System and Technology Expertise

Solutions for Wind Energy
A strong partner for the wind industry
As a strong partner for the wind industry, Liebherr offers the ideal solution for various requirements ranging from individual components used for turbines to excavators, concrete technology, mobile cranes, tower cranes and offshore cranes used not only to erect turbines but to construct entire wind farms. Liebherr works together with virtually all well-known turbine manufacturers and to date has supplied components for thousands of wind turbines. The product portfolio covers components for 800 kW installations up to solutions for multi-megawatt turbines for offshore wind farms.

Advantages

Liebherr is the only manufacturer worldwide who is not only able to supply individual components such as slewing bearings, slewing drives, electric motors, hydraulic cylinders and frequency converter systems but is also able to supply hydraulic and electromechanical pitch systems and electromechanical yaw systems for wind turbines. With a global footprint, Liebherr is furthermore able to support in assembly-line setups where local content requirements are specified or simply due to cost advantages. An important element of the cooperation with customers from all over the world is the applied application-specific engineering necessary for adapting and matching the individual components to each other.

**Wide product range**
Slewing bearings, drives, electric motors, hydraulic cylinders and frequency converter systems – everything from one source

**System mindset and know-how**
One system - one contact
Wide product range

Pitch systems
- Well-engineered mechanical systems for rotor blade adjustment produced by Liebherr
- Precise positioning of rotor blades for maximum energy yield

Electric pitch systems
Pitch system based on 3-4 stage planetary gearboxes with electric motor, which drives a geared slewing bearing

Hydraulic pitch systems
All-in-one solution based on hydraulic cylinders, hydraulic power unit, hydraulic manifolds, control system as well as accumulators and gearless slewing bearing for adjusting the rotor blade position.
**Yaw systems**
- Depending on the specific system design, comprising of up to twelve or more high-performance planetary gearboxes which drive a slewing bearing
- Alignment and supply of entire system, including electric motors, by Liebherr
- Various bearing and ring designs

**Frequency converter system**
- Liquid cooled full-scale converter
- High power density
- Completely closed converter cabinets
- Maximum safety, durability and efficiency

**Main bearing**
- Moment bearings for 2MW turbines and upwards
- Validated on internal test rig
- Design types: Double-row tapered roller bearings or triple-row roller bearings
Slewing bearings

Liebherr slewing bearings for wind turbines are used in rotor blade and yaw adjustment as well as in the main bearing of the rotor. Our solutions for these applications are diverse: **Double-row four-point bearings, triple-row roller bearings, tapered roller bearings and geared rings.**

Liebherr is your development partner for all bearings. Through continuous development and expansion of our portfolio, we are the leading manufacturer of the latest generation of blade bearings with regard to roller bearings. In order to meet our high quality standards, bearings by Liebherr are validated through life time tests on both internally and externally test benches and by field tests.
Application expertise and diversity

Bearing designs for wind turbines:

- **Single-row and double-row four-point bearings**
  for blade and yaw bearings

- **Triple-row roller bearings**
  for blade, yaw and main bearings

- **Gear rings**
  for yaw adjustment

- **Double-row tapered roller bearing**
  for main bearings
The future of the blade bearing
Wind turbines are growing steadily in an effort to attain higher energy yields. The options of adapting existing designs to the growing dimensions and more demanding load profiles are limited, however – particularly in regard to rotor blade bearings. Therefore, in addition to the current single-row and double-row four-point bearings, Liebherr now also offers triple-row roller bearings for pitch systems. This highly increases the potential in terms of dimensioning and load capacity.

**Option 1**
Reduced blade root diameter with consistent blade length

**Option 2**
Longer blades with same bolt diameter
Main bearings

Main bearings by Liebherr
Based on 30 years of experience in the wind sector, Liebherr offers main bearings for wind turbines ranging from 2MW and upwards.

- Optimized sealing systems
- Oil- and grease-lubricated version

In-house main bearing test bench
- Max. bending moment: 8,000 kNm
- Max. radial force: 2,000 kNm

- Optimized regarding cost and function
- Double-row tapered roller bearings
- Triple-row roller bearings
- Optimized sealing system for continuously turning bearings
Reliability and precise positioning are the crucial factors for the rotor blade and yaw adjustment drives. Liebherr offers multistage planetary gearboxes for the rotor blade adjustment. If required by the installation constrains, they can also be fitted with an angled increment. Three- to four-stage planetary gearboxes are usually used for yaw adjustment. Up to twelve or more yaw drives per yaw system are installed to transmit the high torques encountered in wind turbines in the multi-megawatt class.
High power density under high dynamic loads

Reliability and availability
Yaw adjustment and pitch drives are based on tried-and-tested technology. Their high reliability and availability are the result of a variety of intelligent design solutions, such as special sealing concepts, corrosion protection systems, as well as optimised anti-friction bearings and gearing.

