

Multi-Megawatt Nacelle Laboratory Testing

A paradigm for success?

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Abstract

There is a growing interest around the world in laboratory testing of complete Wind Turbine Systems, with the exception of blades. This is corroborated by recent construction of several testing facilities, as those in NREL and Clemson in US, CENER in Spain, NAREC in UK, LORC in Denmark, and the latest Fraunhofer IWES DyNaLab in Germany, commissioned this summer.

Furthermore, the interest in this topic led to the creation last year to the IEA Wind Research Task 35, "full size ground testing for wind turbine and their components", with the objective of developing guidelines and recommendations for test facilities to simulate in-field loads and test them in a laboratory controlled environment, in order to verify the system design, performance, safety and durability.

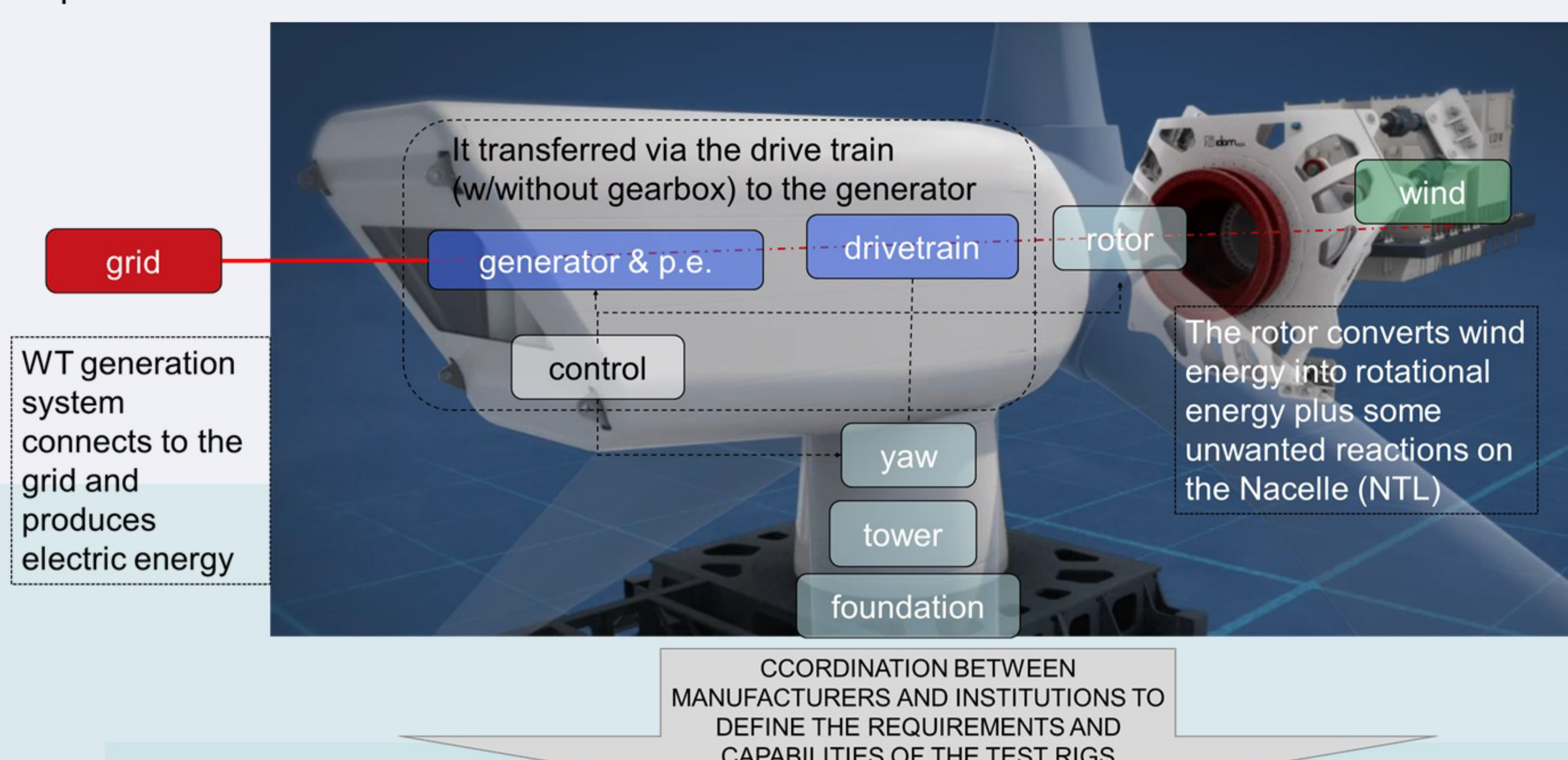
Testing Objectives

The laboratory testing objectives can be diverse:

- Assess wind turbine performance assessment through functional testing
- Prove reliability assurance through endurance tests.
- Develop control strategies through HIL tests
- Business and project risk mitigation through early laboratory testing.
- Electrical certification for different grid codes
- → And why not complete Nacelle certification?

Testing methods and Requirements

SYSTEM TO BE TESTED: Continuous evolution of machine designs and regulations make completely necessary the laboratory testing of machines to reduce reliability and performance problems.



