



Ready for hybrid propulsion

Marine Propulsion Systems



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.

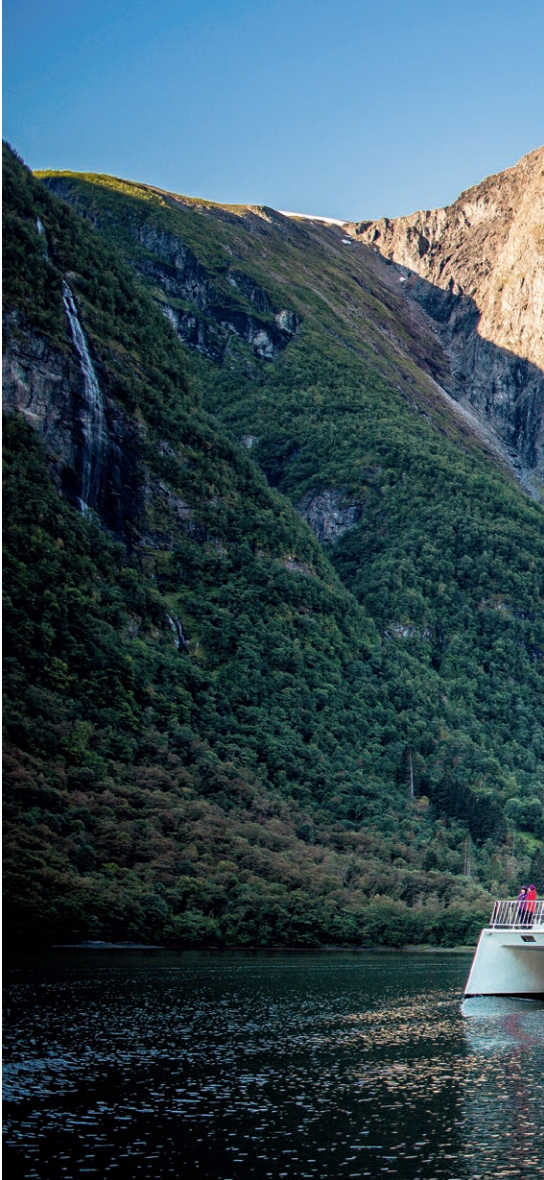
ZF's comprehensive hybrid-ready transmission portfolio is designed to help reduce emissions, fuel consumption and operating costs. This next generation technology will support shipbuilders, vessel owners, and operators in many application segments worldwide. The Group offers transmissions, electric motors, converters and control components 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 will 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 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 helical gearbox compensates for differences in speed between the main unit and the electric motor.

Advantages for almost all ship types

The portfolio of hybrid-ready ZF transmissions 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 600 kWe. Thus, ZF offers suitable propulsion solutions for a large number of different marine applications.



Fulfilling today the requirements of tomorrow: the Norwegian ferry "Vision of the Fjords" crosses the coastal waters of the Nærøfjord emission-free thanks to the ZF hybrid transmission.

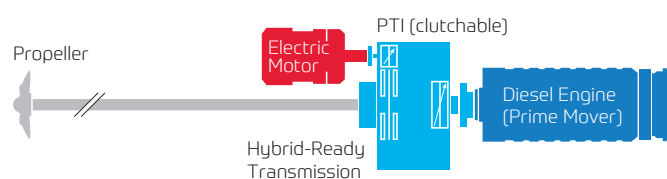


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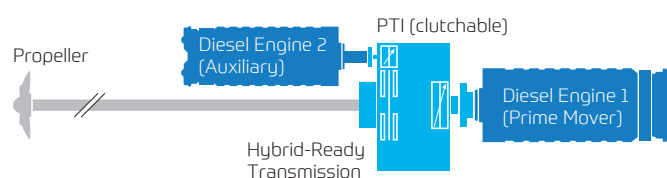
Application-oriented hybrid concepts

ZF transmissions with PTI allow for different 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.

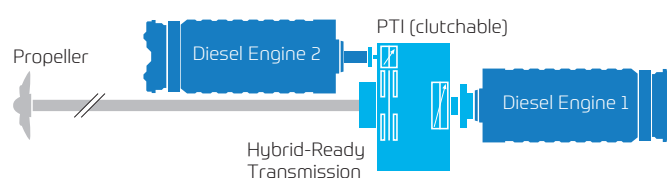
CODAE / Combined Diesel and Electric



CODAD / Combined Diesel and Diesel



CODAD / Combined Diesel and Diesel



Hybrid-ready technology from one source

ZF is expanding its already wide range of hybrid-ready marine transmissions with the ZF 8000 series and underlines the claim of being a complete driveline supplier with the marinized electric drive CeTrax.

