

Joint Industry Project FARWAKES

Models and tools for inter-farm wakes characterisation and estimation of energy production losses

MOTIVATION & BACKGROUND

The downwind influence of a wind turbine or wind farm is referred to as the wake effect. This wake impacts the performance of adjacent turbines and farms over distances exceeding 50 km, affecting both energy yield and system lifetime. The European Union has set a target of 300 GW for offshore wind deployment by 2050. This increase in capacity is anticipated to result in a much higher density of wind farms, leading to inevitable interference among them.

In this context, the following questions have been identified:

- What are the most accurate tools available for far wake characterisation?
- How do atmospheric conditions influence the wake characteristics?
- What will be the impact of massive offshore wind deployment on wind resource and the resulting energy yield?

OBJECTIVES

- To study the reliability of tools for modelling far wakes
- To provide recommendations for assessing the effects of the massive deployment of offshore wind in Europe on wind resource and associated energy yield

Duration: 24 months | Start: 2025 | Total budget: €840K

DELIVERABLES

- Benchmark of 2 wake modelling approaches - engineering models and mesoscale models - against high fidelity large eddy simulation (LES) outputs
- Atmospheric stability climatology over areas of interest for offshore wind farm deployment
- Set of recommendations to assess inter-farm wakes effect on energy production

SCOPE OF WORK

1. Far wake modelling tools benchmark

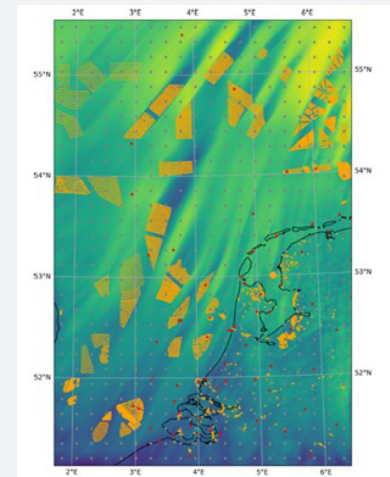
- Literature review of far wake modelling methods
- Selection of 2 engineering tools and 2 meso-scale tools for the benchmarking exercise
- Adoption of appropriate set of metrics and variables for the comparison exercise between the reference case and the tested simulations
- Comparison between the reference case - high-fidelity LES outputs -, the simulation outputs, and *in situ* observations over the North Sea

2. Atmospheric stability climatology over zones of interest

- Comparison and qualification of atmospheric stability metrics
- Mapping of atmospheric stability climatology over offshore areas of interest in France

3. Assessment of inter-farm wakes effect on energy production

- Definition of application cases, models set up and simulations with a focus on French maritime areas
- Investigation of the wind speed deficit and downstream distance for the recovery of mean wind speed behind the wind farms, with regard to the incoming wind characteristics and the atmospheric stability regime
- Issue of a set of recommendations regarding: capabilities and limitations of simulation tools to simulate inter-farm wakes, regional trends of the atmospheric stability regimes, and offshore wind farms planification and corresponding wake-induced losses assessment



Computational domain of the ASPIRE simulations. Colors indicate an example 100-m wind field (green for higher speeds, blue for lower). Turbines are indicated with orange markers (2050). Grey markers indicate a grid of 600 virtual metmasts for which model is available. The same is true for the red markers, but these correspond to *in-situ* measurements (© WINS50 Project)

PARTNERS

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