Intelligent mechanical systems

ZF technology in wind turbines puts wind energy in motion
Wind is on the rise

For centuries, people have used the power of the wind for sailing ships, milling grain and pumping water. Since the late 1970’s, wind turbine technology has enabled us to harness this energy source for generating electricity.

Shaping the future responsibly

A global increase of electricity consumption along with the expected exhaustion of fossil fuel sources are ushering in a new era of environmental awareness that is opening up opportunities for the use of renewable energy sources such as wind power. Our enthusiasm for innovative products, processes and the uncompromising pursuit of quality have made us a global leader in wind turbine gearbox technology. Our advanced technology solutions contribute to the transformation of the global energy system in which reliable, robust and efficient products and systems conserve precious resources. With expertise in both automotive and industrial technology ZF is determined to support its customers in making wind power the leading renewable energy source for the future. Sustainability lies at the heart of our endeavors.

Integrated technology leaders

ZF Wind Power is a globally established designer, manufacturer, and supplier of advanced gearbox solutions for wind turbines. The business unit is part of the Industrial Technology Division within the ZF Group and is the result of a successful integration of three technology leaders. The acquisition in 2011 by ZF (one of the world’s
leading automotive industry suppliers and already active in wind turbine gearboxes since 2008) of the former Hansen Transmissions (one of the major players in wind turbine gearboxes) has resulted in a winning combination of experience, expertise, efficient production, and innovation. In 2015 ZF confirmed its strong commitment to the wind power industry again by the acquisition of Bosch Rexroth’s wind power activities.

As one of the world leaders in the sector of high precision and high performance gearboxes for wind turbines, ZF Wind Power wishes to establish interactive partnerships with customers that include design, manufacturing and customer services.

Pioneering wind technology

Drawing upon a proven track record and expertise as an industrial gearbox manufacturer since 1923, ZF Wind Power became an early entrant into the wind power transmission business in the late 70’s, when large-scale wind power development was still in its infancy. Since then, the company has consistently confirmed its pioneering role at the cutting edge of wind power transmission technology. Over almost four decades now, ZF Wind Power has carved out a reputation as a top-tier global supplier of innovative and durable gearboxes to the world’s leading gear-driven wind turbine manufacturers. Since ZF Wind Power first entered the wind turbine market in 1979, its manufacturing plants have shipped more than 55,000 gearboxes powering more than 100,000 Megawatt of installed wind capacity all over the globe.

A bright future ahead with ZF

As a leading worldwide automotive supplier for Drive-line and Chassis Technology, ZF can look back over 100 years of experience in developing and building transmissions. Add to this more than 70 years of joint experience in wind energy (along with the former Hansen and Bosch Rexroth) and ZF Wind Power is a competent partner, supplying major manufacturers of gear-driven wind turbines with gearboxes ranging from 0.8 to 8 MW power capacity and serving all key wind power segments.
Addressing key market challenges

The global electricity generation market is going through a massive change, driven by factors such as commitments to reduce carbon emissions, retirement of nuclear power plants, and regional dynamics in consumer power demands.
A next-generation gearbox supplier

Renewable energy sources – such as wind – have already reached grid parity in some markets. However, continued technological innovation will be a key factor in developing renewable energy into a low-cost and reliable power source that is able to meet the changing needs of the power generation industry. The objective of all stakeholders in wind energy technology is to take the lead in reduction of the Levelized Cost Of Electricity among renewable technologies.

As wind markets remain very sensitive to political commitments and support systems, wind turbine manufacturers are faced with major demand-shifts across countries and regions. Flexibility in the supply chain is therefore crucial to supporting wind turbine manufacturers in developing their business globally.

Optimization of grid networks and production of wind energy closer to the location of consumption, drive the emergence of new and bigger wind turbines. The development of wind power plants at sea (offshore) increases technology demands even more with turbine output rates up to 8 MW and rotor diameters of more than 160 meters. And even larger turbines are already on the drawing board. Technology advancement is a critical factor in the global wind power industry to enable it to keep up the continuous and rapid pace of development, leading to more productive, reliable and cost-effective turbines. Investments in innovation and technology are critical to sustain wind energy Levelized Cost Of Electricity gains.

