ZF Electrifies

Systems Expertise for Electrically Driven Commercial Vehicles
There is no halt to driveline electrification. It is an essential lever for rapidly reducing emissions from local traffic.

With decades of experience in state-of-the-art vehicle drives, ZF can also offer electric and hybrid system solutions for commercial vehicles. On the one hand, they comprise the driveline; on the other, also the chassis, brakes, steering system, energy distribution and PTOs. With this unique overall package, ZF has become a systems supplier.

With our extensive portfolio, we cover all types of commercial vehicles – from small light commercial vehicles to heavy trucks and city buses. Our expertise in the fields of electric and conventional driveline and chassis technology makes us the partner of choice for vehicle manufacturers and operators: A one-stop shop – in your interest.
ZF leads the way in all vehicle classes when it comes to e-mobility. We have been using electrified drives in passenger cars for many years, and more than 2,200 electric buses worldwide already feature our AxTrax AVE electric portal axle. Vision Zero is our top development target: Zero emissions! Zero accidents!

Quality, technology leadership and innovative strength have shaped ZF’s identity for more than 100 years. Today, we also create comprehensive system solutions for the world of electric commercial vehicles: safe, efficient and sustainable.

The expertise for all relevant components in e-mobility is combined under a single roof at ZF, which makes us unique.

We are consistently working on expanding our portfolio for electric axle and central drive systems. In addition to a modular concept that caters for bus and truck applications from light to heavy vehicles, we also offer perfectly harmonized power and control electronics for best energy efficiency, safety and service life. We use an energy management system for the perfect interaction of the individual systems in the vehicle.

Steering systems and PTOs supplement the range of electric system components. Our systems expertise also comprises relevant chassis technology as well as brakes and driver assistance systems. Consistent lightweight design supports long ranges and high payloads. This is complemented by the conventional driveline technology around transmission and axles, which has always been our core business.

The integration of WABCO further strengthens our expertise in the areas of autonomous driving, vehicle safety and efficiency. Including the WABCO company in the ZF family is therefore also a sign that we are continuing and expanding our fundamental system approach.

Find out more about ZF technology at www.zf.com/emobility.
ZF offers future-proof system solutions for public transport. Worldwide, more than 2,200 electric buses have already traveled around 150 million kilometers with AxTrax AVE.

For clean cities

The AxTrax AVE electric portal axle with an integrated near-wheel drive is the solution for electric buses, hybrid buses and trolleybuses. Purely electric, zero-emission driving is possible both in solo and articulated buses.

Each wheel is driven by a compact, high-torque electric motor to keep the axle weight including the integrated motors low. The vehicle is lighter and the system requires less space because there is no conventional drive and no propshaft. The additional space allows for innovative interior designs with comfortable seating and standing for passengers in the entire bus. They also get on and off faster. Of course, the extra space can also be used for batteries.

No special wheel components are required with the AxTrax AVE. The same tire-rim combinations and standard disc brakes as in normal buses can be used. The brakes are fitted in the same easy-to-service position as with the standard axles.

The ZF system: AxTrax AVE, the inverter and the ZF EST 54 control unit form the basis for the systematic interplay of power request, recuperation and energy storage. As a result, vehicle manufacturers receive an ideally tuned system package.

Advantages at a glance
- Developed for demanding city bus applications
- Driveline designs: hybrid, fully electric (fuel cell or battery) and trolley line
- Compatible with the low-floor axles Av 133 and AVN 132
- Opens up innovative passenger compartment design options and new bus concepts
- High peak and continuous power through liquid cooling
- High torque-mass ratio
- Suitable for all-wheel drives

Climbing ability
29-ton articulated bus with only one electric portal axle

12%
CeTrax

For conventional driveline concepts

Buses and trucks need to be fast and effective as well as – today more than ever – clean and quiet! Logistics companies and transport operators demand low-cost, low-emission vehicles. Especially for conventional driveline arrangements, ZF offers its CeTrax electric central drive.

The new CeTrax system is an all-electric central drive that can be used in different bus applications as well as in delivery trucks. CeTrax was specially developed for demanding inner-city applications. Installed in battery-driven vehicles, the system operates with zero local emissions!

The focus is on manufacturers that want to integrate an electric drive into their existing conventional vehicles. Bus manufacturers benefit from the option of using the system both for low-entry and high-floor applications as well as for low-floor buses in combination with the AV 153 portal axle. It is also suitable for replacing internal combustion engines in truck chassis in conventional arrangements. CeTrax saves on costs and reduces the workload involved in technical integration as well as in service.

With a maximum power output of up to 300 kilowatts and a maximum torque of 4,500 Nm, CeTrax is second to none in terms of performance when compared with a classic drive and enables vehicles to overcome steepest gradients.

Another highlight is the integrated gear stage with proven components from EcoLife. It comes with two advantages compared to conventional systems on the market. On the one hand, the electric motor can be more compact and lighter. At the same time, it enables the use of standard axles with common ratios.

As with all commercial vehicle electric drive systems from ZF, the CeTrax system is supplied complete with an inverter and an electronic control unit.

