tr>
<td>LCoE¹ [EUR ct/kwh]</td>
<td>13.4</td>
<td>11.1</td>
<td>-17%</td>
</tr>
</tbody>
</table>

¹) Idealized model calculation for newly installed turbines on global average

Source: Expert interviews; Roland Berger
Monopiles remain the dominant foundation concept, but trend toward deeper water is shifting growth to jackets

Foundation concepts

<table>
<thead>
<tr>
<th>FOUNDATION</th>
<th>DEPTH [m]</th>
<th>CUM 2012</th>
<th>TREND 2020</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravity-based foundations (GBF)</td>
<td>&lt;20(^1))</td>
<td>21%</td>
<td></td>
<td>Currently only used in shallow water; however, new GBF concepts could have potential for renewed future application up to 40 meters</td>
</tr>
<tr>
<td>Monopile</td>
<td>10-30(^1))</td>
<td>75%</td>
<td></td>
<td>Remains most widespread foundation type. Limitations in water depth and weight are increasingly being overcome with new concepts</td>
</tr>
<tr>
<td>Tripod/pile</td>
<td>25-50</td>
<td>2%</td>
<td></td>
<td>High production costs due to complex structure and great weight are likely to limit use of both concepts</td>
</tr>
<tr>
<td>Jacket</td>
<td>20-60</td>
<td>2%</td>
<td></td>
<td>Jackets will increase their share due their flexibility and low weight (40-50% less steel than monopiles), commercially worthwhile &gt;35 m</td>
</tr>
<tr>
<td>Floating</td>
<td>&gt; 50</td>
<td>&lt;1%</td>
<td></td>
<td>Currently at R&amp;D stage, but could become relevant for countries with steep shores. No commercial use expected before 2020</td>
</tr>
</tbody>
</table>

1) Up to 40 m with new concept

Source: EWEA; 4coffshore; Ramboll; Roland Berger
B. Value chain evaluation for offshore

HVDC connections cause delays and cost overruns in Germany – Similar issues may occur in other markets

Grid connection – Example: Germany

**HVDC GRID CLUSTER**

**BOTTLENECK**

I. Offshore converter stations
   - Only three suppliers: ABB, Siemens, Alstom
   - Delivery time up from 30 to 50 months

II. Offshore HVDC cables and cable laying
   - Only a few suppliers. Shortages may occur

III. Installation vessels for converter stations
    - Only a few vessels can install converter stations >10,000 t

IV. Transmission system operator (TSO)
    - TenneT to provide grid connection for all projects in the German North Sea (CAPEX approx. EUR 1 bn per GW)

**SOLUTIONS IN GERMANY**

- Distribution of liability costs to electricity customers
- Involvement of public institutions and financial investors
- Politically backed master plan for offshore grid infrastructure
- Standards for converter stations

Source: Wind-Kraft Journal; TenneT; Roland Berger
New vessels specifically designed for offshore wind will reduce installation times and costs – Bottleneck resolved

Installation vessels

JACK-UP VESSELS

Application

> Offshore wind farms are constructed by jack-up vessels
> Mostly, jack-ups load material in harbors, carry it to site and install it

History

> Vessels from offshore oil & gas industry deployed for first wind farm installations
> Major bottleneck around 2008 for offshore wind installation vessels
> Some 15 new vessels are being built that are tailored to the needs of offshore wind energy

NEW GENERATION OF VESSELS

DEVELOPMENT

Vessel demand and supply

<table>
<thead>
<tr>
<th>Year</th>
<th>Demand</th>
<th>Supply (existing + ordered)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td>2012</td>
<td>10</td>
<td>23</td>
</tr>
<tr>
<td>2013</td>
<td>21</td>
<td>26</td>
</tr>
<tr>
<td>2014</td>
<td>24</td>
<td>26</td>
</tr>
<tr>
<td>2015</td>
<td>26</td>
<td>26</td>
</tr>
</tbody>
</table>

Vessel KPI | Trend | Benchmark

- Deck space [m²] | → | 4,300
- Capacity [tons] | → | 8,400
- Speed [knots] | → | 13.5
- Water depth [m] | → | >45

EXAMPLE: NEW VESSEL

> New generation of installation vessels specifically designed for offshore wind
> New vessels such as the "Innovation"
  - Are larger in size (148 m x 42 m)
  - Have greater deck space and storage capacity (8,000 t; e.g. 7x6 MW WTG or 12x3 MW WTG, 4 jackets or 7 monopiles)
  - Are faster
  - Can work in deeper water (50 m)
  - Have improved jacking speed

> Faster wind turbine installation will reduce the total cost of ownership

Source: GeoSea; Roland Berger
Operation & maintenance (O&M)

**IMPORTANCE OF O&M**

- Efficient, proven O&M concepts are still not available
- Excellence in O&M is critical to a profitable offshore wind business
  - O&M approx. 28% of lifetime costs
  - 10% O&M cost reduction delivers +4% EBIT or +30 bps IRR\(^1\)
  - 1% increase in availability delivers +2% EBIT or +15 bps IRR\(^1\)
- O&M offers potential for continuous improvement over project lifetime

