

# Fact Sheet XXL

SCHAEFFLER

Schaeffler Symposium 2018  
Mobility for tomorrow

## *#MobilityForTomorrow*

Increasing demand for mobility requires efficient, flexible and sustainable vehicle concepts. Visions and technologies from Schaeffler



A mobile future with IC engines



Powertrain meets chassis – Smart technology for tomorrow



High-tech know-how for sustainable mobility

# Schaeffler shapes *mobility* **for tomorrow**

What moves us? What guides us? What drives us? These are the three major, overarching questions of the Symposium 2018, Schaeffler's technology show centered on the human desire for flexible, personal and efficient mobility. How can this desire be realized in visionary ways using sustainable technologies?



“Decisive for success in the development of solutions for diverse mobility needs is a holistic view of the powertrain and the interaction of the electric motor, the IC engine, the transmission and the related infrastructure”

**Matthias Zink**  
CEO Automotive OEM Schaeffler



“Mobility for tomorrow requires us to come up with totally new and connected solutions for fast and highly automated urban transportation. To achieve high quality of life, these solutions have to exclusively use renewable energies”

**Prof. Peter Gutzmer**

Deputy CEO and Chief  
Technology Officer Schaeffler



“There is no single path to the future with respect to energy carriers or with respect to powertrains or vehicle concepts. The challenging objective of systematic climate protection combined with the preservation of mobility as the basis of social and economic development can only be achieved by the concurrent pursuit of several different paths. Schaeffler as a technologically innovative partner of the automotive and mobility industry enables this new diversity”

**Uwe Wagner**

Senior Vice President R&D  
Automotive and Industrial Schaeffler

## Contact

Schaeffler Technologies AG & Co. KG  
Communications and Marketing  
Schaeffler Automotive  
Industriestr. 1–3, 91074 Herzogenaurach  
presse@schaeffler.com, www.schaeffler.com

## Schaeffler Symposium 2018

All presentations are available  
in digital form at  
[www.schaeffler-events.com/symposium](http://www.schaeffler-events.com/symposium)



# Future mobility concepts

Satisfying the growing mobility needs in an eco-friendly way requires efficient and flexible vehicle concepts

## Bio-Hybrid

### Getting around with ease

The electrified bicycle is an ideal means of inner-city transportation. However, even a so-called pedelec has classic disadvantages of a bicycle: lack of weather protection and the severely limited ability to carry payloads which is typical of a single-track vehicle. In the light of these downsides, Schaeffler developed the "Bio-Hybrid" concept. This novel "city-mobile" transfers the pedelec idea to a double-track vehicle whose operator is assisted by a low-voltage drive system (25 km/h of motor-assisted top speed; range of up to 100 km). In 2018, Schaeffler established a legal entity (GmbH) dedicated to developing this vehicle to production level and short time to market in a startup environment.

## Schaeffler Mover

### Agile, autonomous, modular

At the Symposium 2018, the "Schaeffler Mover" is celebrating its debut. The autonomous electric vehicle is intended to help mitigate growing traffic congestion in the world's major cities, both in terms of passenger and goods transportation. The

"Schaeffler Mover" is propelled by wheel hub motors integrated in the ① four "Schaeffler Intelligent Corner Modules." A ② 90-degree steering angle ensures enormous agility. Various body versions can be easily mounted to the ③ "Rolling Chassis."

**"The key to sustainable mobility lies in the gift of acting with both hands. We have to further develop that which has stood the test of time while concurrently tapping new potential"**

Prof. Peter Gutzmer,  
Schaeffler Chief Technology Officer

The path to mobility for tomorrow is similarly complex as a multi-level highway junction in Shanghai. At least, the aim is clearly discernible: managing the demand for mobility the growth of which parallels that of the population – without excessively burdening the infrastructure and the environment. But what's the right path to achieve this aim? What's the right exit? Continue developing the IC engine? Opting for electric mobility? And if so, what kind: batteries, hydrogen, hybrids, 48 volts? Will automated driving have a future? How is car-sharing going to develop? Will the divide between urban and inter-urban mobility continue to widen? What new vehicle concepts might emerge and flourish alongside the automobile? Can money be made with data-based business models? In the coming years, the automotive industry will be undergoing a more significant transformation than it has in the past 130 years since the invention of the automobile. Mastering all the forthcoming challenges will require enormous capacities in terms of development work.

