

Dear Zhiyu,

Thank you so much for your constructive comments.

They were addressed and suitable modifications were made in the latest version of the paper.

**In relation to your specific comments:**

1. *The title of the paper covers a broad range of interesting subtopics including installation, operation, maintenance, and decommissioning. However, the title appears to be over-ambitious, as the paper only addresses these topics incompletely. It is recommended to revise the title to better reflect the content.*

Response

Since the paper describes and analyses the various marine operations and related facts, the name of the paper has been changed to 'Floating wind turbines: Marine operations challenges and opportunities'. We believe that this title better reflects the content of the paper.

2. *The motivation for this paper should be further strengthened, given a few existing review papers on similar topics. To the reviewer, the discussion of cost modelling of floating wind turbine marine operation is particularly interesting. Many relevant papers have been properly reviewed, but it would be better if the authors can do some quantitative studies to show the cost components of marine operations with clarified assumptions. For example, given the day rates of vessels and existing procedures of marine operations, is it possible to compare the installation costs of spar, semi-submersible floating wind turbines?*

Response

We agree that cost modelling is particularly interesting as an area of study, and in fact, we are currently preparing an in-depth cost-modelling exercise for floating wind farms that includes the elements that you have mentioned as well as cost modelling of other marine operations. We feel that there is huge scope for a significant study here and for that reason are reluctant to include a cost modelling exercise in this report, which we feel is sufficient to stand on its own as a review paper.

The lines 325-330 were added to the latest version of the paper to mention the need for cost modelling of FOWT-related marine operations

3. *The paper has presented many interesting figures. It is not clear if copyright permissions have been obtained for these figures.*

Response

The copyrights to the images used in the paper have been verified and those that might conflict with the copyrights have been removed.

Figures 4,5,13,14,17 from the initial manuscript have been removed.

- 4. The language is acceptable, but a check should be done to avoid a mixed-use of American/British spelling in the manuscript.*

Response

A thorough inspection to spot mixed spelling has been done and the spellings have been set to British English. American English spelt words were corrected.

Dear Wilson,

Thank you so much for your comments. The comments were really valuable and we believe addressing them made the review article better and helped us include important details and specifics of the topics discussed in it.

They were carefully addressed and suitable modifications were made in the latest version of the paper.

**In relation to your specific comments:**

Major comments:

1. *Line 30. The authors recommend to combine all areas related to marine operations, but how these should be done? To analyze a project from the start to the end can be challenging and it seems to be the motivation for writing this paper. What I miss is a linkage between various sections written in the paper. Please comment.*

Response

The paper is an attempt to describe various marine operations, the factors affecting it and the importance of having a stronger and deeper understanding of the metocean conditions of the farm location, vessels that will be used and challenges that could arise along the installation, O&M and decommissioning phases of a floating wind farm. Floater-specific factors are also mentioned so that a wind-farm designer can have a better understanding of marine operations and avoid related difficulties. We are currently preparing an in-depth cost-modelling exercise for marine operations concerning floating wind farms. We believe that such attempts can make use of this review article.

This has been described in the lines 35 - 40 of the manuscript with tracked changes.

2. *It seems like semisubmersibles are the best choice so far. However, I think that the construction costs should be briefly addressed as this is part of the life cycle as shown in figure 1. Please comment.*

Response

The semisubmersibles are the best choices from a marine operation point of view. But they are more expensive to construct compared to spar-type platforms and TLPs because of their larger size. Since the paper is focussing only on the marine operations in the last three phases (shown in Orange in Figure 1), a detailed analysis of the construction costs was not given.

This has been briefly mentioned in line 120 of the manuscript with tracked changes.

3. *Figures 6 and 7. For novel concepts, generally critical operations and parameters that limit an operation are identified and in some cases quantified. I think it is important to briefly mention and analyze them. Please discuss the challenges the authors found.*

#### Response

The critical parameters for these new technologies have been discussed in the latest version of the paper. The design and operation features of the ENEL TLP (Figure 6) has been discussed in a few papers, but the installation, O&M and decommissioning-related factors are yet to be studied. The GICON TLP is at a more advanced stage of development. It has been analysed from a marine operation point of view. The GICON TLP can be towed to the farm location for installation. The critical parameters here are the motions of the towing vessel and the TLP and tension on the towing lines. They have been discussed in the latest version of the paper.

The critical parameters and the corresponding values have been mentioned and discussed in lines 160-165, 175 and 180-185 in the manuscript with tracked changes.

4. *Line 235. Description of weather restricted and unrestricted marine operations does not fit in here. It should appear much earlier when you define a marine operation for the first time. Additionally, the literature review is incomplete. There are some papers dedicated to study the operational limits of marine operations. It would be nice if the authors discuss further the relations between operational limits given in standards such as those from Table 3 and other derived in papers.*

#### Response

The operation limits are important to the paper and section 3.2 'Environmental limits for installation, O & M and decommissioning' has been modified and a better review of the literature available on this topic has been included. The focus was given to critical parameters in various operations. They were analysed and our comments have been incorporated into this section.

