

Abstract Submitted
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Systematic flow manipulation by a deflector-turbine array¹

SHREYAS MANDRE, Brown University, NIALL M MANGAN, University of Washington Seattle — Wind and hydrokinetic turbines are often installed in the wake of upstream turbines that limit the energy incident on the downstream ones. In two-dimensions, we describe how an array can deflect the wake away and redirect more energy to itself. Using inviscid fluid dynamics, we formulate the definitions of “deflectors” and “turbines” as elements that introduce bound and shed vorticity in the flow, respectively. To illustrate the flow manipulation, we consider a deflector-turbine array constrained to a line segment aligned with the freestream and acting as an internal boundary. We impose profiles of bound and shed vorticity on this segment that parameterize the flow deflection and the wake deficit respectively, and analyze the resulting flow using inviscid fluid dynamics. We find that the power extracted by the array is the product of two components: (i) the deflected kinetic energy incident on the array, and (ii) the array efficiency, or its ability to extract a fraction of the incident energy, both of which vary with deflection strength. The array efficiency decreases slightly with increasing deflection from about 57% at weak deflection to 39% at high deflection. This decrease is outweighed by an increase in the incident kinetic energy due to deflection.

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