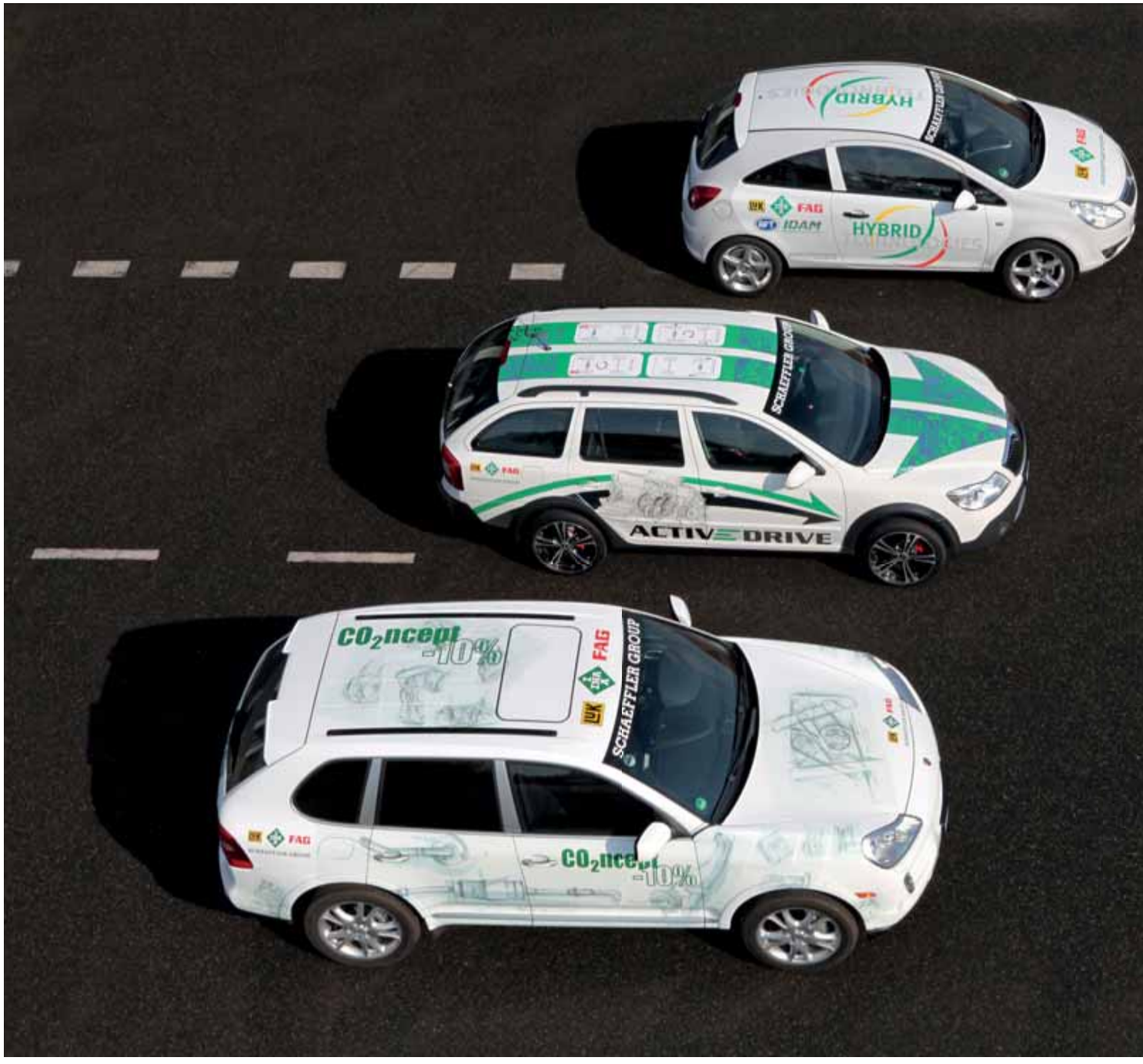
Schaeffler Demonstrator Vehicles

Concept vehicles for sustainable mobility – both today and tomorrow

Joerg Walz



Schaeffler concept vehicles

Schaeffler is a global partner to the automotive industry that is dedicated to devising and implementing sustainable mobility solutions. Since 2009, the company has been using concept vehicles to demonstrate how individual products, when combined and linked together, can help meet the mobility requirements of tomorrow with respect to reducing CO_2 emissions and fuel consumption. To this end, the demonstrator vehicles also serve as a trial testing platform for engineers at Schaeffler's competency centers around the world so that different components and systems can be tested under realistic conditions. Three such vehicles have already been constructed as part of the diversification strategy pursued by Schaeffler and offer a glimpse at the broad product portfolio Schaeffler has to offer, which includes energy-efficient solutions for conventional powertrains equipped with an internal combustion engine, to products developed for hybrid vehicles, through to modular components engineered for all-electric vehicles.

Figure The Schaeffler CO_2ncept-10%, Schaeffler Hybrid, and Schaeffler ACTIVeDRIVE vehicles follow the company's diversification strategy by showcasing a wide variety of concepts and solutions that target future automobiles.

Ten percent lower CO_2 emissions

End-to-end optimization of proven technology

The CO_2ncept-10% concept car is an advance development project carried out by Porsche and Schaeffler that involved coordinating and harmonizing new and optimized components from the Schaeffler portfolio in the powertrain and chassis to achieve a combined 10 percent reduction in fuel consumption and CO_2 emissions. Not only was this figure computed using complex simulation calculations, but also attained by Porsche during sophisticated test bench trial testing.

The base vehicle is a Porsche Cayenne with a V8 gasoline engine. Throughout the joint project, Schaeffler was responsible for designing and verifying the individual components, while Porsche coordinated system internals and validated the overall vehicle.

In optimizing fuel consumption and the associated CO_2 emissions, the engine contributes to a partial reduction of 5.8 percent, the majority of which (-4.1 percent) can be attributed to the modifications made to the VarioCam Plus valve control system by integrating electromechanical camshaft phasing units (in place of the previous hydraulic version) and by optimizing the switchable tappets on the intake side. An additional 1.7 percent reduction was achieved by minimizing the friction loss with improved components throughout the valve train, belt