Rising to the Offshore Challenge

Offshore – Siemens Wind Power A/S, Brande, Denmark
Content

- Siemens Wind Power A/S, Offshore Business Segment
- Our Strategy
- Our Performance
- Our Market Perspectives
- Common Challenges
Siemens’ answers the world’s toughest questions

- The Siemens answer: "Efficient energy supply"
- The Siemens answer: "Early detection and prevention"
- The Siemens answer: "The intelligent factory"
### Answers provided by 15 Divisions in three Sectors

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<tr>
<th>Sectors</th>
<th>Divisions</th>
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<tbody>
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<td>• Industry Automation</td>
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<td>• Drive Technologies</td>
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<td>• Building Technologies</td>
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<td>• Fossil Power Generation</td>
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<td>• <strong>Renewable Energy</strong></td>
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<td>• Industry Solutions</td>
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<td>• Mobility</td>
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Comprehensive portfolio and services: From primary energy to power distribution
Competent solutions in all phases of a wind power plant project

Planning
- Siting guidance
- Financing packages
- Insurance packages
- Network evaluation

Construction
- Product delivery
- Project management
- Installation
- Commissioning
- Turnkey experience
- Local presence around the globe

Service and Expansion
- Inspections
- Maintenance programs
- Modernizations
- Extensions
- Repairs
- Spare parts
- Training
- Global service network

Operation
- O&M agreements
- Monitoring
- Diagnostics
Wind power: The most important "new" renewable energy source

**Worldwide installed onshore wind capacity**

- **2007**: 94 GW
- **2015**: 310 GW
- **2030**: 660 GW

**Worldwide installed offshore wind capacity**

- **2007**: 1 GW
- **2015**: 23 GW
- **2030**: 150 GW

Source: Siemens Energy scenario "Base Case", EWEA, E R WP OF BD

FP&L Horse Hollow, Texas, 300 MW total, 2.3 MW wind turbines

Lillgrund, Sweden, 110 MW total, 2.3 MW wind turbines
## Siemens Wind Power Facts

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
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</thead>
<tbody>
<tr>
<td>Currently employees</td>
<td>Currently 5,800 employees (850 in 2004)</td>
</tr>
<tr>
<td>Deliveries</td>
<td>Deliveries: 2,260 MW in 2009 (600 MW in 2004)</td>
</tr>
<tr>
<td>Capacity</td>
<td>Capacity: Grow to 4,500 MW in 2011</td>
</tr>
<tr>
<td>Installed Base</td>
<td>Installed Base: &gt;8,700 turbines with &gt;11,000 MW capacity</td>
</tr>
<tr>
<td>Record Order Entry</td>
<td>Record Order Entry in FY 2009</td>
</tr>
<tr>
<td>Target</td>
<td>Target: To become Top 3 supplier in 2012</td>
</tr>
<tr>
<td>No. 1 in new orders</td>
<td>No. 1 in new offshore orders in 2007, 2008 and 2009</td>
</tr>
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Siemens Wind Power A/S, Offshore Business Segment

Our Strategy

Our Performance

Our Market Perspectives

Common Challenges
Challenges in the offshore business

- Optimize wind turbine technology for larger projects
- Find the right port locations for growing the industry
- Optimize installation technology and secure vessels
- Optimize project interfaces and service concepts
SWP’s strategy is defined by stepping up a learning curve

SWP has chosen an incremental learning approach to manage the risk on the supplier side, starting with a stringent project selection process.
Siemens Wind Power in Korea

Siemens - as world market leader in wind offshore – is in continuous contact with developers in Korea.

Siemens is already boosting the Korean wind Industry by sourcing components from Korean suppliers.

Siemens foresees the emergence of a Korean wind turbine manufacturing capability, even without foreign presence but is willing to support if requested.

Siemens is prepared to set up local production in Korea when the market takes off.

