FRAUNHOFER GREEN DEAL SERIES – IMPULSE

»Offshore Wind as a cornerstone of the European Green Deal – The potential in upscaling production and utilization«

In a nutshell:
- Offshore wind is one of the most advanced and low-priced renewable energy sources, which serves as backbone for a decarbonized future.
- To tap the full potential of offshore wind energy and enable its reliable grid integration, further research, technological development, and investment efforts are crucial.
- Fraunhofer Institutes contribute with practical knowledge and innovative solutions to challenges in upscaling, cost optimization, and grid integration.

Wind is the only offshore renewable energy source deployed commercially, and Europe accounts for 80 % of its global capacity. The potential of offshore wind is tremendous: it has five to ten times higher energy density than onshore wind, 60 % full load hours, an optimum production range of generators, nearly unlimited turbine and blade size, high availability of large installations, and upscaling yields smaller unit costs and lower levelized costs of energy.

We all agree that we need to have more offshore wind power to be able to reach the climate goals laid down in the EU climate law, but also in the Paris Agreement. The way we do the green transition and integrate green technology in our energy grid and societal models serves not only economic purposes but is also our claim to fame in the geopolitical landscape.
Pernille Weiss, Member of the European Parliament

According to the "Fit for 55" package, delivering the European Green Deal, renewable energies should cover 40 % of the continent's energy needs by 2030. In the pursuit of climate neutrality by 2050, the EU Commission has also specified its goals in the strategy on offshore renewable energy. Currently, offshore wind in Europe has a capacity of 12 GW. To harness it as a cornerstone of the Green Deal, the strategy aims at 60 GW by 2030 and 300 GW by 2050. It is estimated that 800 billion euros are required to fund offshore power generation and the associated grid infrastructure.

It's all about being better than the competition to make sure that European turbines are going to be exploited in the future. The biggest and best times are yet to come for the wind industry.
Andreas Reuter, Managing Director, Fraunhofer Institute for Wind Energy Systems IWES

Fraunhofer experts presented their contributions within research and technological development on the two abovementioned investment areas during our 4th Green Deal Webinar. Fraunhofer fully supports the ambitious goals of the EU with its vast competencies and experiences (see presentation) and has spent more than 150 million euros on infrastructure alone in the last decade. In the area of offshore power generation, Fraunhofer works on three topics to upscale capacities and optimize costs: location, size and grid integration.

Feasible locations are decisive to access performance capabilities to the full extent. Offshore installations are affected by water depth, coastal distance, weather conditions, environmental restrictions, and other usages. As dense areas of wind farms change the wind energy potential and local meteorology, numerical models assess expansion scenarios and their effects before large-scale realizations. For validation by long-term on-site measurements, Fraunhofer developed the LiDAR buoy. Laser remote sensing are used to visualize, assess, and forecast the wind flow around large wind turbines, thereby optimizing turbine model validation, yield prediction and performance control.

The dimensions of turbines and rotor blades are enlarged to harvest the maximum of offshore wind energy and reach sizes that were unimaginable just a few years ago. Being already a low-priced renewable energy source, continuous turbine growth offers the potential to reduce costs even more from 65 euros / MWh to 33 euros / MWh. These are however challenged by immense natural forces, and the full-service life of wind turbines needs to be assessed by mechanical tests in test rigs and complemented by virtual simulations in digital twins prior to installation. In the future, virtual testing will be a key component to further reduce conservative safety margins. To tackle difficulties caused by logistics and storage of offshore wind energy, Fraunhofer operates a hydrogen lab with 2 MW electrolyzer capacity to test the coupling of hydrogen and wind energy production under realistic conditions.
For the future, an economic use case for hydrogen hubs in the North Sea consisting of floating turbines and offshore electrolyzer will allow for, i.a., (semi-)autonomous operation, low environmental impact and NIMBY-effect, and direct conversion of PtX.
However, great efforts in research and investment are crucial to realize this vision, not least into grid integration, the second investment area of the offshore energy strategy.

A powerful on- and offshore grid is the backbone of the future decarbonized energy system.
Kurt Rohrig, Executive Director, Fraunhofer Institute for Energy Economics and Energy System Technology IEE

The grid integration of large amounts of offshore wind, challenges onshore grids and requires detailed power forecasts, reliable system services, authentic virtual power plants and smart sector coupling. A priori forecast tools evaluate the expected grid utilization, control, and optimization. To realize grid connection, reduce its costs, and use the full potential of offshore wind in the Baltic and North Sea, several transmission technologies are available currently, but further research and innovations are necessary to exploit them economically and sustainably. For the development of concepts, products, and services, Fraunhofer operates one of the most powerful simulation tools to produce data and generate information on the future energy system. Based on this data the overall flexibility can be measured, the operation of each component optimized, and critical grid situations assessed. Fraunhofer investigates sector coupling at city quarter level on lab scale to facilitate coordinated interaction between the electricity, heating, and transport sectors.

To tap the full potential for climate neutrality and economic growth, research and investment efforts into one of the most advanced renewable energy sources need to be ramped up within the European Union. We are contributing by **sharing our knowledge and uniting our efforts to spark innovations for our future as a climate neutral and sustainable continent.**