Fraunhofer IWES

Data and facts

Dynamic Nacelle Testing Laboratory (DyNaLab)

Since 2015 the Dynamic Nacelle Testing Laboratory (DyNaLab) offers a full scale test stand for different specimen as generators or complete nacelles in the power output range from 2-10 MW. The DyNaLab provides a realistic testing environment in the multi-megawatt field for component suppliers and manufacturers of wind turbines through facilitating laboratory testing in the evaluation and optimization of established and future turbine concepts. Field trials can be simulated under realistic conditions in the laboratory.

Realistic wind load reproduction

Wind torque is reproduced using two electrically excited synchronous motors which are arranged in tandem and have a drive power of 5 MW each. This means that 10 MW are provided for the test operations. The nominal torque that can be applied to the specimen is 8,600 kNm with 20 Hz large scale control bandwidth. The complete test stand drive is tilted to an angle of 5°. This corresponds with the average actual inclination of a wind turbine drivetrain in the field and thus represents the realistic situation, smaller adjustments can be realized via mechanical adapters. The engine torque is transferred to the specimen via a rod coupling.

The reproduction of parasite wind loads such as thrust, shear forces and bending moments are created by a hydraulic load application system (Stewart platform). The loads originating from the Stewart platform and the rod coupling are combined using a moment bearing and thus transferred to the rotating shaft of the specimen. Using this unique configuration bending moments of ca. 20,000 kNm, thrust and shear forces in the range of 1,900 kN can be achieved. The nacelle test stand can provide in this way a total of 6 degree of freedom with varying dynamic capabilities. With the aid of a drive motor and the hydraulic force application the interactions between nacelle and rotor blades can be simulated realistically in the DyNaLab.

Our competences at a glance

- UVRT & OVRT tests under reproducible conditions (different grid-codes)
- DUT control and operation optimization
- Mechanical drivetrain & component investigations
- Model validation
- Efficiency Measurement

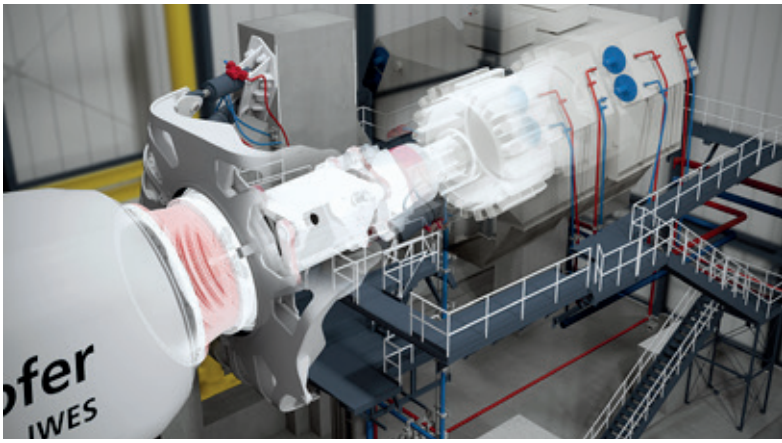
Technical specifications

- Force application: dynamic application of up to 20 MNm bending moment and 2 MN thrust and shear forces
- Nominal torque: 8.6 MNm
- Overload torque: 13 MNm
- Drive performance: 10 (15) MW
- Artificial grid with 44 MVA installed inverter power
- Measurements: more than 600 synchronous, high resolution measuring channels

Simulation of various electrical grid situations
A further focus lies in electrical grid simulation and the resulting possibility of electrical nacelle certification on the test stand. In order to achieve this, the world's most comprehensive grid simulator is installed in the DyNaLab. Here, static tests can be carried out in order, for example, to examine effective and idle power in various network situations or the thermal behaviour of electronic components. Furthermore, transient grid events can be simulated which can impact the complete nacelle system. For this purpose, dynamic Under-Voltage Ride Through (UVRT) and Over-Voltage Ride Through (OVRT) events corresponding to the respective grid codes are simulated on the test stand. An inverter capacity equivalent to 44 MVA is available for these tests. Harmonic current behaviour and nacelle system perturbation can also be investigated in DyNaLab.

Hardware-in-the-loop (HIL)
Due to the missing rotor and tower, the nacelle has different system characteristics on the test stand than in the field. In order to simulate real conditions in the laboratory occurring loads and the interactions between nacelle and rotor are calculated and applied. The necessary wind turbine real-time models and the appropriate control algorithms are developed to facilitate the hardware-in-the-loop operation of test stand and specimen.

Reduction of time to market
Through grid and HIL load simulations different load scenarios under reproducible conditions can be created and wind energy turbine behaviour tested in such scenarios as multi-dips in the grid during storms, network short-circuiting through incorrect pitch control or emergency stops. Besides certification in the field, DyNaLab offers the possibility of greatly reducing certification through application on the test stand, to date a time consuming process, since different operating scenarios can be started up as many times as required in the DyNaLab. In this way, both operational management and control can be optimized and model validation implemented. In addition, wind energy turbine reliability and availability can be increased and, at the same time, maintenance and repair costs reduced.system characteristics on the test stand than in the field. In order to simulate real conditions in the laboratory occurring loads and the interactions between nacelle and rotor are calculated and applied. The necessary wind turbine real-time models and the appropriate control algorithms are developed to facilitate the hardware-in-the-loop operation of test stand and specimen.



Further information

Fraunhofer IWES secures investments in technological developments through validation, shortens innovation cycles, accelerates certification procedures, and increases planning accuracy by means of innovative measurement methods in the wind energy and hydrogen technology sectors. At present, there are more than 300 scientists and employees as well as around 150 students employed at the nine sites: Bochum, Bremen, Bremerhaven, Emden/Leer, Görlitz, Hamburg, Hanover, Leuna and Oldenburg.

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