SCHAEFFLER

We pioneer motion

Technologies for electric mobility

Innovative. Sustainable. Efficient.

We pioneer motion

Introduction

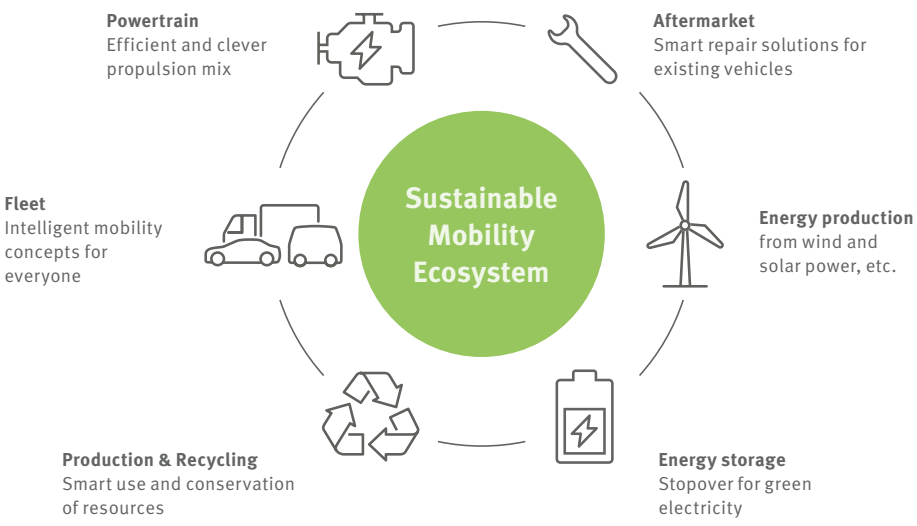
Only a fundamental transformation of mobility and energy systems will lead to a sustainable and environmentally compatible future. As an automotive and industrial supplier with a global footprint, Schaeffler looks ahead and embraces the numerous changes in our social, geopolitical and macroeconomic environment as challenges and opportunities. We strive to shape global progress in mobility.

The quality of our products has always been a success factor, starting with the selection of our suppliers and continuing on the shop floor all the way to the final product. In 75 plants worldwide, we work according to the highest manufacturing standards and assure these across all locations and fields of application. Our quality advantage is based on in-depth knowledge of the correlations between machines, tools and processes. Where necessary, we even build our own production machines, so producing our systems and components for electrified powertrains completely in-house as well is only natural.

We've been taking advantage of our expertise in mechanical components, manufacturing processes and winding technologies plus our knowledge of systems to mass-produce exciting modern and forward-thinking products. The result is an extensive and scalable portfolio for electrification based on a modular concept – for both passenger cars and commercial vehicles.

A vision of sustainable mobility

Schaeffler considers the entire flow of renewable energy: from the source to the vehicle and on to the road, resulting in a holistic framework for sustainable mobility of tomorrow.



We're going to be a key player in shaping electric and sustainable mobility going forward, driven by a passion for developing highly innovative solutions for mobility of the future – with high vertical integration, modularity and scalability.

Dr. Jochen Schröder
President of the E-Mobility Division at Schaeffler

Focus on innovative technologies

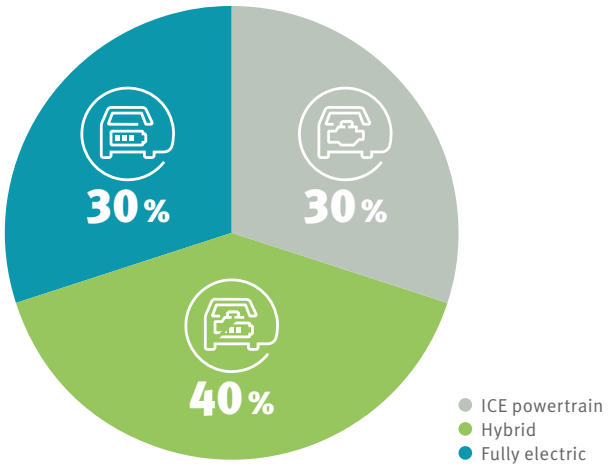
Electrification made to measure

Schaeffler delivers customized solutions for a mix of diverse powertrains as an important contribution to reducing CO_2 emissions by 2050 in pursuit of the 2-degree Celsius climate goal. As a systems partner of the automotive industry, Schaeffler embraces this challenge.

