

Performance Optimization

In a detailed analysis by our most experienced staff, we put your wind farm to the test and determine what you can optimize to gain greater energy yields.

Three good reasons why you need a performance optimisation:

- > One analysis shows many ways to optimize your wind farm and your energy yield
- > Determining the weak points of your wind farm
- > Showing the potential for optimization

Our most experienced staff analyzes your wind farm down to the smallest detail based on their comprehensive wind energy know-how. We then open up new possibilities for the optimized operation of your wind turbines to achieve a significant improvement in your rate of return.

Using specially designed processes, we investigate:

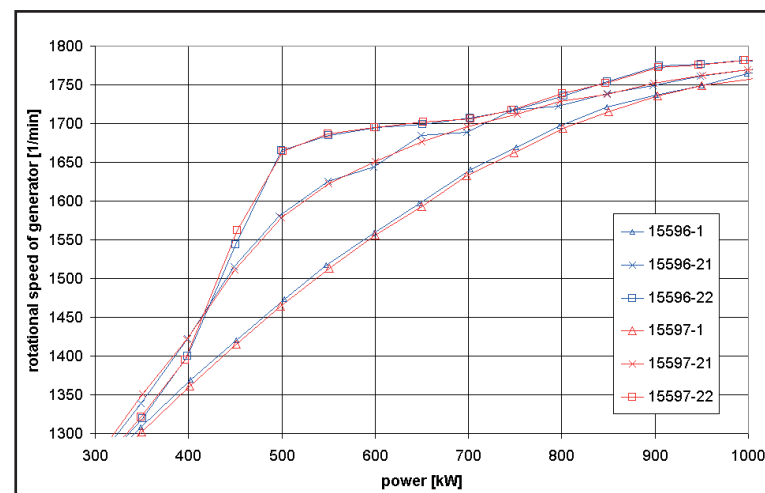
- Wind turbine availability
- Power Curve
- SCADA data
- Long-term correlation of energy yields
- Wind resource
- Energy yield losses

Hence, your goals are our goals:

- Energy yield loss reduction
- Improvement of availability
- Power curve improvement
- Optimization of technical management
- Wind turbine load reduction & subsequent turbine life extension

In combination with our wind turbine measurement services, our experts can provide recommendations for the optimal operation of your entire wind farm based on comprehensive data analysis.

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Power Curve Measurement

The power curve establishes the basic correlation between the wind speed at a site and the power produced by a specific wind turbine. With this measurement, the manufacturer verifies the performance of his turbine to the customer. Also, you may commission a new measurement when it seems that your wind farm does not yield the energy as predicted.

Three good reasons why you need a power curve measurement:

- > Operator: to verify whether your turbines fulfil the guaranteed power performance
- > Manufacturer: to prove the performance of turbines to clients & certification bodies
- > To verify the success of an optimization of the power performance

Deutsche WindGuard Consulting GmbH is an accredited testing laboratory for wind turbine power curve measurements according to DIN EN ISO/IEC 17025:2005 and is accepted by MEASNET for power curve testing. Some key staff members of Deutsche WindGuard have extensive experience and an unparalleled scientific background in power curve testing. This staff has tested power curves of thousands of turbines with a rated power from 50 W to 7.5 MW. Due to this background, Deutsche WindGuard holds an exceptional role as know-how provider for the further development of power curve testing standards, e.g. in the maintenance teams of the standards IEC 61400-12-1 & the draft standard IEC 61400-12-2. Thus, it is not surprising that Deutsche WindGuard is accepted by nearly all major wind turbine suppliers for power curve testing.

Depending on your needs, the power curve testing procedure will be chosen from a variety of possibilities:

- Classical measurements with a met mast according to IEC 61400-12-1, often required for the verification of guaranteed power curves and for the purpose of turbine certification
- Application of advanced nacelle anemometry according to IEC 61400-12-1 (CD[V]), as cost effective alternative to the application of met mast and for measuring the power curve of as many turbines as possible (also offshore)
- Power curve measurement via Lidar without a met mast. Although not yet implemented in standards, this procedure is already accepted in special cases by wind turbine manufacturers, e.g. in cases where no met mast can be implemented
- Integral power curve analysis in order to analyze the variation of power curves within the wind farm



- Integration of turbulence intensity and wind shear in the power curve analysis (e.g. by WindGuard's normalization procedures) in order to provide a more fair comparison of the measured and guaranteed power curve and in order to understand deviations of the site specific power curve from the expected power curve
- Relative power curve analysis without external wind measurement for the validation of an optimization of the power curve

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Offline Vibration Measurement

A frequent cause of damage in wind turbines is the occurrence of unwanted oscillations. An early detection and analysis makes the elimination of these causes possible before any larger damage may arise.

