How to Deal With Growing Pains

Wind turbines are getting bigger than ever, and the manufacturing infrastructure that facilitates their construction needs to start growing with them.

Alex Cannella, Associate Editor

Wind turbines have grown steadily in size. Not even two decades ago, they were only a sixth the size of what they are now, and they've been accelerating in growth ever since.

"When I started in the wind market in 2001, most turbines were 1.5 to 2 MW," Doug Lucas, advanced engineering technologist at Timken, remembers. "Some turbine builders were working on 3 MW and 4 MW designs. As the market grew from the early 2000s to 2010, the conversation changed to 5 and 6 MW turbines. Then, in 2015, Vestas announced their 8 M@ turbine...and now we're seeing others go up to 12 MW."

That big 12 MW turbine is one of GE's most recent innovations from the past year, the Haliade-X, first of its class. The thing is, in a word, intense. It's tall as a skyscraper, standing 260 meters tall with 107-meter long blades, and not only is it the biggest wind turbine you'll find out there, it's also one of the most efficient, with a 63 percent capacity factor. Just one turbine can power thousands of homes.

The demand for the 12 MW turbine is, in fact, so intense that component manufacturers for the wind power industry can only just keep up. Even leading manufacturers in the field like Timken are hitting the limit of what they can do currently.

The loads placed on the bearing is a factor of concern, but just making a bearing big enough to work with these turbines is a complicated undertaking. Currently, many of the biggest wind turbines require bearings over two meters in diameter, something that according to Lucas, only a very select few manufacturers can even make, Timken among them. However, the industry isn't stopping there. They already want to go bigger.

Lucas cited one manufacturer that's already looking ahead and trying to design turbines so large that they would require bearings over four meters, double the size of what's already the cutting edge of what the bearing industry can handle. The sheer scale is mind-bogglingly massive, something that almost nobody in the industry has ever had to deal with.

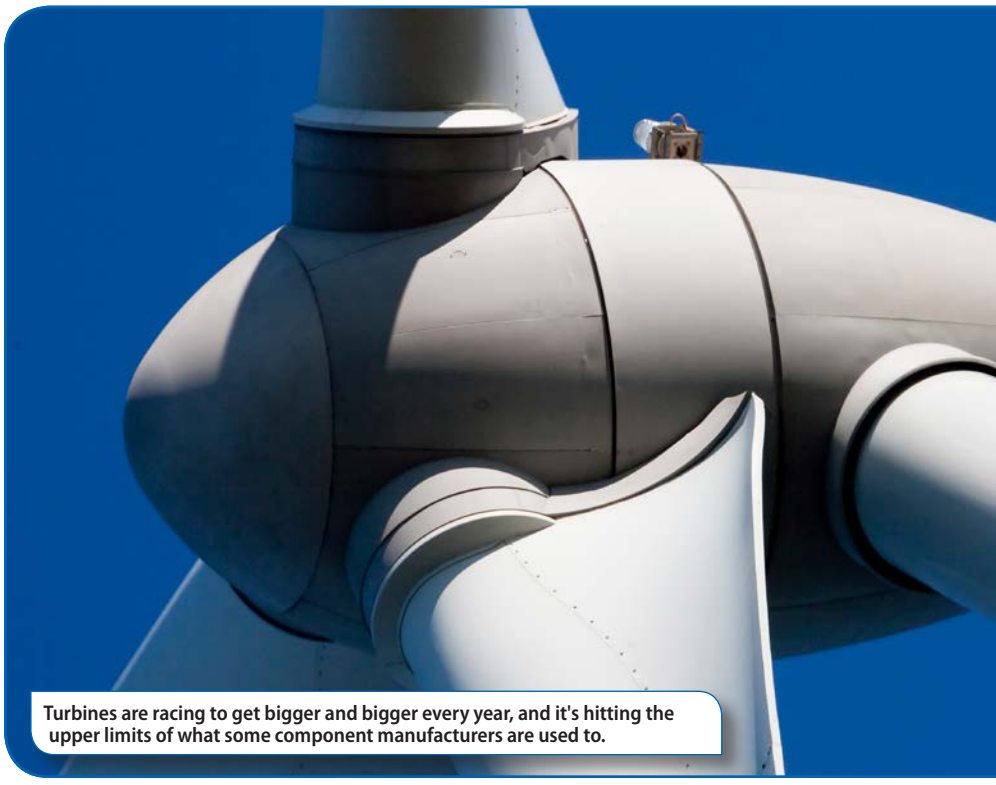
"We're on a size range of bearings that people have never reached before," Lucas said.

According to Lucas, a major challenge to upsizing these bearings is that the supply chain is pushing their upper size limits. In particular, heat treatment is a primary concern, as the size required for a furnace to be able to treat such massive bearings would be financially prohibitive. Pieces as large as what Timken would need are rare, so it's understandable that not many heat treaters would have a furnace set aside capable of handling them. However, heat treatment is a must for these bearings to handle the intense loads they do, so even if we can make bearings that large, finding somewhere to heat treat them is a bit of a predicament, and turnaround time skyrockets.

"Once you get up over two meters in size, there are very few heat treat manufacturers or bearing manufacturers around the world that have the size of heat treatment furnaces needed," Lucas said.

The key operating word here is "currently," however. So how is Timken, along with other bearing manufacturers, keeping up with demand for increasingly massive bearings to power towering wind turbines?

Some general tactics involve changing over from spherical bearings to cylindrical or taper bearings and sidestepping the issue of size by making two bearings to achieve the same effect.



Turbines are racing to get bigger and bigger every year, and it's hitting the upper limits of what some component manufacturers are used to.

"As we start seeing turbines grow upwards into the range of 12 MW and beyond, we're actually seeing that more and more companies are starting to use two single-row pre-loaded tapered roller bearings," Lucas said. "And as those bearings move further apart, we've actually been able to keep the bearing outside diameter down to a range that's more manufacturable."

Along the way, Timken's found that the cylindrical taper bearings just work better in general for wind turbine applications. Spherical roller bearings, according to Lucas, are excellent at carrying radial loads, but they're less equipped for thrust and overturning moment loads, both of which they must handle when used as wind turbine main shaft bearings.

"Using tapered bearings on larger megawatt turbines has advantages, because that type of bearing is designed to handle those loads," Lucas said.

The other half of the issue is the supply side, and Timken has been handling this by switching their heat treatment method. Previously, Timken used case carburizing for their high performance bearing needs, but for the massive bearings they're making for high-end wind turbines, they are using induction hardening. In the process, they've drastically shortened the time it takes to heat treat a bearing from up to a month to just a handful of hours,

"We've developed the induction hardening process to overcome those challenges from manufacturing and the supply chain to be able to provide a high-quality product in a timeframe that will meet our customer's requirements," Lucas said.

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>
> **Doug Lucas,** advanced engineering technologist, Timken

Timken has also started developing custom cage designs for their largest bearings. Many of Timken's bearings have stamped steel cages. Here again, size has outstripped infrastructure. Most stamping machines just aren't big enough to handle the cage size required for these massive bearings, and between that and tooling expenses, Timken has run up against a "limitation" to design in ultra-large stamped steel cages. As a result, the company developed innovative custom cage designs to overcome this challenge.

However, Lucas is confident that component manufacturers, and the infrastructure behind them, will find a way to keep up. They always have before, ever since wind turbines made the jump to multi megawatt almost two decades ago, and they'll do so again in the future.

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