Design of the concentrator – wind turbine combinations

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Wind technology is one of the fastest growing alternative energy technologies. This technology can also be used in hydrokinetic turbines. Today, depending on technological developments, the minimum speed of wind and hydrokinetic current to produce electricity from wind and hydrokinetic turbines is about 3-4 m/s and 1-2 m/s respectively. These limit the choice of physical locations where wind and hydrokinetic turbines can be implemented. To generate electricity at lower wind speed and hydrokinetic current the concentrator augmented wind turbine (CAWT) is considered. The CAWT improves the efficiency of the wind turbines by increasing the wind speed upstream of the turbine. Preliminary work of the study was presented in the 2nd International Conference on Fluid Dynamics & Aerodynamics. In this study, the optimization of the combinations of concentrator with wind turbine is carried out. The actuator porous disc model is used to represent wind turbine in the concentrator. The Box-Behnken experimental method combining the CFD analysis is used in the optimization. Optimum concentrator parameters are determined by the means of the Response Surface Method. The optimum geometric parameters are obtained as a function of the turbine diameter. Concentrator increases the free wind speed and power output by the factors of about 1.38 and 2.62 respectively. The system can be used offshore and onshore wind turbine applications. Geometric parameters are shown in Figure 1. In the figure, c1 and c2 are the chord length of the main airfoil and vortex generator respectively, x and y represent the location of the vortex generator with the respect of the main airfoil, and α and δ are the orientations of the main airfoil and vortex generator airfoils. The structure is defined by 6 non-dimensional parameters, x/c1, y/c1, c1/D, c2/c1, α, and δ.

Figure 1: Geometry and parameters of the concentrator.

Figure 2: Computational domain.

The computational domain structure and grid that is generated around the concentrator is shown in Figure 2 and Figure 3 respectively.
Recent Publications

1. Tahir Yavuz and Emre Koc (2017) Optimization analysis of the combinations of concentrator and wind turbine with flap in CFD, 2\textsuperscript{nd} International Conference on Fluid Dynamics & Aerodynamics, October 19-20, 2017 Rome, Italy

Biography

Tahir Yavuz academic career; BSc in Mechanical Engineering, Karadeniz Technical Univ. Turkey, PhD in Aeronautical Engineering, Leicester University, England. Worked at Erciyes and Karadeniz Technical Universities, Turkey. Currently working as a full time professor at Baskent University, Turkey. Interested in bluff body aerodynamics, renewable energies such as wind energies and wind turbines. Developed a high performance wind turbine blades such as airfoil with slat arrangements.

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