



Blue Seas, Green Technology

Hybrid Marine Propulsion Systems by ZF





Combining the best of two worlds

Progress, much like the sea, is always in motion. ZF knows that the future of shipping belongs to clean and sustainable propulsion systems.



ZF supports sustainable yachting with hybrid propulsion systems, enhancing performance and reliability while reducing emissions. The “Baglietto T52”, equipped with ZF’s 5200 A PTI hybrid transmissions, achieves a range of 7,600 nautical miles in electric diesel mode.

Uniquely positioned as a global leader in maritime drive technology with decades of experience, ZF understands the demands of its customers and their markets like no other. That is why the company’s comprehensive portfolio is designed to answer, and exceed, these demands. With the claim “Next Generation Propulsion,” ZF systems help to reduce emissions, fuel consumption and operating costs. The company has continued to develop and expand its hybrid offerings to include optimal solutions for almost all applications and every type of vessel propulsion. Additionally, ZF’s portfolio includes transmissions for purely electric drives and turn-key solutions like its hybrid module. As a holistic system supplier, ZF offers not only hybrid transmissions, but also an electric motor, control system, power electronics, well mounted azimuth thrusters, fixed pitch propellers and shaftline.

Shipbuilders and fleet operators thus benefit from ZF’s comprehensive approach to propulsion – secure in the knowledge that every component is perfectly tailored to their specific use case. It’s no surprise, then, that the company has sold more than 150 electrified systems in the last ten years alone.

More “E” on the sea: Why hybrid is the future of maritime propulsion

There are many arguments in favor of maritime hybrid propulsion systems: less noise and exhaust gases, significant fuel savings and more effective power delivery during slow speed maneuvering.

Another purpose in this technology: stricter environmental laws that came into force in 2020, which can be met when an electric mode allows hybrid vessels to still drive to ports and waters that are closed to purely conventional vessels. Manufacturers and operators alike therefore benefit from the broad portfolio of hybrid transmissions that ZF offers for almost all application segments.



Neptune's EuroTug 3515, essential for maneuvering massive cargo ships in ports, relies on the robust, hybrid-capable ZF W5355 PTI transmission for superior performance.

Hybrid pays off for everyone

Various options for hybrid operation ensure that vessels are capable of balancing economic benefits, performance, and protection of the environment.

When adapted to the application, the intelligent use of different hybrid operation modes allows optimization in different ship types. Thus, the economic aspects of the operator can be optimally combined with legal regulations regarding exhaust and noise emissions as well as the power requirements of the application in operation.

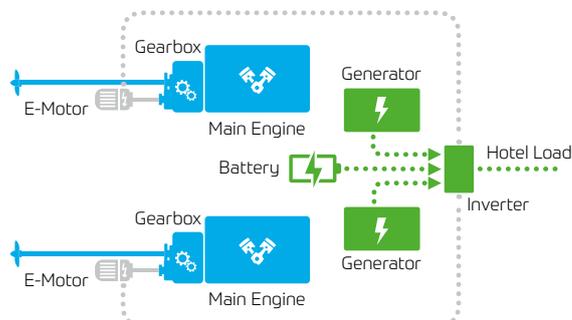
For example, harbor tugboats can be operated in fuel-optimized stand-by mode, ferries and motor yachts can be run purely electrically, and research vessels are maneuvered virtually silent and all with low vibration. When the main engine is offline in electrical drive mode, it increases the lifespan of the unit and reduces operating costs, as maintenance intervals can be further extended. The electric motor also allows for two more modes of operation. In addition to the purely electric or conventional mode, the e-machine can be used as a boost when accelerating. In generator mode, it supplies energy for the ship's onboard equipment, which translates to further fuel savings. Residents of port cities benefit from reduced noise and emission levels, as does aquatic life. All the while, the comfort on board increases.

Operation modes with electric motor

Engines can be operated in different modes depending on priorities.

