1. Offshore Wind Market
2. Nordex Offshore History & Future
3. Competition & Technical Development
4. The N150/6000
Expected annual global offshore wind turbine installation 2010 vs. 2020 in MW

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<th>Year</th>
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CAGR: 19.6%

Total installation volume 2010 – 2020: ~47 GW

Growth drivers of future offshore wind energy development

- Increasing security of energy supply due to higher offshore wind energy capacity load as compared to onshore wind energy
- Growing expertise will lead to decreasing electricity production costs
- Political renewable energy targets can be reached only with extensive use of offshore wind energy only

Source: Nordex estimates
Strong growth prospects for offshore wind energy (2/2)

Expected annual global offshore wind turbine installation 2010 vs. 2020 in MW

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CAGR: 19.6%

Total installation volume 2010 – 2020: ~47 GW

Challenges of future offshore wind energy development

- Bottlenecks financing
- Bottlenecks supply chain
- Bottlenecks grid infrastructure
- Volume not yet high enough for further cost reductions
- Technology to-date offers only limited energy production cost reduction

Source: Nordex estimates
Europe will be the main growth driver for offshore in the years ahead

Offshore installations in Europe by country 2011 - 2016

- Current political debate regarding accelerated nuclear phaseout could boost further offshore wind energy growth

Source: MAKE
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Our offshore test turbines have been running since 2003 without major repairs

Nordex’ offshore experience

Frederikshaven
- N90 2.3 MW Prototype
- Installation in 2003
- Test site with 1 x Nordex, 1 x Vestas, 1 x Siemens turbine
- Best yield at test site
- No major component changes

Breitling
- N90 2.5 MW Prototype
- Installation in 2006
- First offshore WTG in Germany
- 97% availability in operating business year 2009
- Uninterrupted operation

➢ Nordex has installed more than 4,400 WTG turbines to date (proven track record)
➢ High capacity for technological innovation and know how in long term quality assurance as well as turbine development for the most extreme weather conditions
Offshore strategy is built on three main pillars

**Competitive product: N150**
- **Direct drive, 6 MW, 150m Rotor**
- Prototype phase in **2012/2013**

**Experienced Management Team**
- **Establishment** of separate business unit
- **Nordex Offshore Management** with track record of more than 15 years in that area on board
- Additional staff with extensive experience in offshore wind industry hired

**Market entry with reference project**
- **Fast track to achieve** offshore market entry
- 39% share in the “Arcadis Ost 1” project
- Deliver up to **70 turbines**, planned installation in **2014/15**
Nordex’ offshore plan – time schedule

2010
Arcadis Ost 1 Signed

2012/2013
Prototype phase (intensive testing)

2014
Start series production

2015
First large scale project
Extensive testing of prototype turbines and components ensures the high quality of Nordex’ products.
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Swept rotor area to generator capacity drives efficiency

Swept rotor area per MW

- **1st generation (2002 – 2009):**
  *Energy production* per turbine is *too low* with 2-3 MW WTG (high infrastructure costs/MW)

- **2nd generation (2009 – 2014):**
  Existing 5-6 MW offshore turbines are relatively *heavy* and rotor is too small

- **Efficiency generation (2014 -):**
  *Direct drive, large rotor, low top head mass, extended lifetime*

- **The N150/6000** will be one of the first of the new more powerful and lighter generation of offshore turbines
Direct drive reduces operations and maintenance costs and increases energy yield

Advantages of direct drive permanent magnet

- Conventional gearbox drive trains have energy losses of 3-4%

- With direct drive the number of moving parts is reduced significantly which increases reliability

- Maintenance is minimized with direct drive so operating costs are reduced

Proven technology: Direct drive generator already in the market for several years
Low top head mass is a must to achieve low cost per kWh.
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6MW is the optimal generator size for the future offshore turbine generation.

**Efficiency**
- 3 m²/kW
- 55 t/MW

**Output**
High infrastructure costs require maximum energy production

**Durability**
Longer blade = higher technical risk

Nordex offshore turbine with capability for further yield increase.
The N150/6000 is Nordex’ turbine for the offshore market

Technical data

- **6.0** MW rated power
- **Direct drive** permanent magnet
- Rotor diameter **150m**
- **17,671 m²** swept area
- Designed for **extreme offshore** conditions
EUR 322 m additional revenues per wind farm

Discounted revenues of a 70 x 6 MW turbine offshore wind farm

<table>
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<th>6 MW/125m*</th>
<th>Delta</th>
<th>N150 / 6000</th>
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<tr>
<td>Annual revenue per WTG (year 1-12)</td>
<td>3,38 Mio. €</td>
<td>+ 574 k€/a</td>
</tr>
<tr>
<td>Gross output per turbine**</td>
<td>26,5 GWh/a</td>
<td>+ 4,5 GWh/a</td>
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*Rated power 6000 kW, Rotor diameter 125 m; **9.5 m/s @ 100 m
The N150/6000 is the most economical solution for offshore wind projects

Key features of the N150/6000

- **Leading edge swept area to generator ratio**
  - Maximum efficiency

- **Direct drive permanent magnet**
  - Reduced operations and maintenance costs
  - Higher reliability
  - Higher energy yield

- **Very low top head mass**
  - Lower costs (structure + logistics)

- **Service friendly design**
  - Lower logistics and operations costs

- **25 years design lifetime**
  - Minimum cost per kWh
Dimensions of the new N150/6000

- **Rotor Diameter:** 100 m
  - N100/2500

- **Rotor Diameter:** 150 m
  - N150/6000
Dimensions of the new N150/6000

Swept area: 7,854 m²

Swept area: 17,671 m²

N100/2500

N150/6000
The rotor diameter of the N150/6000 exceeds the London Eye by 15 meters.
The rotor diameter of the N150/6000 exceeds the London Eye by 15 meters.
The N150/6000 – A perfect match to customers' expectations

- Nordex offshore wind turbine delivers a superior energy yield
- Nordex is the company with a 25 year track record and more than 4,400 onshore turbine installations that delivers reliable, high quality products
- The Nordex Offshore team will have extensive experience in the offshore wind energy industry