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EDITORIAL

Harvesting Offshore Renewable Energy an Important Challenge for the European Coastal Environment

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In the last decades significant changes in the climate are noticed and it becomes obvious that these dynamics are strongly influenced by recent human development. From this perspective, there is an increasing concern regarding the possible evolution of the climate and various possible scenarios have been designed and analysed. Thus, in 2014 the Intergovernmental Panel on Climate Change (IPCC) adopted the Fifth Assessment Report, where the concept of Representative Concentration Pathway (RCP) was introduced for climate modelling. This is a greenhouse gas concentration trajectory labelled after the expected values of the radiative forcing by the end of 2100.

However, the last years' climate developments showed that even the worst scenarios can be exceeded by reality, and various chain effects may occur having locally much more significant impacts than those indicated by the RCP scenarios. Under such circumstances, it becomes obvious that the RCP approach should be completed somehow, and that is why a new and more complex concept has been defined in 2021, in the context of the Sixth Assessment Report of IPCC. This is called the Shared Socioeconomic Pathway (SSP) and provides a holistic picture of climate change in the general context of society development.

A real race started for decarbonisation and to follow the green road in a more consistent way. Almost three-quarters of the greenhouse emissions are generated by the energy sector, while there is worldwide an increasing

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energy demand [1]. From this perspective, it becomes clear for many responsible factors all over the world that rapid and effective measures have to be taken in replacing conventional energy sources based on fossil-fuelled with green energy. Following this trend, the European Union (EU) adopted 2019 the European Green Deal (EGD), which draws the most significant directions to be taken by the EU for rapid and effective decarbonisation of the energy sector [2].

While the land is almost saturated as regards renewable energy extraction, there are large spaces in the marine environment and it is available a huge green energy potential. From this perspective, special attention is paid to Offshore Renewable Energy (ORE). While offshore energy is used to refer to all sources of energy that can be extracted from the ocean, including both renewable sources and fossil-based (for example gas and oil), ORE refers only to the sources of renewable energy that can be extracted from the marine environment. This includes wind, waves, tides, currents, thermal and salinity gradients, floating solar panels and algae-based biofuels. Ocean energy (OE) includes waves, tides and currents, and thermal and salinity.

According to EGD, very ambitious ORE targets are established for 2050. This implies for offshore wind (OW) an installed capacity of 300 GW, a 25 times enhancement in relationship with 2021. The EU target for OE is 40 GW, and since the basis is quite low (13 MW), this means a more than 3000 times enhancement in relationship with 2021. Such very challenging targets for a 30-year time window imply both large geographical extensions as well as significant technological advances.

Some considerations concerning the existent resources and the expected future renewable energy potential in the European coastal environment will be presented next, highlighting also the environmental and technological challenges that have to be faced in the harsh marine environment in the context of climate change.

The northern seas of Europe, the Baltic and North Seas, represent already reliable ORE sources with almost 60 wind farms operating there. Actually, the Baltic Sea is the pioneer in its relationship with offshore renewable energy extraction, since Denmark installed there in 1991 the first offshore wind farm in the world. Baltic Sea has a significant wind power potential and the climate scenarios indicate a slight enhancement in the near future of the average wind energy. The most significant wind power potential is noticed in the North Sea, where average wind power values higher than 1000 W/m^2 are characteristic of large geographical spaces [3]. Furthermore, the climate scenarios indicate that a significant enhancement of wind power is expected in the future with the tendency of the energy peak to move from the north-eastern to the north-western side of the sea.

A very resourceful marine area is represented by the western European coastal environment, where some tidal power plants are already operational and others are currently at the proposal stage together with power plants based on salinity gradients. In this western side of the continent, the Iberian coastal environment represents a significant nearshore from the point of view of ORE potential and of the resources' complementary [4]. This includes wind, wave, tide, and offshore solar energy.

An area with high unexploited potential from the ORE point of view is represented by the Mediterranean Sea, where the first offshore wind farm project became operational in 2022. Several studies [5] indicate hot spots, from the point of view of the wind energy potential, large geographical spaces from the Mediterranean Sea, such as the Gulf of Lion, the Aegean Sea and the southeast of the Iberian nearshore, where average wind power densities higher than 800 W/m^2 are characteristic. Furthermore, the climate projections indicate that in these areas the average wind and solar power is not expected to decrease. As regards the Black Sea, its western side is more energetic and it has very similar characteristics to the Mediterranean Sea.

Although harvesting wind energy is based on mature technologies, there are still expected significant advances. The largest wind turbine in the world, with a rated power of 16 MW, is expected to become fully operational in 2026, and further on the race to the 20 MW wind turbines seems to face no significant obstacle. An emerging technology is related to floating solar panels, which are expected to have a very rapid development in the near future and this development will require significant challenges from the point of view of developing sustainable marine structures.

Conflict of Interest

There is no conflict of interest.

References

[1] Ostergaard, P.A., Duic, N., Noorollahi, Y., et al.,