"Renewable Energy Transition: A Case Study of How International Collaboration on Offshore Wind Technology Benefits American Workers"

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The European Offshore Wind sector today and in the next decade

Today offshore wind provides 3% of Europe's electricity consumption, with 26 GW of capacity (5,566 turbines grid-connected) across 120 offshore wind farms (EU 27 + UK). Government plans show that installed capacity will grow nearly fivefold to 114 GW by 2030.

Europe is home to 75% of global offshore wind capacity. The sector employs 77,000 people, contributing €7.5bn ($8.8bn) annually to the EU's GDP (2019). This means that on average, every new offshore wind turbine installed in Europe contributes €15m ($17.7m) to the economy, in terms of jobs and economic activities such as construction, manufacturing, and maintenance. Offshore wind has helped to rejuvenate coastal communities which were once dependent on heavy manufacturing, shipping, and fishing.

There are more than 30 ports supporting the European offshore wind industry. They serve as hubs for manufacturing and assembling foundations, the production of large components, installation, and the operation and maintenance of wind farms. They play a key role in coordinating the offshore supply chain and support the production and export of renewable hydrogen, alternative fuels, and other energy vectors.

Despite the economic impacts of the COVID-19 pandemic, 2020 was a record year for offshore wind investments in Europe. There were €26.3bn ($30.9bn) raised for the financing of new offshore wind farms, including €2.1bn ($2.5bn) in offshore transmission infrastructure. 2020 was also a record year for new capacity financed with 7.1 GW, indicating an important shift in speed and volume across the European offshore wind sector.

Floating Offshore Wind is unlocking the potential of wind resources in deep waters. Today floating wind accounts for 75 MW globally, of which 62 MW are in Europe. There is a pipeline of projects for a further 300 MW by 2023 and at least 7 GW by 2030, with France, Norway and the UK forecasting the biggest increases.

Offshore wind is becoming a whole European story. By 2030, European Governments want 114 GW of offshore wind. Countries around sea basins have all drawn up their own ambitions for offshore wind. This also means a major increase in how much new offshore wind Europe installs annually: up from 3 GW a year today to 11 GW a year by 2030 and up to 18 GW a year by 2040.

Offshore wind by 2050

The IEA sees offshore wind becoming Europe's main source of electricity generation by the early 2040s. And the European Commission says the EU will need 300 GW by 2050.

Offshore wind will be at the heart of the European economy's drive to reach climate neutrality by 2050. Under the Green Deal, all 27 EU Member States have committed to turning the EU into the first climate-neutral continent by 2050. To get there, they have pledged to reduce emissions by at least 55% by 2030, compared to 1990 levels.

The European Commission has put forward several strategies to accelerate the energy transition e.g., the Offshore Renewable Energy Strategy (November 2019), the EU Industrial Strategy (March 2020; updated June 2021), and the Energy System Integration and Hydrogen Strategies (June 2020).

All of **these will require a huge expansion in wind energy**. The Commission's decarbonization scenarios see wind accounting for 50% of the EU's electricity production by 2050, up from 16% today. This means around 1,000 GW onshore (up from 165 GW today) and 300 GW offshore (up from 15 GW today) by 2050 (EU-27).

Adding in the UK and Norway, Europe will need 20 times its current capacity to reach climate neutrality, meaning up to 450 GW of offshore wind in Europe. Most of this capacity will be in the North Sea, Baltic Sea, and Atlantic Ocean. But recently interest is growing in other sea basins too, such as the Mediterranean Sea and the Black Sea.

The **Offshore Renewable Energy Strategy (ORES)** targets offshore renewables deployment over the next 10 years, and in preparation for the next 30 years. Actions include legislative proposals and other incentives, while recognizing the investments needed to deliver the ambitions – in terms of technologies, grids, and the supply chain. And it identifies the right policies that will drive those investments: industrial policy; state aid rules; and the correct mechanisms to ensure predictable revenues for offshore wind farm developers at the smallest cost to society.

Success factors

Today offshore wind is 75% cheaper than it was in 2014. The main driver for cost reduction is technological development but other factors have played a role, such as the cost of financing.

