

Offshore wind. Grasping the opportunities and solving the challenges

The [EU's Green Deal](#) objectives will require a significant increase in renewable and affordable energy towards 2050. Offshore wind will play an important role in achieving the goals as explicitly highlighted by the European Commission. The [International Energy Agency](#) highlights the opportunities, but also the obstacles to overcome, if Europe is to have up to 20 times today's installed offshore wind capacity by 2050. The growth in offshore wind power must take place within the framework of the Sustainable Development Goals and European climate objectives. It should also contribute to new jobs in a world leading European industry. To achieve this and bring offshore wind into more remote and deeper waters, a strong research focus is essential.

Why is research focus important?

All parts in the decision-making and value chain must work together and have enough capacity to achieve the European renewable energy objectives. This includes not only technical and manufacturing capacity, but also the legal and financial framework, as well as understanding the environmental and social impact of large-scale offshore wind deployment. The offshore wind up-scaling must be based upon knowledge-based decisions to secure an economically and environmentally sound development; citizen engagement must be part of this development for it to succeed. The European research community must play an essential role in achieving this for the benefit of the environment, European workers, and general economic progress. Furthermore, offshore wind should play a role fostering fairness of access to energy for all European citizens as decisive factor. This will strengthen the European industry and research community's world leadership within offshore wind, operating in a worldwide market.

Problem statement

To build the offshore wind capacity needed within the framework of the Green Deal, the cost of electricity (LCOE) must be further reduced, even if the wind farms are moving into more remote areas and deeper water. The wind farms will occupy significant ocean areas, thus marine spatial planning frameworks and policies that take into account conflicts with other users, environmental impacts and the interactions between neighbouring, and even cross-bordering wind farms are all important issues to be resolved. To reduce the LCOE, the turbine and wind farm sizes must continue to increase. As 85% of the technical available offshore wind resources in Europe are located at water depths larger than 60m, floating support structures will be required at several locations. The offshore wind field in front of and inside large wind farms is only partly understood, adding uncertainties to the LCOE estimates. Both for turbine and wind farm design and energy production estimates, improved understanding of the wind and the combined action of wind, waves and current is required. We need to understand the impact on ecology, as well as design integrated and holistic legal frameworks that can foster the growth of new projects, handle conflicting interests, financial issues, and their environmental consequences. The intermittency in power production must be handled and its impact on the European electricity markets be given due consideration. Connecting wind farms at distant locations, perhaps crossing different jurisdictions, with electrical cables partly addresses the intermittency problem. Producing hydrogen or ammonia for energy storage and energy carrier in the transportation sector are additional options.

It should be underlined that the purpose of this input document is not to cover all aspects important to offshore wind R&D needs. We aim at addressing issues and knowledge gaps that have not had sufficient attention in the past, but will be of high importance if the foreseen up-scaling of offshore wind capacity in the Green Deal is to be realized within a sustainable framework.

Suggested actions

To solve and be at the forefront of the challenges briefly mentioned above, a significant upscaling of the offshore wind related R&D effort is needed. A cross-disciplinary approach is required to avoid “showstoppers”. The need for strengthening and up-scaling of the manufacturing chains and R&D at high technological readiness levels (TRL) is evident. However, if the above challenges are to be solved, also more basic and societal topics need to be addressed, these include:

I. Upholding the European industrial leadership

Why? The European offshore wind industry is a global leader. To achieve the Green Deal’s ambitions a further development and expansion of the industry is needed. This will also secure a worldwide market and increase the number of jobs related to renewable energy.

How?

- Continue R&D activities focusing on improving wind turbines and lowering production costs. This includes industrial and technological challenges related to e.g. flow physics, aerodynamics, structural dynamics and hydrodynamics. The need for and possible replacement of rare earth minerals must be considered. Similarly, the use of new, recyclable materials and the use of nanotechnology need to be addressed. Continue digitalization in all phases from the design, manufacturing through the operational phase of wind turbines.
- Moving into deeper waters requires a continued improvement of bottom fixed support structures and an increased effort to develop floating support structures for large-scale deployment. Test sites for testing new concepts, including integration with other renewable technologies as wave, current and solar power should be established.
- Improved understanding of the wind resources and the structure of the wind is essential to reduced cost of energy. E.g. remote measuring systems for mapping the wind field up to 300m above the sea level is needed. Thereby, the resources in various areas, ranging from the Atlantic to the Mediterranean can be assessed properly. Understanding and improving models for the wind flow over sea and inside the wind farm is needed for optimization of the wind farm control.
- A robust and efficient legal framework must be developed and implemented to foster the growth of the industry across Europe for national and cross-border projects. This should include assessing, revisiting and adapting the existing rules regarding possibilities for public support, through compatible State aid, and licensing processes, as well as encouraging Member States to assess, evaluate and review relevant private financial instruments and rules to facilitate and encourage private investment in offshore wind activity. An adequate cross-border and cross-sectoral (e.g. across various renewable energy sources) legal framework must be promoted.

