Theoretical & Applied Mechanics Letters 11 (2021) 100303

Contents lists available at ScienceDirect

Theoretical & Applied Mechanics Letters

journal homepage: www.elsevier.com/locate/taml

Editorial: Fluid mechanics problems in wind energy

Wind energy is growing as the key energy resource in many countries. Wind turbines convert the kinetic energy of moving air into electricity, in which fluid mechanics plays a vital role, from the aerodynamics of wind turbine blades, wind turbine wakes to atmospheric turbulence. Last one hundred years have seen the dramatic improvement on the performance of wind turbines, that the current designs are featured with higher power efficiency, larger rotor and higher tower when compared with those in 1980s. The growing wind power industry poses new requests for wind technologies, such as the design and control of floating offshore wind turbine (FOWT), the micro-sitting of wind turbines in complex terrains, and many others, which rely heavily on the advancements from the fluid mechanics aspect.

In this special issue on “Fluid mechanics problems in wind energy”, we are very pleased to publish six featured research papers from experts in the field. It is challenging to design a floating platform because of the dynamic coupling between the wind and the wave. In Ref [1], Feist, Sotiropoulos and Guala proposed a quasi-coupled wind wave experimental framework for offshore wind turbine floating systems, and tested it for a FOWT under heave and pitch motions. Another important issue for a FOWT is the control of the floating platform. In Ref [2], Shah et al. developed a model predictive control for minimizing the platform motion, and demonstrated its effectiveness using the baseline FOWT designed by National Renewable Energy Laboratory (NREL). Wind turbine wakes affect the performance of wind farms. Understanding its dynamics is important for the optimization of layout and control of wind farms. In Ref [3], Foti numerically investigated the Coherent vorticity dynamics and dissipation for the wake of a utility-scale wind turbine. The effects of complex terrain on wind turbine wakes are not properly modeled in the current wind farm design tools, because of the poor understanding of the corresponding fluid dynamics. In Ref [4], Cai et al. experimentally investigated the effects of local topography-induced pressure gradient on the wake and power output of a model wind turbine, and proposed a simple formulation based on a linearized perturbation method to account for the pressure gradient effect. The noise generated from wind turbine is of major concern for residents living close to wind farms. Trailing edge serrations provide a way to suppress trailing edge noise. In Ref [5], Cao et al. developed a model for simulating the effect of serrations on trailing edge noise. Installing rooftop wind turbine provides a supplemental way to meet the urban electricity need. In Ref [6], Zhang et al. investigated the effects of a rooftop wind turbine on the dispersion of air pollutant. To this end, we sincerely thank all the authors for contributing to this special issue.

Xiaolei Yang is a Professor in the Institute of Mechanics, Chinese Academy of Sciences. He received his Ph.D. in Fluid Mechanics at the University of Chinese Academy of Sciences in 2010 under the supervision of Professor Guowei He. Prior to joining Institute of Mechanics, CAS, he worked at University of Minnesota with Professor Fotis Sotiropoulos as postdoc and Research Associate, and later at the State University of New York at Stony Brook as Senior Research Scientist and Research Assistant Professor. His recent research interests include turbulent flows in wind farms, wall models for large-eddy simulation, and cardiovascular flows. He has published more than 40 journal papers in fluid mechanics and wind energy. He is the editorial director of Theoretical and Applied Mechanics Letters. He serves in the editorial board of Theoretical and Applied Mechanics Letters, Energies and Wind.

http://dx.doi.org/10.1016/j.taml.2021.100303