【欧州】【海事】

Maritime Issues – Renewable energy including offshore wind power generation: The offshore wind farms' potential to become a main source of power generation in Europe

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【概要：Summary】

Based on the Paris Agreement and the EU's long-term CO2 emission reduction target to reduce CO2 emissions by 80%-95% by 2050 below the 1990 figures, significant changes in the energy generation towards renewable energy sources will become necessary. The utilisation of wind power as renewable energy source is one of the key elements to achieve this reduction of CO2 and other emissions. Offshore wind installations are considered more powerful than onshore wind farms, as they benefit from the ever-larger turbines and the more reliable wind speeds farther away from shore. In Europe, offshore wind technology began its development, with the Vindeby Offshore Wind Farm, in 1991. For the next decades, the offshore wind farms are expected to further expand in Europe, and they are expected to play a big role in reaching the EU's climate and renewable energy targets. According to the International Energy Agency (IEA), offshore wind could become the major source of power generation in Europe by 2042. Regarding the current development of offshore wind installations, it can be expected that Europe will further increase its grid-connected offshore wind capacity, including the utilisation of new technologies like floating offshore wind farms. Floating wind turbines will allow for the breakthrough of offshore wind farms because these platforms have less water depth constraints than the bottom-fixed turbines. Floating wind turbines can be installed further away in places at sea with a depth of more than 60m, which were previously inaccessible as wind farm locations.

Image of offshore wind farm
Photo by Daniel Lee on Unsplash

【記事：Article】

1. Background of offshore wind power generation

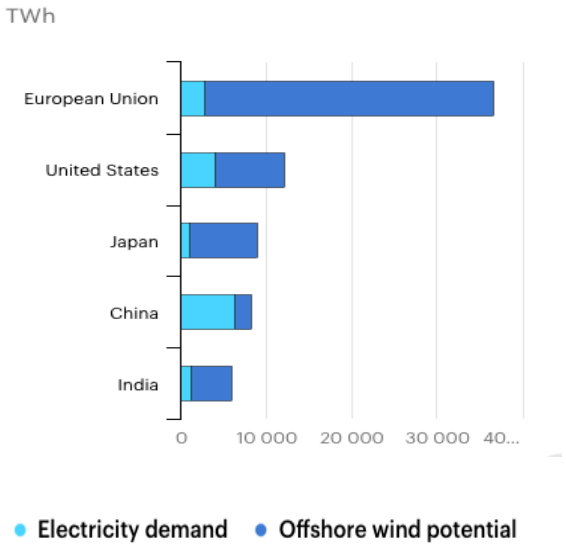
In the Paris Agreement, the EU committed to reduce its GHG emissions significantly in order to mitigate the impacts of climate change. The EU has set its long-term 2050 target of reducing CO2 emissions by 80%-95% below the 1990 figures. In order to reaching

this target, the dependence on fossil fuels needs to be reduced and renewable power generation systems need to become the main source of energy. Renewable energy can be produced from a wide variety of sources including wind, solar, hydro, tidal, geothermal, and biomass. In Europe, wind energy is an essential element of power generation from renewable energies. The energy generation by wind turbines is expected to overtake coal, nuclear and gas as the EU's largest power source. Offshore wind installations are seen as the key element for the expansion of renewable energy generation. In Europe, offshore wind technology began its development with the Vindeby Offshore Wind Farm, in 1991. The idea to go offshore was born out of the lack of space for the development of large onshore wind projects in the densely populated areas of Western Europe and to use the stronger and more stable winds at sea.

In 2009, the European Environment Agency (EEA) presented a report entitled "Europe's onshore and offshore wind energy potential" to evaluate the Europe-wide resource assessment of onshore and offshore wind potential. The EEA report confirmed that wind energy could play a major role in achieving Europe's renewable energy targets. However, the analysis' results also showed uncertainties regarding the expansion of offshore wind farms, particularly as due to the existing restrictions imposed by shipping lanes, gas and oil platforms, military areas, and environmentally protected areas. In order to utilise the up to 80% of offshore wind resources in areas with deep waters of 60 metres and more, the new technology of the floating wind-farm needs to be utilised.