Emission-free power with ZF CeTrax

The electric drive ZF CeTrax enables shipbuilders to pursue a hybrid platform strategy for the driveline with the transmission and electric motor coming from one source. CeTrax is already proven in other applications on land and has been adapted for maritime use in conjunction with powerful hybrid transmissions. The combination of these two innovative technologies in one propulsion system guarantees perfect interaction and optimum power delivery.

The e-drive solution provides additional power of up to 300 kW_e to vessels with a maximum main engine power of 3,900 kW. The drive consists of an electric motor and a downstream planetary stage. This stage is the same as in the ZF EcoLife transmission, with thousands of successful units already to its name.

The three-phase current asynchronous traction motor is water-cooled, making it suitable for high peak and continuous loading.

ZF CeTrax specifications and features

- Electric drive motor with integrated planetary stage proven and tested in the ZF EcoLife transmission
- CeTrax is configured with a maximum output of up to 300 kW_e and a maximum torque of 4,400 Nm
- High-quality ZF inverter, specifically optimized for top performance with ZF components
- High peak and continuous power through liquid cooling
- Compact design, light weight
- Optimal performance as a ZF system with inverter and electronics
- Zero-emission driving in PTI Drive

New and highly flexible transmission series ZF 8000

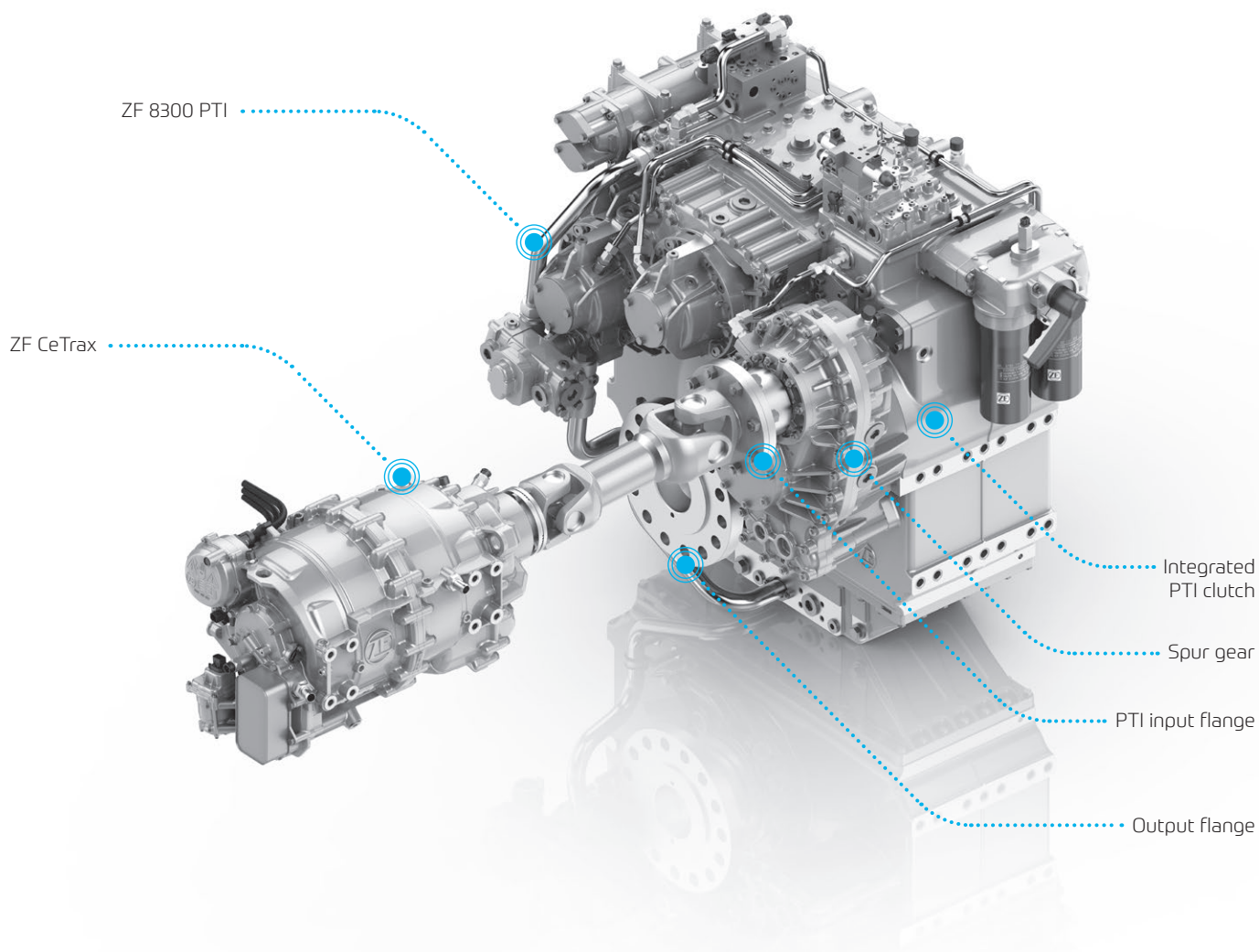
With the ZF 8000 series, ZF is presenting a brand-new marine transmission family for a power range up to 3,000 kW. The availability of multiple gear ratios, housing sizes and variants gives manufacturers high flexibility for new designs and retrofits. Thus, the ZF 8000 series covers a wide range of applications, from coast guard ships and yachts to ferries, supply vessels and small tankers.

