



Powering new generations of cost-efficient wind turbines

ZF is a leading pioneer in cost-efficient wind turbines. The reduction of Levelized Cost of Energy (LCoE) is their principal aim. The SHIFT platform concept means it's now possible to optimize gearboxes for specific-site loads. PES wanted to know more.

LCoE of wind energy happens with big evolutions in wind technology. Big is important. There are a couple of ways to produce more power from the wind in a given area.

The first is with larger rotors and blades to cover a wider area. That increases the capacity of the turbine, i.e., its total potential production.

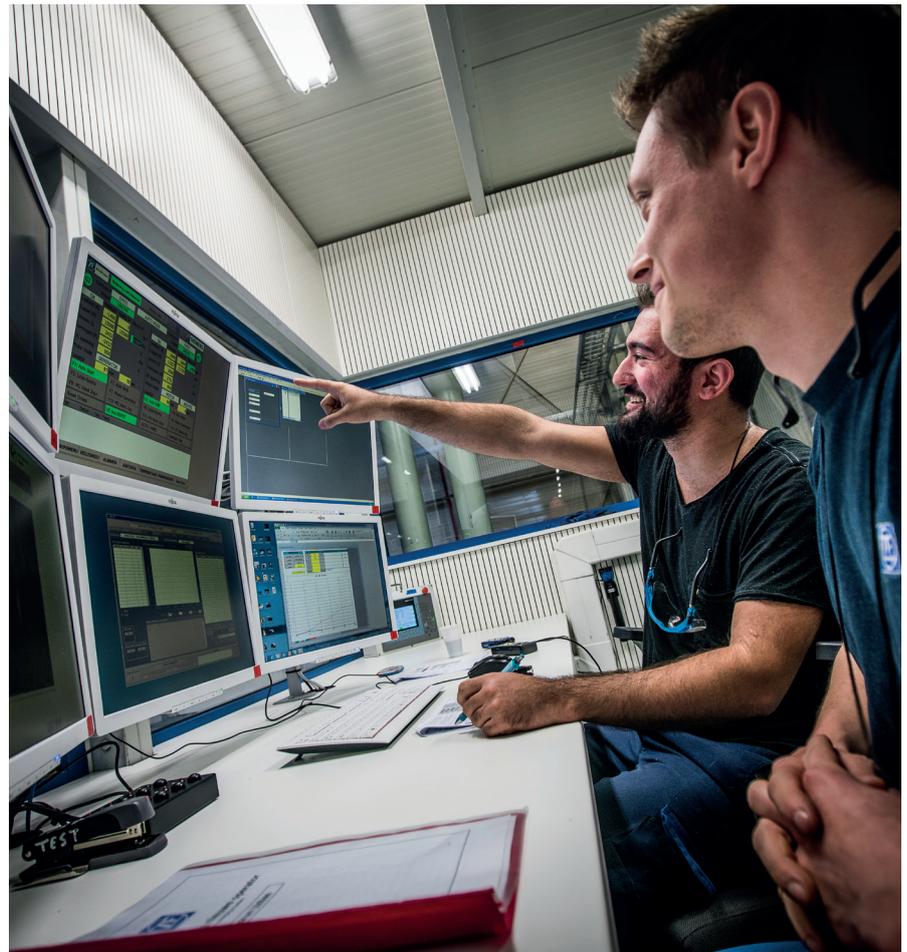
The second is to situate the blades higher, where the wind blows more steadily. That increases the turbine's 'capacity factor,' i.e., the amount of power it actually produces relative to its total potential. The more variable a source is, the more backup is needed to firm it up and make it reliable. By making wind less variable and more reliable, higher capacity factors reduce backup costs.

With increasing capacity factors wind can spread its energy out over a longer period, easing wholesale price pressure during low demand. By extending its hours of operation, a high-capacity-factor turbine is more likely to be producing during demand peaks, when power is most valuable.

Modular gearbox platform designs should have one ultimate goal – LCoE reduction. LCoE reduction drives customer's product roadmaps and challenges in adapting to new markets and dynamics. A modular platform approach is helping customers to realize cost-efficient new generation wind turbines.

How modular wind gearbox platforms can reduce LCOE

A new gearbox development comes at a



cost. In classic designs, these costs, i.e. CAPEX + OPEX + Validation + Design, come at the expense of the wind turbine OEMs. Platform designs take into account the requirements of multiple markets and offer a solution for multiple customers. Hence development costs are shared, significantly lowering the initial development cost compared to a dedicated design.

