March 17, 2023

Reply to WES reviewer comments (WES-2022-100)

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Curran Crawford

Thank you to both reviewers for all their comments, we've found them to be very helpful and they have improved the quality of our work. Herein we address the comments and outline our corrections to the manuscript. A copy of the manuscript showing all edits made during the review process is included as a separate file (). We have included the full comments of each reviewer here for completeness, followed by our responses to each comment.

1 Reviewer 1:

1.1 Comments

1.1.1 General Comments:

Overall, this research adds value to the existing literature. it is crucial to compare the existing innovative ideas so that developers and researchers are able to enhance the design.

1.1.2 Specific Comments:

Regarding the UFOWT's applied forces, two main resistant forces were neglected:

1. **Mean Drift Force:** It is crucial to show that the mean drift force is negligible. Either by referring to existing literature or, **preferably**, by comparing the drift force to the other applied forces and proving that it can be neglected.
2. **Residual Resistance:** This force was considered in the ES design, for good reasons for some hulls this force is important and represents a major part of the total resistant forces. For the platform design used, it is crucial to show that the residual resistance force can be neglected.

Regardless of whether these resistive forces are individually negligible, it is important to include them in the design. The reason is, referring to figure 14, it was shown that the difference between the two designs is small. Accordingly, any minimal change might change the conclusion. In addition, without considering these forces, the FOWT is considered to achieve rated power, which will not be the case otherwise.

1.1.3 Technical Comments:

- line 51: use the present tense.
- line 163: **an** unstable.
- Be consistent with the font type for TWS, TWA, AWA, etc.

- Equations are part of the text, it is important to use the right punctuation. This will enhance the reading experience.
- line 224-225: mention the source of the drag coefficient.
- Table 1: You have unintentionally written that the propellers have a hub height of 150 m.
- Suggestion: Add the dimensions of the FOWT's platform, either in table 1 or in a schematic.
- Figure 4: Add label ticks (x-axis: 2.0, y-axis: 0.8).
- Be consistent in the font types used for graphs. For example, figure 11 and figure 8 have different font types.
- Have you explained what regions I, II, III, and IV mean? Probably it is good to include them in the power curves (figure 11 and figure 14)
- No need to include the references websites. (Suggestion)

Citation: https://doi.org/10.5194/wes-2022-100-RC1

1.2 Replies

1.2.1 General Comments:

1.2.2 Specific Comments:

Thank you for your insight on these topics. We have thoroughly reviewed our modelling process and included the two effects that you mentioned (mean drift and wave-making drag) in our model, details follow.

1. **Mean Drift Force:** We have included two subsections to discuss how we have included the mean drift force in our model. Section 2.1.4 describes the methodology used, and section 3.2.2 discusses results of simulations where mean drift was included. We elect to leave the mean drift force out of the main analyses and comparisons since no equivalent force is present in the energy ship model.
2. **Residual Resistance:** We have included an additional drag coefficient that accounts for the wave-making of the platform. It is described in section 2 and shown in equation 6. The wave-making resistance is in practice very small, and so it's inclusion does not significantly impact the results. To keep consistent between the two models (ES and UFOWT) we include this in our main results and comparisons.

We agree that the difference between the two designs is small and therefore these effects should be, and now are, included. However, the UFOWT is still able to achieve rated power under ideal conditions. This will always be possible as long as there exists a case where all the steady environmental loads can be counter-acted entirely by the drag force. Other effects exist that may change this, such as a steady yaw moment acting on the wind turbine rotor, but they are not within the scope of this work; that is they are either unsteady or they are not within the 2 DOFs that are modelled.

1.2.3 Technical Comments:

Thank you for these corrections, we have addressed them all as follows.

- Line 51: Corrected
- Line 163: This is written as intended it is not “unstable” but “usable”, we want to convert the energy to a form that is convenient for future transportation and use.
- Thank you for pointing this out. I’ve changed the text so that these acronyms only appear italicized, and only when they are referring specifically to a value or range. They are otherwise fully spelled out.
- Corrected.
- Line 224-225: Added a citation here.
- Table 1: This was included in error when constructing the table, the hub height of the propeller is not specified and not considered by the model.
- The dimensions of the platform, other than the frontal area, are not used by the model directly and so were not included. Although we agree it would be nice to include a diagram with all platform specifications labeled, we feel that the paper is already very long, and the reference platform used is well documented in an open access report. I have changed some language to reflect that no changes were made to the UMaine VolturnUS platform so readers will know to directly reference that report.
- Corrected.
- Corrected. We have done a pass over the figures to check font type.
- Region indicators were added to Figure 11 to more clearly show the divisions discussed.
- We have elected to leave these in

2 Reviewer 2:

2.1 Comments

This paper deals with the relatively new and little investigated topic of wind energy conversion in the far-offshore. In particular, it aims at comparing the energy performance of two concepts which have been proposed to harness this resource: unmoored floating wind turbines (UFOWTs) and energy ships.

The paper is well-written and the scientific approach is sound. The results are significant. Morevoer, the paper includes a rather comprehensive and sound litterature review which I believe will be useful to many. Therefore, I think that this paper can become a highly-cited paper in the new field of far-offshore wind energy conversion. Nevertheless, I recommend that my comments below are addressed prior to its publication.

2.1.1 Major comments:

In contrast to previous studies, the authors have not assumed that the UFOWT is stationary. This is a key issue as this is likely to require re-positioning the UFOWT from time to time, which may be highly energy demanding. This should be discussed in more details in the paper.

2.1.2 Minor/technical comments:

- Table 1 : h_{hub} of propellers is unlikely to be 150 m, isn't it?

- Line 346: "UFOWT using **a** about seven times"

- Line 357: "Norespower" --> "Norsepower"

- Line 396: "Figure 9 **shows** that for many angles"

Citation: https://doi.org/10.5194/wes-2022-100-RC2

2.2 Replies

Thank you for all of your comments, please find our responses below.

2.2.1 Major Comments:

While we agree that energy will need to be expended at times to re-position the UFOWT, it is not yet clear when this will be necessary. This is inherently a problem of the navigation of the turbine, whereas in this work we focus instead on mapping the performance of the system. In our view it is possible that large amounts of energy may be required to return the UFOWT to port, but it is also possible that routes may be planned that follow major weather patterns to allow the UFOWT to return without expending much energy. In addition, other pathways could be explored where dedicated ships are used to retrieve the fuel stored onboard an UFOWT. Given this, we do not yet feel that we have a satisfying answer to this problem, though we agree it is a key issue for the success of UFOWTs, it is just one that falls mostly outside the scope of this work.

2.2.2 Minor/technical comments:

All the comments here have been addressed

- Table 1: This was included in error when constructing the table, the hub height of the propeller is not specified and not take into account by the model.
- Line 346: Corrected
- Line 357: Corrected
- Line 396: Corrected