Latest activities include Siemens:
- MoU signing with Jeollanamdo Province for participating in the wind power development
- Actively following up the development of other Offshore project initiatives in Korea
- Using Korea as supply base for components for WTs
Market leader in offshore with 800+ MW installed

- **Burbo Banks, UK**
  → 25 x SWT-3.6-107 (2007)

- **Lynn / Inner Dowsing, UK**
  → 54 x SWT-3.6-107 (2008)

- **Gunfleet Sands, UK**
  → 48 x SWT-3.6-107 (2009)

- **Rhyl Flats, UK**
  → 25 x SWT-3.6-107 (2009)

- **Vindeby, DK**
  → 11 x 0.45 MW (1991)

- **Middelgrunden, DK**
  → 20 x SWT-2.0-76 (2000)

- **Samsoe, DK**
  → 10 SWT-2.3-82 (2002)

- **Rønland, DK**
  → 4 SWT-2.3-93 (2002)

- **Rødsand/Nysted, DK**
  → 72 SWT-2.3-82 (2003)

- **Frederikshavn, DK**
  → 1 SWT-2.3-82 (2003)

- **Horns Rev II, DK**
  → 91 SWT-2.3-92 (2009)

- **Hywind, NO**
  → 1 SWT-2.3-82 (2009)

- **Lillgrund, SE**
  → 48 SWT-2.3-93 (2007)
Over 1000 turbines in projects to come

Greater Gabbard, UK → 140 x SWT-3.6-107
Sheringham Shoal, UK → 88 x SWT-3.6-107
London Array, UK → 175 SWT-3.6-120
Walney, UK → 51 x SWT-3.6-107 → 51 x SWT-3.6-120
Lincs, UK → 69 X SWT-3.6-120
Gwynt Y Mor, UK → 160 X SWT-3.6-107

Rødsand II, DK → 90 SWT-2.3-93
Anholt, DK* → 111 SWT-3.6-120
Pori, FIN → 1 SWT-2.3-101
Baltic I, DE → 21 SWT-2.3-93
Baltic 2, DE → 80 SWT-3.6-120
Borkum Riffgat, DE → 30 SWT-3.6-107

1) In progress
* Subject to approval
Our answer for advanced turbine technology: SWT-2.3: Well fit for sites close to the shore

Main data:

- IEC Class: IA / IIA / IIB
- Rotor diameter: 82 / 93 / 101 m
- Blade length: 40 / 45 / 49 m
- Swept area: 5,300 / 6,800 / 8,000 m²
- Hub height: Site specific
- Annual output at 9 m/s: 9,326 / 10,491 MWh
- Rotor weight: 54 / 60 / 62 t
- Nacelle weight: 82 t
- Tower weight: Site specific
- Installed offshore: 227 units
- Ordered for offshore: 110+ units
Our answer for advanced turbine technology: SWT-2.3: Well fit for sites close to the shore

<table>
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<tr>
<th>Technical data:</th>
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<td>Power regulation:</td>
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<td>Generator:</td>
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<td>Nominal power:</td>
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<td>SCADA system:</td>
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<td>Cut-in wind speed:</td>
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<td>Nominal power at:</td>
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<tr>
<td>Cut-out wind speed:</td>
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<td>Frequency converter:</td>
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<tr>
<td>Nominal grid frequency:</td>
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</tbody>
</table>
Our answer for advanced turbine technology: SWT-3.6-107/120: The No. 1 offshore machine

Main data:

- IEC Class: IA / IA*
- Rotor diameter: 107 / 120 m
- Blade length: 52 / 58,5 m
- Swept area: 9,000 / 11,300 m²
- Hub height: Site specific
- Annual output at 9 m/s: 15,437 / 16,793 MWh
- Rotor weight: 95 / 100 t
- Nacelle weight: 125 t
- Tower weight: Site specific
- Prototype installed: 2004 / 2009
- Serial production: 2006 / 2010
- First installed offshore: 2007 / 2011
- Installed offshore: 152 units
- Ordered for offshore: 700+ units

* Target, certification process ongoing
Our answer for advanced turbine technology: SWT-3.6-107/120: The No. 1 offshore machine

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<tr>
<td>Nominal grid frequency:</td>
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Offshore modifications