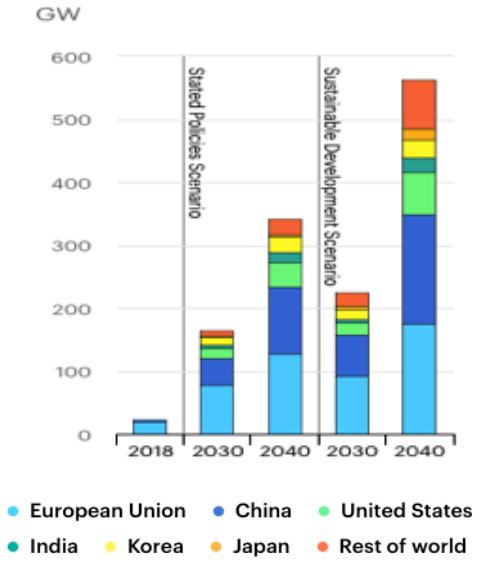
2. Future offshore wind farms' capacity scenarios

The global offshore wind market grew nearly 30% per year between 2010 and 2018, benefitting from rapid technology improvements. Europe in particular has fostered the development of offshore wind installations, as in European countries bordering the North Seas, high quality wind resources and relatively shallow water have provided exceptionally good conditions to develop offshore wind technologies. However, according to the International Energy Agency (IEA)'s report entitled "World Energy Outlook 2019", currently, the global offshore wind market does not even come close to using the full potential of power generation by using offshore wind. The report includes an analysis of the future development of the renewable energy and offshore wind capacity. The IEA report analyses the technical potential of offshore wind to meet electricity demand in several countries and regions worldwide. According to the IEA report, offshore wind has the potential to generate more than 420 000 TWh per year worldwide. Therefore, much work remains to be done by governments and industry for exploring the real potential of this source of clean energy.



Graph 1: Offshore wind technical potential and electricity demand, 2018 (IEA)

Source: IEA (2019), "Offshore Wind Outlook 2019", IEA, Paris https://www.iea.org/reports/offshore-wind-outlook-2019



Graph 2: Installed capacity of offshore wind by region and scenario 2018-2040 (IEA)

Source: IEA (2019), "World Energy Outlook 2019", IEA, Paris https://www.iea.org/reports/world-energy-outlook-2019

The IEA report also provides a set of scenarios that explore different possible futures of wind installations' capacity. The IEA report distinguishes between the Stated Policies Scenario, which incorporates today's policy intentions and initiatives that have already been announced by countries on the one hand, and the Sustainable Development Scenario, which shows what would be a way to meet sustainable energy goals in full, on the other hand. The IEA report shows that currently, the European Union is leading the expansion of offshore wind capacity in the stated policies scenario, followed by China. According to IEA, the increasingly cost-competitive offshore wind projects are on course to attract increasing investment towards 2040, which is underlined by the stated policies scenario. However, it will need further innovations, including floating turbines that can open up new resources and markets, to accelerate the offshore wind generation and to meet sustainable energy goals in full under the Sustainable Development Scenario.

3. Expansion of offshore wind installations in Europe

According to WindEurope, offshore wind is expected to produce 7% to 11% of the EU's electricity demand by 2030. However, this is only a fraction of the wind resource potential available in the European sea basins.

In order to contribute to achieving the long-term CO2 emission reduction goals, the offshore wind industry needs to expand to at least 30 GW by 2035. In reality, Europe is expected to have 25GW of grid-connected offshore wind capacity in 2020, according to WindEurope's report "The European offshore wind industry". These latest figures suggest that the expansion of offshore wind energy is continuing successfully. In 2018, the UK and Germany accounted for 85% of the installations: 1.3 GW and 969 MW respectively. Europe now has a total installed offshore wind capacity of 18,499 MW. In the first half of 2019, the expansion of offshore installations continued, with new installations in the UK (931 MW), Denmark (374 MW), Belgium (370 MW) and Germany (252 MW), among others.

