ABB Wind Power Solution
ABB delivers from A to Z into the wind industry
Wind power generation, transmission and integration, control

EMS: Energy Management System
GMS: Generation Management System
HVAC: High-voltage Alternating Current
HVDC: High-voltage Direct Current
PLC: Programmable Logic Controller
SCADA: Supervisory Control And Data Acquisition
ABB delivers from A to Z into the wind industry

Wind power generation: components for wind turbines

Wind turbine converters
- Doubly-fed/Full power low voltage (up to 6MW, 690V)
- Medium voltage (up to 10MW, 3.3kV)

Generators
- Doubly-fed/full converter concepts (up to 8MW, 690V – 12kV, higher powers also)

Transformers
- Dry-type/Liquid-filled (up to 72.5kV and 40MVA)

Switchgears
- Medium voltage (12-40.5kV)
- High voltage (72.5kV)

Turbine control and protection products
For drivetrain & other sub-systems

Turbine controllers
- PLC (Programmable Logic Controller)
- Support functions (monitoring, power supply, signal conversion)

Motors
- Brake motors for yaw & pitch control
- AC motors for generator cooling, fans and hydraulic systems.

Drives
- Variable speed motor control

Enclosures & connections
- Enclosures
- Wire & cable management, connections, terminal blocks

Updated: February 19, 2013
Products for wind turbines
Generators for all drivetrain concepts

- Leading global generator manufacturer
- Over 30 years know-how in wind power
- Over 30,000 generators and 30 GWs
- Powers 1 – 7 MW; up to 20 MW
- Leader in PM technology since the 1990’s
- Manufacturing: EU, USA, China, India

<table>
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<tr>
<th>Doubly-fed</th>
<th>Full converter</th>
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</table>
| - Standard product platform
- Patented rotor design
- 2.5 kV rotor insulation
- Carbon-fiber winding support
- Overspeed up to 3000 rpm
- Proven slip ring unit
| - Permanent magnet generators
- Low, Medium and High speed
- High efficiency at all wind speeds
- Maximum production of kWhs
- High power and small size |
Products for wind turbines
Wind turbine converters

- Low Voltage Converter
  - Onshore or offshore turbines
  - IGBT power modules
  - Air and liquid-cooled models
  - Doubly-fed converter
    - LVRT and reactive power
    - 0.85 to 6 MW
  - Full power converter
    - Grid code support
    - 0.8 to 6 MW

- Medium Voltage Converter
  - Onshore or offshore turbines
  - IGCT power modules
  - 2.5 to 10 MW and up
  - Liquid-cooled
  - Grid code support
  - Harmonic elimination control algorithm
Products for wind turbines
Transformers

- Compact design to fit through tower doors without disassembly. Dry and liquid filled transformers can be installed in the tower or nacelle, in both onshore or offshore turbines.

### Product highlights
- Classes E2, C2, F1
- Insulation system temperature up to 180 °C for dry transformers
- Organic liquid cooling options

### Technical information
- Dry transformers up to 72.5 kV and 40 MVA
- Liquid filled transformers up to 72.5 kV and 40 MVA
Products for wind turbines
Switchgear

- Compact switchgear solution for all voltage levels. Provides switching and protection of wind power plant networks in harsh operating environments.

- For onshore and offshore turbines
- Combination of standardized modules provides full application flexibility
- Switch fuse or circuit breaker protection

- Available solutions for 12 kV, 24 kV, 36 kV, and 40.5 kV
- IEC and GB approvals
Products for wind turbines
Low Voltage Products for Wind Turbines

- Contactors for main circuit switching
- Circuit Breakers for main circuit switching and protection
- Products for motor control and protection
- Operating and connecting devices (Pilot devices and terminal blocks)
- PLC for turbine control
- Circuit Breakers for sub distribution
- Surge arrestors
- Motors and Drives for Subsystems
Products for wind turbines
Low voltage AC motors

Induction motors used in
- Yaw system: 4 with brake
- Pitching: 2-3 with brake and encoder (new application)
- Cooling for electric control system: 1 set
- Hydraulic system for generator cooling: 1 set
- Lubrication system for gearbox: 1 set

<table>
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<tr>
<th>Product highlights</th>
<th>Technical information</th>
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<tbody>
<tr>
<td>Available for all common voltages</td>
<td>0.06 to 55 kW</td>
</tr>
<tr>
<td>Premium efficiency motor selection</td>
<td>2 to 8 poles</td>
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ABB delivers from A to Z into the wind industry
Wind power transmission and integration: products and systems to transmit and integrate wind power

