

The National Renewable Energy Centre of Spain -CENER- is a technology centre specialized in applied research and development as well as the promotion of renewable energies. CENER is divided into six departments: Wind Energy, Photovoltaic Solar Energy, Solar Thermal Energy, Biomass Energy, Bioclimatic Architecture and Renewable Energy Grid Integration.

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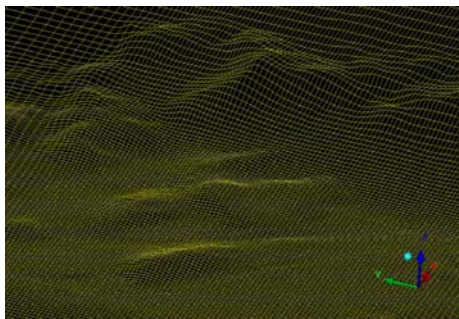


CFDWIND: WIND RESOURCE ASSESSMENT FOR COMPLEX TERRAIN AND OFFSHORE WITH CFD

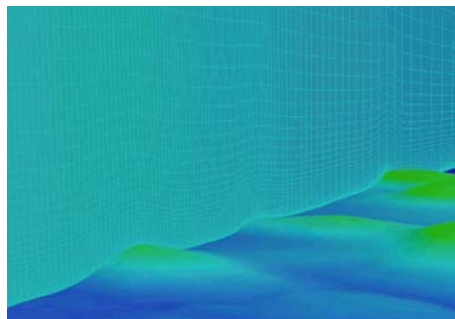


CENER offers to the wind energy sector a validated methodology based on Computational Fluid Dynamics (CFD) especially designed for complex terrain topographies as well as offshore environments and coastal areas, where linear models are less reliable. The CFD methodology developed by CENER can help you to reduce considerably the uncertainty related to wind turbine siting, increasing wind farm profitability.

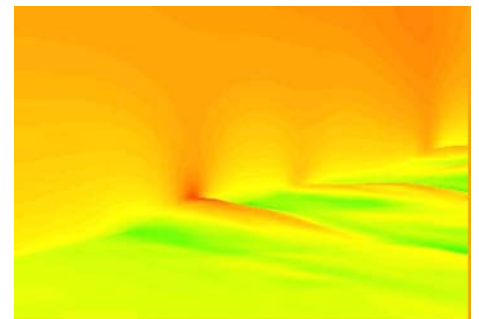
- High resolution wind maps in complex terrain and offshore (up to 5m x 5m resolution)
- Wind speed, turbulence intensity and upflow angle at any point in the wind farm
- Long term annual energy production for each wind turbine and for the wind farm using measurements at one single meteorological mast or several masts
- Reliable vertical extrapolation of measurements to high hub heights
- Significant cost reduction on installation of additional high meteorological masts. Better accuracy compared to linear models using less meteorological stations
- Possibility of coupling to mesoscale models in areas without measurements (onshore and offshore)
- Any customized analysis demanded by customers



3D high resolution
mesh around wind farm

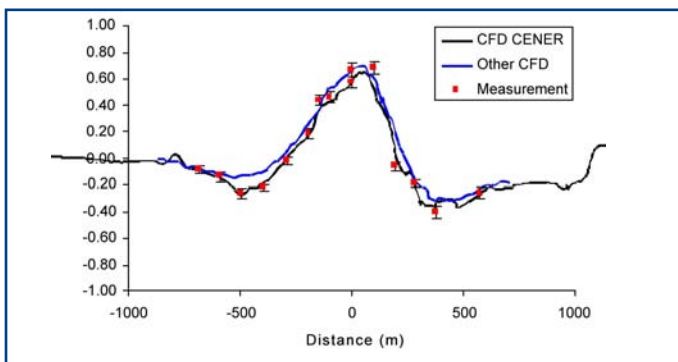
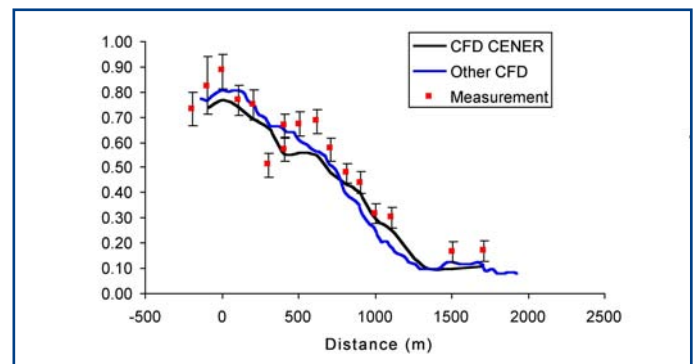
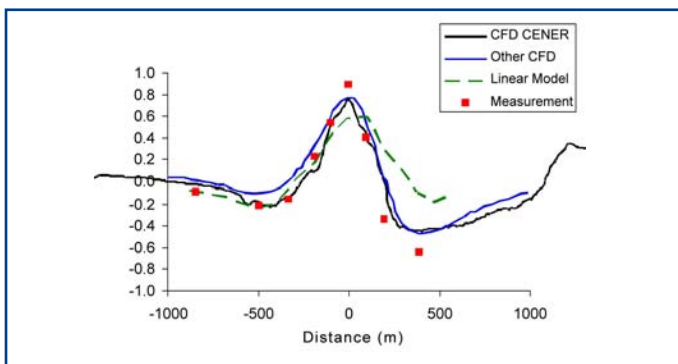


Wind speed at hub height
in highly complex terrain areas



Flow pathlines over complex terrain areas

- Similar requirements to conventional wind resources assessment studies
- Uncertainty calculation
- Automatic generation of surface roughness maps
- Optimized turbulence model parameterization for atmospheric boundary layer
- Generation of results according to IEC standards
- Highly qualified and experienced staff in atmospheric boundary layer analysis
- CFD calculations can be validated in specific cases if local measurements are available
- Successfully validated model in complex terrain and offshore cases (see references)
- Training by specialised staff on wind flow modelling with CFD available.
- Basic and advanced courses adapted to the customer needs
- Customized services focused on the solution of specific problems



Validation of CFDWIND in Askervein hill (LINE A, LINE AA and LINE B)

References:

- Sanz J., Cabezón D., Lozano S., Martí I. Parameterization of the atmospheric boundary layer for offshore wind resource assessment with a limited-length-scale k-É model, Proceedings of the European Wind Energy Conference 2009, Marseille (France)
- Sanz J., Cabezón D., Martí I., Patilla P., van Beeck J. Numerical CFD modelling of non-neutral atmospheric boundary layers for offshore wind resource assessment based on Monin-Obukhov theory, Proceedings of European Wind Energy Conference 2008, Brussels (Belgium)
- Cabezón D., Martí I., A new methodology for estimating wind farm production through CFD codes, Proceedings of European Wind Energy Conference 2007, Milan (Italy)
- Cabezón D., Sanz J., van Beeck J. Sensitivity analysis on turbulence models for the ABL in complex terrain, Proceedings of European Wind Energy Conference 2007, Milan (Italy)