Hurricane-Induced Wind, Wave and Current Effects on Offshore Wind Turbines

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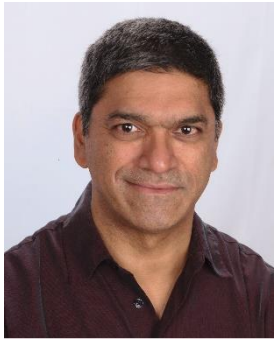
Abstract

Several sites have been identified for offshore wind energy generation in U.S. waters. It is of interest to consider external conditions associated with hurricanes and winter storms for the design of offshore turbines at these sites. We discuss the effect of two recent storms, Hurricane Ike and Superstorm Sandy (a post-tropical cyclone that is sometimes referred to as Hurricane Sandy) on bottom-supported offshore wind turbines hypothetically in their paths as they made landfall. For realistic loads assessment, it is important that the coupled influences of changing wind, wave, and current fields are simulated throughout the evolution of the hurricanes. We employ a coupled model that integrates atmospheric, wave, and ocean components to produce needed inputs. Model wind data are used to generate appropriate wind velocity fields including shear and turbulence, current velocities over the water column are interpolated from discrete model output, and short-crested irregular waves are simulated using directional wave spectra from the coupled model. Loads on monopile-supported turbines sited in 20 meters of water in the Gulf of Mexico are studied during Hurricane Ike; similarly, loads on a jacket platform-supported turbine in 50 meters of water in the mid-Atlantic region are studied during Hurricane Sandy. We discuss important characteristics of the external conditions including the relative importance of swell versus wind seas, of aerodynamic versus hydrodynamic forces, of current velocity effects, of yaw control options for the turbine, of hydrodynamic drag versus inertia forces, and of soil-structure interaction effects. The framework presented explains how coupled environmental inputs (during a hurricane) may be included in turbine loads studies; it can aid in future efforts aimed at developing offshore wind turbine design criteria and load cases associated with severe storm systems.

Dr. Lance Manuel is the T. U. Taylor Professor of Engineering at the University of Texas at Austin, where he has been on the faculty since 1999. He earned a PhD degree in civil engineering from Stanford University. He is the Editor of ASME's Journal of Offshore Mechanics and Arctic Engineering. His work related to loads, inflow turbulence, reliability, and offshore environment characterization as these all relate to wind turbines and wave energy converters has been supported by funding from the National Science Foundation, the U.S. Department of Energy (including Sandia National Laboratories and the National Renewable Energy Laboratory), and the Texas Higher Education Coordinating Board. Dr. Manuel is a member of an advisory group for the International Electrotechnical Commission (IEC) that assists with standardization in the field of wind energy generation systems including wind turbines, wind power plants onshore and offshore, and interaction with electrical systems to which energy is supplied.



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