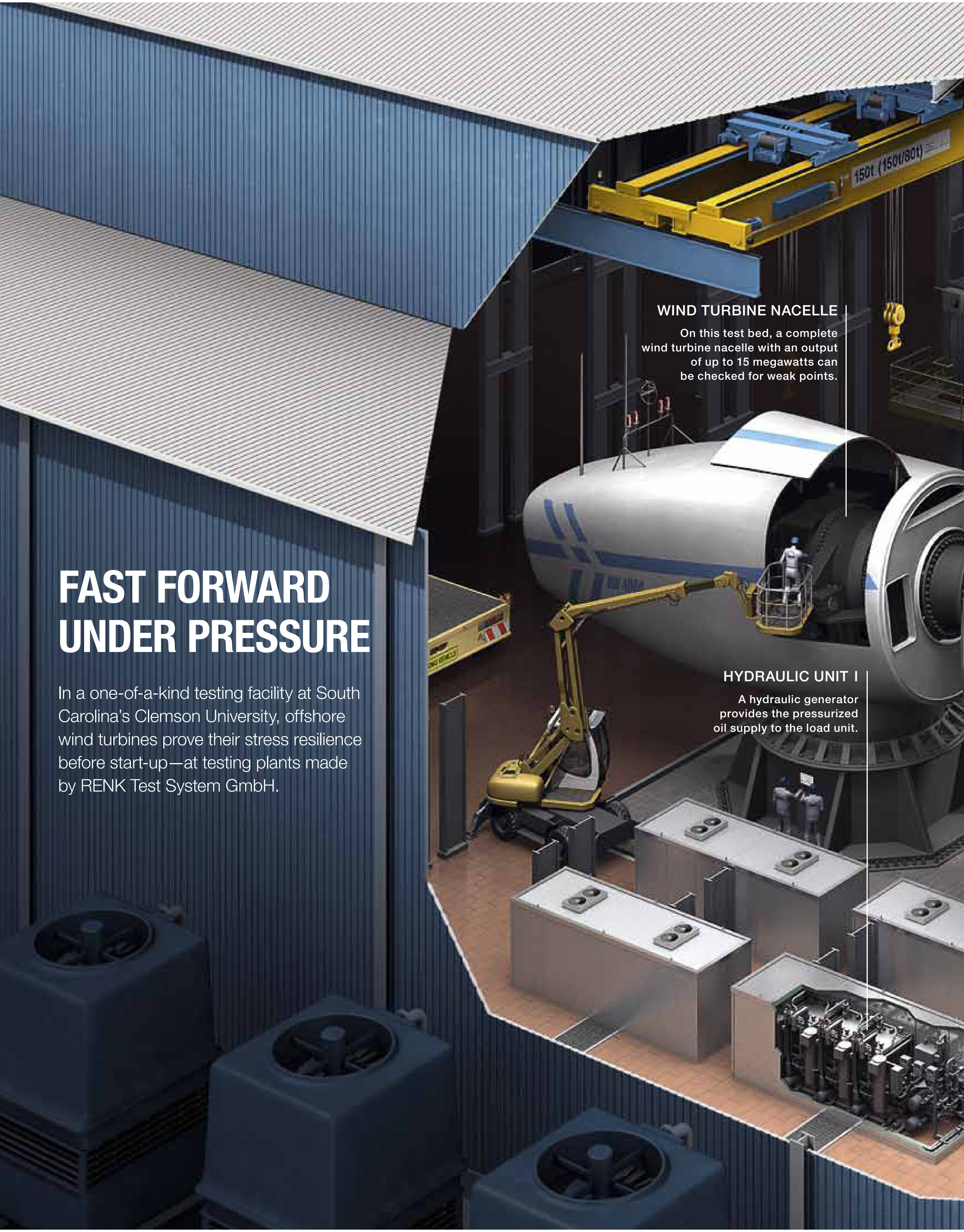