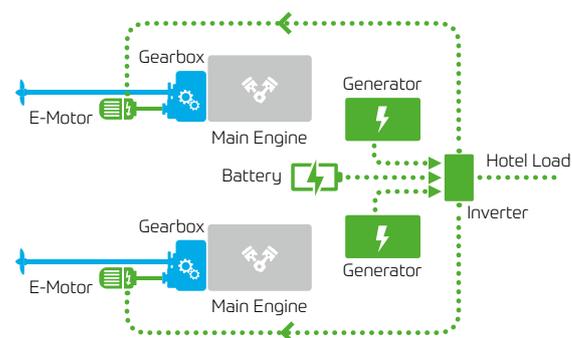
DIESEL DRIVE MODE

- E-Motor off
- Propulsion by main engine (diesel)
- Hotel load by main generator or battery*



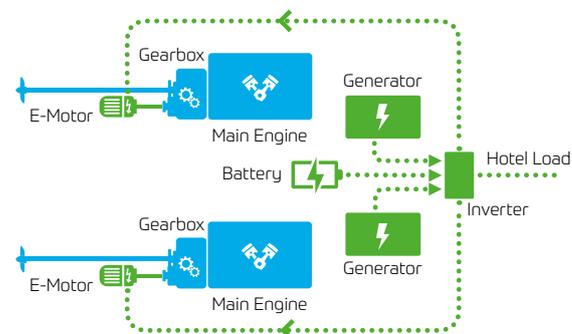
ELECTRIC DRIVE MODE

- Main engine (diesel) off
- Propulsion by E-motor
- Powered by main generator or battery*
- Hotel load by main generator or battery*



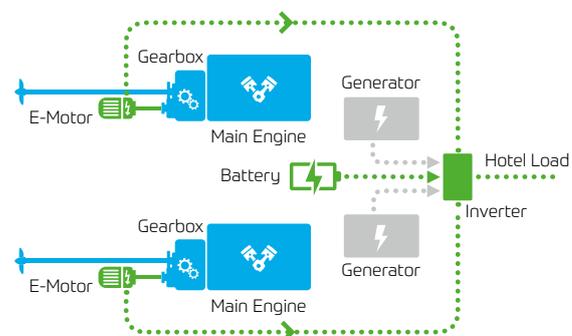
BOOST MODE

- Main engine (diesel) on
- Main generator on
- Propulsion by E-motor and main engine (diesel)
- Powered by main generator or battery*
- Hotel load by main generator or battery*



GENERATOR MODE

- Main engine (diesel) on
- Propulsion by main engine (diesel)
- E-motor as generator driven by main engine
- Main generator only switched on if additional load of battery* or hotel load is required



RECUPERATION MODE (energy harvesting while under sail) available for sailboats

* if battery available (Diesel engine, main generator, power management and battery) not ZF scope of supply.

Almost endless possibilities

With its decades-long experience as a marine propulsion specialist, ZF is perfectly positioned to offer vessel designers and ship builders the right hybrid transmission for their current project.



The 50-meter aluminum yacht "Home" reaches up to 9 knots on silent electric power. Its 1,200 kW diesel and 220 kW electric engines, paired with ZF 3310 PTI hybrid transmissions, ensure superior comfort, acceleration, fuel efficiency, and maneuverability.

ZF Marine offers a broad portfolio of hybrid transmissions with a power range from approximately 600 kW (ZF 33X0 series) to 11,500 kW (ZF 83700) in conventional power and a solution for all propulsion models as FPP, CPP or Waterjet. Via power-take-in (PTI), ZF enables the integration of its transmissions with an electric motor and offers tailored solutions for all specific requirements and all applications.

The compact and lightweight down-angle hybrid transmissions are suitable for fast ships that require

high speeds, such as yachts, patrol boats and speedboats, as they optimally combine performance and efficiency and offer the right solution for every space requirement. For workboats, ZF offers robust hybrid transmissions with cast iron housings and high gear ratios, which are designed for tough operations and a long service life. For applications that require high maneuverability and fast response times, such as high-speed ferries, ZF offers hybrid transmissions for waterjet drives with small gear ratios.

The ZF 3200 A/V PTI

A new addition to ZF's portfolio of down angle hybrid transmissions. This gearbox is designed for a maximum output of up to 1,940 kW and a maximum torque of 7,560 Nm, while the power take-in (PTI) can be coupled with electric motors up to a maximum output of 500 kW_e. The transmission ratio range covers $i=1.892$ to $i=4.240$ (for the primary drive) and $i=1.646$ to $i=13.780$ (for the electric motor). Thanks to its special gear design, the electric motor can be compactly integrated into the transmission via its own drive shaft. In addition to saving space, this also means that the maximum output of the main drive does not have to be reduced in order to accommodate the additional input of the e-machine. This solution for down angle transmissions is unique on the market – and makes the ZF 3200 A/V PTI the ideal choice for a range of fast vessels, such as leisure yachts, ferries or coastguard vessels.