- Offshore modifications implemented as part of basic design. Modifications in place also for onshore turbines
- Arrangements generally according to principles having shown their worth from Vindeby onwards
- Transformer and HV switchgear in tower bottom
- Corrosion, outside – surface protection to C5M in splash and spray zone
- Corrosion, inside – "closed room system", with climate control (dehumidifiers, salt filters) and cooling via heat exchangers.
- Opening reduced to a minimum
- Experience is that offshore operational conditions are generally more benign than onshore due to low turbulence
Our answer for advanced turbine technology: Integral Blade without glue joints

Siemens Integral® Blade

- The blade is manufactured in a single operation, using a closed process invented by Siemens
- No glue joints between spars and shells, no weak points, no easy access for water or lightning
- Combining superior strength with excellent power and noise performance
Our answer for advanced turbine technology: SWT-3.0 DD: An alternative to geared turbines

**Main Data**

- **IEC class**: IA
- **Rotor diameter**: 101 m
- **Prototype installed**: 2009

**Direct Drive Technology**

- No gear box
- Reduced number of parts
- Reduced maintenance costs
- Synchronous permanent magnet generator
- No excitation control systems or slip rings
- High efficiency
Our answer for advanced turbine technology: exceptional innovations for the future

- Cooperation on technology with Statoil to develop the world's first floating offshore installation
- In 2009 Siemens installed the first wind turbine for the demonstration unit off the coast of Norway
- Floating offshore turbines could be installed at sites with greater water depths

Hywind
Our answer for advanced turbine technology: Continuous monitoring to prevent failures

Turbine Condition Monitoring

- Designed to continuously monitor the external and internal state of the wind turbine
- 24 / 7 precise online vibration measurement on the gearbox, the generator and the main shaft bearings
- Detect significant deviations from its normal operating condition
- Prevention of costly breakdowns
- Reduced service costs
- Optimized availability and energy generation
### Siemens does not compromise on safety

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<tbody>
<tr>
<td><strong>1</strong></td>
<td>Stringent safety standards when installing and servicing offshore turbines</td>
</tr>
<tr>
<td><strong>2</strong></td>
<td>Continuous safety training and daily assessments</td>
</tr>
<tr>
<td><strong>3</strong></td>
<td>Safety@Wind program aims at preventing accidents before occurring</td>
</tr>
<tr>
<td><strong>4</strong></td>
<td>Low accident frequency despite rough offshore environment</td>
</tr>
</tbody>
</table>
Siemens Service partnership approach ensures that project and customer needs are met

- **Unmatched track record** for maintaining optimum availability
- Years of **experience** in dealing with the unique demands of offshore fleets
- **Flexible service portfolio**
  - matching project and owner specific requirements
- Strong focus on **building partnerships**
## Offshore wind is in a steep development phase

<table>
<thead>
<tr>
<th># countries with offshore wind</th>
<th>1990s</th>
<th>2000s</th>
<th>2010-2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg. wind farm / project size</td>
<td>6 MW</td>
<td>90 MW</td>
<td>&gt;500 MW</td>
</tr>
<tr>
<td>Avg. yearly installed capacity</td>
<td>3 MW</td>
<td>230 MW</td>
<td>6.000 MW</td>
</tr>
<tr>
<td># Significant manufacturers</td>
<td>2</td>
<td>3</td>
<td>&gt;8</td>
</tr>
<tr>
<td>Avg. turbine size</td>
<td>&lt; 0.5 MW</td>
<td>3 MW</td>
<td>5-6 MW</td>
</tr>
<tr>
<td>Avg. rotor diameter</td>
<td>37 m</td>
<td>98 m</td>
<td>125-130 m</td>
</tr>
<tr>
<td>Avg. water depth</td>
<td>5 m</td>
<td>15 m</td>
<td>&gt;30 m</td>
</tr>
<tr>
<td>Customers</td>
<td>Scandinavian utilities</td>
<td>European utilities</td>
<td>Global utilities, large consortia, non-utility investors</td>
</tr>
</tbody>
</table>
Offshore: A growing market, but will feel impact of financial crisis in 2011