Suppliers like Schaeffler are assuming an increasingly important role in this context. This much is certain: There will be no single "yellow brick road" to achieve the aims. The pursuit of

multiple tracks will lead to success," says Chief Technology Officer Prof. Peter Gutzmer: "The key to sustainable mobility lies in the gift of acting with both hands. We have to further develop that which has stood the test of time while concurrently tapping new potential." Experts refer to this as organizational ambidexterity.

Based on know-how developed over the course of decades, Schaeffler is continuing to pursue its systematic further development in order to actively help shape mobility for tomorrow, tapping new potential and establishing new segments of value creation:

1. For nearly 20 years, Schaeffler has been working on the **electrification of the powertrain**. Products and systems in this segment will contribute at **least 15 percent to total automotive OEM sales by 2020**.
2. Mechanical engineering meets digitalization: Schaeffler, in its "Mobility for tomorrow" strategy, is currently interlinking the three central forward-thinking topics of **E-Mobility, Industry 4.0 and Digitalization** that represent key drivers of growth.
3. In addition to individual components, Schaeffler is now also developing entire **vehicle concepts** such as the four-wheel "Bio-Hybrid" pedelec and the modular "Schaeffler Mover" for people or cargo (see infographics at left and on the following spread).

"Changes will definitely come," says Prof. Peter Gutzmer, expressing his credo. "And we're prepared no matter in what forms they'll occur."



# Mobility for tomorrow with technologies from Schaeffler

## Diversity in E-Mobility

With holistic solutions Schaeffler makes all-electric powertrain technologies possible, as well low- and high-voltage hybrid modules in various configurations.



## Efficient IC engines

With production solutions for modern vehicle architectures Schaeffler helps reduce harmful emissions in urban areas. The product portfolio ranges from thermal management modules to engine valve control systems through to 48-volt hybrid technologies and electric clutch systems.



## Schaeffler Mover

The Schaeffler Mover with wheel hub drive offers a platform for diverse vehicle concepts. The drive and suspension components are consolidated in a single space-saving unit. This enables 90° steering and provides maximum interior space – optimally suited for autonomous and electrified mobility solutions such as robo taxis or transporters.