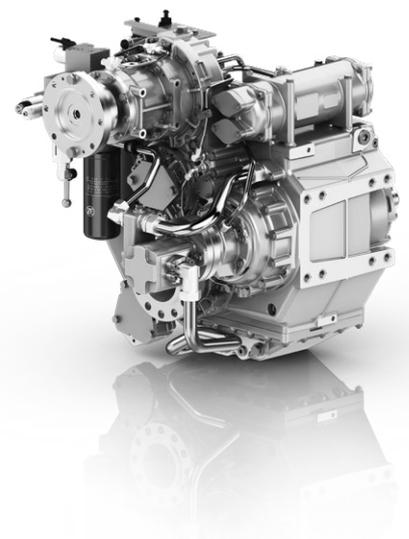


The ZF 5200 A/V PTI

A compact transmission that can be installed in the ship in both V (V drive) and A (down angle) positions. This system can transmit primary drive outputs of up to 2,463 kW and a maximum torque of 9,600 Nm. In combination with the wide transmission-ratio range (main drive: $i=2.588$ to $i=4.250$; power take-in: $i=2.588$ to $i=13.813$), it guarantees high-performance operation with reduced emissions and noise. Its modular construction and compact design make it the ideal choice for ships with limited installation space.

ZF 3000 NRD PTI

The new hybrid transmission for waterjet vessels, ZF has expanded its portfolio to cover this powerful propulsion type. The first entry in this model series, the ZF 3000 NRD PTI, is designed for a maximum output of 1,940 kW and 7,560 Nm on the primary drive unit plus 250 kW_e and 1,500 Nm at the electric PTI. ZF is also developing two other solutions for larger vessels, the ZF 5000 NRD PTI and ZF 8000 NRD PTI.



In addition to a broad portfolio of hybrid transmissions, ZF also offers hybrid all-in-one solutions, transmissions for electric drives as well as electric and hybrid thrusters.



Place your thrust in electrification

Starting in 2022, ZF enhanced its thruster range with the latest advancements in hybrid and electric technology, incorporating cutting-edge features. Available in various sizes and types and covering a performance span from 100 kW up to 2,500 kW, these azimuth thrusters are the ideal choice for a variety of use cases and vessel applications. The ZF AT series is available in a hybrid configuration as a Z-drive, or purely electric configuration as an L-drive. With such solutions for purely electrically powered vessels, ZF is helping to accelerate the development of more sustainable ship types.



Full e-speed ahead: transmissions for electric applications

Going beyond "just" electric thrusters, ZF is also developing propulsion systems for fully electric vessels – the recently unveiled ENC transmission series. The first entry in this range, the ZF 3000 ENC, is available starting Q4 2024. It's available for all series from ZF 2000 to ZF 9000 including all sub-configurations (II, A, V etc.). Optimized for high-rpm electric drives thanks to its outstanding power density and efficiency, this transmission also excels with a noise, vibration and harshness profile tailored for this specific use case.

The Norwegian catamaran ferry "Kinsarvik" recharges its batteries during docking stops. It operates fully electric with its two ZF thrusters.



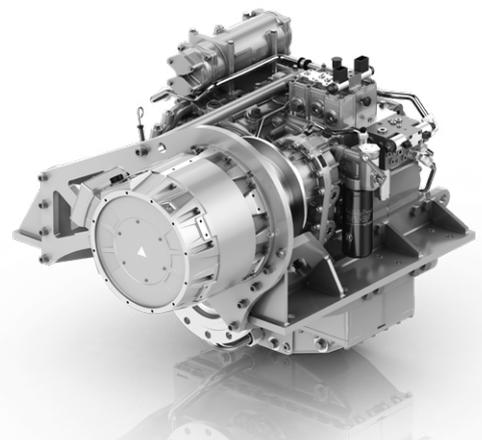


Norled's fully electric ferry "MS Torine" operates on Hvaler's waters in Norway. The ferry transports 8 cars and 147 passengers, promoting sustainable, low-emission maritime transport.

Hybrid module: plug and play bolsters sustainability

With its new marine hybrid module, ZF simplifies electrification of new and existing ship designs. The key feature of this solution is a newly developed supporting frame – which, unlike typical hybrid installations, removes the need for a separate base for the e-motor and offset-adjustment coupling. This plug-and-play approach, which is unrivaled in the market, reduces installation space and considerably simplifies the installation of the module and the maintenance of the e-motor.

