Ensuring Vestas’ current and future competitiveness

Anders Vedel, Executive Vice President & CTO

London, 21 June 2016
Disclaimer and cautionary statement

This presentation contains forward-looking statements concerning Vestas' financial condition, results of operations and business. All statements other than statements of historical fact are, or may be deemed to be, forward-looking statements. Forward-looking statements are statements of future expectations that are based on management’s current expectations and assumptions and involve known and unknown risks and uncertainties that could cause actual results, performance or events to differ materially from those expressed or implied in these statements.

Forward-looking statements include, among other things, statements concerning Vestas' potential exposure to market risks and statements expressing management’s expectations, beliefs, estimates, forecasts, projections and assumptions. There are a number of factors that could affect Vestas' future operations and could cause Vestas' results to differ materially from those expressed in the forward-looking statements included in this presentation, including (without limitation): (a) changes in demand for Vestas' products; (b) currency and interest rate fluctuations; (c) loss of market share and industry competition; (d) environmental and physical risks; (e) legislative, fiscal and regulatory developments, including changes in tax or accounting policies; (f) economic and financial market conditions in various countries and regions; (g) political risks, including the risks of expropriation and renegotiation of the terms of contracts with governmental entities, and delays or advancements in the approval of projects; (h) ability to enforce patents; (i) product development risks; (j) cost of commodities; (k) customer credit risks; (l) supply of components from suppliers and vendors; and (m) customer readiness and ability to accept delivery and installation of products and transfer of risk.

All forward-looking statements contained in this presentation are expressly qualified by the cautionary statements contained or referenced to in this statement. Undue reliance should not be placed on forward-looking statements. Additional factors that may affect future results are contained in Vestas' annual report for the year ended 31 December 2015 (available at vestas.com/investor) and these factors also should be considered. Each forward-looking statement speaks only as of the date of this presentation. Vestas does not undertake any obligation to publicly update or revise any forward-looking statement as a result of new information or future events others than required by Danish law. In light of these risks, results could differ materially from those stated, implied or inferred from the forward-looking statements contained in this presentation.
Introducing your speaker

Anders Vedel

• Executive Vice President & CTO.

• Joined Vestas in 1995 and became CTO in 2012; based in Aarhus, Denmark.

• Engineering degree from Engineering University, Horsens, Denmark, IMD and SIMI Management Programs.

• 2004-2012 Vice President of Service Northern Europe, Vice President of Operations in Vestas Americas, Vice President of CIM, Technology R&D, Managing Director Technology R&D Chennai, India.
1. Introduction and status

2. Our strategy and the link to LCOE

3. Evolution of Vestas 2 MW and 3 MW platforms

4. Investing in innovation in the short-, mid-, and long-term

5. Summary and questions & answers
Highest nominal R&D investments in the industry

Vestas’ size allows for large investments in R&D

Key takes:

• 2015 cash spend of EUR 156m in the R&D organisation, the highest in the industry, however benefitting from scale only equalling approx. 2% of revenues.

• No material changes expected to investment levels in coming years.

• A total of 1,292 employees in Technology & Service Solutions by the end of 2015 – primarily located in Denmark and India.
Our task

What does it take to secure that Vestas has the industry's most competitive products?
Agenda

1. Introduction and status

2. Our strategy and the link to LCOE

3. Evolution of Vestas 2 MW and 3 MW platforms

4. Investing in innovation in the short-, mid-, and long-term

5. Summary and questions & answers
Enabling Vestas to deliver on profitable growth strategy

Lowering the levelised cost of energy (LCOE) faster than the market average

To be the undisputed global wind leader

- Market leader in revenue
- Best-in-class margins
- Strongest brand in industry
- Bringing wind on a par with coal and gas

Deliver best-in-class wind energy solutions and set the pace in the industry to the benefit of Vestas’ customers and the planet

Grow profitably in mature and emerging markets

Capture the full potential of the service business

Reduce levelised cost of energy (LCOE)

Improve operational excellence

Consistency:

Never rest on our laurels
Innovation driven by constant need to reduce LCOE

Historically, turbine size has been a key driver in lowering LCOE.
Strong future ahead for wind

LCOE reduction expected to continue at significant pace

Expected LCOE development, onshore wind
USD/MWh

- Market specific wind LCOE expected to decrease by between 23 and 36 percent from 2016-2030.
- Global variations around these levels to be expected due to differences in market characteristics.

