

## General Comments

Overall, the paper addresses an important topic of the economic viability of floating offshore wind turbines and the challenge associated with modelling these future operating scenarios under a high degree of operational uncertainty. The paper presents a useful contribution to the science of Wind Energy and is relevant to the topic of "Wind energy economics and markets with high shares of renewables" and overall should be recommended for acceptance if some specific scientific quality areas are addressed.

Specifically, the choice to iterate UWise simulations to approach the WOMBAT model output has not been justified. This is an issue since the output of the WOMBAT model shows a continually degrading availability which would not be economically viable, practically desirable for an owner and is not representative of typically observed wind farm availability trends. This suggests there is a fundamental issue with the inputs of this model and this should have been updated to provide a more representative availability profile before the model alignment exercise was performed. It is recognised that a stated objective is to provide "generalized insights on how assumption choices shape O&M simulation outcomes, thereby improving the transparency, robustness, and reproducibility of logistics modelling practices in the wind community" and the representativeness of the simulation does not affect this, however this somewhat unrealistic starting point reduces the value of verification and evaluation of operational models which the paper also aims to achieve.

**Reply:** We thank the reviewer for this thoughtful and important comment regarding the verification approach and the representativeness of the baseline WOMBAT results. We agree that, ideally, bidirectional alignment (e.g., also iterating WOMBAT simulations to approach UWise outputs) could further strengthen the verification exercise. However, within the scope of this study, implementing such adjustments in WOMBAT to systematically reflect the four identified modelling assumptions (Table 2) was not feasible given the time and resource constraints of the project. In contrast, UWise offers existing flexibility to explicitly and efficiently adjust these modelling assumptions (as described in line 191), enabling a structured and transparent exploration of their individual and combined impacts. We therefore consider this approach to be an appropriate and pragmatic way to achieve the study's primary objective.

We also acknowledge the reviewer's concern regarding the representativeness of the WOMBAT baseline, particularly the continuously degrading availability trend. While this behaviour may not reflect typical operational wind farm performance, it provides a transparent and consistent reference point for isolating and analysing the effects of specific modelling assumptions. In this context, the value of the exercise lies not in reproducing absolute real-world performance (which is inherently project-specific and influenced by factors such as component failure rates and O&M strategies), but in revealing how differing assumptions influence O&M simulation outcomes.

To address the overall concern, in revised manuscript, we would acknowledge this limitation of the verification process more explicitly and clarify the implications for interpretation. We hope this clarification addresses the reviewer's concern and highlights the contribution of the study within its intended scope.

The scientific quality and presentation are of a good standard with clear explanation of the investigation approach and sufficient detail about the modelling tools and inputs to allow a full and fair assessment of the work. Given the open-source nature of the WOMBAT tool, it is recommended that a full input data collection for this model is provided so that this model can be independently scrutinized and ultimately other researchers can verify their own models and establish this work as an important reference study.

**Reply:** We agree that providing full transparency of the open-source model inputs would further strengthen the reproducibility and impact of this work. In line with this recommendation, we will make the complete input dataset used for the WOMBAT simulation publicly available via a GitHub repository.

### Specific comments

Introduction is well written and clearly states the objectives.

#### Section 2.1 – O&M Models

Stochastic failure modelling – A single weibull distribution is typically not able to capture the behaviour of complex electro-mechanical machines with different shape factors observed for different operational periods, especially representing early-life and late life-failures of mechanical components such as gearbox, pitch and yaw systems. While a reasonable approach to use a single failure rate per subsystem / failure type for this exercise, some commentary on the impact and sensitivity of models to this assumption should be provided. This is recognised in ‘Future Work’ but suggest it should be moved to Section 2 when describing the modelling approach and other limitations in Future Work remain where they are.

**Reply:** We agree that the use of a single Weibull distribution per subsystem is a simplification and may not fully capture the complex failure behaviour of electro-mechanical components across different life-cycle phases (e.g. bathtub curves). While this assumption is appropriate for the comparative purpose of this study, we acknowledge that it may influence the sensitivity and interpretation of model outcomes. In response to this comment, we will include additional commentary in Section 2 on the potential impact of this simplification on the results. The discussion in the ‘Future Work’ section will be streamlined accordingly.

Section 2 - Strategy and dispatch logic and Section 3 ‘O&M Strategy; – The dispatch logic is not sufficiently detailed but rather described as ‘a coordinated logistical framework’ which is partly driven by overlapping maintenance demands. It is evident how the constraints would influence dispatch feasibility and simulation implementation but not how the prioritisation logic is implemented. Specifically, how do the models prioritise the utilisation of resource when there are constraints to decide which actions are done and in what order? Table 2 describes the modelling assumption differences once an action has been allocated but not the action prioritisation decision logic. To use a practical example, is unscheduled maintenance always prioritised over scheduled maintenance (or is this a model input or time variable), are minor failures that can return turbines to operation sooner prioritised over longer failures, is it a shared technician resource pool and if yes how is it prioritised?

