Large superconducting wind turbine generators

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Topic: New turbine and generator technology

To realize large (>10 MW) direct-driven offshore wind turbines, a number of steps are needed to reduce weight, volume and cost compared to standard technologies. One of these steps can be to introduce superconductor materials, carrying high current densities, in the generator to achieve a compact and light-weighted construction. In this paper we discuss the basics for superconductor generator technology and state-of-the-art of superconductor wire material options, as well as some challenges for the superconductor industry to overcome. Only the rotor carrying a DC current is replaced with superconductor materials. Analytical calculations and FEM-based simulations are used to set the governing superconductor generator conditions. A 5 MW superconducting wind turbine generator forms the basics for the feasibility considerations, defining requirements on performance and costs of superconducting wires, particularly for the YBCO and MgB_2 superconductors currently entering the commercial market. Initial results indicate that a 5 MW generator with an active weight of 34 tons, diameter of 4.2 m and length of 1.5 m can be realized using superconductors carrying 300 A/mm^2 in a magnetic field of 4 T. This is a significant weight reduction compared to conventional drive train solutions. The results are compared to the performance of available superconductors, as well as the near future forecasted performance.

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