

# FL 2500

- Optimal Efficiency
- Optimal Service
- Optimal Grid Performance



Friendly Energy. Friendly World. The Best to Invest.

What started 25 years ago is today a matter of course in more and more countries: Renewable forms of energy play an ever increasing role in the energy mix. And Fuhrländer is a pioneer in the use of the wind energy in Germany and a driving force in its development:



## Open to new ideas, flexible in execution.

We are one of the few independent manufacturers world-wide. That is the basis for a flexible and customer-oriented company policy. Creative engineering spirit and expert knowledge and skills come together to develop wind power projects of all sizes – from individual turbines up to turn-key multi-megawatt wind parks.

## Strong locally, secure into the future.

We prove that there is far more to wind energy than environmentally friendly energy production and security of supply. With wind energy we create secure jobs and apprenticeships around the globe and thereby provide a future for people. Friendly Energy – a new wind blows partnership and fairness throughout the world.





# FL 2500

## More wind energy, less cost

The FL 2500 2.5 MW system sets a new standard: With rotor sizes of 90, 100 and 104 m the FL 2500 can be optimally adapted to all site conditions and wind zones. 85 and 100 m tubular steel towers as well as lattice towers up to 160 m hub height provide the bases for the economic development of inland and coastal regions. For example, the high hub height predestines the FL 2500 even for use in forest areas. Of course, the FL 2500 meets the latest grid connection requirements and is therefore compatible with international power grids.

The unique drive unit concept with its large rotor bearing, the shaft coupling and the compact gearbox provides for even more safety and longer service life. That is also valid for the specially designed hub with its enclosed service area. With its service crane concept the FL 2500 facilitates the replacement of all main components without the need for an expensive mobile crane – greatly reducing the time and expense of repairs.





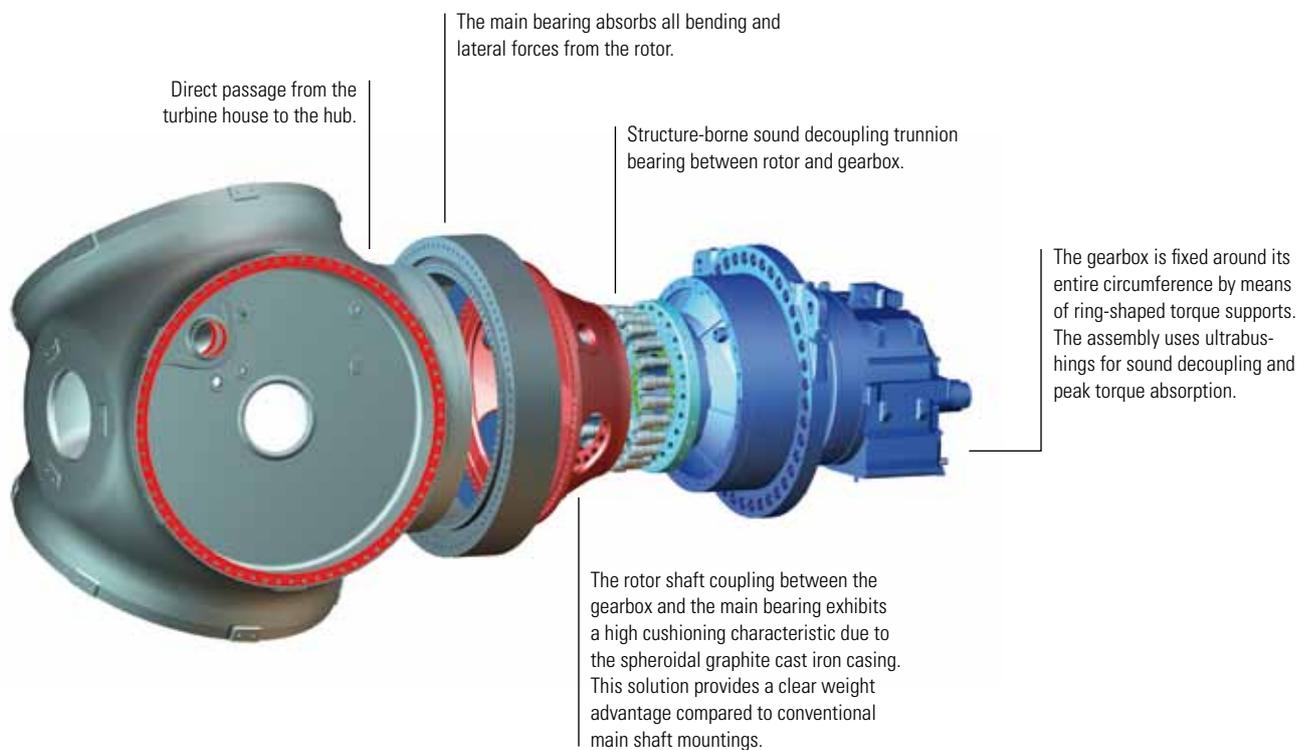
## Elastomer Elements. Innovative coupling between rotor and gearbox.