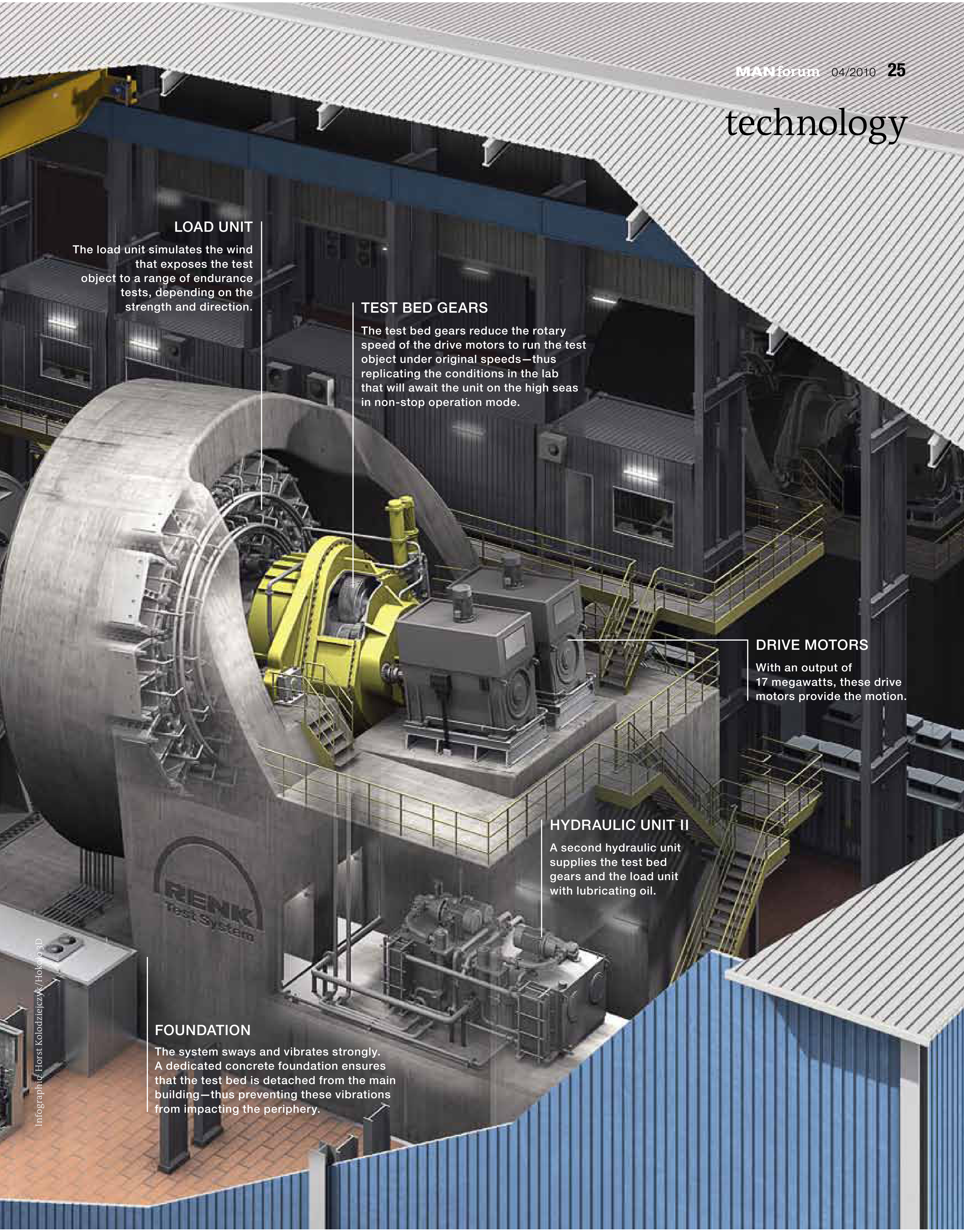
FAST FORWARD UNDER PRESSURE

