SIMULATION OF VERTICAL AXIS WIND TURBINES WITH MOVING BLADES

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ABSTRACT

Vertical axis wind turbines (VAWT) offer a number of advantages as compared with the more conventional design with a horizontal axis. In particular, the design is much simpler, leading to lower cost per kWh, and the turbines can be positioned closer to each other. The design and optimization of VAWTs is not very mature, largely due to the fact that the flow field is very complex and can only be understood using large-scale CFD simulations. This means that there exists a large number of different designs on the market. Obviously, they cannot all be optimal.

We have studied a number of different designs with moving blades on the rotor. The goal was to understand to which extent the efficiency of the turbine can be increased by allowing to the blades to move and the find the optimal motion curve. In addition, we learned a great on how to simulate air foils with very different angles of attack. The simulations were carried out mostly in ANSYS Fluent, which allows for very flexible definition of blade motion using user defined functions (UDF). With this approach, it was possible to work with rigid and flexible blades. In order to validate the results, a small-scale test turbine with 3D-printable blades has been developed at the university.

The results clearly demonstrate the usefulness of CFD and FSI for the design of vertical axis wind turbines. The codes are currently being used in various wind-power related projects at the HSR.