

NEWSLETTER

09/2019

**ADVANCED
TECHNOLOGY**

New energy drivetrains

Our goal is to offer the customer all the services from the concept to the series introduction

Greetings from GETEC

The automotive industry faces major, disruptive and technological challenges related to e-mobility. Our increasing environmental awareness and noticeable climate changes are forcing humanity to make every effort to rebalance its carbon footprint. In future, only a (partially) electrified powertrain will have an opportunity on the market. New players like Tesla, NIO and Byton challenge the long-established manufacturers. Initially, I think the traditional OEMs are falling behind in terms of electrification and battery research, so I feel that they are currently experiencing a reversal of the innovation pendulum in favor of Western engineering. Here is the law of the large inertial mass, which at first wants to be accelerated.

GETEC Getriebe Technik GmbH feels obliged to this change. With 150 employees in Germany and China, we are developing novel hybrid transmissions (DHT) for both transverse and longitudinal installation. Using newly developed simulation tools, a variety of variants regarding fuel consumption, acceleration, performance, climbing ability, starting behavior, driving dynamics, weight, package and production costs are examined and evaluated in concept studies. After defining a concept and a detailed specification with the customer – usually in comparison to a (if existing) benchmark product – the typical A, B and C phases of powertrain development are passed through to maturity. Here, GETEC has repeatedly proven its fast reaction time due to its great experience in very short development cycles. Suppliers are involved in the development process at an early stage in order to generate responsibility for the product and to be able to absorb production quality problems right from the start. Furthermore, GETEC has written on the flag to accompany the series introduction together with the customer.

In addition to the application of the gearboxes into the vehicle and the validation of the characteristics specified in the vehicle requirements, a verification and validation of the products should be carried out on highly dynamic test benches during development right from the beginning. Without our own test benches, the targeted short development cycles of less than 3 years would not be possible. For this reason, GETEC has been operating 12 highly dynamic powertrain test benches in Suzhou, China, for nearly two years now, especially since China is the fastest-growing e-mobility market as supported by the government (as defined in the 5-year plan). However, in order to take account of the growing demand for validation capacity and a complete development service from a single source, GETEC has already installed 3 high-speed test benches (> 20,000 rpm) in Germany, Aldenhoven. All test benches are equipped with highly dynamic battery simulators. By parallelizing currents greater than 1000A can be realized. With appropriate cold-climatic chambers environmental situations between -50 °C and +120 °C can be examined. High control speeds ensure high realistic simulation capability. It is planned to install another 3 test benches in our existing buildings for e-mobility by the end of this year. Our business plan is to build another building with 10-12 test facilities by mid-2021.

Our goal is to offer the customer all the services from the concept to the series introduction including validation and liability from a single source. We advertise with quality and high transparency.

Best regards



Ralf von Dahlen



NEW ENERGY DRIVETRAINS – SMART PRODUCT DEVELOPMENT STRATEGIES



Author: Mr. Joachim Trumpff
Director Engineering & Testing



The automotive industry and therefore also the company GETEC Getriebe Technik GmbH are facing the market challenge of the trade-off between reducing the package, weight and costs and increased requirements for functionality, performance and economy.

Three main authorities are driving the market: the above listed factors of the automotive environment, the governments and the customers.

CONCEPT FINDING

The market challenges are to overcome at first by a good concept. If the basics are defined well, the number of gears, the gear set layout as well as the e-motor integration concept and the software concept can be fixed. A new trend is the development of specific transmissions with regards to new energy. Which means that on the one hand reducer transmissions for e-motors have to be developed and on the other hand complex hybrid transmissions are required, which are combining for example P1 and P3 configurations. These complex hybrid transmissions are also called "DHT" – "Dedicated Hybrid Transmission". These DHTs are not usable as "Standalone" conventional transmissions without e-motors, because e.g. the reverse driving is realized by e-motor driving. For both, DHTs and reducer transmissions, the necessary number of gears need to be defined. Therefore, simulation and calculation models are developed and used by GETEC Getriebe Technik GmbH. The results for a DHT and for a reducer transmission combined with an e-motor to an "EDS" – "Electric Drive System" are shown in the following figures (Fig. 1 / 2).

