



SIEMENS



New dimensions

Siemens Wind Turbine SWT-3.6-107

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Answers for energy.



# New dimensions

The SWT-3.6-107 wind turbine is one of the largest models in the Siemens Wind Power product portfolio. It was specifically designed for offshore applications, but works equally well onshore.

The 107-m rotor has a swept area of 9,000 square meters, and with the advanced aerodynamics of the B52 IntegralBlade® technology the energy yield sets new standards.

The SWT-3.6-107 machine is ideal for offshore markets worldwide. A rugged, conservative structural design, automatic lubrication systems with ample supplies, climate control of the internal environment, and a simple generator system without slip rings provide exceptional reliability at long service intervals. Grid stability requirements grow as more wind power is fed into the grid and the SWT-3.6-107 machine also sets new standards here. Power conversion is

implemented with Siemens' unique NetConverter® system, ensuring compliance with all relevant grid codes and offering maximum flexibility in the turbine response to voltage and frequency control, fault ride through and output adjustment.

Despite the new features, the classical advantages of the earlier Siemens turbine types have not been forgotten in the SWT-3.6-107 design: major components, such as the rotor hub, the main shaft, the gearbox and the yaw system are all of particularly heavy dimensions, the safety systems are fail-safe, the blade and nacelle lightning protection performance is well-proven, and all details are designed using best engineering practice. A solid Siemens basis improved with the latest performance standards – that's the SWT-3.6-107 turbine.



# Technical description

## General design

The turbine design combines a solid and conservative approach with high-performance technical features and innovative safety and monitoring systems.

## Rotor

The SWT-3.6-107 turbine has a three-bladed rotor with pitch regulation for power output optimization and control. The rotor speed is variable in order to maximize the aerodynamic efficiency, and speed compliance during power regulation minimizes the dynamic loads on the transmission system.

## Blades

The B52 blades are made of fiberglass-reinforced epoxy in Siemens' proprietary IntegralBlade® manufacturing process. In this process, the blades are cast in one piece, leaving no weak points at glue joints and providing optimum quality. The aerodynamic design represents state-of-the-art wind turbine technology, and the structural design has special Siemens safety factors over and above all normal industry and customer requirements.

## Rotor hub

The rotor hub is cast in nodular cast iron and is fitted to the main shaft with a flange connection. The hub is large enough to provide a comfortable working environment inside the structure for two service technicians during maintenance of bolt connections and pitch bearings.

## Blade pitch system

The blade pitch arrangement is used to optimize and regulate power output through the operating range. The blades are feathered to minimize wind loads during standstill under extreme wind conditions.

## Main shaft and bearing

The main shaft is forged in alloy steel and is hollow for the transfer of power and signals to the blade pitching system. The main shaft is supported by two main bearings. Both bearings are self-aligning double spherical roller bearings, grease lubricated from an automatic lubrication system. The bearing seals are maintenance-free labyrinth seals.

## Gearbox

The gearbox is a custom-built, three-stage helical-planetary design. The first two helical-planetary, high-torque stages provide compact high-performance construction. The high-speed stage is a normal helical stage, arranged with an offset to allow passage of power and control signals through the main shaft to the pitch systems. The gearbox is equipped with large-capacity cooling and filtering systems that ensure optimum operating conditions.

## Generator

The generator is a fully-enclosed asynchronous machine with squirrel-cage rotor, which does not require slip rings. The generator rotor construction and stator windings are specially designed for high efficiency at partial loads. The generator is internally ventilated and cooled with an air-to-air heat exchanger.

## Mechanical brake

The mechanical brake represents the secondary safety system of the turbine. It is fitted to the gearbox high-speed shaft and has two hydraulic calipers.

## Yaw system

The yaw bearing is an internally geared slew ring with a separate yaw brake. Six electric planetary gear motors drive the yawing.





### **Controller**

A standard industrial computer is the basis of the turbine controller. The controller is self-diagnosing and includes a keyboard and display for easy status readout and adjustment of settings.

### **Power conversion**

The NetConverter® power conversion system allows generator operation at variable speed, frequency and voltage while supplying power at constant frequency and voltage to the MV transformer. The power conversion system is a modular arrangement for easy maintenance. Power is transferred by DC from the rectifier installed in the nacelle to the inverter installed in the tower bottom, thereby minimizing cabling losses and avoiding the complications of a nacelle mounted transformer.

### **Tower**

The SWT-3.6-107 turbine is mounted on a tapered tubular steel tower. The tower is fitted with a personnel hoist.

