Answers to the reviewer:

The authors would like to thank the reviewer for the constructive recommendations and comments which will help improve the current and future work. In the following, the authors would like to respond to the reviewer's comments. The addressed comments are included in italic font.

1. *The manuscript contains the statement "advanced spar-type". In my opinion, there is nothing advanced with either the spar or the optimization problem and the authors should moderate these statements. The proposed approach can perhaps be used for conceptual design studies, but both the optimization problem and the simulations lack capabilities to perform more detailed design. For example, manufacturing considerations and cost, structural requirements, and mooring system design are all excluded. The authors are encouraged to extend the work in at least one of these directions. It may be that the argument that less restrictive feasible sets can provide unexpected designs, but it is clear from the figures that several of the presented designs have structural integrity issues (this is also acknowledged in the manuscript).*

    The phrase advanced floater is avoided and rephrased into advancements taken for achieving a conceptual innovative floater design (e.g. alternative structural realization approaches, alternative ballast materials, …). It is emphasized that the applied approach only aims to obtain a conceptual design, however, that a detailed design optimization can be performed with the same framework due to the fully modular optimization problem setup and the multi-fidelity numerical modelling and optimization environment. These aspects are more clearly stated and emphasized throughout the paper. Especially, most of the abstract is rewritten, so that the focus is directly put into the right light so that the messaging on the intention of the paper and applied approach, as well as on the value of the work and contrast to other approaches is clearer positioned and emphasized. Furthermore, Figures on the referenced "advanced" floater configurations are added to improve the better understanding of the intended innovative character and approach.

2. *Unsuccessful simulations are encountered frequently according to the manuscript. This is an important topic within simulation-based optimization and appropriate actions must be taken. When unsuccessful simulations are flagged, they are dealt with in the implementation by considering the design under study as infeasible. The frequency of unsuccessful simulations, the type, and severity of failures are not reported. This could lead to a very conservative approach, with possibilities of disregarding good designs. The manuscript should be extended to report on the unsuccessful simulations and the authors are encouraged to investigate the reasons, types, and severities for the failures.*

    More details and information are provided on the unsuccessful simulations. Thus, it is made clear that these failing designs were not good designs which are disregarded but unstable designs with negative metacentric height. These explanations are provided in Section 4.3.3, when defining the undesired parameter values for failing simulations, and given as well when presenting and discussing the results in Section 5.1.

3. *The description of the optimization problem is unnecessarily verbose and spread out over several sections. It is for example not necessary to describe bounds on design variables in detail like in Table 3. The same holds for the other linear constraints. The focus should be on the constraints that require simulations. For the presented optimal designs, it is notable that almost none of the constraints are active, which suggests that the problem without simulations should also be solved and the designs compared. The authors should also investigate if the solver has actually found an optimal design.*

    Duplications in the derivation of the assessment criteria (Section 2) and the resulting definition of the optimization problem (Section 3) are removed. The general description of the optimization problem, however, is left complete in the paper, as this was as well asked by other reviewers and is the basis for defining the optimization problem. Based on Figure 5, it becomes clear that most of the constraints are often violated or close to the limit. This is also emphasized by the fact that the number of individuals that comply with all constraints (marked with darker colored markers in Figures 4, 5, and 8) is significantly lower than all simulated individuals. In Section 5.3 in the paragraph from line 484 to 497 it is elaborated in detail on the convergence of the optimization and the found optimum design solution.

4. *Several of the bounds in the optimization problem are physically unrealistic and additionally likely to cause numerical issues in the simulations. The problems should be re-solved with realistic values.*

    The specified allowable value ranges for the design variables do not cause numerical issues in the simulations. The only reason for failing simulations are design solutions which are unstable due to a negative metacentric height, as explained in the answer to the second comment of the reviewer. In Section 2.2, detailed information on the chosen allowable value ranges and corresponding reasons and argumentation are provided. Furthermore, it is elaborated on alternative "physical" realizations of solutions and values, which are initially deemed as unphysical. This is part of the intention of the paper and presented approach, namely that this freer optimization formulation can shed the light on innovative floater configurations, which require alternative structural realization approaches, of which some are already utilized in highly innovative floater concepts, such as the TetraSpar or Hexafloat. Thus, more details and examples are added and provided in Section 5.2.