Current market conditions result in fast changes leading to a shorter product lifetime. With the implementation of auction systems, the number of development cycles and upgrades are increasing still further. High flexibility in gearbox designs needs to keep pace with this LCoE trend, while extending product lifetime to acceptable levels avoiding extensive development and investment costs. ZF's SHIFT platform concept allows wind turbine OEMs to reduce the number of gearbox developments while offering flexibility in turbine performance upgrades and the confidence to adopt forward pricing in auction bidding.

It is crucial for OEMs to collaborate with suppliers who enable a fast time to market. ZF has selectively developed a number of platforms. These platforms

have been pre-developed and validated, reducing time to market significantly. In addition, the SHIFT platform includes pre-designed and validated upgradability, which allows customers to follow future market trends rapidly.

Current practice teaches us that wind turbine OEMs provide a design load set for a specific turbine, covering generally around 90% of the sites in their target markets. This means that the gearbox is overrated for sites where loads are lower than the pre-defined design loads. The SHIFT platform allows OEMs customers to optimize the gearbox to these site-specific loads by selecting the proper variant, optimizing the LCoE per specific wind site. Customers can use platform flexibility to mix variants within a single wind site further optimizing project development costs.

Digital optimization of geared transmissions

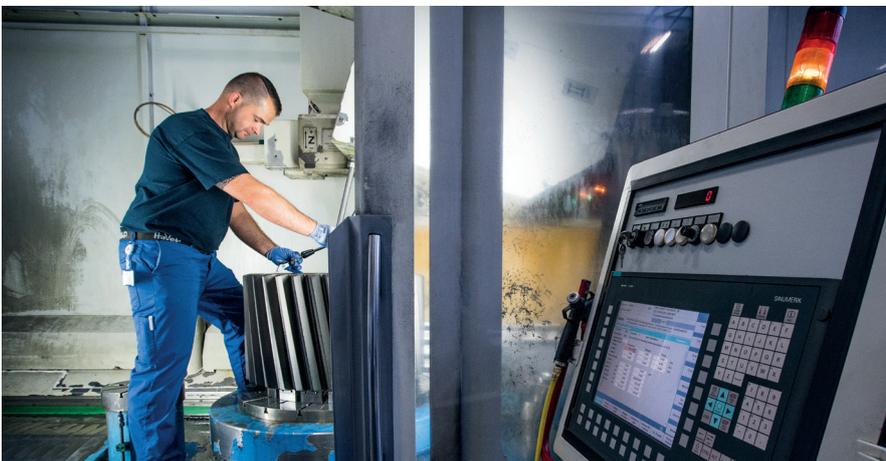
Digital capability in the gearbox platform will bring new opportunities to optimize the energy yield and decrease the operational cost of wind farms. ZF's Intelligent Gearbox is a key component for Intelligent Wind Turbine Performance Management,

optimizing operations and maintenance of wind turbines. The Intelligent Gearbox combines data from gearbox manufacturing, performance monitoring and advanced reliability models to enable better self-diagnostics and predictive maintenance, increasing availability of turbines. In addition, energy yield can be improved significantly thanks to the power upgrade potential. ZF's Intelligent Gearbox contains integrated sensors and is enabled by a cloud platform, digital performance monitoring and data analytics algorithms.

Rise of the onshore titans

As wind turbine manufacturers search for high flexibility for their new onshore and offshore turbine developments, ZF designed the most powerful gearbox platform ever developed for onshore wind turbines while also covering targeted offshore markets, significantly reducing the cost of wind energy.

Through the combination of advanced production and latest innovations, ZF can now offer the SHIFT 6k next to its SHIFT 2k and SHIFT 4k. This platform has best in class torque density, powering new generation wind turbines from 4.5MW up to



7MW, and rotor diameters of up to 180 meters. All ZF platforms have newly developed planetary stages with a modular configuration. This means that the platform is configurable in a broad torque range with maximum reuse of components, all within the same outer dimension per platform series. The multi-planet configurations, unique gear production processes and introduction of new bearing solutions power-up the gearbox platform in incremental and economic steps. The modular platform concept allows both a high or medium speed set-up. Depending on the platform series configuration ratios can go up to $i=200$. Using standardized building blocks simplifies servicing and

reduces maintenance costs, while offering potential for future turbine power upgrades. Serial delivery of the SHIFT 6k series will start in 2020.

The combination of ZF group's experience in automotive platform strategy and reliable wind gearbox technology has created a new breed of wind gearbox platforms. ZF Wind Power continues to innovate and delivers on its commitment to make wind energy one of the most cost efficient renewable energy sources.

Come and visit ZF Wind Power at Hamburg WindEnergy 2018, hall B5 booth 222

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 endeavors.

With state-of-the-art manufacturing plants and worldwide service locations, ZF is dedicated to delivering customized 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.