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Wind tunnel measurements of single and multiple wakes for a wide range of inflow conditions and wind turbines yaw misalignment/power de-rating

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Wind energy production is often organized in wind power plants rather than single isolated wind turbines, because of lower construction, maintenance and commissioning costs. However, the design of a wind farm requires taking into account the complex interactions that take place within the wind power plant itself, since the wakes of upwind wind turbines have a strong impact on the power and loading of downstream machines.

To this aim, several engineering and high-fidelity simulation tools have been developed in the recent years[1]-[4] with the goal of modelling the flow field within the wake shed by a single wind turbine, as well as the interaction and superposition of multiple wakes.

The need of experimental data, useful for the validation of the aforementioned models, is the reason for the research activity described in this paper. Wind tunnel tests (Fig. 1), performed with up to two fully actuated and sensorized scaled wind turbines[5], have been performed within the framework of the CL-Windcon H2020 project. In detail, these tests were performed in the Politecnico di Milano wind tunnel by simulating different incoming flow conditions, typical of onshore and offshore environments. The incoming inflows, as well as single and multiple wakes characteristics, were sampled at several longitudinal distances and with the machines operating under a wide range of yaw-misaligned and power de-rated conditions. The wake features, coupled with the turbine performances, provide an extensive experimental data set.

Most importantly, this data set has been made publicly available, thus allowing for the validation/tuning of a wide range of numerical models developed by the scientific community that can be used to support the synthesis of wind farm control strategies.

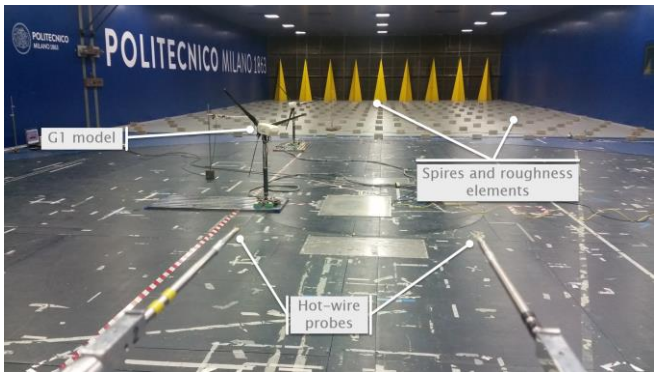

Figure 1: Experimental setup used within the framework of the CL-Windcon H2020 project.

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