



SANY HEAVY ENERGY MACHINERY CO., LTD.

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Quality Changes the World.

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POEM OF THE WIND

The wind blows, the mountains are delicately green;
The autumn wind sweeps up, fruit falls to the earth;
Chasing the wind, following the wildest dreams;
Riding the wind, realizing great dreams in renewable energy;
SANY HEAVY ENERGY MACHINERY, Quality Changes the World.



SANY HEAVY ENERGY MACHINERY

In 2008, Sany Group invested heavily to enter the renewable energy industry and established Sany Heavy Energy Machinery Co., Ltd in 2013. The main businesses of Sany Heavy Energy Machinery are R & D, manufacturing, and sales of wind turbines, wind resource investment, development and operation of wind farms. In addition, Sany Heavy Energy provides wind farms O&M and technology consulting service, conducts general contracting of wind farms construction and operation and is a provider of global wind power integrated solution. Adhering to the Sany concept of "all for customers, all from innovation" and holding truly to the Sany's vision of "Quality changes the world", Sany Heavy Energy Machinery is determined to realize its ambition in the renewable energy sector.



GLOBAL WIND POWER SOLUTION PROVIDER

Sany Heavy Energy Machinery strives to create a unique operation mode of “Whole Industry Chain” with a global vision, through constant innovation and optimization of technology and products. Currently, Sany Heavy Energy Machinery provides integrated solution including site selection, wind assessment, construction, equipment supply, installation and operation of wind farms.

EPCOTF- The Best Solution Provider

Sany provides a complete solution for wind power projects targeting better profit and return.

- “E- Engineering design of wind project”
- “P- Procurement of wind equipment”
- “C- Construction of wind project”
- “O- Operation and management of wind farm”
- “T- Transfer of constructed wind project”
- “F- Financial services”

To become one of the most influential investors in the field of clean energy

- Obtain wind resources, derive continuous value;
- Introduction of partners to develop wind resources;
- Wind farm construction through BT, BOT, EPC.

Best After-Market Services

- Flexible operation & maintenance service packages
- Parts and Components supply through “Center + Regional” logistics management
- Processing capacity of replacement parts (generator, blade etc.)

THREE CORE ADVANTAGES

Two “Highs”

- High Power Generation
- High Reliability

Two “Lows”

- Low Construction Cost
- Low Maintenance Costs

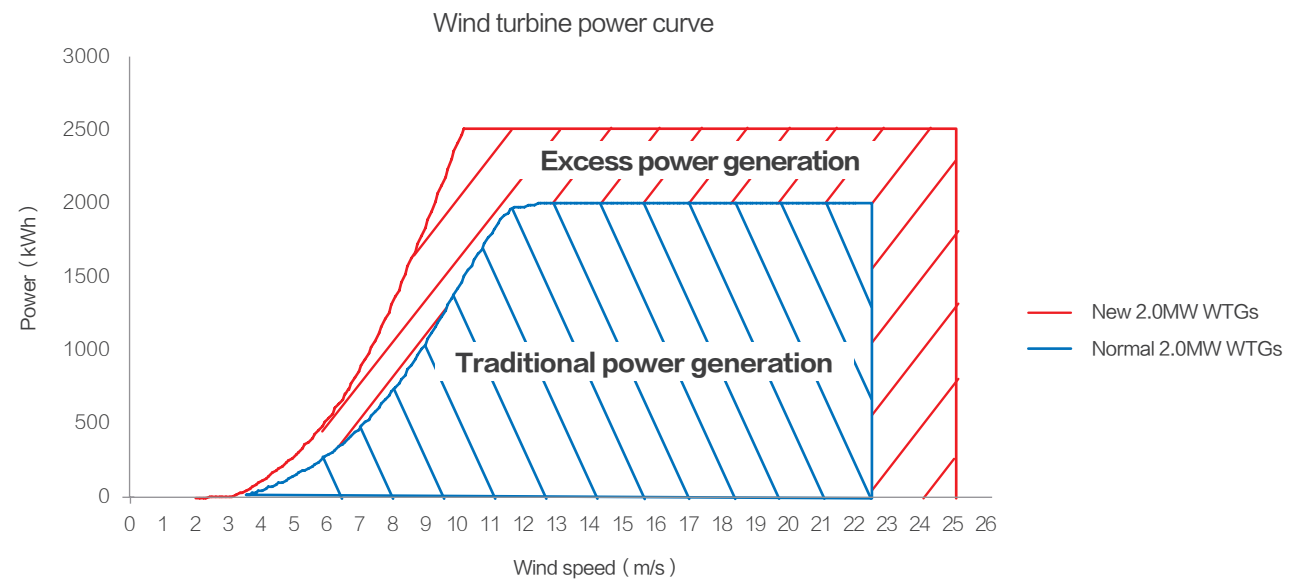
Speediness

- Construction, power generation all realised in one year.

The Essence Of Sany Wind Turbine Is High Reliability & High Power Production

HIGH PRODUCTIVITY

Sany wind turbines with the new technologies can exceed rated power generation and a single wind turbine's generation can be increased by 10% per year.



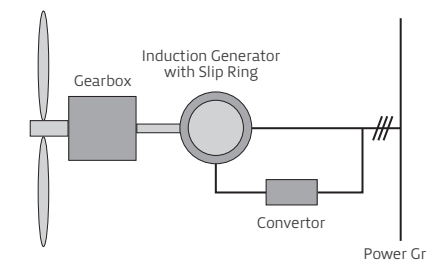
With a segmental, lengthened blade, it successfully increases swept wind area. The 2.0 MW WTG design complies with the safety requirement of the 2.5 MW WTG, which realizes a 25% excess generation capacity.

Low speed synchronization/high speed synchronization + Asynchronous power generation technology, single generator

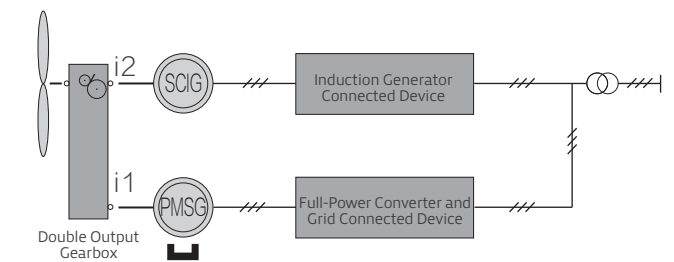
- Single wind turbine has the ability to generate 25% above stated capacity.
- Cut-in wind speed reduced to 2 m/s and cut-out wind speed increased to 25 m/s.

