

Wind Energ. Sci. Discuss., referee comment RC1
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Comment on wes-2021-121

Iver Bakken Sperstad (Referee)

Referee comment on "Analysing the effectiveness of different offshore maintenance base options for floating wind farms" by Nadezda Avanessova et al., Wind Energ. Sci. Discuss., <https://doi.org/10.5194/wes-2021-121-RC1>, 2021

General comments:

This manuscript presents a Monte Carlo simulation tool for analysing operation and maintenance and associated logistics for offshore wind farms. More specifically, it applies it to floating offshore wind farms and considers two logistics support strategies that have been relatively rarely considered in previous work: Service Operation Vessels (SOVs) and offshore maintenance bases.

I consider the main strengths of the paper that 1) it presents new knowledge about the techno-economic merits of important O&M logistic alternatives for far-offshore wind farms, 2) it addresses in a useful manner the gaps in the reliability data needed for thoroughly analysing floating offshore wind farms, and 3) it analyses the impact of the weather data set on the results of such simulation results. I believe that these analyses would be a useful contribution to the scientific literature.

The only weakness is that it does not present major methodological advancements in the analysis of offshore wind O&M strategies, although I believe the inclusion of carbon emissions in such analyses is both novel and important. Some readers may also find some of the material included in the paper superfluous (e.g. in the somewhat lengthy introduction and literature review), but I found it interesting for context and for giving supplementary information. In general, the paper is well written and the findings are clearly presented.

Below are some specific comments, a list of minor/technical/editorial comments, and a list of references. I would expect at least comment 1 and 2 below to be addressed by the authors, whereas comments 3 to 5 are more for their consideration and possible discussion.

Specific comment 1:

The one section that I believe needs some clarification is Section 5.1: Precisely how is the "acceptable level of error of 2%" related to the choice of calculating a 95% confidence interval (on line 274)? Moreover, perhaps it would be clearer if the authors presented explicitly the formula used to calculate the relative error presented in Figure 6 and Table 5 (since these are not actually showing the confidence interval from Eq. (2)?) Still, I believe the authors should be commended for actually including some analysis of the statistical uncertainty in their Monte Carlo simulation results.

Specific comment 2:

In Sec. 5.2, it is stated: "The percentage error presented in the table was based on the convergence study".

a) Related to comment 1 above, I should ask the authors to clarify if the percentage error is that of the OPEX or O&M results considered in Fig. 6?

b) As a pedantic side remark, I could also ask the authors to consider if the terms "OPEX" and "O&M costs" are used precisely and constantly? (In the current manuscript the two terms seem to be used interchangeably.)

c) Depending on the answer to comment (2a), the authors could consider discussing or evaluating the relevance of this percentage error to the availability results. (Depending on the model and the case, the relative error in the availability results could be qualitatively different from the relative error in the O&M cost results.)

d) Since the authors are including information about the uncertainty in the results, I would also ask them to very briefly comment on them in the manuscript, i.e. mention what they imply for the significance of the differences that are observed between the different cases.

Comment 3:

In the literature review it is stated that: "There has been only a handful of studies analysing the usage of SOVs for offshore wind farms". I believe that this is correct, and that this is a knowledge gap that the present study contributes to filling. At the same time, a small part of this gap could also be caused by a confusion of terms: Somewhat similar vessel concepts could also be referred to as either Field Support Vessels [A], Offshore Access Vessels (OAV) [B], mini mother vessels, or Small Accommodation Vessels (SAV) [C], at least in the earlier literature. But I leave it to the authors to consider if any of these do in fact have similar characteristics as the present-day SOVs that they are considering in their work. A more recent investigation of SOVs can be found in [D], which does however consider tactical-operational rather than strategic decision problems.

