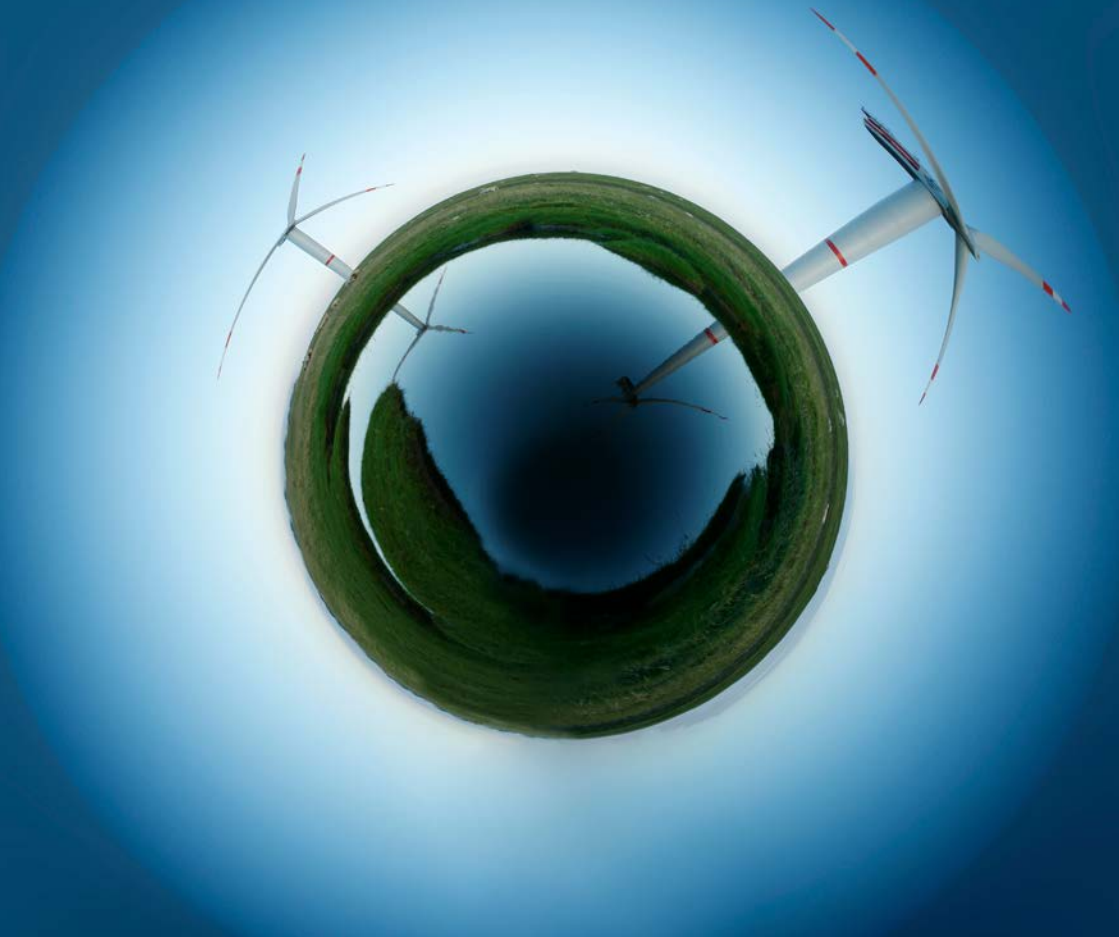
Fraunhofer
IWES

FRAUNHOFER INSTITUTE FOR WIND ENERGY AND
ENERGY SYSTEM TECHNOLOGY IWES

Focus on Validation



Accredited according to DIN EN ISO / IEC17025:2005 for

- determination of physical properties of fiber enhanced synthetic materials and fiber composite materials using mechanic-technological and thermal testing
- testing of mechanical loads on wind turbines

Certified according to DIN EN ISO 9001:2008 in the areas of ´product development up to the prototype stage, technology development and optimization, technology assessments and studies´ as well as ´trials in demonstration centers´.