The advantages of this advanced transmission include higher power density, more robust housing and optimized power to weight ratio. An additional power take-in allows for the connection to an electric motor to gain hybrid functions.

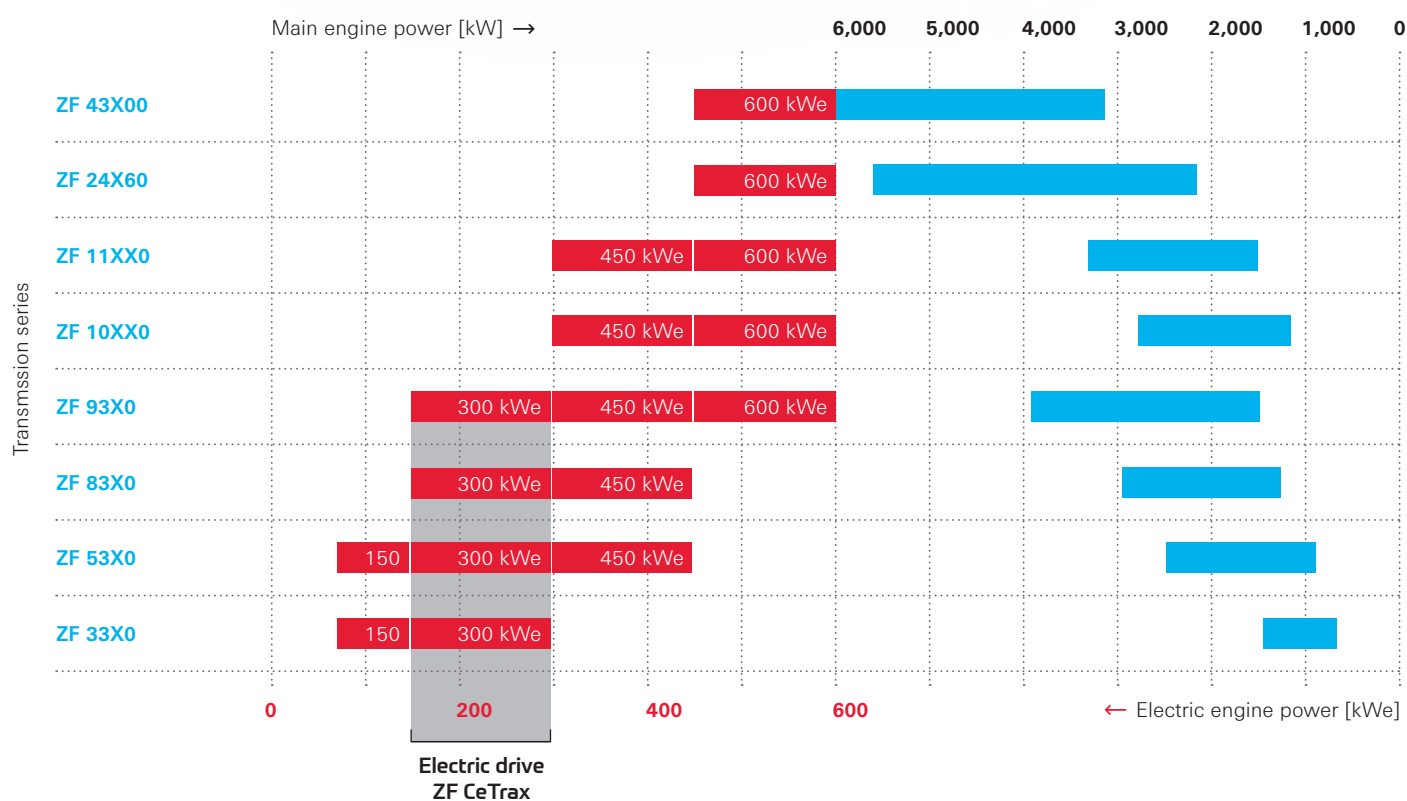
In the new model family, ZF integrates an electrical control system ex works, in addition the ZF 8000 can be supplied in combination with an elastic coupling, electronic pump, control unit and, in the future, with smart condition monitoring.

