Experimental Characterisation of the Far Wake of a Floating Offshore Wind Turbine in Idealised Conditions

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Abstract

Floating offshore wind parks are a promising concept for future renewable energy production. As the wind resource is stronger and less turbulent than onshore, going further offshore is desirable. To accommodate for the deeper waters floating turbines are necessary. As a floating turbine will be in motion due to the current sea state, changes in the behaviour of the far wake are to be expected. Bayati et al. (2017) found that the surge motion frequencies can be found in near wake of a floating offshore wind turbine. This will be verified for the far wake. The development of the far wake plays an important role in wind park layout. Lee et al. (2019) identified pitch and surge motions as central to power production and wake development. The wake becomes highly unsteady when exposed to pitch motion. In this context the FLOATEOLE project will deliver both wind tunnel data and field data measured using a demonstrator platform (FLOATGEN) as a basis. The wind tunnel experiments provide results from a controlled environment, isolating components of the motion and aerodynamic effects over a large area using an idealised maritime boundary layer. The real atmospheric and oceanographic conditions will be included in the field measurements, while giving a spatially limited view of the wake at any point in time. The two types of measurements can be seen as complementary. The results of each part of the project will be compared and used to validate and improve current wake models. FLOATGEN is located at Centrale Nantes' sea test site SEM-REV located about 20km off the coast of Le Croisic, France. In an experimental campaign in the Centrale Nantes wind tunnel we attempt to emulate the motion of FLOATGEN at a scale of 1:400 to analyse the behaviour of the far wake. A three Degree of Freedom (DoF) motion system is being designed and constructed to this avail, the DoFs being surge, pitch and heave. To better understand the influence of each DoF the motion is decomposed into its components. A first campaign will involve idealised 1 DoF motion imposed on a porous disk model. The DoF investigated will be

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surge. To capture a time resolved image of the unsteady wake a rake of pressure sensors will be installed allowing lateral and two dimensional measurements depending on the rakes configuration. We will show first results from this campaign, as well as the endeavours undertaken to achieve these measurements. These include the development of a low turbulence atmospheric boundary layer and the design of the motion system. To correctly model the desired atmospheric boundary layer according to VDI Guideline 3783, modifications to the wind tunnel facility were necessary. The final modelled boundary layer will be presented. The motion system is comprised of several linear motors, each reproducing one DoF.

Keywords: atmospheric boundary layer, floating, wake, imposed motion, surge