Review of Superconducting Generator Topologies for Direct-Drive Wind Turbines

Ronghai Qu, *Senior Member, IEEE,* Yingzhen Liu, and Jin Wang

Abstract—Wind energy, as a clean and renewable energy, is now being widely developed to reduce the production of carbon dioxide from fossil fuels and mitigate the energy crisis. The urgent needs for wind energy motivate larger generators with lower cost, lower weight, and higher reliability. The most popular solution is the direct-drive generator concept, Permanent Magnet Generator (PMG) or superconducting (SC) generator. When referring to weight, volume, and cost, SC generators are superior to PMGs for wind turbines larger than 8 MW according to the report from the American National Renewable Energy Laboratory [1]. In order to find out the most suitable topology for megawatt-class direct-drive wind turbine generators, various designs of SC machines in literatures are carefully reviewed and advantages and disadvantages are concluded. Also promising ways to benefit from their advantages are also included. Electromagnetic, mechanical and thermotic structures, including excitation system, SC support system, cryogenic cooling system etc., are crucial for SC machines applied in wind markets. Therefore, design challenges and possible solutions are also proposed in this paper to guide designers in large wind turbine generators.

Keywords - Superconducting generator, direct-drive wind turbine, electromagnetic topology, cryogenic cooling system

IEEE/CSC & ESAS European Superconductivity News Forum (ESNF) No. 23 January 2013; Category 6.
The published version of this preprint appeared in *IEEE Transactions on Applied Superconductivity* 23, 5201108 (June 2013).