

Development and Control of a High Efficiency Small Vertical-Axis Wind Turbine

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Abstract

Increase the power efficiency of a small vertical-axis wind turbine (VAWT) that can promote its competitiveness by comparison to a small horizontal-axis wind turbine (HAWT). The power efficiency of the wind turbines depends on the power coefficient of the windmill, the efficiency of the generator, the loss of the control circuits, and the algorithm of the optimal control. A good windmill constructed by composite material has an airfoil with a high lift coefficient to increase the power of the wind turbine. Besides, a generator having two windings keeps high efficiency at a lot of rotational speeds. To maximize the electricity output of the wind turbine system, this study used a straight wing vertical-axis windmill having the airfoils NACA3418 and NACA0018 and directly coupled a permanent-magnet synchronous generator having 1kW winding and 3kW winding with the windmill as a 4kW wind turbine system. Meanwhile, a back to back converter controls the operation of the generator. A maximum power point tracking adapts the windmill so that it gives its best performance. The average efficiency of the wind turbine system is 0.316 through field tests. The results demonstrate that the 4kW small VAWT system is not inferior to the small HAWT.

Keywords: wind power, straight wing VAWT, permanent-magnet synchronous generator, back-to-back converter, MPPT