

# WIND POWER APPLICATION GUIDE

DIRECT DRIVE  
MEDIUM SPEED  
HIGH SPEED

**GEISLINGER**<sup>®</sup>   
POWERTRAIN SOLUTIONS. BUILT TO LAST.

# GEISLINGER. LEADERS IN ENGINEERING.

For more than 60 years, Geislinger has been driven by its inventive spirit to develop innovative, customized coupling, damper, and shaft solutions for all kinds of high-performance engines and drivelines.

Geislinger is not only the expert in torsional vibration solutions, but also has more than 30 years of experience in the manufacture of fiber composite products. The Geislinger GESILCO® product group underlines the company's innovative spirit.

Reliable drive systems for wind turbines require sophisticated solutions. Geislinger offers customized coupling and shaft solutions for your drive train. The Geislinger COMPOWIND® and the GESILCO® product line are ideal for medium-speed and high-

speed wind turbines as well as for direct drive technologies. Low reaction forces virtually eliminate parasitic gearbox loads (bending moments, non-torque loads) and the overall dynamic system behavior improves significantly.

Wind drives at onshore sites must not only be reliable, but also quiet. With increasing rotor diameters, reduced speeds, growing structures of the drive trains, and, above all, the reduction of the masking energy of future onshore wind turbines, new and more sophisticated solutions have to be considered.

Geislinger products such as the Geislinger Coupling or the Geislinger Torsional Steel Spring Damper have been successfully used for many years in gearboxes to reduce struc-

ture-borne noise. Our powertrain solutions also have the potential to reduce wind turbine noise by damping the sound path from the gearbox to the rotor blades and tower.

The intensive collaboration and exchange between Geislinger's R&D department and production team, as well as our focus on customized solutions, give Geislinger's products a unique advantage.

We believe that the secret to creating the best product solution for our customers is to precisely design and manufacture every key element. With more than 60 years of experience in manufacturing custom product solutions, we have learned how to get it just right.



# CUSTOMIZED SOLUTIONS. BY GEISLINGER.

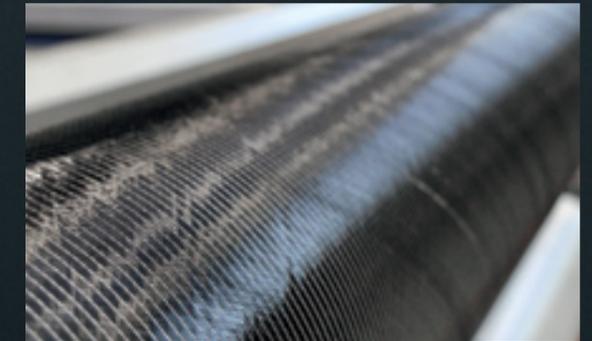
- In-house design, Torsional Vibration Calculation (TVC), Finite Element Method (FEM), whirling calculation and production
- State-of-the-art manufacturing methods with advanced composite materials
- The tight integration between R&D and production enables customized solutions for your specific needs

**The compact and lightweight GESILCO® design paves the way for great opportunities.**

The design, size, function and fiber angles of our GESILCO® products can be adapted to the specific requirements of your application. Acoustically optimized product solutions are possible as well.



# MANUFACTURING, DESIGN, AND CALCULATION BY GEISLINGER



# NOISE VIBRATION HARSHNESS...

As demand for clean energy from renewable sources increases, wind energy is becoming an incomparably important player. While offshore wind farms are thriving, legislation and social acceptance of onshore wind power are proving to be difficult factors. As onshore turbines get larger and aerodynamic blade design to further reduce noise still is progressing, the energy to mask drivetrain sounds lowers, and mechanical sounds become audible. Wind drivetrain NVH (Noise, Vibration, Harshness) is a major issue today, and new technologies are needed to cope with future challenges.

The likelihood of noise and sound problems is exacerbated by the rapidly increasing torque density resulting from the inexorable trend toward ever-larger onshore wind turbines and the race to cut costs. Increased torque density and growing structures mean less mass to absorb vibrations at higher dynamics, i.e., increased excitations and thus a higher risk of structure-borne noise generation.

Wind turbine and gearbox designers tend to use fully or partially integrated drivetrains to handle these high torque densities. More integration of a mechanical system favors the propagation of structure-borne noise.

To meet noise and tonality emission regulations for future large onshore wind turbines, especially in urban areas, wind turbine and gearbox manufacturers must explore new technologies. Powertrain developers are looking for ways to reduce noise pollution from wind turbines, meet stringent noise and tonality regulations, and gain social acceptance, and Geislinger has the answers.

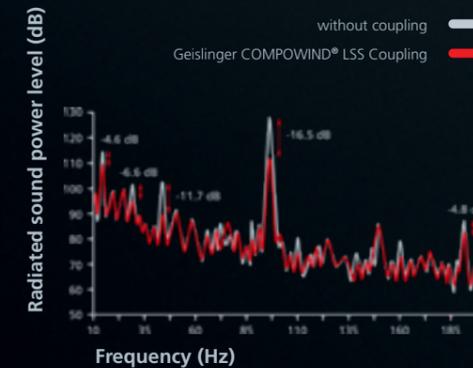


## Geislinger COMPOWIND® LSS Coupling

The Geislinger COMPOWIND® LSS Coupling not only relieves the gearbox and the entire drivetrain from parasitic forces (bending loads, non-torque loads), it influences the dynamic system behaviour of the drivetrain in a way that reduces vibration levels and finally mitigates emission of noise and tonality. Compared to a reference model, a fully integrated, directly coupled, medium-speed powertrain, the Geislinger COMPOWIND® LSS Coupling lowers sound power radiation from the rotor blades up to 17 dB (see comparison of radiated sound power levels).

A study on sound propagation of mid-speed drivetrains and how to avoid tonality issues by the Center for Wind Power Drives, RWTH Aachen and the Geislinger GmbH is available on demand.

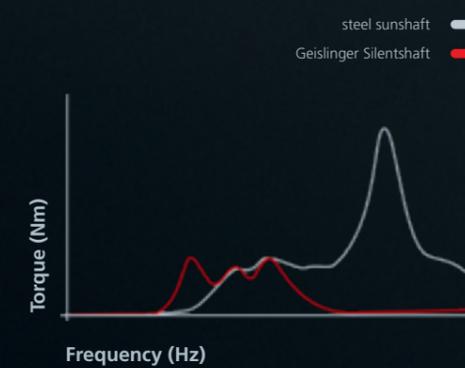
### Comparison of radiated sound power levels (dB) from rotor blades.



## Geislinger GESILCO® Silentshaft Gearbox-integrated

Wind powertrain NVH engineers are well aware of the sun shaft mode, which is torsional eigenfrequency dominated by the second planetary stage. As this eigenmode is quite susceptible to gear mesh excitations, its frequency needs to be carefully adjusted to the gear mesh orders and turbine operation range by tuning the respective torsional stiffness of the sun shaft. A steel sun shaft has a very limited range of tuning the resonance frequency by lowering the torsional stiffness. A sun shaft made from advanced composites changes this limitation and allows tuning the system in such a way as to achieve a tonality-free drivetrain.

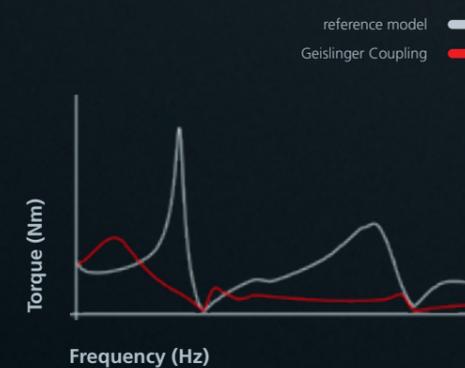
### Comparison of amplitudes - torque (N/m) of a steel sun shaft against a carbon fiber sun shaft.



