



Offshore Windpower **M5000**

Efficient. Reliable. Powerful.

MULTIBRID


AREVA

The future has **already begun with us.**

The wind energy of tomorrow will be generated on open seas. The development of high-performance offshore plants is the challenge for the industry. AREVA Multibrid has risen to that challenge – with the M5000



Company

Since 2000 Multibrid has been developing, planning and producing the M5000, the first 5MW wind energy converter designed exclusively for large-scale offshore wind parks. Highly qualified technicians - specialists from all areas of the wind energy sector – are working hand in hand with component suppliers. This expertise combined with many years of experience results in a powerful competitive edge, both in knowledge and technical know-how, which is consistently realized in production, startup, service and maintenance.

AREVA Multibrid's choice of location also shows consistency, with the development and manufacturing taking place directly at Bremerhaven's quayside. From a logistics point of view this location is ideal for shipping the M5000 out

directly to the offshore wind farms.

As a subsidiary of the French group AREVA and the German PROKON Nord Group, AREVA Multibrid is able to draw on substantiated experience in global energy production and the realization of wind-farm projects.

Production

The production of the M5000 aims for maximum practicability: its erection at the offshore site requires the minimum number of assembly steps. A team of experienced technicians assembles the individual components of the M5000 at a modern production facility in Bremerhaven.



+ Our turbines are complete when leaving the quayside



AREVA Multibrid strives for efficient production processes which are designed for modular manufacturing. This form of production enables highly efficient simultaneous manufacturing of sub-assemblies at specialised preassembly points. The cost and time required to finally assemble the nacelle and power electronics at sea are kept to a minimum. This process guarantees the best possible quality control and ensures that all pre-delivery system controls can be carried out to an optimum. Delivery can then be implemented via a heavy-load terminal adjacent to the production hall.

Furthermore, the finished systems have already been thoroughly tested before they leave the assembly halls.

This ensures the consistently high standard of quality which AREVA Multibrid values so highly.

Manufacturing of the M5000 is divided into separate areas. The tower or S3 section above the foundation is equipped by a specialised team. Specialised personnel is also needed to implement the innovations which are integrated in the 5 MW capacity wind turbine. Each major component of

the M5000 was especially developed for offshore use in collaboration with the component suppliers. The M5000 components designed for conditions at sea are manufactured with extreme precision. Measurements and load tests are integrated into the work flow which was shortened substantially thanks to good teamwork between engineers and production workers.

The processes described and an expansion of production capabilities enables AREVA Multibrid to manufacture increasing numbers of the 5 MW wind power turbine.

The Concept

The AREVA Multibrid M5000 combines everything that makes a high quality offshore wind energy Plant stand out: reliability, efficiency and high performance. its technology is tried and tested and perfectly tailored to the conditions on the open sea.



»» Lightweight

The M5000 is a lightweight despite its output of 5MW. The nacelle and rotor together weigh only about 349 tons. This relatively low weight facilitates the transport and erection of the plant; a crucial factor when working on the open sea. The nacelle is assembled on land by qualified technicians from AREVA Multibrid, so that it can be lifted offshore onto the tower as a complete unit. This saves time and costs and guarantees a high degree of safety. Especially, however, the reduced weight of the nacelle allows cost-effective tower and foundation structures.

»» Compact

Compact with concept. The M5000 is a space-saving miracle harbouring extensive technology in the smallest space. The specific configuration of the technical components in the relatively small nacelle is the result of extensive studies on conventional plants. Its compact design is made possible by the intelligent integration of the rotor bearing, gearbox and generator, thus dispensing with the need for housings for plant components. The small plant dimensions lead to short paths for load transmission to the tower head – ideal for offshore wind energy plants.

+ The AREVA Multibrid M5000 is manufactured and certified according to the latest international standards (DIN ISO 9001 certificate)



