A New Method for Determining the Wind Field at the OST Test Turbine Site

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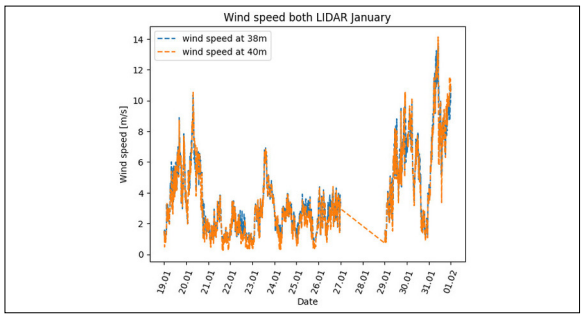
Introduction: OST's wind energy team conducts various measurement campaigns at the OST test turbine in Winterthur. Currently, two measurement systems are being tested at this test turbine - one with the focus on determining the aerodynamic and acoustic behaviour of the rotorblades; as well as a system with various sensors to monitor and optimize the operation of wind turbines.
For the analysis and further use of the measurement data from these systems, the occurring wind field must be known at all times. Without this input knowledge any simulation data is hard to verify. The most common approach is using a wind mast, which is not feasible due to permits and costs, additionally the universities LIDAR is not measuring at the relevant height.
At this point several approaches with wind measuring devices have been conducted. The aim of this work is to gather further data as well as using existing data to develop a recommendation for a best practice approach. The wind turbine is covering heights from 12 to 24m, with a hub height of 18m. Within these limits the wind profile should be defined as precisely as possible.

Approach: The project aims to use four sources of data: Two LIDAR systems, a wind sensor on a drone as well as the SCADA data from the wind turbines gondola. Due to a malfunction and an accident, the drone crashed and could not be used for the analysis. The following data is based on the remaining 3 sources.

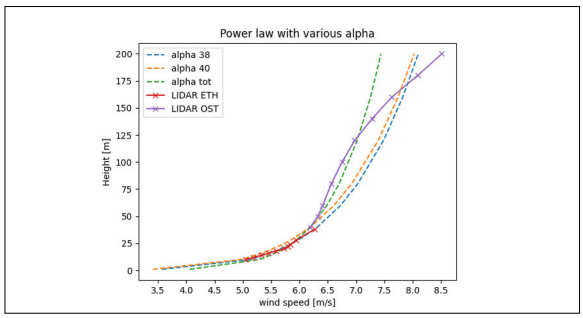
The approach is sectioned in several subtasks:
a) Compare the ETH and the OST LIDAR to see how well these data correlate, since the OST LIDAR is a non-calibrated device. This was used to validate the OST LIDAR input.
b) Calculate the wind profile, using the power law, based on both input LIDAR data
c) Compare the measured speed of ETH LIDAR and SCADA data

Result: The comparison of the LIDAR data has shown good correlation. Therefore the OST LIDAR data was also considered valid for further input. The comparsion has shown that at the two closest heights (38m of ETH LIDAR and 40m of OST LIDAR), the offset in wind speed is comparably small.
The preciseness of alpha highly depends on the input and the included values. As shown in the figure, the wind profile according to OST LIDAR is contradictory to the general power law shape. Based on this, no generally valid alpha could be calculated.
To compare the SCADA and the ETH LIDAR data, the principle of Betz was used as a basic assumption. The most promising results have been shown by the fact that the wind turbine is usually running closely to ideal conditions. Based on this assumption the wind speed measured behind the turbines can be multiplied with a constant factor to calculate the speed ahead of the turbine.

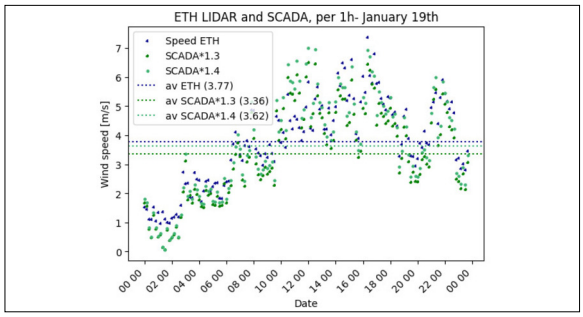
Comparison of the measured wind speed at 40 and 38 m
Own presentment



Calculated wind profile depending on alpha
Own presentment



Calculated wind speed ahead of turbine, based on SCADA data
Own presentment



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Subject Area
Energy and Environment