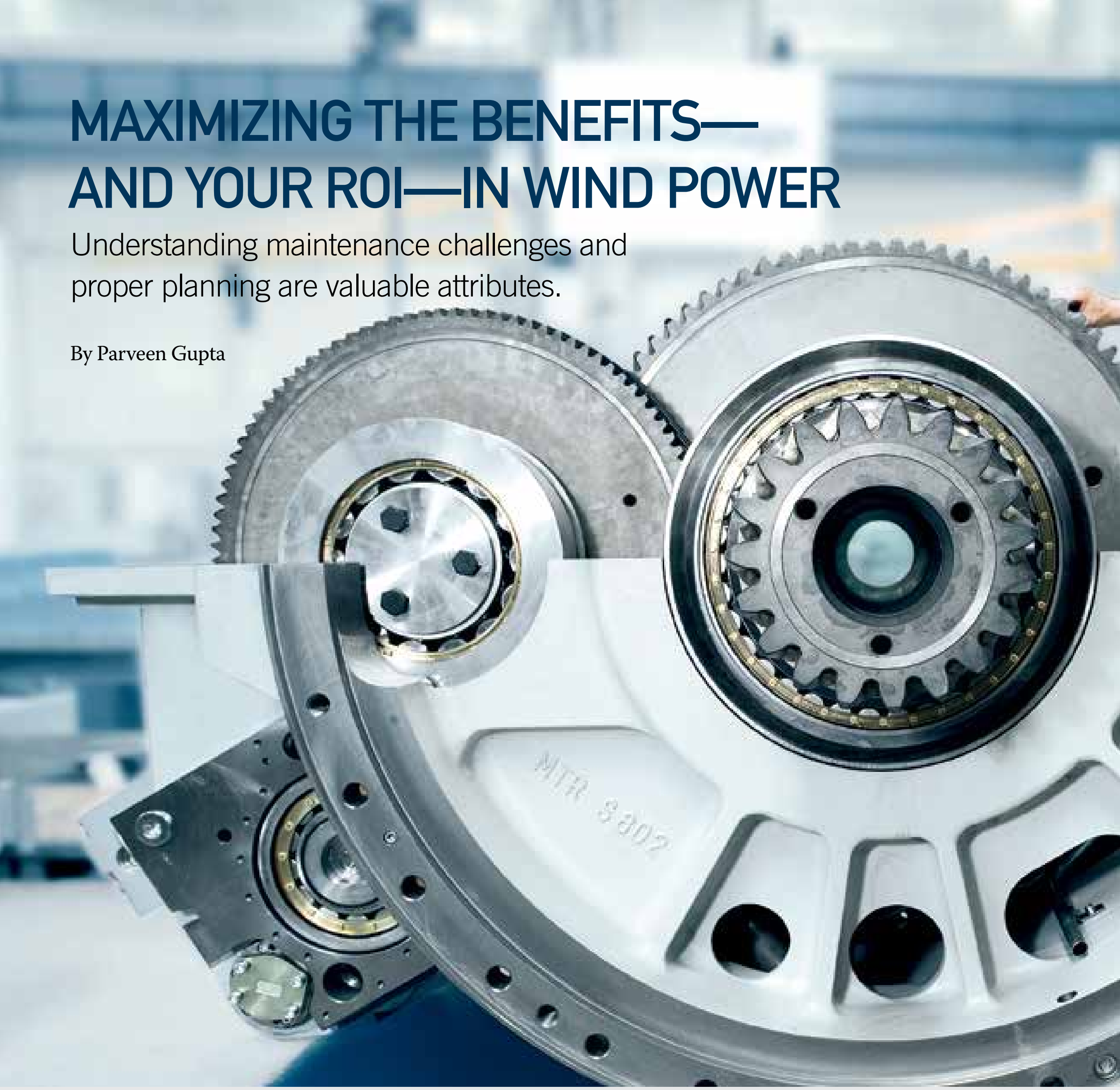
MAXIMIZING THE BENEFITS—AND YOUR ROI—IN WIND POWER

Understanding maintenance challenges and proper planning are valuable attributes.

By Parveen Gupta



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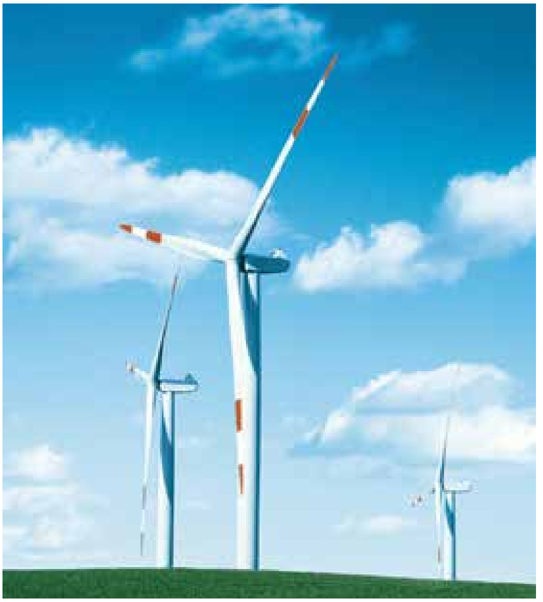
MODERN WIND TURBINES CAN PROVIDE large amounts of electricity, cleanly and reliably. Nearly eight percent of electricity in the state of Texas comes from wind energy, and Germany, Spain, Portugal, Denmark, and Ireland now obtain more than 10 percent of their electricity from wind energy, according to the American Wind Energy Association (AWEA)[1]. The cost of producing wind energy is as competitive as any other new power source.