Main functional capabilities:

- Provide-simulate the power input → rotational torque and non torque loads
- Provide-simulate the power output → controlled voltage/frequency sinking source

Additionally :

- Command the DUT
- Data acquisition and recording. (>1000 sensors)
- Supervision of test facility auxiliary system: electrical system, cooling, hydraulic,...

Testing Capabilities:

- drivetrain including gearbox and generator
- non-torque load testing capabilities
- power generation including generator and power electronics
- grid simulation capabilities
- control system testing, including HIL (Hardware in the Loop) capabilities.

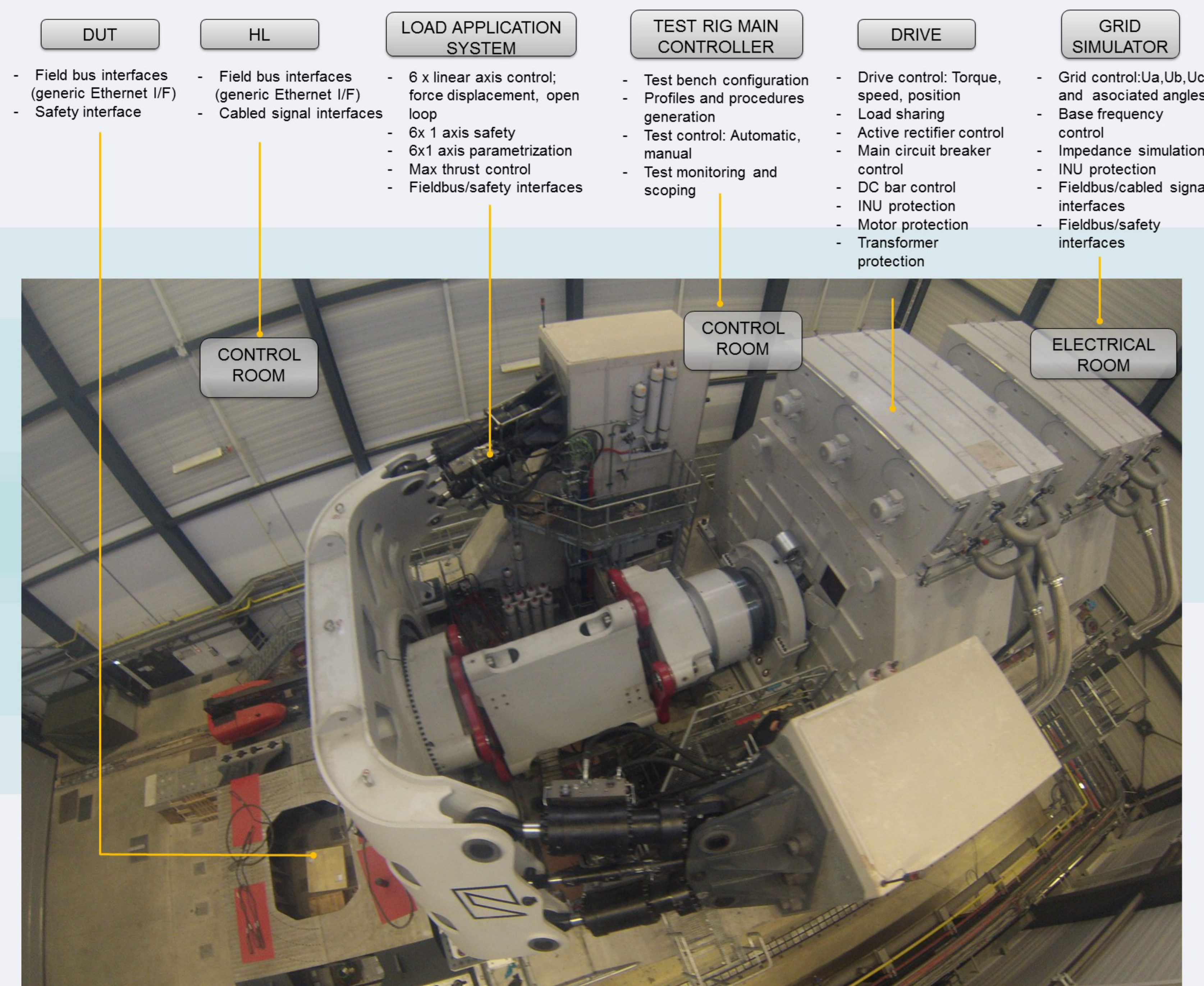
Test Benches Requirements / Inputs:

