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Variations in offshore wind turbine wake profiles with different inflow conditions of non-wake-affected upstream wind

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The wind energy industry has recently started to look in more depth at wind turbine wakes. Studies of wake behaviour have been carried out by analysing data measured from within this turbulent wind flow downstream of a turbine. As part of The Carbon Trust's Offshore Wind Accelerator (OWA) offshore wakes campaign, four nacelle mounted LiDARs were deployed on two neighbouring wind turbines located at the edge of an offshore wind farm in Denmark. The LiDARs were paired in a forward and backward facing configuration on each nacelle.

This particular layout for the LiDARs allowed wind conditions to be recorded for each wind turbine at several distances from them from both upstream and downstream directions. Many variations of inflow wind conditions coming onto the turbines at hub height were captured by the forward facing LiDARs and the respectively different wake profiles were recorded by the aft LiDARs.

Analysis was carried out on the LiDAR data for each wind turbine for the case when the upstream wind direction was from the free stream sector, that is, the sector relative to the turbine in which upstream wind was outside the wake of any other turbine in the farm. Different wind deficit profiles were characterised for the different inflow conditions such as wind speed and turbulence intensity, and any relationships between them were reported.