VALIDATION OF NEW DESIGNS FOR RELIABLE PROGRESS

Fraunhofer IWES North-West ensures investments in technological developments in the field of wind energy through its validation services. By operating large test rigs for rotor blades, nacelles and support structures as well as for components such as bearings, shafts and composite parts, it accelerates the market introduction of innovative products and enhances certification processes. State-of-the-art laboratories and measurement equipment that allow the systematic identification and reduction of development risks complete the portfolio.

The testing spectrum was developed in cooperation with industry leaders, who were involved from the design phase right up to commissioning. This approach made sure that the test rigs and measurement equipment comply with actual industry needs.

These assets combined with the methodological competence of its employees make Fraunhofer IWES a preferred research and development partner for companies all around the globe.

The international network of Fraunhofer IWES is being systematically expanded through, for example, participation in the expert committees of the IEC for the specification of future standards for rotor blade and nacelle testing.

Together with the German Aerospace Center (DLR) and the university association ForWind, IWES is part of the Research Alliance Wind Energy. In total, this alliance comprises more than 500 scientists all investigating topical issues in the field of wind energy. In order to guarantee transfer of academic expertise, strong ties with further universities have been built.

Fraunhofer IWES employs around 140 scientists and administrative staff at four sites: Bremerhaven, Hanover, Bremen and Oldenburg. 60 million Euros have been invested in the establishment of testing infrastructure over the last years. In 2015, the operational budget has been 15 million Euros. The institute is dedicated to wind energy, focusing on OEMs, suppliers, developers and operators.

ACCELERATED TIME TO MARKET: CERTIFICATION IN THE LABORATORY

Experimental testing accelerates the innovation cycle and assures your company´s investments. Scrutinizing new design prototypes in time lapse by applying the loads from the entire operating life speeds up the certification process and, in turn, the launch of new turbines and components on the market.

Given the increasing professionalism of the wind energy sector, only "mature" products which can guarantee proven, reliable operation are accepted nowadays. Testing in the laboratory minimizes the development risk and meets the demand for ever shorter development times.

Your product has to satisfy the challenges presented by the most stringent requirements for extreme environmental and operational conditions. From the design stage to experimental testing and model validation through to industrialization of manufacturing processes, our wide basis of expertise supports the wind energy industry in asserting its competitiveness on an international level.