Optimum use of installation space
The integral design of Liebherr gearboxes allow compact shapes and an optimum power to weight ratio.

High-quality design
Liebherr planetary gearboxes boast a very high-quality design. For instance, the planetary supports are forged and the case-hardened output pinions have ground involute gearing. Meshing errors are also avoided with a very rigid mounting of the one-piece output shaft.

Compatible electric motors
As a system supplier, Liebherr offers electric motors with power between 1.1 and 11 kW for the gearboxes. The larger motors from 11 kW are developed and also produced by Liebherr.

Pitch drives
A distinction is made between the three main designs: With short output shaft, with long output shaft or alternatively as bevel gear.

Yaw drives
The high-performance yaw drives are also designed with short or long output shafts.

Direct lubrication

The integrated lubrication system
Due to small oscillations of the rotor blade angle and a resulting displacement of the lubrication at the tooth engagement there can be a high wear of 0° tooth pairs. With the implementation of an integrated solution, the integrated lubrication system inside the gear pinion however, the 0° tooth engagement is optimally lubricated without the need of a lubrication run.
Liebherr has developed the liquid-cooled Liduro power electronic modules especially for reliable operation, for harsh environmental conditions in onshore and offshore wind turbines. The power electronic modules are installed in completely closed cabinet units. Together with the coordinated additional components, they form an extremely reliable converter system and reveal a very wide performance range in the smallest footprint. The newly developed and unique Liduro Fast Protection System not only provides operating safety, but also increases the availability of the system in total. In addition, a highly efficient integrated cooling system enables maximum energy conversion with maximum service life of all components. The system is virtually maintenance-free. As for placement, it can be installed both in the nacelle and at the tower base - in-line or back-to-back.
Highest power density with small installation volume

Efficiency and service life
Selected components optimized for operation of the converter system achieve a very high efficiency at maximum power. The liquid cooling allows for very high performance at low power consumption per installation volume. Since there are no fans needed for cooling the converter cabinet, the converter systems are fully self contained, so they are almost maintenance free and low noise. Door fans and filter mats do not have to be changed, as is usually the case with air-cooled systems. This makes an operation, both, at very high and low ambient temperatures possible. Also dust, oily air or humidity cannot penetrate the cabinets. Corrosion and high temperature load changes are avoided. This increases the service life of the converters. Power enhancements without changing the size of the cabinet are possible by a simple exchange of internal components. This reduces the development effort for the different wind turbine types.

Safety and quality
The control and protection system monitors all processes inside and outside the frequency converter system with high precision and reacts to unforeseen errors within a few milliseconds. This isolates possible sources of error as quickly as possible and prevents damage to plant components or persons. The integrated condition monitoring also offers reliable component analysis and information for wind turbine operators before the protection systems are triggered. The reliable components enable for wind turbines a long service life with as low maintenance as possible. Selective main filters allow operation even at weak grids. Finally, the operating status of the system can be proved and analyzed via remote diagnosis on a regular basis.

Highly efficient
The liquid cooling system is a special developed system, to achieve maximum lifetime and smallest installation room.

Intelligent control
The custom developed control system enables fast, precise control processes and reliable protective functions.

High durability
All components of the system are subjected to extensive test and quality assurance procedures.
Hydraulic cylinders

- Flexible and low-maintenance construction concepts
- Dynamic calculation and simulation techniques
- State-of-the-art assembly and painting facilities

Since 1958, the Liebherr Group has been developing and producing hydraulic cylinders at the main site in Kirchdorf an der Iller. The product portfolio ranges from highly durable hydraulic cylinders for dynamic applications, large heavy-duty cylinders and suspensions to lightweight and special cylinders. Liebherr benefits from its vast experience also in the development of cylinders for wind turbines.
Precise and reliable work under demanding conditions

**Longlife and high availability**
Liebherr hydraulic cylinders achieve maximum efficiency in non-stop operation thanks to a flexible design which is adapted to the respective application - for example as a tie rod cylinder. The sealing systems are designed to withstand continuous vibrations and high-frequency short stroke operations with low friction and are leak-free. Liebherr cylinders are suitable for both onshore and offshore applications. There is a wide range of special piston rod coatings and cylinder paintings available for optimal corrosion protection.