## Geislinger Torsional Elastic Coupling Gearbox-integrated

The Geislinger torsional elastic coupling follows a similar attempt as the carbon fiber sun shaft. The all-steel powertrain component can be integrated to the gearbox and introduces torsional elasticity to the sun shaft of the second or third stage of a co-axial planetary gearbox of medium-speed drivetrains. In a high-speed gearbox, the coupling can be fully integrated to the second gearwheel of the parallel stage. In both solutions, the reduced torsional elasticity of the system provided by the Geislinger coupling shifts the resonance frequency to lower levels and can fully isolate the system from vibrations (see comparison of amplitudes). Integrated to the camshaft drive gearwheel of large combustion engines, it is already a validated, proven, and widely used solution to reduce structure borne noise in marine propulsion systems.

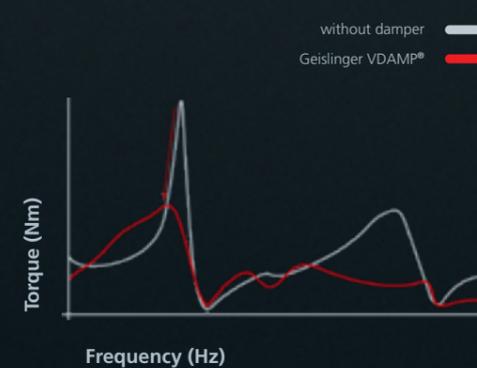
### Comparison of amplitudes - torque (Nm) of a drivetrain with and without the Geislinger Coupling.



## Geislinger VDAMP® Gearbox-integrated

The Geislinger VDAMP® is the ideal product solution for tackling dominant torsional modes to overcome drivetrain tonality challenges. A VDAMP® is a viscous damper consisting of an inertia ring coupled to a housing by a special, high-viscous silicone oil. Torsional vibrations result in an angular offset between damper housing and inertia ring, applying shear load to the silicone oil, converting the vibration energy into heat, and transferring it to the ambient. Vibration amplitudes are effectively mitigated over a wide frequency spectrum. A torsional damper always is located at the spot of the highest level of energy, which normally is at the origin of torsional excitations, which, in the case of a wind gearbox is the second, respectively the third, planetary stage.

### Comparison of amplitudes - torque (Nm) of a drivetrain with and without the Geislinger VDAMP®.



# GEISLINGER COMPOWIND® LSS COUPLING

The Geislinger COMPOWIND® low-speed shaft (LSS) Coupling is based on more than 30 years of experience in developing fatigue resistant, maintenance-free, and weight-saving couplings and shaft lines. The innovative coupling ensures the reliability and availability of the drivetrain on the one hand, and effectively reduces noise emissions and avoids tonalities on the other.

Installed between the rotor and the gearbox, the low-speed shaft coupling is made from advanced fiber composites which enable the gearbox to be mounted rigidly onto the main frame, respectively to couple the gearbox directly to the main bearing unit. Thanks to its low and almost linear restoring forces, virtually all occurring non-torque loads are effectively absorbed by the composite membranes. Due to the simple and robust coupling design which is fully maintenance-free, the reliability of the drivetrain increases noticeably, resulting in reduced operational costs.

The COMPOWIND® LSS Coupling protects the gearbox and the whole drivetrain by significantly reducing non-torque loads. It allows the gearbox to be rigidly attached to the main frame for which reason drivetrain bending eigenmodes are virtually eliminated and the dynamic behaviour

is improved beyond comparison. This is not only important under severe load conditions and after the occurrence of special events, but also helps to achieve tonality free wind turbines: The comparatively low stiffness and the good damping properties of the Geislinger COMPOWIND® LSS Coupling reduce the sound transfer from the gearbox to the rotor blades, while the attenuation of eigenmodes helps to reduce sound propagation within the drivetrain in general. For this reason, the noise radiation from the rotor blades, the gearbox housing, the gearbox supports, and the tower is effectively reduced. This poses an additional customer value and a clear competitive advantage for onshore applications.

The COMPOWIND® LSS Coupling is resistant to heat, frost, salt-water, and oil and offers electrical insulation as an option. The use of advanced materials and our state-of-the-art manufacturing methods give wind turbine producers a competitive lead in the race for robustness, enhancement of reliability, and reduction of operational cost (OPEX). Every COMPOWIND® LSS Coupling is customized to each application.



## DESCRIPTION

Dynamic loads, rotor overhung, and drivetrain weight cause non-torque loads, which – independent of the concept – are present on three-point and four-point suspensions, integrated drivetrains, and gearboxes. Non-torque loads can significantly affect the reliability of the gearbox. It can be expected that the reduction of non-torque loads and the enhancement of the dynamic system behaviour will reduce premature gearbox failures, resulting in reduced gearbox exchange cost and increased energy production. The reduction of operational expenditure (OPEX) over the entire wind turbine life will have a positive impact on the levelized cost of energy (LCOE). A dynamic load study as well as a commercial study done by the CWD (Center for Wind Power Drives, RWTH Aachen) is available on demand.

## TECHNICAL DATA

- Torque & Misalignment:  
Customized to your requirements
- Ambient temperature: -45°C to 100°C

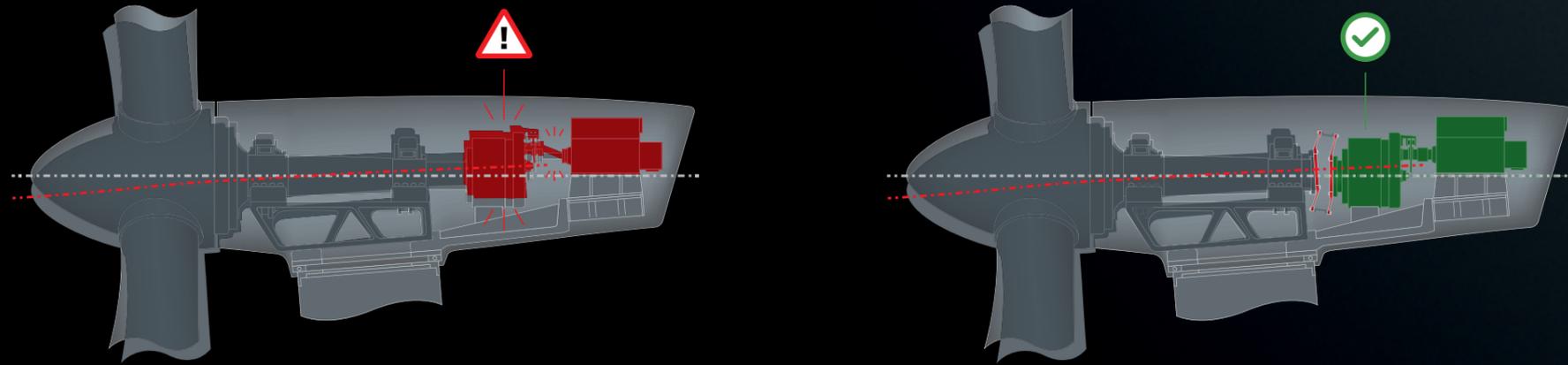
## ADVANTAGES

- Fatigue resistant
- Lower total cost of ownership
- Maintenance-free
- Low restoring forces
- Tonality mitigation
- No aging, no wear, resistant to heat, frost, salt-water, and oil
- Geislinger monitoring system (GMS) is available

Geislinger Compowind® LSS Coupling containing four membranes and an intermediate shaft.