The gearset for a DHT transmission configuration is simulated and calculated (Fig. 1). As example, an engine with an optimum specific consumption of 245 g/kWh is applied. The dark blue colored areas are representing the optimum engine operating

area. It is clearly to see that the fuel-efficient operating area of the engine in all driving conditions is increasing with the number of gears. Another positive aspect is that with an increasing number of gears the nominal and the peak performance area is also increasing. For the above sample DHT application the 4-speed solution is optimal.

This graphic is also created for an EDS (electric drive system) in Figure 2. For an EDS the e-motor efficiency is of interest. There are many discussions about the future of transmissions ongoing in the moment. GETEC is clearly stating that transmissions will be required in the future for several reasons!

With one gear for example, the tradeoff between performance (acceleration / climb ability / top-speed) and an optimal system efficiency must be well selected. This means a huge compromise. With two gears, the result is changing quite a lot. The performance and efficiency are well distributed over the complete operation area. Three gears are bringing minor additional benefit for the efficiency in the operation area. The benefit compared with the effort to apply and handle three gears, leads to the result that in this case study a 2-Speed EDS is the best choice. Due to the increasing demand on e-motor speed, the requirements not only to the e-motor but also to the inverter are rapidly growing. This is strengthening the message that at least a 2 speed transmission is reasonable.

