

Calculating the Power of Wind Turbines with the Blade Element Momentum Theory

Task for a *Master Thesis*

Background

For the past decades, wind power is the leading source of renewable energy. It is the world's fastest growing energy source due to its reliability and cost-effectiveness. The dominant wind turbine design is the Horizontal Axis Wind Turbine (HAWT). A closer look reveals that HAWTs often have an axis with a small angle to the horizon (axis angle). Furthermore, the blades may show an angle with the axis not exactly 90° (cone angle). Almost all engineering-level aerodynamic design calculations for HAWT are done with the Blade Element Momentum Theory (BEMT). Available for work on this task is a FORTRAN program for the BEMT that allows also the introduction of cone and axis angle.

Task

Task is to convert the FORTRAN program of the BEMT into an Excel program and to show how Excel (with the Solver) can be used to optimize the rotor geometry. The subtasks are:

- Review of available free tools to calculate the aerodynamic power output of wind turbines.
- Summary of the fundamental equations of the Blade Element Momentum Theory (BEMT).
- Introduction to the different wind turbine configurations.
- Help to get started with the blade element momentum spreadsheet.
- Investigation of generic $C_p - \lambda_t$ curves.
- Trial to optimize disk geometry.

The report has to be written in English based on German or international standards on report writing.