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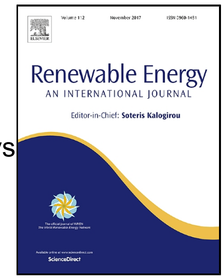

Variability and Stochastic Simulation of Power from Wave Energy Converter Arrays

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Abstract

A novel stochastic model has been developed which allows for the prediction of Wave Energy Converters (WECs) array power time series, based solely on knowledge of an individual WEC power time series. The model is applicable for arrays of independent WECs.

The power from an array of WECs was simulated by deploying 50 individual WECs in a numerical testbed and aggregating the individual power productions. 51 differing WEC array scenarios were completed using four different WEC architectures, differing separation distances, wave directional spreading constants and device degrees of freedom. These allowed investigation into the normalized standard deviation and the frequency content relationships between the power from an individual WEC and an array of WECs. These properties were used to determine if the power from WECs within the arrays was independent.

WECs are found to be independent if the separation distance is greater than 212 m. If small differences in the frequency content of the power is allowable, separation distances of 98 m with directional spreading constants (s) of 15 are allowable. WEC architecture and movement degrees of freedom were shown not to affect independence.

***Keywords*— Arrays; Wave Energy Converters; independent WECs; electricity grid integration; stochastic model.**

Highlights

- The variability of the power from individual WECs and arrays are compared
- A stochastic model has been built that predicts array power from an individual WEC
- The stochastic models applicability depends on WEC spacing and directional spread
- The stochastic model is independent of the WEC architecture
- Moving WECs >212 m apart will not further reduce the variability of the array power

1. Introduction

Wave Energy Converters (WECs) have the potential to supply large quantities of energy to electricity grids, conceivably significantly contributing towards the potential to develop 337 GW of ocean energy by 2050 [1]. In order to provide this substantial contribution, WECs will need to be deployed in large arrays or farms, with suggested array sizes up to a capacity of 50 MW [2]. The temporal characteristics of the WEC array power needs to be quantified prior to large scale electrical grid integration. The temporal variability of the power is required by developers to obtain appropriately rated power electronics and power smoothing mechanisms for short term variations, and for electricity utilities to ensure electricity grid stability at longer timeframes. This study explores