In a one-of-a-kind testing facility at South Carolina's Clemson University, offshore wind turbines prove their stress resilience before start-up—at testing plants made by RENK Test System GmbH.




LOAD UNIT
The load unit simulates the wind that exposes the test object to a range of endurance tests, depending on the strength and direction.
TEST BED GEARS
The test bed gears reduce the rotary speed of the drive motors to run the test object under original speeds—thus replicating the conditions in the lab that will await the unit on the high seas in non-stop operation mode.
DRIVE MOTORS
With an output of 17 megawatts, these drive motors provide the motion.
HYDRAULIC UNIT II
A second hydraulic unit supplies the test bed gears and the load unit with lubricating oil.
FOUNDATION
The system sways and vibrates strongly. A dedicated concrete foundation ensures that the test bed is detached from the main building—thus preventing these vibrations from impacting the periphery.
RENK
Test System
Infographic: Horst Kolodziejczyk/Hokolo 3D

technology

>>> The climate policies of US President Barack Obama are beginning to show effect. By 2030, the US government intends to significantly expand the rate of wind energy, from a production of currently 35 to more than 300 gigawatts. This corresponds to roughly the output of 270 medium-sized nuclear power plants. In order to reach this ambitious target, land-based wind energy units must be supplemented by those located off the coast—so-called offshore wind turbines—which require investment costs about twice as high as those needed for wind parks on land. Considering these massive investments, the economic viability of wind power plants depends implicitly on the expected service life.

To date, the reliability and daily functionality of wind power plants could only be tested in full operating mode, as there were no test facilities available for systems of this magnitude. A research and test center currently constructed by Clemson University in Charleston, South Carolina, will offer turbine manufacturers the opportunity as of 2012 to save time and money in the development of new offshore wind farms.

TEST BED AT 35 METERS LENGTH

RENK Test System GmbH supplies the central component of the test center. It consists of two test beds that can analyze the individual components, gears and complete drive trains with an output of up to 15 megawatts for any weak points—regardless of manufacturer or design. At a volume surpassing €29 million, this represents the largest single order for the Augsburg-based company in the testing sector to date and secured Renk a solid foothold in the growing market for wind power test facilities.

