

Flexibly scaling wind turbine drive trains

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A revolution is happening in the world of renewable energy. All key markets have adopted auction-based approaches to subsidising renewables.

New wind market dynamics

In theory, the idea is rather simple. Set a target level of investment in renewable energy capacity, and then allocate contracts to the lowest bidders. As renewable energy markets mature and penetration increases, a growing number of countries are looking to reduce subsidy costs by spurring competition. This concept will initiate large disruptions as markets evolve to a new equilibrium.

Looking at how procurement costs are falling in countries that had previously relied on other mechanisms, it seems possible – even likely – that auction-based procurement is accelerating price erosion and reducing procurement costs relative to what we would have seen otherwise.

This sounds like good news. But is it really? It's good news if falling procurement costs reflect the market's ability to seek out the most cost-effective projects, and if this competitive pressure will fuel efficient innovation going forward. But there are concerns about whether the industry can cope with the developments and cost reductions going forward.

The success of these dynamic market conditions will depend on an understanding of how auctions can be designed to deliver sustainable cost reductions. ZF Wind Power anticipated these dynamics by developing a new breed of wind gearbox platforms. This modular platform is designed around faster time-to-market and offers high flexibility in adapting wind turbine designs to changing market requirements. This technology innovation

and policy innovation is needed to fully realize renewable energy transition.

Bundling all gearbox experience in a modular platform approach

The traditional wisdom on wind gearboxes is based on bespoke gearbox designs optimized for a specific turbine development. At first sight a gearbox platform approach seems to have a less optimized cost structure when comparing it to a single unique turbine design. But fast changing markets result in reduced turbine lifetime and lower volumes for unique developments. Wind turbine manufacturers are in search of high flexibility for their new generation turbine developments, while shorter time-to-market and business certainty to support forward selling in an auction or project based market become crucial.

ZF Wind Power has developed a new concept to help wind turbine manufacturers reduce the Cost of Energy of new generation wind turbine platforms. Our experience in reliable high torque applications is bundled in a new gearbox platform design to cover the dynamics of the wind market, safeguarding specific customer requirements and significantly reducing time-to-market.

ZF believes that shortening and simplifying all processes is core to ultimately making them cheaper in line with dynamic and challenging market conditions. The integration of new technology needs to speed-up, and a modular platform approach will certainly help to improve on a larger scale.

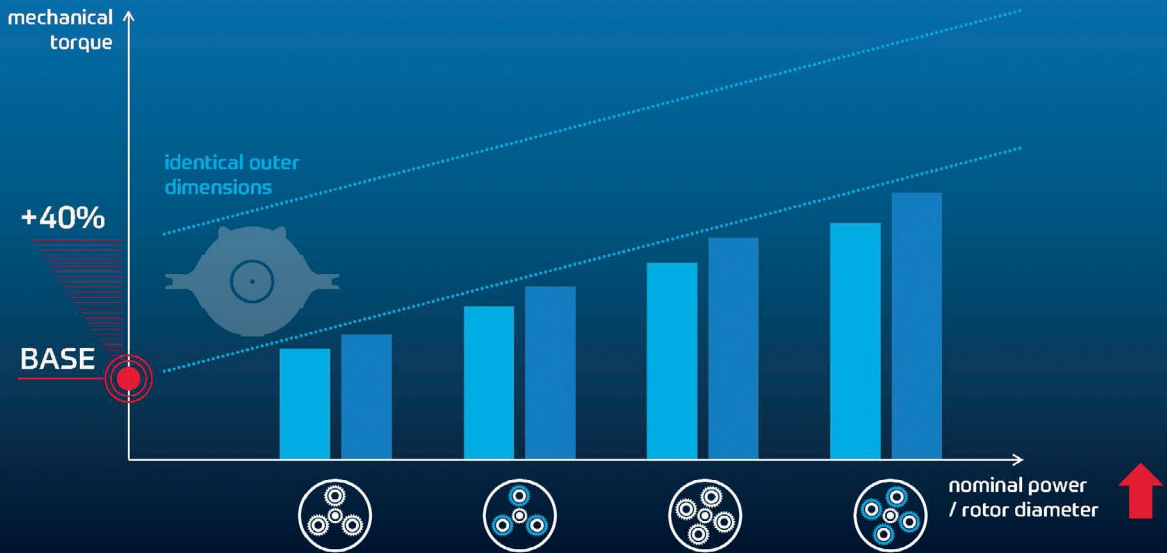
The modular platform designs focus on a number of key requirements, helping turbine manufacturers reduce business uncertainties and life-cycle cost:

- Allowing maximum use of the latest technology developments and optimized designs, processes and supply chain to scale (power density) while reducing Cost of Energy.
- Enabling platform upgrades of the mechanical torque while covering a broad range of gearbox-generator combinations in terms of gearbox ratios.
- Keeping the gear unit interfaces and outer dimensions identical across the full torque range, eliminating the need for major drive-train/nacelle redesigns during the turbine platform lifetime.
- Having standardized building blocks inside the gearbox significantly reduces time-to-market while leveraging the platform supply chain and operational synergies.
- Reusing building blocks simplifies servicing and reduces maintenance costs while offering potential for future turbine power upgrades of the installed base.

Complementary building blocks

The platforms will 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. 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. For example the high speed configuration offers ratios of up to $i=175$.

Modular Platform



ZF Wind Power - Platform modular building blocks

ZF has set itself an ambitious schedule for developing the platform and has already launched the first version onto the market. The first gearbox platform version, which is currently in production, covers a mechanical torque range of 2100 up to 3000kNm. We are now in the process of developing our second version of the platform, with a mechanical torque range of 3500 up to 4900 kNm. Prototypes of this version will be ready Q2 2018.

In addition to this new platform design, ZF Wind Power is also advancing in the area of Digitalization: data insights from gearbox design, manufacturing and actual field performance facilitate the introduction of intelligence into the drive train. Intelligence combined with ground-breaking sensing technologies enable ZF connected platform gearboxes to automatically sense the best way to optimize energy generation and improve turbine economics for any wind site condition.

More information on ZF's Digitalization of wind turbine gearboxes can be obtained at: <http://cdn.pes.eu.com/v/20160826/wp-content/uploads/2017/09/PES-W-3-17-ZF-PES-Essential-6-1.pdf>

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

www.zf.com/windpower



ZF Wind Power - Platform Concept (Mechanical Torque: 2100kNm-3000kNm)

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.