**Estimated global annual offshore turbine installation in MW**

<table>
<thead>
<tr>
<th>Year</th>
<th>SWP</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td>2007</td>
<td>200</td>
<td>212</td>
</tr>
<tr>
<td>2008</td>
<td>194</td>
<td>364</td>
</tr>
<tr>
<td>2009</td>
<td>775</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>1,600</td>
<td>1,600</td>
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<tr>
<td>2011</td>
<td>1,200</td>
<td>1,200</td>
</tr>
<tr>
<td>2012</td>
<td>3,000</td>
<td>3,000</td>
</tr>
<tr>
<td>2013</td>
<td>4,000</td>
<td>4,000</td>
</tr>
<tr>
<td>2014</td>
<td>4,800</td>
<td>4,800</td>
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*Worldwide installed until 2007 = 912 MW*

**Siemens target:**
40 - 50% worldwide market share in offshore installations
Different conditions require different turbines

Europe bodies of water

<table>
<thead>
<tr>
<th>Body of Water</th>
<th>IEC Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baltic Sea North</td>
<td>2A/2B</td>
</tr>
<tr>
<td>North Sea/ Irish Sea / English Channel / Iberia</td>
<td>1A/1B</td>
</tr>
<tr>
<td>Mediterranean</td>
<td>2B/3B</td>
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</tbody>
</table>
Bigger isn't always better...

2.3 MW vs. 3.6 MW turbines at 7m/s

Smaller turbines more efficient in low winds

<table>
<thead>
<tr>
<th>Wind farm size</th>
<th>100MW</th>
<th>100MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbine type</td>
<td>SWT-2.3-101</td>
<td>SWT-3.6-107</td>
</tr>
<tr>
<td>No. of turbines</td>
<td>43</td>
<td>28</td>
</tr>
<tr>
<td>Average wind speed</td>
<td>7m/s</td>
<td>7m/s</td>
</tr>
<tr>
<td>Annual Energy Production</td>
<td>342GWh/year</td>
<td>289 GWh/year</td>
</tr>
</tbody>
</table>

The AEP at above example is 18% higher with the SWT-2.3-101 than with the SWT-3.6-107.

Installed projects with 2.3 MW turbines

- Samsø, Denmark
  - 10 x SWT 2.3-82
- Rønland, Denmark
  - 4 x SWT 2.3-93
- Rødsand, Denmark
  - 72 x SWT 2.3-82
- Frederikshavn, Denmark
  - 1 x SWT 2.3-82
- Lillgrund, Sweden
  - 48 x SWT 2.3-93
- Hywind, Norway
  - 1 x SWT 2.3-82
- Horns Rev II, Denmark
  - 91 x SWT 2.3-93

Future projects:

- Baltic I, Germany
  - 21 x SWT 2.3-93
- Rødsand II, Denmark
  - 90 x SWT 2.3-93
Future trends in offshore wind energy

Larger projects

Projects further offshore

New markets

Future projects will be more challenging in terms of turbine and installation technology, transport, grid connection and service.
Offshore wind power projects
Now and tomorrow

Lillgrund Wind Farm
- **48 wind turbines** (110 MW)
- Water depths: **4-13 m**
- Distance to shore: **6-7 km**
- Wave height: **2 m**

NN Wind Farm Germany
- **80 wind turbines** (300 MW)
- Water depths: **27-35 m**
- Distance to shore: **90 km**
- Wave height: **10 m**
Our answer for tomorrow’s offshore projects:
Develop new solutions for challenging sites

Offshore sites in deeper waters and at a larger distance to the shore need new technology

- **New technologies:**
  We partner with major players to develop new technical solutions

- **Bigger installation vessels:**
  We partner with vessel design companies to ensure solutions for the future

- **New grid solutions like HVDC plus:**
  Together with the Siemens Energy Transmission Division, we offer integrated solutions for grid connections

Technology and equipment for the more challenging sites will be ready early in the next decade, but large investments are required!
Contact

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Thank you for your attention!

Siemens Wind Power A/S