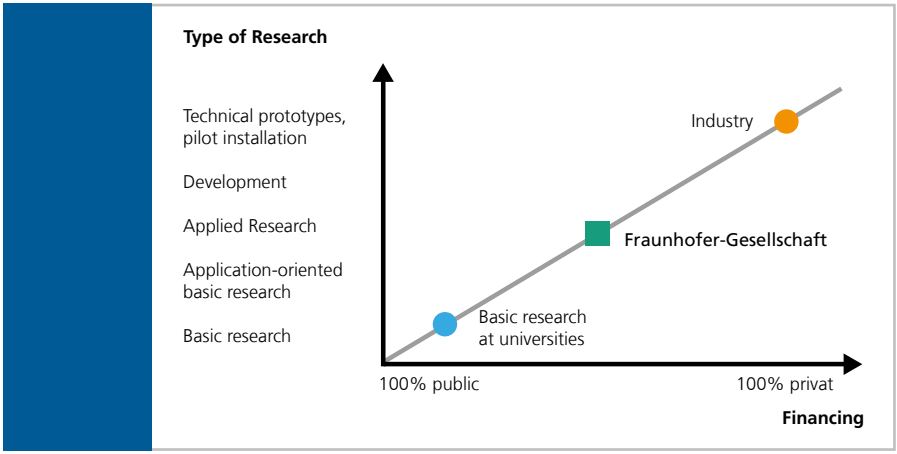
Next generation wind turbines

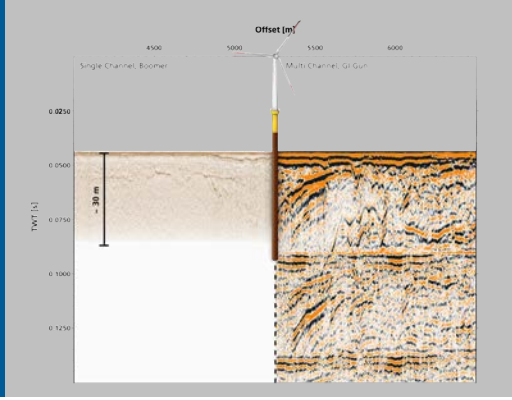
Tomorrow´s challenges need to be addressed today in order to catch up with the pace of development. Shortened product life cycles and the clear demand for cost reduction incite our ingenuity to foster new approaches like innovative measuring methods for wind, current and seabed, active and passive mechanisms for load reduction via smart blades, industrialized rotor blade manufacturing or future concepts for drive trains and generator systems based on new materials. Let us support your striving for the game-changing difference.

THE FRAUNHOFER MODEL: FOCUS ON INDUSTRY AS SUCCESS FACTOR

Fraunhofer is the largest organization for application-oriented research in Europe. Its research activities are conducted by 67 institutes and research units at locations throughout Germany. Affiliated international research centers and representative offices provide contact with the regions of greatest importance to present and future scientific progress and economic development.

Unlike other publicly funded research institutes, Fraunhofer receives only 1/3 of its basic funding from the state; the remainder of its budget has to be raised from industrial sources and public institutions. This results in a clear commitment on industry-oriented services which offer obvious added value for clients.





SUPPORT STRUCTURES, FOUNDATIONS AND SOIL CONDITIONS

With a foundation test pit and span fields, the support structure test center offers numerous possibilities for conducting experimental tests on support and foundation structures on scales from 1:10 to 1:3.5. The dynamic and fatigue behavior of structures subject to the continuous stresses of waves, wind and turbine operation are tested here in "time lapse". Environmentally friendly construction methods can also be developed and validated in the center.

By using structural models, numerical calculations and large-scale experiments, on- and offshore wind turbines can be further improved in terms of enhanced system availability and cost efficiency.

In the geophysics field, Fraunhofer IWES has developed a multi-channel seismic measuring process which is particularly tailored to offshore wind energy requirements.

The results show unprevailed resolution and signal penetration in the characterization of subsoil conditions for offshore wind parks. Regarding geotechnical soil characterization, we offer in-situ surveying methods (CPT) as well as laboratory tests of seabed samples. At the test center, it is possible to examine and evaluate the mechanical subsoil behavior and the interactions between subsoil and construction under long-term cyclic loads.

Technical data

- Foundation test pit: 14 x 9 x 10 m (L x W x D), zoning possible
- Vertical loads: max. 2 MN tension, max. 2.5 MN pressure
- Horizontal loads: max. 2.5 MN tension/pressure
- Test frequency: up to 50 Hz depending on cylinder

ROTOR

Fraunhofer IWES has years of experience in the fields of fibre-composites, static and fatigue composite testing. Component and substructure testing can significantly reduce the risk of damage during a rotor blades' operational life. These tests can be used for validation of calculational models and methods, verification of structural behavior and design improvements according to IEC 61400/23. Test rigs for static and dynamic testing of blades up to 90 meter in length are available in Bremerhaven nearby the pier.

BladeMaker demonstration center
The center supports you with assessing potential savings in the field of rotor blade production. An infrastructure with a gantry robot system and readily available rotor blade molds, will provide the means to adjust materials and processes to better suit the requirements of industrialized blade manufacturing.

Aerodynamics and stochastic dynamics
We offer analyses and optimizations of aerodynamic characteristics for designing rotor blades, based on validated simulation methods. The numerical analysis and optimization of aerodynamic elements, so-called add-ons, allow subsequent performance enhancement. Tools for load reduction and noise diminishment are also available.