>>> Reliable

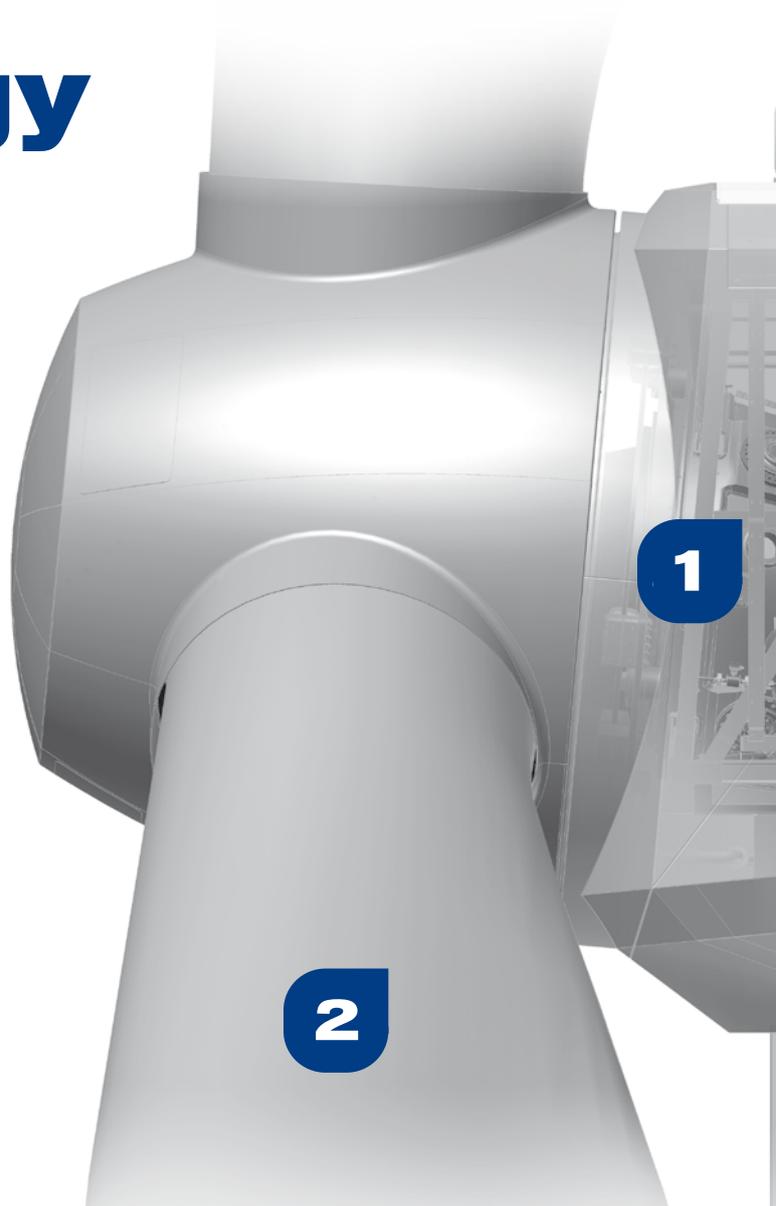
As reliability is such a decisive factor for the plant efficiency of large wind energy converters, this has been a top priority right from the very beginning. The low rotational speed and the low number of rotating parts and roller bearings reduce the risk of damage to the central drive train of the M5000 to a minimum. In addition, all key auxiliary aggregates and sensors are installed in duplicate, so that their failure does not lead to a complete standstill. A special system permanently monitors the status of key components and reliably reports any irregularity. This makes maintenance work easier to plan and thus doubly efficient.

>>> Protected

Protecting the turbine's equipment from the corrosive marine atmosphere is vital to ensure the long service life of offshore wind energy plants. The M5000 is therefore equipped with a patented air treatment system to protect the plant technology. It sucks in the surrounding air and filters out the corrosive particles. An overpressure is created which encloses the entire system, thus protecting it from corrosive external influences. Thanks to AREVA Multibrid's sophisticated technology, neither salt nor moisture can damage the M5000.

Innovative Technology

Experience gained from conventional energy plant types taken up by AREVA Multibrid and developed into an innovative offshore technology, which second to none.



