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From Hurricane Scale to Structural Load: Advancing Energy Infrastructure Design Standards Using High-Fidelity Simulations

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Wednesday, July 15, 2026

1-2 PM (MT) FL2-1022 or Virtual | [Watch Live](#)



As offshore and coastal energy systems expand globally into regions exposed to tropical cyclones, understanding the extreme wind environments experienced by energy infrastructure is increasingly urgent. However, accurately predicting infrastructure-scale structural loading during high-intensity storms remains a major challenge, partly due to complex boundary-layer processes that are not fully resolved by conventional mesoscale models or reflected in existing design standards.

To address this challenge, this study employs high-fidelity large-eddy simulations (LES) to examine near-surface mean winds, turbulence statistics, vertical shear, and coherent structures relevant to wind turbine loading during extreme storms. Given that conventional engineering standards may misrepresent these extreme conditions, the structural response of turbines under simulated hurricane passages is evaluated and compared against design structural loads. Motivated by these simulation findings, a physically grounded framework is proposed to bridge atmospheric boundary-layer physics with infrastructure resilience. Finally, the applications of this framework to other critical infrastructure and across diverse coastal regions are discussed. [Event Website](#)