Title of Diploma Thesis

Investigation of the Performance and of the Hydrodynamic Interactions of a Farm of Wave Energy Converters

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ABSTRACT

During the last years, there is a general trend towards the investigation of alternative ways of energy generation, resulting from the growing energy demand, the lack of fossil fuels and the climate disturbance of the ecological balance. The exploitation of ocean waves presents a promising renewable energy source and it has, nowadays, gathered the interest of both the scientific community and the investors.

Motivated by this, the present diploma thesis focuses on the investigation of a farm consisting of nine floating Wave Energy Converters (WECs) of cylindrical cross-section. Each WEC is assumed to oscillate freely along the vertical axis (heave motion), while wave energy is produced through a linear Power Take Off (PTO) mechanism, which is actuated from the heave motion of the WECs. Based on the above, the objective of the present thesis is the investigation and the assessment of the performance (hydrodynamic behavior and energy production) of the WECs' farm and of the hydrodynamic interactions between the WECs under the action of regular waves. Emphasis is given on: (a) the effect of the incident wave direction on the performance of the WECs, (b) the effect of the change of a WEC's position in the farm on the energy production of the farm and (c) the existence of positive or negative contribution of the hydrodynamic interactions among the WECs to the farm's produced power.

The implementation of all the above is achieved through the numerical analysis of the farm in frequency domain by applying an appropriate numerical model (WAMIT). The model enables the calculation of all the quantities, that describe the hydrodynamic behavior of the WECs, considering the interactions between the WECs, as well as the calculation of the finally formed wave field. Based on the results of the applied numerical model, the produced power of the farm is calculated, as well as an interaction coefficient, q_{mod}, that expresses numerically the positive or negative contribution of the farm to the total produced power with respect to the power produced by the same number of individuals (no consideration of hydrodynamic interactions) WECs.

The results demonstrate the existence of intense positive interaction effects among the WECs in the case, where the incident wave direction coincides with the direction of the main diagonal of the farm. This in turn leads to the maximization of the produced power for this incident wave direction compared to the rest examined wave directions. Moreover, the examined changes of a WEC's position seem to have a negative effect on the total produced power of the farm. The degree of this effect depends upon the WEC, which is re-allocated.