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PERFORMANCE ANALYSIS OF DIFFERENT WAVE ENERGY CONVERTER TECHNOLOGIES FOR THE PARTICULAR WAVE CONDITIONS OF THE BASQUE COAST

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ABSTRACT

The present work aims to evaluate the energetic potential along the coast of the Basque Country, that goes from 20 kW/m in the most powerful place, to 7 kW/m in the least powerful point evaluated, analysing different parameters of 7 representative points situated at different distances alongside the coast. These points have been evaluated through the analysis of the data provided by the Minister of Development and Ports of the State of the Spanish Government in the period of 2007-2016. At the same time, the performance of 7 different WECs (Aqua Buoy, Wave Dragon, AWS, Pelamis, Wave Star, Oceantec and Wavebob) [1] have been tested, evaluating different parameters such as the generated electric power, the device size or the wave width used. So, in spite of Wave Dragon being the most powerful one with 15000kW produced, it wasn't the most suitable due to its large width. For the calculations, power matrix provided by the different companies have been used. In order to be able to perform a conclusion, a parameter has been created to compare the wave width that each WEC covers, with its real width. On this issue, Pelamis and AWS are the most efficient devices with more than 170% of wave width covered compared with their real width. Consequently, this study has tried to create some technical criteria in order to be able to evaluate the performance and efficiency of the devices in any place, and, as a consequence to select and compare the optimum WEC for each place. One of the objectives of this work is to create a methodology of analysis with the available data and information of each WEC, and invite other enterprises to make their performances data available. Therefore, the possibility to make comparisons between different technologies would be possible, and the global purpose of producing electricity from waves energy, more achievable.

INTRODUCTION AND OBJECTIVES

The Basque Coast represents a great for the development of the wave energy converters. Its suitable location in the Atlantic Ocean, and the investment made by the government makes it an adequate place for the research [2].

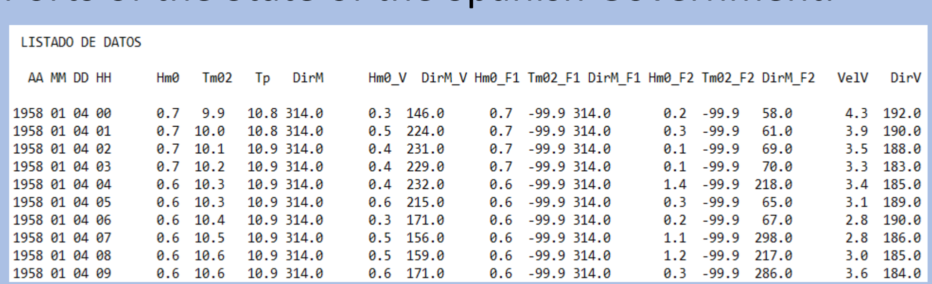
This project´s objective is to evaluate the potential of this coast and determine the most appropriate places for the wave energy production for the future. In addition, it aims to create a methodology to evaluate and compare different types of wave energy converters in each different place, in order to be able to know which technology adapts best for each wave condition.

METHODOLOGY

First, eight different points were selected alongside the Basque coast.

Test points in the Basque Coast

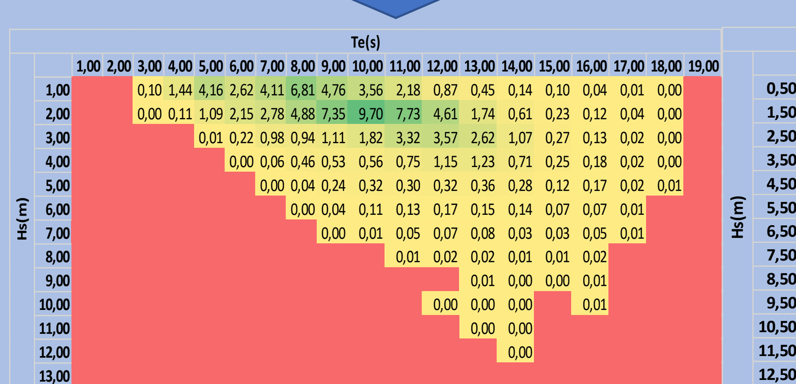
For each of those points, a bivariate distribution of the Hs and Te parameters was made, where the percentage of time that the wave was under certain conditions of He and Te was represented. In addition, in each of those points, the energy produced in each wave condition was calculated. The data was obtained from the Minister of Development and Ports of the State of the Spanish Government.