Vestas has ambitious LCOE targets and will reduce LCOE faster than market average

Source: BNEF Global Wind LCOE Update H1-2016.
Drivers of LCOE

How much can Vestas affect?

\[
\text{LCoE} = \frac{\text{Annualised CAPEX} + \text{Annualised OPEX}}{\text{Average Annual Energy Production}}
\]

- Fully influenced by Vestas
- Partially influenced by Vestas

CAPEX [EUR/year]
- Turbine
- Tower and foundations
- Electrical infrastructure
- Installation, construction, commissioning
- Cost of capital
- Project management and other

OPEX [EUR/year]
- Operation, maintenance, aftermarket improvements
- Administration and management
- Rated power, power curve
- Wind resources (e.g. wind speed)
- Availability, Lost Production Factor
- Site layout, electrical losses

Production [MWh/year]
1. Introduction and status

2. Our strategy and the link to LCOE

3. Evolution of Vestas 2 MW and 3 MW platforms

4. Investing in innovation in the short-, mid-, and long-term

5. Summary and questions & answers
Two highly competitive turbine platforms

Vestas is the only company in the industry with significant volume and track record in both 2 and 3 MW segments

**2 MW platform**

*Order intake by region, 2015 MW*

- Americas: 61%
- EMEA: 18%
- Asia Pacific: 20%

**Total 2 MW**

3,943 MW

- V90-1.8/2.0 MW
- V100-1.8/2.0 MW
- V100-2.0 MW

**3 MW platform**

*Order intake by region, 2015 MW*

- Americas: 34%
- EMEA: 52%
- Asia Pacific: 3%
- Offshore: 11%

**Total 3 MW**

5,000 MW

- V105-3.45 MW
- V112-3.45 MW
- V117-3.45 MW
- V126-3.45 MW
- V90-3.0 MW
- V136-3.45 MW

**Demand for proven performance remains strong:**

- One of the most trusted platforms in the industry providing customers great certainty on their business case.
- Continued demand highlights US flagship status of the V110-2.0 MW.

**Market leading technology with global reach:**

- Fulfilling specific needs, e.g. de-icing, LDST, offshore.
- V136 large rotor perfect match for medium to low wind.
- Vestas has the only 3 MW platform to see real volume across more than one continent.
Evolution of the 2 MW platform

Upgrading our proven products result in significant increased production, driving down LCOE

<table>
<thead>
<tr>
<th>IEC I</th>
<th>V80-2.0MW</th>
<th>V90-1.8/2.0 MW</th>
<th>V100-1.8/2.0MW</th>
</tr>
</thead>
</table>

1.8/2.0 MW

• V80/90-1.8/2.0 MW built based on previous model V66-1.75.

<table>
<thead>
<tr>
<th>IEC III</th>
<th>V100-2.0 MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>V110-2.0MW</td>
</tr>
</tbody>
</table>

2.0 MW

• Upgrade to 2.0 MW nominal rating.
• New rotor: 110m.

<table>
<thead>
<tr>
<th>IEC III</th>
<th>V100-2.0 MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>V110-2.0MW</td>
</tr>
</tbody>
</table>

2.0/2.2 MW

• Introduction of the 2.2 MW power optimised mode.

