Living Lab 70 GW Offshore Wind

FACT SHEET

A better understanding of physical processes to assess impacts on the marine environment

How offshore wind farms change the sea

The installation and operation of offshore wind turbines alter physical processes in the sea. Their presence affects currents, waves, salinity and temperature stratification, sediment transport and sound propagation. These changes are not yet adequately characterised. Newly collected field data will therefore be used to quantify them comprehensively and improve our understanding. This will provide a robust basis for assessing the possible impacts and potential benefits of offshore wind expansion for the marine environment.

- **How does expanding offshore wind capacity to 70 GW affect the sea and the marine environment?**
- **How do changes in the sea caused by offshore wind farms vary by location and season?**

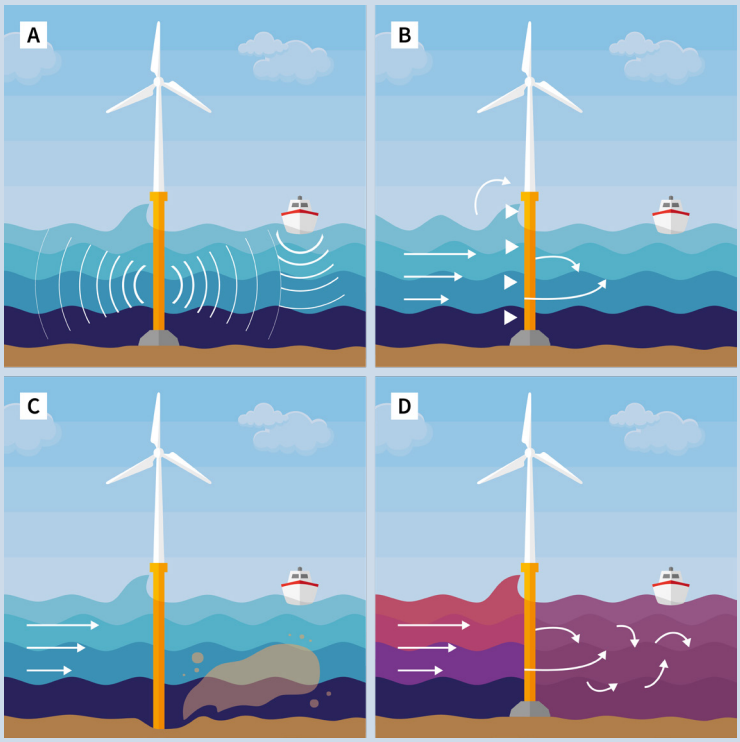
▸ Reaching the target of 70 GW of offshore wind capacity in German coastal waters by 2045 requires innovative solutions across the entire value chain. Living Lab 70 GW Offshore Wind investigates how existing and future wind farms can be planned more efficiently and operated more sustainably. It examines how offshore wind expansion can be reconciled with other demands on limited marine space, such as fishing, shipping and nature conservation.

▸ Our understanding of how offshore wind farms affect physical processes in the sea, and the resulting consequences for marine life requiring protection, such as fish and marine mammals, remains insufficient. To address this, the Living Lab conducts extensive measurement campaigns and combines the resulting field data with model simulations. The aim is to compare changes in physical parameters with changes in the marine environment.

Effects of an offshore wind turbine on physical processes in the sea

The diagram illustrates how the presence of an offshore wind turbine can influence physical processes in the sea.

a) Sound generation and sound propagation
b) Changes in currents and swell
c) Scour and (independently) increased turbidity
d) Mixing of density and temperature layers



- **The influence of offshore wind farms on physical processes in the sea has been demonstrated in specific cases but has not been sufficiently quantified.**
- **Long-term impacts, measurement methods and cumulative interactions remain insufficiently researched and understood.**

► Evidence already exists of physical changes around offshore wind turbines and in the vicinity of offshore wind farms. These effects are visible, for example, in scour and sediment plumes that develop in a turbine's wake and reduce light availability in marine habitats. To date, these effects have mainly been described using parameterised representations in models, while comprehensive field observations over larger spatial and temporal scales are lacking. It remains largely unclear whether model results can be transferred to other sites and how significant the combined effects of different processes are. Standardised measurement and simulation methods are also lacking, making it difficult to document impacts transparently and ensure that results are comparable.

► Describing changes in individual physical processes is complicated by their interactions and their dependence on site conditions.

► Comprehensively capturing long-term and cumulative effects in the marine environment requires substantial logistical, material and staffing resources and is therefore very difficult to achieve.

- **Collecting robust field data through measurement campaigns in an offshore wind farm.**
- **Describing and assessing changes in physical processes in the sea.**

► To improve understanding, data on physical changes are collected in extensive measurement campaigns aboard the research vessel Heincke. These are complemented by long-term monitoring stations and model-based analyses. Suitable approaches are being developed to record and represent pressures on the marine environment across space and time, with a view to integrating them into environmental assessment and planning approaches. Exchange with experts and stakeholder involvement are central elements of this research approach.

- **How can environmental changes caused by physical processes be predicted across different sites?**
- **How do offshore wind turbines affect the marine environment collectively and at a regional scale?**

► Key research questions concern the spatial extent and intensity of physical changes, and how these depend on location, environmental conditions, the turbine life cycle and seasonality. Another question is how causal relationships can be identified among the many overlapping processes so that they can be incorporated into environmental assessment criteria. Particular attention is given to distinguishing near-field and far-field effects, to determine at what distance and under which conditions an influence is no longer measurable.

- **Establishing the scientific basis for integrated environmental assessment and monitoring.**
- **Improving planning and permitting processes.**

► The Living Lab 70 GW Offshore Wind is developing a comprehensive knowledge base on the physical processes affected by offshore wind farms. The findings are intended to improve the prediction and assessment of environmental impacts from the early stages of planning. Together with the stakeholder groups involved, the findings will be incorporated into existing assessment frameworks to strengthen the scientific basis for future standards in spatial planning and environmental assessment.

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