Higher Voltage and Intelligent Pitch Systems Improve Efficiency

Countries around the world are looking to wind energy – both offshore and onshore – as a boon for renewable energy portfolios. Ambitious goals for the expansion of energy farm development have been developed as nations push to move away from fossil fuel energies and to low-carbon societies. Yet leaders in the industry and government officials alike are concerned that if the costs of wind energy don't continue to drop and/or efficiencies substantially increase, these goals will not be met.

Increasing the energy efficiency of wind farm systems is perhaps the most promising method for lowering the costs of wind energy development. As such, there's a race in the industry to develop technologies and launch innovations that propel the industry into a vastly more efficient era. With leading manufacturers working on innovations such as producing systems that operate at higher voltages and developing more intelligent pitch technologies, many promising changes are taking place within the industry.

Exploring the Promise of 66 kV Technology

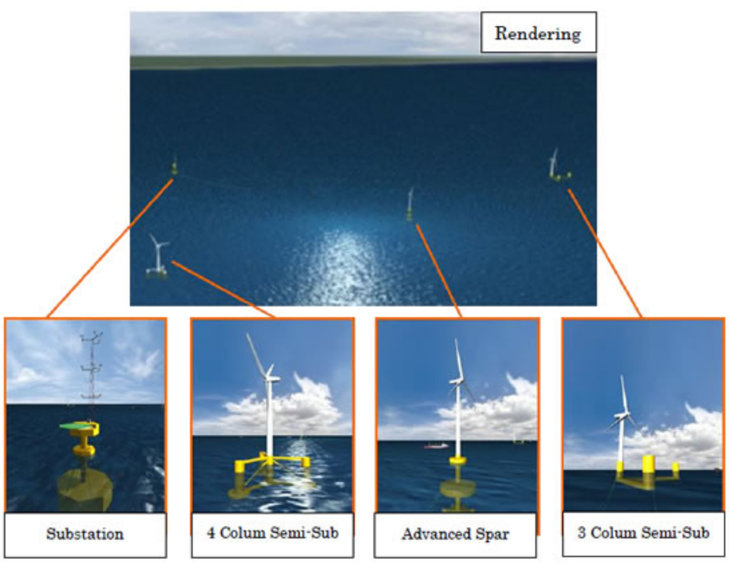
Most industry forecasts by the European Wind Association (EWEA) predict that conventional 2 MW and 3 MW turbines will give way to 5+ MW turbines as wind farms grow to produce hundreds of MWs each. To meet this demand, wind turbines will need to become more cost-effective and more efficient. For that to occur, technologies for reducing power losses of both onshore and offshore farms will need to be developed at lower price points. This is especially true for offshore installations where longer shore to land distances and larger turbines add to the mounting costs of installing wind developments.

It's no surprise, then, that one of the newest innovations being trialed for increasing efficiency in the wind industry is the use of 66 kW inter array cables – cables which are double the voltage of the traditional 33 kV cables. Using higher voltage cables is said to halve the number of substations and cabling required, which could have significant cost saving benefits for individual wind farm developments.

This is accomplished largely because, rather than radial designs, 66 kV cables can be installed in looped circuits in order to allow turbines to transfer power continuously on alternative cables in the event that one is damaged. The hope is that using higher voltage cables to achieve these improvements will reduce the cost of offshore wind in particular by 2%, though the technology can also be applied to onshore developments.[i]

In a recent interview with BusinessGreen.com, Phil de Villiers of the Carbon Trust's Offshore Wind Accelerator (OWA) programme, de Villiers commented, "We want manufacturers to design 66kV and test it so that everyone has confidence that it's going to work."

A recent study of technology that would support higher voltages by Garrad Hassan and Partners Ltd. showed that there is indeed significant incentive to continue to develop such innovations. Efficiencies seem to improve without adversely effecting the cost to power production ratio. That said, the study pointed out that technical issues such as availability of higher voltage cabling and dry type transformers, among other complications, need to be resolved before this type of system can be installed on a large scale.[ii]



Experimental 66 kV Wind Farm in Japan

Additional studies are being conducted at a variety of sites around the world to determine the viability of higher voltage technologies. In fact, the world's first 66 kV floating power sub-station system was installed in 2012 off the coast of Fukushima in an experimental project that includes three floating wind turbines. In the second stage of the project, two 7 MW wind turbines will be added. The experiment is part of the