Because the Global Wind Energy Council (GWEC) predicts that off-shore wind farms can be installed and operational in less than two years[2], wind energy is also proving to be a quicker return on investment compared with other "green" energy sources. As a result, estimates from the GWEC indicate that investment in wind energy will reach $196.7 billion by 2020.[3]

Wind power's unique features—including large turbines and remote locations where wind farms are built—both contribute to its success and pose challenges for maintenance and repair. However, with the right planning and an experienced partner, these obstacles can be overcome to quickly maximize the benefits and ROI.

UNIQUE MAINTENANCE CHALLENGES CAN LEAD TO POTENTIAL PROBLEMS

Wind turbines are large and immense equipment—five times larger than they were 10 years ago.[4]



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The largest wind turbines have blades that are 415 feet long and weigh 25.5 tons.[5] These massive turbines have the capability to produce 15 times as much electricity as ones that were built a decade ago.[4] Even though turbines in offshore wind farms require service only once or twice per year[6], their sheer size and remote locations pose unique challenges for routine maintenance. However, if the equipment is not checked or monitored regularly, reliability issues may arise that can result in excessive downtime and lost revenue.

Storms and other natural events can lead to gusting wind, which can cause unanticipated component damage in wind turbines such as cracks and damage between layers of composite materials on the surface of the blades. Without regular maintenance, the cracks can widen and deepen, causing the blades to become imbalanced, placing more stress on the gearbox and other components. Large gears in traditional gearboxes can become misaligned due to the uneven loads that are generated by damaged blades.

Although most blades are coated with lightning-proof epoxy, they are susceptible to lightning strikes when moisture seeps into developing cracks. When struck by lightning, the water that has accumulated in the blades instantly turns to steam. Depending on its intensity, a lightning strike could cause cracks to deepen, or spark a fire from the oil or lubricants in the gearbox, possibly destroying the entire turbine.

In addition, turbines located on offshore wind farms are particularly at risk for cracks and other damage that occurs from driving ice in the ocean, as well as from sea spray and precipitation that can freeze on the blades or on other components. Ice can cause minor cracks to expand, and create excess loads for the blades, leading to damaging vibrations.

The remote locations of wind farms can present challenges when it comes time to inspect the nacelles for repair or maintenance. Inclement weather and the turbines' location can make access difficult, often limiting service to just one or two times a year. Additionally, workers might need to repair multiple turbines that are spread out in the same wind farm, which may result in higher labor costs and a shorter time spent at each nacelle.

In addition, advanced logistics are required to coordinate the maintenance of the turbines and the repair of faulty components, including the shipment and installation of new parts. Because the components are so massive, their transfer to a remote location usually involves coordinating among various logistics providers, including trucking companies, barge and vessel owners, among others.

OPTIMIZED COMPONENTS AND SERVICE PLANS PROVIDE IDEAL SOLUTION

These potential problems can be avoided with optimized components and software solutions, along with a proactive service and preventive maintenance program that boosts reliability and minimizes downtime and financial risk.

Because of the varied sizes and harsh conditions, wind turbines need efficient components that have been optimized to ensure maximum performance. Proven solutions include a specialized gearbox design and a robust remote condition-monitoring system that helps lengthen the life of the wind turbine and eliminate downtime. For example, the appropriate gearing design can harness gusts of wind and minimize its potentially uneven impact on rotors and other internal components. Alternatives to planetary gears include direct drives, magnetic bearings, torque-splitting systems, continuously-variable transmissions, and hybrid gearboxes.

