Computational fluid dynamics-based surrogate optimization of a wind turbine blade tip extension for maximising energy production

This article presents a design study into the redesign of a wind turbine blade tip seeking to increase the energy production subject to the loads constraints of the existing blade. The blade shape is parameterized to allow for planform changes in the tip region with respect to chord, twist and blade length extension, and additionally three parameters that allow to explore winglet-like shapes. The design strategy uses 3D computational fluid dynamics computations of the geometrically resolved rotor to create a surrogate model, after which the tip shape is numerically optimized based on the surrogate model, subject to a number of geometric and loads-based constraints. The study shows that it is possible to increase power production by 2.6% for a blade extension with a winglet, without increasing the flapwise bending moment at 90% radius, whereas for a straight blade extension it was only possible to achieve an increase of 0.76%.

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