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Passively pitching blades for wave loading mitigation of horizontal axis tidal turbines

Abel Arredondo-Galeana[1], Gabriel Scarlett[2], Anna Young[3] and Ignazio Maria Viola[4,*]

[1] Department of Naval Architecture, Ocean and Marine Engineering, University of Strathclyde, Glasgow, UK

[2] Mocean Energy Ltd., Edinburgh, EH10 4BY, UK

[3] School of Engineering, Department of Mechanical and Aerospace Engineering, University of Bath,Bath, BA2 7AY, UK

[4] School of Engineering, Institute for Energy Systems University of Edinburgh,Edinburgh, EH10 4BY, UK
[*] I.M.Viola@ed.ac.uk

ABSTRACT

Tidal turbines are subject to large load oscillations due the unsteady marine environment. The variability of loads is detrimental to the fatigue life of tidal turbines and exposes them potentially to premature failure. Passively pitching blades offer the possibility of load alleviation and therefore, long-lasting turbine operation. This can reflect in a reduction in preventive maintenance and operational costs. Nonetheless, the performance of passively pitching blades under realistic flow conditions requires further understanding. In particular, better understanding is needed for tidal turbines that operate in the proximity of ocean waves. In this paper, we explore analytically the loading of a tidal rotor equipped with passively pitching blades, subject to wave loading. We explore low and high amplitude opposing waves acting on the rotor. We find that for small amplitude waves, torque and thrust fluctuations are reduced around the same mean values of a rigid blade tidal turbine. In contrast, for high amplitude waves, although thrust and torque oscillations are also reduced, the mean output power is penalised and power production decreases. These results suggest that passively pitching blade systems might need to be redesigned in environments that include high amplitude waves.

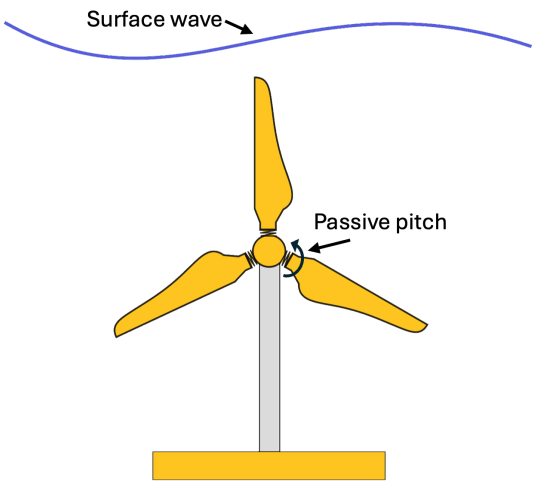

Figure 1: Graphical abstract.