30/40/30: the powertrain scenario

Electrified powertrains are an important building block for the future of sustainable and environmentally compatible mobility.

For **2030**, Schaeffler anticipates that 70 % of the newly produced automobiles worldwide will have an electric motor on board (30 % fully electric, 40 % hybrid). 70 % of the vehicles produced will be equipped with an IC engine – partly in interaction with an electric motor.



Schaeffler solutions for e-mobility

Electric powertrain			**Components and systems for fully electric vehicles** Especially in China and Europe as well as in urban areas, a market for fully battery-electric vehicles is going to emerge in the coming years. Schaeffler has a wide variety of production-ready powertrain solutions for electric vehicles in its product portfolio today.
Hybrid powertrain			**Components and systems for hybrid powertrains** Schaeffler's hybrid portfolio ranges from mild to plug-in hybrid applications, depending on the level of electrification. Both modular and integrated solutions are available.
Mechatronics			**Mechatronic components and systems** Schaeffler has strong expertise in combining mechanical, electric and electronic components and systems. The portfolio ranges from power electronics to actuators to 3in1 e-axle systems.
Mechanical systems			**Conventional mechanical components and systems** Mechanical precision components and systems have been part of Schaeffler's DNA for many decades. Key products include chassis components and systems, technologies for clutches and transmissions, and engine elements.

Hybrid technologies

Components and systems

The hybridization of conventional IC engines is an important key to efficient, more sustainable and demand-based mobility.

Schaeffler's hybrid portfolio ranges from micro to mild to plug-in hybrid technologies based on the level of electrification.

Hybridization reduces IC engine load while assisting and optimizing the engine and, combined with braking energy recuperation, enhances a powertrain system's overall efficiency and range.

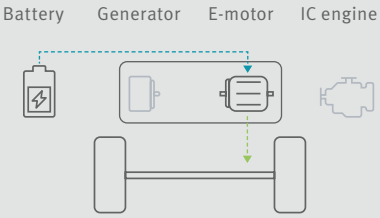
With merely 48-volt hybridization using a belt-driven starter generator, a significant reduction of fuel consumption and emissions can be achieved.

Schaeffler offers a wide range of components and systems for electrifying conventional powertrains. From 48-volt and high-voltage systems with integrated clutches or torque converters to highly integrated hybrid transmissions such as the MultiMode.

The optimal propulsion strategy at all times

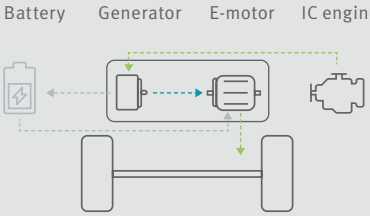
Hybrid transmissions from Schaeffler are efficient, powerful and compact. Featuring three different driving modes, our MultiMode hybrid transmission delivers maximum driving pleasure and efficiency:

E-drive mode



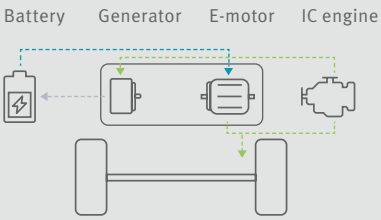
At low speeds, only the e-motor provides propulsion (green arrow = mechanical connection). Power for the traction motor (blue arrow = electrical connection) is supplied by the battery. The IC engine and generator are deactivated.

Series mode



In series mode, the IC engine drives the generator that produces the necessary traction current and charges the battery as needed. The IC engine always operates in the most efficient speed range.

