



Hybrid propulsion technology

Marine Propulsion Systems



David and Goliath: Instead of working against each other, small tugs and huge cargo container ships work together. The latter are irreplaceable for the global transport of goods and cover long distances in demanding seas. But when it comes to manoeuvring in the port area, the steel giants are dependent on the help of “tuggers”. Neptune’s new EuroTug 3515 is one of them. Since robustness and performance are particularly important here, the Dutch shipyard relies on ZF technology, the hybrid-capable ZF W5355 PTI transmission

Combining the best of two worlds

In view of increasingly stringent regulations on the high seas and in port cities, the future of shipping belongs to clean and sustainable propulsion systems.

ZF’s comprehensive hybrid portfolio is designed to help reduce emissions, fuel consumption and operating costs. This next generation technology will support shipbuilders, vessel owners, and operators in many application segments worldwide. The Group offers transmissions, electric motors, converters and control systems from a single source, which further increases reliability, efficiency and quality.

There are many arguments in favor of maritime hybrid propulsion systems: less noise and exhaust gases, but more fuel savings and more effective power delivery during slow speed maneuvering. Starting in 2020, stricter environmental regulations and laws apply to the oceans. In electric mode, hybrid vessels may continue to drive to ports and waters that are closed to purely conventional vessels. Manufacturers and operators alike benefit from the broad portfolio of hybrid-ready transmissions that ZF offers for almost all application segments. To this end, the company is

expanding its gearboxes with an clutchable additional power take-in (PTI), via which an electric machine alone or in conjunction with the conventional power unit drives the propeller shaft. This auxiliary drive can serve a variety of ratios. An optional spur gear compensates for differences in speed between the main engine and the electric motor.

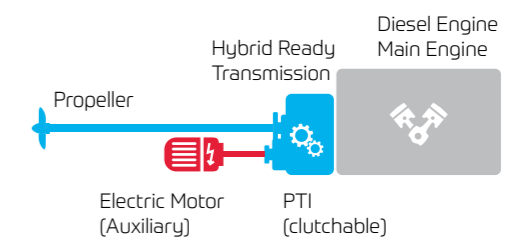
Advantages for almost all ship types

The portfolio of hybrid systems covers a power range from approximately 600 kW of conventional power (ZF 33X0 series) to a maximum of 11,500 kW (ZF 83700). In the lower power range, the hybrid-ready transmissions can be combined with electric motors and converters between 150 kWe and 750 kWe. Thus, ZF offers suitable propulsion solutions for a large number of different marine applications.

Application-oriented hybrid concepts

PTI equipped ZF transmissions allow for various hybrid concepts in marine applications. Not only the future-oriented combination with an electric motor is possible, but also the connection of a conventional internal combustion engine, which may be the more appropriate solution for some applications. Thus, two powerful main engines can be connected for maximum performance. Alternatively, a smaller internal combustion engine is installed as an auxiliary unit to increase performance or as a more economical drive for low-load operation.

CODAE / Combined Diesel and Electric



Hybrid technology from one source

ZF is expanding its already wide range of hybrid-ready marine transmissions with the ZF 5200 PTI as down angle version underlines the claim of being a complete driveline supplier.

Emission-free power

The electric drives offered by ZF enable shipbuilders to pursue a hybrid platform strategy for the driveline with the transmission and electric motor coming from one source. The combination of these two innovative technologies in one propulsion system guarantees perfect interaction and optimum power delivery.

The drive is based on synchronous reluctance assisted permanent magnet technology (SRPM) offering undisputed benefits for the operator:

