ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

EPFL MIDDLE EAST

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Innovation Program :	**Energy**
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Main Laboratory:	WInd engineering and Renewable Energy laboratory (WIRE)
Project time line:	09.2010 – 07.2011
Research project:	**Field measurements and wind tunnel investigations of atmospheric flow through wind turbines and wind farms**

Abstract

The objective of this project is to reach a deeper understanding of the turbulent wake flows generated from stand-alone wind turbines and wind farms. The methodology consists of field measurements carried out inside and around wind farms, and of wind tunnel tests. Both experimental activities aim to create a data set for the characterization of wind-turbine wakes and the assessment of numerical techniques such as Large Eddy Simulation [1]. The synergy between these experimental activities and numerical simulations performed at the WIRE Laboratory will allow us to develop more efficient wind energy systems.

Field measurements will be performed at La Muela wind farm, Spain (Fig. 1), where more than 100 wind turbines are installed with a total capacity of about 100 MW. Wind velocity measurements will be carried out using arrays of sonic anemometers, which will provide point measurements of velocity and temperature at high temporal resolution. In addition, three wind LIDARs (Light Detection And Ranging) will be deployed to provide scans of the wind velocity field inside and above the wind farm, with a spatial resolution of 20 m. This unique experimental setup will allow us to improve our understanding and ability to predict issues such as the interference between wind turbines and the role of turbine wakes on turbine performance.

Wind tunnel measurements will be carried out initially at the boundary layer wind tunnel of EPFL in Lausanne. These experiments will be continued at the EPFL-ME wind tunnel, which will soon be built in RAK. The unique features of the EPFL-ME wind tunnel (e.g., advanced thermal controls) will allow us to model the effects of thermal stratification due to differential heating and cooling of the land surface. Tests will be performed using hot-wire anemometry, pressure sensors and Particle Image Velocimetry. Wind turbine models will be designed on the basis of previous works (see Fig. 2), as e.g. in [2], and instrumented in order to measure the thrust and torque acting on the wind turbines. Typical issues addressed by the wind tunnel experiments include the influence of the incoming boundary layer on the performance of wind turbines, and the effect of wind-farm configurations on wake interactions.

Fig. 1: Wind farm in La Muela, Spain.

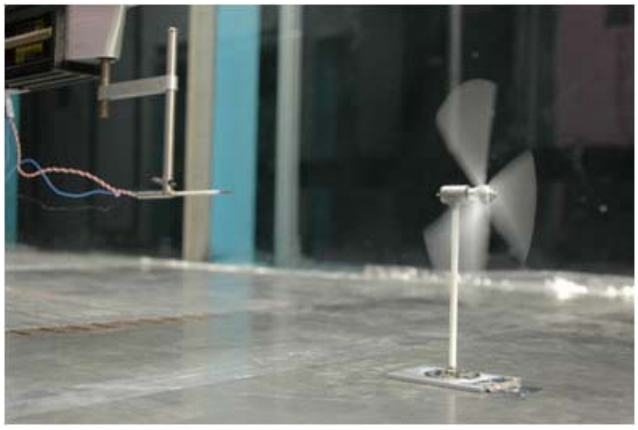

Fig. 2: Wind turbine model for wind tunnel tests.

References

[1] R. Stoll, F. Porté-Agel, Dynamic subgrid-scale models for momentum and scalar fluxes in large-eddy simulations of neutrally stratified atmospheric boundary layers over heterogeneous terrain, Water. Resour. Res. 42 (2006) W01409.

[2] L. P. Chamorro, F. Porté-Agel, A Wind-Tunnel Investigation of Wind-Turbine Wakes: Boundary-Layer Turbulence Effects, Boundary Layer Meteorol. 132 (1) (2009) 129–149.