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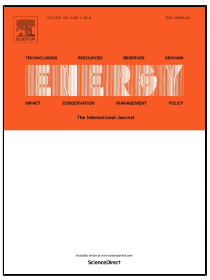

Wind field effect on the power generation and aerodynamic performance of offshore floating wind turbines

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Wind field effect on the power generation and aerodynamic performance of offshore floating wind turbines

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Abstract

This study is aimed at investigating wind field effect on the power generation and the aerodynamic performance of offshore floating wind turbines. For this purpose, three comparative wind fields are generated: a uniform wind field, a steady wind field with wind shear, and a turbulent wind field. Aero-hydro-servo coupled analysis is performed in time-domain to estimate how a referenced semisubmersible offshore floating wind turbine behaves in the three wind fields. The results reveal the importance of wind shear and inflow turbulence to the performance of the floating wind turbine. Thrust force and power generation become very unstable in the presence of inflow turbulence. Due to the control strategy of the wind turbine, the power generation is also correlated with operational state and turbulence frequency. Although wind shear has a tiny effect on the rotor performance, the local aerodynamic load applied at a single blade experiences fluctuation with the presence of wind shear. It is also shown that the ultimate structural and fatigue damage loads at blade root are augmented by inflow turbulence and wind shear.

Keywords: wind field; inflow turbulence; wind shear; power generation; aerodynamic performance; offshore floating wind turbine

1. Introduction

Global demand for energy is expected to climb by up to 25% [1] by 2040 and the world is pursuing economic and sustainable energy sources to keep up with this considerable demand growth. In such circumstance, the utilization of offshore wind energy resources is stimulated, leading to the development of offshore floating wind turbine. Statoil [2] proposed a Spar-buoy floating wind turbine, namely the Hywind concept, which is the first full-scale floating wind turbine that has ever been built. Principle Power installed a full-scale 2MW WindFloat prototype near the coast of Portugal [3]. Most recently, Hywind Scotland, the world's first floating wind farm, already starts to deliver electricity to the grid [4]. In addition to the installation of full-scale floating wind turbines, a series of model test researches have been performed in the meanwhile [5-7]. The noticeable feature of offshore floating wind turbines compared with traditional land-based wind turbines is that the wind turbine is mounted on a floating platform displaced in the waves with mooring system. Therefore, the floating wind turbine

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