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Guest Editorial

Special Section on Risk and Uncertainties in Offshore Wind and Wave Energy Systems

This special section of the ASCE-ASME *Journal of Risk and Uncertainty in Engineering Systems: Part B* comprises seven papers related to recent advances and emerging approaches on the risk and uncertainties that are associated with the fast-changing sector of offshore renewable energy. A concerted effort was made to achieve broad geographic representation, with thematic and methodological diversity, variety in industrial needs. The papers present developments in both fundamental research and engineering applications and are expected to be a snapshot in time around the risks and uncertainties of this topic.

More specifically, the contributions can be categorized with respect to the following three distinct themes: Understanding risks and uncertainties in: (1) the environment of offshore renewable energy systems, (2) the structural system and its mechanical interaction with the environment, and (3) the operational processes and energy production aspects. In a way, we can consider it to cover the input, the system, and the output of this complex and fast-moving technological area.

In the first theme, *Hallowell* et al. predicted breaking wave hazards through an estimation model in offshore design for load cases using long mean return periods of environmental conditions over the U.S. Atlantic coast. It combined commonly used breaking criteria with the inverse first-order method of producing environmental contours and was applied numerically using a catalog of stochastic hurricanes. The study showed that breaking wave hazard estimation is highly sensitive to the breaking criteria chosen (e.g., wave steepness and seafloor slope at shorter return periods) and is most important for locations closer to the coast. Subsequently, *Judge* et al. investigated scaled wave tests in a wave basin and investigated uncertainties around such tests, which are typically carried out to replace the actual environmental conditions in a faithful manner. This paper presented uncertainties for measurements of an oscillating water column wave energy converter in a wave basin. The impact of wave reflections on the experimental results revealed the importance of identifying the incident and combined wave field at each measurement location used to determine device performance.

These led to the engagement with the devices further through *Nispel* et al. who studied the fatigue aspects of an offshore wind turbine (OWT) with soil-structure interaction under varied loading conditions and sensitivity studies. Such considerations can lead to more reliable and robust estimations of structural designs for large offshore wind turbines with limited information at the early stages of design. *Reale* et al. considered uncertainties in geotechnical aspects on monotonic load–displacement behavior for offshore wind turbines. This uncertainty was considered in terms of spatial variability in soil properties, parameter transformation uncertainty, and design model choice. Results show that spatial variability had a limited impact on design load–displacement characteristics of monopiles as variability tends to be averaged out in the process to develop discrete p-y models. This highlights an issue related to data loss and requires careful checking. Soil spatial variability had a noticeable effect on the predicted system frequency response of OWTs, and the influence of subgrade reaction model choice is significant. On the other hand, *Hallowell* et al. also looked into mooring system reliability by considering a multiline anchor system for multiple floating offshore wind turbines connected to a single caisson and an overstrength factor was introduced to address the reduction in system reliability.

Devin et al. presented a multivariable genetic algorithm with elements of Bayesian optimization to examine the tradeoffs between cost and reliability for a floating offshore wind array that uses shared anchoring with an example in the Gulf of Maine considered. Results illustrated how such maximization of strength with minimized investment can be achieved and system reliability was found to be particularly sensitive to changes in turbine costs and downtime, suggesting further research into floating offshore wind turbine failure modes in extreme loading conditions could be particularly impactful in reducing project uncertainty. *Devoy McAuliffe* et al. investigated Levelized Cost of Energy (LCoE), the importance of correctly selecting the discount rate and cash flow based on the perspective and motivation of the user and related variabilities in LCoE. Sensitivity studies further investigated the potential impact of key variables and areas of uncertainty on results and emphasized the need for consistency in the application and interpretation of the metric.

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