Double generator

- Low wind speed: Variable-speed, permanent magnet generator provides the optimum utilization of wind energy coefficient and improves power generation of WTGs in low wind speed conditions.
- High wind speed: Permanent magnet generator with full power generation, adaptive power regulation of squirrel cage generator.
- Low voltage ride through (LVRT) allows the unit to stay online while the permanent magnet generator provides reactive power to support the grid recovery.



Single Generator



Double Generator

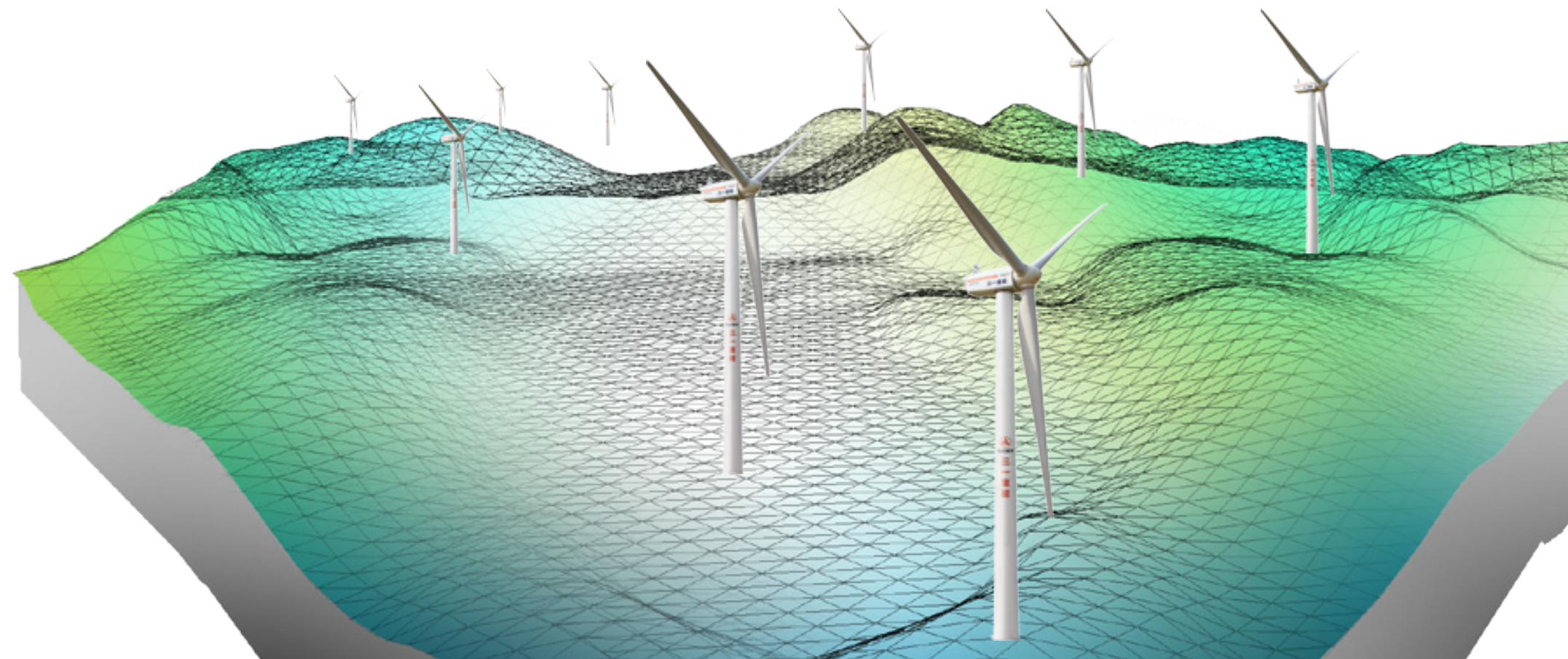
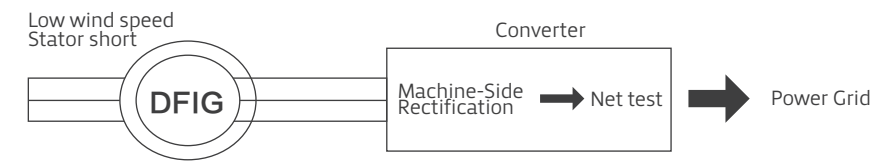


Yaw to the Wind

- Achieves real-time yaw through optimal control strategy, reduces the yaw error, and improves power generation.

Variable current

- Continuous operation ability of the 2MW converter compares favorably to the 2.5MW converter.
- Increase the optimal wind capture mode ensuring an optimal power curve.
- Increase full power generation under low wind speed.
- WTGs perform in optimal wind energy utilization coefficient, to improve power generation in low-wind conditions.



