Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Numerical investigation of the self-starting of a vertical axis wind turbine[1] HSIEH-CHEN TSAI, TIM COLONIUS, California Institute of Technology — The immersed boundary method is used to simulate the incompressible flow around two-dimensional airfoils at sub-scale Reynolds number in order to investigate the self-starting capability of a vertical-axis wind turbine (VAWT). By investigating a single blade fixed at various angle of attacks, the leading edge vortex (LEV) is shown to play an important role in the starting mechanism for both flat-plate and NACA 0018 blades. Depending on the angle of attack of the blade, as the LEV grows, the corresponding low pressure region results in a thrust in the tangential direction, which produces a positive torque to VAWT. Due to the characteristics of the blades, a NACA 0018 blade produces a larger thrust over a wider range of angle of attacks than a flat-plate blade. Therefore, a VAWT with NACA 0018 blades can self-start more easily than one with flat-plate blades. Moreover, by investigating the starting torque of three-bladed VAWTs fixed at various orientations, the optimal orientation that produces the largest torque to start both VAWTs is with a blade parallel to the flow and facing downstream. The simulations are also compared to results from companion water-tunnel experiments at Caltech.

[1]This project is supported by Caltech FLOWE center/Gordon and Betty Moore Foundation.

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Date submitted: 01 Aug 2014 Electronic form version 1.4