ON THE POSSIBILITIES OF EXTRACTING MARINE RENEWABLE ENERGY IN THE ROMANIAN NEARSHORE

Girleanu Alina*, Rusu Eugen,
Department of Mechanical Engineering, "Dunarea de Jos" University of Galati, 111 Domneasca St., 80008 Galati, Romania,
*Correspondence e-mail: alina.girleanu@ugal.ro

The current pandemic crisis has tremendously shaken the economic world, raising many questions regarding energy systems. Nowadays, renewable energy resources represent a priceless part of the energy market, especially when considering the possibility of implementing intelligent energy systems that can provide a sustainable future. Since more than 70% of the planet's surface is covered by water, it is obvious that the marine power potential is extremely abundant, especially in the nearshore, where wave and wind resources can be efficiently harvested. Even though the coastal sectors located close to oceans are far more energetic, during recent years, it was considered viable the idea of developing marine wind-wave farms in enclosed basins, such as the Black Sea. Numerous studies have outlined that the most active area of the Black Sea from an energetic point of view is represented by the north-western part, including the Romanian nearshore.

The continually growing demand regarding the implementation of the renewable energy sector imposed by the European Union and at the same time reaching the ambitious target proposed by the European Green Deal of net-zero emissions of greenhouse gases by 2050 requires a significant enhancement of the renewable energy extraction throughout entire Europe. The number of offshore wind turbines and floating platform designs has constantly increased since 1991 due to substantial technological advances. Furthermore, wave power plays a significant role in the global energy portfolio, and more importantly, it has a higher density and predictability than wind and solar power. Since the primary purpose of a wave energy converter (WEC) farm is to extract energy from the waves, marine projects were also developed for effective coastal protection. The research group has already implemented a multi-level wave prediction system based on the SWAN (Simulating WAves nearshore) model, focusing on the western part of the sea. For the higher resolution coastal zone covering the Romanian nearshore, a multi-parameter assimilation scheme was developed. Consequently, apart from the significant wave heights (Hs), the mean-wave period (Tm) and mean direction (Dir) have been taken into account, considering a successive correction method on the conditions of the computational domain.

Since the offshore wind market has increased tremendously, accounting for more than 4% of the European Union's electricity demand, there has been extensive research regarding the future expected wind power resources along the target area until the end of the 21st century. One of the primary goal of the DREAM research group is to evaluate the marine energy resources within the Black Sea coastal environment, considering the wind speeds provided by the Swedish Meteorological and Hydrological Institute (SMHI) in the International Panel on Climate Change (IPCC) Fifth Assessment Report (AR5). The standard set of climatic scenarios used in the AR5 is

known as Representative Concentration Pathways (RCPs), which describe in a detailed manner four different 21st -century pathways of greenhouse gas emissions. Thus, a stringent scenario is included (RCP 2.6), two intermediate strategies (RCP 4.5 and RCP 6.0), and the worst-case scenario (RCP 8.5). Situations with no additional measures to constrain gas emissions will eventually lead to pathways ranging from RCP 6.0 and RCP 8.5, while the most optimistic case represented by RCP 2.6 targets to maintain global warming below 2℃ above pre-industrial temperature. Having analyzed the historical data provided by the Climate Model Intercomparison Project Phase 5 (CMIP5) for the time interval between 1986 and 2005 for the Black Sea basin, the results seem reliable enough, providing at the same time as a mean of comparison with the expected wind climate. Considering its wave power potential and comparing it to the ocean environment, the Black Sea cannot be regarded as resourceful. However, the Black Sea's offshore wind resource is plentiful, comparable to coastal areas where marine wind farms are entirely and successfully operational. Overall, the project's primary goal is to provide an insight into the future changes in the wind and wave climate and a more comprehensive view of the offshore opportunities that the Black Sea basin offers. Therefore, these steps will help reach the European Union's ambitious energy and climate targets – net-zero emissions of greenhouse gases by 2050. From this perspective, extracting marine renewable energy and developing state-of-the-art renewable energy technologies become some of the most viable solutions.

Keywords: renewable energy, marine energy farms, wind power, wave power, coastal environment, climate change, RCP scenarios.