Parallel mode



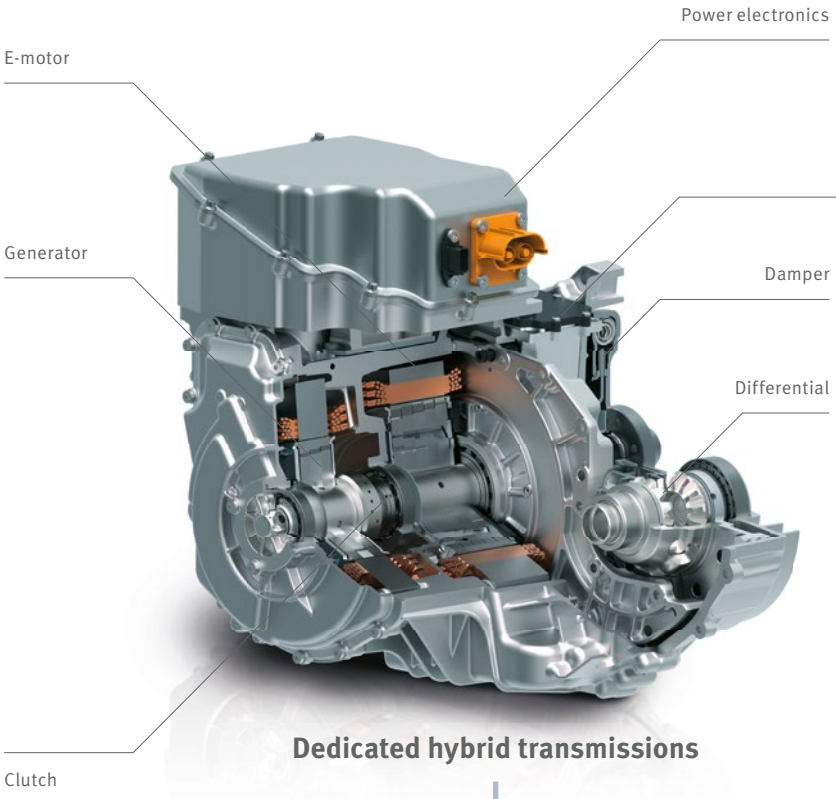
In parallel mode, the e-motor and IC engine act on the axle via the MultiMode transmission. The generator recharges the battery using surplus propulsion power from the IC engine.

Dedicated hybrid transmissions

Innovative solutions from Schaeffler

Dedicated hybrid transmissions (DHT) are highly integrated hybrid solutions for electrified vehicles featuring clever integration of the electric motor in the transmission.

How the transmission becomes a powertrain



Smart hydraulic actuators

Efficient and complex
In the wake of the growing range of diverse types of transmissions due to hybridization and electrification, a particular function of the powertrain is coming to the fore: cooling. Due to innovative interconnections, our hydraulic modular kit can be used as the basis for developing efficient hydraulic units serving complex cooling tasks and performing additional functions – such as operating a clutch and a parking brake – practically along the way.

Dedicated hybrid IC engine

Enhanced efficiencies
In interaction with the transmission and the electric motor(s), hybrid powertrains offer the opportunity to make demand-based use of the IC engine, which causes it to operate exclusively in the high-efficiency ranges. In the area of the camshafts, UniAir, electric cam phasing and electrically actuated switchable cam followers are innovative tools for achieving enhanced combustion processes with high-level thermal efficiencies.

Thermal management module

Intelligent range extender
The thermal management module uses the potential of various operating conditions and is therefore able to eliminate even the need for heating. It ensures optimal temperatures for components such as the battery and, consequently, provides the basis for system components enabling functional and cost optimizations. As a result, range benefits of up to 40% in cold ambient temperatures are achievable.

Functional software

Integration for optimal efficiency
The embedded software for electric mobility applications ensures the functional integration of all components and connection with the vehicle functions for optimal drivability combined with maximum efficiency. Schaeffler offers a complete portfolio of supporting services: from the provision of individual functional modules to a dedicated software platform and integration in Schaeffler's proprietary or customers' control units to application in the vehicle.