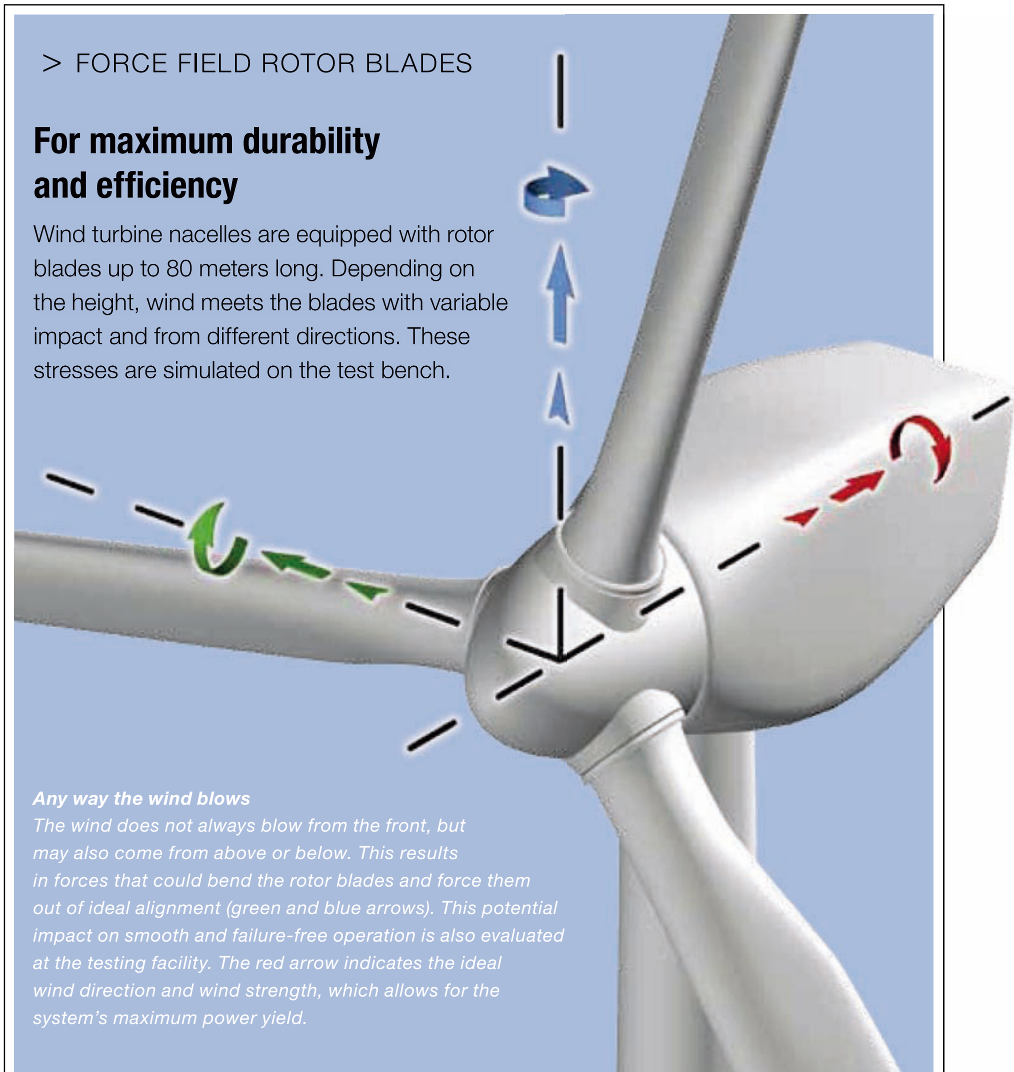
RENK LABECO, the US subsidiary of RENK Test System GmbH, successfully bid for the opportunity to realize this project, up against five competing submissions. "Based on our past experience, we were the only company capable of offering a complete all-round package comprising drive technology and power simulation from a single source," explains Jörg Cordes, President of RENK Labeco Test Systems Corporation in Mooresville, Indiana. He emphasizes that, after all, test beds are nothing less than central tools for getting new technologies to series production and ensuring their reliability.

RENK Test System GmbH delivers a test bed for smaller drive trains with turbines up to 7.5 megawatts, and a larger one for turbines about twice the size. The latter is around 35 meters long and 11 meters high and can accommodate a complete wind turbine nacelle with up to 15 watt output, including the gears, generator, brakes and measuring instruments. As a matter of fact, 15 megawatts is only the short-term peak performance required of the largest turbine in this application: Its nominal output is rated at just 7.5 megawatts. "The test bed should be designed twice as strong as the test ob-

> FORCE FIELD ROTOR BLADES

For maximum durability and efficiency

Wind turbine nacelles are equipped with rotor blades up to 80 meters long. Depending on the height, wind meets the blades with variable impact and from different directions. These stresses are simulated on the test bench.



Any way the wind blows
The wind does not always blow from the front, but may also come from above or below. This results in forces that could bend the rotor blades and force them out of ideal alignment (green and blue arrows). This potential impact on smooth and failure-free operation is also evaluated at the testing facility. The red arrow indicates the ideal wind direction and wind strength, which allows for the system's maximum power yield.

ject," says Cordes, explaining the concept. Only this approach allows for testing extreme situations for the components, materials and controls, including all aspects of operational safety.

