

## Licensable Technologies

# HIGRAD/Windblade – Wind Generation Modeling and Simulation

### Applications:

- Wind farm site identification
- Optimization of wind farm turbine spatial orientation
- Turbine blade design improvements

### Benefits:

HIGRAD can help

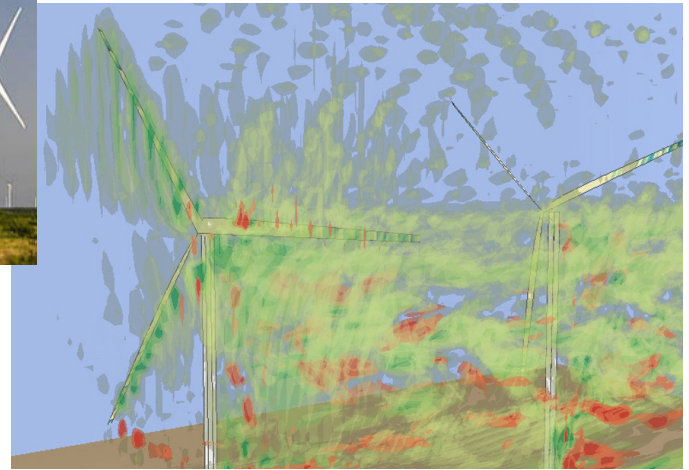
- Decrease the cost of energy production
- Maximize wind energy generation efficiency
- Calculate the effects of single and multiple turbines on wind fields
- Optimize wind turbine placement
- Decrease capital expenditures
- Increase total turbine lifetime
- Prevent early gearbox failure
- Calculate limits of design conditions for turbines and turbine arrays
- Calculate the effects of larger blade spans

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### Summary:

As the wind energy industry works to provide the infrastructure necessary to generate 20% of the U.S. national energy supply by 2030, it will encounter many technical issues along the way.

For example, in order to meet national wind energy production goals, the industry is increasing the size of the wind turbines. As blade spans increase, both the turbine design process and turbine site optimization will increase in complexity. This is due to the significant complexity and variability of interactions between turbine blades and atmospheric processes in the Earth's planetary boundary layer. The variability in wind environments is affected by the surrounding vegetation structure, topography, and turbine array itself as well as transient conditions such as diurnal cycles and evolving weather systems.

Los Alamos National Laboratory (LANL) is developing unique capabilities, like HIGRAD/Windblade, to address these issues. HIGRAD/Windblade is a physics-based modeling software application designed to simulate the interactions between rotating turbine blades and the complex atmospheric conditions to which they are exposed including heterogeneous wind shears, density currents, streamwise vortices, transitions in atmospheric stability, and turbine wakes. The results from these simulations, including transient blade loadings and turbulence generation, are critical for designing wind turbines, predicting wind turbine performance, finding wind farm locations, planning wind turbine arrays, and assessing the environmental effects of wind turbine arrays.

HIGRAD is the only modeling and simulation software capability that captures the blade-scale (meters), dynamic, two-way interaction between rotating turbine blades and the three-dimensional atmospheric structures over turbine-scale (hundreds of meters) to wind-farm-scale domains (multiple kilometers). HIGRAD also calculates high-gradient wind flows and turbulence that affect wind turbine and wind farm performance. As such, HIGRAD will deliver valuable capabilities to the wind energy industry by enabling the optimization of site location, wind turbine placement, and turbine/blade development.

**Development Stage:** Proof of concept has been achieved.

**Patent Status:** Patent pending and copyright protected

**Licensing Status:** LANL is searching for a collaborative partner to complete development of HIGRAD capabilities for use by industry.

[www.lanl.gov/partnerships/license/technologies/](http://www.lanl.gov/partnerships/license/technologies/)

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