Retrofit winglets for wind turbines

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Retrofit Winglets for Wind Turbines

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Wind power is becoming increasingly important as a source of renewable energy. This is even more so in Kansas, which has the second-largest wind resources in the country. In 2016, 29.6% of the state's energy came from wind. Much research has been devoted to technologies that improve wind turbine efficiency, winglets being among them. Blade tip vortices increase induced drag and affect wind turbine lift generated. This affects power generated and efficiency of turbines. In aircraft, winglets have proven to reduce induced drag. However, winglets tend to increase root bending moments, requiring structural reinforcement and making winglets an expensive proposition. In this study, a retrofit winglet for a baseline wind turbine is designed, and its economic feasibility determined. Traditional methods to determine power output of a wind turbine, such as the Blade Element Momentum theory, are insufficient to model a wind turbine with winglets. A Vortex Lattice Method for rotor applications was developed. Economic feasibility is a key issue in the wind industry today. Accordingly, a cost function that compares design, manufacture and labor costs against increment in power was implemented. These tools, along with researched winglet design philosophy, was used to determine a beneficial winglet configuration for a reference turbine. Using lightweight material and careful configuration designed to minimize root bending moments, a retrofit winglet has been designed that mitigates the need for structural reinforcement of the blade. The resulting winglet configuration, increase in annual energy produced and the resulting profits are presented.