energies

MDPI

Editorial

Marine Renewable Energy: An Important Direction in Taking the Green Road towards a Low Carbon Future

Eugen Rusu

Department of Mechanical Engineering, Faculty of Engineering, 'Dunarea de Jos' University of Galati, Domneasca Street, 800008 Galati, Romania; eugen.rusu@ugal.ro

Citation: Rusu, E. Marine Renewable Energy an Important Direction in Taking the Green Road towards a Low Carbon Future. *Energies* **2022**, *15*, 5480. https://doi.org/10.3390/en15155480

Received: 13 July 2022
Accepted: 27 July 2022
Published: 28 July 2022

In recent decades, it has become quite clear that the dynamics of the environmental matrix have been subjected to notable changes. Although there are opinions that this might be mainly due to a cyclic evolution of the climate, there is increasing evidence that human activities significantly influenced recent climate dynamics.

Taking into account this general background, countries from the European Union designed coherent strategies to significantly reduce emissions and reach a meaningful outcome by 2050. The European Green Deal was publicly released in December 2019. This is a programmatic document with the target of an important reduction in emissions and the provision of a clear and stable legal framework in relationship with the climate [1]. It is estimated in the European Union that more than 75% of the greenhouse gas emissions are produced by the energy sector. From this perspective, one important direction considered for the future consists of increasing the share of renewable energy in the energy system. In this context, Marine Renewable Energy (MRE) is projected to play an important role on the green road towards a low carbon future. This is because many European countries have important marine energy resources that can be harvested in an efficient way. Thus, the European Union projects a 25 times increase for offshore wind extraction for the year 2050 compared with 2021 (from 12 GW, which is the current operating capacity, to 300 GW). With regard to other MRE sources (particularly waves, tides, osmo-energy and floating solar panels) the target is even more ambitious, with a planned operating capacity of 40 GW by 2050. This means a more than 3000 times increase compared to the modest existing capacity of 13 MW.

From this perspective, *Energies* pays special attention to the development of the MRE sector, including the evaluation of marine energy resources and of the expected dynamics of the environmental matrix in the context of climate change and also some of the technological challenges that have to be faced in the harsh marine environment. Some recent works targeting these very important issues are highlighted next in this Editorial.

First, a comprehensive picture of the wave energy resources at the global scale is presented in [2]. This is based on recent results provided by two different datasets. The two datasets were derived from ERA5 and the European Space Agency Climate Change Initiative for Sea State. An analysis was first performed in this work based only on the ERA5 data which are related to the 30-year period of 1989–2018. The energy flux per unit of wave-crest (also defined as the mean wave power) was assessed at this step. Furthermore, spatial analysis of wave power on a global scale is presented together with various analyses concerning its variability. In a second approach, the analysis was related to the mean wave energy density, for a time interval of 27 years (1992–2018). This was performed by considering the datasets ERA5 and the satellite data from the European Space Agency. The results indicated good agreement for this wave parameter between the two databases. Nevertheless, slightly higher values resulted from the analysis of the satellite data.

Since the Iberian nearshore can be considered a coastal environment with high potential from the point of view of MRE resources, several works consider this area. Only some of them are discussed next. In [3], the main objective was to evaluate the efficiency and the energy cost for the recent past and near future periods. Two state-of-the-art types of wave energy converters (WECs) were evaluated, namely Aqua Buoy and Pelamis. A SWAN model (acronym from Simulating Waves Nearshore) was considered to evaluate the wave conditions along the northwestern side of the Iberian nearshore. The time intervals for which model simulations were performed were the recent past (1979–2005) and the near future (2026–2045) under the RCP 8.5 scenario. The load factor and capture width were the evaluated parameters for both WECs considered. This was conducted by combining the matrix of the bivariate distributions of the sea states with the power matrices of the devices. The results indicated a tendency of a slight decrease in wave power resources in the future. This induces of course a slight decrease in the electric wave power expected from the two wave energy converters considered. At the same time, it can be highlighted that the methodology designed is general can be extrapolated to other converters, coastal areas, or climate change scenarios. For the same coastal area, an evaluation of the wind energy and of its expected dynamics was performed in [4]. The results indicated that the northwestern side of the Iberian Peninsula has significant wind energy resources and considering recent technological advances such as the development of floating wind platforms, this area is definitely a valid candidate for wind energy extraction in the very near future. Since these coastal areas also have considerable wave energy resources, they look very competitive from the perspective of the joint wind–waves projects.

