Design and testing of a novel building integrated cross axis wind turbine

Abstract

The prospect of harnessing wind energy in urban areas is not promising owing to low wind speeds and the turbulence caused by surrounding obstacles. However, these challenges can be overcome through an improved design of wind turbine that can operate efficiently in an urban environment. This paper presents a novel design of a building integrated cross axis wind turbine (CAWT) that can operate under dual wind direction, i.e., horizontal wind and vertical wind from the bottom of the turbine. The CAWT consists of six horizontal blades and three vertical blades for enhancing its self-starting behavior and overall performance. The study employed a mock-up building model with gable rooftop where both of the developed CAWT and the conventional straight-bladed vertical axis wind turbine (VAWT) are mounted and tested on the rooftop. The height of the CAWT and the VAWT above the rooftop was varied from 100 to 250 mm under the same experimental conditions. The results obtained from the experimental study showed that there is significant improvement in the coefficient of power (C_p) and self-starting behavior of the building integrated CAWT compared to the straight-bladed VAWT. At 100 mm height, the $C_{p,max}$ value of the CAWT increased by 266%, i.e., from 0.0345 to 0.1263, at tip speed ratio (TSR) (λ) of 1.1 and at wind speed of 4.5 m/s. Similar improvements in performance are also observed for all condition of CAWT heights above the rooftop where the CAWT outperformed the straight-bladed VAWT by 196%, 136% and 71% at TSR of 1.16, 1.08, and 1.12 for Y = 150, 200, and 250 mm, respectively. Moreover, the CAWT performs better at 10° pitch angle of the horizontal blade compared to other pitch angles.