Small Vertical Axis Wind Turbine Design

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The Small Vertical Axis Wind Turbine Design participates in the European Wind Turbine Design Contest (EWTDC). This is a contest between universities regarding the design and construction of a small wind turbine. NHL Leeuwarden organizes the event. During the academic year, 5 university teams participate in the contest through two stages with a final experimental evaluation. The first stage involves wind turbine design with a maximum swept rotor area of $2m^2$. Once the committee accepts the design, the second stage involves the students in the turbine's manufacturing. The final event, the 2nd to 4th of July, consists out of several wind tunnel tests at TU Delft, in order to judge the best design, followed by a symposium in Leeuwarden.

The EWTDC contest does not restrict the students to a specific type of turbine to be designed. Given the master study focused more on horizontal axis wind turbines, vertical axis type was the chosen approach. However, there is a large research gap between these two turbine types. For this reason, many variables had to be considered, i.e. VAWT topology, number of blades, airfoil type, control methodology, efficiency, etc. This is indeed a green project, as vertical axis wind turbines have great benefits. Whether offshore or inland, VAWT's are not resource intensive (tower) and harvest wind energy, independent of its incoming direction (less components).

The methods used for the design, involved a self-developed BEM code. However, before any programs in Matlab were written, discussions with researchers at Riso and DTU professors took place. Some first assumptions were done with BEM, in order to determine the appropriate aerodynamic properties for the VAWT design. Later on, simulations using HAWC2, an aeroelastic code developed at DTU, enhanced the process and allowed the team to evaluate various designs and their performance. Indeed the scale of the VAWT posed other challenges as airfoil data is needed for low Reynolds numbers. Literature resources and performed wind tunnel tests provided the needed information. With these simulation results, work will continue in order to finalize the criteria to be considered during the second and last stage, construction. With the VAWT prototype, testing will determine whether some more adjustments will be required before the wind tunnel tests to be performed at the competitions location.

Being DTU's first time to compete in such event, one of the many goals is to compete yearly and win the contest, just like other wind energy related projects, ingoing at DTU. The continuous development of this project is also intended to improve the performance and the design of VAWTs, where innovations are a possibility. For now, after the construction phase and the final wind tunnel tests, the team will be able to evaluate results and compare the assumptions made, during the design phase, with both blade-element-momentum theory and the aeroelastic code used.