

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.

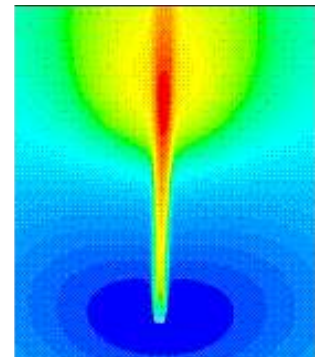
More info: www.cener.com



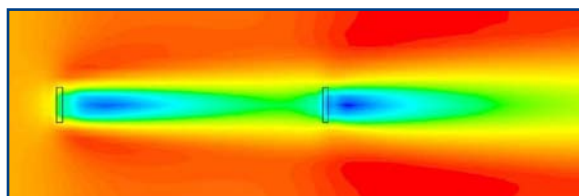
CFD WAKE: WAKES IN COMPLEX TERRAIN AND OFFSHORE WITH CFD



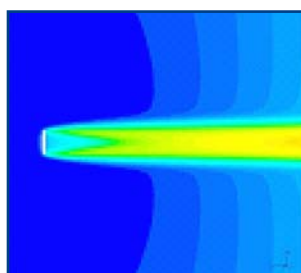
- CFDWAKE is a CFD wake model based on the actuator disk technique for wakes simulation in large wind farms, in complex terrain and offshore; where linear models usually underestimate wakes and overestimate power production.
- Similar input requirements to conventional wind resource assessment studies: rotor diameter, hub height and thrust curve.
- Simulation of the interaction between wakes and terrain through CFD.
- Aggregation of wakes in large wind farms.
- Specific mesh generation for the simulation of wakes with refinement at critical areas.
- Estimation of wind speed deficit and power production deficit for CFD wind resource assessment studies.
- Estimation of ambient and added turbulence intensity with CFD for IEC classification analysis at every wind turbine position.
- CFDWAKE has been successfully validated in the framework of the EU project UpWind (see references)



Wind speed variation after a wind turbine. Interaction with complex terrain. Simulation with CFDWAKE. View from top



Wind speed deficit evolution in a multi-rotor configuration. Simulation with CFDWAKE. View from top

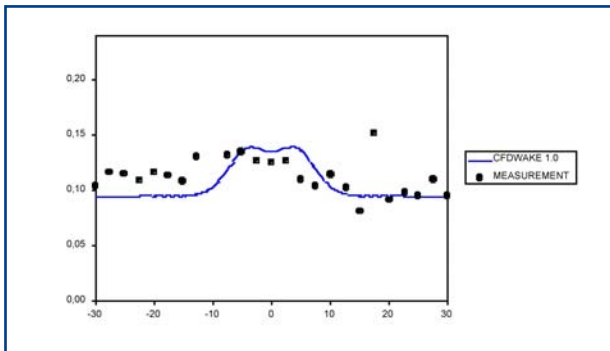


Turbulence intensity generated downwind (after the wind turbine). Interaction with complex terrain. Simulation with CFDWAKE. View from top

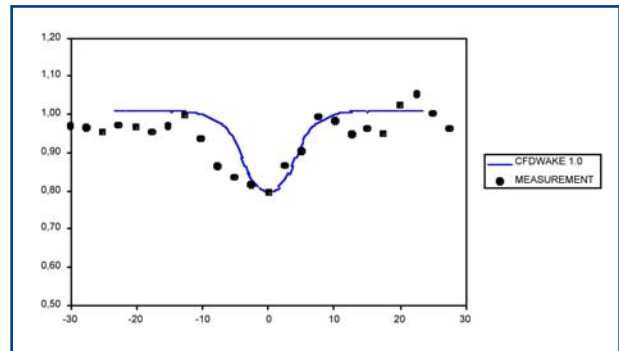


Offshore wind farm

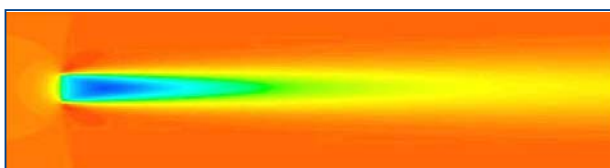
- CFDWAKE simulates the evolution of wakes in challenging environments such as complex terrain and offshore sites, giving an accurate estimation of the net wind farm annual energy production
- Wind farm layout optimization minimizing wake losses in complex terrain and offshore
- Accurate IEC class determination



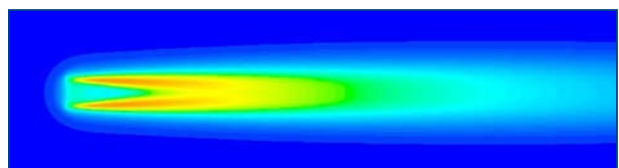
Validation of wind speed deficit (vertical axis) estimated by CFDWAKE in the Sexbierum experiment at 8 rotor diameters downwind. Wind direction in horizontal axis



Validation of turbulence intensity (vertical axis) estimated by CFDWAKE in the Sexbierum experiment at 8 rotor diameters downwind. Wind direction in horizontal axis



WIND SPEED DEFICIT U/U_0



TURBULENT INTENSITY

References:

- Barthelmie, R.J., Frandsen, S.T., Rathmann, O., Politis, E., Prospathopoulos, J., Rados, K., Hansen K., Cabezón D., Schlez W., Phillips, J., Neubert, A., van der Pijl, S. and Schepers, G., Flow and wakes in large wind farms in complex terrain and offshore. Proceedings of the European Wind Energy Conference 2008, Brussels (Belgium)
- Cabezón D., Sanz J., Martí I., Crespo A., Validation of a CFD wake model based on the actuator disk technique and the thrust coefficient. Preliminary results. Proceedings of the European Academy of Wind Energy (EAWE) 2008, Magdeburg (Germany)
- Cabezón D., Sanz J., Martí I., Crespo A., CFD modeling of the interaction between the Surface Boundary Layer and rotor wake. Proceedings of the European Wind Energy Conference 2009, Marseille (France)