ZF 8300 PTI specifications and features

- Flexibility to be integrated into a wide variety of hybrid vessel propulsion solutions
- Rated up to 3,000 kW
- Gear ratios from 2.5 to 5.0
- Incl. PTI ratio with spur gear up to 16.25
- 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 8300 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.

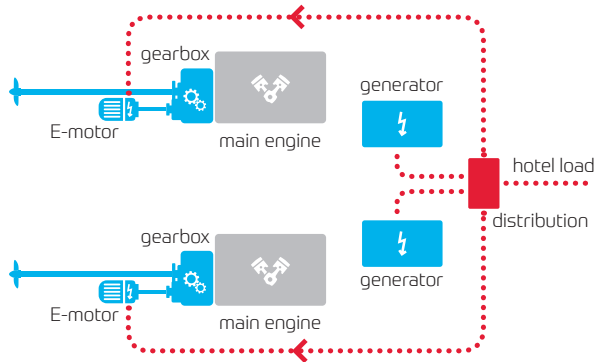
For example, harbor tugboats can be operated fuel-optimized in stand-by mode, ferries and motor yachts can be run purely electrically, and research vessels are maneuvered virtually silently and with low vibration. Since the main engine is offline in PTI mode, operating hours are saved. This increases 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 economic mode – as generator 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 four different modes depending on priorities.

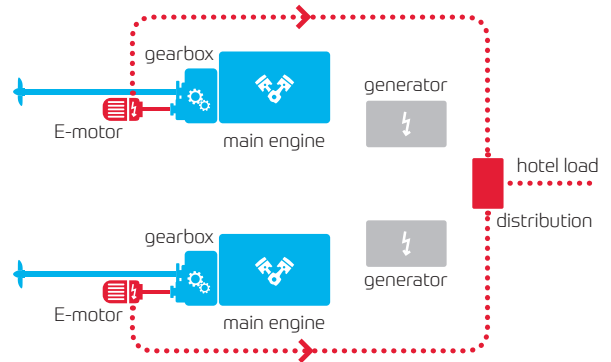
HYBRID MODE



Electric propulsion only

- Main generators on / main engines off
- E-Motors providing mechanical power via PTI (Power Take In) drive of ZF PTI gearboxes to propeller shafts
- Speed up to 9 knots

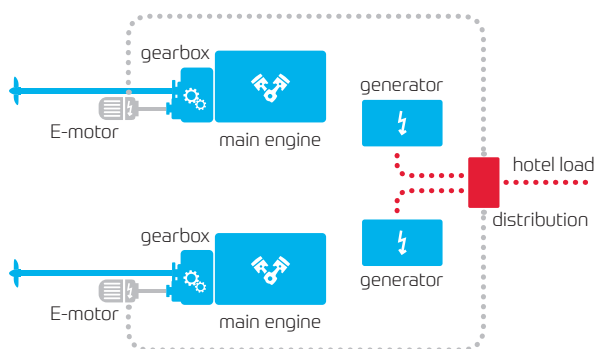
ECONOMIC MODE



Diesel propulsion

- Main generators off / main engines on
- E-Motors providing electrical power (hotel load) via PTI drive of ZF PTI gearboxes to distribution box
- Speed up to 9 to 12 knots

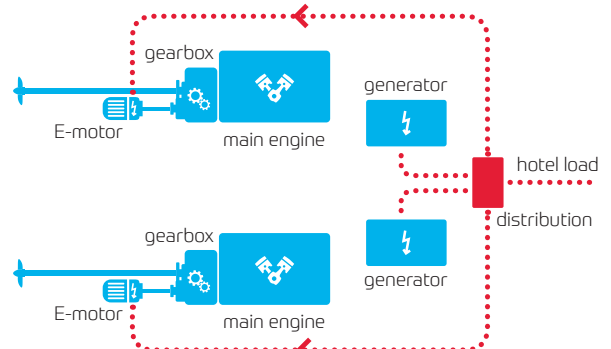
CRUISING MODE



Diesel propulsion

- Main generators on / main engines on
- E-Motors off / PTI drives of ZF PTI gearboxes disengaged
- Speed up to 12 to 15 knots

BOOST MODE



Diesel and electric propulsion

- Main generators on / main engines on
- E-Motors providing mechanical power via PTI drive of ZF PTI gearboxes to propeller shafts
- Speed up to 16.3 knots

The additional operation mode **WIND MILLING MODE** is available for sailing boats.

ZF Padova s.r.l.

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

ZF Friedrichshafen AG

Marine Propulsion Systems
Ehlersstr. 50
88046 Friedrichshafen
Germany
Phone +49 7541 77-2207
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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