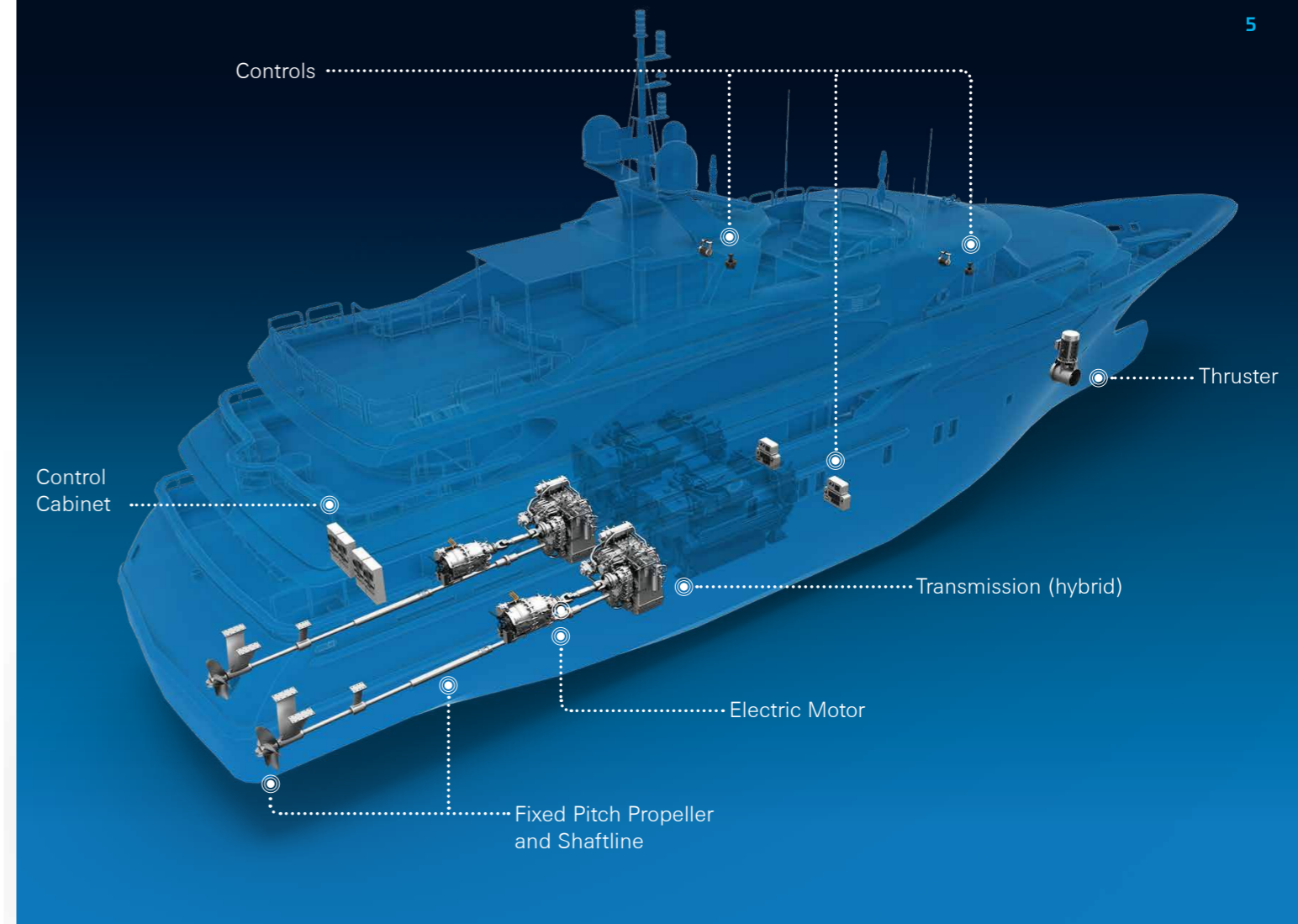
- Liquid-cooled for high peak and continuous loading
- Compact design and light weight, allowing retrofit of conventional drivelines
- Works as generator for maximum flexibility in the power management
- Certification by all major classification societies
- Optimal system performance with ZF PTI-transmissions, inverters and electronics
- Zero-emission driving in fully electrical mode