The bigger turbines get, the cheaper it will become to produce electricity. **The average capacity of a WT installed in 2020 is 8.2 MW**. This has doubled since the years 2012-2014. Consequently, capacity factors have increased too: the newest bottom fixed wind farms can reach 50%, and floating has gone above 55%. Other drivers for cost reduction include **efficiencies in project management, economies of scale, and appropriate revenue stabilization mechanisms**, which lower financing costs. Wind turbine (WTs) capacity is likely to double by 2030, when we can expect 15 MW WTs to be commercialized.

Wind farms require high upfront investments but have very low running costs. This makes financing a significant share of their overall cost. Having a predictable income from stable revenues is the most important way to minimize finance costs**. The two-sided contract for difference** (CfD) is the best model for providing stable revenues. Many Governments in Europe are now using it.

Adding to CfD, corporate sourcing of offshore renewables is rapidly growing following the American trend of solar PV and onshore wind. This provides another source of revenue stabilization, helping to cut the costs of electricity.

Lessons learned in Europe and our next immediate challenges

The European Offshore Wind sector has benefitted from sensible national and international policies and enjoys favorable political momentum today. But to support climate neutral ambitions, new approaches are needed to **allocate new areas for offshore wind and to develop offshore and onshore infrastructure.**

Rising activity in European waters has led to increased spatial demand and growing competition between sea users. To reach the goal of 300 GW by 2050 only around 7% of EU waters will be required. The European wind industry stresses the importance of **coexistence with other economic and societal interests** as a necessary condition for the expansion of wind energy. In particular:

- Collaboration with the **Defense sector** provides opportunities for joint trainings and simulations, unexploded ordnance (UXO) management, and security patrols and reactions. These require close coordination and can be done using mobile or fixed assets in partnership. In Europe, this is already happening both at an international and Member State level, with the European Defence Agency (EDA) and Ministries of Defence already engaging with policymakers and wind industry representatives.

- Engagement with **fishermen** is critical to the safe coexistence of fishing and wind farm operations. European Governments actively promote the involvement of fishermen in all stages of offshore wind development, from site selection to farm operation. Member States have also allocated funds and compensation schemes to address any disruption caused to fisheries at a regional or national level.

- **Biodiversity protection** is a primary consideration for offshore wind development. The European offshore wind industry has pioneered the research, development, and deployment of mitigation solutions. For example, developers can use bubble curtains to limit sound emissions generated form piling, helping to mitigate disturbances to marine life. The first long-term monitoring programs show that fish often return to wind farms in greater numbers as the wind farms act as artificial reefs[1]. Each wind turbine can support up to four metric tons of shellfish that attract other marine wildlife[2]. The sector is also looking at boosting positive effects. For example, it is involved in the eco-designs of mollusk cultures within wind farms, which actively improve seabed conditions, increase water quality, and boost local ecosystem services, including food production.[3]

In Europe the offshore wind industry, leading environmental NGOs and transmission system operators have set up a coalition (the Offshore Coalition for Energy and Nature, OCEaN) to coordinate efforts

[1] This has been proven by long-term monitoring programs, for example in Denmark and in Belgium
[2] The large-scale impact of offshore wind farm structures on pelagic primary productivity in the southern North Sea
[3] Walles B. et al (2018) Offshore Wind Farms as Potential Locations for Flat Oyster Restoration in the Dutch NS.

with the EU and national Governments to reach their climate goals all the while ensuring the success of their environmental protection and biodiversity strategies.

The development of offshore wind needs the **right electricity infrastructure** to be in place. It needs to anticipate the growth of offshore wind energy in order to get power output to the demand locations. Planning for the right amount of grid infrastructure is crucial to avoid delays or high deployment costs and curtailment rates. It can still take up to 10 years to ensure that onshore and offshore developments correctly transmit electricity from generation to the end-user.

In the future large offshore wind farms, or cluster of projects, will connect to multiple countries via interconnectors. These are called Offshore Hybrid projects and help to optimize space and grids. The **Kriegers Flak Combined Grid Solution** demonstrates that hybrid offshore wind projects are already underway – and there are more projects in the pipeline. But there are a number of legal issues which have yet to be fully addressed The European Commission, Member States, and industry are working to assess the risks, costs, and benefits of investing in hybrid assets and to create a mechanism for countries to jointly develop such projects.