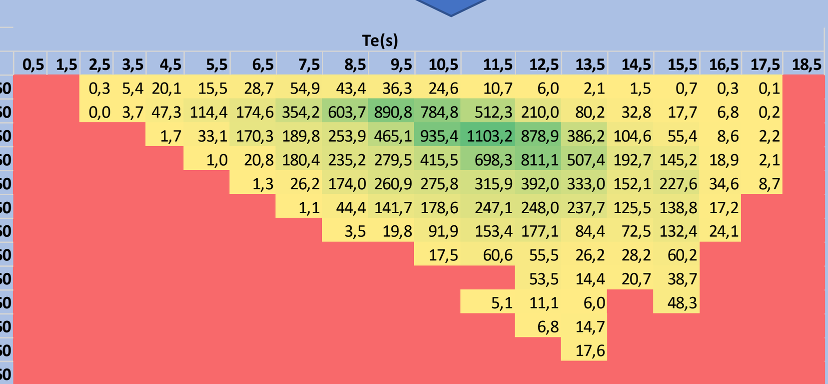
Data obtained form the Minister of Development and Ports of the State of the Spanish Government

$$N_L = \frac{\rho g^2}{64\pi} {H_S}^2 T_e$$

Wave power per length where: (g) gravity, (ρ) density, (Hs) significative height and (Te) wave energy period

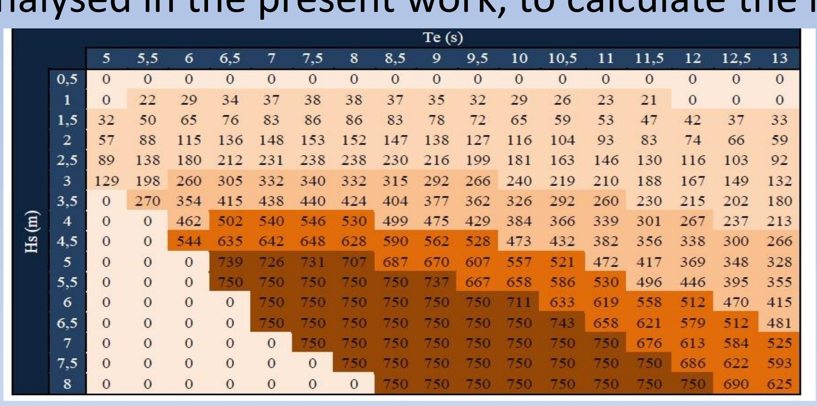


Matrix containing the wave states percentages



Matrix for the calculations of the wave energy per length in W/m

The percentage matrix was multiplied with the power matrix [3] of each of the WEC´s analysed in the present work, to calculate the mean power that each WEC produces (Pe).



Power matrix of the pelamis

$$P_E = \frac{1}{100}\sum_{i=1}^{nT}\sum_{j=1}^{nH} PW_{ij}\, PM_{ij}$$

Electric power produced by the WEC. PW makes reference to the wave state percentage matrix, and PM to the WEC's power matrix

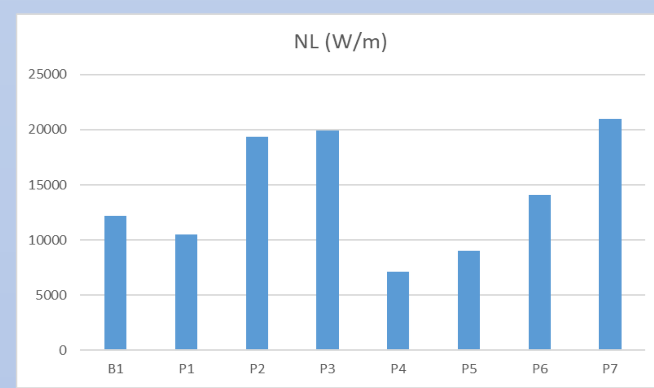
$$C_f = \frac{P_E}{P_{MAX}}$$

$$C_W = \frac{P_E}{N_L} \qquad C_R = \frac{C_W}{W} = \frac{P_E}{N_L W}$$

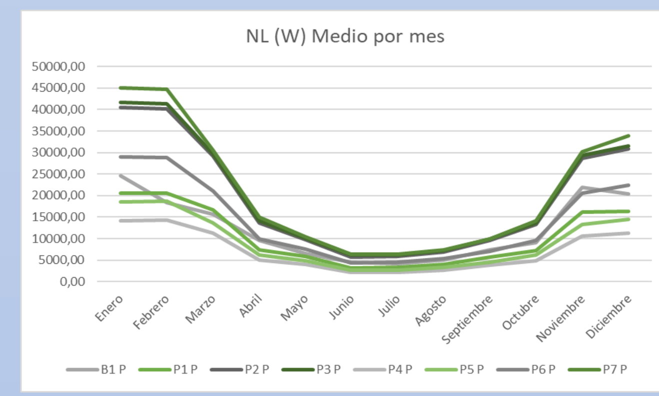
Once the WEC and the sea mean power is calculated the procedure continues with the other parameters: Cf (capacity factor), Cw (captured wave width) and Cr (relative wave width), where W is the WEC's width in perpendicular to the wave direction.

RESULTS AND DISCUSION

The different wave conditions mean power was calculated, and its monthly variability studied.