ZF 5200 PTI transmission with down angle

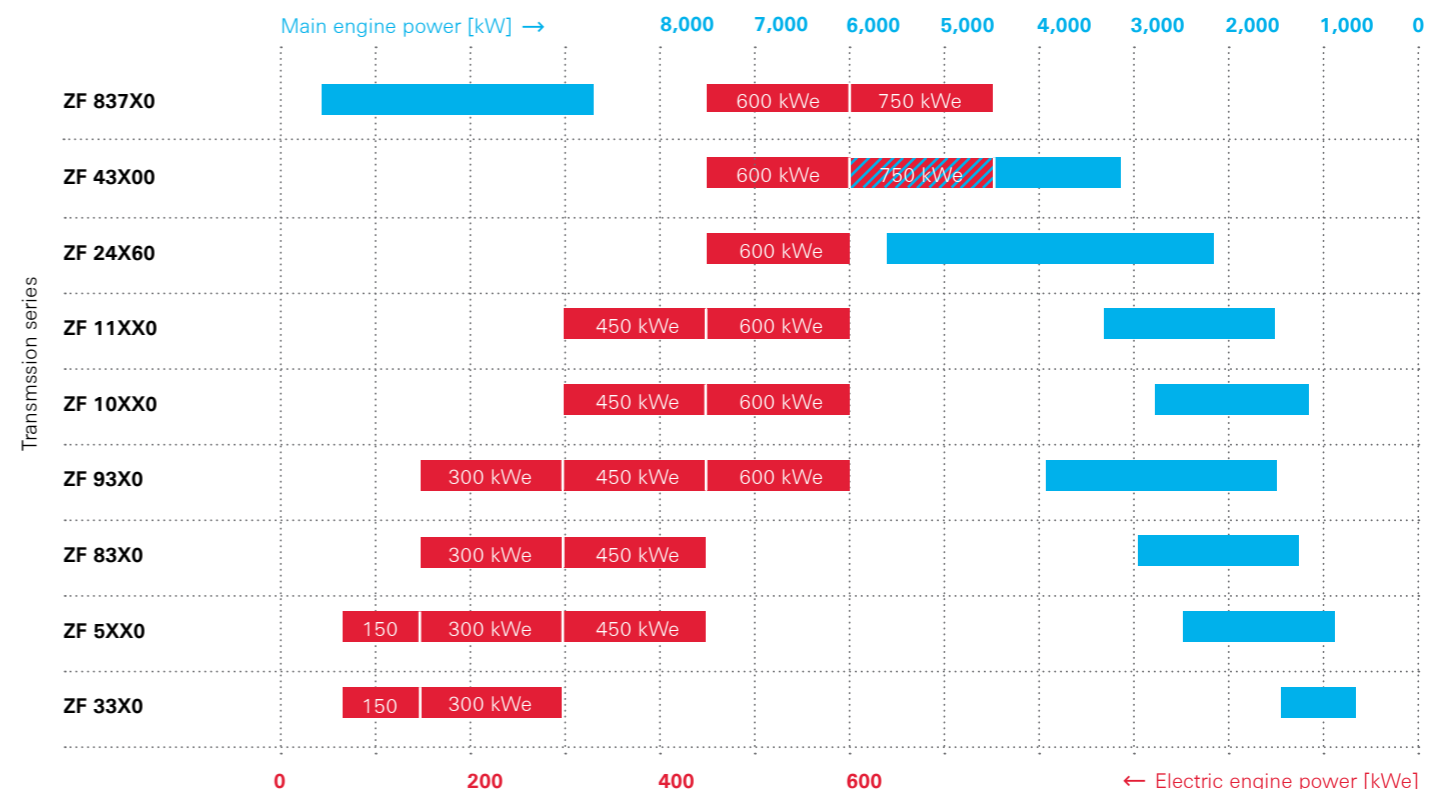
With the ZF 5200 PTI transmission, ZF is presenting the first downangle transmission ready for hybrid applications. With this transmission A and V configurations can be realized, allowing horizontal installation of engine and gearbox giving manufacturers high flexibility for new designs and retrofits. With multiple gear ratios it matches main engines ranging from 900 to 2500 kW and with the variety of PTI spur gears e-motors up to 450 kW can be added. Due to the compact and light design, the e-motors can be flanged directly to the transmission. Thus the ZF 5200 transmission with PTI covers a wide range of applications and can be used in coast guard ships, yachts and commercial vessels.

