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Study of the smoothing effect on the power production in an array of SEAREV wave energy converters.

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ABSTRACT

This paper deals with the smoothing effect on power production in an array of SEAREV wave energy converters (WEC) due to the summation of each single converter's production. A numerical model of the SEAREV WEC developed in previous works is used in this study to perform numerical simulations of motions of each WEC in the array in order to compute the full energy production. Comparisons are made between the electricity produced by each single device and the array. It shows the benefit of this smoothing effect on the global energy production. In monodirectionnal random waves, results show only a few devices are needed in order to reduce strongly the standard deviation of the instantaneous power with the mean power. Several device layouts are also considered, for different sets of random directional waves. It is shown that the smoothing effect does not depend on the sea state conditions nor on the layout of the array but only on the number of systems in the array.
KEY WORDS: Wave energy conversion; array; power smoothing

INTRODUCTION

In case of wave activated bodies, wave energy converters such as the Pelamis (www.pelamiswave.com) or the AWS (www.awsocean.com), ocean waves are used to make masses move. The mechanical energy of the waves is hence converted into masses mechanical energy. Then, the mechanical energy of these masses is converted into electricity by means of a Power Take Off (PTO).

As waves are a random oscillating phenomenon, the motion of the masses is not a steady motion, but an oscillation. Being a quadratic function of first order responses, the power production is also oscillating, and the resulting instantaneous power varies from zero to peak values which can be several times the mean value of the power production. From the grid's point of view, such behaviour of the input electricity flow is not acceptable and solutions for smoothing the power production have to be found. One can use kinetic storage, with flywheels, gas accumulator storage, chemical storage,etc (Salter, 2002)). However, wave energy converters are designed to be deployed in arrays and one can expect the spatial scattering of the devices to have a smoothing effect on the electricity production, which would mean a smaller need for energy storage.

Budal (1977) was the pioneer worker on wave energy converter arrays, which was subsequently made more comprehensive by Falnes (1980) and, independently, by Evans (1980). Smoothing of converted wave energy was considered already in the late 1970s (Shaw, 1982). Later, Salter (1989), considering necessary smoothing by means of short-time energy storage, proposed that "about one hundred seconds of storage will produce a completely steady output from a single device". Considering a case of a combination of 64 separate devices, he finds that this would produce electricity which "would still be an unacceptable input for a small island's network." More recently, most of the work carried about wave energy converters arrays was about interactions between systems and optimising the spatial configuration in order to maximise the power production (Fitzgerald,2007), (Ricci,2007). In this paper, we will focus on the smoothing effect on the power production one can expect from an array of SEAREV wave energy converters.

METHODS

Wave model.

In this paper, we consider both the case of monodirectionnal irregular waves and the case of directionnal irregular waves.

In the case of monodirectionnal random waves, figure (1), we consider a Pierson Moskovitz spectrum S (Molin,