A robust electricity grid will support household and industrial consumers, providing affordable renewable electricity. The direct use of electricity is the most efficient method of electricity deployment. Therefore, a major component of the electricity infrastructure will be the grid itself. Complementing this, power-to-x can be used to decarbonize industry or transport, where direct electricity use is less efficient or not feasible.

Renewable hydrogen is a great opportunity for the offshore wind industry to increase its portfolio, offering advantageous business opportunities to reduce the emissions of various industries. This will lead to increased efficiency in the supply chain, improved environmental performance, and increased synergies with other activities and industries - contributing to their decarbonization.

Main recommendations based on European experience

By delivering on Federal and State ambitions, offshore wind will become an important asset for the US economy, by boosting imports and exports, and attracting significant international investments supporting economic growth.

Many businesses, directly or indirectly active in the offshore supply chain, will benefit from the sector expansion. The challenge in getting timely investments from key suppliers is that they need **confidence in the market for a duration** that will give a return on their investment. Having an attractive market proposition with a long-term strategy that guarantees sufficient volumes will send a strong signal to the manufacturing industry, resulting in local jobs and a positive trade balance. For example, **Europe's ports will need to invest €6.5bn between now** and 2030 to support the expansion of offshore wind. This investment could be paid back in just five years and would bring significant savings to electricity consumers and society.

Due to the infrastructural challenges and costs associated with readying the supply chain for offshore sector growth, it is very important to provide long-term revenue certainty for exploiting these facilities through the right energy policies. **The American offshore wind industry will need clear timing and frequency of auction for offshore wind**. This would smoothen business cycles in the supply chain. And it would give developers sufficient time to prepare for bidding processes.

The Jones Act will have a clear impact on the cost of offshore wind deployment in the US in its early years. There is strong potential to establish a new market for US vessels, but the work needs to get underway now.

Investment in wind energy will create and sustain jobs. Europe for example will have to invest €267bn ($314bn) to finance the offshore wind capacity envisioned in the 2030 national plans. Every €1bn ($1.18bn) spent on delivering the wind volume targets set out in the NECPs sustains the existing 77,000 industry jobs and creates an additional 463 in the offshore wind sector. In 2030, 114 GW of offshore wind will employ 200,000 people in Europe.

In the US, job creation will require new educational programs to train the occupational profiles required for the offshore wind sector. But re-skilling will be important as well. For operations and maintenance at sea, for instance, health and safety skills are vitally important in preventing accidents; for these occupations, experience at sea is of greater relevance. Workers coming from other maritime sectors such as oil and gas or shipping would require upskilling or reskilling to adapt to the risks and dangers of the offshore working environment

To create a robust offshore wind industry in the United States, we recommend that competences and responsibilities between the States and the Federal Government should be clear from the beginning. This will facilitate the permit granting process, while also factoring in the need for coordination between the permitting processes for energy infrastructure and generation assets. Europe has addressed this by establishing one-stop shops for permitting projects based on successful operating models

In addition, regional cooperation between neighboring States will catalyze the deployment of offshore wind and encourage cross-border synergies, collaboration, and coordination. In Europe, regional **cooperation fora** have been established since 2010. These fora are co-chaired by the European Commission and European Member States bring together Energy Ministries of countries sharing the same sea basins to coordinate offshore wind and grid development. The North Sea Energy Cooperation (NSEC) is the most advanced, followed by the Baltic Electricity Market and Interconnection Plan (BEMIP), which recently established a dedicated workstream on offshore wind. Other European sea basins are expected to follow suit.

Regulatory coordination across States is needed for health and safety, environmental impact assessments, radar, and aviation interaction with wind turbines (including lighting and marking), site investigation, project certification and vessels, crew, and other technical requirements. But cross-state cooperation will also be needed for offshore space allocation - especially with projects being built further from shore - offshore and onshore grid development and for coordinating joint projects.