Journal of *Marine Science and Engineering*

Editorial

Offshore Renewables for a Transition to a Low Carbon Society

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Citation: Rusu, L.; Stratigaki, V. Offshore Renewables for a Transition to a Low Carbon Society. *J. Mar. Sci. Eng.* **2023**, *11*, 1185. https://doi.org/10.3390/jmse11061185

Received: 2 June 2023
Accepted: 5 June 2023
Published: 7 June 2023

The need to reduce CO_2 emissions is of utmost importance considering the climate changes that have become more evident and affect us through the significant impact they have. The development of energy production using clean resources represents one of the most effective measures that can lead to a reduction in greenhouse gas emissions, thus preventing the continuation of the warming process. Besides the fact that they are an inexhaustible energy source that nature offers us, renewable energy sources can help us to mitigate the greenhouse gas emissions [1]. Taking into consideration that the oceans and seas of the planet occupy a much larger area than the land and offer various sources of renewable energy insufficiently exploited until now, although they present a high potential, it is obvious that the exploitation of renewable resources from the marine environment must be developed faster and on wider geographical spaces. In this general context, the new strategy established in the framework of the "European Green Deal" highlighted the importance of offshore renewables in transforming the European Union into a low-carbon energy space [2].

From this perspective, *Journal of Marine Science and Engineering* pays special attention to promoting studies regarding the offshore renewable sector, including evaluation of the resources that can be exploited in these zones and their dynamics in the context of climate change. Some technological challenges related to optimization aspects of wave energy converters (WECs) are also discussed. In this context, some very recent works targeting these important issues, and which were published in the Special Issue of *JMSE* entitled "Offshore Renewables for a Transition to a Low-Carbon Society" are highlighted in this Editorial.

Among the renewable resources available in offshore areas, the exploitation of wind energy is probably the most advanced, with the faster growth certainly being influenced by the existence of mature technologies already developed for the implementation of wind farms on land. Offshore wind has the advantage that it is stronger and less turbulent than the one on land, and therefore, it is more energetic and stable and thus more efficient. This makes offshore wind exploitation cost effective and therefore competitive with low-cost energy sources, although maintenance in the harsh marine environment is often more difficult.

Since the energy extracted from wind depends on the wind speed and this is variable, the identification of the best locations is based on various sources of information, such as in situ and satellite measurements or the results obtained through simulations with numerical models. Of course, a global perspective of these resources, with a high spatial and temporal resolution, can only be provided by atmospheric models whose results can be improved by combining them with satellite data or even in situ measurements.

The assessment of wind energy potential in the Romanian coastal area shows that this area can be a viable candidate for the development of offshore wind projects that have good wind energy potential and a large continental shelf. Furthermore, Romania is a part of the European Union, which aims to significantly expand the offshore wind sector [3]. Using the data provided by one of the most credible databases regarding wind speed at 10 m (U_{10})

above sea level, namely ERA5 [4], a long-term analysis of the average and extreme wind speed values was carried out for the Romanian exclusive economic zone (EEZ) in the Black Sea. A comparison with satellite measurements indicates a good agreement between the data in the locations targeted. However, an accurate evaluation of the wind speed at the wind turbine hub height is of higher significance for the wind energy potential estimation. From this perspective, U_{100} data spanning twenty years are also retrieved from ERA5.

Another important aspect, which must be taken into account for the realization of new renewable energy projects, is represented by technical and economic evaluations. Such a study was carried out for the Philippines and is published in this Special Issue [5]. Two of the most used turbines were considered for the technical analyses, namely Siemens SWT-3.6-120 and Senvion 6.2M126. The results of this combined assessment are reflected in the calculated levelized cost of electricity (LCOE) of the offshore wind farms in the Philippines.

Considering that the oceans and seas of the planet occupy a much larger area than the land and that they offer various insufficiently exploited sources of energy, although they present a high potential, it is obvious that the exploitation of resources from the marine environment must be developed faster. Besides the exploitation of the offshore wind energy, in the marine environment there is also the possibility of exploiting wave energy, which has great potential in many coastal areas [6] and is not yet exploited to its true potential. At the same time, wave energy can be predicted with good accuracy, higher than wind or solar.

