


National Wind Technology Center

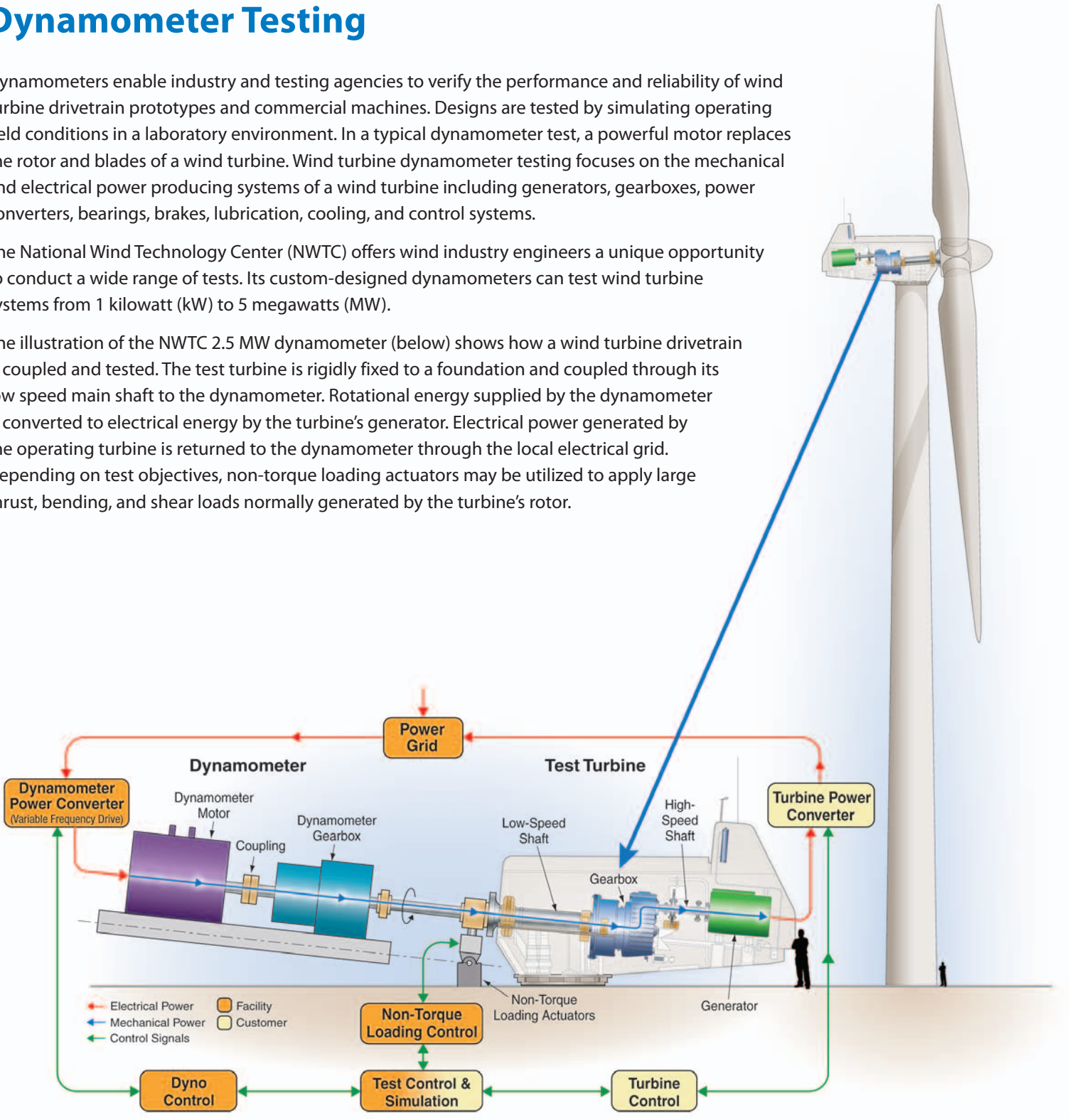
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Dynamometer Testing

Dynamometers enable industry and testing agencies to verify the performance and reliability of wind turbine drivetrain prototypes and commercial machines. Designs are tested by simulating operating field conditions in a laboratory environment. In a typical dynamometer test, a powerful motor replaces the rotor and blades of a wind turbine. Wind turbine dynamometer testing focuses on the mechanical and electrical power producing systems of a wind turbine including generators, gearboxes, power converters, bearings, brakes, lubrication, cooling, and control systems.

The National Wind Technology Center (NWTC) offers wind industry engineers a unique opportunity to conduct a wide range of tests. Its custom-designed dynamometers can test wind turbine systems from 1 kilowatt (kW) to 5 megawatts (MW).

