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Performance Optimization and Analysis of Variable-Pitch Vertical-Axis Wind Turbines DIETMAR REMPFER, PETER KOZAK, Illinois Institute of Technology — The blades of conventional vertical-axis wind turbines (VAWT) operate in a complex unsteady environment, characterized by periodically changing relative flow velocity and angle of attack, accentuated by passage through the wake of preceding blades. For many operating regimes, in particular for operation at low tip-speed ratio which is of interest in order to reduce mechanical loads, the blades experience dynamic stall, reducing overall efficiency and leading to significant torque fluctuations. Periodic pitch variation of the turbine blades may therefore be considered in order to avoid stall and increase efficiency. In this presentation we will discuss gains in operating characteristics and efficiency that can be obtained by such a strategy. We will describe a full optimization of turbine efficiency based on double-multiple streamtube models. In addition, we will compare these results, and discuss the physics of the associated flows using data obtained from two-dimensional Navier-Stokes simulations of such turbines. It will be shown that, while peak efficiency of a variable-pitch VAWT is only moderately higher than the one of a conventional fixed-pitch VAWT, we can achieve a much broader maximum, leading to significantly improved performance in practical use.

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