School V | Institute of Physics
Turbulence, Wind Energy and Stochastics - TWIST

Optimization of Wind Farms: Wind Tunnel Experiments with Modell Wind Turbines

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Wind turbine model using a gimbal support to simulate simplified floating platform

By the year 2030 up to 15GW wind energy should be produced in the North and Baltic Sea.

Wind energy is a major contributor to the renewable energies. To fulfill the increasing demand of power and for economical as well as ecological reasons wind turbines are operated in wind parks with an increasing number of parks being installed offshore. The demand to reliably predict the development of the wind and its fluctuations is of high interest given that wind is the source of energy, but at the same time the source for fatigue loads and damages of the wind turbines. The understanding on the behavior of the wind (e.g. wind direction and speed) within a wind park is essential to efficiently use the available energy and reduce faults of wind turbines. Typically such predictions are done using numerical simulations which, due to the high complexity of the flow, use simplified models to calculate various situations in the park.

These models have to be validated, which is technically complicated and very expensive to accomplish in a real wind park, since the inflow conditions can not be set and important parameters can not be measured.

Therefore, wind tunnel experiments with model wind turbines are performed at the university of Oldenburg. Wind tunnel experiments offer defined inflow situations and reproducible conditions, which is a very flexible and inexpensive way to gain deeper understanding of the behavior of the wind. This allows for improvements of the simulation tools and eventually of the operated wind parks.

Our focus is the influence of turbulent inflow conditions on the power output of wind turbines and their wake. The scaled model wind turbines, which were developed at the university of Oldenburg, allow for investigations of the influence of various inflow conditions and controlling parameter, such as blade pitch, on the wind turbine and its power output, as well as additional dynamics for wind turbines set up on floating platforms.

Model wind turbine with active load and pitch control

Control of a Model Wind Turbine in the Wind Tunnel

Dieses Video zeigt die Regelung einer Modell-Windenergieanlage im Windkanal. Zunächst ist die Regelung ausgeschaltet, sodass die Anlage nicht beim optimalen Betriebspunkt läuft. Der Leistungsbeiwert ist hier kleiner als 20%. Nach ca. 55 Sekunden wird die Lastregelung aktiviert. Die Rotationsgeschwindigkeit wird den Einströmbedingungen nun automatisch angepasst, sodass die Leistungsausbeute optimiert wird.

This video shows the control of a model wind turbine in the wind tunnel. At first, the control is inactive. This way, the turbine is not operating at its optimal point of operation, resulting in a power coefficient below 20%. After approximately 55 seconds, the torque control is activated. The rotational speed is now automatically set according to the prevailing inflow condition, optimizing the power yield.

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