

Effect of Wind Lens on Small Wind Turbines under Low Wind Speed Conditions

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This research focuses on the suitability of using wind lens arrangement in order to improve the power output of a small wind turbine, which operates under low wind speed conditions. The present initiative was inspired by a certain need emanated to integrate wind power so as to power up milk cooling systems in a rural milk framing industry in Sri Lanka. As a result, it was estimated to integrate a 2 kW wind turbine having nearly a 4 m diameter rotor to form a hybrid system with solar photovoltaics system. The average wind velocities in areas where the most of milk farmers are located is about 5 m/s, thus utilizing commercially available wind turbines which are typically designed to operate at higher speeds than 5 m/s or exceeding the size of the turbine to capture the required level of power (2 kW in this case) is not possible. Therefore, this work investigated the use of wind lens arrangements to enhance the effective wind velocity thus the power output. Initially, a 3D model of wind blades consisted with NACA2412 airfoils was designed using available design methodologies. Then, aerodynamic simulations of wind blades were performed using ANSYS CFX computational fluid dynamics software and applying the $k-\omega$ SST turbulence model. The simulation procedure was then validated using previously tested and published data for a similar kind of small wind turbine study. Finally, by extending the simulation model with added wind lens arrangements, it was found that the adaptation of wind lens enhances the peak power by 50% compared to a normal wind turbine. Modifications in the blade design as claimed by the new impact velocities of wind on the turbine blades believed to alter the power output will be analyzed in the next phase of the research.

Key words: wind lens, wind blade, computational fluid dynamics, $k-\omega$ SST turbulence model.