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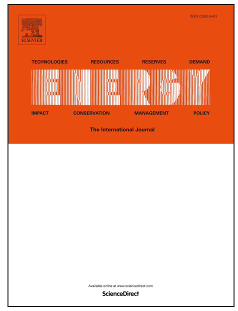

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Annual and seasonal variabilities in the performances of wave energy converters

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Abstract

Locations of wave energy converters (WECs) are, most of the time, determined in areas with the highest density of mean wave power while ignoring the temporal variabilities of the resource. The most energetic regions are, however, characterised by strong inter- and intra-annual variations of wave power that may impact the energy production and performances of devices. We investigated these influences by focusing on the generated power from three well-known WECs that reached the stage of full-stage testing: Pelamis, AquaBuOY and Wave Dragon. This evaluation was conducted in western Brittany, one of the most energetic area along the coast of France. In comparison with the available resource, the generated technical power was characterised by reduced annual and seasonal variations. These effects were particularly noticeable for Pelamis that exhibited a reduced intermittency in the energy output between the winter and summer periods. The most energetic conditions had furthermore a restricted contribution to devices power output, mainly related to events with energy periods between 10.5 and 12.5 s, and significant wave heights between 2.75 and 4.25 m. WECs performances exhibited finally strong variabilities, in winter, with monthly-averaged values of the capacity factor up to 65% for Wave Dragon.

Keywords: Wave power matrix , Capacity factor , SWAN , Pelamis , AquaBuOY , Wave Dragon

1. Introduction

Among the different marine renewable energies (wind, tide, biomass, ocean thermal sources, osmotic…), the power of wind-generated surface-gravity waves presents an abundant resource, estimated at around 2 TW at the worldwide scale [1]. As wave energy may be characterised by a high power density in coastal waters [2], its exploitation has sparked, over the last decade, the most diverse technological developments with a wide range of wave energy converters (WECs) deployed in real sea conditions [3, 4]. In order to guarantee successful deployment of these devices and reduce the risk of investors, it is, however, essential to optimise their design and locations. Numerous studies were conducted to assess WECs performances in most promising locations for wave energy exploitation. A part of these investigations relied on wave buoy records as a refined reference to capture, at high temporal resolution, the variations of sea states distribution [5, 6, 7, 8]. These measurements are, however, not always available at locations of interest or cover (when recently implemented) a restricted period of time that can not encompass the inter- and intra-annual evolutions of the wave climate. Numerical modelling tools were thus, most of the time, retained to complement in-situ observations, and assess the technical power generated from a series of WECs (Tab. 1). These investigations were primarily targeted to the regions with the highest wave power including the west coast of Canada, the south-eastern part of Australia and the Atlantic European seafronts of Ireland, the United-Kingdom, France, Portugal and Spain [9].

Table 1: Non-exhaustive review of regional and local evaluations in WECs performances based on high-resolution numerical wave power assessments. Three WECs are listed (Pelamis, AquaBuOY, and Wave Dragon) whereas these evaluations may consider other devices technologies such as [10] or [11] that rely on specific power matrices.

Study areas	Resource assessments		Selected WECs technologies			References
	Periods	Spatial resolutions	Pelamis	AquaBuoy	Wave Dragon	