HIGH RELIABILITY

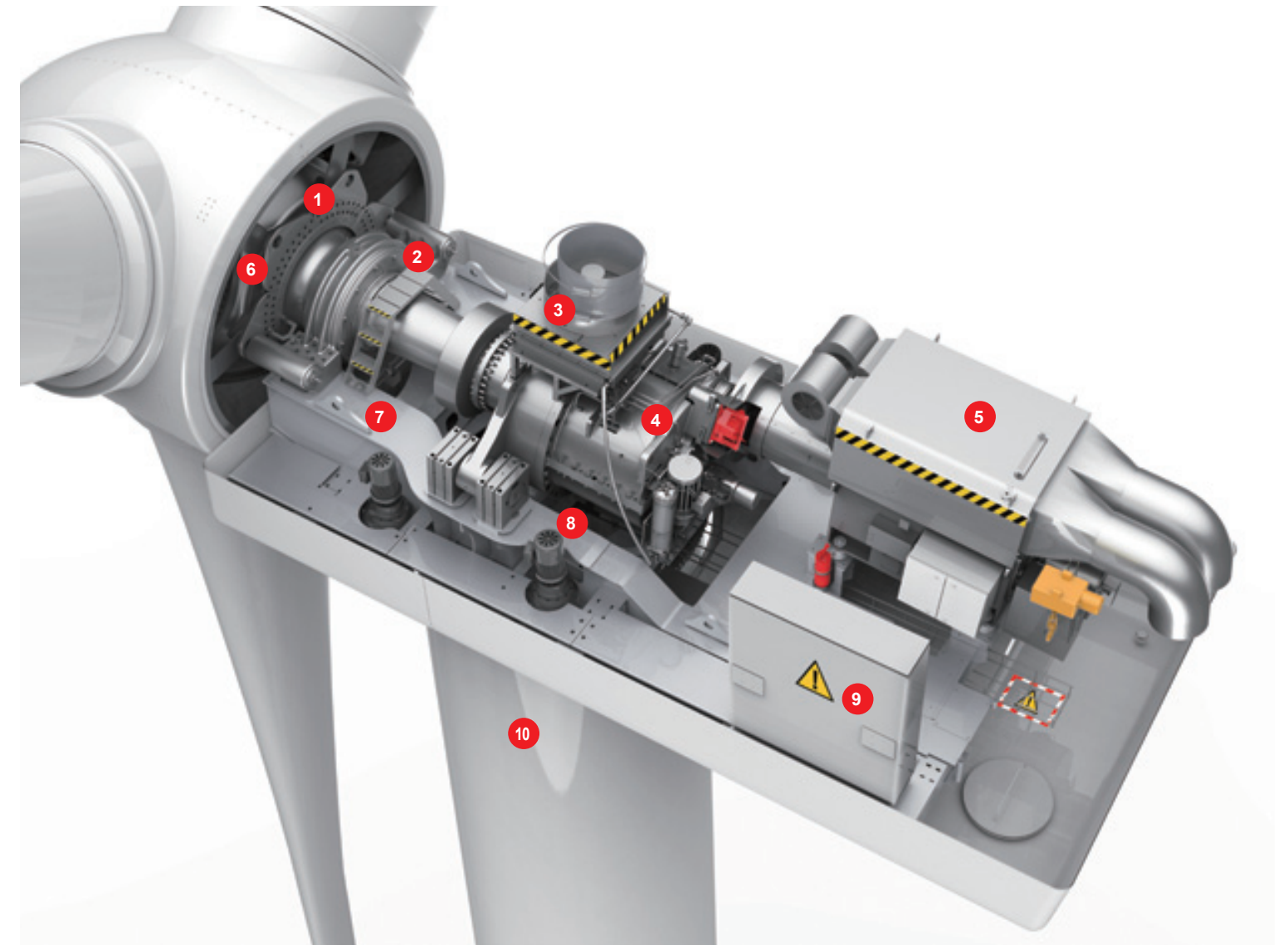
The Most Complete 10 Testing Systems in the industry to guarantee High Reliability of the Turbines

- 100% load testing of turbine, comprehensive testing of gearbox, generator, drive train, control system, converter, to ensure 100% pass rate for quality before leaving the facility.
- 100% rated load power to ensure product reliability.

Generator test station can complete the generator factory test and type test with the following characteristics:

- Provides standard power grid voltage and frequency; output voltage; adjustable, digital stepless frequency; as well as stable and pure wave.
- The system is capable of continuous and uninterrupted operation with automatic test functions for synchronous measurement for power supply system and generator electric signal tests.
- All testing equipment and instruments communicate with the main control system to provide real-time field operation monitoring.

Professional Certification



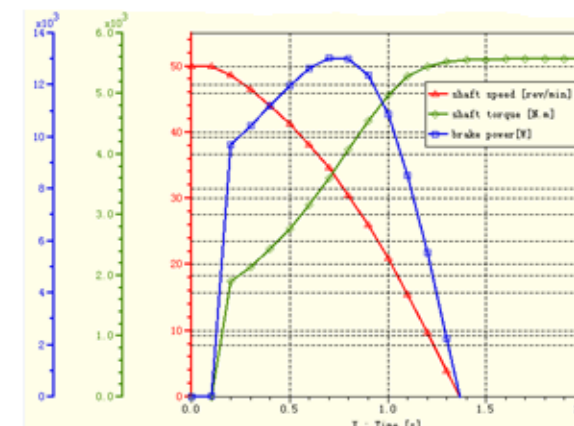
- | | | | | |
|---------------------|----------------|--------------------------------|----------------------------|------------------|
| 1/Hub test | 2/Turbine test | 3/Hydraulic swivel joints test | 4/Gearbox test | 5/Generator test |
| 6/Pitch system test | 7/Frame test | 8/Yaw system test | 9/Main control system test | 10/Towers test |



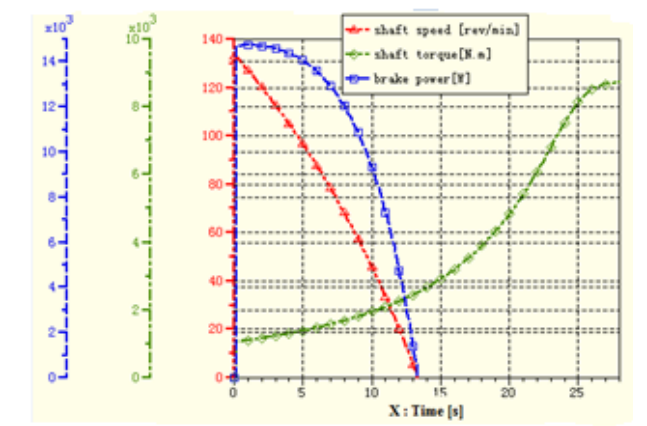
Flexible Braking System

- The system can adjust the high-speed shaft braking parameters. When the braking system engages, it applies with constant pressure.
- Advantage: smooth braking, overload of gears in the gearbox is prevented thus increasing gear life and overheating and fire of nacelle.

— Brake Torque — Brake Torque — Speed of Main Shaft



Traditional high-speed shaft brake curve



High-speed shaft flexible brake curve

Free Correction Coupling

- By replacing the rigid shaft with a cardan shaft, the gearbox and generator are flexibly connected.
- Advantage: correction coupling can reduce coupling maintenance in wind turbine inspection, reduce downtime, and increase effective power generation time. Based on the conditions at the wind farms, the overload capacity can be set accordingly.