With a worldwide installed wind power capacity close to 500 GW, operational efficiency and availability are crucial for power utilities to profitably exploit their investments. An acknowledged track record of reliable products and the availability of worldwide support for servicing and maintaining wind power plants are crucial criteria in their selection of technology partners.

Fulfilling our ambition

ZF is determined to be the leading supplier in geared solutions for wind turbines and is committed to succeed in making wind power the most attractive energy source in the future.

With state-of-the-art manufacturing plants and worldwide service locations, ZF is dedicated to delivering advanced gearbox solutions and services on a global scale, meeting the individual needs of the global wind energy market. The company has a global footprint with a manufacturing presence in Europe, China, India and the US.

Customer satisfaction with products and services provided by ZF is the topmost objective in all company activities. In its close cooperation with international customers, ZF integrates the best services in the product cycle, ranging from development and consultancy to aftermarket service. Proximity to international customers is of great significance to ZF.

Wind turbine development

In the last 30 years the rotor diameters increased by ten times, the output rates even to the 160-fold.
A proven track record

Producing multi-megawatt gearboxes efficiently in serial production with a consistent high level of quality and reliability requires excellence in sourcing, manufacturing, logistics, assembly and testing. ZF Wind Power is continuously investing to excel in its core activities of heat treatment, gear grinding and machining of the housing, which results in state-of-the-art gearboxes.

We use dedicated and integrated production facilities, building on more than seven decades of cumulative know-how in wind turbine gearboxes. Performing critical activities in-house allows us to have full control over quality at all stages of production. We believe this is an essential prerequisite to delivering the high-quality serial products with constant performance characteristics required by the world’s leading wind turbine manufacturers.

ZF Wind Power’s 13.2 MW dynamic gearbox test rig in Belgium is one of the world’s largest test facilities of its kind keeping up with the continuously increasing power of wind turbine output in the market. By means of this test rig, ZF Wind Power is able to test gearboxes under representative wind turbine loading conditions.

With ZF’s dynamic bearing test rig, the company has one of the most advanced facilities of its kind to test real-size bearings in their actual arrangement as built in the gearbox, under representative wind turbine loading and environmental conditions. The flexible test rig design reproduces the same shaft and housing deflection as the real gearbox and enables the verification of bearing behavior and loadability of bearing assemblies.

Leading wind turbine gearbox technology

ZF Wind Power is a globally established designer, manufacturer and supplier of reliable and advanced gearbox solutions for multi-MW wind turbines with power capacities ranging from 0.8 to 8.0 MW.
Serving all demands: ZF Wind Power offers advanced gearbox solutions for different concepts used by its customers in their markets: Integrated, Conventional, High Speed and Medium Speed.

**Rotor side integrated**
The current integrated rotor side solutions build upon the strengths of the bogie principle in the first planetary stage. The bogie principle can compensate for deformations in the surrounding structures thereby ensuring optimal gear load distribution.

**Generator side integrated**
ZF Wind Power is one of the industry leaders when it comes to integrated medium speed drives for wind turbines, with the prototype of our medium speed gearbox already introduced in 2009.

**3-point suspension**
The gearboxes for conventional 3-point suspension wind turbine designs function as the second support point of the rotor shaft. Therefore, the planet carrier, the planet carrier bearings and the torque arm have been dimensioned to carry these extra loads.

**4-point suspension**
For conventional wind turbines with 4-point suspension ZF Wind Power offers products with a proven design topology featuring a combination of 1-2 planetary stages and 1-2 parallel or helical gear stages.

Learn more about the ZF portfolio in the field of wind energy technology.
Covering all torque ranges: The dynamic nature of the wind power market calls for continuous and rapid development to deliver ever more powerful, productive, reliable and cost-effective turbines.

The chart illustrates the market segment evolution and related torque impact for the wind turbine drive-train. The bar graph shows the key market segments in GW of cumulative new installations for the period 2016-2020. The torque-growth curve demonstrates the trend of the mechanical torque linked to the key market segments.

