Developing Floating Wind Farms

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Floating wind is becoming an essential part of renewable energy, and so highlighting perspectives of developing floating wind platforms is very important.

Keywords: renewable energy ; floating platforms ; wind

1. Introduction

Floating wind is currently a leading candidate for renewable energy in many countries around the world, as governments and companies investing large financial resources into developing floating wind projects. The purpose of this research is to present all the corresponding projects in the world, their implemented wind turbine types and corresponding concepts, as this will make a very significant contribution to understanding the floating wind situation around the world.

Renewable energy has become essential to efforts to respond to the increasing world population, and its corresponding demand for energy. It is also seen as essential to stop the reliance on fuels and eliminate pollution and climate change [1].

Renewable energy is also a way to prevent countries with oil and gas resources from becoming economically and politically dominant over countries that lack these resources [2].

Unlike oil and gas energy, renewable energy is carbon-free and limitless, which makes it the perfect solution to both climate change and population growth [2].

While onshore wind energy is currently the cheapest source of renewable energy, it has weaker and more turbulent wind speeds, compared to its offshore counterpart, which is anticipated to dominate in the years to come. Floating wind projects are therefore expected to be constructed in high water-depth areas [1].

From this perspective, the European Union will need 450 GW of offshore wind by 2050 to achieve its complete decarbonization, a substantial increase onits current corresponding power capacity of 25 GW [3].

The European Union must develop 150 GW of floating wind to be carbon neutral by 2050, which is likely to happen, both due to the available financial resources and the substantial efforts of the specialized floating wind companies [4].

Europe currently has 318 MW of floating wind from 34 corresponding concepts, compared to the rest of the world, which has 32 MW power capacity from 16 concepts. Floating wind cumulative capacity is currently led by the European Union, whose future investments will facilitate its industrialization process and reduce the capital expenditures (CAPEX) of future floating wind projects [4].

In 2030, France plans to have 750 MW of floating wind power capacity, the UK plans to have 1 GW, Norway plans to have 1.5 GW (or 3 GW [5]), and Portugal plans to have 275 MW [6], a substantial increase on current floating wind capacities of 114 MW in France, 80 MW in the UK, 95 MW in Norway, and 30 MW in Portugal. The US currently has 12 MW, and Japan has a 20 MW corresponding power capacity [4].

Floating wind projects will be implemented in areas where their offshore bottom-fixed counterparts are not feasible, due to their corresponding negative assembly impact on the marine environment and limited water-depth capacities. Floating wind projects have exceeding water-depth capacities and have less of environmental impact because of their early assembly in the ports. Further, floating wind turbines are on their way toward industrialization, making them cost competitive with their offshore bottom-fixed counterpart [4]. Offshore bottom-fixed turbines are generally limited to water depths of roughly 100 m, while their floating counterparts can be extended to kilometers of water depths.

The conversion of both the existing European infrastructures of oil and gas and bottom-fixed offshore wind will contribute to Europe becoming the world's floating wind leader. Europe is currently planning to take the lead in the floating wind supply chain areas, which will produce tremendous job creation in field areas that include electrical cabling, mooring, and installation. The outcome will be significant when the floating wind global market obtains 18,000 GW in the future [4].

The floating wind levelized cost of energy (LCOE) will be 250 euros/MWh when the floating wind capacity reaches 0.5 GW, and will drop to 50 euros when the floating wind capacity approaches 4 GW in 2030 [7].

2. World's Spar-Buoy FloatingWind Concepts

One of the most widely used floating wind spar-buoy concepts is Hywind [8], which is designed by Equinor and constructed of either steel or concrete material. Advanced Spar [9] and Sea Twirl [10], which are also well-known, are developed by JMU and Sea Twirl, respectively, and are both made of steel. Stiesdal Tetra Spar [11] and Fukushima Forward [12][13] are other spar concepts worth mentioning. They are developed by Stiesdal and JMU, respectively, and are both made of stell. Toda Hybrid Spar [14] is also a Spar floating wind concept that is developed by Toda, and is a hybrid that is made of a combination of steel and concrete.

3. World's Semi-Submersible Floating Wind Concepts

One of the most widely used floating wind semi-submersible concepts is Wind Float [15], which is designed by PRINCIPLE-POWER and made of steel. VOLTURNUS [16], OO-Star [17], and Tri-Floater [18] are also well-known floating wind semi-submersible concepts developed by the University of Maine, Iberdrola, and Gusto MSC, respectively. The first two are made of concrete, and the third is made of steel. Cobra Semi-Spar and SCD NEZZY [19] are also semi-submersibles made of concrete that have been developed by Cobra and SCD Technology, respectively. Hexa-Float [20], EOLINK, Nautilus [21], Tri-Floater, and Truss Float [22] are also floating wind semi-submersibles made of steel that have been developed by Saipem, EOLINK, Nautilus floating solutions, Gusto MSC, and DOLFINES, respectively. Sea Reed [23] is also a floating wind semi-submersible floating wind concept that is made of either steel or concrete (or both, in a hybrid) that has been developed by Naval Energies.

4. World's Barge, TLP, and Multi-Turbine Floating Wind Concepts

One of the most widely used barge floating wind concepts is the IDEOL Damping Pool Barge, which was designed by IDEOL and is made of either steel or concrete. SAITEC SATH (Swinging Around Twin Hull) is a Barge floating wind concept that was developed by SAITEC, and is made of concrete.

One of the most widely used floating wind TLP concepts is TLPWIND [24] which was designed by Iberdrola, and is made of steel. SBM [22], Pivot Buoy [25], and PelaStar are also TLP concepts that are made of steel and were designed by SBM Offshore, X1 Wind, and GLOSTEN, respectively. GICON [26] is a TLP floating wind concept that is made of concrete and was designed by GICON.

One of the most widely used multi-turbine floating wind concepts is the HEXICON multi-turbine semi-submersible [27] which was designed by HEXICON and is made of steel. W2Power [28] and Floating Power Plant [29] are multi-turbine concepts that are made of steel and were developed by EnerOcean and Floating Power Plant, respectively.

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