5. *The reported optimization (wall-clock) time is more than 31 days. This is clearly far too much for conceptual design studies. The authors should make an effort to reduce this or at the very least explain the reasons.*

    More details on the duration of the optimization are added:

    - In Section 5.3 the following sentences are added:
      If, in addition to the maximum number of simulations, a reasonable convergence tolerance had been specified as supplementary stop criterion, the optimization algorithm would not have required all 10,000 simulations and would have stopped

much earlier. However, due to the strong similarity of the last design solutions, no significant differences in the results would have been perceived.

- The following separate paragraph is added in Section 6:
  First of all, the duration of the optimization simulations needs to be addressed. If an additional stop criterion based on a realistic convergence tolerance has been specified, not the full 10,000 simulations would have to be simulated as the convergence tolerance would have been reached maybe already after around 40 generations. Thus, the conceptual design study would have required maybe just less than a quarter of the actually spent time. However, even around 181 hours - which is more than a week - is still too long for just a conceptual design study. The reason behind the currently quite long time required does not lie in the multi-fidelity framework and fully modular optimization problem setup, but rather in the developmental stage of the numerical model for a floating wind turbine system. Thus, a 800 s load case simulation with a floating wind turbine in irregular sea state and with turbulent wind conditions takes about four and a half hours, which is about 20 times as much as the time to be simulated. This is a known issue and part of the current development work at Fraunhofer IWES. While for bottom-fixed wind turbine systems real-time capability of the numerical models based on MoWiT has already been achieved (Feja and Huhn, 2019), the optimization of the code for floating systems is still at an early stage of development. However, based on the experience with the bottom-fixed numerical wind turbine system models, it is expected to achieve as well real-time capability for floating numerical wind turbine system models based on MoWiT after some further advancements of the code. At that time, the full simulation of the specified optimization problem will just require about one and a half days. This would then be very promising both for conceptual design studies, as well as detailed design optimization tasks, which - due to the fully modular and multi-fidelity approach applied - can be realized with the same numerical modeling and optimization environment.

6. *The found mass is compared to an existing design and it is reasoned that significant material reductions can be achieved. It is however not reported if the two designs are subject to the same design requirements and have both been assessed in the same way. The authors should address these topics in detail before stating conclusions.*

   The authors are aware of the fact that the OC3 phase IV spar-buoy floating wind turbine system was defined as a reference design for code-to-code verifications and code-to-experiments validation and, hence, was not necessarily optimized. The statement about the mass, provided in Section 5.3, is mainly and simply to clarify, that alternative configurations can be found by applying the presented procedure. The general aspect that the OC3 phase IV design was not designed with the same design requirements and was not optimized, as it mainly dealt as reference floating wind turbine system design, is added in the paper:

   - In Appendix A, referring to Section 2.1, the following sentence is added:
     This OC3 phase IV spar-buoy floating wind turbine system was defined as a reference design for code-to-code verifications and code-to-experiments validation and, hence, was not necessarily yet optimized.

- In the fourth paragraph of Section 5.3 the sentence with the statement on the mass reduction is extended as follows:
  This design solution yields a reduction of the structure material volume of more than 31% compared to the original (modified) reference spar-type floating platform, for which it must be noted that it neither has been designed with the same design requirements, nor has it yet been optimized.

7. *The manuscript can with advantage be drastically shortened, sharpened, and re-organized. Several sections contain information already presented.*

   In general, the paper has been tightened and a bit restructured. Thus, the introduction now only contains the main information relevant to the content of the paper (the list of spar floaters previously included in the introduction is fully removed). A paper roadmap is included, incorporating the information previously provided in both introduction and the separate chapter on advanced spar-type floater and their characteristics. Duplications in the derivation of the assessment criteria and the resulting definition of the optimization problem are removed. Furthermore, bullet point lists are removed and, if required, tables are used instead. The details for the (already well-known) OC3 phase IV floating wind turbine system are put to the appendix.