**KEY O&M VARIABLES**

1. **Location of service station**
   - Station for service personnel onshore or offshore on service platform

2. **Logistics to and on site**
   - Service vessel concept and potential use of helicopter

3. **Availability of crane or jack-up**
   - Adequate access to vessels for replacing large components

**IMPROVEMENT LEVERS**

- Increased rated power of WTGs reduces O&M costs per kWh
- Increased reliability of turbines and components reduces unplanned service activities
- Geographical clustering of offshore wind farms creates synergies
- Increased in-house O&M activity by utilities will partly or fully replace O&M turbine manufacturers

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1) bps = basis points; IRR = internal rate of return

Source: E.ON; DONG; EnBW; Roland Berger

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Distance to shore is the key parameter for the design of O&M concepts

- Wave height
- Water depth

Coastline

Seabed
Offshore potential to meet LCoE targets

Utilities – Investors – Cost competitiveness – Saving potential – Costs of energy
Utilities by capacity and investment model

<table>
<thead>
<tr>
<th>OFFSHORE CAPACITY [MW]</th>
<th>PIPELINE [MW, EUR]</th>
<th>INVESTMENT MODELS</th>
</tr>
</thead>
<tbody>
<tr>
<td>VATTENFALL 840</td>
<td>4,700 17 bn</td>
<td><strong>1 STANDALONE</strong></td>
</tr>
<tr>
<td>DONG 800</td>
<td>2,900 10 bn</td>
<td>&gt; One utility owns, develops and operates project</td>
</tr>
<tr>
<td>e-on 470</td>
<td>3,400 12 bn</td>
<td>&gt; Utility has full control, but bears all risks</td>
</tr>
<tr>
<td>RWE 160</td>
<td>7,500 27 bn</td>
<td><strong>Examples:</strong> RWE Innogy 1 (RWE), Amrumbank West (E.ON), Horns Rev2 (DONG)</td>
</tr>
<tr>
<td>centrica 140</td>
<td>6,000 22 bn</td>
<td><strong>2 LEAD INVESTOR</strong></td>
</tr>
<tr>
<td>Scottish and Southern Energy plc 90</td>
<td>6,000 22 bn</td>
<td>&gt; Leading utility with one or more minority investors</td>
</tr>
<tr>
<td>EnBW 25</td>
<td>1,100 4 bn</td>
<td>&gt; Utility shares risk and reduces equity requirements</td>
</tr>
<tr>
<td>EDF 3</td>
<td>1,000 4 bn</td>
<td><strong>Examples:</strong> DanTysk (Vattenfall, SWM), Baltic 1 (EnBW, municipal utilities)</td>
</tr>
<tr>
<td>IBERDROLA 0</td>
<td>6,600 24 bn</td>
<td><strong>3 JOINT VENTURE</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; A group of equal players join forces</td>
</tr>
</tbody>
</table>

Status as of September 2012; estimated average investment volume for pipeline: EUR 3.6 m per MW

Source: Company websites; 4COffshore; Roland Berger
C. Offshore potential to meet LCoE targets

New investment models with better risk-return ratios required to attract more financial investors

Investors in offshore wind

WINDFARM OWNERSHIP [%]

- Financial investors: 11%
- IPP and strategic investors: 19%
- Utilities: 70%

Approx. 3,600 MW

- Wind farms are owned by utilities, IPPs and strategic investors with a focus on wind energy – only a few "pure" financial investors
- Trend: Utilities include financial investors as minority investors to reduce their own capital expenditure (e.g. DONG). Interest also expressed by German investors such as Allianz and Munich Re

RISK-RETURN RATIO

- Risk-return ratio unfavorable
  > Compared to other options, offshore risks are not adequately covered by return potential
  > Three actions to improve attractiveness of offshore
    > Reduce risk by raising industry professionalism
    > Increase profitability by lowering LCoE
    > Introduce new investment models (e.g. utility & financial investor)

Source: Company websites; Roland Berger
C. Offshore potential to meet LCoE targets

Offshore needs to raise its cost competitiveness to ensure sustainability – Substantial LCoE reduction expected

LCoE 2012 European generation mix [EUR ct/kWh]

Source: Bloomberg New Energy Finance; IEA; Roland Berger

Note: Competitive cost level as a non-weighted average of non-renewable energy sources is 4.9 ct/kWh

RECENT STATEMENTS

"A cost reduction of 20-30% in offshore by 2017 is realistic"
(DONG Energy)

"Our LCoE target for all wind energy is 5-9 EUR ct/kWh in the medium term"
(Siemens Wind Power)

"Our target: 40% reduction of offshore CAPEX by 2015"
(E.ON Climate & Renewables)
C. Offshore potential to meet LCoE targets

WTG costs are 25% of lifetime costs – Project elements offer further potential to realize a sustainable cost out

### Cost & saving potential

<table>
<thead>
<tr>
<th>COST STRUCTURE ['000 EUR/MW]</th>
</tr>
</thead>
<tbody>
<tr>
<td>WTG</td>
</tr>
<tr>
<td>1,350</td>
</tr>
</tbody>
</table>

