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Hurricane Risk Assessment of Offshore Wind Turbines

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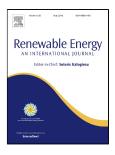
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Hurricane Risk Assessment of Offshore Wind Turbines

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7 Abstract

A barrier to the development of the offshore wind resource along the U.S. Atlantic coast is a lack of 8 9 quantitative measures of the risk to offshore wind turbines (OWTs) from hurricanes. The research presented 10 in this paper quantifies the risk of failure of OWTs to hurricane-induced wind and waves by developing 11 and implementing a risk assessment framework that is adapted from a well-established framework in 12 performance-based earthquake engineering. Both frameworks involve the convolution of hazard intensity 13 measures (IMs) with engineering demand parameters (EDPs) and damage measures (DMs) to estimate probabilities of damage or failure. The adapted framework in this study is implemented and applied to a 14 hypothetical scenario wherein portions of nine existing Wind Farm Areas (WFAs), spanning the U.S. 15 16 Atlantic coast, are populated with ~7000 5 MW OWTs supported by monopiles. The IMs of wind and wave are calculated with a catalog representing 100,000 years of simulated hurricane activity for the Atlantic 17 18 basin, the EDPs are calculated with 24 one-hour time history simulations, and a fragility function for DM 19 is estimated by combining variability observed in over one hundred flexural tests of hollow circular tubes found in the literature. The results of the study are that, for hurricane-induced wind and wave, the mean 20 21 lifetime (i.e., 20-year) probability of structural failure of the tower or monopile of OWTs installed within 22 the nine WFAs along the U.S. Atlantic coast ranges between 7.3×10^{-10} and 3.4×10^{-4} for a functional yaw control system and between 1.5×10^{-7} and 1.6×10^{-3} for a non-functional yaw control system. 23

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25 Keywords: offshore wind; risk; hurricane; fragility; framework

26 Nomenclature

- 27 *c*: Component (monopile or tower)
- 28 *D*: tube diameter
- 29 *DG*: design group

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