Technical data

- Full scale blade test with max. static bending moment: 115,000 kNm, /max. dynamic bending moment: +/- 30,000 kNm
- Meganewton machines with a maximum force capacity of 2.5 MN static and 2 MN fatigue for uniaxial tests, including a climate chamber

DRIVE TRAINS AND GRID CONNECTION

Nacelle testing

The DyNaLab (Dynamic Nacelle testing Laboratory) is equipped for complete nacelles in the power output range from 2 to 8 MW. Field trials can be simulated under realistic conditions in the laboratory by applying loads from the rotor and grid side via particularly dynamic force application. The world's most comprehensive grid simulation allows examining effective and idle power in various network situations as well as the thermal behavior of electronic components on the nacelle test rig.

Technical data

- Load application unit: 20 MNm bending moments
- 2 MN thrust forces, 2 MN radial forces
- Artificial grid with 44 MVA converter capacity
- Up to 47 kV for HVRT tests

Main shaft test stand

The test stand is designed for accelerated fatigue testing of main shafts of 2 to 5 MW wind turbines. Thanks to its modular composition, different main shaft designs can be tested, as well as different components like main bearings, pitch bearings or main frames. In order to reproduce a realistic loading, we have conducted a detailed analysis of simulated and measured load time series for the main shaft. An important output of these analyses is the information which degrees of freedom are relevant for fatigue damage mechanisms.

Technical data

- Max. bending moment: 15 MNm
- Max. radial force: 3 MN
- Max. rotational speed: 60 rpm
- Drive power: 300 kW
- Heavy-duty foundation

Bearing testing

The experience-based construction of bearings is reaching its limits due to new designs and operating modes such as 'Individual Pitch Control'. The damage mechanisms in the bearing depend on a range of factors, which, in turn, have differing effects depending on the actual bearing and lubricant. In cooperation with Senvion GmbH, Fraunhofer IWES has developed a blade bearing test stand which enables testing of the entire hub/blade bearing/rotor blade group. In this set-up, all the significant interfaces are modeled realistically.

Technical data

- Max. bending moment 15 MNm
- Pitch movement when subject to loading with +/- 5°
- 400 measurement channels
- Measurement of thickness of lubrication film

Reliability of power electronics

Operation and maintenance account for around a third of the life cycle costs of wind power plants. System reliability will play a central role in the further sinking of LCOE for wind turbines. Fraunhofer IWES investigates the issue of the reliability of power electronics in a dedicated innovation cluster together with 16 industry partners. It focuses on the main converters of wind turbines, which are crucial to maintaining the high quality demanded of the current fed into the grid. The high incidence of damage to these converters incurs relevant repair costs and downtimes. A systematic damage analysis is performed analyzing failure, maintenance and operating data from over 2,000 wind turbines, spanning the most diverse range of plant models and generator/converter topologies at various onshore and offshore locations. The evaluation of this data will be complemented with surveys and analysis in the laboratory.

SITE ASSESSMENT, CFD SIMULATION AND FIELD MEASUREMENTS

We offer measurement campaigns for determining onshore and offshore wind resource using LiDAR devices. Detailed knowledge of prevailing environmental conditions at established or future sites is substantially important for the planning and operation of wind power plants. We offer the measurement and analysis of the data needed in any project phase: From planning through realization up to operation.

Accredited field measurements
Undertaking measurement campaigns on running wind turbines in order to reliably evaluate their efficiency, functionality and remaining lifetime is also part of Fraunhofer IWES' spectrum. This is done, for example, by carrying out accredited mechanical load and power performance measurements. Special measurement campaigns on the relevant system components are also possible alongside customer-specific electrical and mechanical measurements.

CFD simulation for wind power plants
Numerical flow simulations provide reliable data for site assessment in complex terrain – for example by using OpenFOAM code. Numerous expansions have been developed specifically for its use for site assessment. The simulation of entire wind power plants is another focal point – this employs the code flapFoam which combines the advantages of OpenFOAM with rapid optimization.

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