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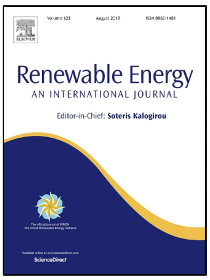

Short-term extreme response and fatigue damage of an integrated offshore renewable energy system

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Short-term extreme response and fatigue damage of an integrated offshore renewable energy system

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Abstract

This study addresses short-term extreme response and fatigue damage of an integrated wind, wave and tidal energy system. The integrated concept is based on the combination of a spar type floating wind turbine, a wave energy converter and two tidal turbines. Aero-hydro-mooring coupled analysis is performed in time-domain to capture the dynamic response of the combined concept in a set of environmental conditions. The mean up-crossing rate method is used to evaluate the extreme response, which takes advantage of an extrapolation method to reduce the simulation sample size. The cumulative fatigue damage is computed based on the S-N method. Simulation results show that the tower base fore-aft bending moment is improved, in terms of extreme value and fatigue damage. Nevertheless, the tension force of a mooring line is worsened. The mooring line bears increased maximum tension due to the tidal turbine thrust force and it is subjected to higher fatigue damage load as well.

Keyword: extreme response, fatigue damage, renewable energy, floating wind turbine, wave energy converter, tidal turbine

1. Introduction

With expanding global demand for power and increasing public awareness to sustainable development, great efforts are taken to exploit the offshore renewable energy resources and a set of offshore renewable energy devices are developed. Statoil launched a demo project of a spar type offshore floating wind turbine, namely the Hywind concept, which is the first full scale floating wind turbine that has ever been built [1]. Principle Power installed a full scale 2MW WindFloat prototype near the coast of Portugal [2]. At the same time, researchers across the world are working on the numerical and experimental studies of floating wind turbine [3-8]. Apart from floating wind turbine, wave energy converter (WEC) and tidal turbine are also widely used to harvest energy from the ocean. Zhang and Yang [9] captured the power output of an oscillating-body WEC. Two symmetrically oblique springs and a linear damper were applied to model the nonlinear behaviour of the power take off (PTO)