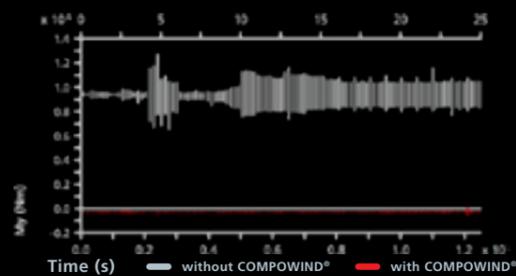
## FUNCTIONALITY OF THE COMPOWIND® LSS COUPLING



**Conventional drivetrain**  
with the gearbox elastically mounted and hydraulic torque supports.

Static and dynamic deflections transmit bending moments from the rotor to the gearbox and its components. These non-torque loads cause excessive, uneven, and unpredictable loads to the drivetrain components and affect the reliability and uptime of wind turbines significantly. The elastically mounted gearbox produces eigenmodes (mainly drivetrain bending modes), resulting in an unfavourable dynamic system behaviour and increased fatigue load (see example of dynamic load study).

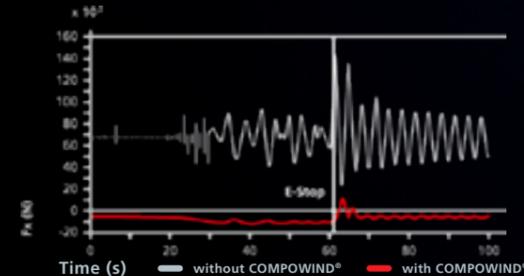
**Pitch moment (My)**  
on the input shaft of the gearbox



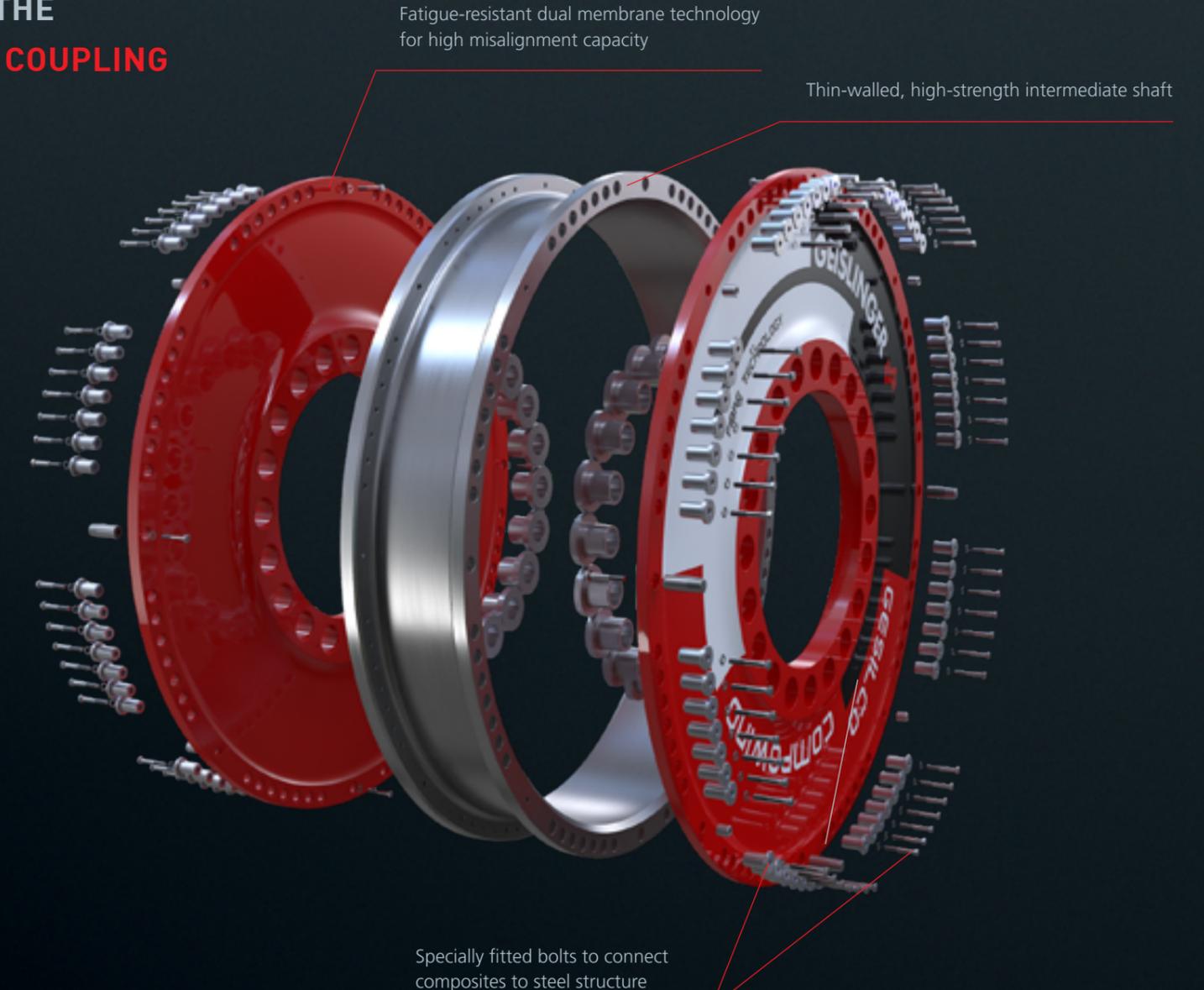
**Drivetrain with Geislinger COMPOWIND® LSS Coupling**  
and the gearbox rigidly mounted.

The Geislinger COMPOWIND® LSS Coupling is the first coupling of its kind to enhance the reliability of your wind turbine's drivetrain. The coupling protects the drivetrain through a significant reduction of non-torque loads and a clear enhancement of the dynamic system behaviour. Thanks to the low restoring forces of the low-speed coupling, gearbox loads are independent of the wind turbine conditions (see example of dynamic load study).

**Thrust force (Fx)**  
on the input shaft of the gearbox – E-Stop



## COMPONENTS OF THE COMPOWIND® LSS COUPLING



# GEISLINGER GESILCO® SILENTSHAFT



The Geislinger GESILCO® Silentshaft Coupling is our smartest solution for mitigating noise, vibration, and harshness for on-shore wind turbines. It effectively mitigates the sun shaft mode by lowering the torsional stiffness of the sun shaft, while it is no 'add-on' solution, and it is fully integrated to the gearbox.

Being designed with advanced composite materials, the Geislinger GESILCO® Silentshaft Coupling isolates the drivetrain system from vibrations and enables finetuning the frequency behaviour of the drivetrain due to optimized torsional stiffness characteristics of the shaft (see comparison of amplitudes and torque (N/m) of a steel sun shaft against a carbon fiber sun shaft).

The Geislinger GESILCO® Silentshaft Coupling perfectly complements Geislinger's product range for mitigating parasitic loads and NVH in onshore wind turbines, alongside Geislinger's COM-POWIND®, VDAMP® and Coupling products.

## DESCRIPTION

The Geislinger GESILCO® Silentshaft Coupling is installed between the sun pinion and the generator rotor. It features a formed advanced fiber composite flange, which provides a direct connection to the generator rotor.

