The Impact of Active Aerodynamic Load Control on Fatigue and Energy Capture at Low Wind Speed Sites*

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Abstract

Active aerodynamic load control of wind turbine blades has been heavily researched for years by the wind energy research community and shows great promise for reducing turbine fatigue damage. One way to benefit from this technology is to choose to utilize a larger rotor on a turbine tower and drive train to realize increased turbine energy capture while keeping the fatigue damage of critical turbine components at the original levels. To assess this rotor-increase potential, Sandia National Laboratories and FlexSys Inc. performed aero/structural simulations of a 1.5MW wind turbine at mean wind speeds spanning the entire operating range. Moment loads at several critical system locations were post- processed and evaluated for fatigue damage accumulation at each mean wind speed. Combining these fatigue damage estimates with a Rayleigh wind-speed distribution yielded estimates of the total fatigue damage accumulation for the turbine. This simulation procedure was performed for both the turbine baseline system and the turbine system incorporating a rotor equipped with FlexSys active aerodynamic load control devices. The simulation results were post-processed to evaluate the decrease in the blade root flap fatigue damage accumulation provided by the active aero technology. The blade length was increased until the blade root flap fatigue damage accumulation values matched those of the baseline rotor. With the new rotor size determined, the additional energy capture potential was calculated. These analyses resulted in an energy capture increase of 11 % for a mean wind speed of 6.5m/s.

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