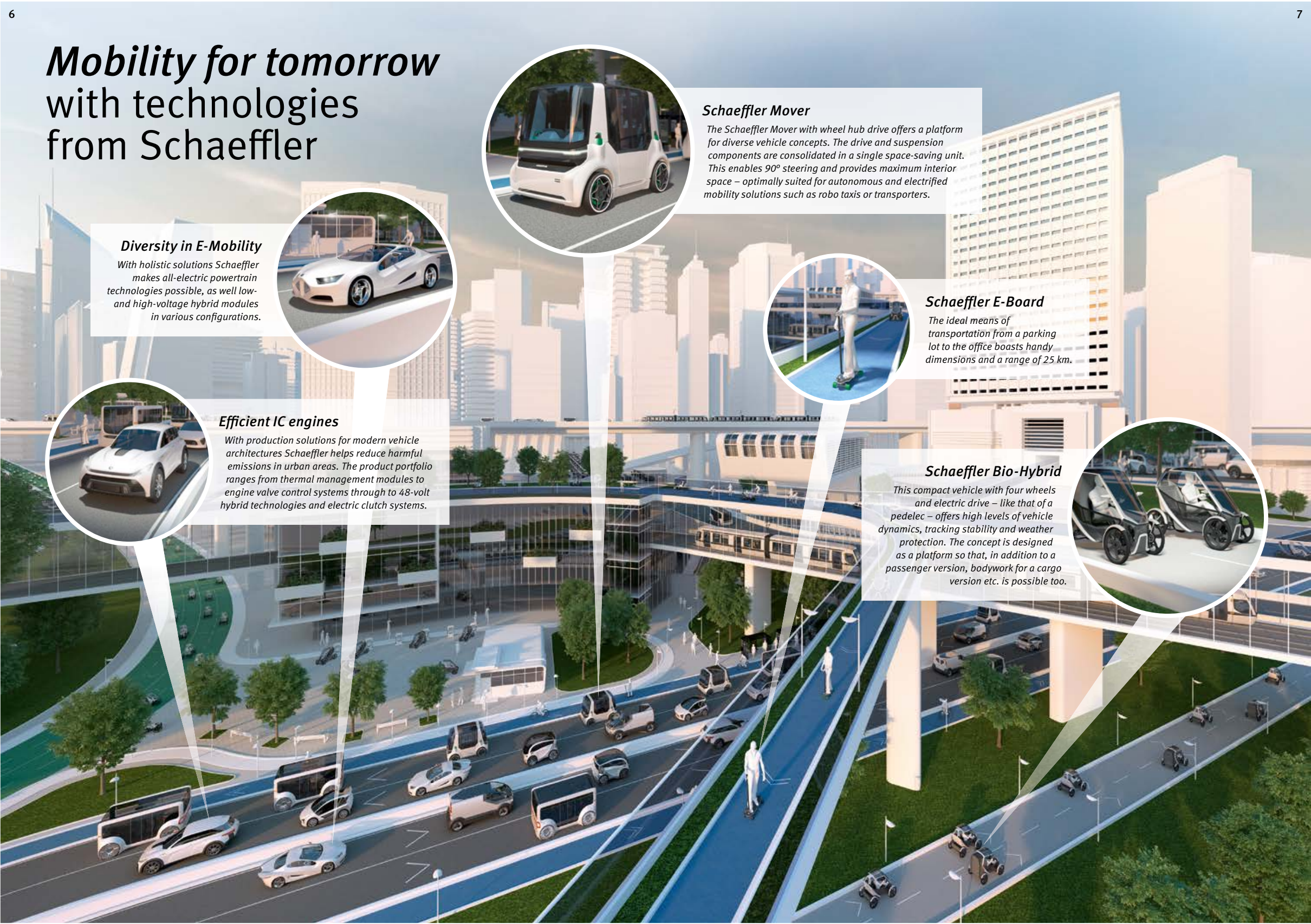


## Schaeffler E-Board

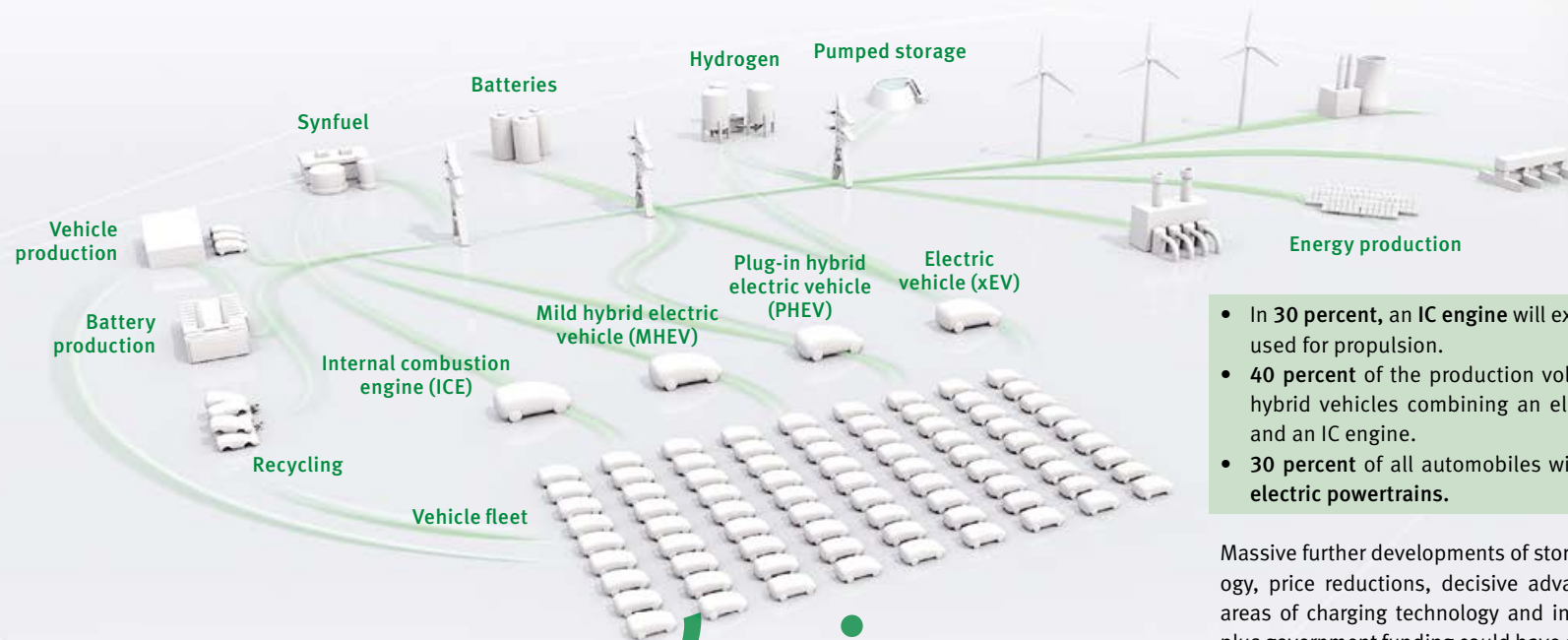
The ideal means of transportation from a parking lot to the office boasts handy dimensions and a range of 25 km.