## TECHNICAL DATA

- Torque & Misalignment:  
Customized to your requirements
- Ambient temperature: -45°C to 100°C

## ADVANTAGES

- Mitigation of tonalities
- Optimized load situation and dynamic system behaviour
- Integrability to co-axial gearboxes
- Avoidance of add-on NHV-products



# 01

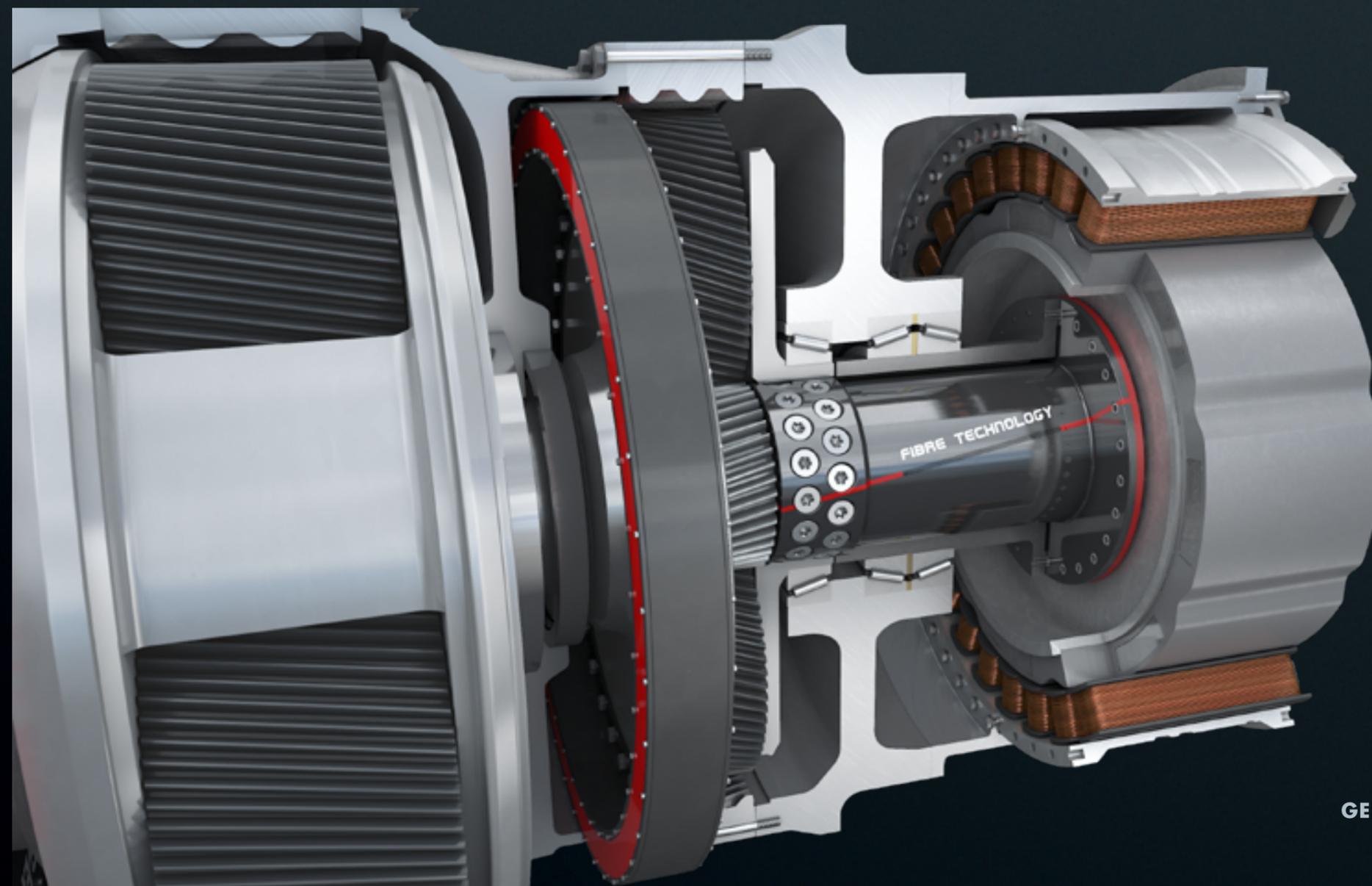
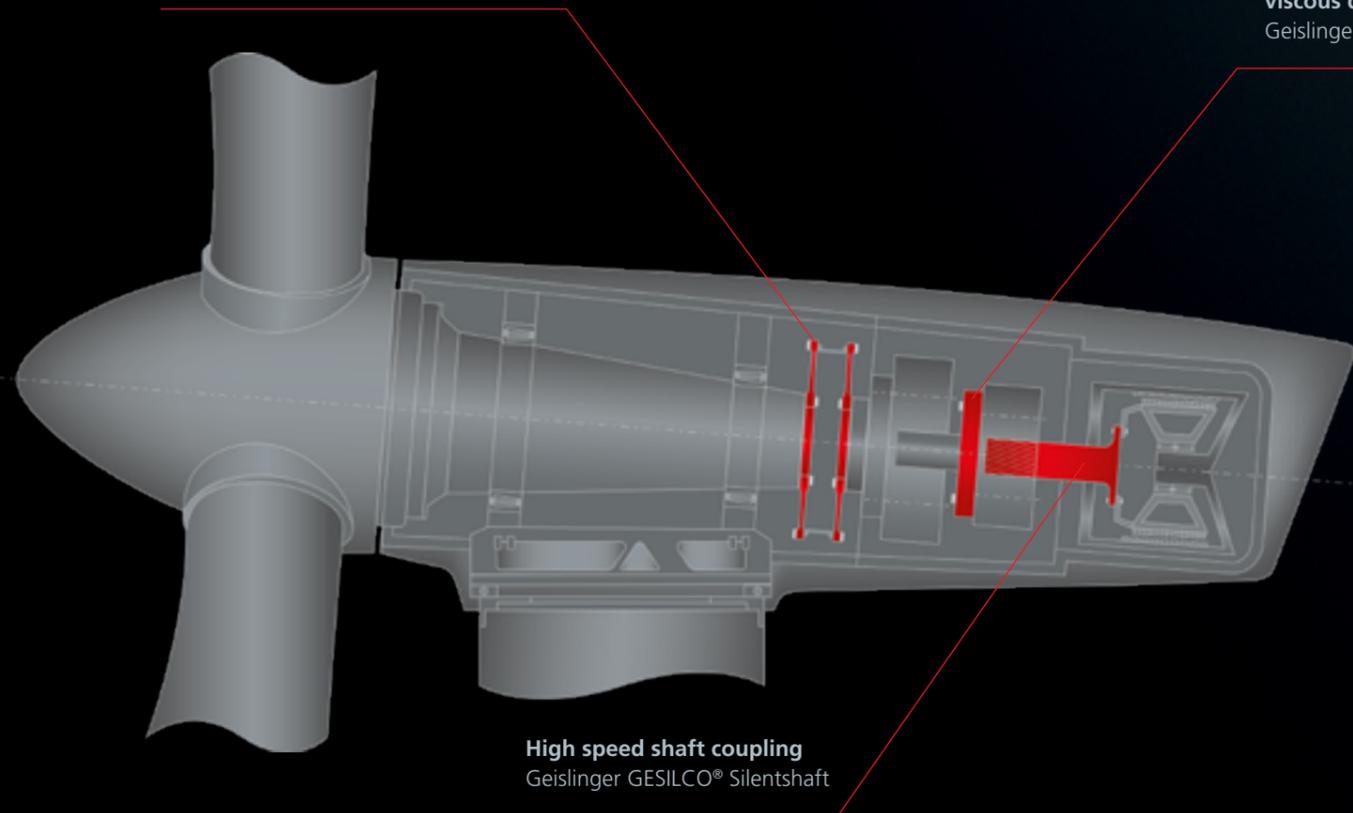
## INTEGRATED MEDIUM SPEED DRIVETRAIN