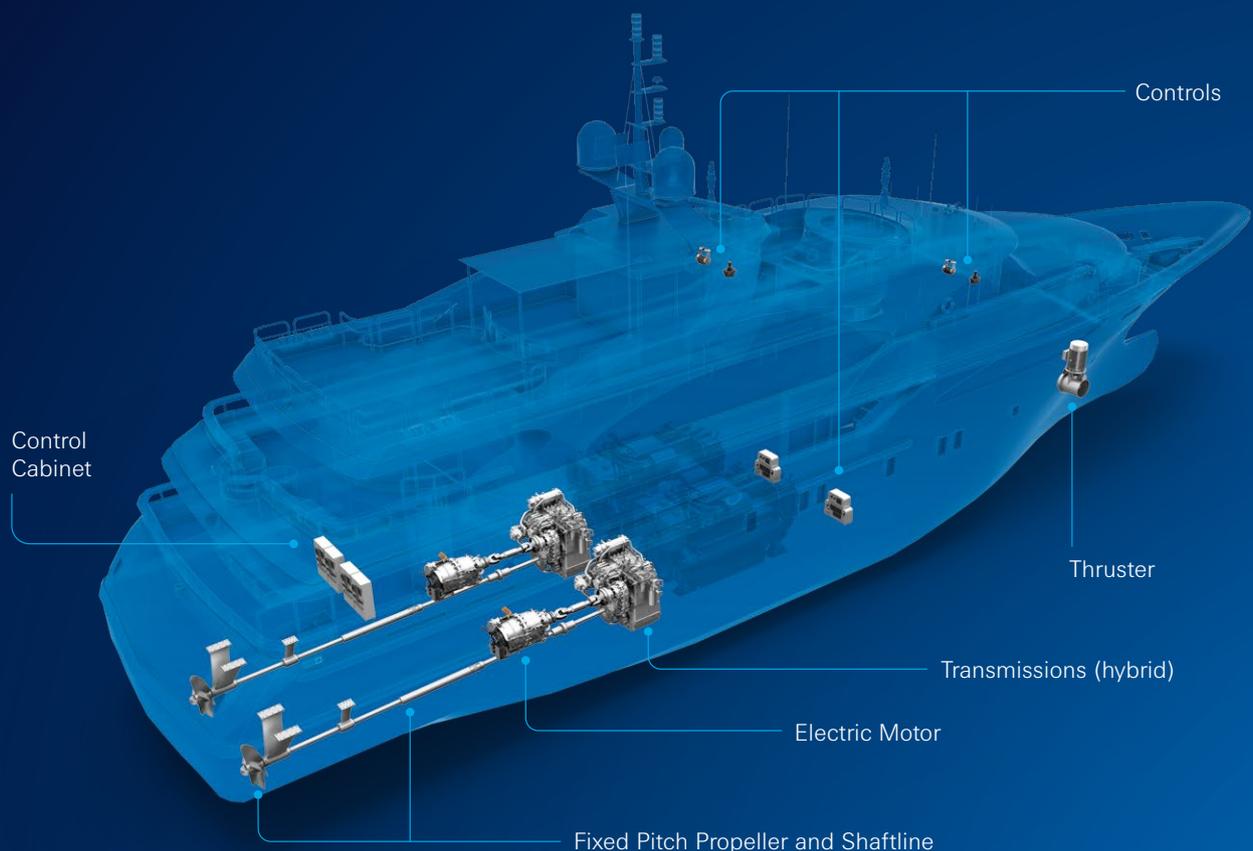
- Available with hybrid transmissions from the ZF 3000 and ZF 5000 series
- Covers a power range of up to 2,463 kW at 2,450 rpm, with an application-specific electric motor (delivering either 150 kWe, 200 kWe or 300 kWe)
- Includes custom-designed torsional clutch to absorb torsional vibrations from the electric motor
- Plug-and-play setup simplifies installation, maintenance, and saves installation space
- Allows existing ship platforms to be retrofitted and electrified



Thanks to its new marine hybrid module, ZF simplifies electrification of new and existing ship designs.

One Source. Tailor-made solutions.

Outstanding propulsion is more than the sum of its parts. ZF not only offers single components but can also act as a one-stop shop for comprehensive electric driveline solutions. Shipbuilders and vessel owners gain access to the market-leading quality, harmonized drive systems and reliability of a global maintenance and service network – with a single point of contact, which saves time and simplifies the process.

