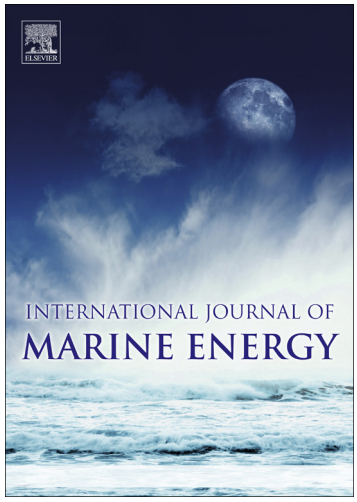

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Methodology for estimating the French tidal current energy resource

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Abstract

This paper presents a method to compute the total tidal energy resource available in French Atlantic and Channel waters. An analysis of outputs from MARS2D hydrodynamic model allowed us to identify 20 potential sites for extraction of tidal energy. These sites are presented in the form of an atlas. Four promising sites with annual average currents exceeding 2 m/s, were identified in the English Channel (Raz Blanchard, Raz Barfleur, Paimpol-Bréhat) and at the westernmost part of Brittany (Fromveur Passage).

By defining characteristics of a turbine array (spacing and power coefficient), we compute the total extractable power for three cases: high, medium and low theoretical performance. Considering the sites with average currents exceeding 1.5 m/s, the total extractable power ranges from 1.46 to 9.71 GW for the low and high performance cases. For all 20 sites, where average currents exceed 0.5 m/s, the total extractable power ranges from 2.49 to 16.58 GW for the low and high performance cases.

Finally, we focus on the most promising site : the Raz Blanchard (Alderney Race) located in the Manche department (English Channel). The variability of the current intensities and directions are presented. Within this high tidal potential site, we define a zone (12 km^2) wherein the current speeds are consistently high (exceeds 2.5 m/s for at least 40% of the year studied) and most often following the NNE/SSW axis.

Keywords: Tidal energy, Available power, GIS, Atlantic, English Channel, Raz Blanchard

1. Introduction

Awareness is growing in European member states to adopt a strategy for sustainable development to respond to increasing greenhouse gas emissions and energy needs (Scarlat et al., 2015) in which marine energy conversion systems are included (Uihlein and Magagna, 2016). In this context, the European Commission has launched a wide-ranging program promoting the use of renewable energy (EU, 2010). One objective of this project is to produce 20% of electricity using renewable energies by 2020 (from 10.3 % in 2009 to 23 % for France in particular, EU (2009)). Europe's oceans have high energetic potential with seven convertible resources: tidal power (streams and tides), wave power, offshore wind power, marine current power, ocean thermal energy, osmotic power and biomass. Each of those resources can produce electrical power by using specific marine energy conversion systems. Tidal energy is one of the fastest growing emerging technologies in the renewable sector (Magagna and Uihlein, 2015) and is set to make a major contribution to carbon free energy generation.

In theory, the energy that could be extracted from the worlds' oceans is well in excess of any current or future human requirements (Charlier and Justus, 1993). Methods to compare and evaluate the energy resource at different locations and scales are required in order to guide project developers (and stakeholders) in selecting suitable sites to achieve optimal power capture and economic performance from their installations. Many assessments of energy resource have previously been