Japanese government's attempt to create employment and develop new renewable energy systems that will aid in the recovery of the region in the wake of the earthquake. Their hope is that they can develop a scheme that can be repeated throughout the region on a large scale to help power the country in the future and lead in the development of the Japanese wind turbine export industry. Results of the study have yet to be released, though there are many who believe this will prove to be a winning technology.[iii]

Intelligent Pitch Systems for Greater Efficiency and Reliability

Transitioning to higher voltage systems is not the only method for improving the power output of a given wind farm. As turbine size increases, so does their susceptibility to the potential destruction of stochastic wind loads. Intelligent pitch controls have been one of the main tools employed by turbine designers in recent years to control each individual rotor blade and achieve higher system reliability, precision, and durability. Most turbine manufacturers today are developing their own intelligent pitch systems to provide more precise control to individual blades for better efficiency, increased safety, and reductions in turbine damage.

Consider Siemen's new High Wind Ride Through application. It's an innovative way for wind turbines to continue operating even in storm-level wind speeds while providing stabilized energy output. Most wind turbines shut down at wind speeds higher than 25 metres per second to avoid overload due to extreme loads. With the High Wind Ride Through technology, a turbine slowly reduces power output resulting in a more stable output overall. This is accomplished with intelligent pitch systems. As soon as the rated power output is reached, the system intelligently pitches the blades out of the wind to limit rotational speed in proportion to the increase in wind speed.[iv]

Rather than stopping the wind turbine abruptly, this type of system allows for continued energy production which increases a turbine's overall production time and profitability. Additionally, by creating a more even output of energy, the turbine is also more grid-friendly because of the predictability of the energy produced. This is increasingly important as grid compliance regulations push for more even energy input. Not only that, but wear and tear on the turbine is reduced due to fewer stops with this type of intelligent pitch control.

Bosch Rexroth has developed their own E-Pitch system which provides increased safety and reliability for their turbines. This intelligent pitch management system allows emergency rotor movement during an inverter failure, even with less expensive AC motors. The E-Pitch system can be configured as required to control the speed of the emergency rotor movement. Additionally, the intelligent networking of the electronics in these turbines makes it possible for an intact inverter to assume responsibility for the functions of the failed inverter to drive the axle. [v] They call this their three-phase current solution, which improves safety and decreases turbine costs, while achieving better emergency operation and reliability.[vi]

Bosch Rexroth Intelligent Pitch Control Systems

They also have developed a Hydraulic Pitch adjustment system which allows for emergency rotor movement during a power outage.[vii] Another innovation, their BLADEcontrol system, detects ice formation directly on the rotor blade, which gives wind farm managers more visibility on the condition of the blades in order to take maintenance action if necessary to keep the turbines functioning at peak efficiency.[viii]

Most intelligent pitch controls rely on sensors built directly into the turbine. But in a recent study by researchers in Texas, engineers tested whether a remote wind sensor (LIDAR) could provide data that would make intelligent pitch control even more precise and effective. Their hope is to develop a histogram based on the data collected from a remote source - such as load amplitudes and fatigue damage as a function of mean wind speeds and turbulence. Using this data, a turbine could make better pitch decisions.

For instance, if the predicted damage by incoming wind is higher than a predetermined level, the intelligent controls could make discrete pitch decisions proportional to the magnitude, structure, and size of turbulence. The same data could also be used to predict the potential increase in fatigue life and total energy output, giving the enhanced intelligent pitch controls an economic advantage over current systems, assuming the additional cost of installing a remote sensor could be justified.[ix]

This isn't the only remotely-operated system being used by turbine manufacturers to achieve greater blade control. Another recent development is Moog's Remote Terminal Software which allows wind farm operators and turbine manufacturers to provide greater control of pitch systems using a single graphical user interface (GUI). This Remote Terminal Software makes it possible to remotely diagnose potential operational issues, take corrective actions, and maintain awareness of the pitch-control system along with other important control information. By providing an early diagnosis of potential issues, operators can avoid and reduce turbine downtime and prevent catastrophic damage.[x] This is an especially important tool for remotely-located turbines, including those in deep offshore environments.

Innovations Continue to Push Wind Industry Toward Grid Parity

The integration of high-tech software and sensors into today's wind turbines holds a lot of potential for vastly improving the performance of these systems, while increasing their safety and limiting damage from maintenance neglect or extremely high wind speeds. This type of technology, as well as the promise of achieving greater efficiency through higher voltage systems, as well as other innovations in turbine design and management, continue to push the wind industry toward greater cost-effectiveness and the holy grail – grid parity.

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