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Grid Connection Improvements by Control Strategy Selection for Wave Energy Converters

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Abstract. In this paper a *wave-to-wire* approach to model the exploitation of ocean energy by point absorbers in heave is presented. Attention is focused on the impact that the control strategy of the Wave Energy Converter (WEC) has both on the power performance of the single device and on the grid power quality at the connection point, when point absorbers are arranged in wave farms. Two different control strategies are proposed and compared to theoretical ones such as the complex-conjugate method. Their effectiveness in improving the system overall power extraction while reducing each Power Take-Off's rating and easing the Wave Farm grid integration is proved by time domain simulations, developed both at single-device level and at farm level.

Key words

Wave Energy Converters, grid connection, control strategies, point absorbers, Wave Farms.

1. Introduction

Despite the increasing attention paid to Wave Energy Converters (WECs), a single leading technology has not yet been established. One of the most promising concepts is that of point absorbers, due to their reduced infrastructural costs and suitability for exploitation in large wave farms.

Point absorbers have been extensively studied in the past decades, with special focus on hydrodynamics, survivability and control issues, to find possible optimizations at single-device level. In order to obtain commercially viable solutions, however, it is now mandatory to achieve the grid connection of such WECs, mainly arranged in arrays. To take this final step it is fundamental not only the rational design of the Power Take-Off (PTO) for the single WEC, but also the careful analysis of the effect that a medium/large Wave Farm has on the power system, whenever connected. The goal of this paper is to show how different control techniques can severely affect the overall power conversion process, including the grid connection stage.

More specifically, two straightforward control strategies for point absorbers in heave will be proposed and analyzed in order to prove their usefulness in limiting the size of the required PTO and easing the WEC grid integration, while improving the total average power extraction.

2. System modelling

The considered system is composed by a cylindrical point absorber in heave, i.e. a single degree of freedom buoy, as the one schematically depicted in Fig. 1. Its main parameters are reported in Table I. The point absorber is directly connected to an electrical generator, without any intermediate hydraulic or pneumatic stage. Each WEC is also equipped with a full power converter allowing both the generator control and the grid interconnection.

A. Hydrodynamic model of the system

For the solution of the hydrodynamic problem, linear water wave theory is applied, based on the hypotheses of incompressible irrotational flow and inviscid fluid. This allows to apply boundary element methods and compute the velocity potential in its components (radiated and

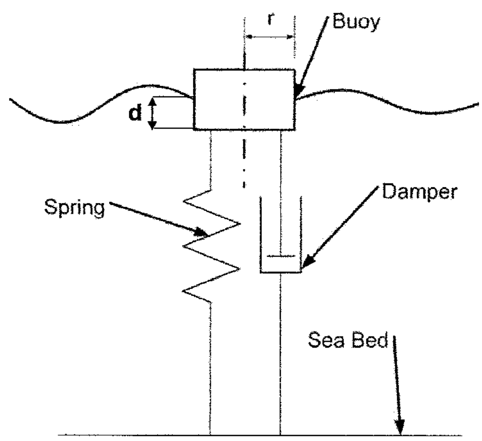

Fig.1. Schematic model of the considered point absorber (buoy)