The rotor bearing is a triple row roller bearing optimally designed for the prevailing load conditions. The shaft coupling to the flange ring of the gearbox is provided by 24 elastomer elements. It provides good structure-borne noise isolation while also absorbing drive train impacts. In endurance tests the elastic elements have reached a twelvefold service life without incurring any damage. If necessary, they can be very easily replaced.

# The Compact Drive Train. Unique drive train concept for quieter running.

The FL 2500's unique drive train concept has many objectives: It allows for a smaller and quieter system. Instead of a heavy main shaft, a new hardened slip less rotor bearing is used between rotor hub and machine carrier. Cross and thrust forces of the rotor are directly transferred over the strengthened machine carrier to the tower and do not load the gearbox bearing. This positively affects the service life of the gearbox. Rotor torque is transferred over a shaft coupling (weighing about 1.9 tons) to the gearbox.

The complete 360° bolting of the gearbox to the machine carrier provides optimal torque support at its centre of gravity. This torsional resistant design minimizes the misalignment of the gearbox under extreme loads, such as strong gusts of wind. The reaction forces on the generator coupling and bearing are also reduced. This also allows service personnel to access the hub without leaving the turbine house – the turbine house and hub form a single air-conditioned service room.





World record: 160 meter hub height



# Intelligent System. For even more operational safety.

## Pitch System

The pitch system of the FL 2500 uses an intelligent control method to reduce the typical peak load-producing windward-tipping of the tower head that occurs during quick, positive blade adjustment processes. The process also reduces the stress produced during braking procedures and during reaction to gusts. The "Pitch Logic Unit" (PLU) located in the hub allows early detection of overspeed situations as well as avoiding high turbine thrusts. All pitch functions are combined in the PLU. Adaptation to different bus systems is possible. A few simple interfaces lead to robust standard industrial units. Capacitors guarantee a highly available, durable and maintenance-free backup over a wide range of temperatures. In contrast to standard systems brake choppers or connecting units are required. The very good energy weight ratio permits high safety and availability in the event of power failure.

## Safety System

The FL 2500 offers a new type of safety system that already meets the requirements of the European Machine Directive and Germanischer Lloyd (GL) specifications. For the first time the safety concept was designed on the basis of a risk analysis in order to increase the safety of both personnel and system. The design meets category 3 of the European Machine Directive.

The safety system reacts selectively to equipment and signal triggering such as emergency off, vibration switch, performance and speed limit relays, overload protection, switched wiring, pitch system and operational defects, transformer and fire protection.

An event-driven, differentiated triggering at the actuator level reduces the stresses and torques of extreme loads, which results in significantly lower mechanical wear of assemblies such as brakes and gearbox. This provides a longer service life as well as cost savings.

## Condition Monitoring System

The FL 2500 is equipped with a sophisticated Condition Monitoring System. The acceleration values of the components are recorded and evaluated by means of broadband audible sensors on the rotor bearing, gearbox and generator. This provides for comprehensive system monitoring.

# Technical Features. Trend-setting Engineering.

## Plug & Play

All cables in the FL 2500 are designed as tested final assemblies and fitted with high quality industrial connectors. The result is less assembly work and greater operational safety. Since the manufacturer tests control boxes, internal cables and units up to the interface, the failure rate during installation is reduced to almost zero.

## Service Crane Concept

Another trend-setting idea: Using the slewing crane in the turbine house and the large floor opening, a mobile service crane can be lifted and set on the system's integrated crane crossmember. With 25 tons of load-carrying capacity, the service crane can reliably lift major components such as rotor, gearbox or generator. Thus the operator can do without expensive mobile cranes and shorten repair times. The result: lower insurance premiums and less lost income.