## Schaeffler Bio-Hybrid

This compact vehicle with four wheels and electric drive – like that of a pedelec – offers high levels of vehicle dynamics, tracking stability and weather protection. The concept is designed as a platform so that, in addition to a passenger version, bodywork for a cargo version etc. is possible too.







# The *energy chain* of mobility

A new powertrain by itself has long ceased to be the answer. Sustainable and efficient products can only be developed by those who consider the entire energy chain of mobility

**T**he good news is that sun, water and wind supply enough energy for all of us. We only need to (further) develop technologies enabling us to make efficient use of this abundance – in terms of energy production as well as storage and consumption. That's why Schaeffler on the road toward efficient and eco-conscious mobility for tomorrow looks at the entire energy chain from the source to the consumer. Currently, the transportation sector causes 25.6 percent of the worldwide anthropogenic CO<sub>2</sub> emissions (OECD average in 2016) which substantially contribute to global warming. Whereas CO<sub>2</sub> emissions in the areas of buildings and industrial operations have in some cases been significantly reduced (in Germany by 34% and 32%, respectively, between 1990 and 2015) emissions in the transportation sector have remained relatively constant. The reason is that the steadily growing transportation of people

and goods equalizes the progress achieved by technological improvements. A change in trend as far as mobility growth is concerned is not to be expected – the opposite is true.

**The number of passenger cars around the globe will double to some two billion vehicles by 2050, according to a Shell forecast.**

To achieve ambitious international climate goals in spite of these forecasts, a substantial change of future powertrain technologies is necessary and the conventional IC engine will be playing an important part in this.

**Based on market analyses and in-house calculations, Schaeffler has developed a scenario according to which an internal combustion engine will still be installed in 70 percent of all newly registered passenger cars in 2030:**

- In 30 percent, an IC engine will exclusively be used for propulsion.
- 40 percent of the production volume will be hybrid vehicles combining an electric motor and an IC engine.
- 30 percent of all automobiles will have fully electric powertrains.

Massive further developments of storage technology, price reductions, decisive advances in the areas of charging technology and infrastructure, plus government funding could have a positive effect on the market success of electric powertrains. However, the IC engine still has some “aces up its sleeve” as well. A specific fuel consumption of 200 g/kWh for gasoline engines equating to efficiency of about 45 percent appears achievable. The diesel engine is already at this level. In this case, the primary challenge is to reduce harmful emissions.

If more efficient utilization of renewable energy could be achieved, the IC engine might benefit from this as well because wind, solar or hydroelectric power can also be used to produce liquid and gaseous fuels for distribution via the existing filling station network. A major advantage is the fact that the combustion of such “synfuels” produced by means of electrolysis results in very low harmful emissions and is CO<sub>2</sub>-neutral (see infobox). However, this only applies if renewable energy sources are used to produce such fuels.