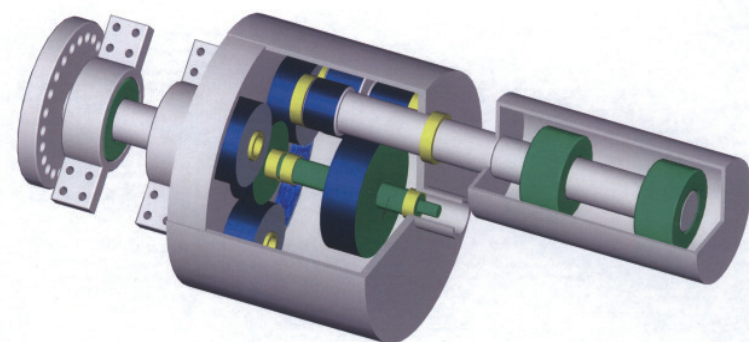
Three good reasons to conduct an offline vibration measurement:

- > Early detection of damages by vibration measurement
- > Cooperation with well-known bearing manufacturers (SKF)
- > Measurement with up to 16 sensors

Vibration analysis helps to keep the dynamics of wind energy turbines under control. Deutsche WindGuard performs qualified vibration measurements, conducts research on root causes and develops solutions for early damage recognition.

We measure high frequency vibrations of the drive train for the condition-oriented maintenance of the main shaft, gear box and generator as well as low frequency oscillations that can occur at the tower and rotor blades and could lead to dangerous resonance frequencies.

We recommend that the vibration characteristics of your wind turbines be included during commissioning. These so-called "fingerprints" lay the foundation for early detection of damage in the context of condition-based maintenance.



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Analysis of SCADA-Data

Wind farm SCADA-data provides a lot of valuable information. Often, the value of this data is ignored by wind farm owners/operators.

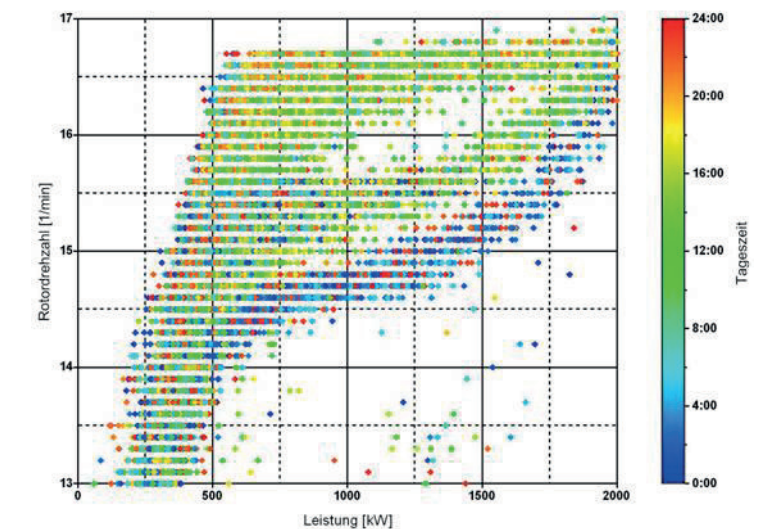
Three good reasons why you need an analysis of the SCADA-data of your wind farm from an independent expert:

- > Root cause analysis and quantification of energy yield losses
- > Analysis of duration/causes of turbine standstills and of WT controller functioning
- > Independent proof for warranty claims

Deutsche WindGuard has long standing experience with time series data stored by wind turbine controllers of all major turbine brands and has developed effective procedures for the analysis of this data. In many cases, expert analysis of SCADA-data as performed by Deutsche WindGuard has been successfully used by wind farm owners for warranty claims and as a basis for the optimization of wind turbines. If the SCADA-data of your wind farm is not stored on a regular basis, Deutsche WindGuard has the possibility to collect this data efficiently by connecting the wind farm to its WONDERv2 database system.

Our assessments convince due to our:

- Experience to handle complex wind turbine error codes
- Capability to generate statistics on the frequency and duration of error types and to quantify the energy loss due to different error types
- Capability to analyze the proper functioning of the rotor speed control (or generator pole switching), pitch control and yaw control
- Ability to analyze the relative gain in the power curve due to changes of the controller settings
- Ability to analyze all relevant temperature signals, such as temperatures measured in the gearbox, in the generator or in the inverter



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