drive, and chain drive assemblies. Double row angular contact ball bearings in the front and rear-axle differentials further lower consumption by 1.1 percent. These twin-tandem bearings replace the previous tapered roller bearings and considerably reduce the frictional resistance as compared to the series production transmission: -35 percent and a full -42 percent at the front and rear-axle differentials, respectively.

Even the chassis reduces consumption (-3.2 percent) with an electromechanical roll stabilizer taking the place of the conventional hydraulic variant and alloy wheel bearings in lieu of heavier steel ones.

Schaeffler Hybrid

An electric mobility concept car

The Schaeffler Hybrid is based on a compact Opel Corsa and was designed and built to serve as a concept car and a practically-oriented testing laboratory for various different hybrid solutions. This highly versatile advance development project facilitates a practical comparison between a large number of possibilities and options for realizing electric mobility. The driving modes available range from conventional operation using an internal combustion engine, to parallel and serial hybrid applications that utilize a range extender, through to fully-electric driving. To this end, the Schaeffler Hybrid features not only the standard internal combustion engine of the base vehicle, but also a centrally positioned electric motor and two wheel hub motors.

The internal combustion engine can power the vehicle and be coupled for use as a range extender, while an automated manual transmission increases the options available. The accumulator – a 16 kWh lithium-ion battery rated to 400 V and 400 A – can be recharged via regenerative braking (range extender) as well as by plugging the vehicle into an external power outlet (plug-in hybrid). The central unit is connected to the automated manual transmission by means of a toothed chain and drives the front wheels. The unit comprises a liquid-cooled 50 kW and 95 Nm electric motor that was designed and manufactured by Schaeffler subsidiary IDAM. “E-Wheel Drive” is the name that has been given to the wheel hub motors developed by Schaeffler. The motors mounted in the Schaeffler Hybrid have an output of approximately 50 kW each and a torque rating that approaches 530 Nm. Schaeffler profits from its profound expertise in the field of wheel bearings and direct drive technology during the design and manufacture of these high-performance components. Accordingly, these wheel hub motors form a compact unit that integrates wheel bearing, drive and brake. The advantage of these drive units is the fact that they can be integrated in an existing vehicle platform for testing purposes without making any major changes to the vehicle architecture.

