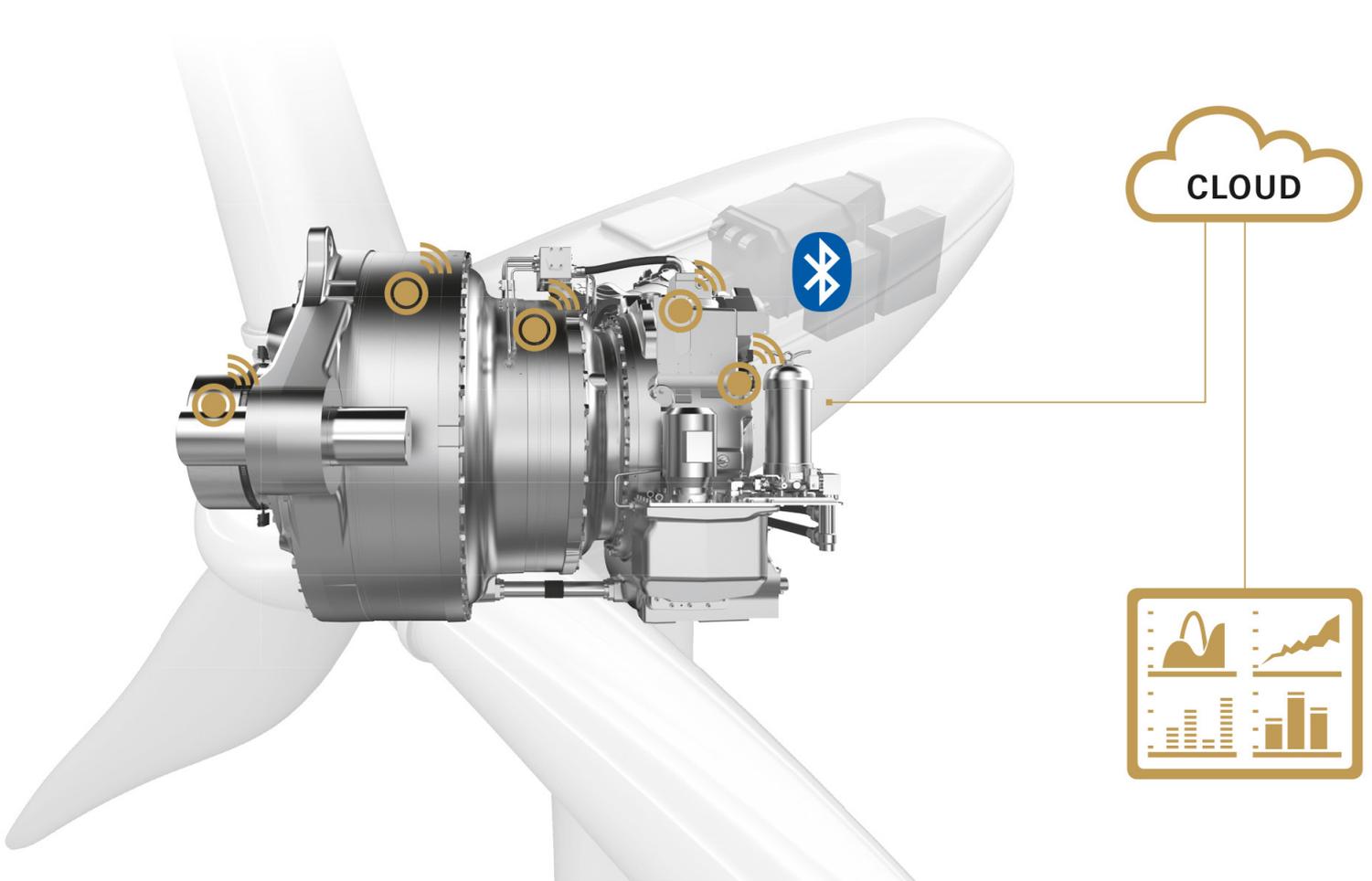


Powering up digitalization of wind power transmission

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Innovative sensor technologies, advanced modelling and new business models are all corner stones in how ZF Wind Power is digitalizing the manufacturing business. For ZF Wind Power digitalization and the Internet of Things (IoT) is an integrated part of this transformation.