Deviation Adjustment Capability Parameter

- Rated Speed 1800 rpm
- Rated Torque 18000Nm
- Radial Deviation $\pm 7\text{mm}$
- Axial Deviation $\pm 15\text{mm}$
- Angular Deviation $\pm 1.5^\circ$



LOW CONSTRUCTION COST



Construction Process Control

By strict process control and detailed construction plan before project beginning, accuracy of each step is ensured and resource waste is avoided to the maximum. Meanwhile, under the premise of project quality, we make optimal cost-effective construction plan so as to strictly control construction cost.

Optimal Cost-effective Product

The core capacity of Sany Heavy Energy is manufacture. In manufacture aspects, Sany owns many world-class digital factories and most parts are made in house, which effectively guarantee quality and construction cost control.

Technology Innovation

Self-climbing cranes can realize hoisting and installing of tower, cabin, wind wheel and other big components without large crawler cranes. Thus dismantling and transferring are less time-consuming. Maintenance and parts replacement period is shorter and installation costs are cheaper. The hoisting device within turbines can achieve maintenance and replace parts less than 2 tons directly and quickly from the ground to cabin. No additional hoisting equipment and less maintenance and installation costs.

LOW O&M COSTS

ECC Monitoring Center

Real-time ECC monitoring, remote maintenance and faults forewarning, experts analysis and diagnosis, in order to change “repair after malfunction” into “maintenance before malfunction” and reduce maintenance costs.

Remote Intelligent Control

Remote intelligent control and seamless connection, realizing less staff numbers and operation costs.

Core Components made in-house

Core components are all made in house to ensure products reliability and to reduce repair and parts costs during life cycle.

SANY’s Service

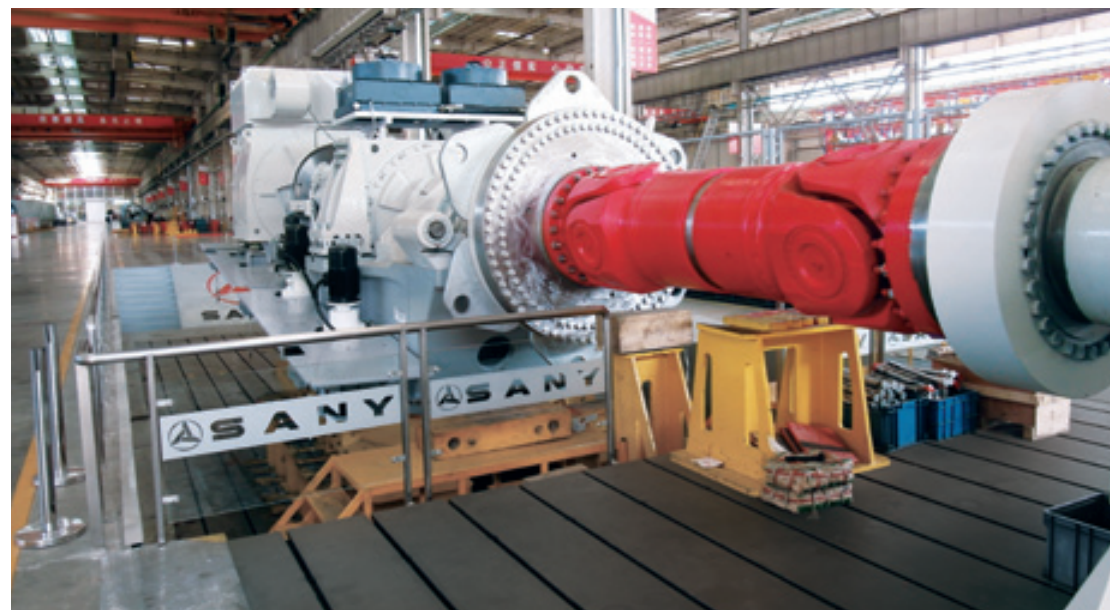
Sany can provide whole life cycle O&M services and eliminates operating costs risk for customers.



INNOVATIONS

Sany Heavy Energy did massive and continuous investment in the scientific research and innovation, constructed the first supercomputer center in the industry. With advanced concept and idea, we realized a number of technical innovation and breakthrough. So far, there are 296 patents including 138 invention patents authorized. We are one of the wind power manufacturing enterprises that has the most patents in the domestic.

There so many benefits of using the vertical integrate, such as collaborative design and development, products quality control, avoiding the restriction of the foreign technology, personalized design. These benefits can help to play the core competitiveness.



Ten Technological Innovations

1. Double Planetary Gearbox

SANY's invention patent: two-stage planetary gearing increases load capacity, gear safety factor and life cycle.

2. Super Gearbox Lubrication System

Large lubrication oil flow, precise distribution, high cooling power and filtering precision

3. Hydraulic Yaw Technology

SANY's invention patent: real-time yaw can realize precise orientation and capture maximal wind power, real-time cast loose, avoid stranded cable.

4. Hydraulic Pitch Technology

Powerful driving force, fast response, high pitch precision, partial parts replacement

5. Converter/Main Control System

Converter: increase full-power rectification at low wind speed and generation, adopt optimal wind capture model and ensure wind turbines to work at the optimal power curve.

6. Blade Transfer Vehicle

Characteristics: convenient transitions, small turning radius, and strong roads adaptability.

