# High-Fidelity aeroelastic analysis of Wind-Turbines in complex terrain - Fluid Model

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## Abstract

The rapid technological advancement in computational resources enables the use of high-fidelity models such as CFD to simulate more and more complex flows. In this way a deeper understanding of complex phenomena can be obtained.

The impact of complex terrain and turbulence on the aeroelastic behavior of a horizontal-axis wind turbine is analyzed within the WindForS project WINSENT. The blade deformation is calculated using an explicit Fluid Structure Interaction (FSI) coupling within the CFD URANS code FLOWer [1] based on structured meshes and a turbine CSD beam model built on the FEM solver KRATOS [2], considering in addition both gravitational and centrifugal forces. The two codes are interfaced by the coupling tool EMPIRE [3] in an explicit way, that means that the loads and deformation exchange happens only once per time step, which is in the order of 1 degree azimuth in the present calculations.

The presented FSI coupling method will be applied to the reference wind turbine of the WINSENT project in the flat terrain under uniform standard inflow conditions. Afterwards, the same turbine will be simulated in the complex terrain with turbulent axial flow conditions. The results will be compared to the rigid turbine and the effects of the blade deformations on the aerodynamic performances and loads will be analysed. The effects of the tower will be also observed comparing the full model to a much cheaper 120 degree model of the same turbine.

## References

[1] Kroll N and Fassbender J *MEGAFLOW-Numerical Flow SImulation for Aircraft and Design*, Springer Verlag.

[2] *Kratos MultiPhysics* URL http://www.cimne.com/kratos/.

[3] *EMPIRE* URL http://empire.st.bv.tum.de/.