Modular elements
- Control unit
- E-motor
- Pump
- Valves
- Software functions
- Technologies

Functions
- Cooling and lubrication
- Switching elements
- Clutch
- Parking brake

Applications
- Hybrid modules
- Dedicated hybrid transmission (DHT)
- E-axles
- Double-clutch transmission (DCT)

E-motor for a hybrid module

Electric motors for hybrid applications

With its highly efficient permanent-magnet excited synchronous and asynchronous motors, Schaeffler offers ideal solutions for the growing diversity of hybrid vehicle concepts, worldwide. Schaeffler's innovative technology platform provides the basis for a necessary variance in the e-motor modular kit and therefore covers the entire performance range from 20 kW to more than 300 kW and battery voltages between 48 and 800 volts.

With high vertical integration, long-standing manufacturing expertise and pioneering winding technology – such as wave winding – Schaeffler develops electric motors with maximum power density and performance at compelling levels of quality.

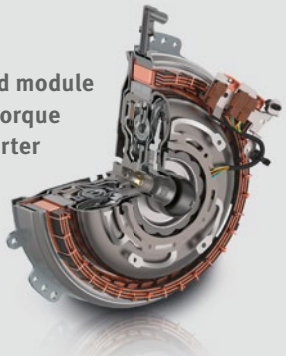
High vertical integration and extensive product portfolio

Products from Schaeffler combine 50 years of automotive know-how with new innovative solutions for electric mobility. Schaeffler develops products in the area of transmission systems into electric drive systems – such as a hybrid module with an integrated torque converter and a hybrid module with a triple clutch – among other things.

With excellence in manufacturing expertise and high flexibility in development, Schaeffer is able to develop novel solutions to market level within very short periods of time across the entire product pyramid – from winding processes to components such as e-motors and clutches to 3in1 e-axle and hybrid systems.

48-volt hybrid module with decoupling clutch

High-voltage (HV) hybrid module with triple clutch



Hybrid module with torque converter

Oil-cooled clutch and brake systems

Shifting, decoupling, moving from rest: With innovative and highly integrated clutch and brake systems, Schaeffler, as a systems partner, offers tailored solutions for the drivelines in the field of electric mobility. Leveraging the symbiosis of production and process know-how with systems expertise and a strong development organization, Schaeffler creates technologies for the future – considering the key areas of efficiency, design space and dynamics.

Schaeffler adds further value by using the Eco wet facing which, thanks to an innovative, energy-saving manufacturing process, sets a new standard in terms of sustainability, therefore making a valuable contribution to forward-thinking solutions.

Fully electric powertrains

Scalable and customized

The e-axle enables very efficient electrification of powertrains. Schaeffler offers the entire portfolio with diverse designs ranging from axially parallel and coaxial with bevel gear arrangements to spur gear differentials, primarily focused on efficiency, performance and thermal management. Schaeffler's e-axles serve the entire range from compact cars to powerful performance cars.

E-axle transmission

Schaeffler offers reliable e-axle transmissions featuring coaxial or axially parallel arrangements with particularly high power densities.

Transmission, axially parallel

Transmission, coaxial (2020 Pace Award)

E-motor

Electric propulsion power is generated by highly efficient electric motors with maximum power density.

E-motor radial flux machine

Highly integrated 3in1 e-axle system

Due to the integration of power electronics, the electric motor and transmission combined form the Schaeffler 3in1 e-axle system. The power electronics unit is used for controlling the drive system and operating the actuator.

3in1 e-axle system (coaxial)

3in1 e-axle system (axially parallel)

Adaptive 2in1 e-axle system

By means of the optimally coordinated combination of the transmission and e-motor a compact drive system with maximum power density – also with existing power electronics – is achieved in the Schaeffler 2in1 e-axle system.

2in1 e-axle system (coaxial)

2in1 e-axle system (axially parallel)

Optional additional functions

Based on the conventional single-speed version, power-shiftable two-speed solutions can alternatively be offered. Parking lock and decoupling units can be added as additional functions, depending on our customers' requirements.

