# Experimental Investigations on Wind Turbines with Horizontal Axis

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## Abstract

Wind energy is growing in popularity and is becoming one of the most profitable source of renewable energy, thus more efficient and optimized wind energy systems are needed. To this end the WIRE group at EPFL is performing a wide research on wind turbines with horizontal axis, consisting in both numerical and experimental investigations. The accuracy of numerical simulations of wind turbines is rapidly growing in the last few years; however, experimental research still remains an essential tool for assessment of numerical codes and to produce reliable results. The presented experimental activity consists in wind tunnel measurements and field tests of real wind turbines. Wind tunnel tests present the great advantage of reproducing wind conditions completely controlled, which can be varied in order to investigate wind turbine performances for a broad range of incoming wind, i.e. with different mean velocity, turbulence and boundary layer height; furthermore, the effects of the surrounding topography and of the characteristics of the terrain can also be mimicked with apposite devices. The interaction of multiple wakes of wind turbines is investigated, which is fundamental to optimize the wind farm layout and, thus, the power production. Particular attention is also paid to the turbulence present in the wake, which can produce dangerous fatigue loads on the wind turbines placed downstream. Wind tunnel measurements are then compared with tests of real wind turbines, which are carried out with instrumented towers, Sodar and RASS. A new challenging setup for field measurements is also presented, which consists in a virtual tower where simultaneous measurements with three Lidars produce 3D velocity measurements in the wind turbine wake.

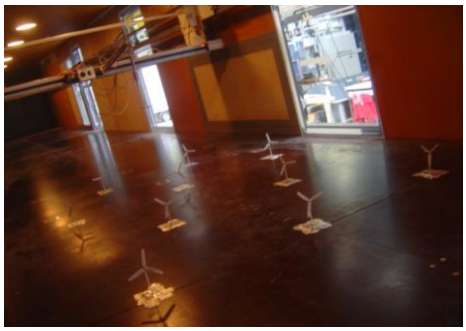

**Figure 1: Wind tunnel models of wind turbines.**

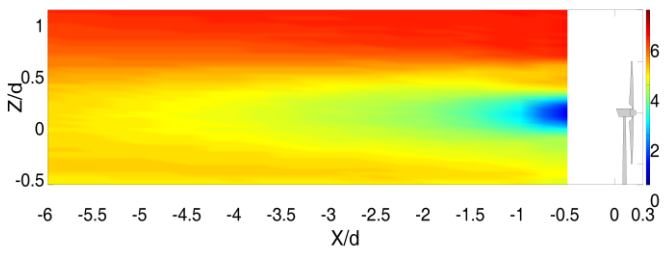


**Figure 2: Wake produced from a wind turbine.**