7. Lightweight Technology/Welding Hub/Welding Chassis

Reduce costs of construction, transportation and service

8. Concrete Filled Tower

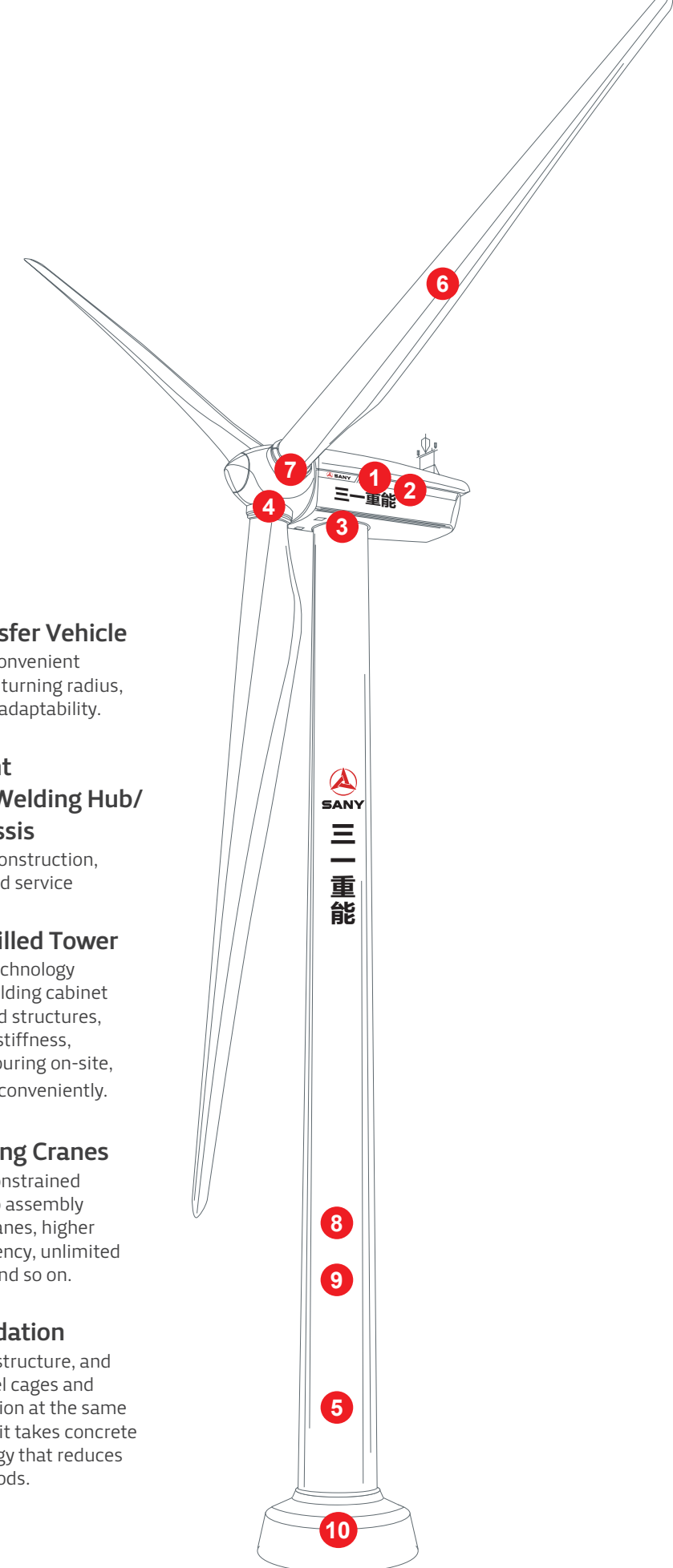
SANY patented technology adopts double welding cabinet and concrete filled structures, improving tower stiffness, realizing tower pouring on-site, and transporting conveniently.

9. Self-climbing Cranes

Advantages: unconstrained hoisting areas, no assembly time for heavy cranes, higher installation efficiency, unlimited climbing height and so on.

10. Pile Foundation

Eight basic rings structure, and manufacture steel cages and excavate foundation at the same time. In addition, it takes concrete pouring technology that reduces construction periods.



LEAN MANUFACTURE

Sany Heavy Energy Machinery owns hundreds of advanced machining equipment, including several imported high-precision gear processing machines. Sany has the most advanced heat treatment production lines and generator paint equipment in China. This ensures Sany's ability to process a variety of high-precision parts, including wind turbine gearbox rings, planet carriers, shells, nacelle undercarriages, stators and frames. Moreover, Sany can manufacture core components at their own facilities, such as wind turbine' gearboxes, control systems, blades and generators etc. In particular, gear and generator machinery not only satisfy production requirement, but also provide support for peer manufacturers in the industry. Sany's lean operations utilize the MES and SPS systems.



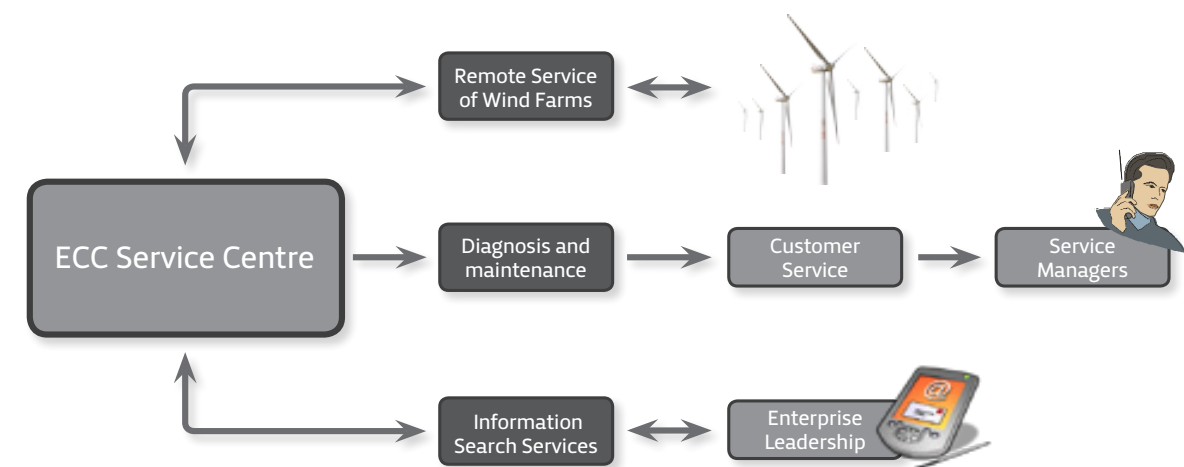
YOUR PROBLEMS,
OUR DUTIES



DOUBLE SURPASSING **SERVICE**

- Surpass the Industry Standard
- Surpass Customers' Expectation

As part of Sany's enterprise development strategy, Sany has accumulated extensive operational management experience in all service areas. It has formulated management system of "eight factors of services": service culture, talent incentive, service resource, information system, parts management, service monitor, pre-sale service and after-sale service. This lays the foundation for Sany service system improvement and the pursuit of perfection. Sany Heavy Energy put forwards "1-2-3-15" service commitment: reply in 1 quarter hour, arrive on site in 2 hours, problem solved in 3 days and serious faults solved in 15 days.



Wind farm management made easy. ECC Service Center provides remote service, upgrades, diagnosis and maintenance of wind farms, to reduce downtime and improve annual power generation.

1.5 MW WTGS

Product features

Optimal Cp Operation Technology

Breaking through the limitations of traditional doubly-fed technology and greatly increasing the turbine's speed regulating range, make turbine run with the optimal Cp before it reaches the rated power, so as to significantly improve the power curve, power generation capacity and reduce the cut-in speed and rated wind speed.

