Project Abstract

Realwind

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1 Overview

The project Realwind takes place at the Competence Center for Renewable Energies and Energy Efficiency (CC4E) at the Hamburg University of Applied Sciences (HAW). CC4E is also a member of the Energieforschungsverbund Hamburg (EFH). Two PhD students are employed in this project. The goal is to develop a deeper understanding of the aerodynamic behaviour of modern wind farms under varying conditions of the atmospheric boundary layer (ABL). This is achieved by simulating farm behaviour using high-fidelity flow simulations. In these simulations, the Navier–Stokes equations are solved on a computational grid. The larger eddies in the flow are resolved, while the smaller ones are modelled. The turbine is simplified to so-called actuator lines (ALM). These lines compute forces from predefined airfoil tables, which act on the flow. In the following figure, a render of example simulation results is shown.

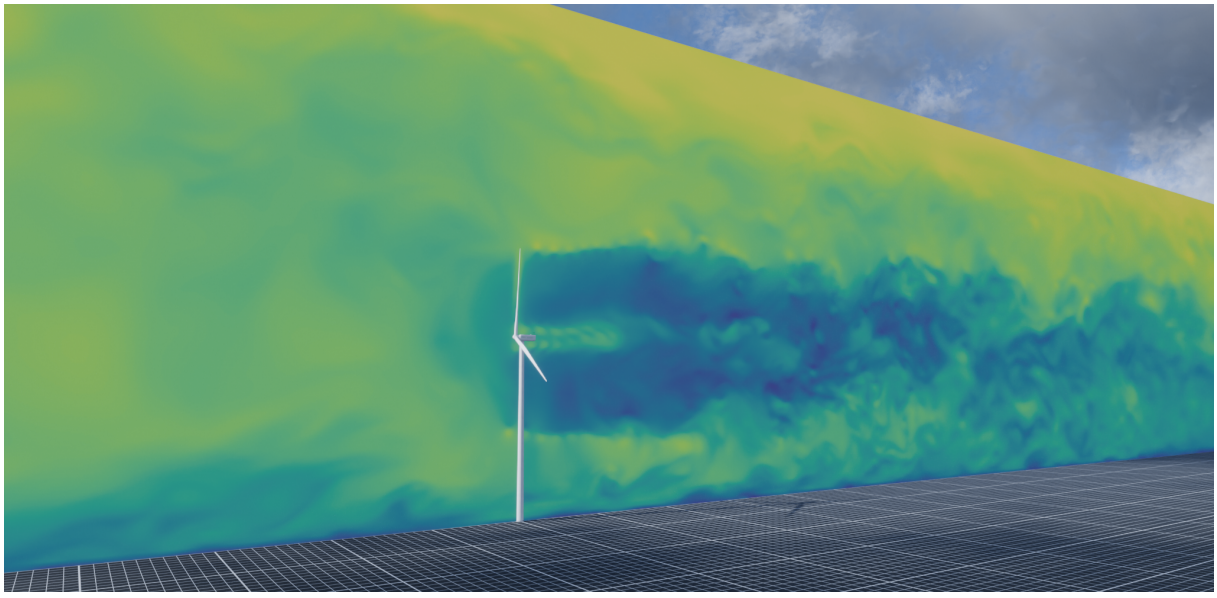

Figure 1: Example result from an ALM simulation; visual render created with Blender

The turbine 3D model is only for visual representation. In the simulation, the turbine consists of four lines (three blades and one tower) acting with forces on the flow field. The effect of the turbine on the flow is clearly visible. The plane is a slice cut through the full 3D flow field, showing the velocity magnitude. The presence of the turbine leads to a reduction in wind speed. This simulation setup allows modelling of the complex interaction between the turbine and turbulent wind.

As input for these models and for validation, measurement data from the research wind farm in Curslack, Bergedorf, is available. The research farm can be seen in the following figure.

Figure 2: Research wind farm in Curslack, Bergedorf

Within the project, the wind farm will be modelled and simulated. The simulations can be tuned and validated against measurements taken from the farm. Through the analysis of the measurements and the additional level of detail provided by the simulations, a more in-depth analysis of the effects of the ABL on the turbines is possible. The complex thermal effects of the atmosphere and their impact on wind farms are not yet fully understood. This project's goal is to strengthen this understanding, allowing for more efficient planning of wind farms and more accurate load predictions for turbines, ultimately reducing the cost of wind energy.