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Thu-Mo-Or18-03: Dual Superconducting Halbach Array Generator for large Direct Drive Wind Turbines

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The development of off-shore wind farms will need to rely on large turbines, ideally over 10 MW, to be economically viable. Therefore, there is a need for cost effective and very reliable drive trains for large wind turbines. The first step in increasing reliability is to not use gearboxes and connect the generator directly to the turbine rotor. The very large torque required leads to very large conventional generators (usually permanent magnet generators) and the only viable option is to use high specific torque, low RPM superconducting machines. We propose a direct-drive wind turbine generator based on a non-conventional assembly of small superconducting dipole magnets assembled to focus the excitation field in a copper wound stator. The generator is based on a Dual Superconducting Halbach Array Rotor and resistive stator. The Halbach array configuration allows for the field to be intrinsically contained within the machine without the need for iron laminations thus reducing the mass to a minimum. The rotor is composed of identical individual superconducting dipole magnets based on the Double Helix configuration leading to perfect dipole fields and ideal mechanical stability. The individual, mass produced, dipole magnets are wound with very high performance REBCO tapes with no insulation allowing for stellar stability and low sensitivity to thermal transients. The stator is composed of air- or water-cooled copper conductors supported by high thermal conductivity 3D printed substrates allowing for direct cooling. The proposed generator technology is applicable to both on- and off-shore wind turbines and is scalable beyond 10 MW with excitation magnetic field of 3-5 T. The generator is composed of standardized mass-produced components that can be assembled on site which leads to an overall cost reduction. The paper deals on the first phase of the project and includes the design and optimization of a 10 MW direct drive generator based on a novel and innovative configuration and its impact on the levelized cost of energy.

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