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Parameter Optimization Applied to Use of Adaptive Blades on a Variable Speed Wind Turbine

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Abstract

The value of adding adaptive blades to a variable speed turbine is studied by applying a general purpose optimization scheme to a baseline turbine configuration. The turbine is the AWT-26. Adaptive-blade effects involve elastic twist coupling tied to centrifugal and flap loadings. Two baseline variable speed approaches are examined. In the "aggressive" approach the speed control is assumed to limit power output perfectly at the rated level, producing the theoretical maximum energy. In the "conservative" approach, speed control is not used at all to limit power; the power is limited by passive stall regulation. The adaptive blades do not substantially improve the performance of the aggressive, theoretical maximum. However, adaptive blades with centrifugal coupling are shown to make up 45% of the difference between the aggressive and conservative baseline cases when applied to the conservative speed control case. Simple pitch adjustments can also compensate for the conservative speed control in low wind sites, but in moderate to high wind sites the adaptive blades achieve substantially more. Cases including simultaneous centrifugal and flap coupling could not be studied with the optimization procedure because they amount to an over parameterization of the problem; i.e., there are many local maxima in the system performance criterion.