Besides the Iberian coastal environment, various other marine areas were considered in *Energies* for an evaluation of the marine energy resources. As an example, an evaluation of wave energy in the Mediterranean Sea is presented in [5], together with the most relevant WECs which are currently tested in this sea. According to this work, conditions in the Mediterranean Sea were tested with devices with different wave powers (varying between 3 and 2500 kW). The essential features of 10 wave energy projects are further discussed. Italy is the Mediterranean country with the most significant activity in terms of wave energy extraction, followed by Greece, Israel and Gibraltar. It has to be highlighted at this point that this work represents the first relevant work describing the most recent developments of the wave energy industry in the Mediterranean Sea. The results also indicate that significant developments have occurred in the Mediterranean Sea for the MRE sector. Nonetheless, further development is still necessary to harvest MRE in this environment in order to become effective. Another relevant study related to the Mediterranean Sea is [6]. The objective of this work was to discuss the expected dynamics of wave energy due to climate change in the Mediterranean coast of Morocco. For this objective, various datasets were considered corresponding to the scenarios RCP4.5 and RCP8.5. The results indicated that the expected wave power is expected to be very similar in the future to that of the present. However, it can be noticed that in some particular areas a significant enhancement of the wave power variability is expected, especially in the case of RCP8.5. For the same Mediterranean coastal areas, in [7] a study based on some previous projects concerning the development of a wave energy converter, integrated as a vertical wall breakwater, is presented. The work assesses the power performance and the economic parameters of the installation considered. Furthermore, the authors also evaluated the payback period, which is in general between 10–15 years. When considering the reduction in CO_2 emissions, this approach appears to be very effective.

Going now to the Indian Ocean, the expected wave energy variations in the short and long term are discussed in [8]. Taking into account these objectives, simulations with wave models were carried out for the entire Indian Ocean and for various nearshore areas. The results indicated that the southern side of the Indian Ocean has higher wave energy potential and it appears to be more stable, both with regard to the short and the long term. On the other hand, the results indicated that more extreme events are characteristic to this part of the ocean.

Furthermore, focusing on wind energy and comparing offshore with onshore resources, the spatial–temporal estimation and analysis of Japan's onshore and offshore wind energy potential was analysed in [9] while in [10] a long-term assessment of onshore and offshore wind energy potentials of Qatar is presented. Both studies indicated the high importance of offshore wind in the future energy budget.

Finally, it has to be highlighted that *Energies* considers marine renewable energy as an important direction on the green road towards a low carbon future. The projections discussed in the above presented works indicate for many marine areas an enhancement in terms of average values of the wind and wave power as well as accelerated technological advancement, which will be coupled with large geographical extensions of MRE extraction. From this perspective, *Energies* will continue to focus on MRE issues and to present to its readers the most recent developments in this area.

Funding: No funding received for this editorial.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The author declares no conflict of interest.

References

1. A European Green Deal, 2019. Available online: https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en (accessed on 12 July 2022).
2. Rusu, L.; Rusu, E. Evaluation of the Worldwide Wave Energy Distribution Based on ERA5 Data and Altimeter Measurements. *Energies* **2021**, *14*, 394. https://doi.org/10.3390/en14020394.
3. Ribeiro, A.; de Castro, M.; Rusu, L.; Bernardino, M.; Dias, J.; Gomez-Gesteira, M. Evaluating the Future Efficiency of Wave Energy Converters along the NW Coast of the Iberian Peninsula. *Energies* **2020**, *13*, 3563. https://doi.org/10.3390/en13143563.
4. Ruiz, A.; Onea, F.; Rusu, E. Study Concerning the Expected Dynamics of the Wind Energy Resources in the Iberian Nearshore. *Energies* **2020**, *13*, 4832. https://doi.org/10.3390/en13184832.
5. Dialyna, E.; Tsoutsos, T. Wave Energy in the Mediterranean Sea: Resource Assessment, Deployed WECs and Prospects. *Energies* **2021**, *14*, 4764. https://doi.org/10.3390/en14164764.
6. Sierra, J.P.; Castrillo, R.; Mestres, M.; Mösso, C.; Lionello, P.; Marzo, L. Impact of Climate Change on Wave Energy Resource in the Mediterranean Coast of Morocco. *Energies* **2020**, *13*, 2993. https://doi.org/10.3390/en13112993.
7. Lavidas, G.; De Leo, F.; Besio, G. Blue Growth Development in the Mediterranean Sea: Quantifying the Benefits of an Integrated Wave Energy Converter at Genoa Harbour. *Energies* **2020**, *13*, 4201. https://doi.org/10.3390/en13164201.
8. Kamranzad, B.; Lavidas, G.; Takara, G. Spatio-Temporal Assessment of Climate Change Impact on Wave Energy Resources Using Various Time Dependent Criteria. *Energies* **2020**, *13*, 768. https://doi.org/10.3390/en13030768.
9. Delage, R.; Matsuoka, T.; Nakata, T. Spatial–Temporal Estimation and Analysis of Japan Onshore and Offshore Wind Energy Potential. *Energies* **2021**, *14*, 2168. https://doi.org/10.3390/en14082168.
10. Aboobacker, V.M.; Shanas, P.R.; Veerasingam, S.; Al-Ansari, E.M.A.S.; Sadooni, F.N.; Vethamony, P. Long-Term Assessment of Onshore and Offshore Wind Energy Potentials of Qatar. *Energies* **2021**, *14*, 1178. https://doi.org/10.3390/en14041178.