Intelligent Optimization Technology

WTG can automatically adjust the relationship between power and rotate speed by improving the control algorithm, in order to adapt itself to environmental changes (such as air density, temperature and humidity) and other factors resulting in error, and perfectly match turbine's operation parameters with actual environmental condition, aerodynamic and mechanical characteristics, etc.

Intelligent Load Avoiding Technology

Based on the load condition of every part of turbine, control turbine's operating state, intelligently avoid limit condition, and substantially reduce turbine's limit load, so as to protect turbine's safety.

High Reliability Design

The utilization of reliability design methodologies, such as redundancy design, margin design, environmental adaptability design, simulation modeling method with dynamics knowledge and analysis software such as CAE, which is scheduled for calculation, simulation and verification of the design.

Good Grid Adaptability

Make the stator side of doubly-fed wind power generator output the same voltage and current with the frequency and phase of power grid voltage by magnetizing the rotor side of doubly-fed wind power generator, and carry out the independent active and reactive decoupling control according to requirement.

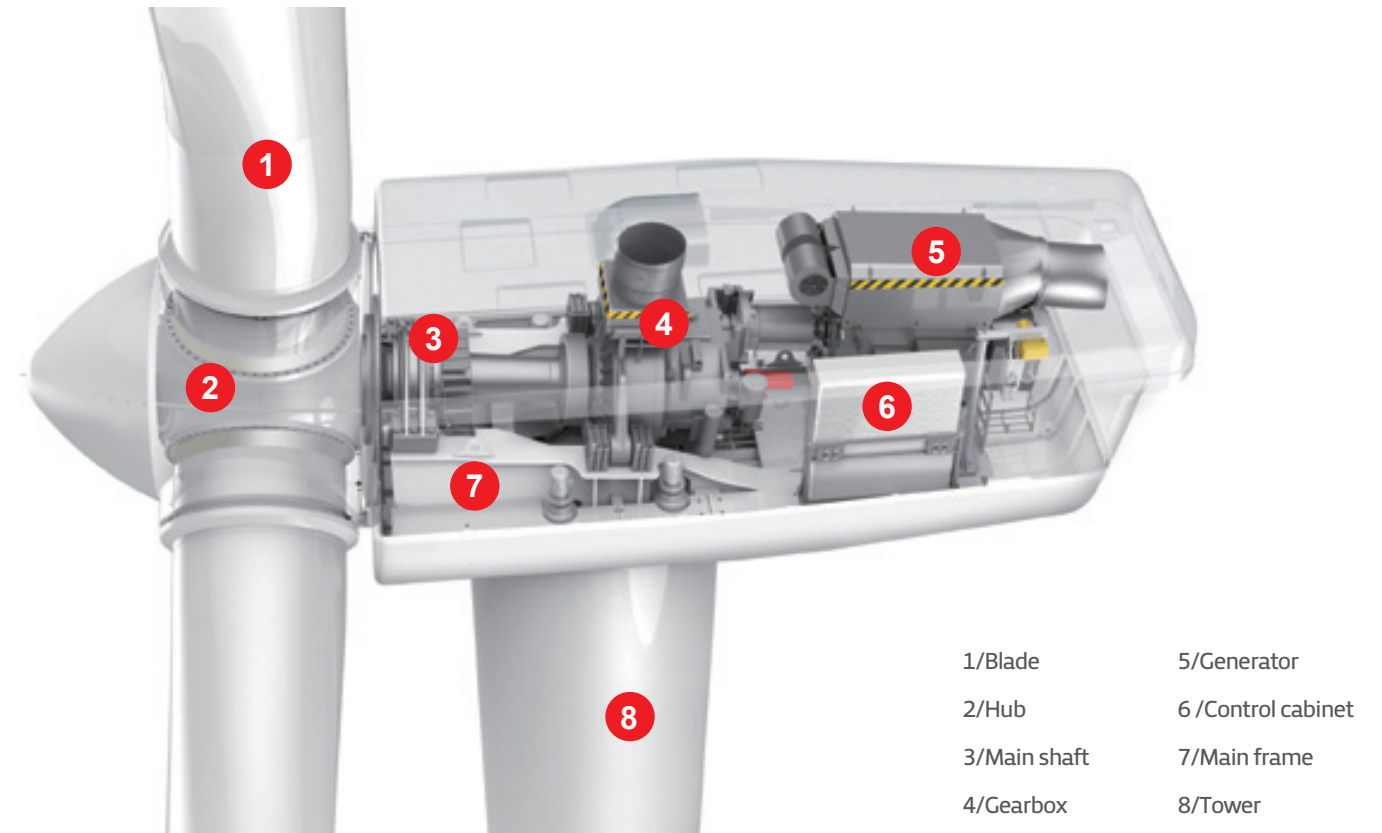
The Low voltage Ride through Capability

The low voltage ride through test and evaluation of every model is accomplished, thus it can respond rapidly during the reduction of voltage, generate the dynamic reactive power, support the recovery of grid voltage, and the active power is recovered rapidly after the clearing the fault. It has good adaptability to all kinds of grid, a wider range of reactive power adjustment ability and capability of supporting the grid voltage.