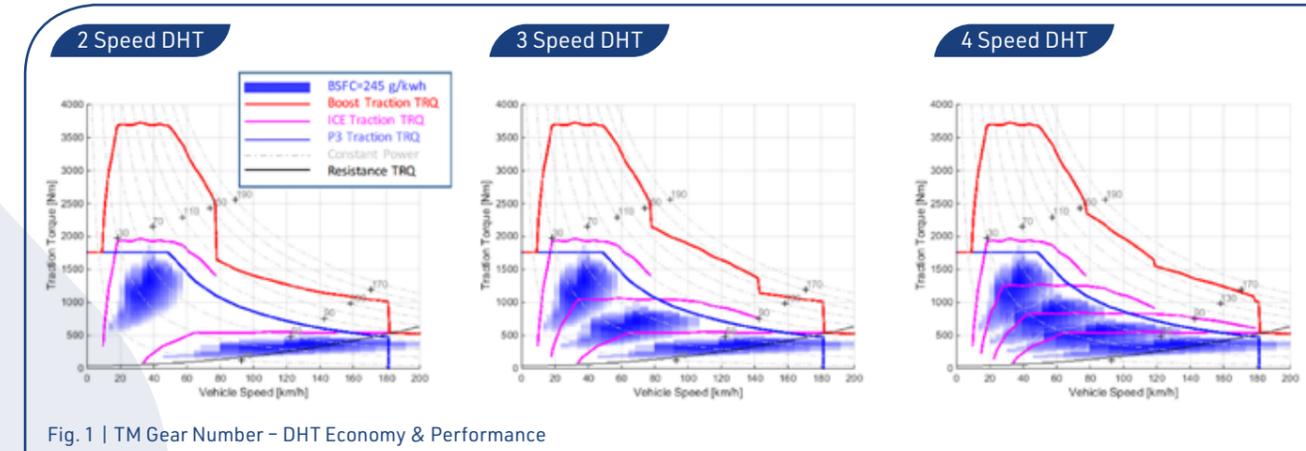


Fig. 1 | TM Gear Number - DHT Economy & Performance

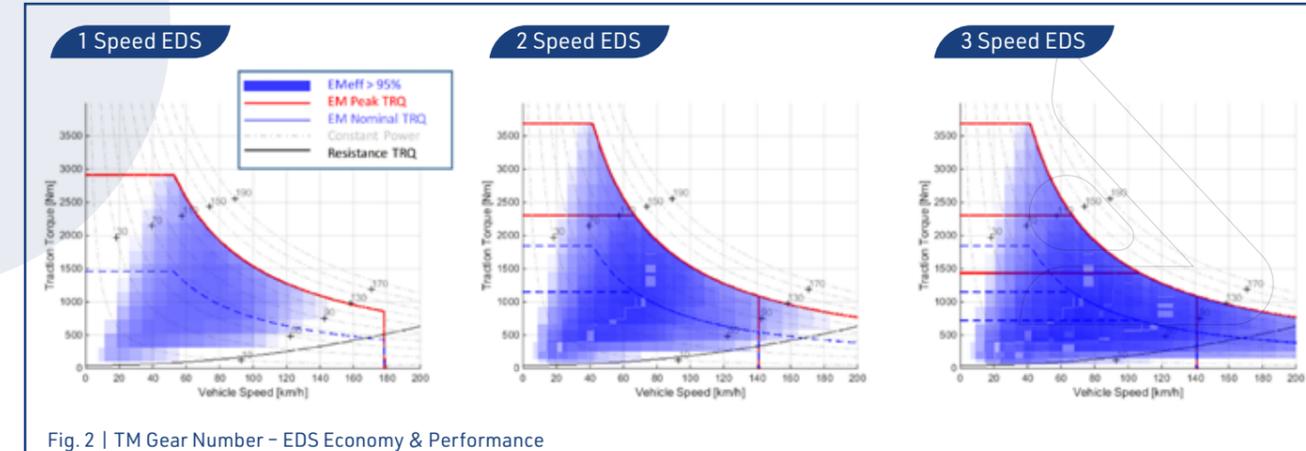


Fig. 2 | TM Gear Number - EDS Economy & Performance

DEVELOPMENT

During the development, a couple of challenges are faced. The hardware component selection has a much bigger variety as for conventional transmissions. Picking out the e-motor, it is necessary that the e-motor needs to be well developed and multiple development targets have to be considered. For example, the technology for the windings need to be analyzed from technical perspective as well as from the perspective of production. Not every supplier can produce the hairpin technology. By defining the system software, it is also essential to define the functions and responsibilities together with the vehicle manufacturer. The software, especially for a hybrid control needs to consider a couple of different driving modes. All the hand overs from one to another mode have to be adjusted and optimized to satisfy the customer. New developed functions like boosting and sailing needs to be developed, calibrated and tested.

Compared to the conventional transmissions the level of electrification is increasing and also the overall drivetrain efficiency

needs to be further optimized. However, the performance and cost level has to be well balanced. To overcome these challenges, it is unalienable to optimize the development strategy. Therefore, GETEC is developing based on a modular strategy.

The target of this modular development strategy is to develop transmission families for different transmission types like DCT, DHT and EDS. All these transmission families have to use as much as possible out of a pool of components. Within this pool there are e-motors, resolvers, dual clutch modules (DCM), hydraulic control modules (HCM), pumps (electrical and mechanical), parking locks, filters, synchronizers, bearings and so on. The benefit is that many parts are existing and do not need further development capacities which reduces costs and time. A further cost and time reducing factor is that the parts are already tested and do not need further component tests. The testing time and costs can also be reduced significantly and in overall the time to market is decreased accordingly. The remaining development tests for the new developed components are easier to place due to a better availability of the development test rigs.

