Superconducting Generators for Large Wind Turbine: Design Trade-off and Challenges

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Abstract - As the wind power generation industry goes towards more off-shore wind farms, larger turbines generating 10 MW or more are needed to keep the cost of electricity competitive. Such large turbines located in remote areas must exhibit outstanding reliability in order to limit the cost of maintenance and therefore should not rely on gearboxes. Because of the poor scaling of conventional direct drive generators, they cannot be deployed cost effectively in large power turbines leaving superconducting generators as the only viable option. Using a superconducting generator in a direct drive 10 MW wind turbine can reduce the mass of the nacelle by a 2 to 4-fold compared to state-of-the art permanent magnet generators, depending on the type of generator configuration. Wind generators represent an ideal application for superconducting machines; the very large torques and low speed taking full advantage of their unmatched specific torque scaling. However, some critical technological trade-offs need to be performed in order to obtain a reliable and cost-effective system. This paper presents a review of the ongoing superconducting generators for large wind turbine development efforts and gives an overview of the major design challenges including the choice of generator topology, conductor and associated cryocooling system. The different trade-offs related to technological choices, engineering and cost are also discussed.

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