Excellent Adaptability in Plateau

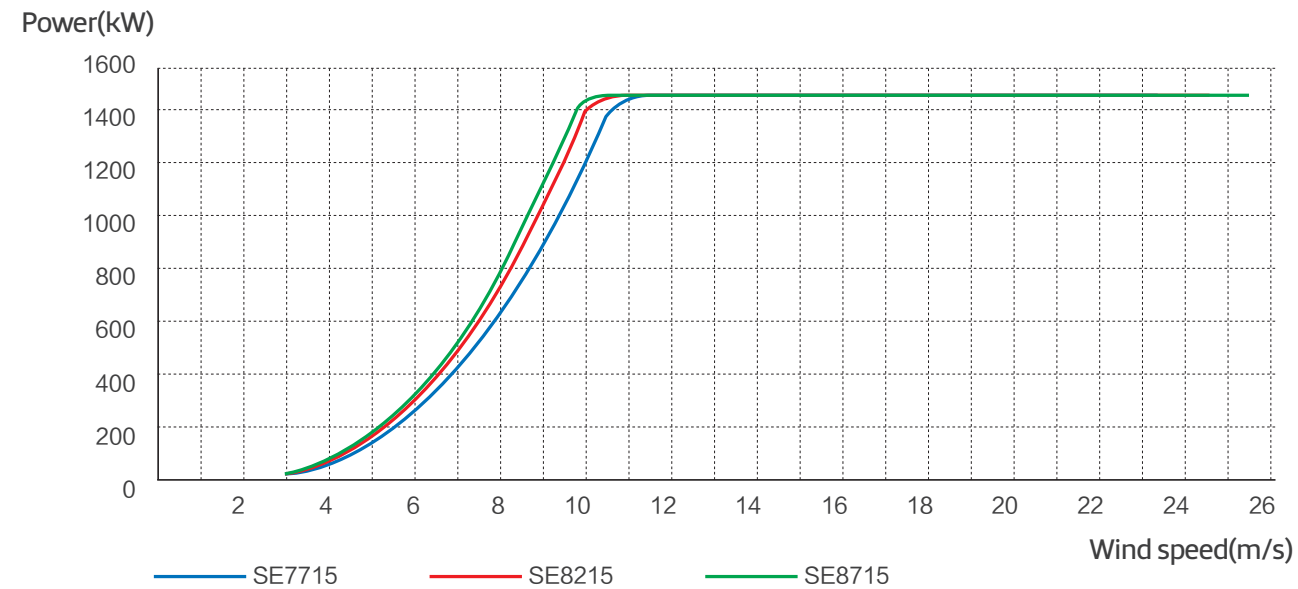
High-efficient radiator with increased safety margin, to ensure that device works in a safe temperature range under full power situation. The air cooling system of the generator adopts a double centrifugal fan cooling scheme, the convertor is specifically designed for high temperature and high altitude.

Turbine Structure & Equipment Layout



- 1/Blade
- 2/Hub
- 3/Main shaft
- 4/Gearbox
- 5/Generator
- 6/Control cabinet
- 7/Main frame
- 8/Tower

Power curve



Technical Specifications

Model	SE7715	SE8215	SE8715
Wind class	IEC II	IEC III	IEC S
Rated power	1500kW	1500kW	1500kW
Rotor diameter	77.7m	83.3m	88m
Swept area	4736m ²	5447m ²	5900m ²
Rated speed	19rpm	17.3rpm	16.7rpm
Rated wind speed	11.5m/s	11m/s	10.5m/s
Cut-in wind speed	3m/s	3m/s	3m/s
Cut-out wind speed	25m/s	25m/s	25m/s
Hub heights	65/70/80m	65/70/80m	70/80m
Rotor weight	33t	34t	36t
Nacelle weight	56t	56t	56t

2.0 MW WTGS

Product features

Optimal Cp Operation Technology

Breaking through the limitations of traditional doubly-fed technology and greatly increasing the turbine's speed regulating range, make turbine run with the optimal Cp before it reaches the rated power, so as to significantly improve the power curve, power generation capacity and reduce the cut-in speed and rated wind speed.

Intelligent Optimization Technology

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Intelligent Load Avoiding Technology

Based on the load condition of every part of turbine, control turbine's operating state, intelligently avoid limit condition, and substantially reduce turbine's limit load, so as to protect turbine's safety.

Low Wind Speed Design

Apply to wind resource of annual average wind speed lower than 5m/s, meanwhile reducing cut-in wind speed and increasing generating capability of low speed wind period

