How can we deploy affordable offshore wind power in Europe and Japan
Agenda

- Who we are
- Offshore Wind Market in Europe
- What we can deploy in Japan
Competencies for Synergies

MHI has Strong and long-standing presence in global power unit industry
MHI has brought not only financial foundation but a wide range of technology background, advanced manufacturing management and network with Japanese industry.

Vestas has a proven track record of 83GW of installed wind turbines
A pioneer in offshore wind and the most knowledgeable player in the wind industry
High reliability based on extensive verification testing
Established in 2014 on decades of experience
Delivering affordable offshore wind power

<table>
<thead>
<tr>
<th>Company name</th>
<th>MHI Vestas Offshore Wind A/S (MVOW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head Office</td>
<td>Aarhus, Denmark</td>
</tr>
<tr>
<td>CEO / Co-CEO</td>
<td>Jens Tommerup / Tetsushi Mizuno</td>
</tr>
<tr>
<td>Product and Operations</td>
<td>R&amp;D, engineering, procurement, manufacture, sales and service of offshore wind turbine</td>
</tr>
<tr>
<td>Number of Employee</td>
<td>2336 employees (as of 13 Nov 2017)</td>
</tr>
<tr>
<td>Establishment</td>
<td>1st April, 2014</td>
</tr>
<tr>
<td>Equity Rate</td>
<td>Mitsubishi Heavy Industries, Ltd.(MHI) 50% VestasWind Systems A/S (VWS) 50%</td>
</tr>
</tbody>
</table>
Product Line-up

- **V39-500kW**
- **V80-2.0MW**
- **V90-3.0MW**
- **V112/117-3.0/3.3/3.45MW**
- **V164-8.0MW-9.5MW**

**Sales**: M

**Procurement**

**Manufacturing**: V

**Construction**: M

**O&M**: M
The V164-8.0 MW turbine – the world’s most powerful available turbine –

- Rated power: 8,000 kw
- Rotor diameter: 164 m
- Blade length: 80 m
- Blade weight: 35 tonnes/each
- Swept area: 21,124m²
- Nacelle dimensions: H 8 m x L 20 m x W 8 m
- Nacelle weight: approx. 390 tonnes
- Tower height: 105 m

Burbo Bank Extension
United Kingdom
(V164-8.0MW x 32 units)

The first 8MW class offshore wind turbine in the world
In operation since May 2017
Dimensions – V164-8.0MW

- Approx. Tip Height: 187 m
- Approx. Hub Height: 105 m
- Rotor Diameter: 164 m
- London Eye Diameter: 135 m
- Blade Length: 80 m

Airbus A380 Length: 72.7 m
the world's largest passenger airplane
V164 - Blades

V164 Blade 80m

B747-8 76m
MVOW Footprint in Denmark

Østerild test centre
(V164/V126 prototype WTG)

Esbjerg facility
(ESPF*)
(WTG Pre-assy.)
Esbjerg factory
(PCM** assy.)

Lindø factory
(V164 Nacelle assy.)

MVOW HQ
(Aarhus)

Nakskov factory
(V164 Blade mfg.)

* Esbjerg Pre-Assembly Facility
**Power Conversion Module
MVOW Footprint in UK

Blade Factory
Isle of Wight (UK)