**Development and quality**
State-of-the-art analysis and simulation methods are used during the development stage. These methods provide information about the material behaviour and the vibration resistance in realistic operating conditions, thus allowing the right material and sealing to be selected. In order to demonstrate the service life of several decades, hydraulic cylinders for wind turbines are subject to high-speed endurance tests at special test benches. State-of-the-art assembly and painting equipment with a high degree of automation also ensure process stability at all times and the ability to react flexibly to changes in customer requirements. Furthermore, Liebherr meets its own high quality requirements through continuous material testing, as well as continuous process monitoring. The acceptance of hydraulic cylinders is possible through various classification bodies, for example the DNV Type Approval.

**From the individual product to the complete system**
In addition to the individual hydraulic cylinders, Liebherr also offers its customers complete hydraulic systems from a single source. Customised hydraulic power units and piston accumulator systems are developed and produced in-house for this purpose. Matching control and valve units round off the range as a system supplier.

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**Designed to suit the requirements**
Customer-specific and flexible design concepts allow worldwide availability and service.

**Low-maintenance design**
Already in the development phase, the components are designed for minimum maintenance and the simplest service conditions in use.

**Various design options**
The cylinders can also be optionally equipped with various sensors, cushionings as well as specific interfaces and hydraulic connections.
System mindset and know-how

- Modularization based on standard components
- Wide range of configuration options
- Optimized value chain - more flexibility

Flexibility on a new level: The yaw module concept is one example how to enable application-specific, cost-optimized modularization based on standard products without geometric restrictions. Hub and nacelle assemblies could also be optimized based on a sub-system approach. How could your company benefit from sub-system approach from Liebherr?
The sub-system approach

The implementation of a sub-system as a ready-to-install module enables processes to be simplified and resource locations to be optimized along the entire value chain.

**Specification**

Current process

Sub-system approach

**Legend**

- Responsibility OEM
- Responsibility Liebherr
- Control
- Information flow
- Product transfer

**Parts management**

Module management instead of individual management for each integrated component.

**Assembly**

- No specific production line required
- Functionality test is performed by Liebherr
- The module is delivered on site, ready for installation

**Commissioning**

- Easy access for service work
- One system - one contact
A strong partner for the wind industry

Liebherr has one of the most diverse portfolios of all suppliers for the wind turbine industry. From the gear cutting machine by which the demanding blade and yaw bearings are machined, to the onshore and offshore cranes, excavators and concrete mixers used during construction of wind farms. Liebherr is a reliable partner for the wind industry at all times.

**Liebherr concrete mixing plants**

Liebherr concrete mixing plants ensure that the required concrete for tower elements and foundation for modern wind power plants is available in high quality.

**Tower cranes**

For the construction of wind turbines with hub heights above 110 m in low wind areas, Liebherr has developed special tower cranes.

**Mobile cranes**

For ever more powerful systems and increasingly taller towers Liebherr develops performance-optimized mobile cranes and jib systems for particularly high loads.
Mobile harbour and ship cranes
Mobile harbour and ship cranes by Liebherr transport and load heavy wind power components e.g. onto ships, jack-up vessels, low loaders or freight wagons.

Gearing cutting and automation solutions
Slewing bearings for rotor blade and yaw adjustment are manufactured on high-precision Liebherr gear machines. With automation systems by Liebherr, rotor blades can be processed economically.

Crawler cranes
Liebherr offers crawler cranes in different performance classes, which are used in the construction of wind power plants.

Key components for wind turbines
With slewing bearings, drives, electric motors, hydraulic cylinders and frequency converter systems Liebherr supplies the entire product range for the electromechanical and hydraulic blade and yaw adjustment in wind turbines. In addition, Liebherr now supplies main bearings and full frequency converter systems for 2MW turbines and upwards.
From A to Z – the components division of the Liebherr Group offers a broad range of solutions in the area of mechanical, hydraulic, electric and electronic drive system and control technology. The efficient components and systems are produced at a total of ten production sites around the world to the highest standards of quality. Central contact persons for all product lines are available to our customers at Liebherr-Components AG and the regional sales and distribution branches.

Liebherr is your partner for joint success: from the product idea to development, manufacture and commissioning right through to customer service solutions like remanufacturing.

components.liebherr.com