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Performance Estimation of Small Scale Wind Turbine Rotor for Very Low Wind Regime Condition

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Abstract : Rapid development experienced by India requires huge amount of energy. Actual supply capacity additions have been consistently lower than the targets set by the government. According to World Bank 40% of residences are without electricity. In 12th five year plan 30 GW grid interactive renewable capacity is planned in which 17 GW is Wind, 10 GW is from solar and 2.1 GW from small hydro project, and rest is compensated by bio gas. Renewable energy (RE) and energy efficiency (EE) meet not only the environmental and energy security objectives, but also can play a crucial role in reducing chronic power shortages. In remote areas or areas with a weak grid, wind energy can be used for charging batteries or can be combined with a diesel engine to save fuel whenever wind is available. India according to IEC 61400-1 belongs to class IV Wind Condition; it is not possible to set up wind turbine in large scale at every place. So, the best choice is to go for small scale wind turbine at lower height which will have good annual energy production (AEP). Based on the wind characteristic available at MANIT Bhopal, rotor for small scale wind turbine is designed. Various Aero foil data is reviewed for selection of airfoil in the Blade Profile. Airfoil suited of Low wind conditions i.e. at low Reynold's number is selected based on Coefficient of Lift, Drag and angle of attack. For designing of the rotor blade, standard Blade Element Momentum (BEM) Theory is implanted. Performance of the Blade is estimated using BEM theory in which axial induction factor and angular induction factor is optimized using iterative technique. Rotor performance is estimated for particular designed blade specifically for low wind Conditions. Power production of rotor is determined at different wind speeds for particular pitch angle of the blade. At pitch 15o and velocity 5 m/sec gives good cut in speed of 2 m/sec and power produced is around 350 Watts. Tip speed of the Blade is considered as 6.5 for which Coefficient of Performance of the rotor is calculated 0.35, which is good acceptable value for Small scale Wind turbine. Simple Load Model (SLM, IEC 61400-2) is also discussed to improve the structural strength of the rotor. In SLM, Edge wise Moment and Flap Wise moment is considered which cause bending stress at the root of the blade. Various Load case mentioned in the IEC 61400-2 is calculated and checked for the partial safety factor of the wind turbine blade.

Keywords : annual energy production, Blade Element Momentum Theory, low wind Conditions, selection of airfoil
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