**Low speed shaft coupling**  
Geislinger COMPOWIND® LSS Coupling

**Broadband torsional vibration  
viscous damper**  
Geislinger VDAMP®

**High speed shaft coupling**  
Geislinger GESILCO® Silentshaft

Watch the video and learn more about  
the Geislinger COMPOWIND® LSS Coupling



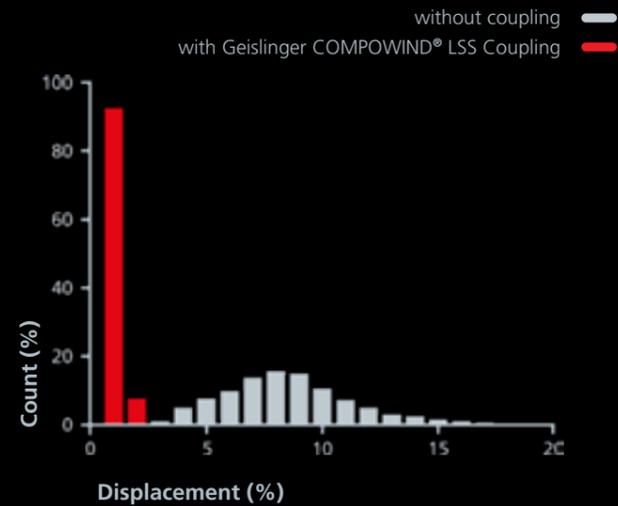
# GEISLINGER COMPOWIND® LSS COUPLING

FOR DIRECT-DRIVE WIND TURBINES

The air gap diameter of the latest generation of direct-drive wind turbines is about ten meters and even more. The design of the generator requires a very rigid structure and a massive bearing arrangement to minimize the effect of external and internal loads on the deflection between generator-stator and generator-rotor (the air gap), which is in the range of one per mil of the air gap diameter. The deflection, which causes a change in the air gap, not only reduces the energy efficiency, and increases the loads on the bearings, it also bears the risk of a wind turbine shut down in case of a contact between the generator stator and the generator rotor, and consequently a costly downtime and repair of the wind turbine.

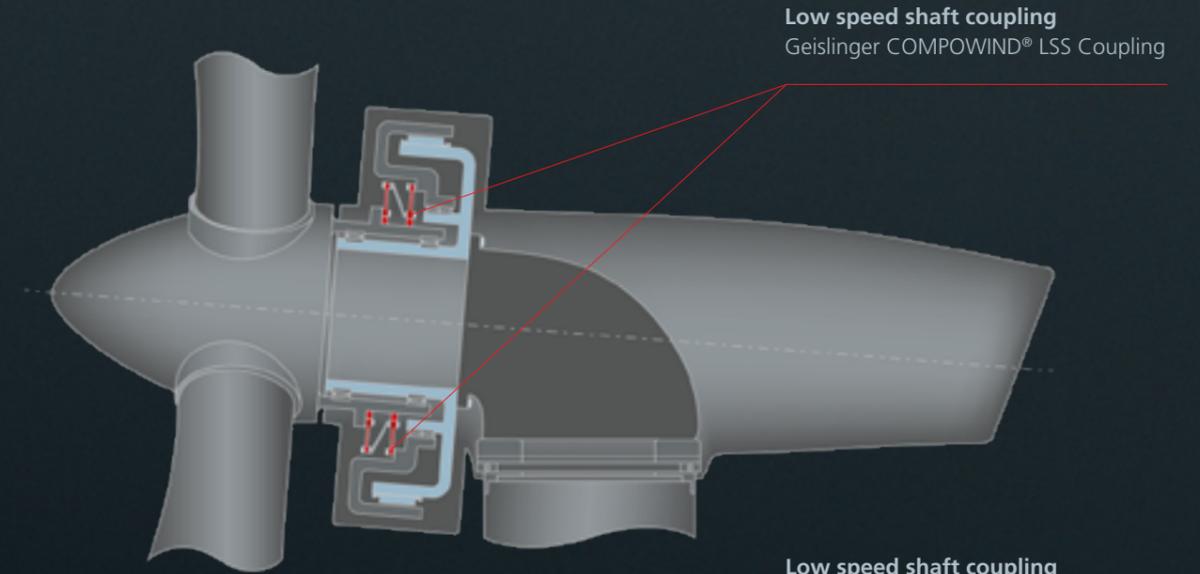
A study carried out by the Center for Wind Power Drives unveils a massive potential to stabilize the air gap of direct-drive wind turbines by using a composite low-speed shaft coupling between the main bearing and the generator. Summarized, the use of a coupling decreases the maximum air gap deflection from 20% down to 3%.

