CENER research in blade erosion

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Blade roughness

- CENER research's in roughness modelling and characterization since 2009 •
- Field characterization of blade roughness ٠
- Equivalent sand grain values smaller than expected ٠





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1.00 mm

Blade roughness CFD Modelling







WMB 18% airfoil Re=3e6 Experiments in the HDG wind tunnel



- Roughness modelling both in XFOIL and CFD (WMB and OpenFOAM)
- Boundary conditions implemented in WMB and OpenFOAM: Hellsten and Laine

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Blade roughness: CFD Modelling for high roughness values



CFD to measure erosion impact over power production



CFD to measure erosion impact over power production



AERODYNAMICS: CENER's LOW drag Vortex Generator design



CENER owns a Low Drag VG :

- 1. Design tested in the wind tunnel
- 2. Aerodynamic shape VG
- 3. Recovery of eroded blades' AEP about 1.5%



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AERODYNAMICS: CENER's LOW drag Vortex Generator design



Low Drag Vortex Generators







Wind tunnel experiments S839 airfoil (30% thickness) including CENER's low drag VGs



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The Future...

- Standardize roughness models for CFD simulations \rightarrow IEATask 46
- Definition of erosion catalogue \rightarrow IEATask46
- Design decision-maker tools more independent from CFD
- Advance in new mitigation measures





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Main references

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THANKS A LOT.

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