Abstract Submitted
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New insights into the spectral behavior of the power fluctuations of horizontal-axis turbines[1] GEORGIOS DESKOS, National Wind Technology Center, National Renewable Energy Laboratory, Golden, USA, GREGORY PAYNE, Ecole Central Nantes, France, BENOIT GAURIER, IFREMER, France, MICHAEL GRAHAM, Imperial College London, UK — The spectral behavior of the turbulence-driven power fluctuations of a single horizontal-axis turbine is investigated both experimentally and through a novel semi-analytical model. The study confirms that the power spectra follow a -11/3 power law over the inertial sub-range (or part of it) as well as that significant spectral energy content may exist around the blade-passing frequency and its higher harmonics. The shape and magnitude of the power spectra are shown to strongly depend on the blade aerodynamics (e.g. lift curve slope), the angular speed of the rotor as well as the integral length scale and distortion level of the approaching turbulence. To gain these new insights, we have derived a novel semi-analytical model which combines the turbulence distortion and blade-element momentum theories, as well as it uses the rotationally sampled spectra technique, to calculate the power spectra. The model is validated using detailed experimental data obtained in the long water flume situated in the laboratory facilities of IFREMER in Boulogne-sur-Mer, France, where a fully instrumented horizontal-axis turbine was deployed, and synchronous measurements of the upstream velocity and the rotor quantities (thrust, torque etc.) were collected for different tip-speed ratios

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