DOWNTIME COSTS MONEY

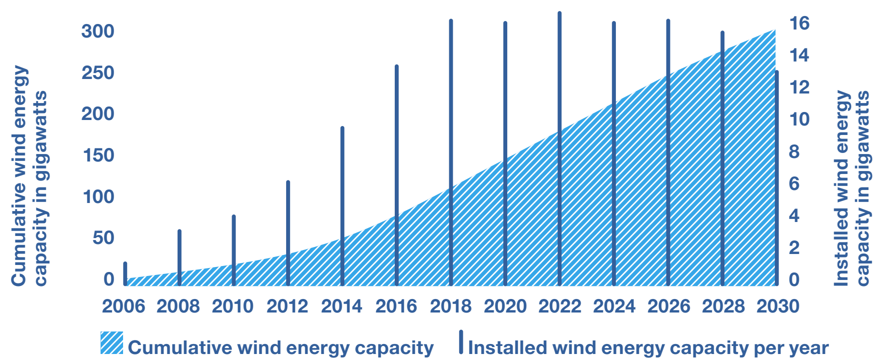
One extreme situation might be the necessity to shut down because of strong wind. At a height of 90 meters, the long rotor blades of the turbine generate massive torque and forces that the hub bearing must be able to absorb and transfer. When shut down, the rotor blades come to rest in a Y position in front of the mast to minimize the surface area exposed to the wind's attack—yet constitute adverse conditions for the bearings. Once the rotor blades are stationary, the still powerful vibrations keep pounding on the same spot. How long can they withstand this stress before they wear out and start to yield? In addition, climatic conditions such as salty and moist air, extreme heat and cold can impose strain on the material. The objective of working with the test bed is to detect any critical spots.

In the case of wind farms designated to generate electricity on the high seas, failure-free operation is even more crucial than for systems installed on land—as faults occurring off the coast that cannot be fixed by remote maintenance, will sometimes take days to fix in detriment weather or even weeks in winter. Stationary turbines, however, generate no profits and just cost money. Companies like Germanischer Lloyd, which ensure wind farm operators against such failures, therefore consider these tests crucial. At final inspection, they demand a seal of quality that guarantees operational safety for four years until first overhaul—otherwise the manufacturer will be liable. Previously, such a guarantee had not been feasible, for only individual components, such as the rotor blade adjustment system, could be tested prior to starting up—but not the entire plant.

> BUILDOUT OF WIND POWER BY 2030

Ecological awakening in the US

The United States has excellent wind conditions for power generation, primarily on the Atlantic coast. The US Department of Energy is anticipating a potential offshore capacity of 54 gigawatts by the year 2030. Total wind energy output by 2030 is expected to amount to about 300 gigawatts.



Source: US Department of Energy (DOE)

To best meet all possible scenarios and avoid high guarantee expenditures, as well as costly down time, the test systems are simulating operational stress as if it were in fast forward mode and absolutely realistic, thus revealing system durability. "Five years in the field are reduced here to just a few months," explains Cordes. This makes it possible for the engineers to carry out improvements before something actually happens in day-to-day operations, with a component proving unable to withstand the stress.

Supplied by RENK Test System GmbH in turn-key condition, the test beds examine all factors at hand very closely: How do the gears behave under various stress conditions, such as high winds or dead calm? How precisely will the control systems respond to these scenarios? Are the data readings entered into the data management system correctly? The wind farm units must be able to withstand gusts, for example, which may greatly surpass wind strength factor 7 for short periods of time, while still remaining connected to the grid and supplying electricity for as long as possible. These load cycles can be simulated and reproduced on the test bed, according to any requested parameters. Such thorough testing processes would require much more effort under field conditions.

DELIVERY PLANNED FOR 2013

Problems with existing wind plants can also be resolved on the test bed, and then improved retroactively. These include gears and bearings, for instance, which are generally tested on the smaller test unit. Still measuring a good 26 meters in length, the smaller bed is currently in the planning and design phase at the Augsburg works. The assembly phase for these components is scheduled to begin in about a year, with installation in the United States taking six months. The large test bed will be operational in early 2013. <

Infographic: Horst Kolodziejczyk/Hokolo 3D