‘While developing the IoT, modelling and analytics capabilities, ZF Wind Power is already pioneering new business models where risks are transferred across the value chain and performance optimization solutions are being deployed.’

For a long time, the wind power industry has been among the front-runners when it comes to connectivity of products and analyzing data in order to optimize products and processes. However, the challenges and benefits have mainly been left to OEMs and turbine owners, with limited feedback to component suppliers.

As the leading transmission supplier in the wind industry, ZF Wind Power is now stepping up the ambition of data insights, taking a leading position on product risk commitments and launching ground-breaking sensing technology used to control speed and drivetrain torque. Thanks to digitalization, ZF connected gearboxes can automatically sense the best way to optimize energy generation and improve turbine economics for any wind site conditions.

A new control strategy with the focus on drivetrain torque

ZF Wind Power, as a business unit of ZF Friedrichshafen AG, has extensive experience of delivering transmissions across industries. More than a decade ago a paradigm shift in drivetrain design for automotive changed how gearboxes were treated.

Instead of designing the gearbox to absorb all the engine torque, a refined control of engine torque was implemented to ensure smooth transmission. Lifetime improved and transmissions have become smoother through the elimination of torque oscillations.

Similarly and based on group-wide learnings, ZF Wind Power is implementing gearbox design standards and operational control strategies to optimize and smooth out torque resulting in more efficient and reliable operation of wind turbines. However, in a wind turbine, the power is less controllable, which forced ZF to develop leading sensing technologies to measure the actual speed and load on the rotor side of the gearbox.

This is because only by knowing the actual speed and load on the main shaft it is possible to manage the matching power of the generator and ensure smooth operation and reap the same benefits as in the case of automotive.

Reliable sensing with inspiration from automotive

Measuring the actual torque on the main shaft is not an easy task, given the diameter of the steel structure. In fact, traditional torque measurement techniques were ruled out during the design phase, as their precision or reliability could not match the requirements. Instead, an innovation team at ZF was able to use speed sensors, already used in automotive, to precisely measure the angular twist of the main shaft and derive real-time high torque data.

With this technology at its disposal, ZF has managed to create patented speed and load monitoring solutions, which can

perform measurements directly on the rotor side of the wind turbine and feed the controller for closed loop control.

It has created a breakthrough solution, as it is now possible to use the actual torque on the transmission, rather than relying on the generator power signal.

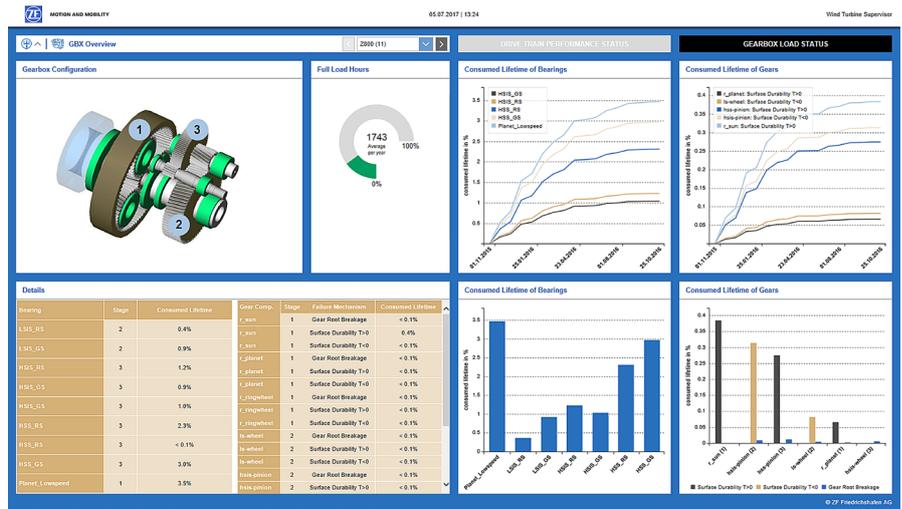
A speed and load strategy with multiple benefits

The load control strategy uses real-time measurement data from monitoring to dampen the drive train torque and speed oscillations by actively adjusting the generator torque via the frequency converter.

