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A GUIDE TO UNDERSTANDING THE MOST COMMON TYPES OF WIND TURBINE GENERATORS

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As you drive into work in the morning, you can see that the turbines at your wind farm are spinning and are online. They are producing power. But can you tell how much power? I can't. Why is that?

That's because the turbine turns pretty much the same speed or revolutions per minute (rpm) when the turbine is producing minimal or maximum power.

How much does your team understand about how the turbine's generator produces power? Let's find out.

There are many different types of generators used today in wind turbines, but the most common types are asynchronous generators. The two types most commonly used are the squirrel cage induction generator and the wound rotor induction generator—also known as a doubly feed induction generator (DFIG).

Both types work pretty much the same way, with DIFGs having some additional capabilities.

I will start with explaining the operation of the squirrel cage induction generator and then explain an attribute of the other.

For most turbines today, if the turbine is safe, has no faults or errors, and sufficient wind is present, the turbine will face into the wind and the blades will start to rotate as they absorb energy. As the rotor turns the gearbox, the generator also rotates. But as we all know, the turbine is not generating power if it is spinning at less than the connecting speed of the generator. The turbine can pinwheel for hours or days if there is not enough wind to get it up to spinning to the generator connection speed. We know that the turbine—that is, the generator shaft—has to get up to a certain speed before we connect it to the grid by applying power to it. That speed is called synchronous speed and is the speed at which the generator neither consumes power nor makes power (other than reactive power, but that's a topic for a whole other article).

In reality we could apply power to the generator at any time. But if we do so before we reach the connecting speed, we will be running the generator as a motor. If we run the generator as a motor, then we will be consuming energy and that will cost us money. Why is this?

The connecting speed of the generator is determined by the number of poles in the generator. It is also a function of the frequency of the grid. The frequency in the U.S. is 60hz (or cycles per second). Other parts of the world use 50hz. The generator is constructed is such a way that there is a relationship between the number of poles in the generator and the frequency of the power supplied by the grid. This relationship is what determines synchronous speed of the generator. A six-pole generator has a synchronous speed of 1,200rpm @ 60hz, and a four-pole generator has a synchronous speed of 1,800 rpm @ 60hz.

You may be asking: "What does that all mean?" Synchronous speed means that the shaft of the generator rotates at the same speed of the rotating magnetic field that is formed when the generator has power applied to its stator when it is connected to the grid. If the shaft rotates slower than the magnetic field in the stator, then the generator will be working as a motor and will consume power. That is why we don't connect the generator at rpms much lower than the synchronous speed. We typically connect just under or at synchronous speed—the point at which the turbine is expected to produce power. When we connect power to the generator just at synchronous speed, the wind tries to push the generator faster than the rotating speed of the magnetic field in the generator. Instead of the generator spinning faster, the system produces power. If the wind pushes soft against the magnetic field or pushes hard against the magnetic field, the generator maintains pretty much the same rpm but produces more power the harder the wind pushes.

Here is a good practical example of what is happening. The rotating magnetic field in a 4-pole generator rotates at 1,800rpm at 60hz here in the U.S. That magnetic field is basically a wall that prevents the generator shaft from spinning faster. To illustrate this point, choose a wall in your office. This wall will represent the generator's magnetic field spinning at 1,800 rpm. Go ahead and push against that wall with your hand. Does it move? No. Push harder. You may be able to cause the wall to flex, but it won't move—no matter how hard you push against it. The same principle applies with the magnetic field in the generator. Once the turbine gains speed and connects to the generator, the wind pushes, but the magnetic field in the generator doesn't let the generator rotor shaft turn any faster. Instead, power is produced according to how hard the wind pushes. The wind spins the turbine and in turn pushes against the rotating magnetic field of the generator.

If you were to remove the wall and push in the place where it once existed, you would go tumbling forward (presumably into another room. The same thing would happen if you removed the magnetic field from the generator (disconnected the generator). If you removed the magnetic field while the wind is blowing, the blades would still be absorbing energy. That energy has to go somewhere. In this case, the energy transfer would increase the rotational speed of the turbine, resulting in the turbine entering overspeed.

