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Towards uncovering the structure of power uctuations of wind farms LEONARDO P. CHAMORRO, HUIWEN LIU, YAQING JIN, NICOLAS TOBIN, University of Illinois at Urbana-Champaign — The structure of the turbulence-driven power fluctuations in a wind farm is fundamentally described from basic concepts. A derived tuning-free model, supported with experiments, reveals the underlying spectral content of the power fluctuations of a wind farm. It contains two power-law trends and oscillations in the relatively low- and high-frequency ranges. The former is mostly due to the turbulent interaction between the flow and the turbine properties; whereas the latter is due to the advection between turbine pairs. The spectral wind-farm scale power fluctuations Φ_P exhibits a power-law decay proportional to $f^{-5/3-2}$ in the region corresponding to the turbulence inertial subrange and at relatively large scales, $\Phi_P \sim f^{-2}$. On the order of the advection time between turbine pairs, an oscillation exists with the product of a sinusoidal behavior and an exponential decay in the frequency domain.

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