Regarding the future development, according to a new WindEurope report, entitled "Our Energy. Our Future", the European Commission estimates that 450 GW of offshore wind power generation would meet 30% of Europe's electricity demand in 2050. However, this would require an enormous scaling up from the currently 20 GW of offshore wind operating in Europe to 450 GW by 2050. This 450 GW vision for offshore wind by 2050 requires a significant increase in the annual installation rate for wind turbines. The WindEurope report states that 212 GW should be deployed in the North Sea, 85 GW in the Atlantic (including the Irish Sea), 83 GW in the Baltic, and 70 GW in the Mediterranean and other Southern European waters. This would also reflect the relative wind resources, proximity to energy demand and location of the supply chain.

However, currently, Europe installs only around 3 GW per year and this figure would have to be increased

to 7 GW per year by the second half of the 2020s. After 2030, over 20 GW per year for the offshore wind industry would have to be installed in order to achieve the 2050 target. Investments in offshore grids would need to increase from less than €2 billion in 2020 to up €8 billion per year by 2030.

European governments must be more determined and decisive to enabling higher levels of deployment of offshore wind power generation, starting now. However, more offshore wind farm activities in European seas will lead to increased spatial demands and growing competition between sea users. Authorities should allow different activities to take place within and around offshore wind farms in order to increase the functionality of their locations at sea, as multi-use of space will be increasingly necessary. Furthermore, the electricity grid infrastructure in Europe has also to anticipate major growth in both offshore and onshore wind energy, which will require the expansion of offshore grids and the reinforcements of onshore grids.

In 2016, the North Seas Energy Cooperation, including Belgium, Denmark, France, Germany, Ireland, Luxembourg, the Netherlands, Norway, Sweden and the UK, signed a political declaration regarding the development of an offshore grid linking the wind power generation countries in the North Seas. The countries reaffirm their commitment to cooperating for achieving the two goals of facilitating the cost-effective deployment of offshore renewable energy, and to promoting interconnection between the countries in the region. The declaration emphasises the importance of voluntary cooperation, with the aim of securing a sustainable, secure and affordable energy supply for the North Seas countries. Also the Baltic Energy Market Integration Plan (BEMIP) needs to step up the work on offshore wind.

Meanwhile, the 10 North Seas Energy Cooperation countries agreed at their Ministerial meeting in Esbjerg in June 2019 to broaden the scope of their cooperation on maritime spatial planning, electricity grids and developing hybrid and joint offshore wind farms. In their 2020 Work Programme, the 10 countries have committed to assessing the current framework for offshore wind farms that have a grid connection to more than one country and to identify possible obstacles. The countries have also recognised that space in the North Seas is “finite”, and they will collaborate on maritime spatial planning to “be able to utilise the energy potential of the North Seas”. The countries will better coordinate the planning and development offshore (and onshore) electricity grid expansion and they will develop “concrete plans” for potential joint cross-border offshore wind farms.

4. Exploring the potential of floating wind farms

The expansion of offshore wind installations is seen as an indispensible part of the shift towards renewable energies to reduce the global CO2 emissions in energy production. However, the problem of offshore wind installations is that conventional bottom fixed wind turbines are usually not suitable for constructing wind farms in deep-water areas with a depth of more than 60m. On the other hand, up to 80% of the offshore wind resources can be found in areas with deep waters of 60m and more. Therefore, the relatively new technology of floating offshore wind turbines needs to be pushed ahead to unlock new locations for wind power generation at sea. Floating installations allow to expanding the wind power generation into new deep-water areas, opening vast new areas and markets currently unavailable for offshore wind. Floating structures are also less intrusive to the seabed than bottom fixed structures, and provide the potential for increased standardisation and mass-production in the longer term.

As the International Renewable Energy Agency (IRENA) noted, several countries have set specific targets for floating offshore wind. In Europe, floating offshore is expected to become a sizable part of the 450-GW European target for offshore wind. According to IRENA’s projections, floating wind farms could