#### SAVING POTENTIAL

- **High potential for cost reduction**
  - New turbine technology and innovative design options (e.g. 2 blade option, drive train solution, tower concepts)
  - Innovative design concepts and use of standards for serial production (e.g. new jacket structures)
  - Optimized logistics and new installation concepts (e.g. footprint optimization, new vessel concepts)
  - Standards for converter platforms and inclusion of new investors for grid connection (e.g. Anbaric & TenneT)
  - Increased control of project and reduction of interface risks (e.g. EPC models/partnership model)
  - Innovative O&M concepts and joint use of offshore service stations (e.g. SLAs, asset management strategies)

- **Low potential for cost reduction**

1) Discounted over 20 years

Source: IHS EER; Project Finance; Erneuerbare Energien; Handelsblatt; Roland Berger
## Offshore potential to meet LCoE targets

LCoE target of 11 ct/kWh is achievable by 2016 and 9 ct/kWh are targeted by 2020

### LCoE forecast

<table>
<thead>
<tr>
<th>Year</th>
<th>LCoE (ct/kWh)</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>11</td>
<td>-17%</td>
</tr>
<tr>
<td>2020</td>
<td>9</td>
<td>-19%</td>
</tr>
</tbody>
</table>

### Prerequisites

#### WTG SIZE
- Average rated power of newly installed WTG: 3 MW
- Average rated power of newly installed WTG: 6 MW
- Average rated power of newly installed WTG: 8 MW

#### FOUNDATION
- Currently available foundation types
- Initial savings from improved foundation concepts
- Serial production effects for selected foundation types

#### O&M
- Limited experience with far-shore O&M
- Far-shore experience leads to reduced O&M costs
- Mature O&M concepts with minimized cost structures

### Source:
Roland Berger

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**COMMENTS**

- Cost level of 9 ct/kWh should be reached for new additions in 2020
- Offshore will not match the competitive cost levels of conventional energy by 2020
- Offshore is on the pathway to cost competitiveness, but further time-consuming efforts are required
- Political support and a joint industry effort will be essential for offshore to meet the prerequisites and reach the targets

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1) Idealized LCoE model calculation for newly installed WTGs on global average

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Source: Roland Berger
D. Conclusion
Offshore on the pathway to cost competitiveness
**Offshore – Conclusion**

**MARKET STABILITY**
Offshore is a policy-driven market and depends on public support schemes

- Ensure reliability of regulation and stability of political support

**LCoE COMPETITIVENESS**
Offshore needs to become independent of public support mechanisms (e.g. Renewable Energy Act) to maintain political support

- Reduce LCoE to 11 ct/kWh by 2016 and 9 ct/kWh by 2020

**TECHNOLOGY**
Offshore is still at an early stage and combines technologies from different industries – optimized integration possible

- Maintain Europe's technology leadership and boost innovation

**OEM COMPETITION**
New players are entering the market and competition will increase significantly

- Achieve cost competitiveness driven by product excellence

**RISK-RETURN RATIO**
Achievable margins do not yet compensate for potential risks

- Improve risk-return ratio and develop new investment models

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**Source:** Roland Berger

- 2012 13 ct/kWh
- 2016 11 ct/kWh
- 2020 9 ct/kWh
D. Conclusion

Offshore is on the pathway to cost competitiveness – Joint efforts are required in this young industry sector

Offshore – The journey to maturity

**Offshore maturity cycle**

<table>
<thead>
<tr>
<th><strong>Joint efforts to achieve cost competitiveness</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Turbine manufacturers</strong></td>
</tr>
<tr>
<td>&gt; Focus on innovation to achieve product excellence</td>
</tr>
<tr>
<td>&gt; Optimize processes to enable a rigorous cost out</td>
</tr>
<tr>
<td><strong>Foundation suppliers</strong></td>
</tr>
<tr>
<td>&gt; Explore new technologies and foundation concepts</td>
</tr>
<tr>
<td>&gt; Drive standardization efforts to achieve scale effects</td>
</tr>
<tr>
<td><strong>Grid suppliers</strong></td>
</tr>
<tr>
<td>&gt; Develop solutions to guarantee timely grid connection</td>
</tr>
<tr>
<td>&gt; Include new investors on a project basis</td>
</tr>
<tr>
<td><strong>Construction companies</strong></td>
</tr>
<tr>
<td>&gt; Reduce interface risks through partnership models</td>
</tr>
<tr>
<td>&gt; Develop EPC models to offer turnkey solutions</td>
</tr>
<tr>
<td><strong>Utilities/operators</strong></td>
</tr>
<tr>
<td>&gt; Increase control over project development</td>
</tr>
<tr>
<td>&gt; Incentivize OEMs and suppliers to drive out costs</td>
</tr>
<tr>
<td><strong>Banks/investors</strong></td>
</tr>
<tr>
<td>&gt; Develop investment models with larger utilities</td>
</tr>
<tr>
<td>&gt; Attract new investor groups to the sector</td>
</tr>
</tbody>
</table>

Source: Roland Berger
It's character that creates impact.