Another important aspect is to find the most suitable WEC for a coastal area, taking into consideration that there are currently a wide variety of WECs tested. Given the characteristics of the sea state conditions on the western coast of the Iberian Peninsula, this region is identified by various studies as having great potential for wave energy exploitation. Thus, the Galician coast (NW Spain) is one of the areas identified with a high potential for wave energy exploitation. In this context, for the Galician coast (NW Spain), an evaluation of the wave power resource was carried out together with an analysis of the expected electrical energy output that could have been produced by four WECs over the period from 2014 to 2021 [7]. For each device, the performance was investigated considering two elements: efficiency and power load factor. The results indicate that the Atargis device, a cycloidal WEC, appears to be the most efficient.

A very important issue is also the optimization of the WECs, and in the case of a floating flapping-panel device, numerical simulation studies and a laboratory physical model hydrodynamic study were performed to evaluate the feasibility of the device [8]. In this way, an optimal damping coefficient to give maximum captured energy was identified.

It is clear that commercial wave energy exploitation can be efficient by placing multiple WECs in an array configuration. The point absorber is an efficient device that captures energy from waves coming from various directions, and for this reason, it is very suitable to be placed in arrays. However, an optimization of the WEC array layout is necessary, together with the applied control strategy. An extensive literature review on the state of the art in physical modelling of the point-absorber WEC arrays is presented in an article published in the present Special Issue [9]. Some scientific gaps were also identified, and they were reformulated as design requirements for the experimental setup. The experimental setup of an array of two to five generic heaving point-absorber devices is presented. Wave basin testing in waves simulating real sea state conditions was performed in response to the urgent need for reliable data on the WEC array tests [10]. These data are used to perform the optimization of the WEC array and to validate new numerical models (non-linear). A model predictive control (MPC) method was also proposed for improving the efficiency in extracting the energy of a WEC array [11]. As a conclusion, the experimental tests using MPC with the interconnected system model indicate a better wave energy capture efficiency.

Offshore solar energy could be a viable option for making many coastal communities, islands, and isolated locations more sustainable. As with the other renewable energy sources presented here, the amount of energy that could be extracted in an area is influenced by the geographic location where the systems are deployed.

A new methodology to identify the most appropriate marine areas for the deployment of some offshore solar farms in the Aegean Sea is presented in [12]. Two phases are included in the methodology proposed. In the first one, exclusion criteria are applied for the marine zones based on the information collected from various sources and maps which were created using a GIS environment. Then, in the second phase, objective and subjective models were applied, and to establish the correlation between them, the Kendall rank correlation coefficient was used. The subjective model based on the value of the solar radiation encountered in an area indicates the offshore area near Crete Island as the most suitable site for an offshore solar farm deployment. On the other hand, the objective model considers the offshore area around Thasos Island as a better location.

Additionally, the installation of floating solar panels on the water surfaces of lakes and lagoons can represent a viable solution, and this is shown in the study focused on the western Black Sea and the Razim-Sinoe lagoon system [13]. In such locations, the environmental conditions in which the floating structures would work are milder than in open coastal areas. Based on the data retrieved from the ERA5 database regarding the solar radiation at four points (one point located on the Romanian coast, the other three in lakes), it was found that the energy produced at all points has similar values.

It is also well known that large quantities of greenhouse gases are produced in maritime transport, and possible solutions should aim to reduce these emissions. For this reason, a solution would be to provide reliable information based on a long-term analysis of the mean and extreme values of the weather conditions, especially wind and sea state conditions that affect navigation safety. Such a study was carried out for the main maritime routes in the European seas and where information can be found regarding the areas that should be avoided as they are more exposed to extreme events [14]. The seasonal analysis also indicated the periods of the year that present lower risks for maritime transport.

