Title: **Innovative Wind Turbine Design for Offshore Application**

Abstract

The novel cross-axis-wind-turbine (CAWT) that complements the horizontal-axis-wind-turbine (HAWT) and vertical-axis-wind-turbine (VAWT) is designed to extract maximum wind energy from both the horizontal and vertical wind streams. The CAWT consists of three vertical blades and six horizontal blades arranged in a cross-axis orientation. The CAWT is integrated with an innovative omni-directional deflector. The on-coming horizontal wind can be harvested by the vertical blades while the deflected vertical air stream can be harvested by the horizontal blades of the CAWT. This ensures higher torque and better performance across varying wind directions. The proposed CAWT can float on the water surface through its platform (deflector with guide-vanes assembly) serving as a buoy. The heavy components of the CAWT are mounted at the platform base, hence lower centre of gravity can be attained compared to HAWT. It also provides easier accessibility for inspection and maintenance works, and it has better stability especially during rough sea profiles in bad weather. The CAWT power extraction and start-up performance is expected to out-perform the VAWT due to the higher torque is available from the guided wind produced by the omni-directional deflector. The computational simulation and wind tunnel testing showed that the CAWT model can achieve the power coefficient, C_P of 46% at the tip-speed-ration = 3 (0.36 from vertical-blades and 0.11 from horizontal blades). The CAWT boasts a C_P greater than 0.4 (typical HAWT Cp around 0.45 and typical VAWT Cp around 0.35). Compared to conventional VAWT (Darrieus rotor), at TSR = 3; the average rotor power coefficient, C_P is only 0.22. The CAWT can self-start at wind speeds as low as 2.8 m/s, a feature that sets it apart from many competitors (typical HAWT cut in wind speed at 4.0 m/s). This adaptability allows the CAWT to operate in regions with lower average wind speeds, thereby diversifying its applicability and revenue sources. This high efficiency of CAWT translates into more energy generated per unit of investment and longer operating hour, thereby enhancing profitability and opening up new revenue streams. Traditional HAWTs require larger floating platforms to counteract the large overturning moments generated by their design (high center of gravity due to the heavy components on the top of wind tower). In contrast, the CAWT's lower center of gravity allows for a smaller and more cost-effective floating platform.