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A simplified model for average kinetic energy flux within large wind turbine arrays COREY MARKFORT, IIHR-Hydroscience and Engineering, University of Iowa, WEI ZHANG, Cleveland State University, FERNANDO PORTE-AGEL, EPFL — We investigate the kinetic energy distribution within an array of wind turbines using a 1-D model for the interactions between large-scale wind farms and the atmospheric boundary layer (ABL). Obstructed shear flow scaling is used to predict the development length of the wind farm flow as well as vertical momentum flux. Within the region of flow development, momentum and energy is advected into the wind farm and wake turbulence draws excess momentum in from between turbines. This is characterized by large dispersive fluxes. Once the flow within the farm is developed, the area - averaged velocity profile exhibits an inflection point, characteristic of obstructed shear flows. The inflected velocity profile is responsible for a characteristic turbulence eddy scale, which may be responsible for a significant amount of the vertical momentum and energy flux. Prediction of this scale is useful for determining the amount of available power for harvesting. The model result for kinetic energy flux is compared to wind tunnel measurements. The model is useful for optimizing wind turbine spacing and layout, and for assessing the impacts of wind farms on nearby wind resources and the environment.

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