Isle of Wight
Blade Factory
### Our Track Record – 2.7 GW Installed

953 turbines installed across 23 projects, ~ 2.2 GW under service contract

<table>
<thead>
<tr>
<th>Barrow*</th>
<th>Country: United Kingdom</th>
<th>Owner: Dong Energy</th>
<th>Installation year: 2006</th>
<th>Number of turbines: 30</th>
<th>Turbine type: V90-3.0 MW</th>
<th>MW: 90</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scroby Sands</td>
<td>Country: United Kingdom</td>
<td>Owner: E.ON UK</td>
<td>Installation year: 2004</td>
<td>Number of turbines: 30</td>
<td>Turbine type: V90-2.0 MW</td>
<td>MW: 60</td>
</tr>
<tr>
<td>Tunø Knob</td>
<td>Country: Denmark</td>
<td>Owner: Npower Renewables</td>
<td>Installation year: 1995</td>
<td>Number of turbines: 10</td>
<td>Turbine type: V39-500 kW</td>
<td>MW: 5</td>
</tr>
<tr>
<td>Sprogø*</td>
<td>Country: Denmark</td>
<td>Owner: Sund &amp; Bælt</td>
<td>Installation year: 2009</td>
<td>Number of turbines: 7</td>
<td>Turbine type: V90-3.0 MW</td>
<td>MW: 21</td>
</tr>
<tr>
<td>North Hoyle*</td>
<td>Country: Denmark</td>
<td>Owner: Npower Renewables</td>
<td>Installation year: 2013</td>
<td>Number of turbines: 10</td>
<td>Turbine type: V90-3.0 MW</td>
<td>MW: 216</td>
</tr>
<tr>
<td>Kentish Flats*</td>
<td>Country: United Kingdom</td>
<td>Owner: Vattenfall</td>
<td>Installation year: 2010</td>
<td>Number of turbines: 30</td>
<td>Turbine type: V90-3.0 MW</td>
<td>MW: 90</td>
</tr>
<tr>
<td>Nobelwind*</td>
<td>Country: Belgium</td>
<td>Owner: Parkwind</td>
<td>Installation year: 2016-17</td>
<td>Number of turbines: 50</td>
<td>Turbine type: V112-3.3 MW</td>
<td>MW: 165</td>
</tr>
<tr>
<td>WIndfloat-floating Foundation</td>
<td>Country: Portugal</td>
<td>Owner: Windplus</td>
<td>Installation year: 2011</td>
<td>Number of turbines: 1</td>
<td>Turbine type: V80-2.0 MW</td>
<td>MW: 2</td>
</tr>
<tr>
<td>Thanet*</td>
<td>Country: United Kingdom</td>
<td>Owner: Vattenfall</td>
<td>Installation year: 2010</td>
<td>Number of turbines: 100</td>
<td>Turbine type: V90-3.0 MW</td>
<td>MW: 300</td>
</tr>
<tr>
<td>Offshore Windpark Q7*</td>
<td>Country: The Netherlands</td>
<td>Owner: WP Q7 Holding B.V.</td>
<td>Installation year: 2007</td>
<td>Number of turbines: 60</td>
<td>Turbine type: V80-2.0 MW</td>
<td>MW: 120</td>
</tr>
</tbody>
</table>

*Currently under service contract.
### Order pipeline

1,900 MW of firm orders secured, in line to supply a further 2,490 MW

#### Unconditional orders/ under installation

<table>
<thead>
<tr>
<th>Project</th>
<th>Country</th>
<th>Owner</th>
<th>Installation year</th>
<th>Number of turbines</th>
<th>Turbine type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aberdeen Bay</td>
<td>United Kingdom</td>
<td>Vattenfall</td>
<td>2018</td>
<td>11</td>
<td>V164-8.0 MW</td>
</tr>
<tr>
<td>Horns Reef 3</td>
<td>Denmark</td>
<td>Vattenfall</td>
<td>2018</td>
<td>49</td>
<td>V164-8.0 MW</td>
</tr>
<tr>
<td>Walney Extension</td>
<td>United Kingdom</td>
<td>DONG Energy</td>
<td>2017</td>
<td>40</td>
<td>V164-8.0 MW</td>
</tr>
<tr>
<td>Norther</td>
<td>Belgium</td>
<td>Norther NV</td>
<td>2019</td>
<td>44</td>
<td>V164-8.0 MW</td>
</tr>
<tr>
<td>Deutsche Bucht</td>
<td>Germany</td>
<td>British Wind Energy</td>
<td>2019</td>
<td>Not disclosed</td>
<td>V164-8.0 MW</td>
</tr>
</tbody>
</table>

#### Conditional orders

<table>
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<tr>
<th>Project</th>
<th>Country</th>
<th>Owner</th>
<th>Installation year</th>
<th>Number of turbines</th>
<th>Turbine type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borssele III &amp; IV</td>
<td>The Netherlands</td>
<td>Consortium</td>
<td>2021*</td>
<td>Not disclosed</td>
<td>Not disclosed</td>
</tr>
<tr>
<td>Triton Knoll</td>
<td>United Kingdom</td>
<td>Consortium</td>
<td>2021*</td>
<td>90</td>
<td>V164-9.5 MW</td>
</tr>
<tr>
<td>Moray East</td>
<td>United Kingdom</td>
<td>Consortium</td>
<td>2022*</td>
<td>100</td>
<td>V164-9.5 MW</td>
</tr>
</tbody>
</table>

