Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

A geometry-based approach for optimizing wind turbine layout NIRANJAN GHAISAS, CRISTINA ARCHER, University of Delaware — Layout studies are critical in designing large wind farms, since wake effects can lead to significant reductions in wind power generation. Optimizing wind farm layout using computational fluid dynamics is practically unfeasible today because of the high computational requirements of the numerical simulations. Simple statistical models, based on geometric quantities associated with the wind farm layout, are therefore attractive because they are less demanding computationally. Results of large-eddy simulations of the Lillgrund wind farm are used here to develop such geometry-based models. Several geometric quantities (e.g., blockage ratio, or the fraction of the swept-area of a wind turbine which is blocked by upstream turbines) are found to correlate very well (> 0.95) with the power generated by the turbines. These models are particularly accurate at predicting the farm-averaged power and are therefore used here to study layout effects in large wind farms. Several layout parameters are considered, such as angle between rows and columns, turbine spacing, staggering of alternate rows, and wind direction. This study demonstrates the utility of simple, inexpensive, and reasonably accurate geometric models to identify general principles governing optimal wind farm layout.

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Date submitted: 01 Aug 2014 Electronic form version 1.4