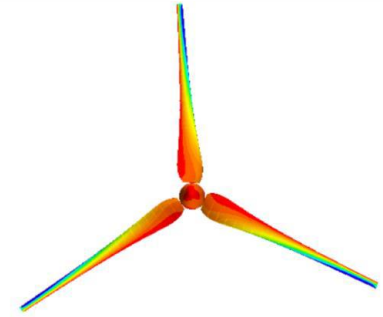
Reference sheet/Success story

Wind turbine

Evaluation of the aerodynamic performance of a wind turbine

Objective

Wind energy is at the heart of community and global challenges that stem from the desire of many countries, including France, to reduce greenhouse gas emissions. To make this energy economically viable, it is necessary to maximize the efficiency of wind turbines. In the design phase, manufacturers want to increase the power generated over a full range of operational conditions while improving the durability of the system. The aerodynamic optimization of the rotor as well as the prediction of the load exerted on the wind turbine thus represent two key success factors for achieving this objective. In this project, Zelin acts as a designer and assesses the aerodynamic performance of the rotor via digital simulation, in order to optimize the device.



Result

The rotor's performance is precisely assessed for different input conditions and configurations. In this way, the optimal operating regime of the reference system could be determined for each range of conditions.

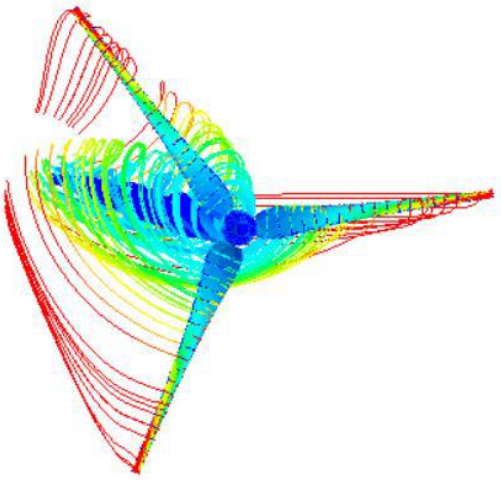
In addition, an in-depth study of the flow dynamics allows for the identification of its specific aerodynamic characteristics, such as, the load exerted on the blades, the formation of false blade tip vortices, or the development of a wake downstream of the rotor. These details are used to assess the performance of a change in design.

A new virtual rotor prototype has been proposed and tested, making it possible to limit the identified undesirable effects and to increase the power recovered over the high-speed ranges.

Implementation

Zelin has set up a calculation process that's dedicated for modeling this type of flow:

- 3D model of the wind turbine
- Material resources: 32-core HPC station & SIEMENS StarCCM + software
- Some analytic examples:
  - Model of blade rotation by steady approach (MRF)
  - Estimated generated power and power coefficient under different operating conditions
  - Advanced post-processing: interference factor, streamlines at the blade tips and feet, vorticity iso-surface, vortex visualization



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