

## Production Outlook for Operating Wind Farms

Wind resource assessments from the planning phase of wind farms are linked to high uncertainties due to the large number of evaluation steps and assumptions involved. In order to provide an accurate outlook of future energy yields, commission an energy yield assessment for your operating wind farm with us.

Our production outlooks for operating wind farms are characterized by:

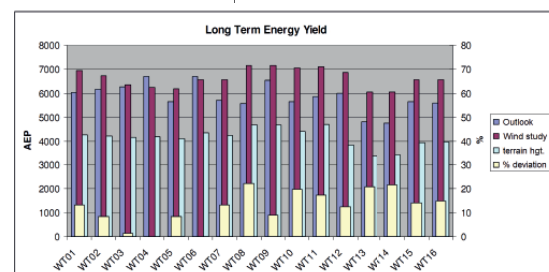
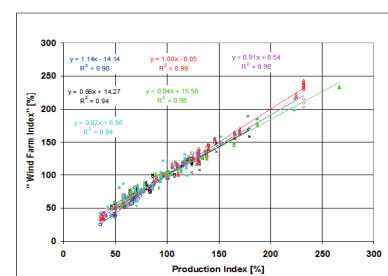
- > Unparalleled know-how in the analysis of production data & long-term correlations
- > High acceptance by banks and investors
- > Methods accredited according to DIN EN ISO/IEC 17025:2005

After a wind farm has been in operation for a while, the future energy yield can be predicted much more accurately. This is possible because the required evaluation is limited to a long-term correlation of energy production observed over time. Such precise production estimates can be beneficial to improve the financing conditions of the wind farm and to prove the wind farm performance to investors.

Deutsche WindGuard has conducted post-planning production analysis for multiple GW of existing wind farms in various regions of the world for owners, financing banks or potential investors. It is often surprising how the long-term correlated production deviates from the predictions of the planning phase. In many cases overly high expectations have been observed. Often, the post planning prediction can identify reasons for deviations in the energy yields as expected in the planning phase and predictions based on the actual energy production.

Our assessments convince due to our:

- Sophisticated methods for the identification and filtering of outlier production data caused by special events during the operation of the wind farm
- Advanced methods for the correction of non-availability losses in the past and for the estimation of the development of technical losses in the future
- Effective methods for long-term correlation of energy yield data, including careful assessments and selections of long-term data from all relevant wind databases worldwide
- Detailed assessments of uncertainties
- Capabilities to identify the origin of deviations of the actual production and from the expectations of the planning phase



Deutsche WindGuard's methods for long-term correlations of wind farm energy yields fall under the accreditation for wind resource assessments according to DIN EN ISO/IEC 17025:2005. WindGuard has a leading role in all relevant harmonization committees where long-term correlations of wind farm energy yields are considered (Fördergesellschaft Windenergie - Expert committee wind resources, BWE-Wind expert advisory committee).

Contact:  
Martin Strack: [m.strack@windguard.de](mailto:m.strack@windguard.de)

## Wind Resource & Energy Assessment

Bankable wind resource and energy assessments are the basis for economic planning and financing of your wind farm. These assessments are a complex task due to the large number of evaluation steps and assumptions involved.

Our wind resource & energy assessments are characterized by:

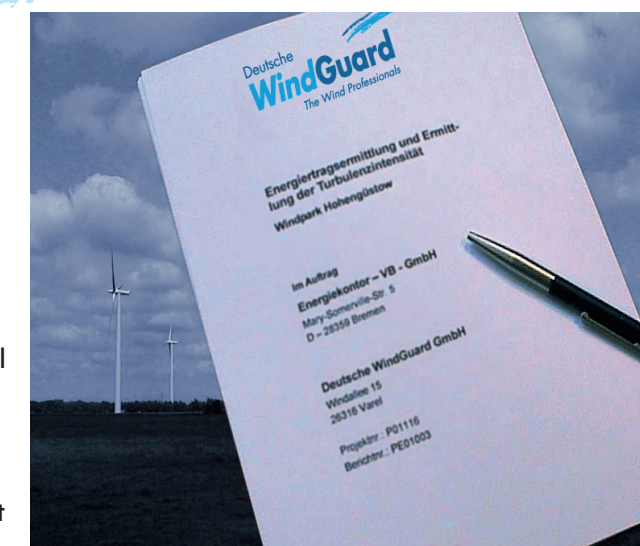
- > Expertise in meteorology, wind measurements, fluid mechanics and power curves
- > Worldwide and extensive experience, also in extreme complex terrain and offshore
- > Fully accepted by financing banks and investors