- ✓ Control on hard Real Time. Coordination of different subsystems.
- ✓ Power Inputs → accuracy, dynamic issues
- ✓ HIL integration capabilities: rotor, pitch, yaw, grid,...
- ✓ DAQ synchronization and mass storage.
- ✓ Safety: personnel and equipment safety. E-stop coordination.

Test Benches Requirements / Outputs (grid connection requirements):

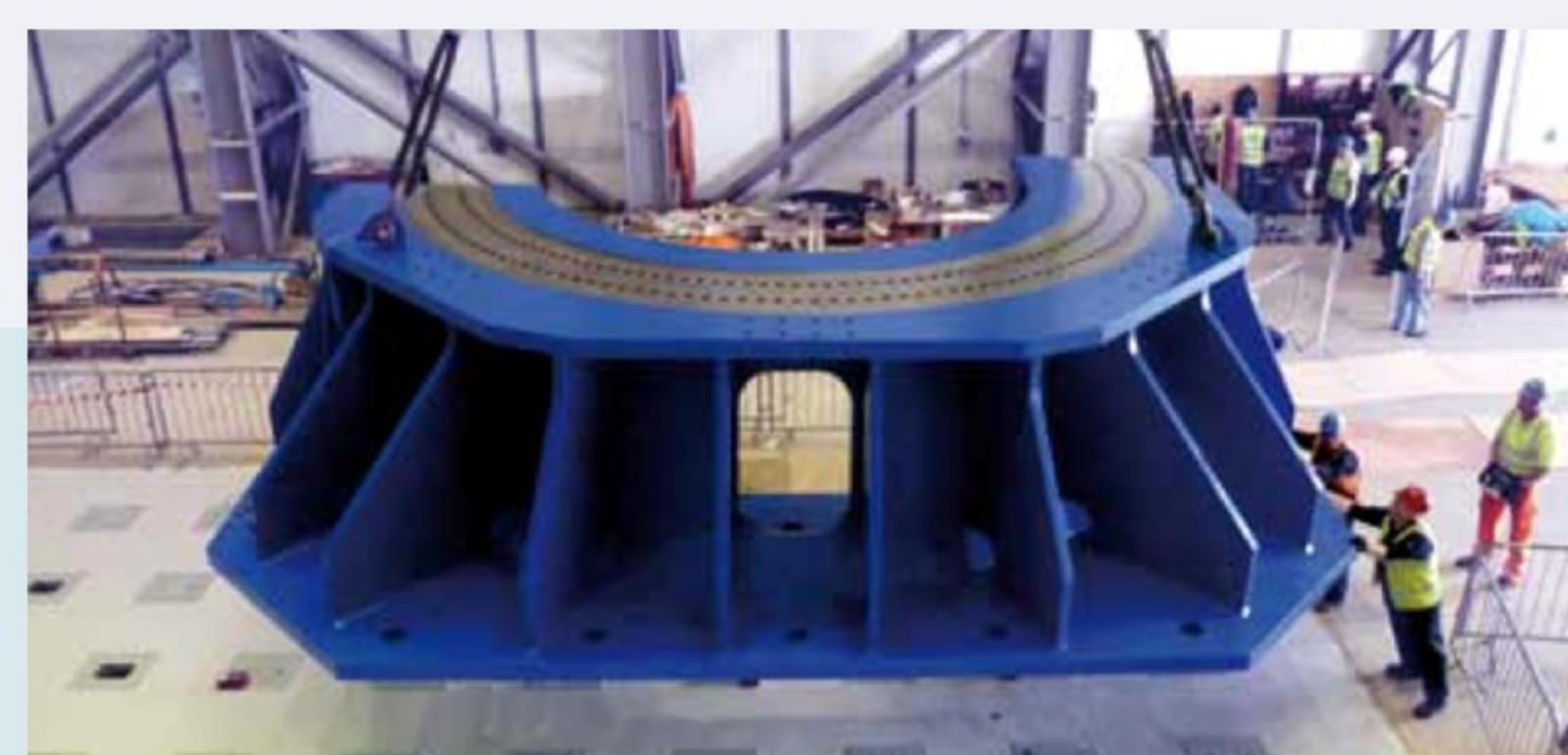
- ✓ LVRT as per different grid codes
- ✓ Voltage and frequency variations, flickers
- ✓ Simulation of Power Plant Grid
- ✓ Stability, low Harmonics
- ✓ Short circuit capability

REAL IMPLEMENTATION: Example of the Fraunhofer IWES Dynalab test rig that includes the following capabilities



