WORKSHOP

DREAM Project - Dynamics of the REsources and technological Advance
in harvesting Marine renewable energy - PN-III-P4-ID-PCE-2020-0008
Galaţi, ROMANIA, 11 June 2021

THE EXPECTED DYNAMICS OF THE WIND POWER RESOURCES IN THE EUROPEAN NEARSHORE

Rusu Eugen,

Department of Mechanical Engineering, "Dunarea de Jos" University of Galati, 111 Domneasca St., 80008 Galati, Romania, e-mail: erusu@ugal.ro

Starting with 1991 when the first offshore wind farm (Vindeby) was installed by Denmark in the Baltic Sea; offshore wind has had a spectacular advance. If refer only to the European Union, the currently installed capacity for offshore wind is of 12GW (by the end of 2020) while very ambitious targets are set in the framework of the European Green Deal for the near future. Thus, a 60GW capacity is expected to be installed in the European nearshore by 2030, while by 2050 the target is 300GW. Such ambitious targets imply significant technological advances, but also implementation at a much larger scale of the marine wind energy farms. This includes either fixed-foundation wind turbines, operating in relatively shallow water, as well as floating wind turbines, which are now still in an early phase of development and deployment, for deeper waters. Under these circumstances, the expected dynamics of the wind power resources in the most relevant European coastal environments from the point of view of wind energy extraction represents an issue of increasing importance.

The research group of the DREAM project has already performed some preliminary studies concerning the assessment of the expected wind conditions in the Baltic, North, Mediterranean and Black Seas and also for the Iberian nearshore at the Atlantic Ocean. These were focused on the 30-year period 2021-2050 especially considering the climate scenarios RCP4.5 and RCP8.5. Furthermore, in order to have a valid criterion of comparison various 30-year periods for the recent past have been also considered for analyses. The results indicate a slight enhancement of the average wind power in the Baltic Sea and this is relevant information since in the Baltic Sea already operate more than 20 wind farms and several new wind projects are expected to be implemented there in the very near future. A more significant increase of the wind power (approximately between 10% and 40% in relationship with the present) is expected in the near future in the North Sea. At this point it has to be highlighted that the North Sea is already the most important source in Europe as regards the offshore wind energy extraction, with more than 40 wind farms currently operating. Taking into account the expected wind dynamics in this coastal environment, a significant increase of the number of the wind farms in this area seems very logical. Furthermore, some giant projects are planned also there since Denmark has approved plans to build the world's first artificial energy island in the middle of the North Sea. This green energy hub will at first provide and store enough green energy to power three million European households. The north-western part of the Iberian nearshore has also relevant wind conditions. At this moment only the WindFloat Atlantic pilot project, which developed an innovative technology to the exploitation of wind potential at sea at depths of more than 40m, is operating. However, a moderate enhancement of the average wind power is also expected and this is very encouraging from the perspective of the extension of the wind energy extraction in this nearshore. The European coastal environment of the Mediterranean Sea and the western side of the

Black Sea indicate also a moderate relative enhancement of the average wind power and there are various nearshore areas that are suitable for future wind energy extraction.

From this perspective, a more systematic research of the wind power dynamics is proposed in the framework of the DREAM project. Thus, three large European geographical areas are mainly targeted. The first is represented by the Baltic and North Seas. As specified, these two seas are very representative for the offshore wind energy. The second includes especially the Iberian coastal environment. Due to the high waves that are characteristic, this area can be considered as having a high potential in relationship with the joint marine energy resources. Finally the third target area is the Black Sea, focused on its western side. The objective is to assess the future expected wind conditions for the target areas considered corresponding to two different time intervals each of 40 years. These are NF (near future, the interval 2021-2060) and DF (distant future, the interval 2061-2100). Three RCP climate scenarios RCP2.6, RCP4.5 and RCP8.5 will be considered for NF and DF time intervals. In parallel, another 40-year period (1980-2019) denoted as the recent past (RP) will be considered for providing a benchmark.

Keywords: marine renewable energy, wind power, climate change, RCP scenarios, extreme events

References

Makris, C., Galiatsatou, P., Tolika, K., et al, 2016, Climate change effects on themarine 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., Onea, F., 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 2020, 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* 2020, *13*(18), 4832; https://doi.org/10.3390/en13184832

Rusu, E., A 30-year projection of the future wind energy resources in the coastal environment of the Black Sea, *Renewable Energy*, Volume 139, August 2019, 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, November 2020, Pages 350-362, https://doi.org/10.1016/j.renene.2020.06.152

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

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

"Dunărea de Jos" University of Galaţi, Department of Mechanical Engineering, 111 Domnească Street, web: www.dream.ugal.ro

2/2