Acknowledgment: This work was carried out in the framework of the research project DREAM (Dynamics of the REsources and technological Advance in harvesting Marine renewable energy), supported by the Romanian Executive Agency for Higher Education, Research, Development and Innovation Funding – UEFISCDI, grant number PN-III-P4-ID-PCE-2020-0008.

References

Girleanu, A., Rusu, E., 2021, 'An evaluation of the main physical features and circulation patterns in the Black Sea basin', *Journal of Marine Science*, Volume 03, Issues 01; https://ojs.bilpublishing.com/index.php/jms/article/view/2552

Girleanu, A., Onea, F., Rusu, E., 2021, 'The efficiency and coastal protection provided by a floating wind farm operating in the Romanian Nearshore, 6th International Conference on Advances on Clean Energy research (ICACER 2021), Barcelona, Spain, http://www.icacer.com/index.html, work accepted for further publication in *Energy Reports*, https://www.jornals.elsevier.com/energy-reports.

Majidi, A., Bingolbali, B., Akpinar, A., Rusu, E., 2020, 'Wave power performance of wave energy converters at high-energy areas of a semi-enclosed sea', *Energy*, Volume 220; https://doi.org/10.1016/j.energy.2020119705

Makris, C., Galiatsatou, P., Tolika, K., *et al*, 2016, 'Climate change effects on the marine characteristics of the Aegean and Ionian Seas', *Ocean Dynamics*, 66:1603–1635.

Onea, F., Rusu E., 2014, 'Wind energy assessments along the Black Sea basin', *Meteorological Applications*, Vol 21, Issue 2, pp. 316-329.

Onea, F., Rusu, E., 2016, 'Efficiency assessments for some state of the art wind turbines in the coastal environments of the Black and the Caspian seas', *Energy Explor. & Exploit.*, Vol 34 (2), pp. 217-234.

Onea, F., Ciortan, S., Rusu, E., 2017, 'Assessment of the potential for developing combined wind-wave projects in the European nearshore', SAGE Journals, *Energy & Environment*, 2017, 010.

Onea, F., Rusu, E., 2018, 'Sustainability of the Reanalysis Databases in Predicting the Wind and Wave Power along the European Coasts', *Sustainability* Journal.

Onea, F., Ruiz, A., and Rusu, E., 2020, 'An Evaluation of the Wind Energy Resources along the Spanish Continental Nearshore', *Energies*, Volume 13(15), 3986; https://doi.org/10.3390/en13153986

Ruiz, A., Onea, F., and Rusu, E., 2020, 'Study Concerning the expected dynamics of the wind energy resources in the Iberian Nearshore', *Energies*, Volume 13(18), 4832; https://doi.org/10.3390/en13184832

Rusu, E., 2019 'A 30-year projection of the future wind energy resources in the coastal environment of the Black Sea', *Renewable Energy*, Volume 139, Pages 228-234.

Rusu, E., 2020, 'An evaluation of the wind energy dynamics in the Baltic Sea, past and future projections', *Renewable Energy*, Volume 160, Pages 350-362; https://doi.org/10.1016/j.renene.2020.06.152

Rusu, E., Onea, F., 2016, 'Study on the influence of the distance to shore for a wave energy farm operating in the central part of the Portuguese nearshore', *Energy conversion and management*, Volume 114, Pages 209-223; http://dx.doi.org/10.1016/j.enconman.2016.02.020

Rusu, E., Onea, F., 2019, 'A parallel evaluation of the wind and wave energy resources along the Latin American and European coastal environments, *Renewable Energy*, Vol. 143, Pages 1594-1607.

Rusu, L., 2020, 'A projection of the expected wave power in the Black Sea until the end of the 21st century', *Renewable Energy*, Volume 140, Pages 136-147; https://doi.org/10.1016/j.renene.2020.06.092

Rusu, E., Rusu, L., 2019, 'Evaluation of the wind power potential in the European nearshore of the Mediterranean Sea', International Conference on Advances on Clean Energy Research (ICACER 2019; 10.1051/E3SCONF/201910301003