**Torque:weight ratio (system)**

Nm/kg

15.3

**Advantages at a glance**

- Can be combined with common drive axles and ratios
- Application of proven components from ZF-EcoLife city bus transmission
- Use of standard axles with common ratios possible
- ZF system including inverter and electronics
Bus Products

When it comes to power sources for electric buses, ZF develops central drives and near-wheel drives. Matching inverters and control units complete the drive systems. All-electric power steering makes the perfect addition.

The CeTrax electric central drive can be integrated simply into vehicle designs with a conventional driveline layout. It can also be combined with standard axles and common transmission ratios. With a top performance of 300 kilowatts and high system efficiency at low weight, it is suitable for all bus types up to a vehicle weight of 29 tons.

The AxTrax AVE electric portal axle is suitable for all electric energy sources. High-torque electric motors installed directly in the axle hub units deliver top performance of 250 kilowatts to get fully loaded buses in motion quickly. During braking, they recuperate energy. The lack of a conventional driveline leaves space that allows for new vehicle designs. Using standard components saves warehousing and service costs compared to other near-wheel drives.

ZF high-voltage inverters with nominal voltages of 325 to 650 volts control the asynchronous motors of ZF electric drives.

The electronic EST 54 control unit, which has already proven its value in EcoLife transmissions, uses the SAE-J-1939 standard to communicate with drive and vehicle components and also features a diagnostic interface. The software can be adapted to the specific vehicle and telematics solutions offer a variety of additional features.

The REAX EPS fully electric steering system for heavy commercial vehicles and the REAX-e for light commercial vehicles are compact, lightweight and fuel-saving. Thanks to its powerful electric motor, it requires no support, neither from hydraulics nor from an internal combustion engine. That makes them predestined for especially eco-friendly, all-electric or hybrid commercial vehicles.

The electrically driven EPHS steering booster pump makes it possible to use conventional hydraulic power steering systems even in vehicles with hybrid or fully electric drives.
**Truck Products**

ZF electric drive systems provide all-electric or semi-electric solutions for light commercial vehicles and trucks. They range from central drives to axle and wheel drives or hybrid drives, complete with suitable inverters and electric control units. Also available is all-electric power steering.

With the compact, lightweight **CeTrax lite** drive system for vans and light trucks, both the electronic control unit and the inverter are fully integrated. When it comes to the electrical components, ZF relies on scalable solutions from the passenger car sector and validates them for commercial vehicles. CeTrax lite will be designed so it is combinable with standard axles and common ratios.

The **CeTrax electric central drive** can be integrated simply into vehicle designs with a conventional driveline layout. It can also be combined with standard axles and common transmission ratios. With its high system efficiency, it is suitable for small and medium-duty commercial vehicles, for example waste collection vehicles.

Currently, the **AxETrax electric driven axle** for purely electric trucks is being developed. The integrated electric motors are capable of full recuperation in coast mode. Since there is no cardan shaft, the battery packs can be accommodated in the body-on-frame. The result is highest-possible safety in case of collisions.

The **TraXon Hybrid** modular hybrid system is also being developed. Its electric motor is fully integrated in the TraXon automated manual transmission. Support of the combustion engine (boosting) and recuperation of the braking energy can significantly save fuel. Depending on the system design, purely electric driving is also possible.

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With the **eWorX** product family, ZF offers a fully electric system solution to electrify work equipment. This solution is completely independent from the drive architecture. Here, the modular eCubE, consisting of power electronics, ZF control unit and application-specific software modules, forms the link between vehicle and work equipment. It is possible to integrate new safety and assistance functions by using GPS and ADAS signals via the vehicle’s CAN bus.
Energy Management System
EMS

For reliable operation in fully electric commercial vehicles, all energy consumers must be supplied with electrical energy efficiently and reliably. Sophisticated energy management is therefore a must.

Today's accumulator systems limit energy storage in fully electric commercial vehicles. Therefore, the existing energy must be made available to all existing consumers prudently and efficiently. Here, the vehicle drive itself plays just as an important role as power electronics or the energy accumulator. However, the provision of compressed air, thermal management, the steering pump and the voltage converter have to be optimally supplied with energy.

This is where the ZF Energy Management System (EMS) comes in. The EMS software offers the functional integration and control of all electric components and auxiliaries in the vehicle. It controls all processes in the vehicle that require energy supply – from starting the vehicle to full speed, but also during standstill and when operating PTOs. EMS uses the CAN structure in the vehicle and activates each unit with the respective priority.

The efficient, economical distribution of existing energy takes top priority. When calculating the demand, the EMS system relies on anticipatory GPS and PreVision data. This allows for topography, resulting recuperation processes as well as assistance functions to be integrated effectively in the overall energy management. The EMS system also monitors the charging processes of the energy accumulators and assumes its charging management.

A major advantage of the EMS system is the flexible adaptation of existing interfaces to the most different types of auxiliaries used in the vehicle. It also harmonizes perfectly with the electric PTOs of our in-house eWorX system.

Electric PTOs
eWorX

Fully electric commercial vehicles feature a significantly modified vehicle architecture compared to conventional diesel-powered vehicles. This confronts body and vehicle manufacturers with entirely new challenges.