II. Improve Marine Spatial Planning and understand ecological and human impact

Why? A substantial up-scaling of the installed offshore wind capacity will require careful and consistent evaluation of conflicting interests related to ecology and other human activities as

e.g. fishery and shipping. Many of these issues are national decisions despite their regional effects, while offshore wind is likely to become a cross-border activity. Legislative integrated and cross-border coordinated measures concerning marine spatial planning and sea use are time critical to reach the Green Deal Goals.

How?

- Improve the understanding of the ecological impact of offshore wind farms, both in air and water. This involves mapping of e.g. the impact of noise on humans and the marine ecosystem, both for the construction and operational phases. Improve knowledge on bird migration routes and possible conflicts with the turbine rotors.
- Refine the legal framework on handling conflicting interests, environmental issues, and international harmonization of regulations. Promote the establishment of international area planning standards and marine spatial planning and strategies to reduce conflicts and optimize production when licensing new projects and addressing interaction with other sea users.
- Incorporate planning and decision-making framework aspects related to larger carbon-neutrality ambitions, among them the circular economy and material aspects.

III. Integrate the social and economic benefits beyond the market power and technological actors

Why? Research related to offshore wind must embrace knowledge creation for evidence-based input for policy and decision-making, including cross-cutting domains like social challenges to anticipate and address future global challenges. Research to understand how social identities, norms, and values affect human attitudes and decision making is crucial.

How?

- The R&D effort should stimulate international and multidisciplinary cooperation throughout Europe, also involving common study programmes. To develop a sustainable industry, continuous developing of skills to meet future needs is crucial, taking into account gender aspects and the promotion of gender balance in new emerging industries.
- Improve the understanding of the social and economic impacts of upscaling of the offshore wind energy deployment, as well as society's responses to offshore wind projects towards securing societal acceptance of these projects.
- Measures and empirical identification of sources for political legitimacy to create knowledge to understand how people's opinions form.
- Active dissemination of research to the community at large, to increase public engagement and secure evidence-based decisions.

IV. Support energy demand and improve grid integration.

Why? Wind energy represents an intermittent source of energy. With the increased need for reliable electricity supply from renewable sources, grid integration, storage and alternative energy carriers become important to support the demand side. This includes energy transmission across national borders.

How?

- Promote cross-border transmission network infrastructures connecting several jurisdictions, as well as 'hub' facilities connecting different offshore renewable energy related technologies. A comprehensive and integrated legal framework addressing sectoral

complementarity and cross-border elements in EU law as well as Public International Law should be considered. Further, the Union and its Member States should foster the promotion of coordinated approaches towards developing regional policies, including the decision-making by national and supranational regulator, as well as the lawful sharing of information among stakeholders.

- System efficiencies should be increased by e.g. an improved grid as well as taking advantage of the geographical distribution of wind farms. The losses in converting the electric energy to alternative carriers as hydrogen and ammonia should be minimized. This implies increased effort in e.g. developing efficient catalysts.

Main impact

A strengthened R&D on the above issues will significantly contribute to realizing the offshore wind energy potential needed for the Green Deal to be successful. Improving our knowledge in these matters is essential to reduce costs and develop the offshore wind industry within the framework of the Sustainable Development Goals and the European carbon-neutrality ambitions. An upscaling of the offshore wind industry will ensure job creation in Europe, and also contribute to a worldwide market. The R&D efforts are essential for improving skills for the growing workforce in the renewable energy sector.

Closing remark

This strategy input is based on dialogue meetings with European industry, academia, and stakeholders from governmental and public bodies. It remains, however, the product of the authors.

For further information about the background of this document, the process, or further details, please contact Finn Gunnar Nielsen (Professor and Head of Bergen Offshore Wind Centre), or Charlotte Krafft (Manager Energiomstilling Vest -knowledge cluster for Energy Transition)

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ANNEX

Process and input to the Statement Document

Energiomstilling Vest (EOV) and Bergen Offshore Wind Centre (BOW) planned an Offshore Wind Round Table Conference 22 April 2020 in Brussel. The purpose of the conference was to provide input to EU's offshore wind strategy.

Due to the COVID-19 situation remaining unchanged and the health authorities' restrictions was maintained, the planned conference was replaced by several digital video conferences. A preliminary input document was prepared and discussed in three preparatory meetings organized 8 June. In the meetings representatives from European industry, academia, and governmental and public bodies were present.

The input from the video conferences 8 June was summarized and discussed at a meeting organized 17 June 2020. In this meeting, representatives from the Directorate-General Energy (DG ENER) and the Directorate-General Research and Innovation (DG RTD) were present. They provided valuable comments regarding the upcoming new strategy, the Green Deal as well as knowledge gaps.

The final document is prepared after the meetings. It is the authors attempt to summarize the input provided.

Participants and stakeholders in the preparatory video conferences 8 June 2020:

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Equinor
Fraunhofer Institute for Wind Energy
Innovation Norway Bergen
Innovation Norway Brussels
Italian National Research Council, Rome
Mission of Norway to the European Union
Norwegian School of Economics
Norwegian University of Science and Technology
Siemens Gamesa
The Confederation of Norwegian Enterprise in Brussels
The EEA and Norway Grant
The Norwegian Shipowners' Association
The Research Council of Norway, Brussels office
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