Specifications and features

- Flexibility to be integrated into a wide variety of hybrid vessel propulsion solutions
- Rated up to 2,500 kW
- Gear ratios from 2.588 to 4.250
- Incl. PTI ratio with spur gear up to 13.81
- Configurable to various applications in the appropriate power range, for both super yachts and commercial vessels
- Top, live, and pump PTO available, as well as optional trailing pumps
- The ZF 5200 PTI, like all ZF marine transmissions, can be certified by all major classification societies



Power range of electric motors for PTI transmissions





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 the best possible consideration of different, sometimes conflicting interests for 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 fuel-optimized in stand-by mode, ferries and motor yachts can be run purely electrically, and research vessels are maneuvered virtually silently and with low vibration. Since the main engine is offline in Electrical Drive Mode, operating hours are saved. This increases the life 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 electric power unit can be used as a boost when accelerating or – in generator mode – to cover the electric power requirements on board of the ship. This allows for 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.

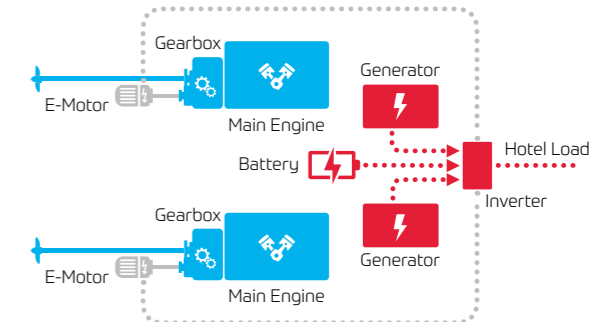


Operation modes with electric motor

Engines can be operated in different modes depending on priorities.

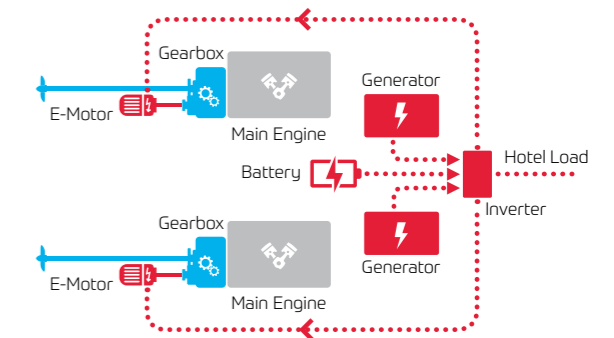
DIESEL DRIVE MODE

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



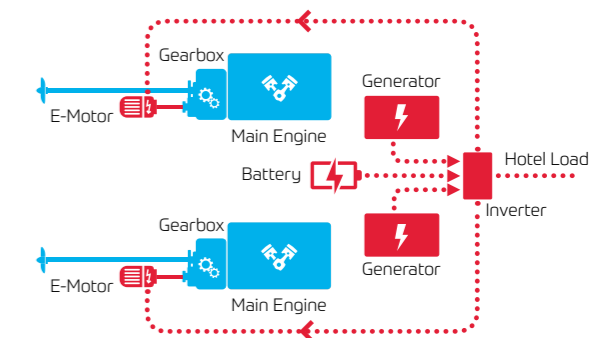
ELECTRIC DRIVE MODE

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



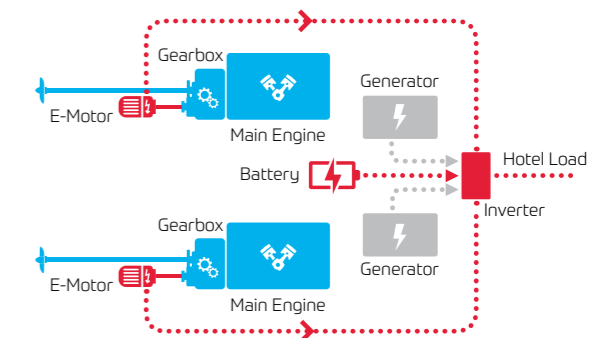
BOOST MODE

- 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.

ZF Friedrichshafen AG

Marine & Special Driveline Technology
Ehlersstr. 50
88046 Friedrichshafen
Germany
Phone +49 7541 77-2207
info.zfmarine@zf.com

ZF Padova s.r.l.

Via Penghe, 48
35030 Caselle di Selvazzano (PD)
Italy
Phone +39 049 8299 311
info.zfmarine@zf.com

ZF Marine Krimpen B.V.

Zaag 27, P.O. Box 2020
2930 AA Krimpen aan de Lek
The Netherlands
Phone +31 180 331000
info.zfmarine@zf.com

www.zf.com/marine



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