Comment 4:

Another reference (much more recent, and potentially more relevant) that the authors could consider for the literature review section is [E]. This work also investigated maintenance logistics for floating offshore wind farms but did not consider SOVs or offshore maintenance bases. (It does include a simple sensitivity analysis on the minimal working duration that is allowed in the model, which could be relevant to the current limitation mentioned for the COMPASS model that it does not allow tasks to be split over several weather windows of shorter working duration.)

Comment 5:

I find the comparison of weather data sets interesting, but I wondered if there is more that could be inferred from the comparison(?) In particular, since ERA-20C has lower temporal resolution (3 h) than ERA5 (1 h), is it a possibility that ERA5 is more restrictive to the vessel logistics because it allows for fluctuations in wave height within each 3 h time period that is not captured by the ERA-20C and the linear interpolation?

Technical corrections:

- l. 5 (p. 1): "fixed" -> "bottom-fixed"
- l. 18 (p. 2): "to be installed" <- this is a long-term forecast with large uncertainty, so I suggest adding e.g. "expected"
- l. 66: "timedomain" -> "time-domain"
- l. 74: "fixed" -> "bottom-fixed"
- l. 93: "Strathclyde strategic O&M tool" <- I am not sure what is the official name of the tool, but was e.g. "The Strathclyde ..." or "Strathclyde's intended"?
- l. 112: The abbreviation "OPEX" has already been defined in Sec. 1
- l. 137: "ideal energy" <- perhaps something like "the ideal energy production" or "theoretical energy production" would be more precise?
- l. 185: "resolution" <- perhaps "geographical resolution" or "spatial resolution" would be more precise?
- l. 280: "minimize" <- would "reduce" be more precise?
- l. 333: "if further work is implemented" <- it could be more precise and avoid ambiguity to add e.g. "in COMPASS" in the same sentence
- l. 373: Please add more complete bibliographical details for the reference (Ferguson et al., 2012).
- l. 407: Does the reference to (McCartan and Thompson, 2015) mean to refer to the EWEA Offshore Conference paper by McCartan et al.? If so, please update the reference with the full author list and conference reference; if not, please include a publisher or other bibliographical details that would make it easier to identify unambiguously.

References:

[A] I. Dinwoodie, O.-E. V. Endrerud, M. Hofmann, R. Martin, and I. B. Sperstad, "Reference Cases for Verification of Operation and Maintenance Simulation Models for Offshore Wind Farms," *Wind Eng.*, vol. 39, pp. 1-14, 2015. [Online]. Available: <http://multi-science.atypon.com/doi/abs/10.1260/0309-524X.39.1.1>.

[B] Y. Dalgic, I. Lazakis, I. Dinwoodie, D. McMillan, and M. Revie, "Advanced logistics planning for offshore wind farm operation and maintenance activities," *Ocean Eng.*, vol. 101, pp. 211-226, 6/1/ 2015, doi: <http://dx.doi.org/10.1016/j.oceaneng.2015.04.040>.

[C] I. B. Sperstad, M. Stålhane, I. Dinwoodie, O.-E. V. Endrerud, R. Martin, and E. Warner, "Testing the robustness of optimal access vessel fleet selection for operation and

maintenance of offshore wind farms," *Ocean Engineering*, vol. 145, pp. 334-343, 2017/11/15/ 2017, doi: <https://doi.org/10.1016/j.oceaneng.2017.09.009>.

[D] F. Neves-Moreira, J. Veldman, and R. H. Teunter, "Service operation vessels for offshore wind farm maintenance: Optimal stock levels" *Renewable and Sustainable Energy Reviews*, vol. 146, p. 111158, 2021/08/01/ 2021, doi: <https://doi.org/10.1016/j.rser.2021.111158>.

[E] V. Trueba, Á. Rodríguez-Luis, S. Fernández-Ruano, and R. Guanche, "Impact of vessel logistics on floating wind farm availability," *Journal of Physics: Conference Series*, vol. 2018, no. 1, p. 012041, 2021/09/01 2021, doi: [10.1088/1742-6596/2018/1/012041](https://doi.org/10.1088/1742-6596/2018/1/012041).