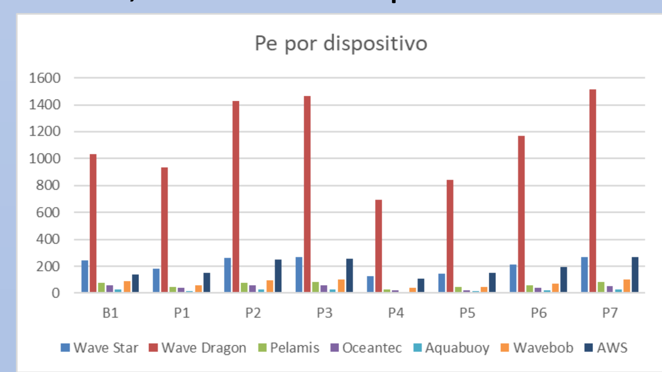


Anual mean power in each analyzed coast point

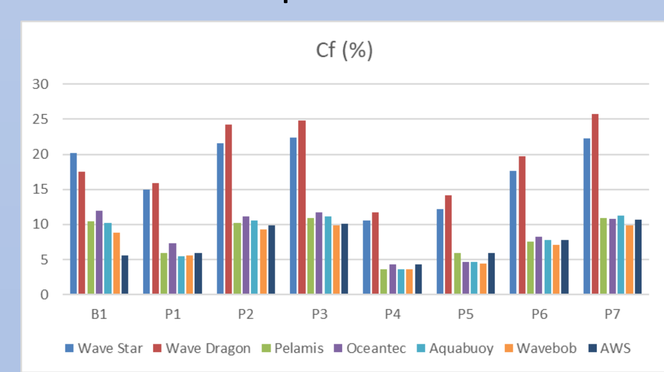


Monthly mean power in each analyzed coast point

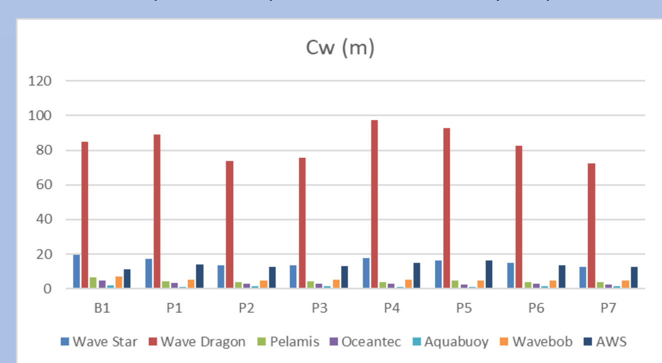
To continue, the different parameters were calculated and compared.



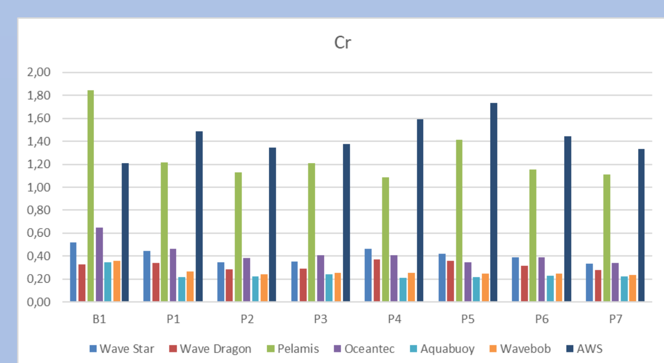
Power produced by each WEC in the analyzed points



Capacity factor of each WEC in the analyzed points



Captured wave length of each WEC in the analyzed points



Relative wave width of each WEC in the analyzed points

CONCLUSION

1. As a result of the project realized, the first conclusion taken is that the Basque Country Coast has the power and the potential to be a great location for the wave energy converters production. The P2, P3 and P7 have been the most powerful ones, in fact, in the P2 is located BIMEP, and would be great places for the electric production in the future.
2. The other main objective of the project was to create a methodology to evaluate different WECs in different places. The power produced, and the captured wave have been studied, but, the most interesting parameter would be the relative width. It gives the possibility to compare the real width of the converter with how much wave width is able to capture. This way, the physical efficiency would be evaluated.
3. In the results obtained is possible to see that, although, the Wave Star and the Wave Dragon are the most powerful ones, and, have the best power capacity ratio, the Pelamis and AWS are the ones that are able to capture more wave width with less real space taken. So, they give the perspective of the importance physical and energetical effectiveness have.
4. Finally, it would be interesting to remark, that the developing technologies wave performance is not available for the investigation and comparison, making the development slower due to the impossibility of discarding the least efficient technologies.

REFERENCES OF INTEREST

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3. Rusu, L., Onea F. (2017) The Performance of some state-of-art wave energy converters in locations with the worldwide highest wave power. Renewable and Sustainable Energy Reviews (article in press).