

# IPID4all Doctorate Research Exchange with Norwegian University of Science and Technology

## Feedback report

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Experimental Investigation of wind turbine wakes

### Introduction

As modern wind turbines are often installed in clusters, wind farms, they constantly interact with each other due to changing wind directions. The flow behind a wind turbine, its wake, is therewith the inflow to further turbines. A wind turbine wake features a reduced velocity causing power deficits in wind farms. Further, a wake flow is characterized by an increased turbulence level causing higher loads for downstream turbines, having a direct effect on the lifetime of turbines and therewith the cost of energy.

In order to understand wake effect of wind turbines, a combination of field measurements, numerical simulations and wind tunnel experiments is necessary in order to validate results. In wind tunnel experiments, the upscaling of the results found in the laboratory is of major interest and a distinction between setup-specific effects and general effects is important. Therefore, this study aims to isolate effects of boundary conditions and draw conclusions on general wake effects of wind turbines experimentally, using two different wind turbine models in a wind tunnel.

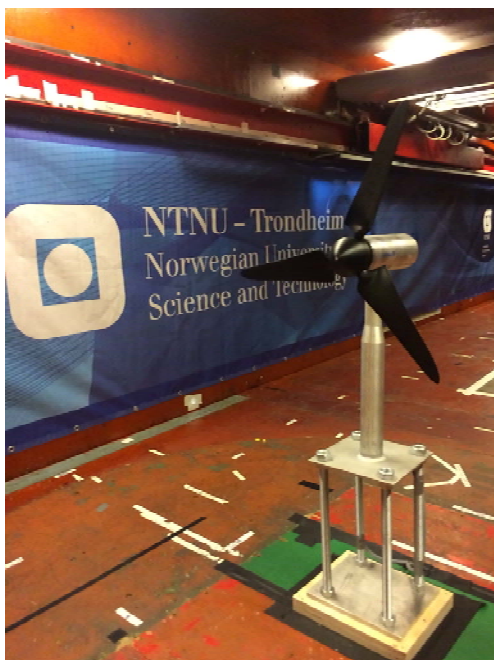


Figure 1: Model wind turbine developed by ForWind, University of Oldenburg installed at the wind tunnel at the Norwegian University of Science and Technology in Trondheim, Norway.

### Research Undertaken

Two different model wind turbines were used, which vary in size, blade design and geometry. A turbine developed at ForWind, University of Oldenburg was shipped to Norway, where experiments were conducted in a wind tunnel study. Those measurements were repeated with a wind turbine model developed at the NTNU in Trondheim, using the same boundary conditions and measurement techniques. The results allow for an isolation of general wake effects from turbine specific effects and are likely to enhance the understanding of the complex phenomenon of wake effects of wind turbines. The experiments were conducted in December 2017, during our meeting in January, we analysed the measured data in detail and discussed the results in detail.

### Personal Experience

The collaboration with the NTNU on this project has been established two years prior to this exchange at a conference in Trondheim. Ever since the communication was very fruitful on a personal and a professional level.

The possibility to conduct joint experiments was of great relevance and is highly appreciated.

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### **Conclusions**

The collaboration has produced very valuable results, exceeding the expectations prior to the experiments. A blind test workshop was organized, which is a collaboration with modelling groups from Siemens, the Technical University of Denmark, the University de la Republica, Montevideo, Uruguay and the Technical University in Milano, Italy. Further, one conference paper was published at the Wakes Conference 2017 in Visby, Sweden, where some selected were presented.

The work will be a relevant part for three PhD-theses.

### **Outlook**

Due to the promising results, at least three journal publications are planned based on the joints experiments conducted, whose outlines were drawn during the research stay in January. Further, collaborations with other researchers world wide with the acquired data are planned. At the Wind Energy Science Conference in Copenhagen, June 2017, the results will be presented to the research community and further steps of publications will be discussed among the collaborating researchers from Oldenburg and Trondheim.

**DAAD**



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