Schaeffler ACTIVeDRIVE

Electric vehicle with active torque splitting

The ACTIVeDRIVE concept car is based on a production Skoda Octavia Scout and is an all-electric vehicle with a four-wheel-drive system. One of the innovations the ACTIVeDRIVE boasts is an active electric differential, or eDifferential, which is mounted to both the front and rear axle. New for 2014 is a third-generation eDifferential for the rear axle assembly which, unlike the first-generation module installed on the front axle, has a much higher power density. The unit now features a 2-speed transmission that is coupled with a smaller electric motor for a higher maximum axle torque output of 2,000 Nm and higher top speeds in excess of 260 km/h. Despite this increase in performance and the integration of a power electronics module for the torque vectoring system directly on the axle, the space required by the axle drive and its total weight have been trimmed from 120 kg to 79 kg compared to the first generation. Both eDifferentials combine an electric drive with the option of controlling the drive power in each wheel independently. This facilitates torque vectoring (distribution of torque between the right and left wheels), which is beneficial for driving dynamics, safety and comfort. Due to the use of two active electric differentials, the concept car has an overall output of up to 170 kW, with power sent to all four wheels, as well as the capacity to distribute drive torque longitudinally.

The range of the vehicle in this configuration is up to 100 kilometers. The solution demonstrated in the ACTIVeDRIVE makes Schaeffler a pioneer of such electric concepts in a single vehicle drive system. At the same time, the potential application range of the eDifferential extends from extremely agile and dynamic sports cars, to more conventional passenger car setups, through to agricultural machinery.

Additional information on this topic can be found in section 14.

Schaeffler offers customized products for efficient mobility in markets all around the globe

Schaeffler concept cars not only demonstrate the capabilities of technically-oriented solutions, but also underscore the capacity of global and regional development expertise coming together. Two examples of this are the Efficient Future Mobility North America and the Efficient Future Mobility India concept cars from Schaeffler. Both vehicles are undeniable proof that coordinating and integrating a host of Schaeffler technologies can offer additional, substantial potential for optimizing powertrains that utilize an internal combustion engine while symbolizing and characterizing the individual situations, needs, requirements and tastes that prevail in different regions. The same applies to the E-Wheel Drive concept car, which was jointly developed with Ford based on the Ford Fiesta platform and features a wheel hub drive mounted in each of the rear wheel arches. Wheel hub drives offer a great deal of potential for realizing revolutionary new vehicle architectures and are a particularly attractive option for small, nimble city cars that draw their power from a battery pack. Viewed in the context of the current global trend toward urbanization and stricter environmental rules and regulations, the demand for vehicles of this kind will no doubt increase. Key target markets include the high-growth metropolitan areas in Asia and North and South America.

Efficient Future Mobility North America

Integrated technology for fuel savings of up to 15 percent

This concept vehicle is based on the current version of a mid-size SUV that is popular in North America and features an automatic transmission with a torque converter. The solutions highlighted take the market-specific demands and customer requirements in North America into account. By integrating and coordinating different Schaeffler technologies, a reduction in fuel consumption of up to 15 percent can be achieved, depending on the user profile. This, in turn, makes it possible for the large vehicles so popular in North America to also take a big step toward complying with CAFE standards. CAFE stands for Corporate Average Fuel Economy and describes the USA's increasingly restrictive legal regulations for fleet consumption with regard to the targets set for 2020 and 2025.

