

A case study surrounding the impact of Vortex Generators on wind turbine performance.

WIND FARM OWNERS ARE CONSTANTLY SEEKING

new technology to help optimize and increase Annual Energy Production (AEP) and while Vortex Generators (VGs) have existed for some time, the latest technology and installation procedures have made VGs a popular topic in wind energy. UpWind Solutions, in partnership with SMART BLADE®, studied the design and installation of VGs to determine exactly how they affected the AEP and the potential ROI for the wind farm owner.

VG CASE STUDY

The case study spanned three months and compared turbines with the UpWind Solutions – SMART BLADE® VG solution to control turbines without them for the purposes of the VG performance evaluation. After analyzing the data, the following conclusions were drawn:

- The mean AEP increase experienced within the three-month time period is in the range of +2.1% to +2.5%. Considering the good condition of the blades and simple topography of the site this is considered a very good performance result.
- The turbine performance without VGs is characterized by significant power scatter. This is most likely the result of considerable aerodynamic stall of a big part or even the entire blade during storms with gusty wind conditions.
- The overall effectiveness of VGs on this site is positive and is able to increase the revenue of the operator/owner with a high ROI.

The AEP of the turbines was calculated based on the actual wind distribution of the site and the measured power curves of the test (A & B) and control turbines (C & D). In all cases the test turbine had a slightly lower performance than the control turbine. However the installation of VGs fully reversed this trend and further increased the energy yield of the test turbines. The increase in AEP for the three months of measurement data were +2.14% for test group A and +2.45% for test group B.

Considering the fact that the test turbines were quite new and their blades are in good condition without indication of any erosion or surface roughness, the AEP increase is quite significant. Additional revenue of the turbines (approximately \$7,000 per turbine per year) due to the VG installation can consequently pay-back for the VG installation investment in a very short time.

INSTALLATION PROCESS

Every wind turbine manufacturer uses a different geometry for their blades. Thus, for optimal performance improvements, the VG design and installation procedure

must be customized for each blade type. This technique is used for every installation of VGs on different turbine platforms. Naturally, identical turbines do not require individual flow analysis procedures, thus keeping the development and installation cost and time to a minimum.

To identify the optimal VG position, it is necessary to investigate in depth the aerodynamic performance of the rotor blades. For this reason, SMART BLADE has developed a proprietary flow analysis methodology that involves flow visualization and advanced image processing and flow analysis. A team of SMART BLADE engineers are responsible for the analysis of the aerodynamics of every new wind turbine type. Custom-made equipment is installed on site and the aerodynamic performance of the test turbines is carefully analyzed.

VALUES OF A CUSTOM INSTALLATION PROCESS

Customized: Custom VG designs maximize energy yield for every turbine technology in which the VG solutions are installed. The design work is performed at the SMART BLADE research facilities in collaboration with the Institute of Fluid Dynamics and Technical Acoustics of TU Berlin. The VG design is accomplished by means of wind tunnel measurements on actual wind turbine airfoils and extensive flow simulations (CFD).

VG Location: A custom V-shape installation line optimizes the stall delay vs. drag penalty. The wind tunnel tests and flow analysis of SMART BLADE® resulted in customized installation locations for each type of blade.

Repeatable: Once the VG pattern is developed, precise installation processes are formulated to assure accurate and repeatable VG placement during installation. Templates ensure aerodynamic balance and reduce total turbine down-time.

Proprietary Adhesive: To install the VGs, rope access technicians apply a durable, proprietary rapid curing adhesive tape. The self-adhesive, cost effective tape reduces room for error and assures form bonding of the VG on the blade even in extreme climates. Utilizing the new adhesive also increases the speed of installation.

Speed: Utilizing custom templates, processes, self-adhesive backing, and skilled rope access technicians, UpWind Solutions was able to achieve an average of less than one day of downtime per turbine resulting from the new installation techniques that improves speed of implementation.

Safety: Safe, certified rope access technicians manage high quality installations at high speed with minimum down-time for the turbines. ↘