Extremum Power Seeking Control of A Hybrid Wind-Solar-Storage DC Power System

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Recently, there have been concerns on global climate deterioration and its related harmful effect such as environmental pollution and sustainable development problems. As a solution, clean renewable resources have been given increasing interest. Compared with other new energy technologies, wind and solar have been set up as proven future sources of energy because of their environment-friendly, abundant and cost-effective utilization characteristics. Harnessing these two energies for electric power generation is the area of aiming at quality and reliability in the electricity delivery. However, there are some difficulties associated with wind and solar in power system, e.g. intermittency of wind or solar and instability of the load. Accordingly, photovoltaic (PV) arrays, wind turbines and batteries are used to feed a dc or ac bus connected to the load, as well as the utility grid, constituting the so-called micro-grid. Micro-grids operate in both standalone and grid connected modes. The wind and solar sources can compensate each other and their simultaneous intermittency is complemented by the use of an energy storage device.

This research presents a combined power system with a common dc bus which contains solar power, wind power, battery storage and a constant dc load (CDL). In wind system, the AC-DC rectifier is controlled by a maximum power point tracker (MPPT) at first stage and the voltage regulation is accomplished through a boost converter by utilizing an adaptive voltage controller. In the solar system, two cascaded boost converters are controlled through a sliding mode controller (SMC) to regulate the power flow to the load. A supervisory control strategy is also introduced to maximize the simultaneous energy harvesting from both renewable sources and balance the energy between the sources, battery and the load. According to the level of power generation available at each renewable energy source and the state of charge in the battery, the controller results in four contingencies. Simulation results show accurate operation of the supervisory controller and functionality of the maximum power point tracking algorithm for solar and for wind power.

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