Power-shiftable two-speed solution 2in1 e-axle system (axially parallel)

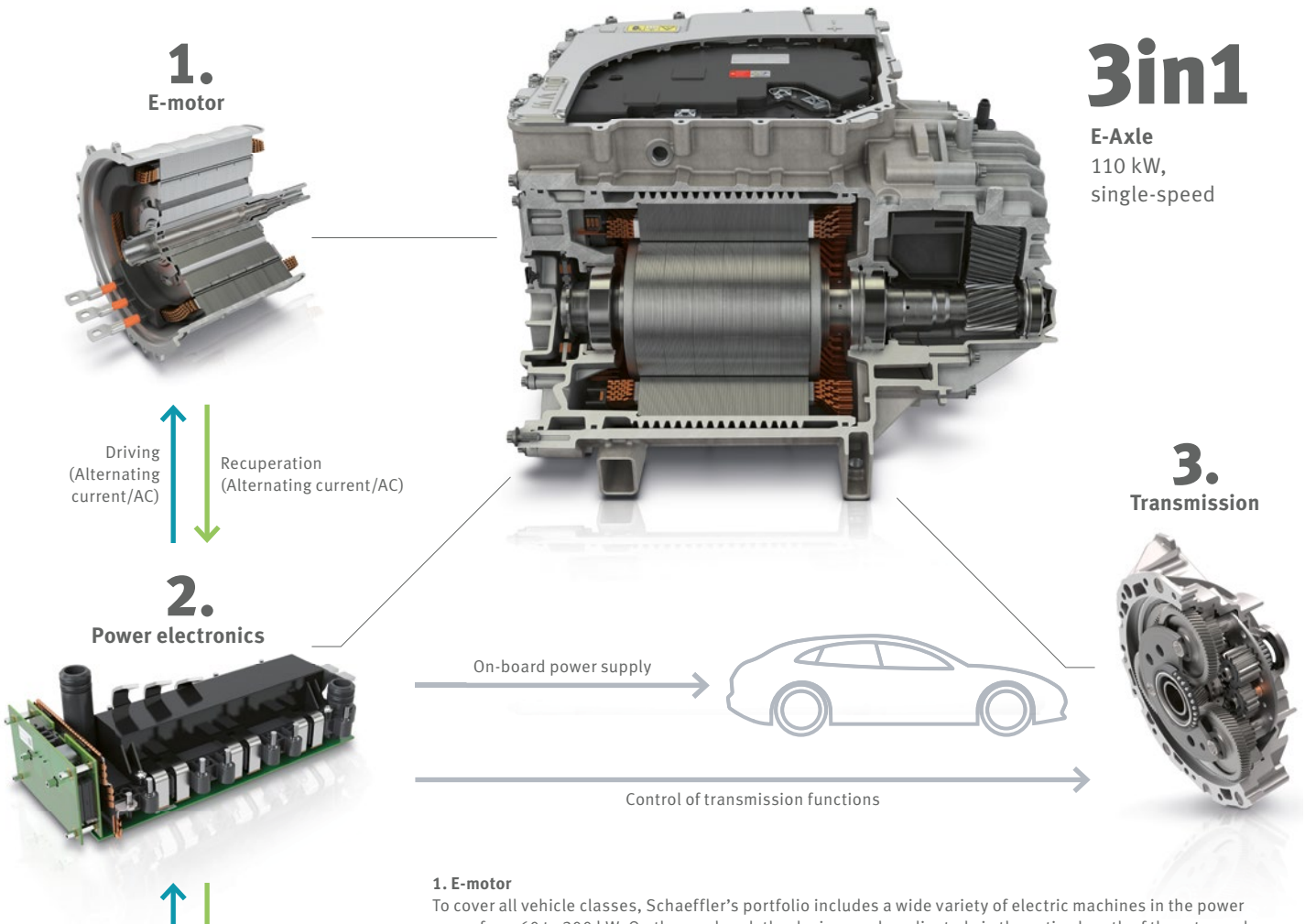
Decoupling unit

Parking lock

Highly efficient systems

3in1, thermal management, fuel cell

The development of highly efficient powertrains requires an optimal system with very close coordination of the three subsystems: e-motor, power electronics and transmission. The solution: 3in1 from Schaeffler.