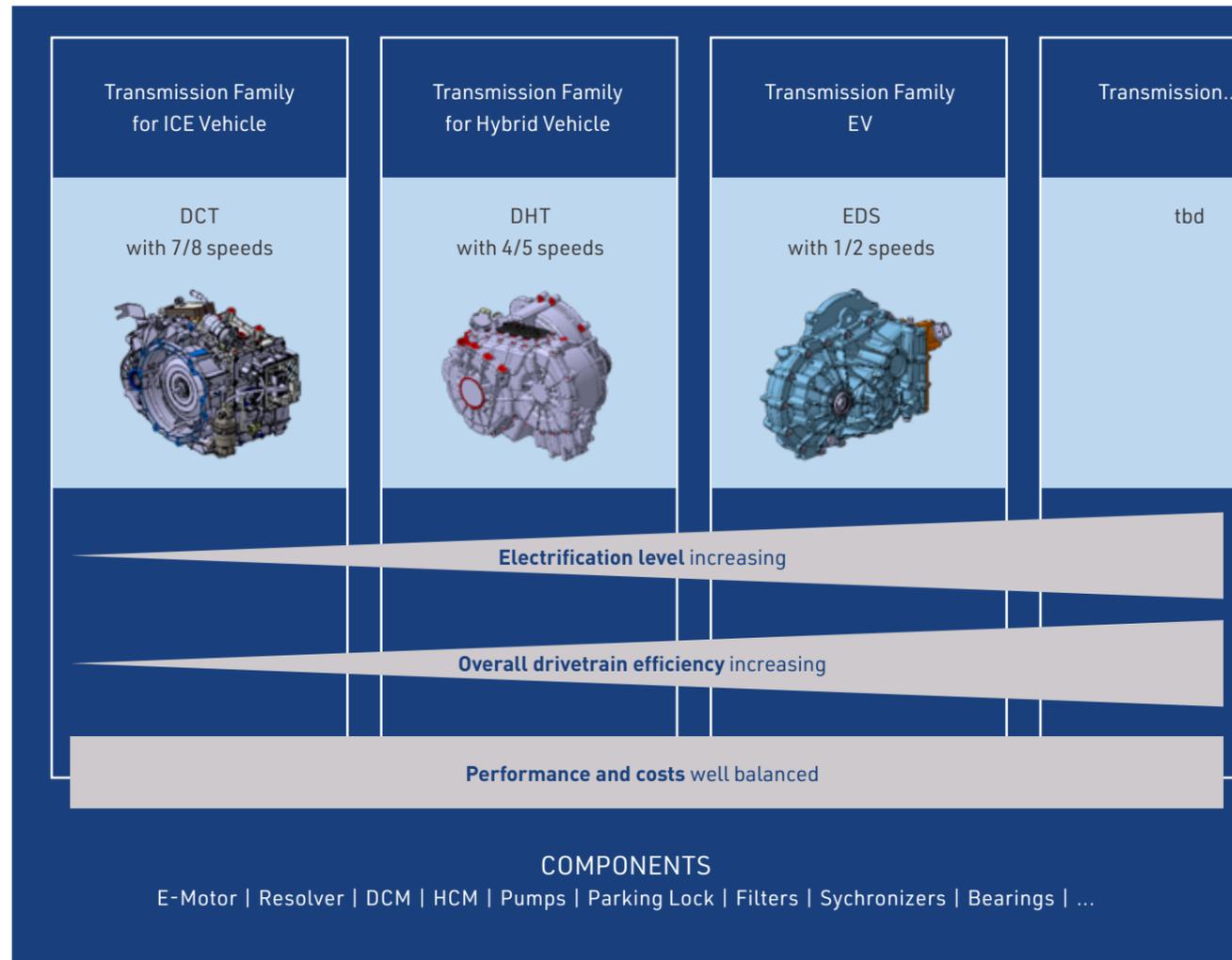


Fig. 3 | Modular Development Approach

TESTING

The testing effort on component development has to be reduced as much as possible by using common parts because the overall verification testing is becoming more and more complex and a lot of different variants have to be tested. Therefore, tailor made duty cycles are a suitable solution to test as much as necessary and as less as possible. The new requirements on vehicles like car sharing are also influencing the test cycles. Small cars are used much more frequently than before and meanwhile by completely different drivers which are not taking care about the vehicle as much as a "vehicle owning" customer.

The overall target is to develop an "ideal design" and test this design with an appropriate durability test. If the customer usage is totally clear, it is easy to develop a suitable design. Usually there are many items which are unclear, to eliminate the unclarity the solution is the measurement and evaluation of road load data. During the road load data process, a couple of drive events on specific roads are conducted with a comparable vehicle and

