Outcome of the project performance and survivability of wave power farms

J. Engström*, M. Eriksson, M. Giassi, M. Göteman, S. Thomas and J. Isberg

*Division for electricity
Uppsala University
Box 534
751 21 Uppsala
Sweden
e-mail: jens.engstrom@angstrom.uu.se

ABSTRACT

If wave power is to take the step to a reliable, effective and grid integrated energy source in Sweden and worldwide, the cost of its energy must be strongly reduced and its survivability improved. The project Performance and survivability of wave power farms (SUPERFARMS) financed by the Swedish Energy Agency during the years 2015-2018 was looking at this question via studies on large arrays of point absorbing wave energy converters. The project aimed to improve the wave arrays performance via studies on optimal array layout which also included a connection to a new economic model and wave farm control algorithms. The theoretical models were tested in small scale tests in the wave tank of COAST laboratory at Plymouth University. The project used new approaches when using genetic algorithms and machine learning with artificial neural networks. Two different control algorithms for wave energy farms have been developed. One control algorithm based on coordinated control that finds the optimal absorption for each wave energy converter that optimize the total energy absorption for the whole farm [1]. And one control algorithm based on collaborative control and latching where the wave energy converters learned each other to improve the damping and latching time to increase the energy absorption [2]. The latter control algorithm increased the energy absorption of up to 30% in simulation and worked satisfying in wave tank tests. To study and optimize large-scale parks of wave energy converters, the semi-analytical method of [3] was extended to handle devices of different dimensions [4] and omnidirectional waves moving in several directions simultaneously [5]. The model was coupled with an optimization algorithm in [6] and verified against parameter sweep for a single wave energy device. The optimization tool was then used in [7-8] to find optimal configurations of wave energy parks with focus on park layout. The optimization is currently being extended to include an economical cost function, such that not only the power production of a park can be maximized, but the total cost of electricity of a large-scale wave energy system minimized. During the summer 2017 tests were performed with two full scale wave energy converters at the Lysekil test site on the Swedish west coast. The project have generated 9 journal papers, 6 conference papers and 2 licentiate thesis.

For any further request, please contact Jens Engström:

Division for electricity
Uppsala University
Box 534
751 21 Uppsala
Sweden

Tel: +46 18 471 5818
Fax: +46 18 471 5810
E-mail: jens.engstrom@angstrom.uu.se

REFERENCES

[1] Wang, L., Engström, J., Leijon, M. and Isberg. J., "Coordinated Control of Wave Energy Converters Subject to Motion Constraints", *Energies 9(6) 475 (2016)*, doi: 10.3390/en9060475
[2] Thomas, S., Eriksson, M., Göteman, M., Hann, M., Isberg, J., Engström, J., "Experimental and Numerical Collaborative Latching Control of Wave Energy Converter Arrays", *Energies 11*(11), 3036, (2018), doi.org/10.3390/en11113036
[3] Göteman, M., Engström, J., Eriksson, M. and Isberg, J., 2015. Fast modeling of large wave energy farms using interaction distance cut-off. *Energies*, *8*(12), pp.13741-13757.
[4] Göteman, M., 2017. Wave energy parks with point-absorbers of different dimensions. *Journal of Fluids and Structures*, *74*, pp.142-157.
[5] Göteman, M., McNatt, C., Giassi, M., Engström, J. and Isberg, J., 2018. Arrays of Point-Absorbing Wave Energy Converters in Short-Crested Irregular Waves. *Energies*, *11*(4), p.964.
[6] Giassi, M. and Göteman, M., 2017. Parameter optimization in wave energy design by a genetic algorithm. In *32nd International Workshop on Water Waves and Floating Bodies (IWWWFB), 23-26th April, 2017, Dalian, China.*.
[7] Giassi, M., Göteman, M., Thomas, S., Engström, J., Eriksson, M. and Isberg, J., 2017. Multi-parameter optimization of hybrid arrays of point absorber Wave Energy Converters. In *12th European Wave and Tidal Energy Conference (EWTEC), Cork, Ireland, August 27-31, 2017.*
[8] Giassi, M. and Göteman, M., 2018. Layout design of wave energy parks by a genetic algorithm. *Ocean Engineering*, *154*, pp.252-261.