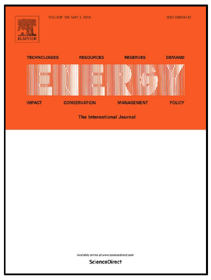

The power performance of an offshore floating wind turbine in platform pitching motion

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PII:	S0360-5442(18)30756-4
DOI:	10.1016/j.energy.2018.04.140
Reference:	EGY 12779
To appear in:	*Energy*
Received Date:	25 January 2018
Revised Date:	12 March 2018
Accepted Date:	23 April 2018

Please cite this article as: Binrong Wen, Xingjian Dong, Xinliang Tian, Zhike Peng, Wenming Zhang, Kexiang Wei, The power performance of an offshore floating wind turbine in platform pitching motion, *Energy* (2018), doi: 10.1016/j.energy.2018.04.140

The power performance of an offshore floating wind turbine in platform pitching motion

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Abstract

The platform pitching motion of the Offshore Floating Wind Turbine (OFWT) introduces an additional wind profile to the rotor, which may significantly impact the power performance of the OFWT. In this paper, the power performance of an OFWT in platform pitching motion is investigated using the Free Vortex Method (FVM). Firstly, the pitching and non-pitching cases are compared. Then, the power performance of the OFWT in pitching motions with different amplitudes and frequencies is investigated at the design point (tip speed ratio $\lambda = 7$). Afterwards, the reduced frequency k is proposed to integrate the influences of the platform pitching amplitude and frequency. The power performance curves of the pitching OFWT are derived as functions of λ and k in the whole operating region. Results show that as k increases, the mean power output decreases at low λ but increases at high λ. The mean power coefficient declines with the increase of k. The power variation increases with the increases of λ and k. To make up the loss of the mean power coefficient and to mitigate the side effects resulted from the power variation, advanced control strategies and platforms with good motion performances should be developed for OFWTs.

Keywords

Offshore Floating Wind Turbine, Free Vortex Method, Pitch, Power Performance, Reduced Frequency

1. Introduction

Recently, there is an increasing interest in both academia and industry to develop offshore floating wind turbines (OFWTs) in deep waters. The OFWT technology is believed to be promising because the offshore wind is much stronger and steadier than the onshore wind. In addition, there are less transportation constraints and environmental restricts at sea [1-3]. However, economical challenges [4, 5] and technical problems [3, 6, 7] should be overcome before OFWTs advancing into deep waters commercially. One of the most important technical challenges is that the stability of the OFWT cannot be easily achieved due to the dynamic loads induced by wind, wave and ocean current. OFWTs tend to inevitably experience excessive 6-DOF (Degree of Freedom) platform motions as shown in Fig. 1(a). Among the 6-DOF rigid-body motions, pitch is the most important motion mode when it comes to the

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