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Train^{2}Wind, or how large is an infinite wind farm?

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TRAIN^{2}WIND is a PhD TRAINing school analysing enTRAINment in offshore WIND farms with computer models and experiments. By its very nature, a wind turbine extracts energy from the wind, which is replenished from the wind field on the sides and above due to the ambient turbulence. However, offshore the turbulence is lower, and wind farms are typically larger than onshore, therefore the wind can only be replenished from above in a process called entrainment. Train^{2}Wind will investigate the entrainment process using advanced high-resolution computer modelling and wind tunnel models together with measurements of the wind field above, in and downstream of large wind farms, using lidars, radars, satellites and Unmanned Aerial Systems.

Besides the natural science package, one humanities PhD student at the University of Copenhagen will investigate the collaboration between the researchers from a social science and collaboration tools perspective.

The main work is done during the education of 18 fellows, where 13 embark on a PhD, while the other ones are employed for one year. The students will work with high-fidelity numerical simulations, lidars, unmanned aerial systems, wind tunnels and satellite data in order to understand entrainment of new momentum in very large wind farms. This changes the atmospheric boundary layer over a very extended wind farm, which becomes a wind turbine array boundary layer. The resulting change in wind resource is the main object of interest. The main planned activity is an experimental campaign at a major cluster of wind farms, probably in the North Sea. Another activity revolves around vertical axis turbines and their significantly different wake pattern, a potential mitigation measure.

So far we recruited the fellows and started with the simulations and the development of the hardware. We intend to employ a vertical take-off and landing model plane with a wing span of about 2m, which would allow to start and land from a helicopter pad offshore, and after the vertical start enjoy the advantage of a winged plane and its much larger range and endurance. Another instrument is a hexacopter mounted with a sonic anemometer, which allows to sample in a single point much akin a conventional met mast, but at any given point in or above a large wind

farm. Lidar usage and development is part of the project as well, with a floating lidar in Bergen University and long-range lidars at DTU.

There are three numerical codes used in Train^{2}Wind: Ellipsys3D, a Large Eddy Simulation (LES) high-fidelity code from DTU, WIRE-LES, another LES code from EPFL, and the Weather Research and Forecasting model run at DTU.

The outcome of the project is more knowledge of the entrainment process, and a guidance on how close to position clusters of wind farms in order not to exhaust the wind resource. The talk will give an overview of the project, highlighting the challenges.