International Energy Agency (IEA)
Implementing Agreement for Co-operation in the Research and Development of
Wind Energy Systems (IEA Wind)

IEA Wind Task 35 – Wind Turbine Testing
Full Size Ground Testing for Wind Turbines and their components

Goals and Activities

In the past 15 years the average nominal power of new wind turbines generators (WTG) has increased tenfold. This rapid increase in size has presented challenges to OEMs in design, manufacturing quality and reliability of the turbine and their components. To improve the quality and reliability and as a possible long term means to reduce the design and development time, as well as the overall costs, the use of full scale ground test facilities for validating WTG designs has become an attractive option to the component manufactures, WTG OEMs and WTG owner/operators. For some years several test facilities have been operating to test multi-MW WTG components, but much larger facilities are currently in planning or construction stages. These existing or in-process facilities utilize a variety of different test bench configurations for blade, drivetrain, and other subcomponent testing. These test facilities are purpose built by the test rig users (OEMs, researchers, component designer/suppliers) pursuing different objectives, such as:

- functionality tests of the overall WTG system and their components
- design validation, acceptance testing, or certification testing
- behaviour in controlled environments (e.g., cold climate conditions or acoustic chamber tests).
- durability tests to determine the safety and life time of components (e.g., blades, gearboxes, yaw drives, pitch systems, etc)
- determination of component interaction and loads during wind turbine operation for validation of design models.

This proposed task is intended to discuss and guide the use of test facilities for wind turbine components as a reliable alternative or complement to on-tower field tests in design validation and demonstration of functionality, service life, and safety response. WTG OEMs, supply chain companies, research entities and certification agencies will collaboratively research and specify the requirements and boundary conditions of test rig configurations and to develop recommended practices for uniform test and measurements procedures.

Although there are some test methods for wind turbines and their components defined in the International Electrotechnical Commission (IEC) TC88 standards it is recognized by many of the aforementioned wind turbine industry stakeholders that system reliability could be improved by further defining new testing procedures and refining existing methods. To this end, it is necessary to specify requirements and boundary conditions of test rig configurations and develop...
uniform test procedures and measurements. Recommended practices will be provided for the necessary interfaces and subsystems of wind turbines required for a realistic investigation on drivetrain and component specific test rigs. Results of this work will provide recommended practices for standardized test procedures as well as proposals for uniform and qualitative analysis of test results for wind turbines components. This guidance may be used to refine the standardization and certification procedures of the entire wind turbines and components.

The proposed activities build upon the discussions during the 68th IEA Topical Expert Meeting “Advances in Wind Turbine and Component Testing”, February 2012, Aachen, Germany. It was decided at the meeting to prepare a task proposal under the umbrella of IEA Wind about new test methods for wind turbines and their components.

The objective of this proposed task is to develop guidelines and recommended practices for test facilities that simulate in-field loading of wind turbines and wind turbine components in a controlled environment to verify design assumptions and demonstrate system or component function, safety and durability.

The IEA Wind framework provides the opportunity to get the key stakeholders in the wind industry (e.g., OEMs, component manufacturers, research entities and certification agencies) at one table to discuss the requirements for the development and the use of system test rigs for wind turbines and their components. Since such testing always involves some simplifications of reality, the required interfaces and subsystems must be determined. In order to be able to determine similar results compared to the investigation of wind turbines in the field, uniform test procedures and measuring methods as well as approximate values for qualitative evaluation must be defined. This is necessary to identify the differences of the load application on different test rigs as well as the required capabilities of load application for test equipment. The integration of grid and wind loads via hardware in the loop (HIL) models are essential in order to examine the wind turbine controller and thus the behaviour of the entire turbine under realistic operating conditions on the system test rig.

With the technical skills and the different experiences of the participants it will be possible to recommend improvements to the test procedures for the overall wind turbine rotor and nacelle systems as well as for individual components. The exchange of ideas from different perspectives will advance the use of test facilities for improving wind turbine reliability.

The resulting work will provide recommended practices on basis test procedures for wind turbines and their components, with focus areas including:

- Detection of the structural component loads
  - Definition of reference load collectives for test rig investigations or rather HIL model requirements for wind- & grid load calculation
  - Clarify the dynamic interaction between the different components (system and subsystems) of a wind turbine and describe the influences

- Function test procedures
  - replacement/extension of conventional in field test procedures with test rig investigations (comparison between IEC field tests and ground tests)

- Durability test procedures
  - Increase the quality of prediction for the prognosticated durability of components in the overall wind turbine system through the development and refinement of new test procedures

The expected results can be used for the advancement of the present certification processes and to improve extant test procedures leading to improved reliability and potential reductions in test and development costs.