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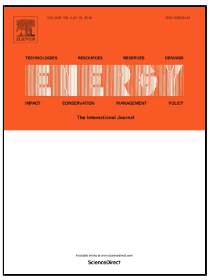

LES simulation and experimental validation of the unsteady aerodynamics of blunt wind turbine airfoils

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LES simulation and experimental validation of the unsteady aerodynamics of blunt wind turbine airfoils

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Abstract:

In order to investigate the unsteady performance of blunt wind turbine airfoils caused by boundary layer separation and wake eddies, this paper studies the aerodynamic performance by large eddy simulation (LES) and wind tunnel experiment at a Reynolds number of 2.62×10^5. The blunt airfoils are obtained by enlarging the trailing edge of the DU 91-W2-250 airfoil to 6% and 10% chords symmetrically on both pressure and suction sides of the airfoil. The simulation was carried out with the incompressible finite-volume Navier-Stokes code EllipSys3D; and, the experiment was done in a wind tunnel with a cross-section of 0.5m × 0.5m by measuring the surface pressure and wake velocities using ESP-64HD pressure scanner and TSI hot-wire anemometer. The unsteady wake was captured by hot-wire in the wind tunnel, and LES with EllipSys3D. Both experiment and LES show that the spectrum of aerodynamic forces has a broadband nature which is in coincidence with the wake eddies, implying that the unsteady Kármán vortex sheet is the driving mechanism of the force fluctuation. Moreover, the trailing edge size affects the separation bubbles and transition process in the boundary layer. It shows that the boundary layer near the leading edge is unstable in the spanwise direction, which is characterized by low frequency waves.