

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.

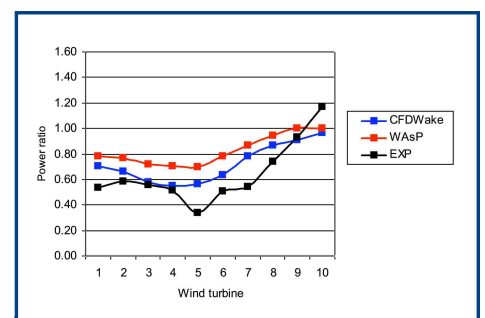
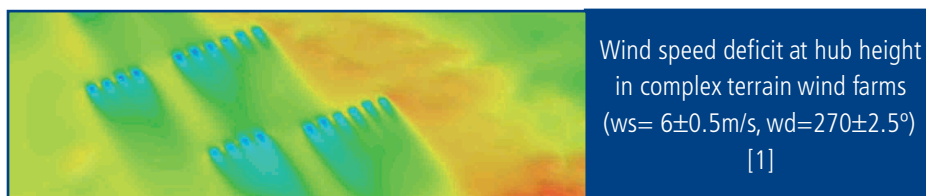
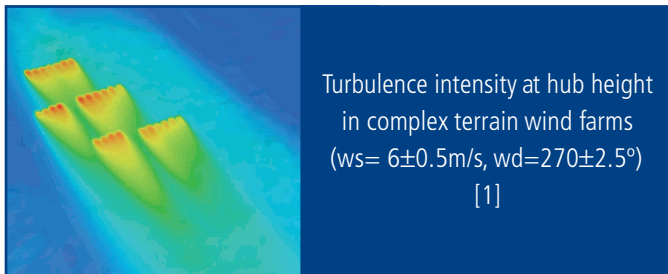
More info: www.cener.com



CFD WAKE 1.0: WAKES IN COMPLEX TERRAIN AND OFFSHORE WITH CFD

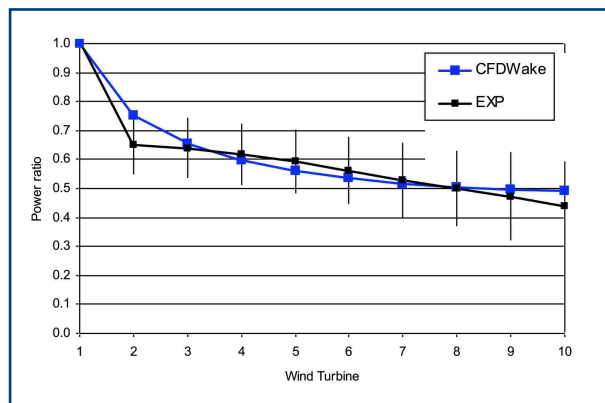


- CFD WAKE is a CFD wake model based on the actuator disk technique for wakes simulation in large wind farms, in complex terrain and offshore; where linear models usually underestimate wakes and overestimate power production.
- Similar input requirements to conventional wind resource assessment studies: rotor diameter, hub height and thrust curve.
- Simulation of the interaction between wakes and terrain through CFD.
- Merge 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 turbulent intensity
- CFD WAKE has been successfully validated in the framework of the EU project UpWind (see references)

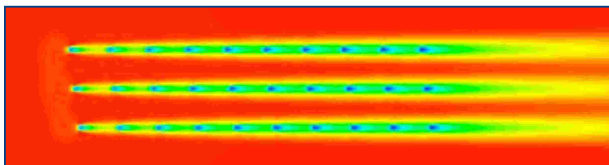


Validation of CFDWAKE
power ratios along a row of wind turbines
inside a complex terrain wind farm ($w_s = 6 \pm 0.5 \text{ m/s}$, $w_d = 270 \pm 2.5^\circ$)

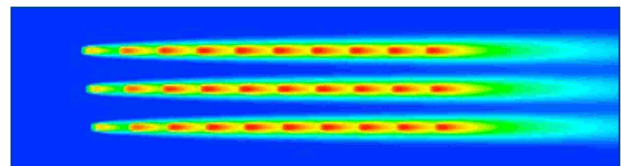
- CFD WAKE simulates the evolution of wakes in challenging environments such as complex terrain and offshore sites, giving an accurate estimation of the net wind farm annual energy production
- Wind farm layout optimization minimizing wake losses in complex terrain and offshore
- Possibility of adding atmospheric stability effects



Validation of cfdwake
power ratios averaged for all rows in horns rev wind farm
(WS= 6 ± 0.5 m/s, WD= $270\pm 2.5^\circ$)



Wind speed deficit at hub height
in offshore wind farms [1]



Turbulence intensity at hub height in offshore wind farms
[1]

References:

- [1] Cabezón, D., Hansen, K. and Barthelmie, R.J 2010: Analysis and validation of CFD wind farm models in complex terrain. Effects induced by topography and wind turbines. European Wind Energy Conference, Warsaw (Poland), April 2010, 7pp.
- [2] 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)
- [3] 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)
- [4] 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)