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Design and Optimization of an Internal Turbine to Interface with AeroMINE using the Proper Orthogonal Decomposition Method

The design of a low Reynolds number (order 100,000) turbine blade is presented that maximizes lift over drag using design of experiments and the Proper Orthogonal Decomposition (POD) methods. This blade was created to interface to the novel wind energy harvester AeroMINE, which has no external moving parts. Power is extracted by a low-speed horizontal axis turbine mounted in the intake. Flow in the intake is driven by a pressure gradient caused by AeroMINE's external mirrored airfoil-pairs. As wind passes through these external foils, suction occurs on their low-pressure surfaces. This suction draws out air from air-jets located along the surfaces of the foils themselves and causes a pressure gradient within the intake. To begin the design process, an exploration space was set up using a D-Optimal design. Eight factors, which described the geometry of the airfoil, with three levels per factor were examined. Constraints on each factor were based on airfoil data found in the literature for low Reynolds number flows. The results of the design exploration provided an initial guess for the optimization method. The POD method was used to reduce the computational cost of the optimization procedure.

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Authors:
Elizabeth Krath
Brent Houchens
David Marian
Suhas Pol
Carsten Westergaard