WindGuard has performed wind resource and energy assessments for multiple 10th of GW of planned and existing wind farms all over the world. WindGuard's leading experts have long-year experience and participated in numerous R&D projects related to wind resource assessments. Based on this we have developed unparalleled know-how and world leading procedures for the different assessment tasks.

This is also the reason for WindGuard's exceptional role in all relevant harmonization groups related to wind resource assessments. Our assessments convince due to our:

- Complex examinations and processing of wind measurement data.
- Effective methods for long-term correlation of wind and energy yield data, including careful assessments and selections of long-term data from all relevant wind databases worldwide.
- Sophisticated methods for the transfer of measurements to wind turbine locations and hub heights by flow modelling, while minimizing uncertainties.

Contact:  
Martin Strack: [m.strack@windguard.de](mailto:m.strack@windguard.de)



- Extensive expertise in the field of power curve evaluations.
- Advanced methods for the estimation of technical losses
- Detailed assessments of uncertainties.

## Site Suitability Studies

Site suitability studies are aiming to assess the compatibility of the design of the planned wind turbine type with site-specific conditions and wind farm layout. The assessment covers all load relevant variables such as ambient and wake induced turbulence intensity, wind speed distribution, extreme wind speeds, wind shear, vertical flow inclination, air temperature range, and air density.

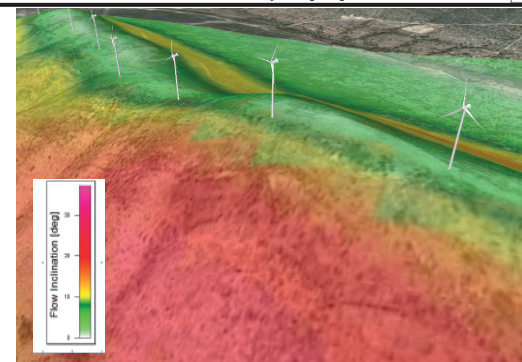
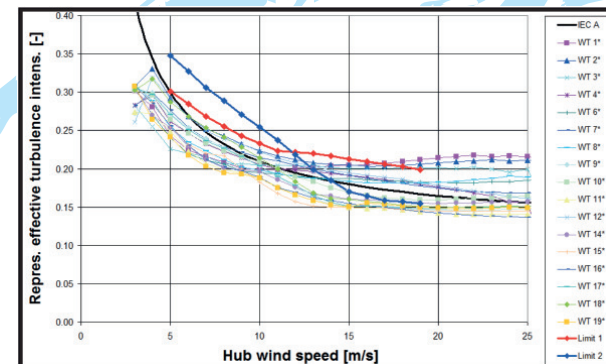
**Three good reasons to let us prepare your site suitability study:**

- > Expertise in meteorology, wind measurements, fluid mechanics and certification
- > Worldwide and extensive experience, even in extreme complex terrain and offshore
- > Fully accepted by wind turbine manufacturers, financing banks and investors

WindGuard has performed site suitability studies for multiple GW of planned wind farms all over the world and is often engaged by wind turbine manufacturers or wind farm developers for complex cases such as highly complex terrain or dense wind farm layouts. WindGuard's experts are second to none in having experienced the development of all relevant standards related to site suitability tasks and have participated in numerous related R&D projects. Based on this, we have developed unparalleled know-how and world leading procedures for the different assessment tasks. This is also the reason for WindGuard's leading role in the relevant related harmonization groups (e.g. MEASNET).