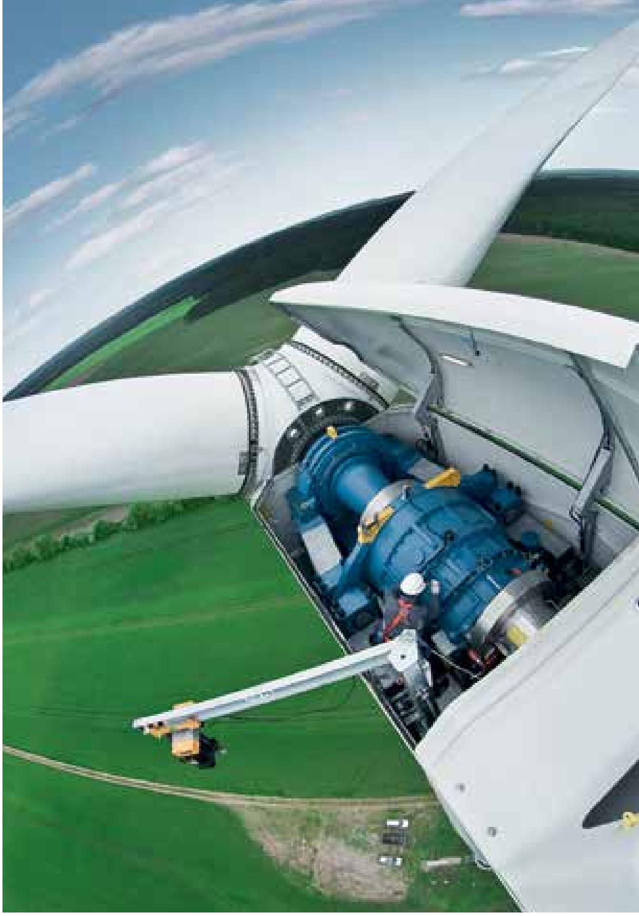
Direct drives eliminate the need for a gearbox by increasing the number of magnetic pole pairs in a generator from the four or six conventional generators to 100 or more. In addition, a smaller number of moving parts boosts efficiency and reliability. However, turbines with direct drives cost up to three times as much as those with traditional gearboxes. The components themselves are costly and the systems are expensive to manufacture.

An active magnetic bearing system includes a magnetic shaft, controller and multiple electromagnetic coils attached to a stator shaft location. Magnetic bearings reduce the amount of wear, are more efficient than traditional gears and do not require lubrication. However, when exposed to higher loads, they need to be replaced more frequently. In addition, they require a great amount of power to generate the current needed to create enough of a magnetic force to handle those higher loads.

Torque-splitting systems utilize a gearbox design featuring external double helical gears that spread the torque among various generators that operate simultaneously. Like magnetic bearings, torque-splitting systems are unable to handle high loads, but one generator can be replaced without having to remove the entire gearbox. In addition, a turbine with one faulty generator can still operate at reduced capacity until it can be fixed.

Output shafts in gearboxes with continuously-variable transmissions, or CVTs, have the ability to maintain a constant speed of rotation, despite the fluctuations of wind gusts and changes to the rotor speed. Although CVTs are more efficient than traditional gearboxes, it's unknown whether this technology can be scaled for larger, off-shore wind farms.[7]

Besides the gears themselves, other components in the nacelle can be optimized to maximize the benefits of wind power. Designing the turbine with modular components, including multiple generators and gear units,



can simplify access for staff that need to replace faulty equipment. Other components, like asynchronous motors in electromechanical pitch adjustment systems, eliminate the need for regular maintenance.

Hybrid gearboxes, like the Rexroth REDULUS GPV main gearbox, weigh 15 percent less than traditional gearboxes, making installation and replacement easier and faster. Serviceability is also enhanced by the lighter weight as rigging equipment can be installed in the nacelle so repairs could be made without heavy cranes and lifts.

Control systems in wind turbines can be designed to maximize efficiency, as well. A control system that includes redundant monitoring and data exchange between and among the master control communication layer and axis drives allows the wind turbine to continue to operate and produce electricity in the event of a fault. Other areas of redundancy in wind turbines include backup systems for cooling, controls, and fluids.

Besides efficient components, a variety of monitoring systems can reduce downtime by detecting problems before they occur. A lubrication and oil condition monitoring system can detect the effects of wear and friction in cooling systems. A robust remote online monitoring system continually inspects the status of the rotor blades and alerts off-site operators to any conditions that deviate from the normal operation of the turbine. It can detect minor cracks and ice that can affect the performance of rotor blades. In addition, a remote online condition-monitoring system can extend the life of the equipment by detecting problems at an early stage, so components can easily be repaired instead of replaced.

In addition to monitoring systems, a failure analysis program can help simplify maintenance and repair by determining why a fault occurred. The program should include a list of potential failures and the corresponding steps needed to repair or replace components. The plan also serves as a guideline for inventory and other equipment that will be required in case of an emergency.

Simply monitoring for problems is not enough. It is imperative to partner with a service and support organization that has technical knowledge and engineering expertise regarding wind turbine repair and maintenance. Some companies offer localized service centers that can handle preventive care, including the ability to perform measurements and tests. The service partner also should be able to provide a number of repair services—including overhauling, remanufacturing and regrinding of gear teeth—as well as OEM-quality spare equipment and upgrade kits for outdated parts.

After years of successful worldwide development and support, wind energy has proven to be a worthwhile investment. To maximize ROI and reduce high costs that result from unplanned downtime, ensure that the turbines are designed with control systems and optimized components specifically for the unique nature of a wind power application. A comprehensive preventive maintenance program and conditioning monitoring system helps lengthen the life of those components. Finally, partnering with an organization that specializes in the service and maintenance of off-shore wind farms can help overcome any potential obstacles that may occur.

SOURCES

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