**FACTS:** Flexible AC Transmission System  
**HVAC:** High-voltage Alternating Current  
**HVDC:** High-voltage Direct Current  
**STATCOM:** Static Synchronous Compensator
Power Systems Consulting in Wind Sector

AC and DC power system analysis
- Connection to grid studies
- Grid code compliance
- Wind farm grid optimization
- Modeling and software support

Asset assessment
- Audits & diagnosis
- Failure assessment
- O&M optimization
- Retrofit (P&C)

Training
- Standard courses
- Software training seminars
- Tailor-made courses
Products for grid connection

STATCOM

- Static synchronous compensator (STATCOM) and voltage control for grid code compliance in turbines lacking built-in grid code capabilities.

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<td>Dynamic reactive power compensation</td>
<td>100 kVar to 10 MVar</td>
</tr>
<tr>
<td>Prevents transients from other circuits in the wind power plant’s collection network</td>
<td></td>
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Products for grid connection
Capacitor Banks

- The future of reactive compensation for all wind generated applications and distribution utility systems. Complete aluminium enclosure (up to IP65) for the most demanding environments

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<td>Repeatable modular design with defined, Incomer module, Power modules and Integrated control &amp; protection.</td>
<td>Designed for voltages up to 36kV</td>
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<tr>
<td>Customer benefits include: compact foot print, expandable, proven performance and reliability over 15 years.</td>
<td>Busbar system type tested</td>
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<tr>
<td>Flexibility in design</td>
<td>Flexibility in design</td>
</tr>
<tr>
<td>Range of voltages, step sizes, networks configurations etc.</td>
<td>Current limiting inrush or detuned harmonic reactors</td>
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Energy storage for wind applications:

With the increase of renewable sources, delivering power reliably where and when it is needed is a bigger challenge than ever before.

The storage of power is required - both to balance generation and consumption and to maintain grid stability. Applications for the wind sector include

- Ramp rate control
- Power quality
- Frequency regulation
- Capacity firming
Offshore Wind Connections
ABB Offer

- Offshore and onshore AC and DC (HVDC for longer distances – large wind farms)
- Reactive power control systems (FACTS)
- HV-Cables including land and subsea cable laying
- Training and advise on operation
- System studies including grid code compliance solutions and advise on connection to onshore main grid
- Maintenance contracts
Overview
Offshore AC wind power connections

- Wind farms
- Offshore AC substation
- 24-72 kV Collection grid
- 72-245 kV Subsea cable
- Onshore AC substation with reactive compensation
- Main AC network

50 – 300 MW: 72-150 kV
Traditional AC substations located offshore

200 – 600 MW: 150-245 kV
Key issue is to fulfill grid code compliance

Key issue is to fulfill grid code compliance
Overview
Offshore HVDC wind power connections

Wind farms
Offshore AC substation
Offshore HVDC converter station
DC cable transmission
Onshore HVDC converter station

100 – 300 MW: ± 80 kV HVDC Light (VSC)
300 – 500 MW: ± 150 kV HVDC Light
500 – 1100 MW: ± 320 kV HVDC Light
VSC technology for compact solutions
Our knowledge is based on a number of completed and ongoing offshore power projects

- **Princess Amalie**: 120 MW, AC-connection
- **Borwin 1**: 400 MW, HVDC-connection
- **Thornton Bank**: 325 MW, AC-connection
- **Dolwin 2**: 900 MW, HVDC-connection
- **Valhall**: 80 MW, HVDC, Power from shore
- **Dolwin 1**: 800 MW, HVDC-connection
- **Troll 1 & 3**: 80+80 MW, HVDC, Power from shore
ABB Wind Care
Comprehensive service portfolio supported by regional hubs

- ABB services span the entire product ownership life cycle:
  - Installation and commissioning
  - Training, both classroom and online (LV breakers, converters, switchgears…)
  - Spare parts and spare parts kits (LV components, spare parts for ABB converters and generators, …)
  - Preventive and corrective maintenance including condition monitoring
  - Retrofit and upgrades
  - Replacement and repair (ABB Generator Replace and Recycle, converter factory repair with full load testing, transformer on site repair, …)
- Advanced services
- Technical support, Engineering and consulting
Power and productivity for a better world™