Our assessments convince due to our:

- Complex examinations and processing of wind measurement data.
- Excellent knowledge of related standards like IEC 61400-1 Edition 2 and Edition 3, Amendments to these standards, GL guidelines and DIBT
- Sophisticated procedures for the assessment of extreme wind speeds and vertical flow inclination and advanced flow modelling capabilities
- Extensive know-how in wake modelling even in special cases such as large offshore wind farms



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## Optimization of Wind Farm Layouts

The positioning of wind turbines in wind farms can be a complex task. Proper positioning should not only aim to optimize the energy yield by making use of the most windy sites within the wind farm area and by reducing wind turbine wake effects like it is considered by commercially available software products. The positioning process must also consider the suitability of the wind turbines selected for the site, i.e. sufficient spacing between wind turbines and avoidance of too harsh wind shear and vertical inflow conditions to remain within the design parameters of the wind turbine. In addition, other constraints must also be considered, such as sound power levels, restricted areas, safety distances, entry lanes for offshore wind farms etc.

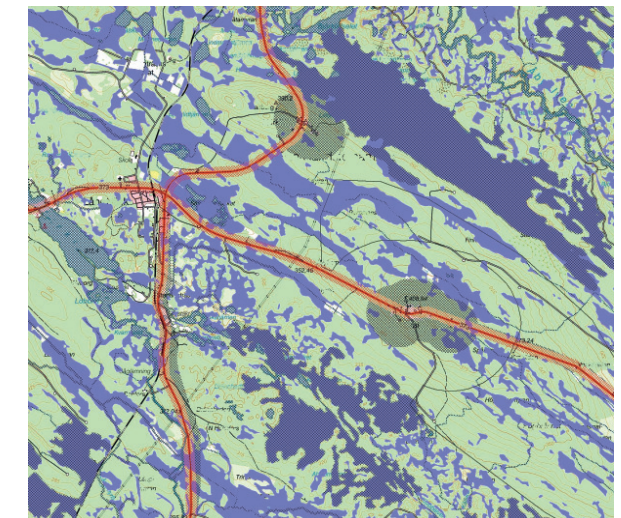
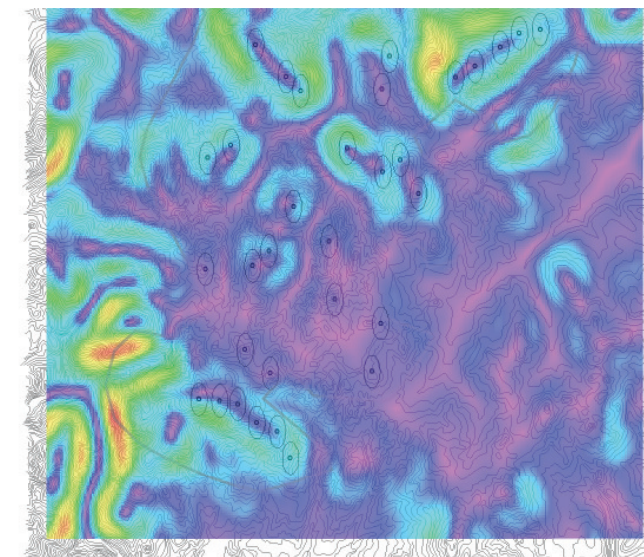
**> WindGuard has extensive experience with all these factors**

WindGuard has optimized wind farm layouts for a large number of wind farms of widely different sizes and under very different conditions. WindGuard is often contracted for wind farm layouts in non-trivial cases, for example where the suitability of the wind turbine design for a specific site becomes critical due to overly complex terrain or offshore wind farms that are populated too densely.

Our assessments convince due to our:

- Unparalleled know-how in all related fields like wind resource assessment, flow modelling, site suitability studies, wind turbine certification

- Experience in layout optimization and sophisticated optimization procedures
- R&D capabilities to develop solutions for new types of problems



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Martin Strack: [m.strack@windguard.de](mailto:m.strack@windguard.de)