Wind Energ. Sci. Discuss., referee comment RC1
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Comment on wes-2021-15

Anonymous Referee #1

Referee comment on "Objective and algorithm considerations when optimizing the number and placement of turbines in a wind power plant" by Andrew P. J. Stanley et al., Wind Energ. Sci. Discuss., https://doi.org/10.5194/wes-2021-15-RC1, 2021

General comments:

The paper presents an interesting research on demonstrating the different results obtained in a wind park optimization problem when defining different objective functions, as well as using different optimization algorithms, including a new proposed repeated sweep algorithm method. Furthermore, not only the layout within the wind park is subject to change but also the number of turbines within the park.

The paper is of high quality, well written, and well structured.

Specific comments:

- Chapter 1 (Introduction):
  - Directly in the second sentence, the authors state that "wind turbines … require no external fuel, and require little to no water". With the last statement, the reviewer guesses that the authors refer to the manufacturing of wind turbines, however, this on the other hand requires external fuels. Thus, the authors should be more precise: Either all statements in this sentence should only refer to the wind turbine during operation or more details on the separate statements should be provided.
  - References to relevant literature are missing in the third paragraph. Of course, most references are addressed in the cited review paper, however, some relevant literature should be added for each aspect outlined in this paragraph.
  - References are missing in the last paragraph. It is only referred to previous papers. Please be more precise what has already been done in other research work and what is novel in this study.
- Chapter 2 (Wake Model):
  - Which coordinate system has been used? This does not become clear when the

location (x, y, z) is introduced after Equation 2.
  - Just after Equation 4 the lateral and vertical direction are introduced as corresponding to y- and z-direction. This information would be required already earlier, directly after Equation 2. When mentioning this definition directly at the beginning, the question regarding the coordinate system might no longer be so relevant.
  - How are the nine locations (for determining the average rotor wind speed) distributed with respect to the lateral and vertical? Maybe a small figure could help explaining this.
- Chapter 5 (Optimization Algorithms):
  - As the parameter for the maximum number of generations is used in the algorithm code, the specified number for the maximum number of generations should be addressed in the text (Section 5.2).
  - Why is at the end of Section 5.4 a range of 2-18 turbines defined, whereas in Section 5.5 the spacing constraint is only defined as two times the rotor diameter?
  - Why are just 2D specified as minimum spacing? The authors themselves state later in Section 6.4.1 that this is not a realistic assumption. To work with more realistic example cases, why is not directly a spacing of for example the mentioned 5D used?
- Chapter 6 (Results)
  - Within the 1D example (Section 6.1) it is interesting to see that $70/MWh and $90/MWh yield the same optimum of 18 turbines. Maybe it can be further discussed on this result in the text as well.
  - Why was the specific value of $30/MWh taken for the further example cases (mentioned at first in the second paragraph of Section 6.2)? In Section 6.6 and Figure 15 later in the paper, the authors present already a good reasoning for going for $30/MWh. This should be mentioned already (and as well) at this point.
  - Some statements in the discussions on the results are too generic. Thus, it is not really true that "the greedy and repeated sweep algorithms do not perform very well", as the repeated sweep algorithm finds the second-best solution for the COE objective (Section 6.2.2).
  - The sentence "For the large wind plant, some of the turbines in the layout optimized for COE are more waked than in the small wind plant" in the first paragraph of Section 6.3.1 needs some more explanations. Based on the Figures presenting the optimal layouts, as well as based on the presented numbers for the wake losses, the reader gets rather a different impression opposite to the statement in the above-mentioned sentence.
  - Some additional discussion on the time and number of function calls is missing in Section 6.3.2, as there are also interesting changes compared to the small plant example.
  - What is the probability of occurrence taken for each wind direction bin in Section 6.4?
  - Especially with respect to the three different objectives, a case with realistic annual wind distribution would be interesting to be investigated and of most relevant meaning for real applications.
  - The discussion and especially last statement ("However, the optimizer didn't find this solution from the five optimizations that we ran") in the first paragraph of Section 6.4.1 are not satisfactory. There is a significant difference between the results of the two cases (48 versus 54) and furthermore there is a large discrepancy between the results from the different optimizers, presented in Table 4. Furthermore, the last sentence leaves the question on the sensitivity and trustfulness of the results, as the results cannot be repeated and there is some random chance to score one time maybe better or not or just another time.
  - Section 6.7 could go into a separate new Chapter. In general, the reviewer suggests to have another Discussion Chapter (before the final Chapter Conclusions), in which additionally the assumptions made and considered example cases should be investigated in more detail, e.g. with respect to realistic cases (see some comments

before on the wind speed distribution or the spacing constraints), required further sensitivity studies, meaningfulness of the results due to the specified optimization settings (limited number of iterations, no repeatability), …

Technical corrections:

- Chapter 1 (Introduction): A separate paragraph at the end of Chapter 1 (Introduction), in which the structure of the paper is presented, would be useful to help navigating the reader through the paper.
- Some word repetitions should be avoided (e.g. addressed in the fourth paragraph of Chapter 1).
- Chapter 2 (Wake Model): The definition of the parameter I_0 might not be relevant, as this is not used in the equations.
- Figures and tables should be placed in such a way that text within a paragraph is not separated if this is not required (e.g. Table 1 and Figure 1 or Figure 2).
- The Greek symbol should be used as well in the text instead of writing phi (Section 3.1).
- Throughout the paper it should be ensured that the tenses are used consistently.
- Chapter 6, first sentence: the word "of" is missing between results and our.
- Figure 5: Please complete the legend in the right plot, such as "PPA in $/MWh".
- The reference to "previous section" in the second sentence of Section 6.6 is wrong. Please use the reference to the number of the specific section (here to 6.4) to be clear.