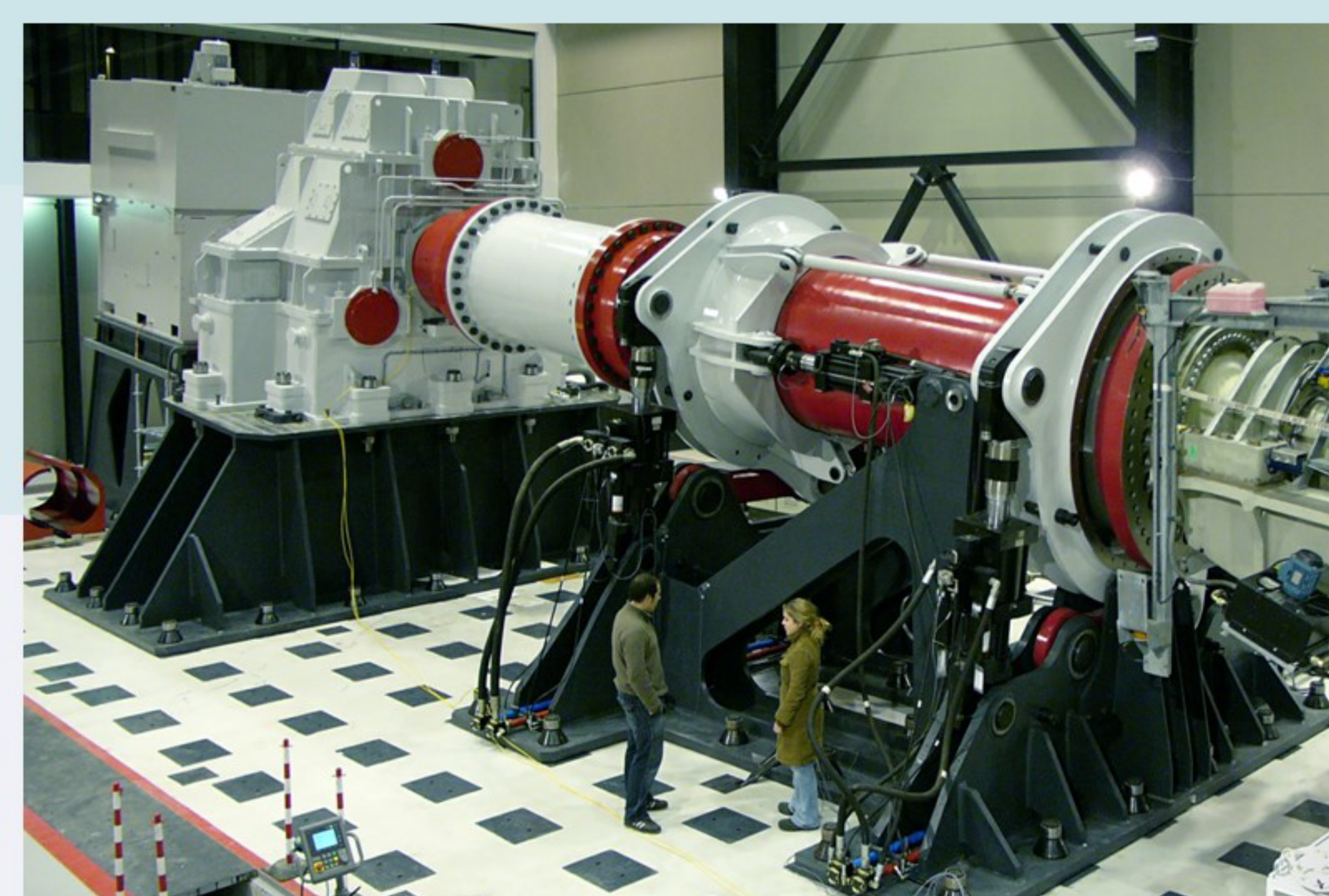
Testing facilities

In the last years, IDOM ADA has directly been involved in projects related to **Large Drive Train Test Facilities**, in particular:



NAREC Fujin Drive Train Test Facility:

Detail design for construction of the strong-floor foundation and machine supports.



CENER Wind Turbine Test Laboratory:

Full design and construction management, including four test rigs (drivetrain, generator, full nacelle, and assembly stand) and the facility including the facility building and auxiliary installations.

Fraunhofer IWES DyNaLab Testing Facility:

Design and construction management the contract to design of the facility building and auxiliary installations. EPC supply of the 10 MW test bench.



Clemson University Restoration Institute Drive Train Test Facility:

Complete design of the facility, test rig foundations, integration services and assistance to construction



Conclusions

Based in our experience on the analysis of different laboratory capabilities, we can conclude:

- The laboratories are progressively implementing testing capabilities lead by wind turbine manufacturers that allow performance testing of new machines and prototypes, but ...
- There exist a need of standardization on the test campaign to be done to a wind turbine, in order to demonstrate its performance and reliability. Output from the IEA Wind Research Task 35, "full size ground testing for wind turbine and their components" will be welcome.
- From here, it will be easy to progress to certification of machines, that would dismiss project risks and improve wind power plant promoters confidence.

