Control Strategy of Wind Turbine Based on Permanent Magnet Synchronous Generator and Energy Storage for Stand-Alone Systems

Introduction:

Wind turbine technology has being undergoing a dramatic development and is now the world’s fastest growing energy. With large-scale exploration and integration of wind sources, variable speed wind turbine (VSWT) generator systems have become more popular than that of fixed speed. Recently, the permanent magnet synchronous generator (PMSG) has received much attention in wind-energy application. The use of PM in the rotor of the PMSG makes it unnecessary to supply magnetizing current.

Hence, for the same output, the PMSG will operate at a higher power factor because of the absence of the magnetizing current and will be more efficient than other machines. The multi-pole PMSG also improves significantly the reliability of the variable speed wind turbine by using a direct-drive train system instead of the gearbox, which also results in low cost.

Existing system:

In normal grid-connected operation with the aforementioned full-scale power converter structure when wind power is a relatively small portion of a strong grid, the grid-side converter is used to regulate the DC-link voltage while the generator-side converter regulates the generator to achieve the desired power transfer novel
control strategy for a variable-speed wind turbine with a PMSG in a stand-alone system, where the load-side inverter is used to regulate the DC-link voltage, output voltage, and frequency.

The generator side converter is adopted to track the optimal energy from the wind. Here, the excess power during fault or over generation is dissipated by the dump-resistor and stored by the energy storage system. It means that the dump-resistor would continuously work in the standalone system if the load power is less than the optimal power and the energy storage system is full, which may be not practical.

Dis-advantages:

- Dump-resistor would continuously work in the standalone system if the load power is less than the optimal Power and the energy storage system is full.

- Less efficiency.

Proposed system:

A novel control strategy for this stand-alone wind turbine system is proposed. The load-side converter is controlled using vector control scheme to maintain the amplitude and frequency of the converter output voltage. The ESS has the bidirectional power control ability, which is used to keep the DC-link voltage of the full-scale power converter constant. At the same time, the generator side converter operates together with the ESS to support the loads.

The variable speed wind turbine with the proposed control strategy is suitable for a small-scale stand-alone generation system installation for remote-area power supply. The ESS here is only considered as BESS which has the bi-directional power control ability. It is used to keep the DC-link voltage $V_{dc}$ of the power
converter constant. The BESS has the ability to provide or absorb power in the DC link of the full-scale power converter.

**Advantages:**
- High efficiency,
- Zero or low emission of pollutant gases,
- And flexible modular structure.

**Applications:**
- Small-scale stand-alone generation system.

**Block Diagram:**

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Wind Turbine -> Generator side converter -> Dc link capacitor -> Grid side converter -> Load

12VDC -> Gate driver circuit

5VDC -> Buffer circuit

Microcontroller circuit
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