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Thu-Mo-Po4.08-07 [59]: Electromagnetic design of tens MW-class fully-superconducting wind power generators with high-performance REBa2Cu3Oy wires

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Fully-superconducting generators with compactness and lightweight are promising candidates for direct-drive multi-mega-watt offshore wind turbines due to its high current density properties. The compactness and lightweight design should bring about the cost reduction of nacelles, towers and foundations. Furthermore, high-performance REBa2Cu3Oy (REBCO: RE = rare earth) tapes and the reduction method of AC losses which our research group have developed should contribute to realize tens MW-class fully superconducting wind power generators. The developed REBCO tapes have a large critical current in high magnetic fields at a wide range of operating temperatures (20-77 K), which leads to the reduction of wire length and cost. The high-performance REBCO tapes also makes it possible to operate the superconducting windings at a high temperature of 65 K via subcooled-liquid nitrogen. It also brings about high stability of the system due to its high specific heat. The objective of this study is to study the feasibility of large-capacity over 10 MW wind power generators employing the high-performance REBCO windings both on rotor and stator in the view point of cost, weight and efficiency. 10-20 MW fully-superconducting synchronous generators are designed using finite element analysis. 15 MW-class generators with 32 poles, an operating temperature of 40 K and magnetic flux density at the gap of 2 T were designed. The electrical weight of this model is below 100 tons which is much lighter than that of a conventional synchronous generator (300-400 ton).

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