A DFIG works the same way as a squirrel cage generator, except that it allows you to move the "wall" you're pushing against. We can move the generator's magnetic field by adjusting the power to the rotor through slip ring connections. Instead of the wall being fixed at 1,800 rpm, it can be adjusted electrically. By adjusting the power to the rotor, it can move forward to say 900 rpm and backward to 2,000 rpm. The advantage of being able to move the wall allows us to produce power at lower rpms and to absorb some gust loads by allowing the wall to move back or faster, absorbing the additional load. The way we move the wall or the magnetic field in the generator is by adjusting the power to the wound rotor with power electronics.

I hope this increases your understanding of how the generators in your turbines produce power, and explains why you can't tell from looking at the spinning turbines how much power is being produced. I'll leave you with one last tip about wound rotors. If the turbine experienced a true overspeed, it would be prudent to perform a bore scope inspection of the windings for expansive movement. At the minimum, the situation necessitates a climb to the turbine to listen to the generator up-close at very low rpms in order to detect rubbing of the rotor windings on the stator. If rubbing is present, the rotor could be damaged, and you could take steps to prevent damage to the stator.

As always work as safe as possible and work to prevent surprises.

Siemens, Pattern Energy agree to long-term service contract

10-year maintenance program encompasses 400 turbines at six sites in the United States, Canada, and Puerto Rico totaling more than 930 MW

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Underscoring growing customer confidence in the valuable benefits Siemens Energy can provide with its flexible, longer term wind service agreements, the company has been awarded 10-year wind service agreements encompassing over 400 onshore wind turbines in the U.S., Canada and Puerto Rico. The customer is Pattern Energy Group Inc., based in San Francisco. Combined, the scope of these long-term contracts represents one of Siemens' largest agreements with a single customer in North America.

Pattern Energy is a leading independent power company with a portfolio of 10 wind power projects in the United States, Canada and Chile.

"This is an important milestone in the continued maturation of the wind industry in North America," said Tim Holt, CEO of Service Renewables, a business unit of the Siemens Energy Service Division. "As more and more wind energy is placed into service, our commitment is to provide long-term added value to customers like Pattern Energy in order to help them realize favorable performance throughout the turbines' lifecycle."

"As an industry leader with vast experience, Siemens brings long-term reliability and technology enhancements to our wind projects, ensuring improved performance and lower operating cost risks from each and every turbine," said Mike Garland, President and CEO of Pattern Energy.

Helping Pattern Energy obtain continued reliability, availability and performance of the turbines, Siemens will provide the long-term service and maintenance, as well as technology updates, for six Pattern Energy wind projects located in the U.S., Canada and Puerto Rico with a combined output of over 930 MW.

The current operating projects included in the new service agreements are Pattern Energy's St. Joseph Wind project in southern Manitoba (138 MW); Spring Valley Wind in eastern Nevada (152 MW); Ocotillo Wind in Southern California with (265 MW); Hatchet Ridge Wind in Northern California (101 MW); and Santa Isabel in Puerto Rico (101 MW). These projects are also slated to receive a variety of modernization and upgrade components representing the latest technological advancements, such as Siemens' Power Curve Upgrade, a combination of add-on components designed to help improve the aerodynamic performance of installed turbines.

In addition to the projects currently in operation, Siemens has also signed a 10-year service agreement for the Panhandle 2 wind project in Texas (182 MW), which Pattern Energy has agreed to acquire when the project reaches operation later this year.

Spider Provides Turnkey Blade Access with Largest Platform to Date

Spider, a division of SafeWorks, LLC, recently designed, manufactured and rigged its largest 360° Blade Access Platform (BAP) to date.

The customer, Alstom, required access to the blades of its massive 3.0 MW prototype turbine at the National Renewable Energy Laboratory in Boulder, CO to conduct R&D on a new power performance improvement package. The scope of work required the platform to pass the max chord on the blades and have access to the blades' root.

In less than four weeks—two weeks ahead of the anticipated production schedule—Spider designed, manufactured and delivered the custom 15 ft x 10 ft BAP—its largest to date—to Alstom.

