frontiers | Frontiers in Energy Research

TYPE Editorial
PUBLISHED 01 September 2022
DOI 10.3389/fenrg.2022.1002690

OPEN ACCESS

EDITED AND REVIEWED BY
David Howe Wood,
University of Calgary, Canada

*CORRESPONDENCE
Adem Akpınar,
ademakpinar@uludag.edu.tr

SPECIALTY SECTION
This article was submitted to Wind Energy,
a section of the journal
Frontiers in Energy Research

RECEIVED 25 July 2022
ACCEPTED 08 August 2022
PUBLISHED 01 September 2022

CITATION
Akpınar A, Rosa-Santos PJ and Carvalho D (2022), Editorial: Offshore wind and wave energy and climate change impacts.
Front. Energy Res. 10:1002690.
doi: 10.3389/fenrg.2022.1002690

Editorial: Offshore wind and wave energy and climate change impacts

Adem Akpınar[1]*, Paulo Jorge Rosa-Santos[2,3] and David Carvalho[4]

[1]Department of Civil Engineering, Bursa Uludağ University, Bursa, Turkey, [2]Faculty of Engineering of the University of Porto (FEUP), Porto, Portugal, [3]Interdisciplinary Centre of Marine and Environmental Research of University of Porto (CIIMAR), Matosinhos, Portugal, [4]Center for Marine and Environmental Studies (CESAM) and Physics Department, Aveiro University, Aveiro, Portugal

KEYWORDS

offshore wind energy, Ocean wave energy, wave energy converters, resource assessment, climate change impacts, multi-criteria analysis, offshore energy parks

Editorial on the Research Topic
Offshore Wind and Wave Energy and Climate Change Impacts

As a result of the increasing global energy demand and growing awareness of the repercussions of greenhouse gas emissions, the need for expanding renewable energy production has become clear in recent years. Therefore, renewable energy resources such as hydropower, geothermal, solar, wind, and wave energy have become even more popular. Offshore wind energy is already well-established, with several offshore parks in operation worldwide. However, there are still some challenges to face and opportunities to explore. The global wave energy resource is vast but largely untapped. Together, offshore wind and wave energy have the potential to contribute significantly to decarbonization of the present energy mix and energy self-sufficiency of many countries. As a result, and in view of the continuous development of wave energy converters and technologies for wind harvesting in deep waters, these resources can constitute an essential source of renewable energy to be exploited in high-potential areas. Therefore, the assessment of wave and wind resources, as well as the development of the corresponding harvesting technologies, is a very important task, not only for their exploitation as a power resource but also for their destructive effects in coastal zones.

Following up-to-date developments on wind and wave hindcasts/forecasts and atmospheric and climate models, more accurate offshore wind and wave energy potential assessment, energy generation determination, and climate change impact identification research is possible. On the other hand, significant research efforts are being carried out to improve the efficiency and reliability of the harvesting technologies, which should be designed to work efficiently under typical environmental conditions and withstand extreme conditions, which could be worse in the future due to the effects of climate change. The ultimate goal of these efforts is to reduce the levelized cost of the energy produced. In this context, this research topic on *Frontiers in Energy Research* aimed at creating a multidisciplinary forum of discussions and a technical compilation of the most recent advances in the fields of offshore wind and wave energy, energy generation by wave energy converters (WECs), and geo-spatial multi-criteria evaluation for installation of WECs in various marine environments and to identify possible climate change effects on offshore wind and wave energy.

The present collection of research articles reflects the most recent contributions on harvesting wind and wave energy. It includes four technical articles (Fang et al.; Jiang et al.; Susini et al.; Zheng et al.). These research works cover 1) a detailed investigation into the wave energy resource at a small-scale ocean energy test site in China (Fang et al.); 2) climatic trends of a series of key factors of wind energy in the global oceans, including wind power density (WPD), effective wind speed occurrence (EWSO), and rich level occurrence (RLO) (Zheng et al.); 3) climate change impact on the offshore wind energy over the North Sea and the Irish Sea (Susini et al.); and 4) development of a site selection method to identify the most suitable sea area for the construction of co-located offshore wind and wave farms (Jiang et al.).