The illustration of the NWTC 2.5 MW dynamometer (below) shows how a wind turbine drivetrain is coupled and tested. The test turbine is rigidly fixed to a foundation and coupled through its low speed main shaft to the dynamometer. Rotational energy supplied by the dynamometer is converted to electrical energy by the turbine's generator. Electrical power generated by the operating turbine is returned to the dynamometer through the local electrical grid. Depending on test objectives, non-torque loading actuators may be utilized to apply large thrust, bending, and shear loads normally generated by the turbine's rotor.



Dynamometer test configuration for a wind turbine drivetrain.

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

NWTC – Dynamometer Facility Specifications

		5.0 MW Dynamometer*	2.5 MW Dynamometer	225 MW Dynamometer
Facility	Test Bay	-20 x 12 m (65 x 40') - Test stand configuration TBD	12.2 x 15.2 x 9 m (40 x 50 x 30 ft) test article area 3.7 x 6.4 m (12 x 21 ft) t-slotted anchor floor 1.74 x 8.77 x 3.13 m (5.7 x 28.75 x 10 ft) direct drive generator pit	2.3 x 4.6 m (7.5 x 15 ft) elevating slotted test article table, can accommodate up to apprx. 8-10 ft diameter test article
	Lifting Capacity	-Dual 68,000 kg (75 ton) overhead cranes -12 m (40 ft) max hook height	-45,000 kg (50 ton) overhead crane -9.14 m (30 ft) maximum hook height	-13,605 kg (15 ton) overhead crane
	Test Article Interconnection	-13.2 kVAC, 60 Hz. -Outdoor pad for customer supplied transformer	-575, 600, 690, and 4160 VAC 60 Hz.	-120, 240 VAC (50 kVA) 60Hz. -480 VAC , 250 kVA max. -0-216 VDC, 20kVA (battery charging simulation)
	Cooling/Heating	-Forced ventilation with outside air -Gas and electric heated test bay, climate controlled control room	-Forced ventilation with outside air -Gas and electric heated test bay, climate controlled control room	-Passive ventilation with outside air -Heated test bay, climate controlled control room
Dynamometer	Prime Mover	-6 MW (8000 HP) AC induction motor -Variable Frequency Drive (VFD) with full regeneration capacity, 350 Hz. torque response -75:1 3-stage gear reducer	-2.5MW (3351 HP) 4160V, 415A AC Induction Motor -Variable Frequency Drive (VFD) with full regeneration capacity, 2 Hz. torque response -71.937:1 3-stage Epicyclic reducer	-225 kW (300 h.p.) variable speed induction motor, variable speed drive, harmonic filter -Rated power achieved @ 1800 rpm, 3600 max rpm. -Mulitple gearboxes
	Rated power and speed to test article	0-12 rpm: torque limited to 4 MN-m 12-24 rpm: power limited to 5 MW	0-16.7 rpm: torque limited to 1.4 MN m 16.7-30.0 rpm: power limited to 2.5 MW	
	Drive Table	5 degree fixed inclination	3.66m (12 ft.) max height @ 0 degree tilt 0-6 degree tilt capacity	Fixed, concrete with steel weldment tables
	Control System	Same as 2.5 MW dynamometer	-Torque and speed control modes -Ramp generation, arbitrary time series, and external command capability -100 Hz. update rate -Custom scripting and programming	-Torque and Speed modes
Non-Torque Loading		Max yaw or pitch moment 13.4 MN-m (120 M in-lb) Max radial force: 1.6 MN Max thrust: 1.4 MN	Radial capacity: 440 kN (100Kip) force, 152 mm (6 in.) stroke x 2 Thrust capacity: 156 kN (35 Kip) force, 254 mm (10 in.) stroke x 2	-na
Data Acquisition		Same as 2.5 MW dynamometer	-500+ channel 24-bit, distributed data acquisition -Standalone power quality condition monitoring systems	-96 channel, 24 bit distributed data acquisition -Standalone power quality monitoring systems

* Specification as of Oct 2010. Some specifications may change prior to completion of this facility in Spring of 2012.

NWTC Dynamometer Test Capabilities

Dynamometers are an effective means by which new designs can be validated because the "wind" input into the turbine can be simulated without waiting for nature-driven events to occur. During steady state, or "static" testing, a series of speed/torque points along the turbine's power curve are imposed by the dynamometer, for a fixed period of time, to evaluate mechanical and electrical performance. Points outside the turbine's normal operating range can be selected to assess response to extreme events or to conduct Highly Accelerated Life Tests (HALT). By intentionally overloading a turbine in a HALT test, a lifetime of wear and tear is applied during a reasonable period of testing. To gain a better understanding of a turbine's mechanical, electrical, and control system response in real world conditions, "model-in-the-loop" techniques are employed to replace the rotor, tower, pitch, and yaw systems with computer simulations operating in real-time. Soon, NWTC test capabilities will be further enhanced with a 5 MW dynamometer and the addition of electrical power grid simulation equipment.

NWTC dynamometer facilities are available for industry users. Contact the NWTC for testing inquiries at 303-384-6900.

2.5 MW prototype turbine undergoing dyno testing.

National Renewable Energy Laboratory

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