The descriptions of the weather restricted and unrestricted marine operations have been moved to lines 195-210 of the latest revision of the paper. Lines 265-290 discuss the operational limits in detail. All the changes and detailed discussion on the critical parameters and environmental limits can be seen from lines 255-320

5. *Line 315. There are papers and equipment available in industry for noise mitigation. Please refer and discuss these developments.*

#### Response

Compared to bottom-fixed wind turbines, floating wind turbines do not produce as much noise that is harmful to the ocean environment during operation. However, piling operation for pile-driven anchors can produce noise. This noise can be mitigated using technologies like bubble curtains and by carefully engineering the piling process. The noise mitigation methods applicable for floating wind turbines have been discussed in section 3.4 'Health, Safety and Environment (HSE)' of the latest revision of the paper.

The details can be found in lines 400-405 of the manuscript with tracked changes.

6. *Line 320. ..floating-floating couple, which makes access and egress challenging. I believe that two floating structures can be moored together using fenders and soft lines. This will reduce relative motion and structures will move in unison. This has actually been experienced in the O & G industry. Please comment.*

Response

Mooring floating bodies together during an offshore operation have been observed in the O&G industry mainly during the transfer of cargo, removal of parts during maintenance etc. For crew transfer, this might not be recommended as it is time-consuming and requires additional work. Since FOWTs operate in harsh sea conditions, using a Service Operation Vessel (SOV) is advised due to higher operability. Both the platform and the vessel will be moving in this case. The feasibility of tying together floating bodies during crew transfer is yet to be investigated.

This has been mentioned in line 410 of the manuscript with tracked changes.

7. *Line 380. Please comment about technical feasibility and if possible add facts, critical parameters, critical components, etc.*

Response

The shared mooring and anchoring systems have been found to be feasible for pilot-scale floating wind turbine arrays. The critical parameter concerning a shared mooring system is the tension on the mooring line. The maximum tension should always remain below breaking load in all environmental conditions. In a shared anchoring system, the anchors should be capable of handling multi-directional loading.

These parameters have been discussed in detail from lines 470-480 in the manuscript with tracked changes.

8. *Line 390. What about weight of tendons. Please comment*

Response

For ultra-deep installations, the weight of the tendons increases dramatically. This is not economically feasible. From a marine operation point of view, large expensive vessels will be required for transporting and installing such tendons.

This has been briefly mentioned in line 490 of the manuscript with tracked changes.

9. *Figures 15, 16 and 17. Please add technical facts or results and discuss about technical feasibility. The reader wants to know how feasible are the concepts either using simulation or experimentation.*

Response

Most of the mentioned innovations are still in the development stage. The concepts are theoretically feasible but extensive research and experimental investigations are required to check the practical application of these concepts. The critical parameters identified by the researchers have been discussed.

The discussion of such parameters can be found in lines 560-565, 570-575, 585-590 of the manuscript with tracked changes

Minor comments:

1. *Spelling , commas, and gramatical errors. Please check that spelling and punctuation are correct. For example, Line 30.....new and maturing, there is. Line 70. Should you use season or period instead of window period?. Figures 4 nd 5, Characteristic durations(,), Line 85. This incurs additional costs; Sentence is incomplete, use a semicolon instead (see also line 225). Same line, must also.. Line 140, pro-type, Musial et al. (2004) have,..etc.*

#### Response

All the mentioned grammatical errors have been corrected in the manuscript with tracked changes.

The changes are visible at lines 40, 80, 95, 440

2. *Line 180. Do the authors mean dynamic motions?*

#### Response

No, what we meant was dynamic cables, the special kind of cables that can withstand high fatigue loading. They are well-suited for floating offshore wind turbines that are constantly moving.

3. *Table 2. Title should read Operational limits instead of operability. Likewise, Max. Sea state should read Max. significant wave height*

#### Response

The title has been corrected and the mentioned changes have been made in the manuscript with tracked changes.

The changes are visible at lines 290-295

4. *Try to avoid referring twice as in line 265*

#### Response

The repeated references have been deleted.

The change is visible at line 345 of the manuscript with tracked changes.

5. *Fixed wind industry? Please rewrite*

#### Response

The sentence has been rephrased to 'bottom-fixed wind turbine industry'

The changes are visible at line 385 of the manuscript with tracked changes.

6. *Line 345. ...savings in material and installation costs.*

Response

The correction has been made.

The changes are visible at line 435 of the manuscript with tracked changes.

7. *Figure 13 is not referred to. Show parts*

Response

The figure has been removed due to copyright issues.