1. E-motor
To cover all vehicle classes, Schaeffler's portfolio includes a wide variety of electric machines in the power range from 60 to 300 kW. On the one hand, the design can be adjusted via the active length of the rotor and stator and, on the other, optimized for 400- and 800-volt systems. The machines used are either permanently excited synchronous motors or asynchronous machines.

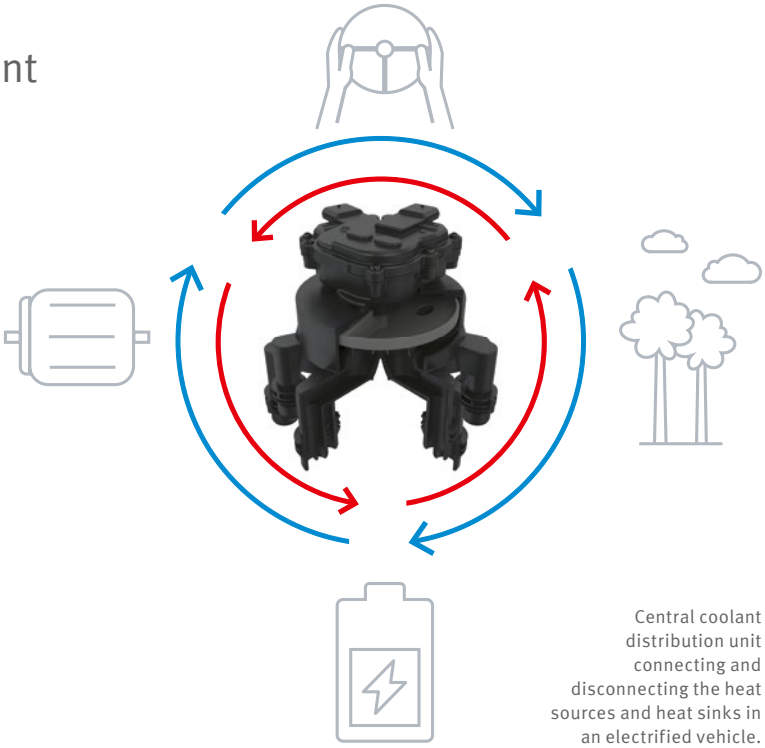
2. Power electronics
Power electronics units have to be adjusted to the application-specific performance requirements in accordance with the electric machines. Power electronics units include the system's intelligence and primarily serve to control the drive system and to operate actuator output stages (e. g. decoupling, gear selector or parking lock). In addition, the power electronics unit includes the power path to deliver performance. To efficiently cover the entire performance spectrum and various voltages, silicon and silicon carbide semiconductor technologies are used.

3. Transmission
As a rotational speed and torque converter, the transmission provides the connection between the traction motor and output. The various types and gear set designs featuring spur gear or compact planetary versions make it possible to cost-efficiently develop customer-specific solutions. For various electric motor performance ratings, the transmission ratios can be flexibly adjusted via the gear set geometry. For optimized starting power and top speed, individual two-speed solutions are available. They are based on single-speed transmissions and extend the functional spectrum and efficiency potential. The gearshift logic is integrated in the power electronics unit as a module and enables convenient gear changes – with or without interruption of traction – depending on the customer's requirement. For twin-drive systems, individual provision of torque to the wheels for enhanced agility and stability is available.

Energy and thermal management

Especially in electrified powertrains, it is essential to comprehensively optimize the vehicle's energetic management – in terms of total vehicle efficiency and performance capacity. In this context, Schaeffler focuses on high efficiency of the powertrain as well as on assuring comfort functions and optimal component protection and achieves these objectives by combining its expertise in electrified powertrains with system-level thermal management.