“This is another example that shows the **importance of the interaction of the individual links along the energy chain,**” explains Uwe Wagner, Senior Vice President Research & Development at Schaeffler, “because not only the powertrain concept of a vehicle is of crucial importance. Equally important is the way in which energy for propulsion is generated and stored.”

## Synfuel

### Electricity turns into fuel for combustion

Synthetic fuels can be used like diesel or gasoline. They can be produced using various methods and raw materials (biomass, fossil sources or water). Of particular interest is the process that exclusively requires **renewable energy**, i.e. **electricity, CO<sub>2</sub> and water**. If the CO<sub>2</sub> is separated from the ambient air or in other combustion processes, combustion in the engine is **CO<sub>2</sub>-neutral and almost no fine dust or nitrogen oxide is emitted**.

Another advantage of synthetic fuels is their suitability for **ships, aircraft or trucks** – in other words in areas where wide-spread deployment of battery-electric propulsion systems is unlikely to occur. Plus, there's another aspect that speaks for synfuels: Similar to gasoline or diesel, they can be stored really well. Consequently, surplus **electricity generated on days with plenty of sunshine and wind can be converted into fuel and stored this way**. However, in the light of current processing technology and crude oil prices, synthetic fuels are **not economically feasible yet**.

## Energy chain

### A matter of perspective

#### Tank-to-Wheel

When looking at the event chain from the fuel tank (or the battery) to the wheel the input energy is put in relation to the kinetic energy achieved. In this analysis, **the electric traction motor with efficiency of 60 to 80 % in real operation clearly outperforms the IC engine (max. 45 %)**.

#### Well-to-Wheel

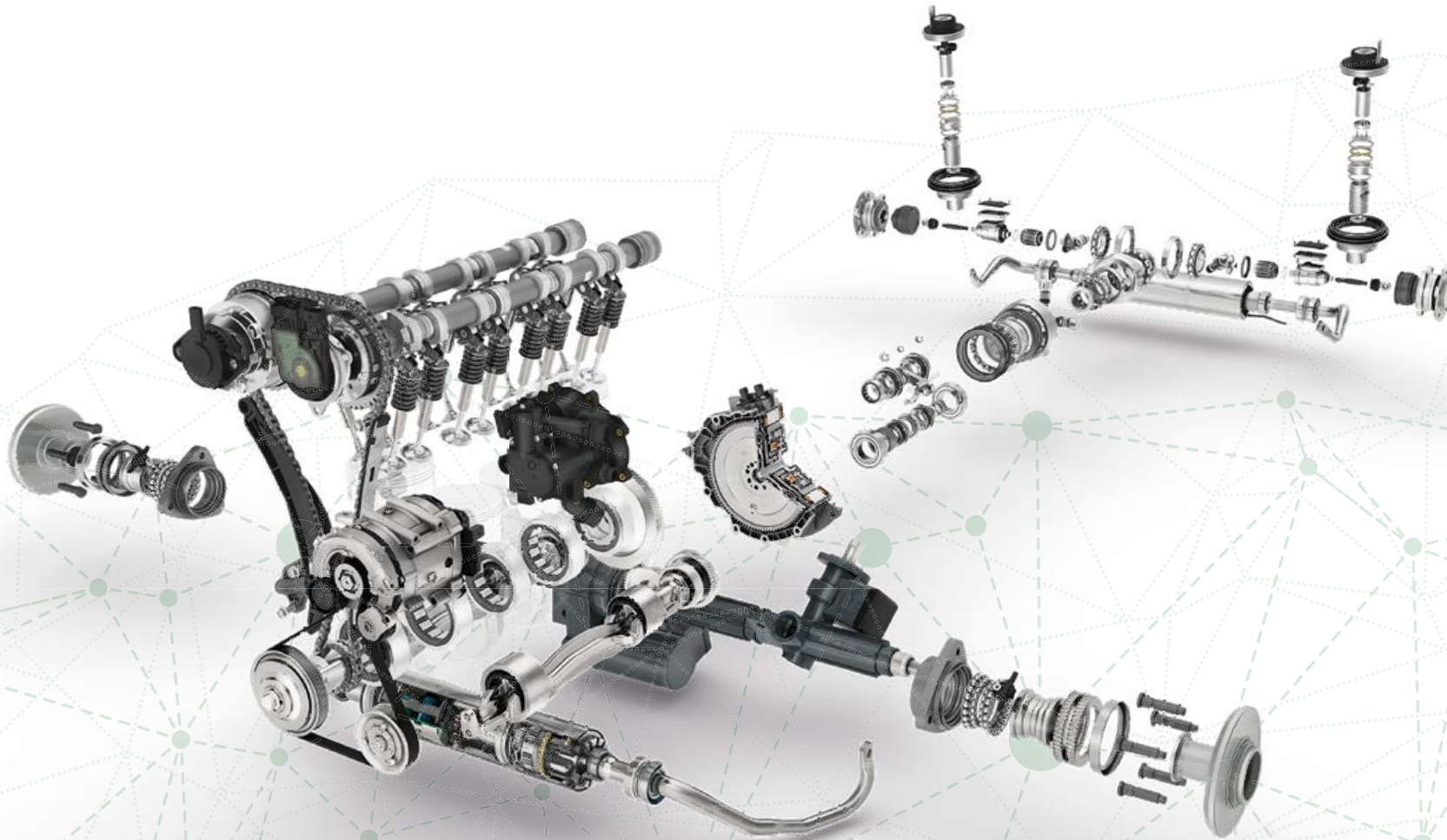
An efficiency analysis – as performed by most experts – of the powertrain systems along the entire energy chain from the source (“well”) to the “wheel” reveals that **the IC engine can make up ground compared with the electric vehicle – especially if fossil fuels are burned to produce the charging current**. In 2017, the electricity mix in the EU amounted to 30% for renewable energies versus 44.4% fossil energies and 25.6% nuclear energy.