### **Operation**

The wind turbine operates automatically, self-starting when the wind reaches an average speed of about 3–5 m/s. During operation below rated power, the pitch angle and rotor speed are continuously adjusted to maximize the aerodynamic efficiency. Rated power is reached at a wind speed of about 13–14 m/s, and at higher wind speeds the output is regulated at rated power. Speed compliance during power regulation minimizes the dynamic loads on the transmission system. If the average wind

speed exceeds the maximum operational limit of 25 m/s, the turbine is shut down by feathering of the blades. When the wind drops back below the restart speed, the safety systems reset automatically.

### **Remote control**

The SWT-3.6-107 turbine is equipped with the unique WebWPS SCADA system. This system offers remote control and a variety of status views and useful reports from a standard Internet web browser. The status views present electrical and mechanical data, operation and fault status, meteorological data and grid station data.

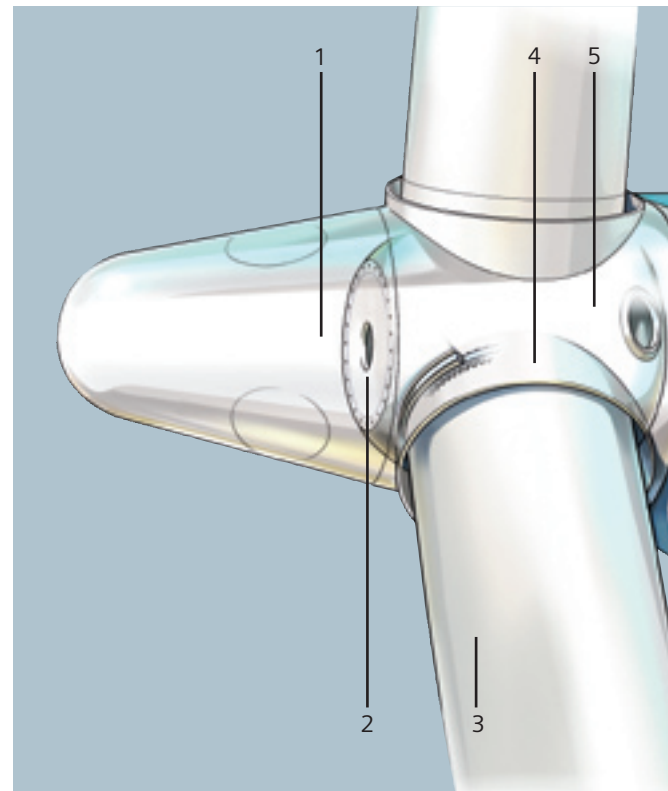
### **Turbine Condition Monitoring**

In addition to the WebWPS SCADA system, the turbine is equipped with a web-based Turbine Condition Monitoring (TCM) system. The TCM system carries out precise condition diagnostics on main turbine components continuously and in real time. It gives early warning of possible component failures by continuous comparison of current vibration spectra with previously established reference spectra. The TCM system has various alarm levels, from informative through alerting level to turbine shutdown.

### **Grid compliance**

The SWT-3.6-107 turbine complies with all currently valid grid code requirements on relevant markets. Voltage and frequency control and other grid-related adjustments can be implemented by the integrated Park Pilot facility in the WebWPS SCADA system, and the turbine has ride-through capability for all normal faults.

# Technical specifications



## Rotor

|                  |                                      |
|------------------|--------------------------------------|
| Diameter         | 107 m                                |
| Swept area       | 9,000 m <sup>2</sup>                 |
| Rotor speed      | 5–13 rpm                             |
| Power regulation | Pitch regulation with variable speed |

## Blades

|        |      |
|--------|------|
| Type   | B52  |
| Length | 52 m |

## Aerodynamic brake

|            |                   |
|------------|-------------------|
| Type       | Full span pitch   |
| Activation | Active, hydraulic |

## Transmission System

|                       |                           |
|-----------------------|---------------------------|
| Gearbox type          | 3-stage planetary/helical |
| Gearbox ratio         | 1:119                     |
| Gearbox oil filtering | Inline and offline        |
| Gearbox cooling       | Separate oil cooler       |
| Oil volume            | Approx. 750 l             |