Finally, the editors are confident that the works included in this Special Issue offer useful information for both researchers and stakeholders.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Soukissian, T.; O'Hagan, A.M.; Azzellino, A.; Boero, F.; Brito e Melo, A.; Comiskey, P.; Gao, Z.; Howell, D.; Le Boulluec, M.; Maisondieu, C.; et al. *European Offshore Renewable Energy: Towards a Sustainable Future*; Future Science Brief No. 9; European Marine Board: Ostend, Belgium, 2023.
2. A European Green Deal. Available online: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en (accessed on 19 March 2023).
3. Onea, F.; Rusu, E.; Rusu, L. Assessment of the Offshore Wind Energy Potential in the Romanian Exclusive Economic Zone. *J. Mar. Sci. Eng.* **2021**, *9*, 531. [CrossRef]
4. Hersbach, H.; Bell, B.; Berrisford, P.; Hirahara, S.; Horányi, A.; Muñoz-Sabater, J.; Nicolas, J.; Peubey, C.; Radu, R.; Schepers, D.; et al. The ERA5 Global Reanalysis. *Q. J. R. Meteorol. Soc.* **2020**, *146*, 1999–2049. [CrossRef]
5. Maandal, G.L.D.; Tamayao-Kieke, M.-A.M.; Danao, L.A.M. Techno-Economic Assessment of Offshore Wind Energy in the Philippines. *J. Mar. Sci. Eng.* **2021**, *9*, 758. [CrossRef]
6. Rusu, L.; Rusu, E. Evaluation of the Worldwide Wave Energy Distribution Based on ERA5 Data and Altimeter Measurements. *Energies* **2021**, *14*, 394. [CrossRef]
7. Arguilé-Pérez, B.; Ribeiro, A.S.; Costoya, X.; deCastro, M.; Carracedo, P.; Dias, J.M.; Rusu, L.; Gómez-Gesteira, M. Harnessing of Different WECs to Harvest Wave Energy along the Galician Coast (NW Spain). *J. Mar. Sci. Eng.* **2022**, *10*, 719. [CrossRef]
8. Song, T.; Li, Z.; Zheng, H.; Liang, C.; Wan, Z. Optimization on Hydrodynamic Performance for First Level Energy-Capturing Enhancement of a Floating Wave Energy Converter System with Flapping-Panel-Slope. *J. Mar. Sci. Eng.* **2023**, *11*, 345. [CrossRef]
9. Vervaet, T.; Stratigaki, V.; De Backer, B.; Stockman, K.; Vantorre, M.; Troch, P. Experimental Modelling of Point-Absorber Wave Energy Converter Arrays: A Comprehensive Review, Identification of Research Gaps and Design of the WECfarm Setup. *J. Mar. Sci. Eng.* **2022**, *10*, 1062. [CrossRef]
10. Vervaet, T.; Stratigaki, V.; Ferri, F.; De Beule, L.; Claerbout, H.; De Witte, B.; Vantorre, M.; Troch, P. Experimental Modelling of an Isolated WECfarm Real-Time Controllable Heaving Point Absorber Wave Energy Converter. *J. Mar. Sci. Eng.* **2022**, *10*, 1480. [CrossRef]

11. Zhang, B.; Zhang, H.; Yang, S.; Chen, S.; Bai, X.; Khan, A. Predictive Control for a Wave-Energy Converter Array Based on an Interconnected Model. *J. Mar. Sci. Eng.* **2022**, *10*, 1033. [CrossRef]
12. Vagiona, D.G.; Tzekakis, G.; Loukogeorgaki, E.; Karanikolas, N. Site Selection of Offshore Solar Farm Deployment in the Aegean Sea, Greece. *J. Mar. Sci. Eng.* **2022**, *10*, 224. [CrossRef]
13. Manolache, A.I.; Andrei, G.; Rusu, L. An Evaluation of the Efficiency of the Floating Solar Panels in the Western Black Sea and the Razim-Sinoe Lagunar System. *J. Mar. Sci. Eng.* **2023**, *11*, 203. [CrossRef]
14. Chirosca, A.-M.; Rusu, L. Characteristics of the Wind and Wave Climate along the European Seas Focusing on the Main Maritime Routes. *J. Mar. Sci. Eng.* **2022**, *10*, 75. [CrossRef]