RC3: 'Comment on wes-2024-35', Anonymous Referee #3, 04 May 2024

First and most importantly the scientific archival value of the study is not apparent, and perhaps not strong enough for journal publication. Despite the large quantity of data presented in the study the main take away that I was able to see from the study is the fact that differences in power curve and AEP caused by erosion can be similar or even smaller in magnitude than the differences caused by turbulence intensity. This can make it hard to diagnose blade erosion in the real world, as the decrease in power output may be masked by variations in turbulence intensity. This message is interesting, but the large amount of data that is presented in the paper is redundant for this relatively straightforward message. In addition, authors do not suggest ways to work around this issue but the discussion in the paper is limited to presenting the data and little else. Finally, as the authors suggested, the large effect of turbulence on wind turbine power curve can already be found in the existing scientific literature, making the specific contribution of this work somewhat more unclear, and diminishing the scientific value.

- We appreciate the reviewer's detailed feedback. The primary aim of our research was to develop methods for detecting wind turbine performance degradation, particularly due to blade erosion, in operational turbines using real-world SCADA data. This is a critical issue in the industry, where significant time and resources are spent annually to diagnose such degradation, which has proven challenging due to the lack of an established correlation between blade erosion and full-scale turbine performance degradation.

  Furthermore, the extent to which turbulence intensity and time-averaging practices influence the analysed performance, potentially masking the effects of blade erosion, is not well understood. We acknowledge that this message may not have been effectively communicated in the original manuscript.

  We respectfully disagree with the assertion that our study lacks scientific value. This topic necessitates further insights so as to better analyse full scale turbine measurement data. Our research contributes to support the enablement of detection of erosion, a challenge recognized by both industry and academia.

  To address the reviewer's concerns, we have rephrased both the introduction and conclusion to more clearly articulate the purpose and significance of our study. We emphasize that understanding these influences is essential for accurately diagnosing aerodynamic degradation in wind turbines, a complex task due to the interplay of various factors.

  Furthermore, while we acknowledge that the effect of turbulence on wind turbine power curves is well-documented, our study goes beyond this established knowledge. Rather than focusing on aerofoil performance as a function of turbulence, we investigate rotor performance. While turbulence is indeed investigated in existing literature, some of them focus on turbulence at the aerofoil level, which is not the focus of our research. Specifically, our focus is in the context of how turbulence intensity variations can obscure the detection of blade erosion in operational settings.

  In response to the reviewer's feedback, we have especially rephrased the introduction and the conclusion section. We believe these revisions and clarifications throughout shall better highlight the scientific value and practical implications of our research for the wind energy industry.

To add to this, the data appears to be presented without a clear goal in mind. This makes the manuscript, despite it being divided in many subsections, very difficult to read. It is unclear what is the “glue” between the sections and how they contribute to the final take aways. In addition, many graphs are hard to understand (such as Figures 7, 13). Some other Figures are hard to tell apart – for instance it took me quite a while to understand the difference between figures 16-1 and 18-19.

- This adds to the comment above and we recognize the need to be clearer in our message. To address this, we have rephrased sections including the introduction and conclusion.

Figure 11 and especially 10 are misleading, and if I have understood how they are computed, incorrect in my opinion. In fact, the Cp seems to be computed by dividing mean power by mean wind speed. This is incorrect, as Cp is an instantaneous value and should be computed based on instantaneous power and wind speed, and then averaged. Please explain how these values are computed. Authors attempt to warn readers about the high values of Cp in figure 10 at lines 237-241 but the explanation could be improved. The main reason for the large Cp values is the fact that wind turbine power near cut-in as a function of wind speed is cubic, thus increases in wind speed increase power more than decreases in wind speed do.

- We appreciate the reviewer's comments and concerns. We are fully aware of the reasoning behind the high Cp values and we shall make this issue clearer. We acknowledge the potential for misunderstanding and shall take steps to clarify this issue. The primary message we intend to convey here is that power curves, could be understood as steady-state performance, but the unsteadiness is changing this and that is why the figures are presented to make it clear that power efficiency apparently can be very good but that the reason - in this case - is the turbulence level and that one can make false conclusions.

  To address this, we shall rephrase section 3.2.3 to make this clear for the reader.