With the ZF eWorX product family, we provide a fully electric system solution in one compact, smart unit comprising all functions required for electrifying work equipment – no matter which architecture is used for the drive.

The ZF eWorX system offers an efficient, cost-effective electrification of work equipment. The modular design allows for maximum flexibility in terms of function, design and installation. The energy management system optimally controls all processes in the vehicle. The ZF eCubE serves as the interface between the vehicle and the work equipment. The harmonized combination of power electronics, the powerful ZF control unit and application-specific software modules enables all components to work with maximum efficiency, which optimizes the performance of the battery.

The connection to the vehicle CAN bus allows for seamless integration into the vehicle's battery and energy management and thus ensures even better utilization of the battery charge. New safety and assistance functions can be realized via GPS and ADAS signals that are also available in the CAN bus.

Using a smartphone or tablet, work equipment and eWorX products can also be controlled from outside of the vehicle via an easy-to-handle user interface.

With a local grid, ZF also offers the opportunity to operate external work equipment by means of standard plugs for 400 V or 230 V using the vehicle power supply.

The ZF eWorX family: from left to right
Switch box with Local grid, eCubE, electric drive for work equipment (illustrated example: electric motor with hydraulic pump)
Electric vehicles present many new challenges for chassis technology; however, they also open up new chassis layout options.

The permitted payload is the decisive factor for the cost-effectiveness of a commercial vehicle. Components required for electric drives, especially batteries, increase the empty weight. The challenge here is to offset this with systematic lightweight design. At the component level, the answer is using lightweight materials. Intelligent chassis solutions are required for developing new space- and weight-saving vehicle architectures.

The ZF 4-point link, for example, combines three chassis tasks in a single component: not only longitudinal and transversal axle guidance, but also roll stabilization. It is made from fiber-reinforced plastic, and with this integration of functions, ZF is also accelerating lightweight design.

Depending on the electric vehicle concept, the relevant factors for dynamics, stability and comfort vary. The intelligent CDC damping system compensates for rolling which occurs with a higher center of gravity, e.g. through batteries on the bus roof.

CDC is an intelligent control system composed of system sensors, control unit and CDC dampers. The sensors determine the current driving situation. CDC uses the data of the sensor cluster integrated into the ECU as well as the information available on the CAN bus. The system can adjust the damping force in just a few milliseconds.

ZF provides a perfect offer of driveline and chassis technology from a single source. Both at system and component level.

Example of a weight-optimized chassis:
• Lightweight-design AirtracX rear axle suspension with 4-point link and fiber-reinforced plastic torque rods
• ITS independent suspension on the front axle
Zf is there to serve its customers, always nearby with more than 650 service partners around the globe ready to help drivers, owners or fleet operators whenever they need professional support.

Customers around the world trust in ZF products, which is why ZF, as a global company, provides corresponding services in every market. Added to decades of experience with conventional drives our specialists have gained in cooperation with our customers.

Here’s how you benefit: ZF offers service for both conventional and electromobility products from one source and supports you as you move into electromobility. For all your service questions, you can rely on the same contacts who support you with your conventional ZF products. Similarly, in preventive maintenance and warehousing, you benefit from our comprehensive expertise. For example, our AxTrax AVE electric portal axle features many of the same parts as our conventional ZF rear axles, which have been proven hundreds of thousands of times in the field. It is also just as easily accessible. That means maintenance is quick and there is no need for large inventories.

Also available from ZF are additional services, such as warranty extension contracts (LCC) or repair risk insurance contracts (ECP), preventive maintenance as well as training or fleet management.

ZF is there to serve its customers, always nearby with more than 650 service partners around the globe ready to help drivers, owners or fleet operators whenever they need professional support.

Worldwide On-Site Service – for Conventional and Electric Products

The ZF Group

Groundbreaking technologies for future mobility.

ZF Friedrichshafen AG is a worldwide leading technology company whose comprehensive solutions enable cars, commercial vehicles and applications in industrial technology to see, think and act.

In its “Next Generation Mobility” corporate strategy, ZF has anchored the goal of making tomorrow’s mobility clean, safe, automated, comfortable and available to everyone everywhere. To achieve this, the Group is active in four fields of technology: Vehicle Motion Control, Integrated Safety, Automated Driving and Electromobility.

The Group offers its innovative system solutions both to established vehicle manufacturers and to the newly established providers of transport and mobility services. The company contributes to reducing emissions and protecting the climate, since ZF electrifies vehicles in a wide range of categories.

On May 29, 2020, ZF acquired WABCO Holdings Inc. and integrated it into the Group as the Commercial Vehicle Control Systems Division. With this addition to its own Commercial Vehicle Technology Division, ZF is not only a systems supplier with many years of experience offering a complete product range in the passenger car segment, but now also covers the commercial vehicle range with the same comprehensive portfolio.

As a result of the latest acquisition, ZF Friedrichshafen is now represented with 160,000 employees worldwide at around 260 locations in 41 countries. In 2019, the two then-independent companies achieved sales of €36.5 billion (ZF) and $3.4 billion (WABCO).