1



Rotor bearing/gearbox

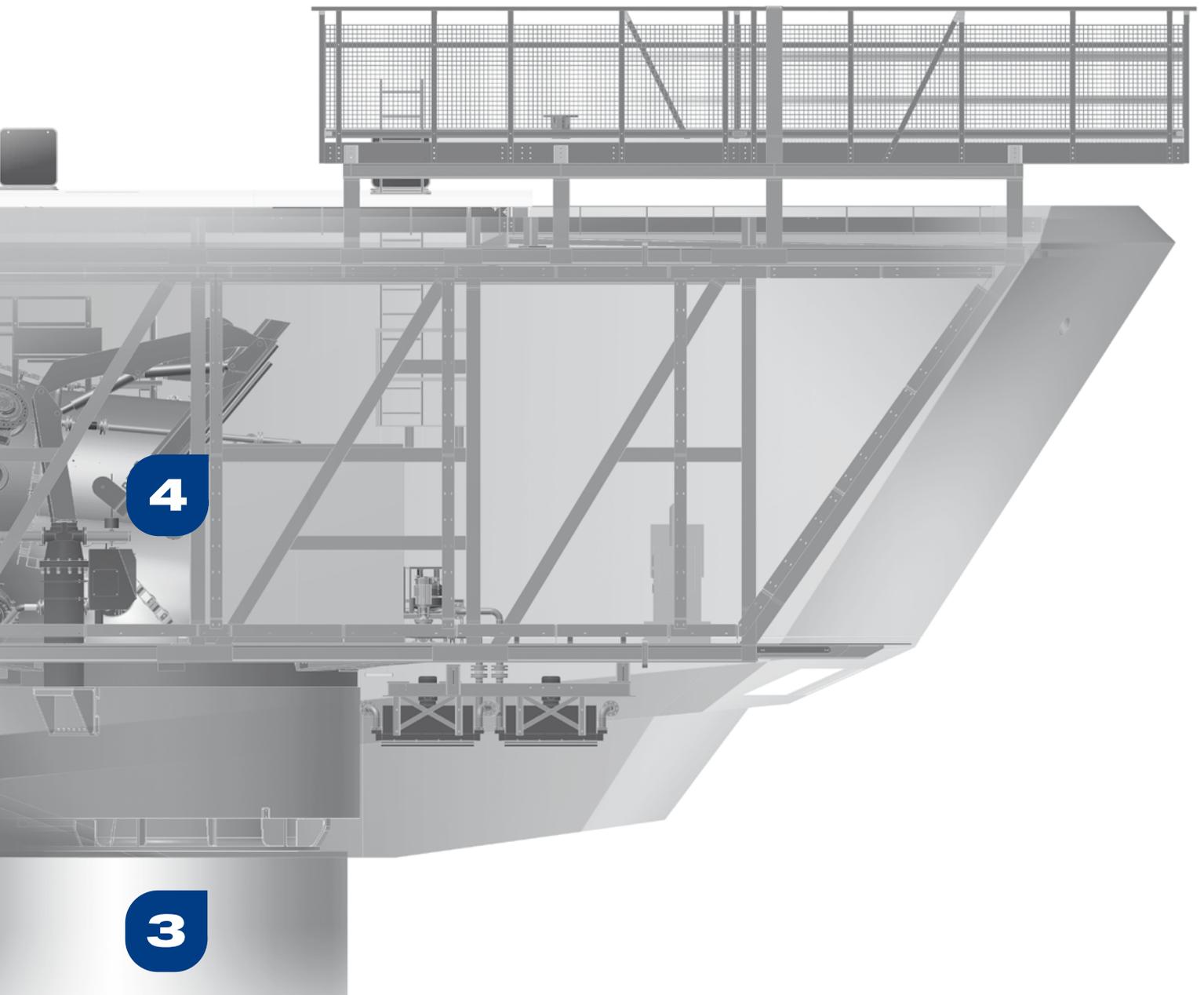
A double-tapered roller-bearing connects the rotor with the machine housing. The geometric assembly of the rotor bearing and gearbox is such that the dynamic rotor loads can not have a harmful impact on the gear meshing. The helical planetary gear train ensures the optimal lubrication of all shafts and wheels. Independently of this, the gearbox permanently supplies the rotor bearing with oil.

2



Rotor

The load-bearing elements of the M5000 rotor blades are made of carbon fibre. This ensures an exceptionally high stiffness at a low weight. The special aerodynamics of the rotor blades guarantee a high yield performance and lowers noise emission considerably. Three independent electrical blade pitch systems ensure a highly dynamic blade angle adjustment and maximum safety in case of failure. The blade pitch system is completely incorporated inside the closed rotor hub, and thus optimally protected against all weather influences.



3



Air treatment

The M5000 is equipped with an air treatment facility at the point of entry to the wind energy plant. It sucks in external air which is then cleansed in several stages from particles of salt and moisture. The cleansing principle is based on the deposition of water particles due to inertia forces. The treated air is then blown into the tower and ensures that no salty ambient air can intrude into the wind energy plant.

4



Generator/converter

The permanent magnet synchronous generator is directly installed in the machine housing. As the rotor of the generator rotor is mounted on the output shaft of the gearbox it needs no own bearings. In combination with the frequency converter the permanent magnet technology achieves a maximum rotation speed range resulting in an ideal electrical and aerodynamic efficiency rate. The generator is connected to the grid via a 4Q converter, which allows maximum speed variability and compliance with all grid directives.

Service and maintenance

We offer wind park operators the supervision of their energy plants they require. Our goal is to facilitate the long-term scheduling of service and maintenance work at sea and to combine and make it more effective. At the same time, we can offer optimal control of the M5000 using appropriate hardware, sensor and visualisation concepts.



» Offshore Service Challenge

Accessibility of an offshore wind park is heavily dependent on the weather. This is why the Multibrid M5000 technology is especially designed for long periods between maintenance. A high quality monitoring system guarantees permanent turbine control. This ensures reliable monitoring that the M5000 is operating. Moreover, integrated condition monitoring permits a precise analysis of the turbine components at all times. Therefore, maintenance and service work on the high sea can be planned long term and combined to make the work effective. The turbine auto-responds if weather conditions do not permit servicing. If required, the

system appropriately connects the components which exist in duplicate. The M5000 carries on operating reliably.