* Estimated market demand period 2016-2020
ZF’s “Design Operational Robustness Test” philosophy – DORoTe – is used to assess the robustness of a new gearbox design with respect to the operational conditions as specified by the customer. This test philosophy takes principles of highly accelerated life testing (HALT) one step further by incorporating dynamics and transients of wind turbine applications.

**Delivering advanced gearbox solutions**

With a long tradition of innovation, ZF Wind Power differentiates itself in the marketplace by means of quality and reliability in advanced solutions for different concepts used by its customers in their markets: Integrated, Conventional, High Speed and Medium Speed.

ZF product designs combine planetary and helical gear stages, with optimized dimensioning of bearings and shafts and continuous oil circulation through the bearings. These technologies ensure excellent strength and torque capacity, surface durability and low noise performance as well as optimum bearing life under specified loads, thereby contributing to the gear unit’s long, trouble-free working life.

More than seven decades of cumulative know-how in the wind power industry and long-term partnerships with the world’s leading suppliers of wind turbine gearbox components, and with wind turbine manufacturers and operators, have enabled ZF Wind Power to confidently meet any challenge customers may face – including the highest efficiency standards, sustained durability, reliability and extended longevity of gearboxes, as well as weight-reduced gearboxes with low-noise performance.

The development of a new product starts from proven and approved technology, which reduces the product validation process to the validation of the specific application of the technology.

**Covering all torque ranges**

The prevailing trend in the wind power industry toward ever more powerful, reliable, and available turbines under challenging operating conditions requires a novel modular approach and advanced digital solutions.

The dynamic nature of the wind power market calls for continuous and rapid development to deliver productive, reliable and cost-effective turbines. ZF is committed to delivering advanced gearbox solutions that can handle the torque growth-curve induced in the drive train as turbine platforms are being equipped with larger rotors. ZF invests heavily in research and development of technologies and concepts to increase torque density, enabling torque increase within the same outer gearbox dimensions. Thanks to digitalization, ZF connected gearboxes can automatically sense the best way to optimize energy generation and improve turbine economics for any wind site condition. Coupled with its reliable product portfolio and the ability to provide worldwide service and maintenance, ZF is the technology partner of choice in the wind power industry.
As a continuous innovator, ZF is preparing for the next generation of wind turbine gearboxes and intelligent connection solutions that will further improve the Levelized Cost of Energy for different segments and markets. Extending high-performance mechanical systems with digital services opens up new potential to optimize energy yield of wind farms.

Vision of intelligent wind turbine performance management
ZF develops a concept of the “Intelligent Wind Gearbox” as a contributor to the overall vision of “Intelligent wind turbine performance management”.
Innovation efforts are driven by mega-trends as well as by key trends in the wind power market and are focused on contributing to all aspects of the Levelized Cost of Energy, i.e. CapEx, OpEx and annual energy yield. Key areas of innovation are seen in the development of alternative bearing technologies, technologies to increase the gearbox torque density, alternative drive-train concepts and optimal system behavior of the gearbox in its surrounding structure.

As a technology company, ZF dedicates considerable effort to innovative approaches in all its product fields. ZF anticipates that one of the current big mega-trends, the trend toward “digitization”, will not turn out to be just a show-item, but that the high rate of innovation will soon lead to stronger demand. As such, ZF accepts this challenge and combines mechanics, electronics and digital technologies for industrial applications. High-performance mechanical systems are turned into smart systems by using ZF’s digital know-how and electronics competence. Through their connectivity features these “Intelligent Mechanics” will enable performance optimization of the overall system.

Example of intelligent wind gearbox technology: Registered by sensors, operational and environmental data of the wind turbine will be transmitted via the Internet to an evaluation portal. Other relevant partners for optimal operation, for example, the electricity exchange and weather stations, also provide data to determine the best time for maintenance, e.g. when the price of electricity is low or there is no wind. So unnecessary or costly downtimes are avoided.
Customer satisfaction with the products and services provided by ZF is the topmost objective in all our company’s activities. All services integrated into the product cycle, ranging from development and consultancy to aftermarket service are focused on this. Thus, proximity to international customers is of great significance to ZF.

