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INNOVATIVE DESIGN APPROACHES FOR LARGE WIND TURBINE BLADES FINAL REPORT

WindPACT Blade System Design Studies

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ABSTRACT

The goal of the Blade System Design Study (BSDS) was investigation and evaluation of design and manufacturing issues for wind turbine blades in the one to ten megawatt size range. A series of analysis tasks were completed in support of the design effort. We began with a parametric scaling study to assess blade structure using current technology. This was followed by an economic study of the cost to manufacture, transport and install large blades. Subsequently we identified several innovative design approaches that showed potential for overcoming fundamental physical and manufacturing constraints. The final stage of the project was used to develop several preliminary 50m blade designs.

The key design impacts identified in this study are: 1) blade cross-sections, 2) alternative materials, 3) IEC design class, and 4) root attachment. The results show that thick blade cross-sections can provide a large reduction in blade weight, while maintaining high aerodynamic performance. Increasing blade thickness for inboard sections is a key method for improving structural efficiency and reducing blade weight. Carbon/glass hybrid blades were found to provide good improvements in blade weight, stiffness, and deflection when used in the main structural elements of the blade. The addition of carbon resulted in modest cost increases and provided significant benefits, particularly with respect to deflection. The change in design loads between IEC classes is quite significant. Optimized blades should be designed for each IEC design class. A significant portion of blade weight is related to the root buildup and metal hardware for typical root attachment designs. The results show that increasing the number of blade fasteners has a positive effect on total weight, because it reduces the required root laminate thickness.