The central coolant circuit unit controls the heat flow between the drive system, the traction battery, the passenger compartment and the environment and is directly connected with the air conditioning circuit or heat pump. As a result, the electric drive system, for instance during a fast-charging process, can be used as a buffer for the valuable, albeit surplus, thermal energy of the traction battery.



Central coolant distribution unit connecting and disconnecting the heat sources and heat sinks in an electrified vehicle.

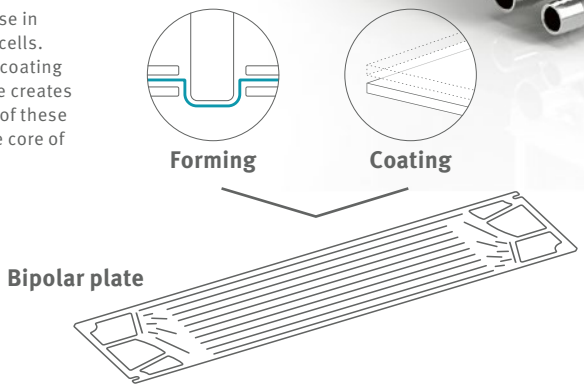
Fuel cell technology

Schaeffler has recognized the potential of hydrogen technology as a sustainable energy source of the future and develops key components for the fuel cell using its traditional core competencies in material, forming and surface technology. In addition, the company benefits from its broad positioning in the Industry and Automotive Technologies sectors and, consequently, is involved from the stage of energy generation to use in the vehicle.

As energy converters, fuel cell stacks from Schaeffler cause H_2 and O_2 to react to form water, generating electric current in the process that is used to power the electric motor in the vehicle. Schaeffler offers high-performance control units, low-friction bearings and thermal management systems that make fuel cells even more economical.

Competence in components

Schaeffler has expertise in the production of fuel cells. Precision forming and coating in the nanometer range creates bipolar plates. Stacks of these bipolar plates form the core of the fuel cell.

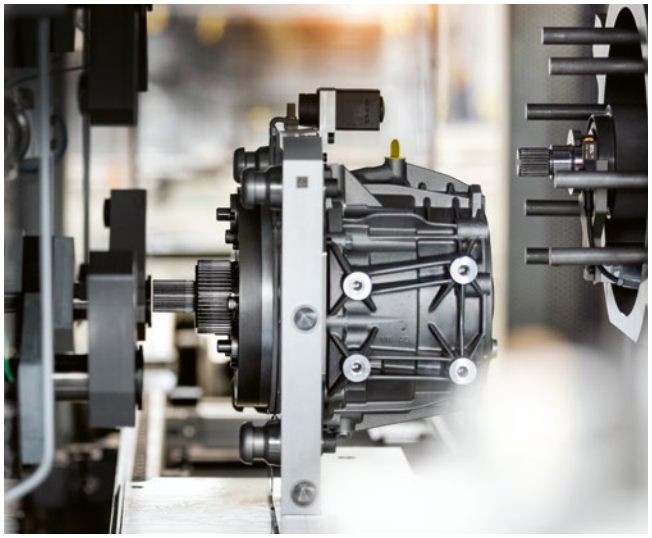


Global manufacturing expertise

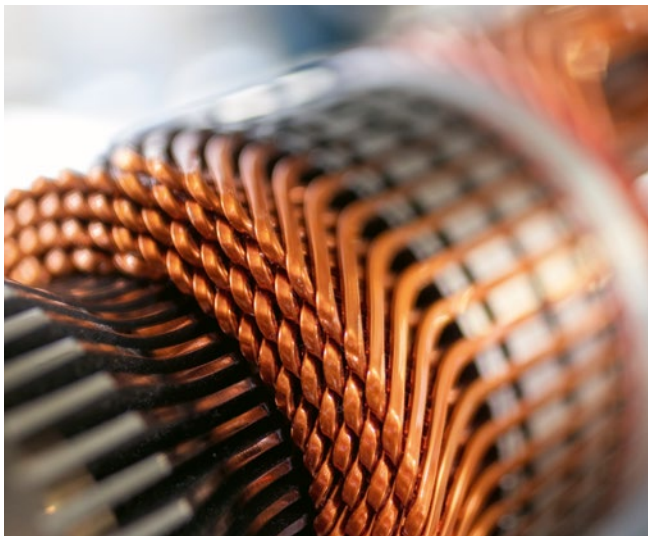
Decades of know-how from a one-stop source

The Schaeffler Group has a globally connected manufacturing network. In-house tooling and special-purpose machinery engineering benefit from the close interlinking of research and development with prototyping and manufacturing.

