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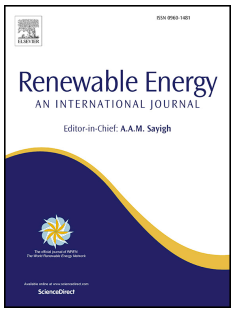

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Experimental observations of active blade pitch and generator control influence on floating wind turbine response

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Abstract

In this paper, the influence of wind turbine blade pitch and generator controls on the global response of a floating wind turbine is investigated. Several different active turbine controllers are considered and the resulting floating wind turbine global response is compared with that for a baseline configuration employing a fixed blade pitch and a fixed rotor speed. Results from platform pitch free-decay tests as well as a simultaneous dynamic wind and irregular sea state condition are used to understand the controllers' influence on floating wind turbine dynamic behavior.

Keywords: Floating, wind, turbine, control, semi-submersible

1. Introduction

Floating offshore wind turbine technology shows great promise as it enables the harnessing of abundant, clean renewable deep water wind energy [1]. However, the technology is not yet commercially mature and there are several areas where further research and development may permit smarter, more economical designs. One area of great interest pertains to active turbine blade pitch and generator controls and their influence on the coupled dynamic response of floating wind turbines [2]. Jonkman [3] showed through simulation that standard land-based controls aimed at regulating power generation can induce platform pitch instabilities for floating wind turbines with compliant foundations. Numerous researchers have worked towards developing floating wind turbine-specific turbine control strategies that prevent such instabilities, mitigate loads and properly regulate power using theoretical frameworks and simulation (e.g. see [4-13]). Despite the great interest in the topic, little work has been done experimentally to understand the influence of active turbine controls on floating wind turbine global performance. Azcona et al. [14] performed model-scale experiments of a semi-submersible floating wind turbine that incorporated aerodynamic thrust using a ducted fan which was controlled via a real-time numerical simulation with active turbine controls. Huijs et al. [15] also performed model-scale testing of a floating turbine with active turbine controls in a wind/wave basin, albeit with a fully-functioning wind turbine operating in a Froude-scaled wind environment. Both Skaare et al. [16] with the Hywind Demo and Viselli et al. [17] with the VolturnUS 1:8 have performed numerical model correlation studies with experimental data from ocean-deployed prototypes employing active turbine controls. One of the few works that goes beyond simply incorporating turbine controls into the experiment and begins to explore the influence of control parameters on turbine performance can be found in Chujo et al. [18]. Chujo et al. performed 1/100th-scale experiments in a wind/wave basin and altered turbine blade pitch control parameters to understand their impact on rotor speed and platform pitch motion variation for a spar-based floating wind turbine.

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