# Multidisciplinary Blade Resolved Wind Farm Simulations using High Performance Computing

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Wind plant modeling involves multiple physics which span many scales, from the millimeter size thin aerodynamic blade boundary layers, to the complete wind plant scale of several kilometers. Until recently it was assumed that simulations capturing all relevant scales were unfeasible. However, recent advances in high performance computing hardware, coupled with novel algorithms, and more rigorous software development procedures have enabled high fidelity multidisciplinary simulations of complete wind farms. These capabilities can be used to provide a better understanding of individual wind turbine performance and service life, as well as to assess and optimize the performance of complete wind plants. This talk will discuss some of the technologies required to build a complete wind farm simulation capability and will emphasize the multidisciplinary nature of these technologies, which must draw on expertise in diverse areas including applied mathematics, computer science, aerodynamics and atmospheric science. The formulation of efficient numerical solvers, which minimize the number of arithmetic operations required to solve systems of non-linear equations, as well as techniques for achieving scalability of these algorithms on massively parallel computer architectures will be discussed. A flexible software structure that enables tight coupling of multiple disciplines within a single simulation will then be described and the application of these technologies to large aerodynamic and aeroelastic analysis problems including individual wind turbines as well as complete wind farms will be shown. The talk will conclude by discussing the prospect for future advances in simulation capability as we advance towards the exascale era.