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# Advances in Wind Power Generation, Transmission, and Simulation Technology

Wind is an increasingly important piece of electricity generation portfolios worldwide. This dissertation describes advances related to the electromechanical energy conversion system of wind turbines, and the electric transmission system for offshore wind power plants. The contributions of this work are the following: (i) We propose that the power electronics topology commonly called the “Vienna rectifier” can be used for improved variable-speed wind energy conversion. Theoretical analysis is conducted to show how a Vienna rectifier could drive either a squirrel-cage induction generator or a permanent-magnet synchronous generator-based wind turbine. Computer simulations and experimental results demonstrate the feasibility of the proposed topology and potential improvements in energy conversion efficiency. (ii) We propose a novel low-frequency ac (LFAC) transmission system for offshore wind power plants. A system design and control method is set forth, and key system operational characteristics are illustrated via computer simulations. The LFAC system constitutes a promising option for medium- or long-distance transmission, and could be an alternative to high-voltage dc (HVDC) transmission. (iii) We develop a technique that utilizes a field programmable gate array (FPGA) as a dynamic simulation platform for wind turbines. A doubly fed induction generator-based wind turbine simulation is implemented on an FPGA board, in order to verify the effectiveness and performance advantage of this approach.