**Summarized air gap displacement**  
of a direct-drive turbine with and without the Geislinger COMPOWIND® LSS Coupling.



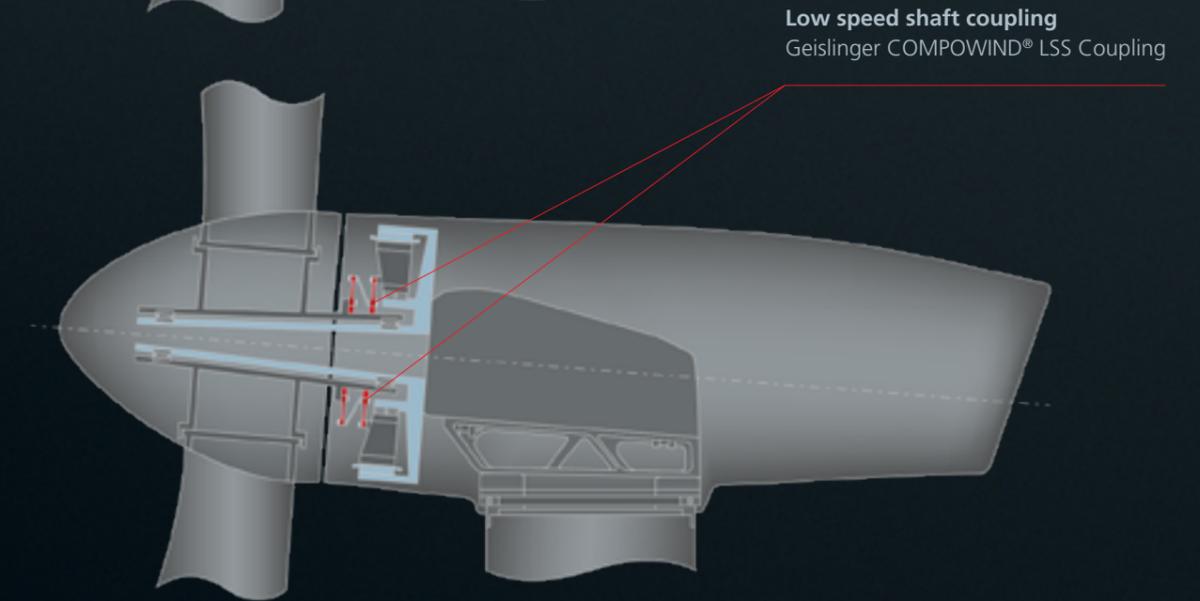
## 02

DIRECT DRIVE WIND TURBINE  
OUTER ROTOR



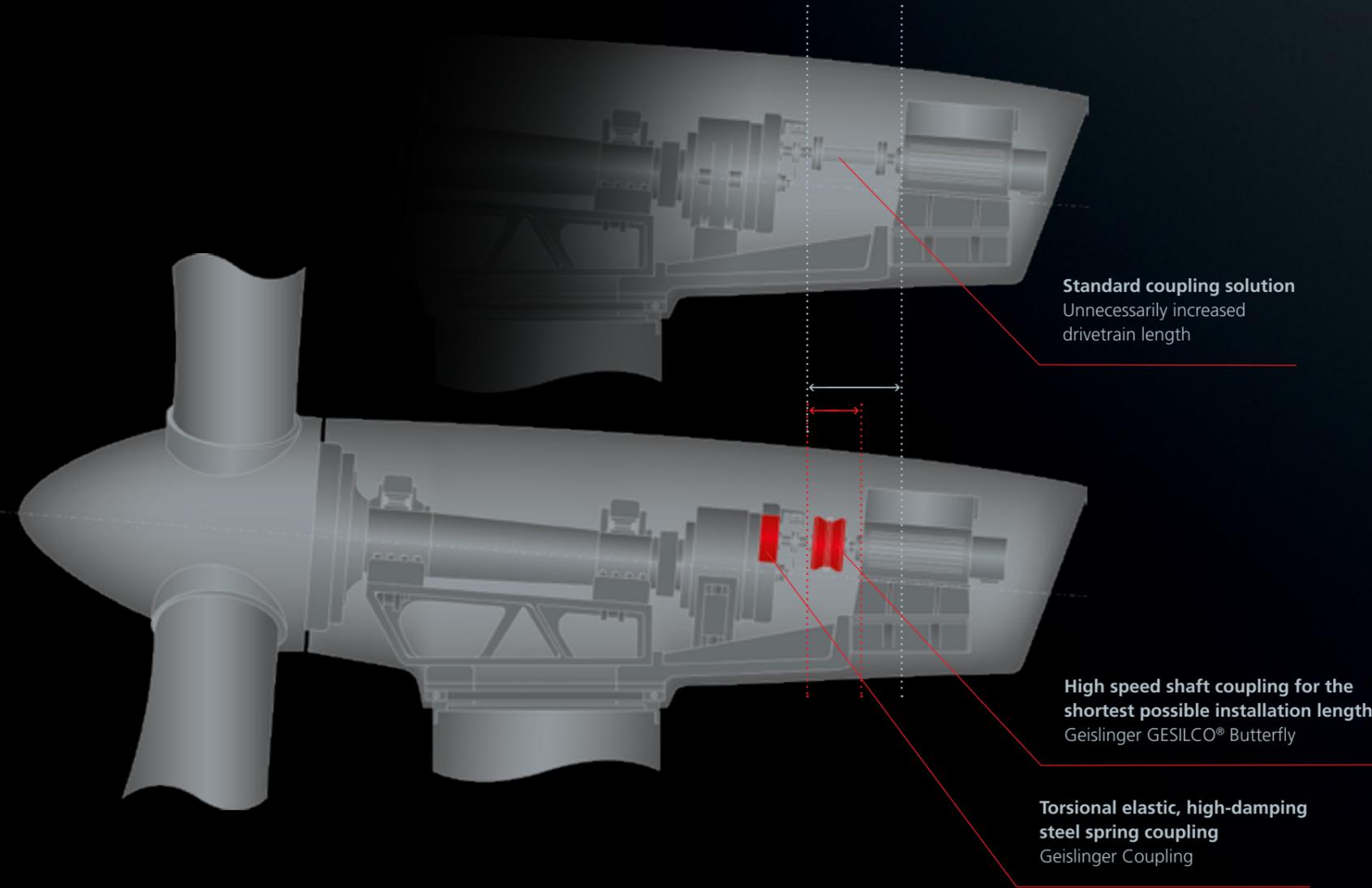
## 03

DIRECT DRIVE WIND TURBINE  
INNER ROTOR



# 04

## HIGH-SPEED DRIVETRAIN WITH 4-POINT OR 3-POINT SUPPORT

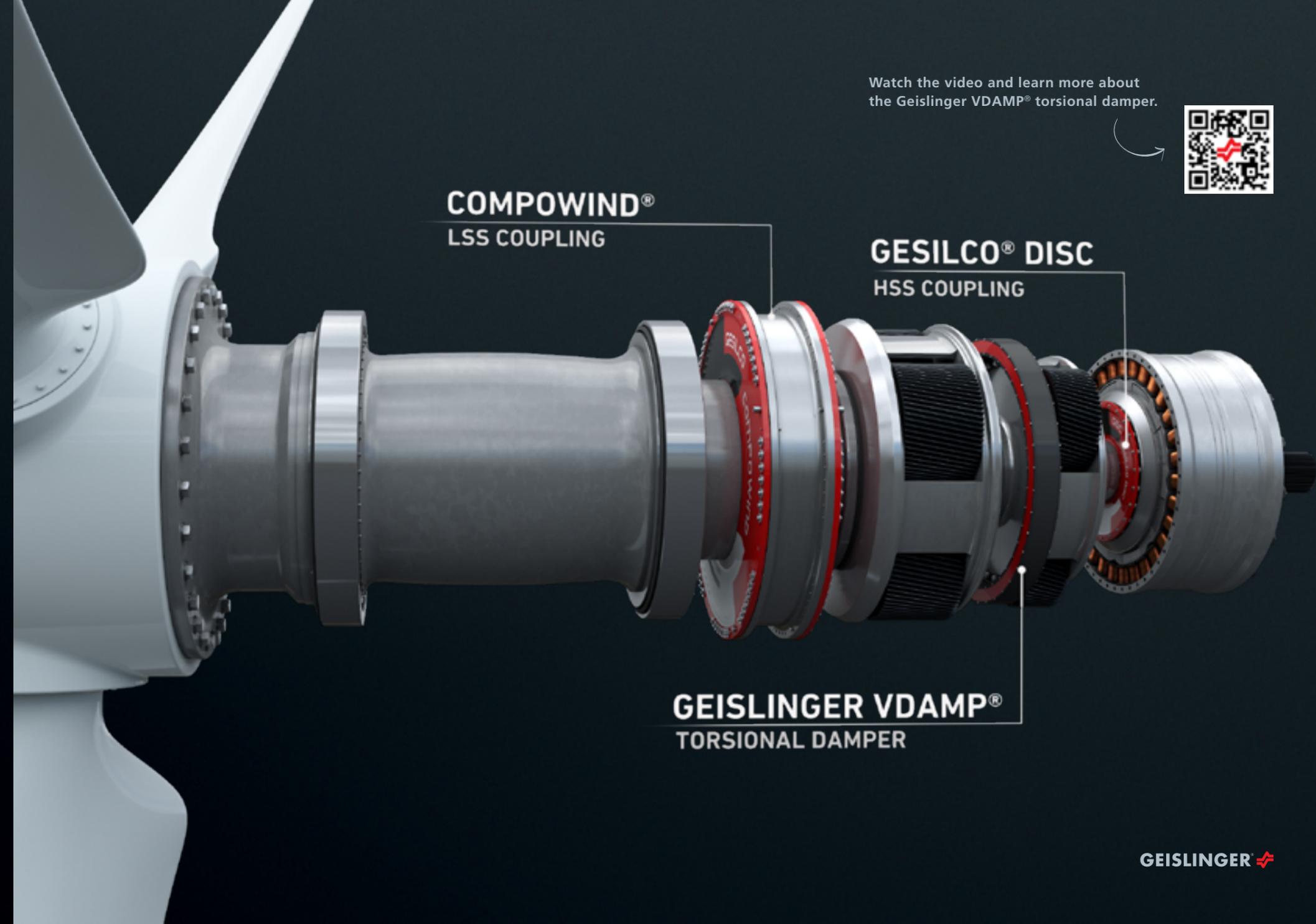


**Standard coupling solution**  
Unnecessarily increased drivetrain length

**High speed shaft coupling for the shortest possible installation length**  
Geislinger GESILCO® Butterfly

**Torsional elastic, high-damping steel spring coupling**  
Geislinger Coupling

Watch the video and learn more about the Geislinger VDAMP® torsional damper.

