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Electric Innovations in Wind Power Transformers, Converters, and More

A wind farm is nothing without the electrical systems that form its backbone. But conventional technology is undergoing a lot of changes in light of the new demands placed on it by power from the wind sector. The following is a brief survey of some of the most recent developments.

More Rugged, Adaptable Transformers for Safer Wind Energy Production

Wind farms rely on transformers to transfer clean energy into the grid, and in light of the cost restrictions demanded by the wind sector, power companies are looking to a variety of solutions to provide efficient transformation of energy at a lower cost than ever before. ABB is one of those companies looking into new solutions. Their 500 kilovolt gas-insulated Station Service Voltage Transformer "TIP" was installed in El Centro California. Though their solution was only rated up to 420 kV with outputs up to 600 V, the site needed 525 kV product and output of 333 kVA. They solved this problem with a compact transformer system that would also pass seismic shock tests for the region.[i]

Image Via Flickr: PincasPhoto

Likewise, CG Global has developed two new transformers – their SLIM and Bio-SLIM – that address several of the current challenges in the wind industry. These transformers are hermetically sealed with biodegradable fluid (to reduce contamination risks with spills in sensitive environments). The company touts their technology as highly reliable, fire safe, low maintenance, and long living – durable even in very harsh environments. As such, it provides good installation and maintenance cost savings. CG was recently awarded the Germanischer Lloyd Renewables Certification (GL RC) for its liquid immersed SLIM and Bio-SLIM distribution transformers. The award recognized the two technologies as the most efficient solutions for offshore wind farm platforms. The Bio-SLIM in particular was also awarded for being the most advanced environmentally friendly transformer.[ii]

Modulating Converters for Greater Energy Transformation

A high performance converter has significant impacts throughout a wind farm system, but especially on the generator design requirements. Improving the performance of a converter can have benefits such as simplifying insulation systems and cooling system requirements as well as improving efficiency. As such, many manufacturers are looking into better converter technology to provide cascading benefits within a wind array.

A three year joint project in Germany has produced a power converter system that is said to be both highly cost effective and high efficiency. Called the "more efficient use of regenerative energies with multi-level topologies" or EEMT project , the research project is backed by the German Federal Ministry of Education and Research (BMBF) and part of the Power Electronics for Improved Energy Efficiency Initiative. The aim of the project was to design an inverter system with a new modular phase component design that would integrate into a power converter by PCS.

Image Via Flickr: Peat Bakke

At first, the project was focused on improving the efficiency of wind turbines by examining driver circuitry and protective components. The finished design is able to efficiently and inexpensively convert electrical energy generated by wind turbines to supply the power network. They're designed with intelligent three-point phase components, which are equipped with three-level IGBT modules. Communication between the phase components happens through a decentralized modulator which allows for plug and play integration into traditional conversion systems. Further, all components – from the central controller to the decentralized phase components - are all synchronized through a serial high speed EtherCAT data bus connection. [iii]

Instead of using conventional technology which relies on electrical filter switches to meet minimum feed-in quality requirements – a process that results in high energy losses – the new converters use multi-level topology that results in significant reduction in the need for filter switches. As a result, energy losses are also reduced. [iv]

Boulder Wind Power (BWP) has also been working on a modular power converter that is promising high performance and low cost for wind applications. Using their proprietary power converter technology, the converter is able to improve quality of the voltage and current waveforms while reducing damaging voltage stresses as well.

Because it is modular, it is also highly reconfigurable, which means it can be used with the same basic software and hardware as a conventional system regardless of power rating. This also means that the requirements for spare parts inventory go down while increasing the ability to provide upgrade kits that help to extend the life of existing units as technologies develop and change. Together, these features make this modular converter option a highly affordable one. Further, the BWP system can be serviced quickly and easily in the field to further reduce maintenance costs.[v]

Better Pitch Control Systems for Wind Turbine Blades

As a necessary component of any modern wind turbine system, the pitch control is essential for protecting the turbine by adjusting the angle of the blade to halt rotations when necessary. Conventionally this type of system relies either on batteries or ultracapacitors to power their functioning, though batteries have traditionally received more attention and are more popular.

However, in recent months the ultracapacitor technology is gaining ground in the wind industry as advancements in the technology are made. They offer the advantage of being able to function in extreme temperature conditions (unlike batteries) while also providing a big burst of power when needed in short order.

What's more, because they are relatively simple devices – they do not require charging or monitoring systems – they are a lot easier to manage over the life of the turbine. And because they're made of materials like carbon and aluminum, they're lightweight and when they need to be replaced, it's a quick job that's also a lot cheaper than replacing batteries, allowing for very little downtime.[vi]

The good news is that ultracapacitors, which were previously too expensive to be feasible, have come down in cost in recent years thanks to the volume being purchased. They're also cheaper as a result of better manufacturing techniques. As such, these devices now offer wind developers an alternative to batteries that may prove to be highly cost-effective.

Another innovator in the area of pitch control for wind turbines is Moog. Their AC Pitch Servo technology use significantly less complex and more compact modular AC architecture than previous designs. What's new in this design is the fact that it includes a more ruggedized motion control system as well as a remote terminal software system. The motion control system can be used in extreme temperatures

ranging from -40 to 70°C and can withstand shock, vibration, and humidity so that it can be used in almost any environment. The remote terminal software provides maintenance scheduling and monitoring services that increase the availability and reliability of the pitch control systems.[vii]

The US's NREL is also working on a variable speed pitch control system which incorporates adaptive torque gain control. Using power measurements taken over a period of time, it works while the turbine is operating, allowing for real time modifications to the pitch of one or more blades in continuous increments. Adjustments can be made until the optimal pitch and power production are achieved, which in the end results in more power generated in lower wind speeds.[viii]

Future Wind Electrical Systems to Receive Greater Testing

The wind power industry will continue to push the boundaries of the electrical systems they rely on. And to ensure these new systems meet safety and environmental standards, new testing facilities are being developed. One such facility – the Offshore Wind Infrastructure Application Lab (OWI-Lab) built by Sirris in the Port of Antwerp – has created a climatic chamber that will be the testing laboratory for stress tests on wind turbine components. The only one of its kind in Europe, OWI-Lab can adjust temperatures between -60°C to +60°C and can handle components weighing up to 150 tonnes. It will no doubt prove to be an invaluable tool for the electrical side of wind energy as new innovations are developed.

The test facility, which is a joint venture between 3E, ZF Wind Power Antwerpen NV, CG, DEME and GeoSea, along with Agoria (Belgium's federation for the technology industry), the innovation platform Generaties, Sirris and the Vrije Universiteit Brussel (VUB), has already put to the test various electrical components. It is capable of conducting between 30 and 40 series of tests annually.[ix]

As Dr. Jan Declercq, CTO of CG, recently commented, "Our customers need transformers that will operate without any problems at all times, even under extreme climatic conditions. Accordingly, it's crucial that we test at -30°C and from cold start to full capacity in a short time. Maintaining offshore wind turbines is no easy task and requires more work."

Maryruth Belsey Priebe

Maryruth can't help but seek out the keys to environmental sustainability - it's the fire that gets her leaping out of bed every day. With green writing interests that range from sustainable business practices to net-zero building designs,

environmental health to cleantech, and green lifestyle choices to social entrepreneurism, Maryruth has been exploring and writing about earth-matters and ethics for over a decade. You can learn more about Maryruth's work on JadeCreative.com.

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