JOHNS HOPKINS
Center for Environmental & Applied Fluid Mechanics

SPRING 2020 CEAFM SEMINAR SERIES

"Wind Turbines Icing Physics and Innovative Strategies for Wind Turbine Icing Mitigation"

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Wind turbine icing represents the most significant threat to the integrity of wind turbines operating in cold climates. By leveraging the Icing Research Tunnel available at Iowa State University (ISU-IRT), a comprehensive experimental study was conducted to elucidate the underlying physics of the important micro-physical processes pertinent to wind turbine phenomena and explore novel anti-/de-icing strategies for wind turbine icing mitigation. A suite of advanced flow diagnostic techniques, which include molecular tagging velocimetry and thermometry (MTV&T), digital image projection (DIP), and infrared (IR) imaging thermometry, were developed and applied to quantify the transient behavior of wind-driven surface water film/rivulet flows, unsteady heat transfer and dynamic ice accreting process over the surfaces of wind turbine blade models. The potentials of various bio-inspired icephobic coatings, including lotus-inspired superhydrophobic coatings and pitcher-plant-inspired Slippery Liquid-Infused Porous Surfaces (SLIPS), for wind turbine icing mitigation are evaluated under various icing conditions (i.e., ranged from dry rime icing to wet glaze icing conditions). A novel, hybrid anti-/de-icing strategy that combines minimized electro-heating at the blade leading edge and an ice-phobic coating to cover the blade surface was developed for wind turbine icing mitigation. In comparison to the conventional strategy to brutally heating the mass blade surface to keep the blade ice free, the hybrid strategy was demonstrated to be able to achieve the same anti-/de-icing performance with substantially less power consumption (i.e., up to ~90% power saving). Our recent field campaign in a 50 MW mountainous wind farm to investigate the effects of icing events on the performance degradation of multi-megawatt (1.5MW) wind turbines by using a Supervisory Control and Data Acquisition (SCADA) system and an Unmanned-Aerial-Vehicle (UAV) equipped with a high-resolution digital camera will also introduced briefly.

Friday, February 14, 2020
3:00 PM, Hodson Hall 213