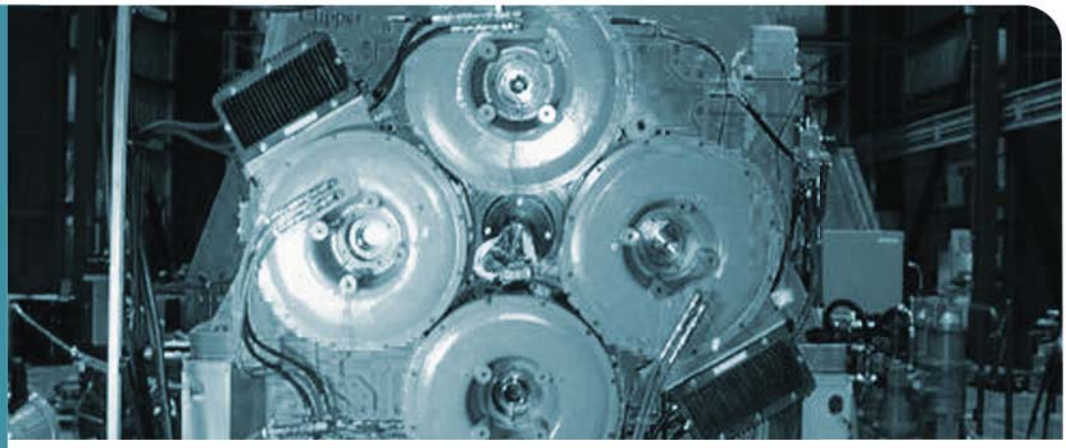
AWEA Wind Power
Value Chain



Electrical Components for the Wind Industry

To achieve 20% electricity from wind in the US, the industry would require a major scale-up in annual wind power installations. This installation rate would need to gradually increase from around 8,300 megawatts (MW) in 2008 to more than 16,000 MW of new wind capacity each year by 2018, and continue at roughly that rate through 2030. The job of converting wind into mechanical, and mechanical into electrical, energy poses substantial challenges on a large scale. A single modern utility-scale wind turbine capable of producing between 1 and 3 MW of power is a sophisticated, highly-precise machine with extreme requirements for temperature, humidity, weight, mechanical stress and vibration.

This document provides an overview of supply chain status for electrical components and the role of suppliers / sub-suppliers to provide such components and services to the wind energy industry.

Electrical Components Needs in the Wind Energy Industry

- Generators are low on the priority list where currently supply is meeting demand
- Lead times are shorter than other constrained components
- There are industry concerns about meeting future increases in demand
- Parasitic losses in generator windings, power electronics, and other electrical devices, as well as in gears and bearings, are individually quite small but add up to significant numbers when summed over the entire system. Improvements that remove or reduce even small fixed losses during low power generation are likely to have an important impact on raising capacity factor and reducing cost across multiple, utility-scale turbines.
- Medium- and low-speed generators are being sought
- Permanent, rare-earth magnet designs are in demand to reduce size/weight and reduce problems with winding degradations. Raw materials (rare-earth magnets) are of short supply in the US.
- Rare-earth magnets can degrade when subjected to high temperatures.

Recent Installations Numbers for the Wind Energy Industry

Megawatts of wind power installed in 2006:
2,454 megawatts
(1,535 turbines)

Megawatts of wind power installed in 2007:
5,249 megawatts
(3,190 turbines)

Megawatts of wind power installed in 2008:
8,300 megawatts
(5,000 turbines)

Estimated megawatts of wind power to be installed in 2009:
Over 5,000 megawatts
(3,000 turbines)

American Wind Energy Association®

At present, gearbox reliability is a major issue and the high cost of gearbox replacement is a major expense. One solution is a direct-drive power train that entirely eliminates the gearbox. This approach was successfully adopted long ago by Enercon and is being examined by other turbine manufacturers. A less radical alternative reduces the number of stages in the gearbox from three to two or even one, which enhances reliability by reducing the parts count. These improvements could include innovative power-electronic architectures and large-scale use of permanent-magnet generators. Direct-drive systems also meet this goal by eliminating gear losses. Modular (transportable) and maintenance-friendly versions of these large generation systems will go a long way in making the low-wind portion of the power curve much more productive.

Some studies have identified generators as one of three top component supply bottlenecks, although interviews with experts show that they are a distant third to bearings and gearboxes. Other studies were less concerned about generator supply.

The use of rare-earth permanent magnets in generator rotors instead of wound rotors also has several advantages. High energy density eliminates much of the weight associated with copper windings, eliminates problems associated with insulation degradation and shorting, and reduces electrical losses. However, rare-earth magnets cannot be subjected to elevated temperatures without permanently degrading magnetic field strength, which imposes corresponding demands on generator cooling reliability. Availability of rare-earth permanent magnets is a potential concern because key raw materials are not available in significant quantities within the United States.

Power electronics have already achieved elevated performance and reliability levels, but opportunities for significant improvement remain. New silicon carbide devices entering the market could allow operation at higher temperature and higher frequency, while providing greater reliability and/or lower cost. New circuit topologies could furnish better control of power quality, enable utilization of higher voltages, and increase overall converter efficiency.

As competition for generators increases worldwide, lead times and costs have increased. Supply for raw materials needed for generators – copper and laminate steel and castings – has also become tighter.

However, the fact that generators are top-of-mind for industry executives indicates that there is concern about generator manufacturers' ability and willingness to meet demand in the future.

The industry appears well supplied with generators with a good level of in-house capacity and, in addition, supply from several large industrial players including ABB and Siemens. Also, the lead time for new capacity is far shorter than anywhere else in the supply chain.