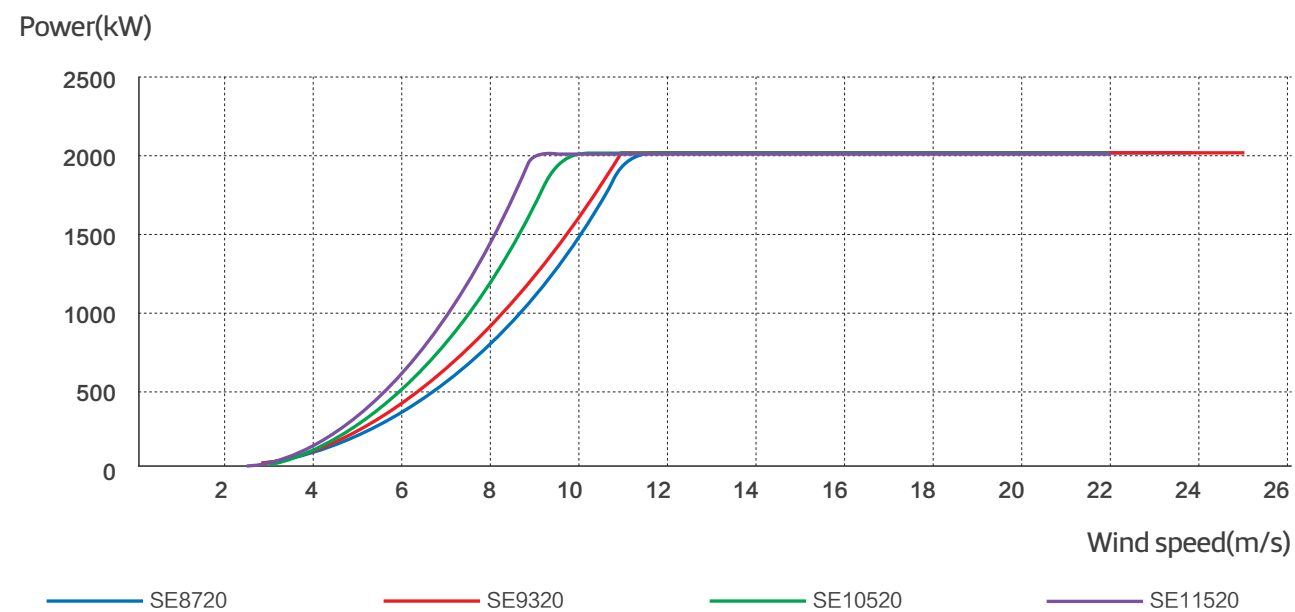
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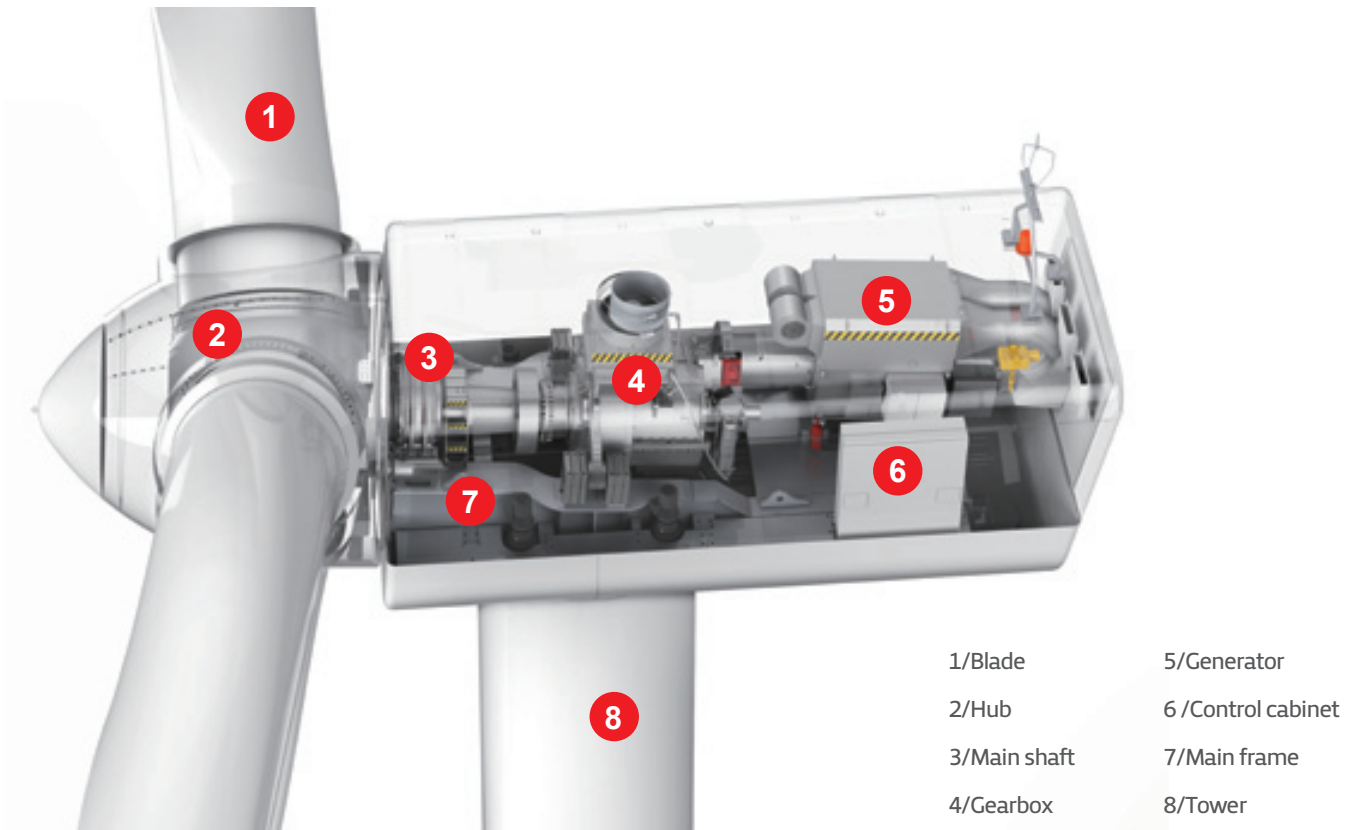
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Power curve



Turbine Structure & Equipment Layout



- 1/Blade
- 2/Hub
- 3/Main shaft
- 4/Gearbox
- 5/Generator
- 6/Control cabinet
- 7/Main frame
- 8/Tower

Technical Specifications

Model	SE8720	SE9320	SE10520	SE11520
Wind class	IEC II	IEC III	IEC S	IEC S
Rated power	2000kW	2000kW	2000kW	2000kW
Rotor diameter	87m	93m	103m	115m
Swept area	6079m ²	6789m ²	8231m ²	10450m ²
Rated speed	17rpm	16rpm	15rpm	14.2rpm
Rated wind speed	11.5m/s	11m/s	10m/s	9m/s
Cut-in wind speed	3m/s	3m/s	3m/s	2.5m/s
Cut-out wind speed	25m/s	25m/s	22m/s	22m/s
Hub heights	70/80m	70/80m	80/90m	80/90m
Rotor weight	47t	49t	52t	62t
Nacelle weight	68t	68t	68t	68t

Cases



Shanxi Tongmei

Zhinquan, China wind farm is a PC project that had the shortest construction period(with a fixed total-price, general contract model for sourcing and construction). Basic construction started in July 2011. In January 2012, the wind turbine lifting and integrated project was completed. As of December 1, 2013, Zhinquan wind farm generated cumulative power 140,524,200 kWh and 138,123,480 kWh on grid. It fully reflects the excellent performance and high stability of Sany wind turbines.



Yunnan, Maoniuping

Maoniuping wind farm set a record for high-altitude wind farm construction in China. The project made a breakthrough in the wind farm construction on mountains, especially in the aspect of avoiding several negative factors such as high cost, long-distance road construction, cycle life and environment destruction.



Hebei, Zhangbei

Sany's wind turbines are used in all 4 phases of Zhangbei wind farm.

Internationalization



International business is the long-term development strategy of Sany Heavy Energy. Sany Heavy Energy takes full advantage of 4 Sany R&D and manufacturing bases in India, America, Germany and Brazil and global network and resources covering more than 100 countries and areas. Sany has made many great international achievements.



United States

2010, the first 2.0MW Sany wind turbine arrived at the Ralls Wind Farm. This wind turbine has the highest rated power then exported overseas.



Ethiopia

In May 2013, Sany Heavy Energy Co.,Ltd. signed a 690 million RMB(108 million USD) contract for the Ethiopian ADAMA II Wind Power Project with Hydrochina CGCOC JV. The total capacity of Adama II is 153MW utilizing 102 sets of SE7715 wind turbines. Adama II is so far the biggest overseas WTC export record in China.
On May 18, 2015, a grid connecting ceremony was held at the Adama Wind Farm. This installation consists of 102 sets of SE7715 wind turbines. The Ethiopian president and Chinese ambassador to Ethiopia were present at the ceremony and expressed their congratulations.



Vision: To create products of the best quality;
To become the No.1 brand in wind power industry;
To contribute to the harmonious development of
mankind and nature.

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