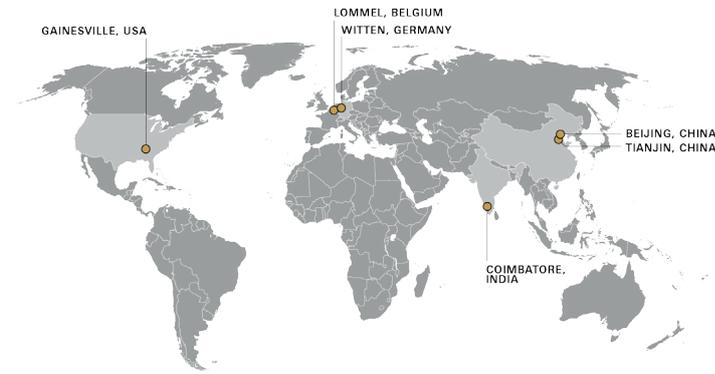
This can be used to improve power density ratio through active control, perform site-specific load optimization to fine-tune for local conditions, or enable lifetime extension through mitigation of critical loads. But there are also benefits.

Measuring is considered part of the essential operational parameters that should always be logged, together with temperatures, vibration and lubrication. This will enable better prognostics for preventive maintenance and lower cost of operation.

ZF Wind Power is now able to provide the ‘Consumed Life-Time Calculation’ for each individual gearbox component based on the actual accumulated loads.



Online dashboard – gearbox component lifetime overview



ZF Wind Power manufacturing locations

Prognostics based on the real design models

Using the measured load duration distribution stored in the ZF cloud solution, the consumed lifetime for all bearings and gears are calculated as well as the progression over time. The results for each gearbox can be visualized within the individual online customer interface provided by ZF. Here it is possible to analyze and visually explore consumed lifetime and loads for different time periods.

Combined with the measured drive train dynamics it is possible to detect unfavourable operating conditions, which will lead to increased wear on a certain bearing or gear pair.

Armed with this information it is then possible to avoid these operating conditions which will reduce the stress for the gears and bearings and will result in less maintenance and repair cost as well as a higher reliability and longer lifetime of the components.

New business models and optimized solutions for transmission

While developing the IoT, modelling and analytics capabilities, ZF Wind Power is already pioneering new business models where risks are transferred across the value chain and performance optimization solutions are being deployed.

Novel platform concepts enable new generation wind turbines to grow to higher nominal power and rotor sizes, within the same gearbox outer dimensions. Compared with traditional manufacturing products, time-to-market for the novel solutions has been cut to less than half,

iterative development is becoming a part of daily business, and direct customer interaction on tested solutions gives immediate feedback.

Learning to manage a new way of working, connecting ZF transmission solutions, and providing additional value to OEMs and turbine owners is a cornerstone of ZF Wind Power’s strategy.

Connecting products, IoT – gives the opportunity to monitor and optimize the performance of both the product itself and associated services as described above. This results in increased ability to manage risk and commercialize products in yield-based arrangements.

This combination will position ZF Wind Power as an industry leader for delivering reliable transmission solutions – from design to end-of-life operation, by minimizing risks across the full lifecycle, supporting customers in energy availability contracts and leveraging opportunities to reduce LCoE.

www.zf.com/windpower

ZF Wind Power

ZF’s 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 combined expertise in 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 endeavours.

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.

As a continuous innovator, ZF anticipates the trend towards intelligent systems by enabling performance optimization of the overall wind turbine. ZF – Putting Wind Energy In Motion.