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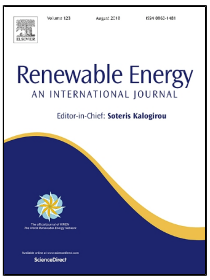

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Modelling the hydrodynamic and morphological impacts of a tidal stream development in Ramsey Sound

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Abstract

A number of sites around the UK are being considered for development of tidal stream energy, one of which is Ramsey Sound off the coast of Pembrokeshire, South Wales. The Sound was used to test the prototype of the Delta Stream by Tidal Energy Ltd. After initial testing, a 10 MW tidal array was proposed at St David's Head. To investigate any possible environmental impacts of the array due to energy extraction, a case study of the Pembrokeshire coast was performed using a high-resolution depth averaged hydrodynamic model, Telemac2D, to investigate changes to hydrodynamics and morphodynamics. Results show that the proposed array of nine tidal energy converters will cause alterations to eddy propagation leading to changes in the velocity field up to 24km from the tidal array. Changes in morphodynamics are predicted through alterations to the bed shear stress. Changes to the mean and maximum bed shear stress, over a 30-day period, are found to be more localised and extend 12km from the array. These changes indicate that the proposed tidal array will lead to localised sediment accumulation and will act as a barrier to sediment transport, with potential consequences for the benthic ecology of the region.

Keywords: Tidal Energy, Tidal Turbines, Ramsey Sound, Hydrodynamic model, Benthic Habitat

1 Introduction

The UK tidal stream energy industry has seen large growth in recent years (RenewableUK, 2015). The number of pre-commercial scale devices currently being tested at test facilities, such as the European Marine Energy Centre (EMEC) in Orkney, reflects this development, however, the ability to commercialise this technology remains a challenge. Even the established UK wind industry still faces significant issues, with numerous Round 3 offshore wind developments halted on grounds of environmental impacts, and the tidal industry is likely to encounter similar challenges. Round 3 sites are the third and latest set of lease sites designated by the UK Government that are consented for development. They reflect the current state of the offshore wind industry, utilising the most state-of-the-art technology and best practices in the UK. Despite numerous proposed array scale projects, some still fall to monetary barriers (reNEWS, 2014), and those that pass these barriers face an increasing challenge to show that their environmental impacts will be minimal. Unlike the wind industry, where physical effects of wind turbines have been catalogued through the deployment of thousands of turbines, the tidal industry lacks such array-scale quantitative data. The MeyGen development in Orkney has been operating the first four turbines, since February 2017 as part of a phased development. It will be the first to provide such datasets.

Many of the impacts are qualitatively known but of great importance is a thorough understanding of the scale of the impacts and their relative significance. Research studies have demonstrated how individual turbines and array scale developments will potentially alter the ecological environment (e.g. Shields et al., 2009; Shields et al., 2011; Miller et al., 2013). In summary, a tidal turbine decreases the near field current flow directly in its wake through energy extraction and the drag caused by the physical structure. The turbine will also affect the far field hydrodynamics, altering the spatial variability of turbulence. The likely consequences of this interaction are alterations to bed characteristics, sediment transport regimes and suspended sediment concentrations.

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