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**Lecture in CSM:**

# Wind Turbine Blade Dynamics Influenced by Stochastic Perturbations due to Turbulence and Load Errors

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## ABSTRACT

Offshore wind turbine manufacturers are currently considering the design of larger, low-mass towers and blades to increase renewable energy extraction and optimize costs and maintenance. As a result, wind turbine blades are becoming longer, e.g., about one hundred meters and beyond. Long, flexible blades are sensitive to wind load effects either during operational conditions or extreme events. The interaction between the rotating blade and the flow can lead to dynamic vibrations and, ultimately, aeroelastic interactions.

This presentation will discuss recent studies by the author on the analysis of blade coupled-mode flutter. Flutter involves the interaction between flap-wise and torsional vibrations of the blade that may lead to dynamic instability. Investigations analyze various perturbation sources, e.g., wind turbulence, loading errors and modeling simplifications and their effects on the onset of flutter. Blade flutter may lead to blade damage and, ultimately, failure. It is therefore important to address this issue from a structural reliability point of view. Although this phenomenon is not important for shorter blades, the presentation will show that flutter probability cannot be ignored in the case of long, offshore blades. Specifically, the presentation will consider the behavior of the NREL (National Renewable Energy Laboratory) 5MW standard offshore wind turbine blade. The seminar will summarize both analytical modeling developments, numerical Monte Carlo – based simulations and experimental verification in wind tunnel. Various wind field and load scenarios will be considered.