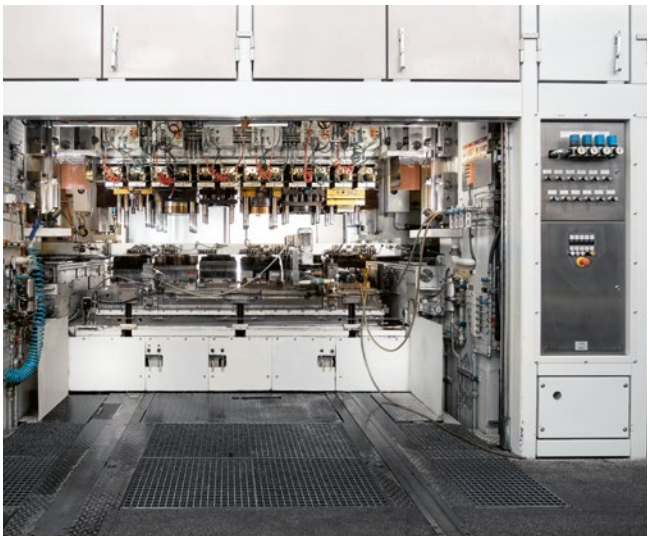
Testing and inspecting



Manufacturing



Winding technology



Stamping and forming

ELMOTEC STATOMAT

The leading manufacturer of high-volume production lines for electric motors has been part of Schaeffler since 2018.

High tech in electric motor engineering

Elmotec Statomat has unique expertise in the field of winding technology and a more than 60-year track record as a technology leader in electric motor manufacturing machines. Especially wave winding is regarded as a leading technology for electric mobility in terms of power density, efficiency and efficient high-volume production going forward.

Motorsport as a test lab

Technology transfer “from race to road”

We love competition and test technologies in extreme conditions.
Know-how gained in motorsport is carried over directly into development.
Top quality and optimal reliability are in our DNA. That’s #WhyWeRace.

Schaeffler in electric motorsport around the globe

ABB FIA Formula E

On the grid from the get-go
Schaeffler is the exclusive technology partner in the Audi Sport ABT Schaeffler team. Since 2014, two titles have been celebrated in the fully electric single-seater racing series.

FIA WRC

Partner from 2022 to 2024
Schaeffler’s subsidiary Compact Dynamics will be the exclusive supplier of the hybrid system for the new Rally1 car class in the World Rally Championship starting in 2022.

HYRAZE League

Racing with hydrogen
The 800 hp hydrogen cars of the HYRAZE League use forward-thinking steer-by-wire technology. The inaugural season is planned for 2023.

DTM Electric

1,200 hp prototype
At the 2020 DTM finale, Schaeffler, as the new series and innovation partner, showcased what an electric and “green” future of the popular racing series could look like.

#SimRacing
Technological progress, a zest for innovation and sporting competition – that’s Simracing. For Schaeffler, it’s the perfect complement to real-world motorsport because the future of efficient and sustainable mobility is being shaped at Schaeffler using innovative simulation technologies. Simulated motor racing turns this key expertise into an emotional experience.

Compact
Dynamics

Experts in high e-performance

Compact Dynamics is a Schaeffler subsidiary and leading specialist in high-performance electric drives and inverters with a special focus on one-off to high-volume production of electric motors. Compact Dynamics is a partner of racing teams, automotive manufacturers and suppliers as well as of visionary research and pre-development projects.

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