Fang et al. implemented a nested modeling system to the test area using a SWAN (Simulating WAves Nearshore) numerical model to provide a 10-year high-resolution wave hindcast between 2009 and 2019 with an approximately 60 m resolution to understand the wave characteristics and the wave energy resource in China's National Ocean Integrated Test Site (NOITS). A statistical analysis of the high and extreme wave conditions and their occurrence was performed. By applying scaling methods to wave resources, four WECs were tested at different scale ratios in the NOITS. A strong seasonality of wave energy resource was found, with the mean wave power density of >1. 5 kW/m during winter and <0.2 kW/m during summer. The ideal scale factor for WEC testing was dependent on the WEC's specifications at full scale, the season in which the test is planned to be carried out, and the purpose of the test. Overall, the NOITS was considered suitable for testing WECs with lower-rated power or early-stage prototypes of higher-rated-power WECs.

Zheng et al. presented the climatic trends of a series of key parameters (WPD, EWSO, and RLO) of wind energy resources in the global oceans, including overall annual trends, regional difference and seasonal difference of the trend, abrupt changes, and variation of wind energy in the key region based on the ERA-Interim reanalysis winds for 1979–2014. The correlations between the wind energy and key oscillating phenomenon were also investigated. A positive wind energy trend was globally found for the past 36 years, with overall annual increasing trends in WPD, EWSO, and RLO. The areas distributed in the mid–low-latitude waters of global oceans and part of the southern hemisphere westerlies had significant increasing trends. The annual increasing trend of WPD was strongest in the southern westerlies, especially in the extratropical South Pacific. The annual increasing trends of EWSO and RLO were strongest in the tropical waters, especially in the tropical Pacific Ocean. There was no evidence of abrupt changes of wind energy in the extratropical waters globally and in the tropical Atlantic Ocean.

Susini et al. analyzed the impact of climate change on the offshore wind energy sector over the North Sea and the Irish Sea, where the majority of European investments are located. They evaluated seven regional climate model simulations from the EURO-Cordex project against the ERA5 reanalysis winds as the historical reference information, after its validation against *in situ* records. No significant differences between simulations were highlighted, so an ensemble of all the seven simulations was used to characterize future changes in the wind field climatological mean and extreme events using the RCP8. 5 scenario for the future period of 2081–2100 in the offshore climate. Using bias-corrected regional climate model simulations, by applying the empirical quantile mapping technique, future changes in six wind energy climate indicators (i.e., mean and extreme wind speed, wind power density, operation hours, gross energy yield, and capacity factor) were estimated for seven operating offshore wind farms. They indicated a slight decrease in wind energy production, particularly in the northwest of the domain of the study, testified by a reduction of all the climate indicators. However, large uncertainties in the projected changes were found at the wind farms located close to the south coast of the North Sea.

Jiang et al. proposed a site selection method to identify the most suitable sea area for the construction of co-located offshore wind and wave farms in Zhejiang, China. They first developed a geographic information system database to identify unsuitable areas for co-located offshore wind and wave farms. After that, a system of resource, economic, and technical selection indicators was established, and the Delphi method was used to determine the weight of each indicator. The sea areas suitable for construction of co-located offshore wind and wave farms were evaluated and ranked, and the order of power plant development was given. They illustrated the potential of developing co-located offshore wind and wave farms in Zhejiang, especially in the northern part of Zhoushan and the southern part of Taizhou.

Last, we would like to thank all the contributing authors and reviewers for their invaluable thoughts and insightful discussions. We also sincerely acknowledge the valuable support of the journal editors and the publication team behind them. Without their hard effort, this article collection would have never been possible.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note