The flow upstream of a row of aligned wind turbine rotors and its effect on power production

The blockage developing in front of a laterally aligned row of wind turbines and its impact on power production over a single turbine was analysed using two different numerical methods. The inflow direction was varied from orthogonal to the row until 45°, with the turbines turning into the wind, thereby resembling a wind turbine testing site or row in a wind park. The numerical methods included computational fluid dynamics (CFD) with an actuator disc representation of the rotor and a simple vortex method. The forces on the actuator disc were either derived from airfoil data of a modern wind turbine or set as constant. For all methods significant changes were found in the developing flow-field with corresponding effects on the individual power output of the wind turbines. These became more pronounced with increasing inflow angle and predicted a rise in power of up to 2% for the downstream and -1% for the upstream turbines. The vortex method agreed with the CFD method on the overall trend, but its magnitude was lower.

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