#### Preferred supplier

<table>
<thead>
<tr>
<th>Project</th>
<th>Country</th>
<th>Owner</th>
<th>Installation year</th>
<th>Number of turbines</th>
<th>Turbine type</th>
</tr>
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<tr>
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<td>British Wind Energy</td>
<td>2019</td>
<td>Not disclosed</td>
<td>V164-8.0 MW</td>
</tr>
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*Publically communicated by the owner, subject to change
Reliable turbine supply
Product development & launching

【V112-3.0/3.3/3.45MW】
1. Rich experience
   • 219 V112-3.0 MW turbines or the equivalent of 662 MW installed offshore since 2013.
   • Since 2010 more than 10 GW of V112-3.X MW turbines including for onshore have been installed around the world.

2. Thorough verification makes marvellous performance
   • Various verification of components in a modern wind turbine test facility and in pre-production of actual wind turbines before serial production.

【V164-8.0MW】
Turbine design is based on the V112 proven technology and thorough verification is executed before serial production which enables both reliability and high performance as well as V112.
Reliable turbine supply
Product development & launching

Prototypes are installed to test power curve, power quality, installation techniques and service. Three V164-8.0MW provide invaluable knowledge and experience prior to going offshore.

The V164-8.0 MW prototype set a record in October 2014, producing 192,000 kWh in a 24 hour period, enough to power approximately 13,500 Danish households, demonstrating full capability.

Logistics, construction and installation techniques were tested during the erection of two V164-8.0 MW at Maade. Service teams will also have invaluable opportunity to service and maintain the turbines.
Reliable turbine supply
Reduction of delivery period of reliable wind turbines owing to over 20 years experience and continuous improvement

- Pre-assembly and onshore commissioning at Esbjerg facility enable lead-time reduction and reliability of products
- Continuous improvement for installation

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**2010 Thanet project (UK)**
V90-3.0MW x 100WTGs in 100days

- **FACTS**
  - Country: United Kingdom
  - Owner: Vattenfall
  - Installation year: 2010
  - Number of turbines: 100
  - Turbine type: V90-3.0 MW
  - Total output capacity: 300 MW

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**2015 Luchterduinen project (Netherlands)**
V112-3.0MW x 43WTGs 2 WTGs/1day

- **FACTS**
  - Country: Netherlands
  - Owner: EWE (56%), Mitsubishi Corporation (50%)
  - Installation year: 2015
  - Number of turbines: 43
  - Turbine type: V112-3.0 MW
  - Total output capacity: 129 MW
Installation of Luchterduinen, the Netherlands (Film)

Project completed 3 months ahead of schedule

Embed Installation Video here
Reliable turbine supply
Commitment to the market; big data and predictive service reduces production loss

Monitoring 33,000+ wind turbines worldwide, by the Vestas Performance & Diagnostics Center (VPDC):
- Upto 500 data points /turbine every 10 mins
- Big data: 60 TB in total
- High speed event logging
- Vibration monitoring

Analysis of the data allows early anomaly detection:
- Vibration patterns can reveal component irregularities that might need attention
- Preventive maintenance is therefore planned before potential damage to the wind turbine
- Planned regular maintenance and replacement

Minimize Lost Production Factor and warranty order

LPF (Lost Product Factor) = (Producible-Actual power) / Power producible

MVOW Fleet Lost Production Factor (LPF)
Agenda

● Who we are

● Offshore Wind Market in Europe

● What we can deploy in Japan
Offshore wind power

Over 90% are installed in Europe with high growth of 1 -2 GW/year. In European market, 5 countries (UK, Denmark, Germany, Belgium and Netherland) strongly lead the development and account for 97% of the market.
Driven by UK, Germany and Netherlands, so far the government has targeted new market of around 3GW/per year.
Offshore market overview – Competitors

Huge scale and risk of current offshore wind projects have accelerated consolidation by global power engineering giants, with two strongest WTG OEMs left accounting for 85% of European market.