#### Cradle-to-Grave

In a comparison of diverse vehicle concepts, in addition to the energy chain, the substance and energy streams in the production and disposal of powertrain components must be considered as well. In the case of the current electricity mix in Germany, for instance, **the additional energetic input required for the production of an electric vehicle compared to a diesel is only equalized beyond 150,000 km, according to the German Federal Environmental Agency (UBA)**.

# The new *diversity*

The automotive industry is in a state of transformation. New regulations and new mobility wishes require appropriately adapted drive concepts. Schaeffler covers nearly all demands with a wide product portfolio



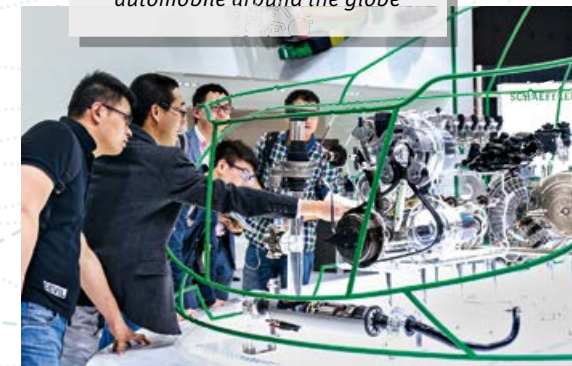
**T**he automotive industry is at a turning point. Great challenges to be mastered are often mentioned, yet many of those involved in the discussion primarily point out the opportunities technological progress currently presents – opportunities that will maneuver mobility into a new efficient future. The transformation process the industry is going through at the moment also shapes the daily work of Matthias Zink, Automotive CEO at Schaeffler. Like other decision makers in the industry, he has to deal with the variance of usable forms of energy storage (fossil and synthetic fuels, batteries and fuel cells) as well as the diversity of the three propulsion systems in the form of gasoline and diesel engines, and electric traction motors. Plus, there are five different types of transmissions and at least six different forms of hybrid system installation and installation locations.

“This complex matrix requires a **high level of powertrain and vehicle expertise** in order to develop optimum solutions in terms of technology and economy,” says Zink.