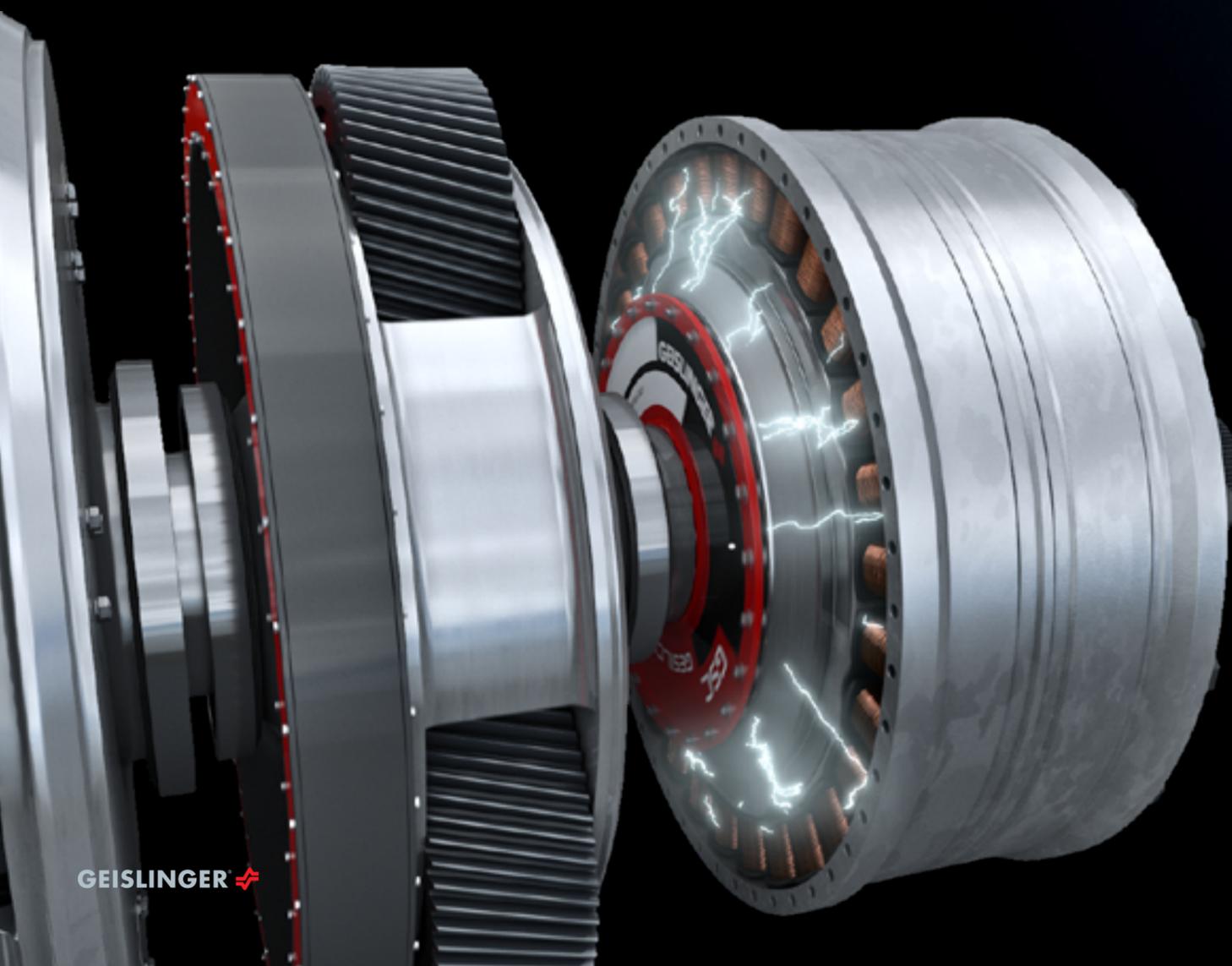


**COMPOWIND®**  
LSS COUPLING

**GESILCO® DISC**  
HSS COUPLING

**GEISLINGER VDAMP®**  
TORSIONAL DAMPER

Watch the video and learn more about the Geislinger GESILCO® Disc.



Designed to  
**>1 MΩ**  
electrical  
resistance

## GEISLINGER. ONE PARTNER. FIVE BENEFITS.



ENGINEERING

Geislinger's innovation is underlined by our motivation to produce long-lasting products which are perfectly fitted to individual applications. We invest a high percentage of our turnover in research, in order to improve the performance of our products even further. Using state-of-the-art machinery and tailoring, each product is precisely fitted to the individual system.



ANALYSIS

More than five decades ago, we started developing our own monitoring software. Being continuously improved by our highly experienced engineers, the Geislinger Monitoring System has become one of the most outstanding torsional vibration software tools worldwide.



SERVICES

Professional maintenance of a system is essential to ensure its smooth performance over a long service period. Geislinger's services do not end with the sale of a product. A global network of subsidiaries and service partners provide after-sales services, anywhere, at any time.



SOLUTION

Working with advanced materials such as high-grade steel, composite material, and elastomer, the core benefits of our products include low cost of ownership, outstanding service life and a very high level of reliability. In addition to tailor-made products, Geislinger also offers standard solutions.



MONITORING

To ensure the correct performance of a system during operation and to facilitate a condition-based monitoring of the Geislinger products, we offer a monitoring system that was developed by our experts and has been improving for more than 25 years.



# OVERVIEW

## WIND POWER APPLICATIONS

Learn more about the Geislinger wind power solutions.



### Geislinger COMPOWIND® LSS Coupling

Fatigue-resistant, maintenance-free, and lightweight LSS coupling

The COMPOWIND® Coupling is based on an innovative concept of fiber composite membranes. Installed between the rotor hub and the gearbox, the low-speed shaft (LSS) coupling protects the gearbox and the whole drivetrain by significantly reducing non-torque loads. The coupling allows the gearbox to be mounted rigidly onto the main frame without the use of elastomer-hydraulic torque supports. As a result, bending modes and dynamic effects are virtually eliminated. The reliability of the drivetrain increases noticeably, resulting in reduced operational costs.

**Benefit:** Fatigue-resistant, maintenance-free, and lightweight

### Geislinger GESILCO® Silentshaft

Torsional elastic and vibration damping shaft solution

The Geislinger GESILCO® Silentshaft is made of advanced composite materials and is characterized by optimized torsional stiffness characteristics and an integrated fiber flange connection. The Geislinger GESILCO® Silentshaft Coupling isolates the drivetrain system from vibrations and is our solution for mitigating noise, vibration, and harshness for onshore wind turbines. It can easily be adapted to your requirements.

**Benefit:** Mitigation of tonalities, electric isolation optional

### Geislinger GESILCO® Disc

Radially stiff and fatigue-free coupling

The GESILCO® Disc was originally designed for closed coupled generator sets. In wind drivetrains, a GESILCO® Disc is the ideal replacement for a steel coupling used in integrated medium-speed drivetrains to couple the gearbox drive end to the rotor shaft. It is electrically isolating and safeguards the gearbox bearings from tracking current. The flat membrane allows the transmission of high torsional vibratory torques and radial forces at high engine speeds. The GESILCO® Disc is also suitable to bear axial loads of a certain magnitude.

**Benefit:** Elimination of electrocorrosion in integrated drivetrains, maintenance-free

### Geislinger GESILCO® Butterfly

Lightweight, maintenance-free coupling for short installation lengths

The membranes of the GESILCO® Butterfly coupling are made of lightweight and highly flexible composite materials in order to secure the lowest possible reaction forces, which increases the system's reliability. As a replacement to a state-of-the-art high-speed coupling in 3-point or 4-point supported drivetrains, a GESILCO® Butterfly allows the distance between the gearbox and the generator to be approximately cut in half. Shortening the length of the main frame and nacelle enables valuable weight and cost saving potential.

**Benefit:** Reduction of the length and the cost of the drivetrain, maintenance-free

### Geislinger SILENCO®

Lightweight coupling with high additional acoustic sound attenuation

The Geislinger SILENCO® is an acoustically optimized misalignment coupling based on our renowned GESILCO® technology. It consists of maintenance-free composite membranes with increased damping properties, a composite connecting shaft and additional acoustic flanges to achieve the best possible sound attenuation of your driveline. The coupling provides resistance to heat, frost, oil and offers electrical insulation as an option. Depending on the acoustical needs and the required torque, different versions of flanges, membranes, and shafts are available.