cover about 5% to 15% of the global offshore wind installed capacity by 2050. As IRENA also pointed out in its October 2019 report entitled "Future of Wind", there is great potential for the floating wind turbines to offer a lower-cost and environmentally beneficial alternative to bottom-fixed installations. The world's first floating wind farm was installed off the coast of Peterhead, Scotland, in the Statoil Masdar's 30MW Hywind project in 2017. The experiences from Hywind Scotland can be expected to open up new global market opportunities for floating offshore wind farms. However, from the economic perspective, commercially used floating wind turbines are still at the early phase of deployment. In fact, the floating wind farms still need financial support in order to accelerate the clean energy transition. The key challenges for floating offshore wind projects is to access to the significant amount of capital and to find potential investors. Therefore, the European Commission and the EIB financially support floating offshore wind farm projects in their construction but also in their operation phase. Finally, grid connection is a challenge for the entire offshore wind sector. The distance to shore and the availability of networks at the point of connection are a bottleneck hampering both floating and bottom-fixed offshore wind installations. In case of floating wind installations, the mooring system and the dynamic electrical cable are crucial parts and the industry needs to reduce the cost of such key components as well as the related offshore operations. Monitoring the aging of the floating substructure under cycling loads can significantly contribute to cost reduction through lifecycle management. Furthermore, in waters deeper than 100m, it is difficult to fix the cables to the seabed and different solutions need to be investigated.

In 2018, the European Commission supported the construction of a floating wind farm in Portugal. On 19 October 2019, the first turbine from the WindFloat Atlantic project was successfully towed to its destination 20 km off the coast of Viana do Castelo in Portugal. Two more floating turbines will be added in the coming months. In February 2019, the European Commission approved also a French plan for four demonstration projects of floating wind farms in the Atlantic Ocean and in the Mediterranean Sea. Fully commercialised, the floating wind farm concept is expected to greatly contribute to the EU's renewable energy targets. However, the floating offshore wind energy projects still urgently need action from the EU and Member States. The EU Member States should coordinate their schedules of capacity deployment and supporting policies for floating wind farms.

The European institutions, and in particular the European Commission and the European Investment Bank (EIB) can play a decisive role in the facilitation of the financing. They should earmark funding instruments targeted to provide access to financing for floating in farms.

Table 1: Announced pre-commercial Floating wind farm projects in Europe (to be commissioned in the next 5 years)

Wind Farm Name	Country	Capacity (MW)	Commissioning date
Hywind Scotland	United Kingdom	30	2017 (in operation)
Windfloat Atlantic	Portugal	25	2019
Flocan 5 Canary	Spain	25	2020
Nautilus	Spain	5	2020
SeaTwirl S2	Sweden	1	2020
Kincardine	United Kingdom	49	2020
Forthwind Project	United Kingdom	12	2020
EFGL	France	24	2021
Groix-Belle-Ile	France	24	2021
PGL Wind Farm	France	24	2021
EolMed	France	25	2021
Katanes Floating Energy Park -Array	United Kingdom	32	2022
Hywind Tampen	Norway	88	2022

Source: Floating offshore wind energy. A policy blueprint for Europe. In: https://windeurope.org/wp-content/uploads/files/ policy/position-papers/Floating-offshore-wind-energy-a-policy-blueprint-for-Europe.pdf

Finally, the EU should earmark a dedicated budget for large-scale floating wind farms in the upcoming

Multiannual Financial Framework in the Investment EU programme, the Innovation Fund and Modernisation Fund. With the right policy measures, the floating wind farm projects could really take off over the next five to ten years.

5. Outlook

In order to achieve its carbon neutrality by 2050, Europe will have to transform its energy system by replacing fossil fuels with renewable energy across all economy sectors. An ambitious expansion of the European offshore wind installations for power generation is expected to take place in the next decades. Currently, the offshore wind capacity in Europe is at about 20 GW, with 105 wind farms and 4,500 turbines of almost all bottom-fixed installations. However, more sites will become suitable for offshore wind power generation installations also in deeper waters of more than 60m with the wider deployment of floating wind farms. Floating turbines are now being tested in Scotland Portugal and France.

The expansion of offshore wind farms can be expected to further continue also because of decisions like the recent one of the European Investment Bank (EIB), to stop funding most of the fossil fuel projects by 2021, assuming that this investment is going to renewable energies. The target is to increase offshore wind capacity to nearly 130 GW by 2040, or even to around 180 GW, in order to becoming Europe's largest single source of energy. In order to achieve this target, the construction of offshore wind farms will have to be decisively pushed ahead, in quantity, size and power capacity.

