

NORTH SEA WIND FARMS

OFFSHORE TEST CASE



THE TEST CASE

- **Main goal:** Use MERIDIONAL tools to predict the energy yield of a large offshore wind farm for inflow phenomena relevant to offshore scenarios.
- **Location context:** Based on various offshore wind farms in the North Sea, but with broad applicability in other maritime areas.
- **Partners:** TU Delft, Technical University of Denmark (DTU), Technical University of Munich (TUM)

TECHNOLOGY OVERVIEW: TOOLS ADOPTED

DTU WIND FARM WIND FACTOR

A theoretical limit for offshore wind farm energy extraction

→ [Read the paper](#)

TUM WIND FARM AS A SENSOR

Engineering wind farm model correction based on operational wind farm data

ENVIRONMENTAL CONDITIONS OF INTEREST

Blockage, atmospheric stability state, and inter-farm effects (particularly common as new clusters get built next to existing ones).

KEY ENABLING FACTOR

Access to operational turbine data from advisory board partners RWE and JERA Nex bp (formerly Parkwind) that gives researchers insights into how turbine and farm production changes hourly, daily and annually.

RESULTS & KEY FINDINGS

- 1 From the DTU work on the wind farm wind factor and verifying this with data from 72 offshore wind farms with over 420 cumulative years of data across all farms, results showed that a **simple parametric model can give a good estimate of farm level yield** providing a rapid assessment of expected capacity factors for offshore wind farms.
- 2 From a study by TU Delft involving the use of operational SCADA data from the Belgian/Borssele Cluster and N4 Heligoland Cluster, **a clear dependence on offshore wind farm efficiency was seen** with variation between 40% and 90% depending on atmospheric stability state.
- 3 Using operational SCADA data from the N4 Heligoland cluster, it was shown that **engineering wind farm models commonly used in site assessment studies cannot capture the actual pattern of production** where blockage effects and inter-farm wakes are present.

LESSONS LEARNED, FUTURE RESEARCH & INNOVATION

Analysis of operational data indicates that actual energy yield of offshore wind farms can vary significantly due to the influence of factors such as blockage, inter-farm wakes and atmospheric stability. This **variation can only be captured by the application of appropriate modelling tools**.

Through the work in the MERIDIONAL project, **several models and methods of correcting for these effects have already been developed**. Continued work is needed to study these effects, using both simulation and operational data provided by operators, to improve existing models and develop new ones to ensure the realistic assessment of new offshore wind farm developments.

POLICY RECOMMENDATIONS

The DTU wind farm efficiency model can be used by policymakers for broad level assessment of expected offshore wind farm yield. These **results set realistic expectations of future wind projects, help guide new installation targets and can help non-experts evaluate the feasibility of proposed projects**. The analysis of operational SCADA data has demonstrated the importance of external wake loss factors showing developers the need for appropriate modelling tools which can be further developed through future collaboration.

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