

General comments:

The authors address with their research an important aspect of offshore wind - modelling of operation and maintenance. While many models exist, especially for fixed bottom wind turbines, validation and verification of said models is lacking to date. The authors compare two models and present the modeling results, and most importantly driving factors for differences between the two models.

The methodology of the study is mostly well explained and fits the purpose of the study.

In some areas, the research article can benefit from revisions, mainly consisting of how the ideas and findings are presented.

Reply: We thank the reviewer for your time and careful evaluation of our manuscript. We appreciate the positive assessment of the relevance of the study and the overall methodology, as well as the constructive suggestions for improving the presentation of our ideas and findings. We have carefully considered all comments and will revise the manuscript accordingly to enhance clarity and readability.

Specific comments:

In section 2.1 it is not quite clear which modelling principles are general and common for all kinds of DES models, and which are concrete examples for the WOMBAT and UWise models.

In line 147f you write: "... to how DES-based O&M models in general represent operational states and process flows. The shared modelling principles of the DES models are summarized below:" However, there exist DES models (in the context of (fixed bottom) offshore wind O&M models) which use slightly diverging methods than the ones listed below. Some examples include:

Failure modeling: While, to my knowledge, most models use Weibull distributions for stochastic failure modelling, some models use Poisson or Bernoulli processes. Linear fatigue accumulation or exponentially increasing failure probabilities are also seen in the literature.

Weather: Recorded historical data is most commonly used, however not all of the datasets have an hourly resolution. The FINO data, which is commonly used by European researchers, includes 10min resolution for wind speeds. 30min wave measurements are also common. Additionally, sometimes simulated weather based on the historical data is used.

I believe therefore that section 2.1. will benefit from rephrasing and making the distinction between the two models investigated in this paper and the general body of DES models clearer.

Reply: We fully agree that the current wording in Section 2.1 may blur the distinction between general DES modelling principles and specific implementation choices in the WOMBAT and UWise models.

In the revised manuscript, we will carefully rephrase this section to avoid over-generalization. In particular, we will distinguish more clearly between (i) general characteristics of discrete event simulation (DES) approaches for offshore wind O&M, and (ii) modelling choices that are specific to the implementations in WOMBAT and UWise. We will also revise statements that currently suggest universal practices (e.g., regarding failure modelling and weather data representation) to reflect that these are common, but not exclusive, approaches in the literature. Where appropriate, we will adopt more precise wording (e.g., "commonly used" instead of "in general") and clarify the scope of our descriptions.

Section 2.2.:

185: I am not familiar with the use of "harmonized" in the context of creating a baseline scenario - can you explain the difference of creating a baseline scenario to be used in the analysis and creating a harmonized baseline scenario? Are you harmonizing between multiple existing baseline scenarios? If there is no difference between the concepts, you might consider removing the use of harmonized in this context.

Reply: We agree that the use of the term "harmonized" in this context may be unclear. In our original intention, "harmonized baseline scenario" referred to the use of identical input assumptions and inventories across both models (UWise and WOMBAT). We acknowledge that this wording may suggest a more complex process than intended. In the revised manuscript, we will replace "harmonized baseline scenario" with clearer terminology (e.g., "common baseline scenario" or "shared input assumptions") and explicitly state that both models are configured using the same environmental conditions, turbine characteristics, and maintenance strategies.

187: What is the order of magnitude of the "multiple random seeds"? If possible, provide the reader with a concrete number (i.e. "using 17 random seeds").

Reply: While the number of seeds is provided later in the manuscript (line 246), we acknowledge that introducing this information earlier as well would make the description of the methodology more transparent. In the revised manuscript, we will explicitly state the exact number of random seeds that are used when first describing the simulation setup.

Figure 1 and 190ff: From the written explanation, I am understanding that you are iteratively modifying the assumptions in the UWiSE model and then comparing those results to the baseline scenario. In Figure 1, you write "Adjust one modeling assumption in UWiSE to align with WOMBAT's assumption". This second part of aligning with WOMBAT's assumption is not mentioned in the description. Could you please explain this further?

Reply: We agree that the current written explanation does not sufficiently describe the iterative process illustrated in Figure 1. In particular, the step of adjusting selected modelling assumptions in UWiSE to align with those implemented in WOMBAT is not clearly stated in the text.

In the revised manuscript, we will clarify that the comparison is conducted through an iterative process in which specific modelling assumptions in UWiSE are sequentially modified to match the corresponding assumptions in WOMBAT, while keeping other elements unchanged. The results of each step are then compared to the baseline scenario to assess the impact of individual modelling differences.

220 and Figure 3: It would be beneficial to mark the BoP components in the overview, to make the distinction between components used in both fixed bottom and floating wind farms and those specific to floating even easier.