+18% AEP increase since 2009

First Prototype Installation


** Power modes applicable, suitability and performance depends on site specific conditions.
2 MW high-level design changes

Increasing annual energy production and lowering LCOE

**Improved cooling system**
- New slim Cooler Top Design
- Generator cooling switch from Air/Air to Air/Liquid
- Conditioning system update

**Blades**
- Aerodynamic add-ons increase power production
- Serrated trailing edges for noise sensitive markets

**Transformer**
- Option for ECO transformer (EU)

**Generator**
- Improved generator bearing lubrication
- New 50Hz Optislim generator improves power mode in higher temperature climates and higher altitudes

**Towers**
- Optimised light weight towers

**New power modes - 2.2 MW**
- Up to app. 3.3 % (V110) & 3.9%(V100) AEP improvement

**Power performance optimisation**
- Adaptive Wind Sensing increase AEP
- Higher operational temperature up to 45°
- Wind Speed Estimator

**Balance of plant improvements**
- Increased reactive power capability to minimise/eliminate compensation equipment at substation
Evolution of the 3 MW platform

Upgrading our proven products result in significant increased production, driving down LCOE

<table>
<thead>
<tr>
<th>IEC I</th>
<th>V90-3.0 MW®</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC II</td>
<td>V112-3.0 MW®</td>
</tr>
<tr>
<td>IEC III</td>
<td>V112-3.0 MW®</td>
</tr>
</tbody>
</table>

- V112-3.0 MW first member of new 3 MW platform.
- Most tested turbine in the industry.

**3.0 MW**

- Upgrade to 3.3 MW rating.
- New rotors: 105m, 117m, 126m.
- 3.45 MW**.

**3.3 MW**

- Upgrade to 3.45 MW rating.
- New rotor: 136m.
- 3.6 MW**.

**3.45 MW**

- V105-3.45 MW™
- V112-3.45 MW™
- V117-3.45 MW™
- V126-3.45 MW™
- V136-3.45 MW™

+18-35% AEP increase since 2010*

* AEP=Annual Energy Production. Compared to V112-3.0 MW/V90-3.0 MW. Actual performance depends on site specific conditions.

** Power modes applicable, suitability and performance depends on site specific conditions.
3 MW high level design changes

Increasing annual energy production and lowering LCOE

- Main shaft modification for higher loads.
- Aero add-ons on blades
  - Improved leading edge protection.
- New 136 m rotor.
- Larger pitch cylinders and accumulators for V117
  - Stronger pitch suspension
  - Modified hub layout and relocated blade access hatches.
- Larger blade bearing for V136
- Modified hub structure (cast structure) for load and weight optimisation.
- Optimised load carrying structure for higher rating and wind class upgrade (hotspot optimization).
- Redesigned nacelle rear structure for loads and weight optimisation
  - Generator lowering still possible.
- Optimised transformer foundation.
- Stronger yaw gears without torque limiter.
- Modified rear cover and side covers.
- Redesigned nacelle rear structure for loads and weight optimisation
- Simplified and industrialised fire suppression system.
Full-scope testing proves Vestas’ turbine quality

A significant contributor to keeping Lost Production Factor at a low level, improving output, and reducing cost

Vestas testing strategy

- Proof of concepts
- Other components
- Main + Critical components
- System test
- Integration test
- Nacelle
- Prototype
- 0 series

Functional performance, robustness, reliability & compliance

**Components**
- Testing of 20+ main components incl.:
  - Generator
  - Gearboxes
  - Blade & main bearings
  - Yaw gear
  - Converter

**System**
- Testing of 15+ systems incl.:
  - Drivetrain
  - Wind park control
  - Rotor & Hub
  - Pitch actuation
  - Conditioning & cooling
  - Power conversion system

**Integration**
- Testing of integration i.e.:
  - Nacelle assembly test
  - Generator & converter integration
  - Drivetrain system integration
  - Grid compliance
  - Tonality

**Field / Product**
- Field testing i.e.:
  - Run in and tuning
  - Power curve
  - Grid compliance
  - Loads
  - Noise
  - System validation
Agenda

1. Introduction and status
2. Our strategy and the link to LCOE
3. Evolution of Vestas 2 MW and 3 MW platforms
4. Investing in innovation in the short-, mid-, and long-term
5. Summary and questions & answers
Ensuring market-leading products in the future through innovation

