D7.7 Identification of critical environmental conditions and design load cases

The design process for new substructure concepts is highly complicated, as relevant environmental conditions and simulation settings for numerical load assessment have to be defined for each concept individually. This is due to the novel state of the FOWT technology and the out-standing of large scale deployment and validation of simulation tools with full-scale measurements of different substructure concepts. This lack of experience with the technology makes it important to carefully select design conditions for the system in order to provide a conservative yet cost effective design.

In order to support the designers of FOWT systems, this report provides methodologies to help the designer identify reduced sets of critical design-driving load cases, and the therein relevant environmental conditions and simulation requirements.

These methodologies are derived and applied based on the two selected concepts of LIFES50+ phase I: the *LIFES50+ OO-Star Wind Floater Semi 10MW* and the *NAUTILUS-10* floating sup-port structure. The derived critical design load cases are the DLC 1.2 (fatigue loads during power production and normal sea state), DLC 1.6 (ultimate loads during power production and severe sea state) and DLC 6.1 (ultimate loads during parked conditions and 50yr wind and wave environment). A global Monte Carlo based sensitivity analysis methodology is implemented for the determination of relevant environmental conditions of FOWT and more in-depth statistical methods such as Bootstrap and analysis of the backwards standard deviation are used for the determination of convergence behavior of the simulations. Finally, based on results from this task as well as previous tasks in LIFES50+, methodologies for determining the environmental impact on the LCOE as well as upscaling considerations are given.

Next to the methodologies, the results of the substantial simulation studies performed in this work provide the reader with specific recommendations for the simulation setup of both fatigue and ultimate limit state (FLS, ULS) simulations regarding run-in-times, required number of seeds, simulation length, and relevant environmental conditions. The determination of relevant environmental conditions may be a complex and numerically intensive task, which is why global sensitivity analysis is proposed as part of the design process. This may also support the definition of a more thorough, probabilistic design process which is considered to lead to more cost effective FOWT substructures.

It is highlighted that the reduced set of load cases cannot be taken to be sufficient for a complete design and do not present a possibility to reduce the overall design effort. The effort of identifying critical load cases is seen as advantageous in the early design stage, where a large variety of design possibilities is considered, and fast evaluations are key in order to find an optimized solution.