» Online CMS

The M5000 was especially designed for offshore projects. The turbine is therefore equipped with two kinds of online condition monitoring systems, ensuring its reliable and safe operation. Extended and unpredictable down times can therefore be prevented. The online Condition Monitoring System (CMS) for the entire drive train from rotor bearing, via generator and gearbox, is especially adjusted to the low rotary speed of the M5000.



+ Service and maintenance under the specific offshore conditions

A long blade service life is crucial for the economic viability of the M5000, that is why it is equipped with an additional rotor blade monitoring system. Detecting damage at an early stage permits working out longer term replacement scheduling.

MULTIVIS

To ensure highest levels of availability, the M5000 is equipped with a control system developed in-house called MULTIVIS (Multibruid visualisation). The system guarantees prompt and direct access to turbine control and all components which is essential for operation. Therefore, in addition to temperatures, flow and switching rate, parameters and component condition can also be monitored. A major proportion of the error detection and status identification codes that occur can already be rectified online using MULTIVIS.



24/7 – A lot of the error detection and status identification codes that occur can already be rectified online using MULTIVIS. If this is not possible, our service team will come and remedy the fault.

Our service technicians are especially trained for the components integrated in the M5000 and are constantly kept up to date. A high quality and safety standard in service provision is high priority, whether it is commissioning, maintenance or repair work. Helicopters and ships are routinely deployed to ensure that the turbines are reached fast and efficiently.

Alpha Ventus **Offshore project**

A vision becomes reality. Areva Multibrid has set up six Multibrid M5000 wind generators in record time. They are situated at a depth of 30 metres in the first German offshore test field about 45 kilometres from the island of Borkum. As the general contractor, Bremerhaven's wind turbine manufacturer is proud to have installed its turbines with 5 megawatt generating potential, towers, foundation structures and rotor stars. All of these were designed for offshore use from the outset.



+ The choice of foundation structure for the Multibrid M5000, depends on the specifications of the wind park it is located in. For the alpha ventus project, three-legged foundation structures or tripods, fastened to the bed of the North Sea using piles, were recommended because of the water depth of around 30 metres.



>> Windfarm

Six AREVA Multibrid M5000s were set up in line with German Ministry for Shipping specifications for standard design in the German offshore test field. And they are already generating electricity. alpha ventus is the first German wind farm that has been constructed at sea under true offshore conditions and in such deep water. Design, construction, operation and integration into the electricity grid are to be tested at alpha ventus. This data should supply key information for the future development of offshore wind farms. For the wind turbine manufacturer AREVA Multibrid, a major vision has already become reality. The test field will be able to supply about 50,000 households with electricity.

position them there at their anchoring site. The tower sections were put on board a jack-up platform and installed in one step. The lower part of the tower (S3) that is placed on the tripod weighs about 165 tonnes and includes essential electrical components for the Multibrid M5000. The tower section that fits on top, the S2 segment, weighs 104 tonnes. The next step was to install the top tower section (S1), as well as the nacelle and rotor. A larger platform was needed to transport the 244-tonne nacelle, rotor star and tower section. Tower section (S1) and nacelle were quickly installed afterwards.

>> Construction and loading

Construction and commissioning was carried out simultaneously in a few months. The main components, such as the foundation structures, the nacelle, rotor hub and rotor blades, were transported to Eemshaven in the Netherlands and stored there until needed.

The Taklift 4 floating crane was used to transport the 45-metre tall foundation structures, the tripods weighing 710 tonnes each, to alpha ventus and to

>> Commissioning

At this stage of the project, after setting up the generator, the specialist installation team started commissioning. Adjustments were then made to ensure constant operation of the 5-megawatt offshore wind power converter.

The alpha ventus project consists of a total of 12 wind turbines and belongs to the operating company DOTI, Deutsche Offshore-Testfeld- und Infrastruktur GmbH & Co. KG.

All over the world, AREVA provides its customers with solutions for carbon-free power generation and electricity transmission. With its knowledge and expertise in these fields, the group has a leading role to play in meeting the world's energy needs.

Ranked first in the global nuclear power industry, AREVA's unique integrated offering covers every stage of the fuel cycle, reactor design and construction, and related services. In addition, the group is developing a portfolio of operations in renewable energies. AREVA is also a world leader in electricity transmission and distribution and offers its customers a complete range of solutions for greater grid stability and energy efficiency.

Sustainable development is a core component of the group's industrial strategy. Its 75,000 employees work every day to make AREVA a responsible industrial player that is helping to supply ever cleaner, safer and more economical energy to the greatest number of people.

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