[Continue reading on page 14](#)

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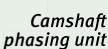

























*Schaeffler components on average are installed in every automobile around the globe*





# Schaeffler powertrain matrix

Solutions for all powertrain concepts – the key to efficient, sustainable and needs-based mobility for tomorrow. An overview of Schaeffler’s components and systems

	Micro HEV (Micro Hybrid Electric Vehicle) Components for micro hybrid EVs	Mild HEV (Mild Hybrid Electric Vehicle) Components for mild hybrid EVs	PHEV (Plug-in Hybrid Electric Vehicle) Components for plug-in hybrid EVs	xEV (Electric Vehicle) Components for all-electric vehicles
Engine	 <p>Camshaft phasing unit</p>  <p>Pulley Decoupler (FEAD: Front end auxiliary drive)</p>  <p>Roller bearing for turbo charger</p>  <p>eRocker</p>  <p>VCR (Variable compression ratio)</p>	 <p>ECP (Electric cam phaser)</p>  <p>UniAir</p>  <p>Smart Valve</p>		
Transmission	 <p>DMF (Dual mass flywheel)</p>  <p>Torque Converter</p>  <p>Double Clutch</p>	 <p>E-Clutch</p>  <p>Clutch Disk</p>	 <p>MCA (Modular clutch actuator)</p>  <p>EPA (Electronic pump actuator)</p>  <p>Hybrid damper</p>	 <p>PRND Actuator</p>  <p>Parklock</p>
E-Mobility		 <p>48 V e-axle</p>  <p>48 V Hybrid Module</p>	 <p>Bearing for e-motors</p>  <p>Dedicated Hybrid Transmission 6+2</p>  <p>Hybrid module with triple clutch</p>	 <p>Basis e-axle</p>  <p>E-Wheel Drive</p>  <p>E-axle drive</p>



**“With its expertise in electric mobility as well as engine and transmission systems and chassis Schaeffler is in a superb position”**

Matthias Zink (right), CEO Automotive OEM Schaeffler, at IAA 2017 during the visit of Federal Chancellor Dr. Angela Merkel. Pictured in the middle: Klaus Rosenfeld, CEO of the Schaeffler Group

Zink, a mechanical engineer, puts the major challenge posed as a result of the highly ambitious resolutions for CO<sub>2</sub> reduction and emission controls in a nutshell: “All forms of propulsion that are conceivable in the future have to convert stored energy into kinetic energy as efficiently as possible.”

In the quest for the “right” form of propulsion, the real intended purpose of the vehicle must be given equal consideration as the respective conditions in individual markets and regions. Notably, in view of the current primary energy

structure, the range limitations of current electric vehicles and the limited availability of charging infrastructure, the prospect of covering more than 30 percent of the global market with fully electric vehicles is not realistic in the medium term.

**“Therefore, the optimization of the ICE powertrain is absolutely necessary to meet further CO<sub>2</sub> targets,”** Zink is sure. Schaeffler’s portfolio already includes numerous solutions for this purpose. Here are two examples:

1. Technologies enabling variable control of the valve train and compression tailored to the respective driving mode enhance efficiency.
2. The same applies to modern attenuation and damping technologies for the engine and transmission. They enable the engine to operate in lower speed ranges and thereby reduce consumption and emissions as well.

In spite of all the current and future efficiency increases, it will be difficult for internal combustion engines to meet future emission targets by themselves – diesel and gasoline engines require electric assistance.

“The electrification of the powertrain offers opportunities to further reduce energy consumption and emissions,” Matthias Zink explains. **Schaeffler will be investing 500 million euros in electric mobility alone by 2020 – a clear commitment to this forward-thinking technology.** “Should this amount have to be adjusted then it will more than likely be an upward adjustment,” says Zink.

Based on the level of electrification – “micro,” “mild,” “plug-in-hybrid” and “xEV” – Schaeffler, in a so-called powertrain matrix is developing new solutions in the engine, transmission and electric drive subsystems. They include electro-mechanical actuators as well as 48-volt hybrid technologies and efficient electric drive systems. “Decisive for success is a holistic view of the powertrain and the interaction of the electric motor, the internal combustion engine, the transmission and the related infrastructure.”