References:

BUILDING A LOW-CARBON, CLIMATE RESILIENT FUTURE: SECURE, CLEAN AND EFFICIENT ENERGY, Call ID: H2020-LC-SC3-2018-2019-2020. In: https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/lc-sc3-ja-3-2019, retrieved 9 December 2019

EEA, European Environment Agency: Europe's onshore and offshore wind energy potential. Technical report No 6/2009, in: https://www.eea.europa.eu/publications/europes-onshore-and-offshore-wind-energy-potential, 08 Jun 2009, retrieved 3 December 2019

EU executive approves support for six offshore wind farms in France. In: https://www.reuters.com/article/us-eu-france-windfarm/eu-executive-approves-support-for-six-offshore-wind-farms-in-france-idUSKCN1UL18K, 26 July 2019, retrieved 30 July 2019

Europe installs 4.9 GW of new wind energy capacity in first half of 2019. In: https://windeurope.org/newsroom/press-releases/europe-installs-4-9-gw-of-new-wind-energy-capacity-in-first-half-of-2019/, 25 July 2019, retrieved 30 July 2019

European Commission: North Seas energy cooperation. In: https://ec.europa.eu/energy/en/topics/infrastructure/high-level-groups/north-seas-energy-cooperation, retrieved 10 December 2019

Floating offshore wind energy - A policy blueprint for Europe. In: https://windeurope.org/wp-ontent/uploads/files/policy/position-papers/Floating-offshore-wind-energy-a-policy-blueprint-for-Europe.pdf, retrieved 9 December 2019

Governments need to step up to unlock the vast potential of floating wind. In: https://windeurope.org/newsroom/news/governments-need-to-step-up-to-unlock-the-vast-potential-of-floating-wind/, 28 November 2019

IEA (2019), "World Energy Outlook 2019", IEA, Paris https://www.iea.org/reports/world-energy-outlook-2019

IEA (2019), "Offshore Wind Outlook 2019", IEA, Paris https://www.iea.org/reports/offshore-wind-outlook-2019. In: https://www.iea.org/reports/offshore-wind-outlook-2019

IEA: Offshore Wind Outlook 2019. World Energy Outlook Special Report. In: https://www.iea.org/reports/offshore-wind-outlook-2019/geospatial-analysis#abstract

Keating, Dave: Offshore wind carry EU to meeting Paris goals, says IEA. In: https://www.euractiv.com/section/energy-vironment/news/offshore-wind-carry-eu-to-meeting-paris-goals-says-iea/, 19 Nov 2019

Mace, Matt: World's first floating wind farm opens off the Scottish coast. In: https://www.euractiv.com/section/energy/news/worlds-first-floating-wind-farm-opens-off-the-scottish-coast/, 18 Oct 2017, retrieved 3 December 2019

North Seas Energy Ministers reinforce cooperation on offshore wind. In: https://windeurope.org/newsroom/press-releases/north-seas-energy-ministers-reinforce-cooperation-on-offshore-wind/, 4 December 2019

Patel. Sonal: Floating Offshore Wind Buoyant on New Developments, Projects. In: https://www.powermag.com/floating-offshore-wind-buoyant-on-new-developments-projects/, 12/02/2019,

Simon, Frédéric: World's second floating wind farm sets sail for Portugal. In: https://www.euractiv.com/section/energy/news/worlds-second-floating-wind-farm-sets-sail-for-portugal/, 21 Oct 2019, 3 December 2019

What is the future of European offshore wind technology? In: https://www.endiprev.com/future-offshore-wind-technology-europe/, 18 November 2019, retrieved 6 December 2019

WindEurope: Offshore Wind in Europe. Key trends and statistics 2018. In: https://windeurope.org/wp-content/uploads/files/about-wind/statistics/WindEurope-Annual-Offshore-Statistics-2018.pdf, retrieved 30 July 2019

Wind Europe, BVG Associates Limited: Our energy, our future. How offshore wind will help Europe go carbon-neutral, November 2019. In: https://windeurope.org/wp-content/uploads/files/about-wind/reports/WindEurope-Our-Energy-Our-Future.pdf, retrieved 3 December 2019

WindEurope: Unleashing Europe's offshore wind potential A new resource assessment https://windeurope.org/wp-content/uploads/files/about-wind/reports/Unleashing-Europes-offshore-wind-potential.pdf, June 2017