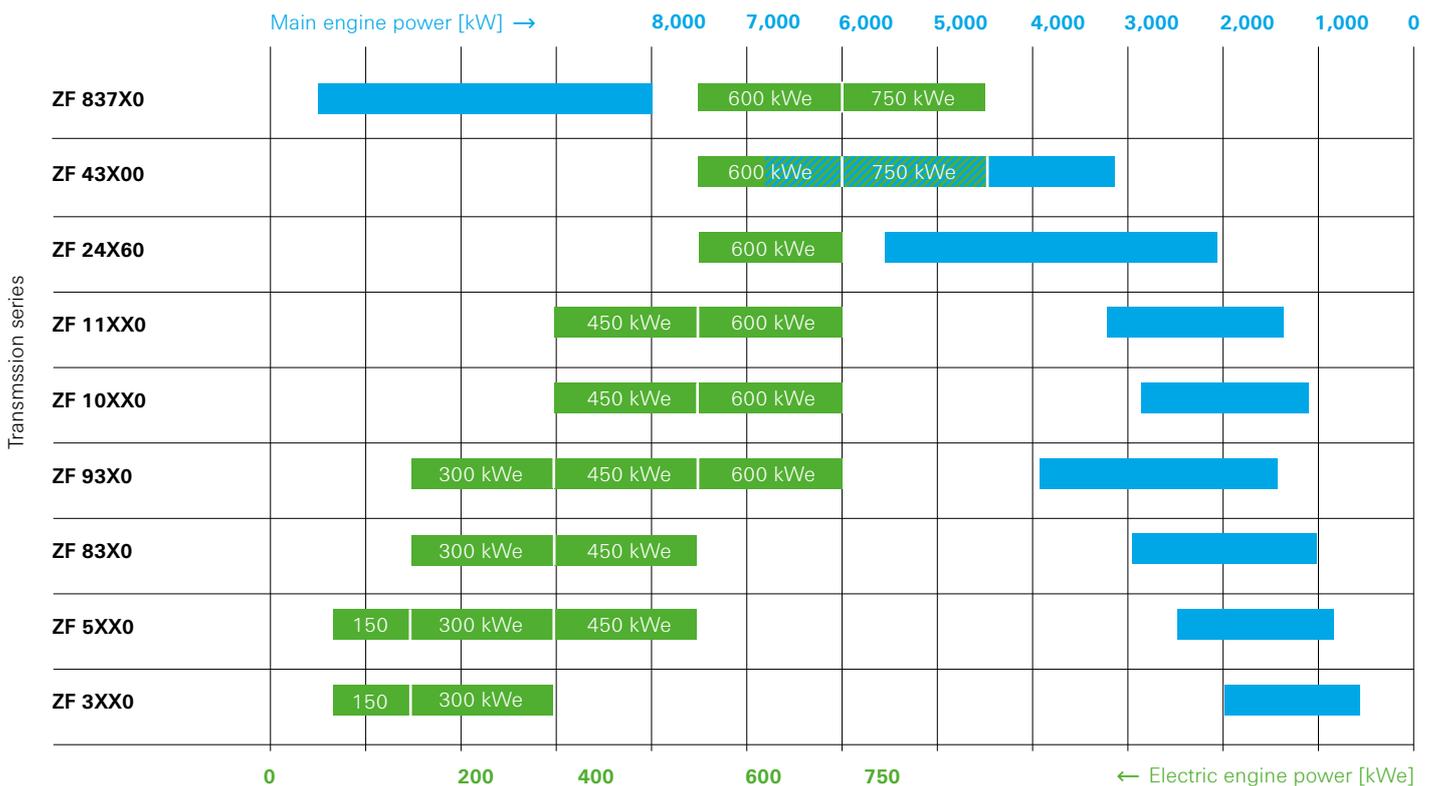


ZF Hybrid System: optimal performance, hassle-free integration

With this comprehensive overall solution, ZF offers shipbuilders an easy way towards a powerful and reliable hybrid propulsion. The ZF Hybrid System includes a hybrid transmission, electric motor, control system, power electronics, plus well mounted azimuth thrusters, fixed pitch propellers and shaftline. This turn-key approach ensures that all components are perfectly harmonized with each other before leaving the factory. It also guarantees that the system performs optimally in every application without any additional integration effort.

- Singular source for complete driveline
- Components perfectly harmonized at production
- Optimized performance in every application
- No additional integration effort
- Extended life cycle and reduced maintenance costs
- Simplified maintenance and service requirements

Power range of electric motors for PTI transmissions



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