**ZF global footprint**

ZF Wind Power currently operates six state-of-the-art manufacturing plants with an annual output capacity of approximately 18,000 MW. The business unit has a global footprint with a manufacturing presence in Belgium, Germany, India, China and the US, and with worldwide sales and service operations. The ZF Group has 230 locations in 40 countries and seventeen main development locations. In addition, ZF has 120 service companies of its own, as well as 650 service points. This enables ZF to provide a dense network of highly qualified contacts close to international customers at all levels and in all regions.

Profit with ZF from a strong, global partnership and enhanced multi-brand full service for wind turbine gearboxes and drivelines enabling you to successfully stand your ground amongst the competition.

**Fully committed to perfect service**

Globally present, locally anchored

ZF delivers original spare parts for wind turbine gearboxes paired with fast, comprehensive service, upgrade and maintenance support, embedded in a seamless network of contracting partners and owned subsidiaries.
in order to maximize turbine operational availability and overall wind-farm operating efficiency, and to minimize down-time for repairs, maintenance and servicing.

**ZF – your specialized service partner**

ZF understands the customer’s need of total reliability for maximum productivity. ZF offers fast and individual solutions for ZF and non-ZF mechanical drive-train repair and service. As a leader in wind turbine gearbox design and development, ZF wants to ensure that our customers and partners gain maximum benefit from their investment in renewable energy. Therefore, in addition to producing the world’s most innovative and reliable gearboxes, ZF does everything to keep them operating at the highest possible efficiency level – 24/7. Establishing a Wind Service Center in Germany will guarantee dedication to the specific requirements of servicing wind turbine drive trains.

**Serving your needs**

ZF stands for customer-oriented and flexible service of the complete mechanical drive train for wind turbines, based on a number of specific solutions for repairs, upgrades and extensive support programs. Low lifetime cost combined with high availability and minimum downtime is the key to a short payback of investments in wind power. ZF integrates the advantage of using genuine ZF parts for repairs at our specially equipped regional wind power service centers and by our global field service teams. Since 1979, ZF offers a wide range of options to best suit your specific requirements and as an expert to advise you on the service you need. ZF builds on many years of experience and on the know-how and technological expertise developed in our company over the decades.

Since 2007, ZF increased its existing service portfolio by offering repairs and services for a variety of gearboxes including gearboxes from other manufacturers. Our global field service teams are committed to execute repairs, maintenance and upgrades according to ZF’s specific solutions and high quality standards. Our dedicated support programs make sure our service teams can swiftly react to sudden demands. For example, ZF offers replacement gearboxes and a dedicated stock of replacement parts, such as geared parts and bearing sets. Intensive cooperation with customers helps to continuously improving our service offer with the goal of minimizing turbine down-time.

With state-of-the-art manufacturing plants and worldwide service locations, ZF offers a global footprint to deliver advanced gearbox solutions.
The ZF Group

Shaping the future responsibly

ZF Friedrichshafen is a global leader in driveline, chassis and safety technology and its broad portfolio of products and services is advancing mobility in the automobile, truck and industrial technology sectors. Specializing in highly efficient driveline technologies, ZF has expanded into urban mobility solutions which help protect all road users. With its intelligent mechanical systems that combine innovative automotive components and advanced digital technology, ZF is allowing vehicles to see, think and act.

The company is playing a major role in implementing key technologies that are shaping the megatrends of efficiency, safety and autonomous driving in the global automotive industry. Its engineers are currently working on the next generation of advanced safety systems to help enable autonomous driving for both cars and trucks.

ZF focuses on highly efficient driveline solutions with products for E-Mobility and develops solutions for urban mobility and assistance for vulnerable road users. We work on autonomous and remote driving technology for trucks to make the transportation of goods more efficient and safe.

ZF has a global workforce of around 137,000 employees with approximately 230 locations in some 40 countries. In 2016, ZF achieved sales of €35.2 billion. The company supports sustainable business practices and believes in the importance of corporate social responsibility. It annually invests about six percent of its sales in research & development – ensuring continued success through the design and engineering of innovative technologies. ZF is one of the largest automotive suppliers worldwide.
Get a new or better view of ZF – a technology-based company.

Share Responsibility Globally
Improve Efficiency Permanently
Leverage Opportunities Jointly
Demonstrate Reliability Daily