Additionally, Spider technicians surveyed the turbine to develop a rigging plan that allowed the use of a four hoist platform by routing the rigging slings over the blades in a bunny ear position. With Spider on site daily to handle the rigging needs and provide immediate support throughout the three-week project, Alstom's blade technicians were able to focus on their scope of work.

"In addition to providing a stable and safe working platform, Spider's management of design, construction, rigging and on-site support allowed us to complete our project without any issues," commented Jon Campbell, innovation program manager with Alstom.

GE unveils wind farm plant management suite

GE recently announced the expansion of its brilliant wind platform to include plant-level wind management software applications to improve overall wind farm output.

Using the power of the Industrial Internet and turbine-to-turbine communications capabilities, GE's new software allows the turbines within a wind farm to act as a cohesive unit, rather than individual assets. Wind plant wake management is the first farm-level management application launched by GE and enables customers to recapture lost power output from waking effects.

With the wind farm wake management application, turbines balance performance and loads throughout the entire wind farm. In turn, wind farms can achieve greater power output as an overall plant, and customers can expect to see 5-10 percent reduced wake losses and improved mechanical loads due to lower wake turbulence. This translates to up to 8 percent more profit for the wind plant.

GE's wind plant management applications will be optional features on new projects. For turbines currently in operation, the technology will be integrated into GE's Wind PowerUp technology platform.

GDF SUEZ to upgrade 19 Gamesa turbines in France

Gamesa has landed a contract from La Compagnie du Vent, a wind energy subsidiary of GDF SUEZ, to upgrade 19 wind turbines in the south of France.

The contract includes the frames' reinforcement as part of the life extension program of the five wind turbines of 660kW, the implementation of the algorithm improvement software, and the Gamesa premium Availability (GPA) in 14 Gamesa 2.0 MW wind turbines.

This contract bolsters Gamesa's presence in the operation and maintenance market, a linchpin of the company's growth potential. Moreover, this activity is a vital tool for creating value associated with the development, availability and profitability of wind energy projects.

The wind turbine life-extension program consists of a series of structural reforms and a monitoring system designed to prolong the useful lives of WTGs made by Gamesa and also by other manufacturers beyond that of the original design specifications, thereby guaranteeing the equipment's safety and availability, enabling control over O&M costs and streamlining the cost of energy.

ACoS CONDITION MONITORING SYSTEM REDUCES COST OF ENERGY

Bosch Rexroth teams with DMTto develop advanced holistic monitoring system

Cost of energy (CoE) is the key measure of wind turbine efficiency, as well as being a top priority for turbine operators. Condition monitoring systems make an important contribution in this regard, enabling condition-oriented maintenance to reduce operating costs, and therefore the CoE, in a sustainable manner. ACoS, the Advanced Condition Monitoring System from Rexroth, is a world first, combining condition monitoring for all components in the power train of a wind turbine and intelligently networking measurement data from different sensors. A standardized operating interface for all sub-systems speeds up the analysis process and reduces the need for training.

Building on many years of experience with the BLADEcontrol rotor blade monitoring system, Bosch Rexroth AG has now joined forces with technology company DMT GmbH & Co. KG to develop the holistic ACoS condition monitoring system. The system combines monitoring for all relevant function groups by means of a standardized and continuous connection to a control desk, thereby reducing the need for hardware. By synchronizing the data measurement process, the detection sensitivity and data quality are also increased.

The universal system philosophy enables easier operation while simultaneously increasing the efficiency and transparency of the monitoring process, allowing a considerably greater number of turbines to be covered by each monitoring expert. The system reduces turbine monitoring costs, while also improving the ability to plan for maintenance operations.

Operators of onshore and offshore wind turbines are thereby able to reduce their CoE on a long-term basis over the entire service life of the turbine.

Proven measurement and analysis strategies are combined to form a holistic monitoring strategy on an open platform composed of individual function modules. All measurements are synchronized with each other. By combining monitoring of the rotor and power train, abnormalities on one component can be checked and verified by means of cross-comparison with the measurement data of the other component.

In addition to holistic turbine monitoring, ACoS includes GL-certified ice detection on the rotor blades. This option eliminates on-site inspections of wind turbines to ensure that they are free of ice, allowing the turbine to be restarted safely and promptly once the ice is no longer present.