

Data and facts

Dual Doppler Wind Radar – long-range, ultra-high resolution wind field measurement

The challenge of measuring 3D wind fields in large areas

Currently available wind measurement technologies such as vertical-profiling lidar and met mast systems provide high-quality but essentially point-based measurements, while long-range scanning lidar can map wind fields only with a limited range and resolution.

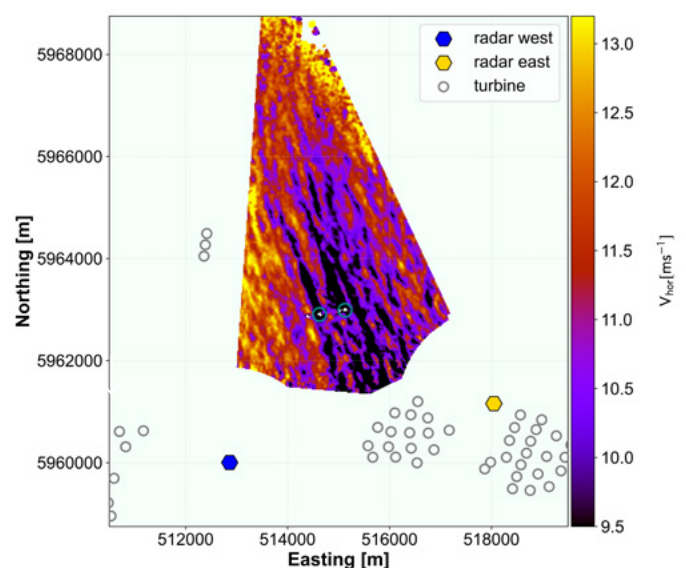
Dual Doppler Wind Radar is able to characterize the wind field across an entire wind farm or wind farm cluster as a full 3D field in extremely high temporal and spatial resolution. This enables developers, operators and manufacturers to e.g. validate wind farm control algorithms, measure power curves of all turbines of a wind farm or perform long-range wind resource assessments over a large area.

Overview of services

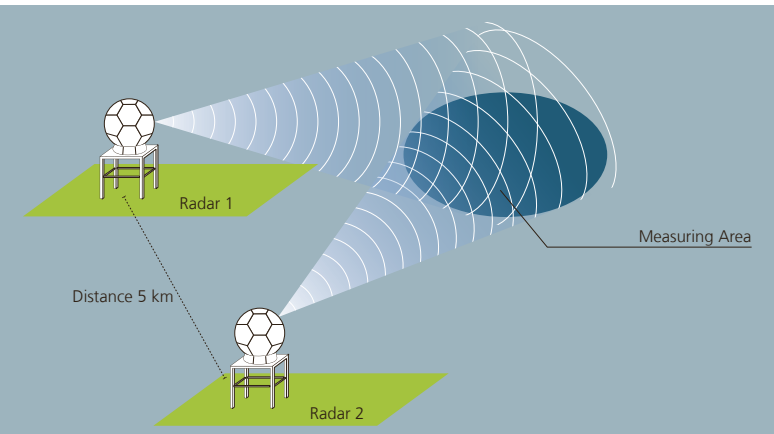
- Performance of a complete measurement campaign at your site from planning to decommissioning
- Delivery of a comprehensive data set of the measured 3D wind field in high temporal and spatial resolution
- Analysis of the data to answer your specific need
- Combination with model data or other wind measurement systems as appropriate

The Dual Doppler Wind Radar solution

Dual Doppler Wind Radar uses two spatially separated radar units whose beams both cover the region where the wind field is to be resolved. Each minute, it can record up to one million wind measurements at multiple heights over a wind farm area exceeding 1,000 square kilometers. This unique data set provides developers with a comprehensive description of the site conditions and gives operators unprecedented insight into the interaction between turbines and the surrounding atmospheric flow.



Example of a radar-measured wind field. The white dots are wind turbines. The heatmap shows the current wind speed.



Schematic example measurement setup of the Dual Doppler Wind Radar system.

How does the wind radar technology work

The wind radar system emits short pulses that are backscattered by particles in the air (e.g. dust or raindrops). These radars were originally used mainly for rain or pollutant detection, until SmartWind Technologies (Texas, USA) used Doppler processing to derive wind speeds from the reflected signal. Fraunhofer IWES has qualified the measurement system for wind energy applications and carried out an extensive validation program. To resolve the 3D wind field, Doppler shifts from two directions are needed, so two radars several kilometers apart are deployed across the wind farm.

Dual Doppler Wind Radar 3D wind field data service

The Dual Doppler Wind Radar is provided as a measurement service that delivers processed, ready-to-use wind field data. From the radar beams, a 3D wind field is retrieved on a user-defined grid that can span entire wind farm and wind farm cluster areas, with temporal resolutions down to about one minute. The resulting datasets include wind speed and direction at multiple heights, as well as shear, veer and wake evolution, all supplied as consistent time series over the full measurement campaign. These data products can be used to validate wind farm control systems, flow and wake models at wind farm scale, refine site assessments, support layout optimization and power performance testing, and analyze specific operational situations such as curtailment events or extreme inflow conditions.

Technical specifications

- Power: 6.5 to 8.5 kW
- Carrier frequency: 9.3 GHz
- Wavelength: ~3 cm
- Maximum range: 35 km
- Scan speed: 30°/s
- Range resolution: 9 to 15 m
- Azimuth / elevation resolution (physical): 0.5°
- Azimuth / elevation resolution (oversampled): 0.352°/0.1°

Further information

The Fraunhofer Institute for Wind Energy Systems IWES conducts application-oriented research for a sustainable future. The focus topics of the Fraunhofer IWES are offshore, hydrogen, test infrastructure and digitalization. The research work in these future-oriented key technologies plays a central role in the innovation process and strengthens the business location for the benefit of our society by transferring the research results to industry. More than 400 employees at nine locations are developing innovative methods to accelerate the expansion of the wind energy and hydrogen economy, minimize risks, and increase cost efficiency.

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