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Optimization of wind farm performance using low-order models

JOHN DABIRI, IAN BROWNSTEIN, Stanford University — A low order model that captures the dominant flow behaviors in a vertical-axis wind turbine (VAWT) array is used to maximize the power output of wind farms utilizing VAWTs. The leaky Rankine body model (LRB) was shown by Araya et al. (JRSE 2014) to predict the ranking of individual turbine performances in an array to within measurement uncertainty as compared to field data collected from full-scale VAWTs. Further, this model is able to predict array performance with significantly less computational expense than higher fidelity numerical simulations of the flow, making it ideal for use in optimization of wind farm performance. This presentation will explore the ability of the LRB model to rank the relative power output of different wind turbine array configurations as well as the ranking of individual array performance over a variety of wind directions, using various complex configurations tested in the field and simpler configurations tested in a wind tunnel. Results will be presented in which the model is used to determine array fitness in an evolutionary algorithm seeking to find optimal array configurations given a number of turbines, area of available land, and site wind direction profile. Comparison with field measurements will be presented.

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