## Mechanical brake

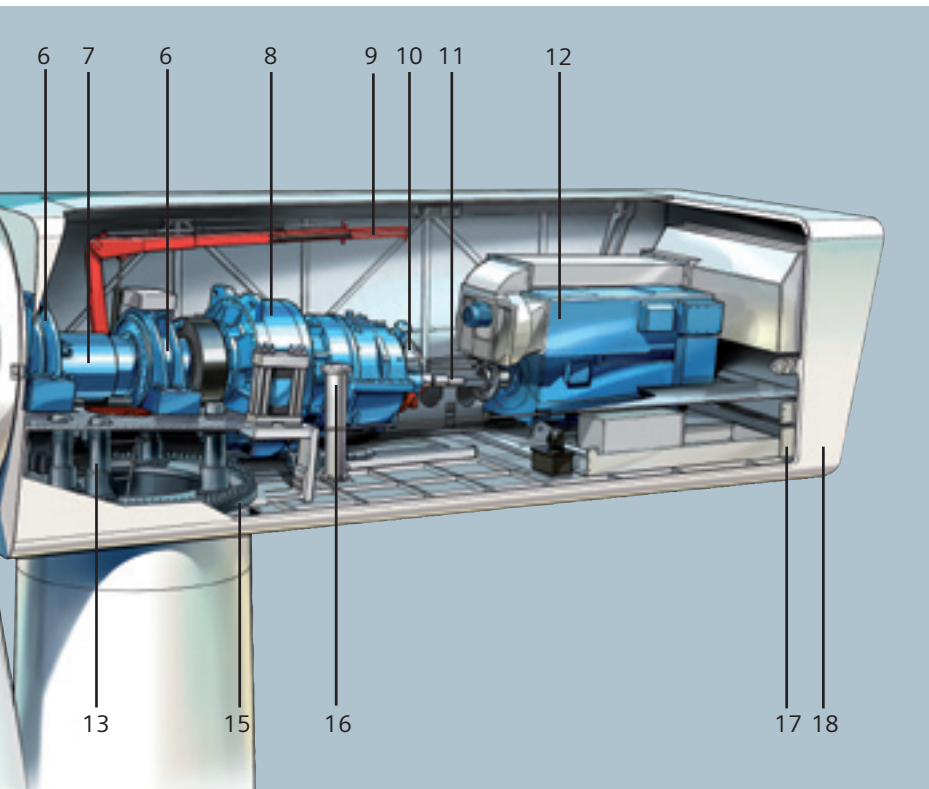
|      |                      |
|------|----------------------|
| Type | Hydraulic disc brake |
|------|----------------------|

## Generator

|                |                           |
|----------------|---------------------------|
| Type           | Asynchronous              |
| Nominal power  | 3,600 kW                  |
| Voltage        | 690 V                     |
| Cooling system | Integrated heat exchanger |

## Yaw system

|      |        |
|------|--------|
| Type | Active |
|------|--------|



### Nacelle arrangement

- |                    |                   |
|--------------------|-------------------|
| 1. Spinner         | 10. Brake disc    |
| 2. Spinner bracket | 11. Coupling      |
| 3. Blade           | 12. Generator     |
| 4. Pitch bearing   | 13. Yaw gear      |
| 5. Rotor hub       | 14. Tower         |
| 6. Main bearing    | 15. Yaw ring      |
| 7. Main shaft      | 16. Oil filter    |
| 8. Gearbox         | 17. Generator fan |
| 9. Service crane   | 18. Canopy        |

### Monitoring system

|                |                      |
|----------------|----------------------|
| SCADA system   | WebWPS               |
| Remote control | Full turbine control |

### Tower

|            |                                    |
|------------|------------------------------------|
| Type       | Cylindrical and/or tapered tubular |
| Hub height | 80 m or site-specific              |

### Operation data

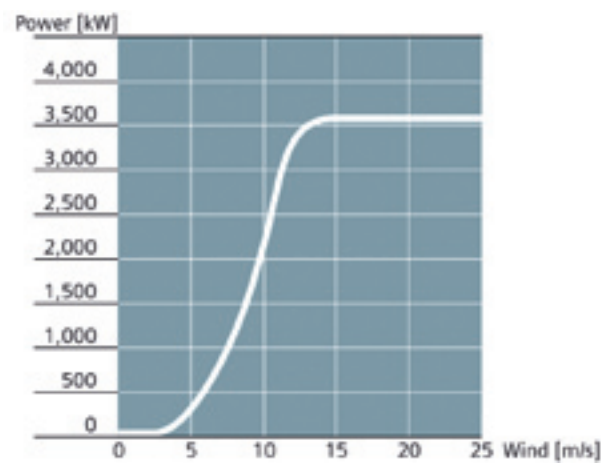
|                    |   |
|--------------------|---|
| Cut-in wind speed  | 3–5 m/s   |
| Nominal power at   | 13–14 m/s   |
| Cut-out wind speed | 25 m/s  |
| Maximum 3 s gust   | 55 m/s (standard version)<br>70 m/s (IEC version) |

### Weights

|         |               |
|---------|---------------|
| Rotor   | 95 tons       |
| Nacelle | 125 tons      |
| Tower   | Site-specific |

### Sales power curve

The power curve data are valid for standard conditions of 150 Celsius air temperature, 1,013 mBar air pressure and 1,225 kg/m<sup>3</sup> air density, clean rotor blades, and horizontal, undisturbed air flow.



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