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Commentary

Advances in Wind Energy Conversion Systems and their Major Components

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DESCRIPTION

A Wind Energy Conversion System (WECS) uses wind energy to generate mechanical energy, which is then transferred to an electrical generator to generate electricity. Wind turbine generators can be Permanent Magnet Synchronous Generators (PMSG), doubly fed induction generators, induction generators, synchronous generators, and so on. Wind energy from the wind turbine is transferred to the generator. A pulse width modulation converter controls the rotating speed of the generator to extract the most power from the WECS. The generator's output electricity is fed into the grid *via* a generator-side converter and a grid-side inverter.

There is a growing interest among both the industrial and scientific sectors in creating green technology in general, and renewable energy in particular, in order to contribute to sustainable development. The use of renewable energy has been hampered by a lack of understanding that enables for efficient gathering and storing of clean energy. As a result, there is a critical need for education for sustainable development with a trans disciplinary perspective that integrates technological, economic, social, and environmental components while understanding their interdependence.

A typical wind energy conversion system consists of a wind turbine, an electric generator, connecting interfaces, and control systems. In some applications, a gearbox is used to match the rotation speed of the wind turbine to the characteristics of the generator, so optimizing the captured energy.

The wind turbine collects wind energy and converts it into mechanical rotation, supplying torque, rotation speed, and mechanical power to the electric generator. Currently, synchronous generators, permanent magnet synchronous generators, and induction generators, including squirrel-cage and wound rotor types, are employed in wind energy conversion systems.

Permanent magnet generators and squirrel-cage induction generators are frequently employed in small to medium power wind turbines due to their dependability and low cost. Currently, induction generators, permanent magnet synchronous generators, and wound field synchronous generators are used in a variety of high power wind turbines. Connectivity equipment such as power electronic converters is used to achieve power control, soft start, and interconnection operations.

Since the load is such a significant factor, there are two major consumer scenarios that influence the power electronic converter layout and control strategy: insulated customers and grid linked consumers. The Control Unit (CU) directs the power electronic converter to assure the desired parameters for the delivered electric energy. A good control approach can result in the most energy being harvested. Obviously, the CU requires access to system variables such as voltage, frequency, and current provided by the generator. Taking into account additional information (such as wind speed, customer behaviour, and so on) can improve overall WECS efficiency and reliability through a more complicated control method. In some cases, the CU can even adjust the geometry and mechanical characteristics of the wind turbine.

The primary benefit is system flexibility; the number of wind turbine types, with or without gearboxes, that can be executed and tested using the emulator is virtually limitless; the only limitation is expertise of a good mathematical equation combined with the features of the used asynchronous motor. Furthermore, turbines can be simulated using real-time sampled data obtained from current turbines. As a result, there is no need to invest money on costly wind turbines or aerodynamic tunnel experiments. A wide range of environmental conditions, both typical wind conditions and unusual situations (wind gust or strong fluctuating wind), can be simulated, as can any transient regime or successive steady-state regimes. Not to mention the ability to test various control loops, power converters, storage devices, and electrical loads in real time.

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