**Reply:** We agree that the prioritisation logic governing task allocation under resource constraints was not described sufficiently. In situations where constraints occur (e.g., limited vessel or technician availability when multiple maintenance tasks are required simultaneously), both models apply a user-defined “planning priority” to determine the order of execution. As summarised in Table 3, this priority is specified by the user. In this case study, actions are prioritised from replacement to major repair to minor repair, with scheduled inspections assigned the lowest priority (Lines 298–300) and therefore deferred when resources are limited. This results in unscheduled maintenance and higher-impact failures being addressed first. We will revise Section 2 to explicitly describe this prioritization logic within the dispatch logic.

**Verification process, see comment in ‘General Comments’**

In model inputs, duration of some activities are < 1hr but weather models are noted to be hourly intervals, the simulation resolution should be clarified and whether maintenance actions are rounded up/down or weather model is sub-sampled.

**Reply:** We agree that the temporal resolution of the metocean data and its interaction with time-resolved activities was not sufficiently clarified. In this study, metocean data are provided at hourly intervals (e.g., 07:00 representing conditions from 07:00–08:00). For activities that do not align with these intervals, the corresponding hourly data are applied according to the exact activity timeline. For example, for an activity executed between 07:20–08:20, the first 40 min (07:20–08:00) uses the data collected at 07:00, while the last 20 min (08:00–08:20) uses the data at 08:00. In other words, metocean conditions are effectively sub-sampled from the hourly data according to the activity timeline. We will clarify this explicitly in the revised manuscript when introducing the metocean data (e.g., line 212).

## Results

20 runs may or may not be sufficient, there are no error bars presented on the main results for costs and losses. A presentation of model convergence and uncertainty of these key results is required to assess whether sufficient simulations have been performed and provide better context overall (such as when presented in Figure 6 and Figure 7).

**Reply:** We acknowledge the reviewer’s comment regarding the number of simulation runs and the absence of uncertainty representation in some of the results. Due to the scope and resource constraints of this study, we limited the number of simulation seeds to 20. Based on our experience, this number is sufficient for the key outputs to reach a high level of convergence. However, we agree that this was not explicitly demonstrated in the manuscript. Moreover, for some figures, statistical indicators (e.g., error bars) were not included in order to maintain readability and clarity, and to focus on the main comparative insights. In the revised manuscript, we will emphasise in the Future Work section that increasing the number of simulation runs and further analysing uncertainty would strengthen the robustness of the results.

Scheduled inspection – this level of incomplete actions would be in breach of any turbine warranty or servicing contract suggesting the models in both baseline models have insufficient resource to be fully representative of real-world operations. Only scenarios 3 and to some extent 4 using UWise presented later show broadly acceptable levels of scheduled maintenance (>70%).

**Reply:** We recognize that the baseline results reflect insufficient resources (vessels and technicians), leading to the deferral of lower-priority activities such as scheduled inspections. Nevertheless, as noted earlier regarding the verification approach, the objective of this study is not to reproduce fully representative real-world performance, but to explore how modelling assumptions influence O&M outcomes.

The current baseline setup is therefore retained, as it aligns with this objective and provides a consistent reference to demonstrate the impact of the identified modelling assumptions. For example, Scenario 2 shows that increasing resource availability via implementing the logic of 24-hour continuous technician shifts could significantly improve maintenance efficiency and reduces deferrals (with scheduled inspection completion increasing from 59% to 90% in UWise).

The comparison of models generally provides satisfactory explanations for the variation between models but should be presented in order consistently.

**Reply:** Agree, we would improve that in the revised manuscript.

#### **Technical corrections**

**Reply:** We thank the reviewer for spotting these wording errors. We will incorporate the proposed improvements in the revised manuscript.

Some figures (particularly Figure 13 could benefit from increased font size)

1. **Page 8, Figure 1 flowchart** – "Iterate with next assumption" should be "Iterate with next assumption."
  2. **Page 3, line 50** – "to authors' best knowledge" should be "to the authors' best knowledge".
  3. **Page 3, line 56** – "tow-out/in" should be "tow-out/tow-in" for clarity.
  4. **Page 12, line 257** – "in WOMBAT then in UWise" should be "in WOMBAT than in UWise"
  5. **Page 12, line 258** – "between two models" should be "between the two models"
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1. **Page 15, line 282** – "In UWise, time-based availability occasionally drops to around 80% in certain period" should be ""in certain periods".
  2. **Page 20, line 352** – "On opposite" should be "On the opposite", "Conversely" or "In contrast."
  3. **Page 24, line 395** – "workin vessel" should be "working vessel."