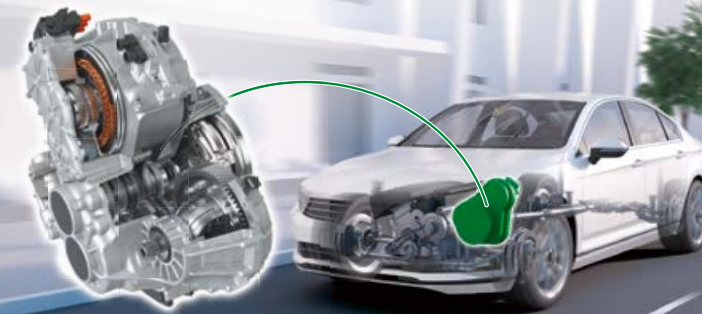
To support this holistic view, Schaeffler has departed from the conventional approaches to the unit classifications of “engine” and “transmission” in order to focus on the development of the total system – this allows Zink and his colleagues to perform substantial investigations and to achieve innovations on the level of the powertrain and the total vehicle. Optimum outcomes of all solution paths pursued can only be achieved by looking at the entire powertrain. This means having to take all the physical interactions between the IC engine, the transmission and the electric motor into account – in other words not only power flow paths but also acoustical and thermal phenomena.

Zink knows that in this effort he can count on the support of a capable research and development with about 7,600 employees at 18 locations: “With its expertise in electric mobility as well as engine and transmission systems and chassis Schaeffler is in a superb position.”

## Smart hybrid transmissions

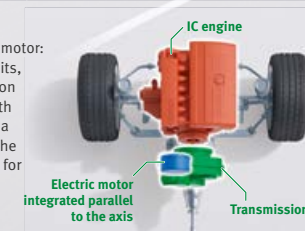
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Schaeffler has developed a space-optimized transmission for plug-in hybrid vehicles. The dedicated hybrid transmission combines the benefits of an automated manual transmission with those of the electrified powertrain. At the same time, driving dynamics and ride comfort are enhanced while consumption and emissions are reduced.



### Functional principle: DH-ST 6+2

One total transmission system for the IC engine and the electric motor: Its special feature is a division of the transmission into two units, each with two gear ratios. Located between them is a replication transmission, also with two gear ratios. The IC engine uses both transmission units including the one of the electrical path. As a result, six gears in total are available to the IC engine. Due to the dual use of one gear level, five gear wheel levels are sufficient for this purpose. Two gears are available to the electric motor.



### Benefits of the transmission architecture

- High power output
- Small space
- Cost-efficient
- Reduced consumption





During shifting events the integrated electric motor compensates for the absent torque of the IC engine. The compact design of the mechanically sophisticated transmission saves valuable space. Six gear ratios in ICE mode and two in electric mode ensure particularly low consumption. The dedicated hybrid transmission is ideally suited for vehicle concepts with high overall system output.



# Facts and figures

pertaining to the Schaeffler Symposium 2018

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# 7,600

*employees are engaged in Schaeffler's research and development projects for mobility of today and for tomorrow at 18 research centers around the globe*

# 30/40/30

*In 2030, according to Schaeffler forecasts, 30% of all new cars will have ICE, 40% hybrid and 30% fully electric powertrains*

# 16.6%

*of the world's electricity is produced by hydroelectric power stations*

# 29.5%

*of the electric power in Germany is produced from renewable sources*

# 1,000 Wh/l

*This will be the storage capacity of batteries in 2025 – about four times as much as that of today's, according to assumptions by experts at the Schaeffler Hub for Advanced Research at the Karlsruhe Institute of Technology*

# 0%

*sulfur oxide emissions are produced by vehicles using synthetic fuels. In addition, particulate emissions are reduced by 40 percent compared to diesel fuel*

# ≈ 2,400

*patent applications were filed by Schaeffler in 2017 alone. Active patents and patent applications currently total about 26,000*

# 25 kW

*of maximum traction power output is delivered by the wheel module of the compact Schaeffler Mover – 7 kW more than the first VW Beetle*



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