Installed capacity by WTG OEM in Europe

- Siemens 67.8%
- MHI Vestas 16.4%
- Senvion (REpower) 6.2%
- Adwen 5.2%
- GE 0.3%
- Other 0.9%

Cumulative MW share to 2016
Source: WindEurope

Cumulative MW share from 2016 to 2020
Source: MAKE

Since 1980
Acquired 2004
Merged 2017

Since 1981
Acquired 2007
JV 2015 for offshore

Since 1979
JV 2014

Since 1994
JV with Vestas

Acquired the Zond in 1997
Acquired 2002

Siemens 67.8%
European Offshore Wind Market | Trajectory of LCOE

Along with the growth of the market, LCOE also reduced rapidly over the past few years. Latest, it marked $50/MWh.

LCOE range (nominal $/MWh) time series

Source: Bloomberg New Energy Finance
European Offshore Wind Market | Comparison of LCOE

Due to drastic reduction in LCOE, offshore wind power is recognized as a large power supply comparable to other energy supply in Europe. Project owners such as Ørsted (former Dong Energy) and E.ON, are concentrating their management resources on Renewable energy.

Legend: The triangle displays the LCOE benchmark value. The coloured bars show the range from the LCOE low value to the high value.

Chart: If the chart is blank, please change the date, country or sector selection above.

Source: Bloomberg New Energy Finance
Consequences of a market under rapid development.

Market design and strong regulatory framework are key elements.

**Strike prices in Europe auctions are down to grid parity…**

**Recently awarded subsidies**

- **East Anglia**
- **Neart na Gaoithe**
- **Horns Rev 3**
- **Borssele 1+2**
- **Borssele 3+4**
- **Krigers Flak**
- **He Drei**
- **BR West II**
- **Danish Near Shore**
- **Gode Wind**
- **OWP West**
- **Triton Knoll**
- **Moray**
- **Hornsea 2**

*Grid parity range by ~2024*

**Latest auctions have shown dramatic reductions in costs.**
- How to ensure a visible and stable market?
- How to ensure continued innovation and investment?
- How to ensure the renewable energy build-out?

Collaboration and partnerships with developers and the supply chain is paramount, not just in turbine technology, but in market design, and supply chain philosophy.

The figure shows the results for the UK auctions converted into 2016 euros for ease of comparison with the euro-dominated auctions.
Agenda

- Who we are
- Offshore Wind Market in Europe
- What we can deploy in Japan
Offshore wind farm project in Japan
Relationship with Japan | Transfer knowledge to Japan

MVOW has kept intense dialogue with policy makers of Japan
Relationship with Japan | Collaboration with Japanese suppliers

Japanese manufacturers are providing key components for V164-8.0 MW

- **TORAY**
  - Innovation by Chemistry
  - Carbon fibers for blade

- **ZOLTEK**
  - Carbon fibers for blade

- **YASKAWA**
  - Generator

- **THE SWITCH**
  - 66kVA Switch gear

- **MITSUBISHI ELECTRIC**
  - Changes for the Better
Relationship with Japan | Investment by Japanese trading company
Major Japanese trading companies have had significant footprint in offshore in Europe
Key actions to make Offshore Wind fly in Japan

“Offshore wind power was not built in a day”. To transfer 25 years experience and know-how to Japan should be the best way to make offshore wind viable solution for sustainable energy mix in Japan

1. **Strong commitment to offshore wind**
   - Long-term target of offshore wind deployment ensuring the visibility of market volume
   - Stable but competitive support mechanism ensuring cost reduction

2. **Clear roadblocks by provisioning the law and infrastructure**
   - Proper legislation framework and zoning by government
   - Transparent and efficient authorization process
   - Ensure grid connection
   - Efficient environmental assessment procedure reflecting experience in Europe

3. **Introduce the latest knowledge and experience of Europe**
   - Proven turbine technology, construction method and utilization of installation vessel
   - Mature project management
   - Contract / Risk Management Scheme, Finance structure
   - O&M (Technical, operation method, ship operation etc.)
Let’s move the horizon.