# Analysis of the power output and the far-field effects of a 50-WEC farm using a novel coupling technique

Balitsky Philip, Verao Fernandez Gael, Stratigaki Vasiliki and Troch Peter

Department of Civil Engineering, Ghent University, Technologiepark 904, 9052 Zwijnaarde (Ghent), Belgium
E-mail: Philip.Balitsky@UGent.be

To reduce the likelihood of catastrophic effects of climate change, there is an urgent need to decarbonize of the world electricity supply. Consequently, all viable renewable energy sources need to be investigated for their potential to contribute to the electrical power mix. Ocean waves provide an exciting potential for clean, reliable energy, yet this source is still too costly to be commercially exploited at present.

As has recently occurred with offshore wind, a significant cost reduction of electricity from waves will come from aggregating large numbers of wave energy converters (WECs) in farms. Given the practical constraints on the size of individual WECs derived from first principles, it is likely that an electrical node comparable to the size of a large offshore wind turbine will be provided by an array or cluster of closely spaced WECs. Therefore, the most likely scenario for commercial WEC farms will be one of multi-array farms consisting of sparsely spaced WEC arrays of densely packed WECs. However, unlike single WEC turbines, the power output of the arrays and the WEC farms will change depending on the layout of both the WECs and the WEC arrays because of hydrodynamic interactions in these arrays.

One of the problems in studying the impact of large WEC farms is choosing an appropriate level of granularity in the numerical simulation of the hydrodynamic effects. Resolving too many equations leads to a loss in computational efficiency while fast approaches such as spectral models do not provide a sufficient level of detail and do not resolve the phase relationships that lead to large fluctuations in power output.

Our novel solution is to couple a BEM code in the areas immediately surrounding the WECs and propagate the perturbed waves to the surrounding farm area and beyond a wave propagation model [1]. The BEM solver utilized in this study is NEMOH [2], while the wave propagation model is the mild-slope equation package MILDwave [3]. A novel 2$^{nd}$ order precision iterative technique is used to calculate the wave field for a wave farm composed of several arrays [4].

In this presentation, we demonstrate the results of a numerical study which traces the effect of various layouts to the power output of a wave farm composed of several clustered arrays. The study utilizes a staggered configuration of shallow draft heaving buoys to mimic a realistic clustered WEC array. The effect of varying array separation distances and wave incidence angles are demonstrated for many regular and irregular wave conditions.

The effects of changing the incident wave conditions and the layout on the WEC farm are explained in a qualitative and quantitative way. The former via demonstrating the perturbed wave field in the WEC farm and the latter via a table and plot of the power output for the various configurations considered.

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