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Fractional Flow Speedup from Porous Windbreaks for Enhanced Wind Turbine Power. NICOLAS TOBIN, ALI M. HAMED, LEONARDO P. CHAMORRO, University of Illinois at Urbana-Champaign — A wind tunnel experiment was performed to investigate the potential of porous windbreaks to increase the momentum into the swept area of a wind turbine, and thus power output. Planar particle-image velocimetry (PIV) along with linear perturbation theory is used quantify the effect of windbreak height in the changes in power output. Results show that far above the windbreak, perturbations reduce to potential flow, with a near-ground boundary condition defined by the recirculation zone behind the windbreak. Similarity in the windbreak flow is investigated and used to predict an increase in power which depends roughly linearly with windbreak height, which is corroborated by direct measurements of power from a model wind turbine. The flow field predicted by the linear theory is in broad agreement with the PIV measurements. By incorporating this result with a top-down wind turbine boundary layer approach which treats the windbreaks as additional roughness, it is found that there exists an inter-turbine spacing, on the order of 10 rotor diameters, for which windbreaks induce a net positive effect. This break-even spacing is dependent on surface roughness and the spanwise width of the windbreaks.

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