To optimize fuel consumption, the AWD disconnecting clutch, which decouples the unused drive axle from the powertrain depending on the driving situation (e.g. on the highway), is capable of reducing fuel consumption by up to 6 percent all by itself. Further savings are achieved by integrating a thermal management module, which allows the engine to reach its rated operating temperature as quickly as possible while precisely controlling and regulating heat levels, including for other major powertrain assemblies such as the transmission and/or hybrid componentry. Also on board are Schaeffler innovations for engine start-stop systems such as the permanently engaged starter generator with a wrap-spring one-way clutch and a latching valve. Thanks to the permanently engaged starter generator, in-town fuel consumption can be reduced by up to 6 percent while at the same time improving comfort levels during change-of-mind situations. The friction-optimized fine tuning of the belt drive, valve train, and balancer shafts, as well as the optimized torque converter, further contribute to the impressive overall result. Additional information on this topic can be found in section 32.

Efficient Future Mobility India

Fuel-saving potential of up to 10 percent for the growth market in India

The vehicle developed in India is a rolling test bed based on a low-cost compact car with a manual transmission that is very popular in the country. The Efficient Future Mobility India concept car is the combined result of the research and development work that went into optimizing the powertrain for the special conditions, driving behavior, and market constraints that prevail in India. In so doing, the car offers a vision of where powertrains may be headed in emerging markets.

Efficient Future Mobility India integrates a selection of powertrain technologies developed by Schaeffler that focus on the special conditions present in the automotive market in the country. Together, they make it possible to reduce fuel consumption and CO_2 emissions by up to ten percent while improving driving comfort. Included among the products showcased in the vehicle equipped with a manual transmission is the electronic clutch management system, or ECM, which replaces the clutch pedal with an actuator. Coupled with sensor-based gear detection, the vehicle facilitates automated driving. This aspect is especially important in the metropolitan areas in India, which are renowned for stop-and-go traffic.

Other innovations the Efficient Future Mobility India offers are automatic detection of optimal gearshift points and the integration of an engine start-stop system, variable cam timing (VCT), specially coated valve tappets, and an intelligent thermal management system.

All of the solutions presented in the vehicle are relatively inexpensive to implement, are close to production launch, and can make a significant contribution to improving the performance and fuel efficiency of compact cars.

Schaeffler concept car Fiesta E-Wheel Drive

The power of choice for tomorrow‘s city car.

The E-Wheel Drive concept car is a development vehicle that was designed and built together with Ford and is based on a Ford Fiesta platform. The compact car is powered by two wheel hub drives mounted in the rear wheel arches, whereby the wheels house all of the components required to propel and brake the vehicle as well as ensure safety. This, in turn, allows the platform to be optimized to provide as much space as possible for passengers and luggage as well as generously accommodate the battery pack and electronics and communications systems.

Each drive unit can generate up to 40 kW of power, and the entire powertrain is rated for a continuous output of 66 kW (2 x 33 kW). This corresponds to a conventionally powered vehicle that has 90 to 110 horsepower. Much more impressive, however, is the fact that the liquid-cooled wheel hub drive developed in the beta stage is capable of producing up to 700 Nm of torque! As a result, the current E-Wheel Drive Beta has one-third more power and 75 percent more torque than the first-generation wheel hub drive (alpha) used in the 2010 Schaeffler Hybrid concept car, which was based on an Opel Corsa.

The highly integrated wheel hub drive makes it possible to fundamentally rethink and redesign the city car. Fitted in electric vehicles used in urban environments, the drive offers unprecedented levels of space and room. The Fiesta E-Wheel Drive also provides for exceptional driving dynamics, since the two drive units not only combine to form a stability control system, but also realize a torque vectoring facility, which sends torque to the drive wheels in real time, based on the vehicle‘s movements. Highly integrated wheel hub drives therefore allow engineers to maximize cabin space as well as significantly improve maneuverability, driving dynamics, and active safety. This can play a key role in the future, especially in conjunction with autonomous driving systems. Schaeffler‘s highly integrated wheel hub drive thus provides something of a „key“ to „unlock“ new vehicle concepts that will be leveraged in tomorrow‘s automobiles. Additional information on this topic can be found in section 30.

Schaeffler concept car at the Silvretta E-Auto Rally in Montafon, Austria.

Harmonization of chassis, dynamic handling control, and torque vectoring.

The Fiesta E-Wheel Drive during extended testing in the freezing Scandinavian winter.