Working with external partners in all stages of the process

<table>
<thead>
<tr>
<th>Innovation process</th>
<th>Implementation process</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technology ingredients</strong></td>
<td><strong>Concept development</strong></td>
</tr>
<tr>
<td>Universities, adjacent industries, tech companies</td>
<td>Strategic partners and suppliers</td>
</tr>
</tbody>
</table>

**Process**

- Investigation of new materials/technologies from other industries
  - Exploitation of ultra high fatigue resistant material.
  - New processes for fabrication of bionic metal designs.
  - Additive manufacturing of composite and metal components.

- Validation of high uncertainty concepts
  - Localised load control.
  - Alternative turbine concepts easing early introduction of new technologies.
  - Concepts exploiting elastic material.

- Validation of low uncertainty concepts
  - Journal gearbox bearings.
  - Alternative Power Train concept (GMA).
  - Leading edge wear resistance.
  - Low friction/high wear resistant materials for rotating machinery.

- Integration into products
  - Turbine upgrades.
  - Development of new products.

<table>
<thead>
<tr>
<th>Partners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic suppliers and customers</td>
</tr>
</tbody>
</table>

**Examples**
Example: Challenging scaling rules with multi-rotor demonstrator

Continuous reduction of LCOE requires new solutions and new ways of thinking

What are the benefits of a turbine like this?
Examples: Investing in new technology materials

Optimising performance, cost and sustainability

- Radical weight reduction through Bionic design and Additive Manufacturing.

- Active damping and control solutions to minimise societal disturbance of wind turbines.

- Recyclable composites through alternative materials - option for low cost short life time/sales of upgrades.

- Carbon based high property conductive materials applied to pre-empt the electrified society’s shortage of metals.
Examples: Value chain and supply chain concepts

Providing access to new markets with undeveloped logistical infrastructures

- **Mobile Factory reducing logistics challenges through portability and offering local labor creation at low investments.**

- **Flexible crane solutions for high towers and markets with infrastructural constraints.**
Examples: Ancillary services and solutions
Responding to solar, distribution and intermittence

- Improve capability to offer ancillary services by improving control and optimal integration of storage in wind power plants and wind turbines.

- Offer turn key off-grid/micro grid solutions for frontier markets integrating MW/kW wind, solar, storage, water and fuel.

- Removing the intermittence challenge of the grid in mature markets by concepts converting surplus wind to heat and fuel.

- Strive toward concepts relocating, storing, pumping, cleaning, desalinating or producing water by surplus wind.
Examples: Investing in digitalisation
Leveraging on Vestas’ world-class data collection

- Further utilise model prediction, high performance computing and big data to support energy systems dynamics.

- Combine power capacity and quality control through Internet-of-Things based Real Time interoperability.

- Exploit Vestas’ access to big data for diagnostics, remaining useful life analysis, service and after sales optimisation.

- Turbine R&D, value chain simulation + business case modeling, O&M performance and optimisation all founded on high performance computing.
Reducing LCOE faster than the market average

Vestas has the capabilities and know-how to deliver on our promise of reducing LCOE faster than the market average

Expected LCOE development, onshore wind
USD/MWh

Vestas has ambitious LCOE targets and will reduce LCOE faster than market average

Source: BNEF Global Wind LCOE Update H1-2016.
1. Introduction and status

2. Our strategy and the link to LCOE

3. Evolution of Vestas 2 MW and 3 MW platforms

4. Investing in innovation in the short-, mid-, and long-term

5. Summary and questions & answers
Summary

1. Vestas continuously optimises energy output in its products and is committed to reduce LCOE faster than market average – enabled by the strongest product line-up in the industry.

2. Vestas invests in innovation across the value chain, both on current platforms and on breakthrough technologies.

3. By doing this, Vestas ensures our current and future competitiveness and thereby our market leadership position in the short-, mid- and long-term.
Thank you for your attention