

Dear Editor, Referee #1,

First and foremost, thank you for reviewing our paper “Combining wake redirection and derating strategies in a wind farm load-constrained power maximization” (Preprint wes-2023-145). We are glad that your feedback was positive.

We have revised the original manuscript to accommodate what you suggested. We have also taken this opportunity to make minor improvements to the text.

We believe that the manuscript has improved, and we hope that this amended version will satisfy your expectation for this work.

The point-by-point reply to your comments is reported here below.

[Reviewer] The authors do not discuss the wake behaviour due to the possible combination of derating and wake steering. Are there any studies that investigate the combination of derating with wake steering? How does the derating affect the wake displacement?

Adding to this point, it is also not deeply discussed how these phenomena are modelled in FLORIS. To the knowledge of the reviewer, there are currently no explicit models for derating in the wake models in FLORIS. How does the derating affect the wake added turbulence and wake recovery? Are there hints that the modelling through changing the C_t curve of the turbine is sufficient? How does derating affect a steered wake in FLORIS?

[Answer] The derating of the turbine indirectly affects the wake displacement through the implied variation of the thrust coefficient C_T . In fact, a derated turbine works at a lower power coefficient and different thrust coefficient than the nominal ones. We did not develop a dedicated model for wake behavior in yawed and derated operations, but we simply based this research activity on the modeling already implemented in FLORIS, which follows the treatment of Bastankhah and Porté-Agel (Journal of Fluid Mechanics. 2016;806:506-541. doi:10.1017/jfm.2016.595). According to this model, the turbine thrust coefficient affects multiple wake characteristics including the onset of the far-wake region, TI, speed deficit and lateral displacement of the wake center. Bastankhah and Porté-Agel model is considered adequate, at least for the scope of our work, to capture the combined impact of derating and misalignment on wake behavior.

[Action] We added a short paragraph to better explain this. This paragraph was added at the end of section 3.1.

[Reviewer] Line 408: It says twice 3.8%

[Answer] The reviewer is right. The second value should be 3.9% as reported in the table.

[Action] The text was modified.

[Reviewer] Figure 11 has a very small font

[Answer] We agree with the Reviewer.

[Action] The font size of the text in the figure was increased and the figure itself enlarged.

[Reviewer] It seems that turbine 5 in figure 11 is both waked and performing control actions. Does the impinging wake of turbine #1 influence the result? It is hinted before, that the method so far is only applicable for free stream turbines. If that is the case, it is a bit confusing to show also an optimized turbine #5.

[Answer] Yes, clearly, the internal turbines belonging to a row of three or more machines can be waked and perform control actions, as the Reviewer pointed out. Floris framework can model this situation and suitably compute the power output of internal turbines. The assumption that we made in this analysis is that the possible presence of the wake does not significantly influence the load-constraint functions. This means that the load constraints can be evaluated once for the isolated turbine and then applied to all turbines belonging to the farm. Probably, this assumption is strong for fatigue loads but may be acceptable for ultimate ones, that, in the case at hand, represent the active constraints.

In section 3.4, we wrote “In this analysis, it is assumed that the constraint function $g_i^{\text{constr}}(\phi_i)$ stays the same for all turbines, independently of the location within the farm”, to emphasize this.

Moreover, the same concept is expressed in the conclusion (“Secondarily, it will be important to include in the formulation also fatigue and ultimate loads of the downstream machines. In fact, ...”)

[Action] The sentence of section 3.4 was extended a bit to stress the limitation of the proposed approach.

We look forward to your kind reply, and in the meanwhile we send our warmest regards.

Sincerely yours,

Alessandro Croce and Stefano Cacciola