Design of Wind Energy Systems – Summer Semester 2016
CIP-Tutorial 5: Windfields & Wake Modelling

Tasks to be solved in CIP Tutorial 5:

1. Estimate the distribution of hours in a year for different wind speeds (0-25 m/s) assuming a Rayleigh distribution. Assume a wind class type I-B. Plot wind speed vs. hours in a year and indicate the operational conditions of the turbine (stop, partial-load, etc.).

   Hint: Rayleigh distribution function, IEC Type class tables in the IEC standard and wind bins can be found in the tutorial slides

2. Estimate the power produced at each wind speed and the annual energy produced. Calculate the revenue if the feed-in tariff is 0.08 €/kWh. How do these values vary if turbine availability changes from 100% to 95%?

3. Assume a wind class type I-B and free stream conditions. Calculate the turbulence intensity for various wind speeds (5, 10, 15, 25 m/s) and indicate the operational conditions of the turbine (stop, partial-load, etc.) in each case. Comment it with respect to your findings in questions 1 & 2.

   Hint: The necessary equations according to IEC standard can be found in the tutorial slides

4. Generate wind fields using TurbSim with the corresponding turbulence and wind speed combinations (5, 10, 15, 25 m/s). Plot and evaluate your results.

   Hint: The procedure is explained in the tutorial slides

5. Time for analyzing the impact of wakes. Using the definition according to Frandsen, estimate the effective turbulence due to the presence of neighboring turbines. Perform your calculation for two cases: when the neighboring turbine is at a distance of 4 and 8 rotor diameters. Use the same wind speeds (5, 10, 15, 25 m/s). Generate wind fields for wake conditions. Plot results for one wind speed and qualitatively evaluate your results with respect to free stream conditions.

   Note: Wind speeds generated in questions 4 & 5 will be used in CIP-06 to estimate mechanical loads in the turbine

6. During turbine operation some faults may occur; in these cases turbine behavior is simulated to evaluate structure integrity. Discuss possible faults that could have been taken into account during the simulation of turbine operation.

   Hint: Search for typical failures of components located in the rotor-nacelle-assembly