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The horizontal planar structure of kinetic energy in a model vertical-axis wind turbine array[1] ANNA CRAIG, ROBERT ZELLER, FRANCISCO ZARAMA, JOEL WEITZMAN, Stanford University, JOHN DABIRI, California Institute of Technology, JEFFREY KOSEFF, Stanford University — Recent studies have indicated that arrays of vertical axis wind turbines (VAWTs) could potentially harvest significantly more power per unit land area than arrays composed of conventional horizontal axis wind turbines. However, to design VAWT arrays for optimal power conversion, a more comprehensive understanding of inter-turbine energy transfer is needed. In the presented study, a geometrically scaled array of rotating circular cylinders is used to model a VAWT array. The horizontal inter-cylinder mean fluid velocities and Reynolds stresses are measured on several cross-sections using 2D particle image velocimetry in a flume. Two orientations of the array relative to the incoming flow are tested. The results indicate that cylinder rotation drives asymmetric mean flow patterns within and above the array, resulting in non-uniform distributions of turbulent kinetic energy. The variability is observed to be directly related to the ratio of the cylinder rotation speed to the streamwise water velocity. Emphasis is placed on the implications of the asymmetries for power production.

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