Master's Thesis Description

This thesis project is conducted in collaboration with Vattenfall, focusing on enhancing the accuracy of Turbulence Intensity prediction through the reduction of uncertainty in measurements for ground-based LiDAR data. Building upon the insights gained from the Joint Industry Project at Vattenfall, the project aims to implement a similar approach to analyze data from ground-based LiDAR installations at a Vattenfall wind park.

The primary objective of this thesis is to mitigate the uncertainties associated with Turbulence Intensity predictions derived from ground-based LiDAR data. The focus will be on developing and applying a way of resolving uncertainties in LiDAR data to enhance the precision of predictions. By doing so, the project aims to contribute to the optimization of wind energy resource assessments and subsequently improve the overall efficiency of wind park operations.

The data provided by Vattenfall comes from onshore sites with a 'flat' terrain as defined by IEC 61400-1 or IEC 61400-12-1. One of the sites is an active wind park and the other a met mast site without turbines. The project also has the opportunity to look at more complex terrain for a different wind park. The measurements are done by ground-based vertical profiling lidars over the time period of a year.

Methodology:

- Data Collection: Utilize ground-based LiDAR data collected at the wind park. This data will serve as the foundation for the analysis. (*This step is already completed*)
- Literature Review: Conduct an in-depth review of existing research and methodologies related to Turbulence Intensity prediction using LiDAR data. Identify gaps and opportunities for improvement, while also comparing LiDAR with different measurement methods.
- Implementation of JIP findings: Using the formulas and methods used in the Joint Industry Project to see how it affects the LiDAR data of the wind park.
- Reduce uncertainties using Perturbation Theory: Implement the Pertubation Method tailored to the characteristics of ground-based LiDAR data. This calculation will provide probabilistic insights into Turbulence Intensity predictions, acknowledging the inherent uncertainties in atmospheric conditions.
- Comparison with JIP project: Evaluate the performance of the implementations by comparing its predictions with those derived from the JIP project. Highlight the improvements achieved in terms of reducing prediction uncertainties.

The successful reduction of the uncertainty in LiDAR measurements has the potential to significantly impact the wind energy sector. Reduced uncertainty in Turbulence Intensity predictions enhances the reliability of wind resource assessments, leading to more accurate energy production estimates and improved decision-making in wind park management.

Expected Outcomes:

- A refined uncertainty calculation specifically designed for Turbulence Intensity predictions from ground-based LiDAR data.
- Validation of the effectiveness through comparisons with traditional prediction methods.
- Insights into the practical implications and benefits of implementing LiDAR adjustment in wind energy operations.

By addressing the challenges associated with Turbulence Intensity prediction using ground-based LiDAR data, this thesis project contributes valuable knowledge to the renewable energy sector. The outcomes are expected to facilitate more informed decision-making in wind park design, operation, and measurements, ultimately advancing the efficiency and sustainability of wind energy production.