Reply: We thank the reviewer for this helpful suggestion and agree that distinguishing BoP components specific to floating versus those common to both fixed-bottom and floating wind farms could provide additional context. However, Figure 3 is primarily intended to present the overall structure of model input categories. We are concerned that adding this additional layer of detail may reduce the clarity of the figure and distract from its main purpose as a high-level overview. To address the reviewer's point while maintaining figure readability, we may clarify this distinction in the accompanying text, explicitly indicating which BoP components are specific to floating wind applications and which are common across both concepts.

Section 3.1:

While reading about the simulation results, the reader would greatly benefit from having deeper knowledge of the two models - if at all possible, could you include all of the assumptions and boundary conditions already in Section 2? (e.g. the implementation of minimum charter period, first mentioned in 267ff), Table 2 already summarized some of the differences, this might be a good place to include this kind of information.

Reply: We agree that providing a more extensive comparison of assumptions and boundary conditions would improve transparency. However, a fully detailed-level comparison of all model implementations is beyond the scope of this study, as

discussed in Section 4.2 (limitations and future work). That said, we note that the major modelling differences between the two models are already identified and summarized in Table 2, which serves as a key reference for interpreting the results. In particular, the analysis presented in the results section is directly based on modifying these assumptions.

We nevertheless acknowledge that certain assumptions are not sufficiently explained in the current version. In particular, the implementation of the “minimum charter period” lacks clarity. In the revised manuscript, we will provide a clearer description of this assumption in the relevant paragraph.

Section 3.2:

I do not quite understand the value of scenario 5 at this point in the paper. Scenario 1 is limiting the number of crews being transported per vessel, the hypothesis will be that this increases the time it takes to complete maintenance tasks, hence increasing the length of downtime events. Scenario 2, with uninterrupted shifts, has the potential to reduce downtime, by removing the mid-day crew change and handover. These two scenarios Applied at the same time will most likely, cancel each other out to a certain extend? Similar arguments can be made for scenarios 3 and 4, one increasing (wind turbine) downtime and one having the potential to decrease (wind farm) downtime. Applying all four scenarios at once (while most likely very easy in the verification setup you have built), does not offer an obvious benefit. Later, we implicitly learn that scenario 5 makes UWise most like WOMBAT, could you please explain this reasoning behind scenario 5 already at the start of section 3.2. to avoid confusion?

Reply: The intention of Scenario 5 is to provide a reference case in which all investigated modelling assumptions in UWise are aligned with those implemented in WOMBAT. This allows us to assess how closely the two models can converge when key assumptions (the listed four assumptions) are made consistent. In this context, Scenario 5 serves as a diagnostic case: the remaining result differences between UWise and WOMBAT under this fully aligned setup can be attributed to other, unexamined modelling choices or structural differences between the models.

We agree that this rationale should be made explicit earlier in the paper. In the revised manuscript, we will clarify the role and motivation of Scenario 5 at the beginning of Section 3.2 to avoid confusion and better distinguish it from the individual scenario analyses.

324ff: It would be more logical to present the results for the scenarios in "chronological" order, i.e. starting with scenario 1 and ending with 4.

Reply: We agree that presenting the scenarios in a chronological order is more logical and intuitive and would improve readability. In the revised manuscript, we will restructure the results section to present the scenarios in chronological order, starting with Scenario 1 and progressing through to Scenario 5.

Section 3.3: The unit of k€ /MW /y as presented in Figure 15 (and formatted wrong in the text) is a concept that is not readily understood. Cost per MW or even cost per MW*time (e.g. MWh) is more readily understood. Consider reformulating, in order to avoid the double fraction, which creates ambiguity.

Reply: We thank the reviewer for this comment. To authors' best knowledge, the unit "k€ / MW / year" is a commonly used metric in offshore wind O&M benchmarking, as it enables normalized comparison of annual costs across wind farms of different sizes. For this reason, we prefer to retain this unit in the figure. To improve clarity, we will provide a brief explanation of its meaning when first introduced in the text. We believe this will address potential ambiguity while maintaining consistency with commonly used performance indicators in the literature and industry.

Technical corrections:

Reply: We thank the reviewer for these additional minor comments and suggestions. We agree with the points raised and will incorporate the proposed corrections and improvements in the revised manuscript, including adjustments to wording, typographical errors, and figure presentation.

Caption Figure 1: Iteratre -> Iterate

229: suggestion to add an additional comma: towing as well as reconnection -> towing, as well as reconnection

238: replace "," with "."

323: observed variation is maintenance cost -> observed variation in maintenance cost

353: On opposite -> on the opposite

Figure 13: The labeling inside the figure is too small. Consider including just one legend (as it is the same across all scenarios, labelling the scenarios next to the graph, reducing the number of scenarios shown in the figure, a combination of the above suggestions, or any other measures to improve readability.

Section 3.3: the units for costs are formatted wrong.

394: workin -> working