**Benefit:** Reduction of wind turbine noise, maintenance-free

### Geislinger Coupling

Robust torsional elastic, high-damping steel spring coupling

High reliability, long intervals between overhauls, and low operating costs are some of the main features of the coupling. Integrated to a wind gearbox, a Geislinger coupling bears the potential to reduce structure borne noise at its origin: Integrated onto a gearwheel of a high-speed gearbox, the torsional elastic coupling reduces angular accelerations as a result of gear mesh excitations. It is already a validated, proven and widely used solution to reduce structure borne noise in large combustion engines.

**Benefit:** Reduction of wind turbine noise

### Geislinger Damper

Tuned torsional vibration steel spring damper

Various design options, and hydrodynamic damping, allow the torsional Geislinger spring type damper to be adapted to every single application. The Geislinger Damper not only reduces amplitudes, but also effectively eliminates critical resonances to a frequency beyond operation points. Attached to the planet carrier in the second stage of a medium-speed gearbox, angular accelerations as a result of gear mesh excitations are effectively reduced. Simulation results showed a reduction in double-digit dB values.

**Benefit:** Reduction of wind turbine noise

### Geislinger VDAMP®

Broadband torsional vibration viscous damper

The Geislinger VDAMP® viscous type damper is a broadband torsional damper which can be considered as an alternative to a Geislinger spring type damper in wind gearboxes to reduce structure borne noise. Since a VDAMP® is a closed system without the need of pressurized oil supply and oil return, it is ideally suited to reduce structure borne noise in direct-drive wind turbines. A VDAMP® effectively reduces angular accelerations of the second stage planetary carrier over a wide band of frequencies.

**Benefit:** Reduction of wind turbine noise

# ENHANCE YOUR POWERTRAIN. GEISLINGER DIGITAL SOLUTIONS.

Geislinger Digital Solutions combine excellent product performance with world-class engineering to provide additional operational reliability, reduced costs, and optimized performance for your wind farm.

Geislinger Digital Solutions' two core units, the Geislinger Analytics Platform and the Geislinger Monitoring System are our industry-leading software and hardware solutions that work together to provide continuous measurement of your dynamic system behavior and a cloud-based data push.

With Geislinger Digital Solutions, our products became intelligent to get even more out of them. We monitor them, provide insights, and all this helps us optimize our customer's operations. In addition, collaboration and sharing of data with partners provide additional opportunities.

Using the Geislinger Analytics front end, users can manage information from any location. The platform enables easy comparison of wind turbines on a wind farm, real-time access to alerts and alarms, and the ability to download reports. These features make it easy for users to stay informed and effectively manage their wind farm.

Trend analysis, AI-powered anomaly detection, rapid troubleshooting, data analysis, reporting, predictive maintenance, are just some of the features of Geislinger Digital Solutions.

Monitoring your drivetrain with Geislinger Digital Solutions ensures maximum safety, prevents downtime, mitigates overall operational risk, and leads to the lowest total cost of ownership.



Here you can learn more about  
Geislinger Digital Solutions.



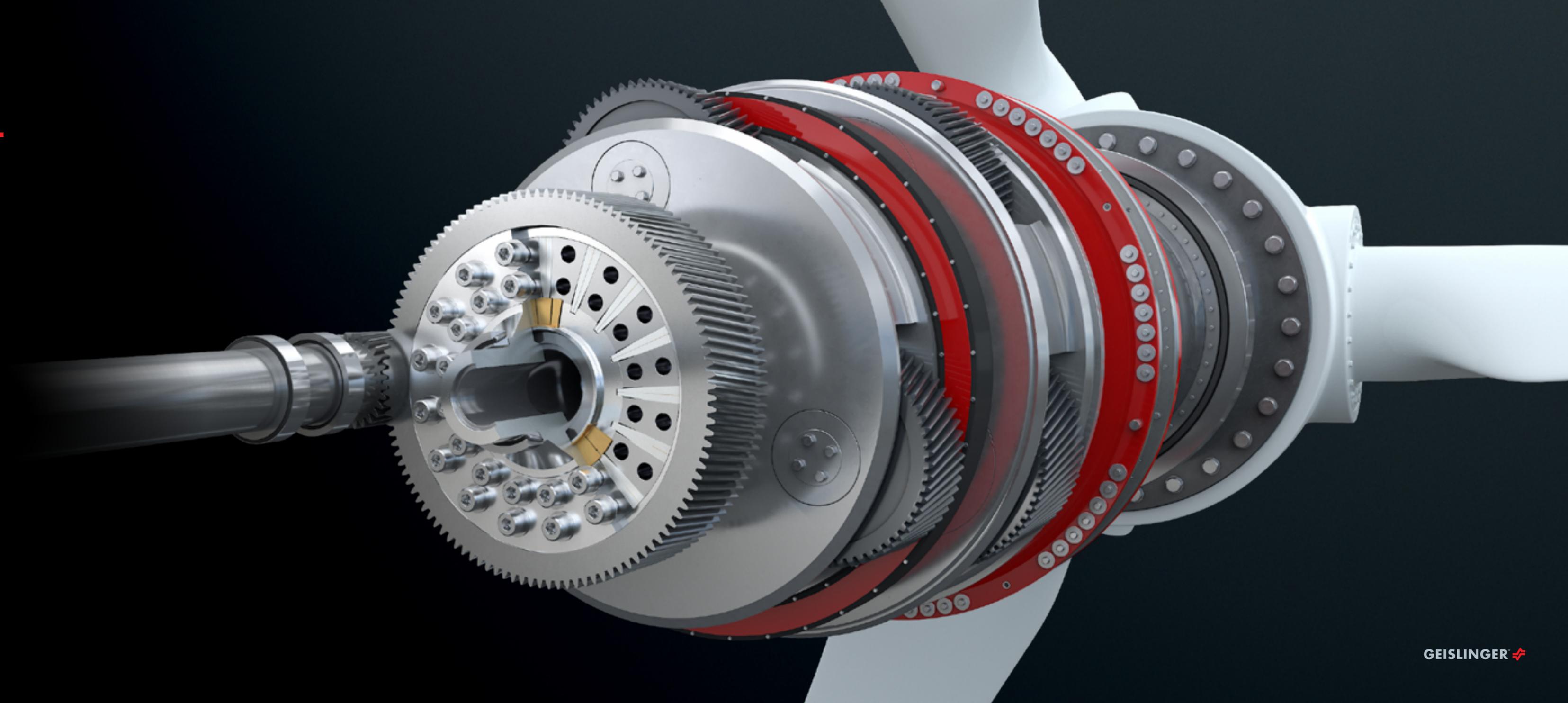
## ADVANTAGES

- Remote wind farm overview
- Additional operational safety and risk reduction
- Lower total cost of ownership
- Predictive maintenance
- Increase in uptime
- Data exchange with other systems

# YOUR CHALLENGE. YOUR SOLUTION PARTNER.

Geislinger's innovation is underlined by our motivation to produce long-lasting products which are perfectly fitted to individual applications. Using state-of-the-art machinery and tailoring, each product is precisely fitted to the individual system. It is our aim to provide our customers with the perfect solutions for their applications. Geislinger works with advanced materials such as high-grade steel, composite material, and elastomer, in order to develop extremely compact and reliable designs with outstanding power density.

The core benefits of our products include low cost of ownership, outstanding service life and a very high level of reliability. In addition to tailor-made products, Geislinger also offers standard solutions.



# DISCOVER THE WORLD OF GEISLINGER



[geislinger.com](http://geislinger.com)

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