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Placing Betz on the Improvement of Wind-Turbine Efficiencies through Unsteady Streamwise Motion[1] NATHANIEL WEI, JOHN DABIRI, California Institute of Technology — The Betz limit represents the theoretical maximum efficiency for power conversion of a fluid-driven energy-harvesting device in steady flow. Dabiri (Phys. Rev. Fluids, 2020) has suggested that this constraint can be circumvented in the case of unsteady flow through the influence of time-varying velocity potentials. We extend this analysis by incorporating analytical models for these velocity potentials, which allow us to directly consider the effects of periodic streamwise motions of an actuator disc on its theoretical efficiency. Various motion profiles for the actuator disc are considered, informed by physical constraints derived from the analytical framework. Cases in which the theory predicts increases in efficiency above the Betz limit are then identified and scrutinized. The results of these theoretical analyses will inform the design of experiments that will evaluate the feasibility of using streamwise motion to improve the efficiency of energy-harvesting devices.

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