

# **The Unsteady Blade Element Momentum Theory (UBEMT) Used to Calculate Wind Turbines with General Cone and Axis Angle**

Task for a project

## **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  $90^\circ$  (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 [Seminar Lecture](#) (Chapter 10.2) with a FORTRAN program for the Unsteady BEMT (UBEMT) that allows also the introduction of cone and axis angle. The topic has recently been addressed again in a [Preprint](#).

## **Task**

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

- Summary of the fundamental equations of the Unsteady Blade Element Momentum Theory (UBEMT).
- Help to get started with the blade element momentum spread sheet.
- 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.