$v_{\text{wind}}$ [m/s]	Power Rating 90 m rotor* [kW]	Power Rating 100 m rotor** [kW]	Power Rating 104 m rotor* [kW]
4	38	81	85
5	160	229	240
6	333	439	460
7	559	712	760
8	869	1103	1160
9	1260	1552	1650
10	1678	2036	2140
11	2114	2355	2443
12	2412	2462	2500
13	2500	2501	2500
14	2500	2500	2500
15	2500	2514	2500

\* Theoretical Power Curve

\*\* Power curve measured in accordance with IEC 61400-12-1

# Technische Daten

## Rotor

Diameter	90/100/104 m
Surface area	6.362/7.854/8.495 qm
Number of blades	3
Speed	10.4-18.1/9.4-17.1 min.
Power regulation	converter
Windklasse	IEC 2a/2/3a

## Gearbox

Design	comb. spur/planet gear
Stages	3
Gear ratio	1:72.3/1:79.6

## Generator

Design	Dubble fed asynchronous with slip-ring rotors
Speed	750-1,310 min <sup>-1</sup> (50 Hz), 900-1,570 min <sup>-1</sup> (60Hz)
Voltage	690 V (50/60 Hz)
Converter system	static inverter with intermediate DC circuit

## Power

Rated output	2,500 kW at 12/13.0 m/s
Start wind	3.5-4.0 m/s
Stop wind	25 m/s
Survival wind	59.5/52.5 m/s

## Tower

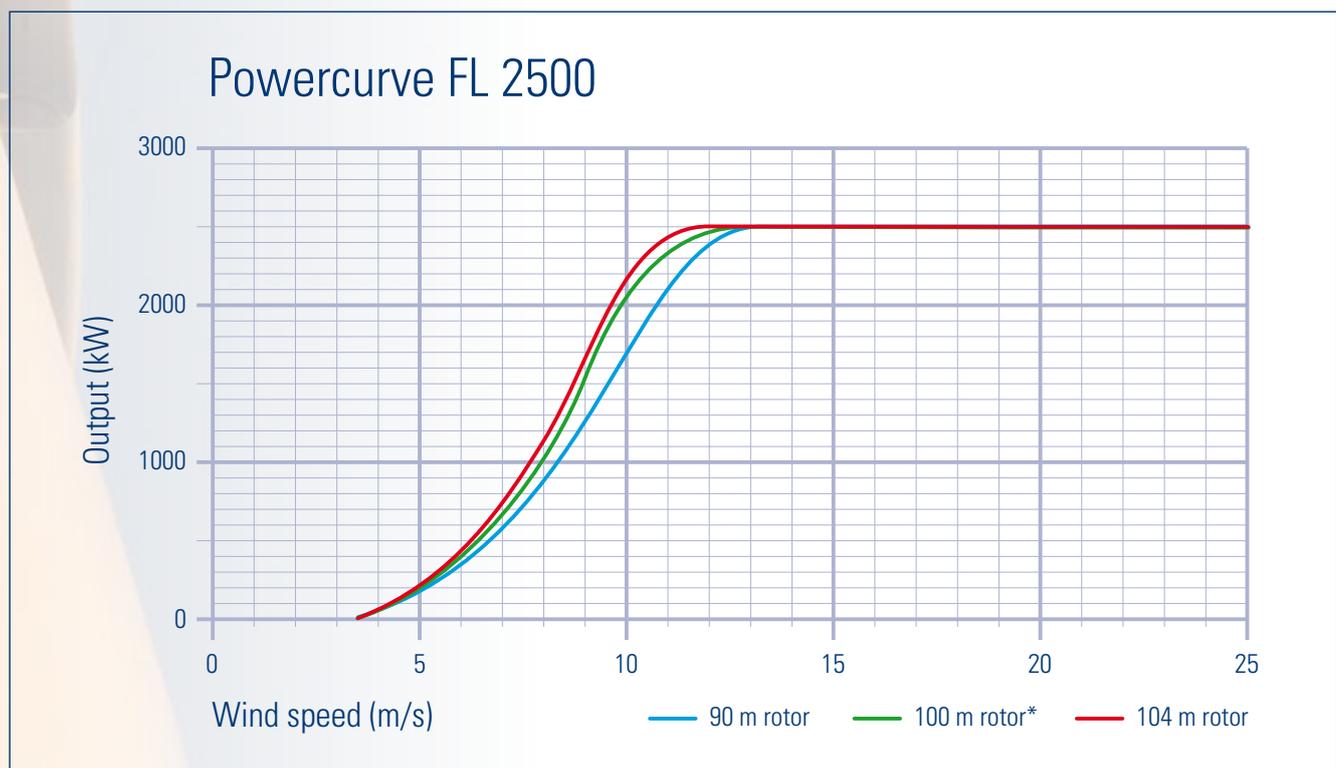
Hub height	85/100/117*/141*/160* m
Design	conical tubular tower, lattice tower*

## Weights

Rotor	50,000/52,000 kg
Nacelle	96,000 kg
Tower	170,000-350,000 kg

## Control

Speed regulation	electronic pitch system
Yawing control	4 gear motors
Main brake	triple independent pitch system
2nd brake system	hydraulic disk brakes
Monitoring	fixed network/radio/Vabera



\* Power curve measured in accordance with IEC 61400-12-1



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