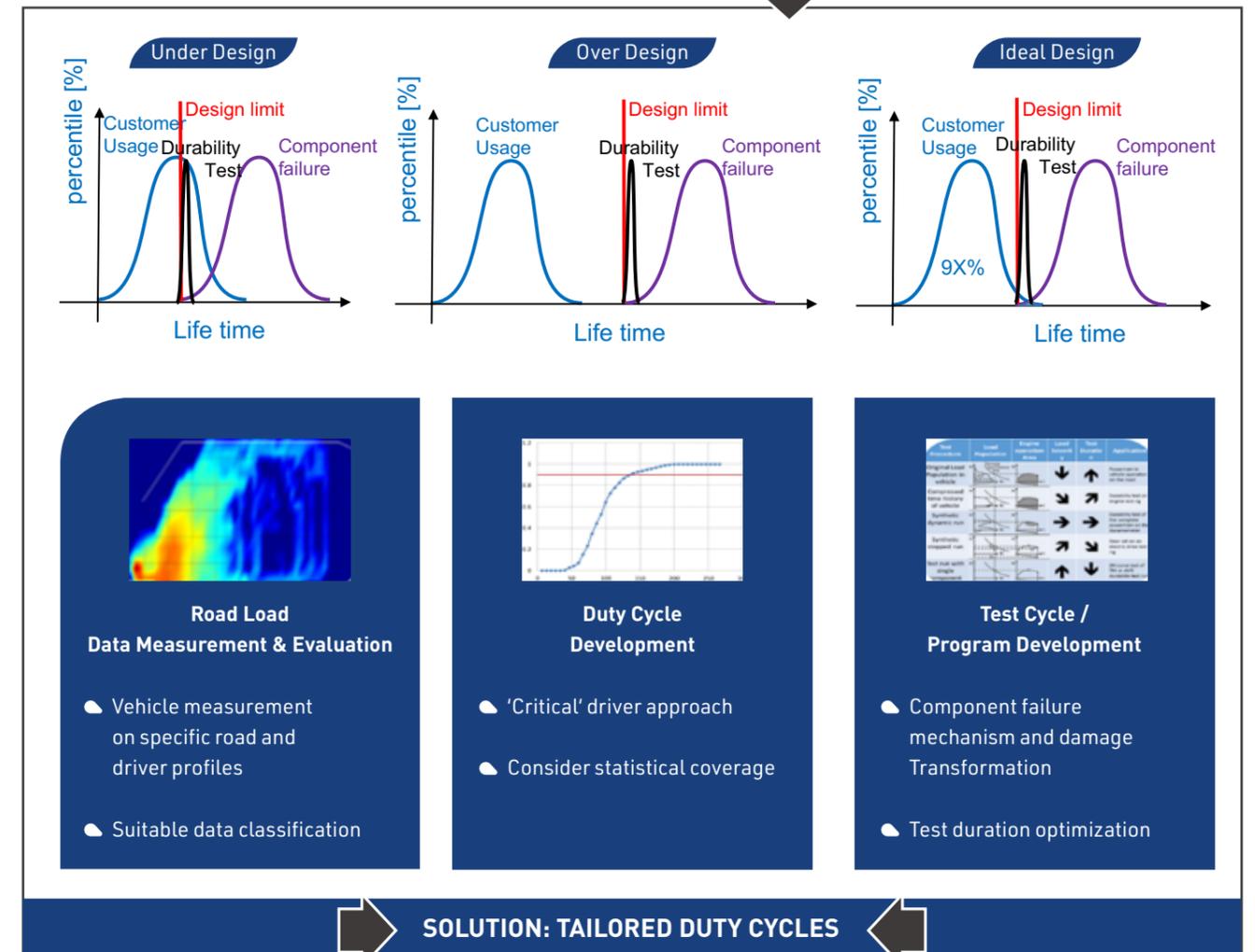
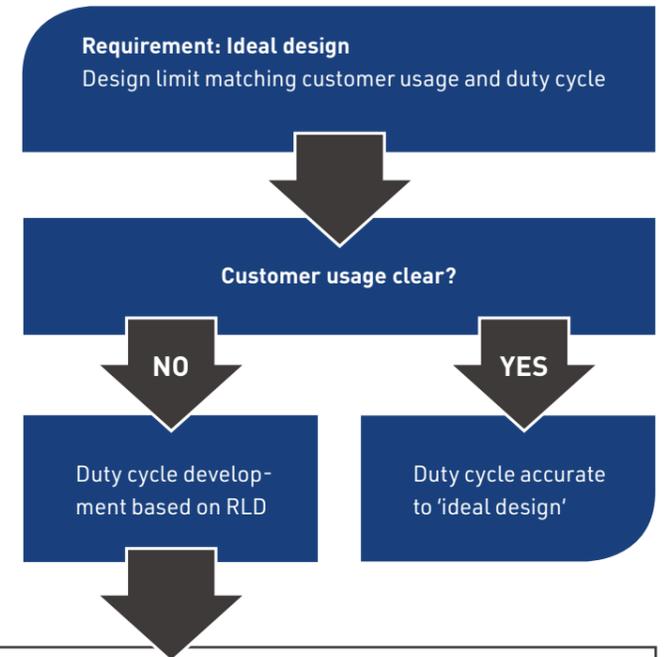
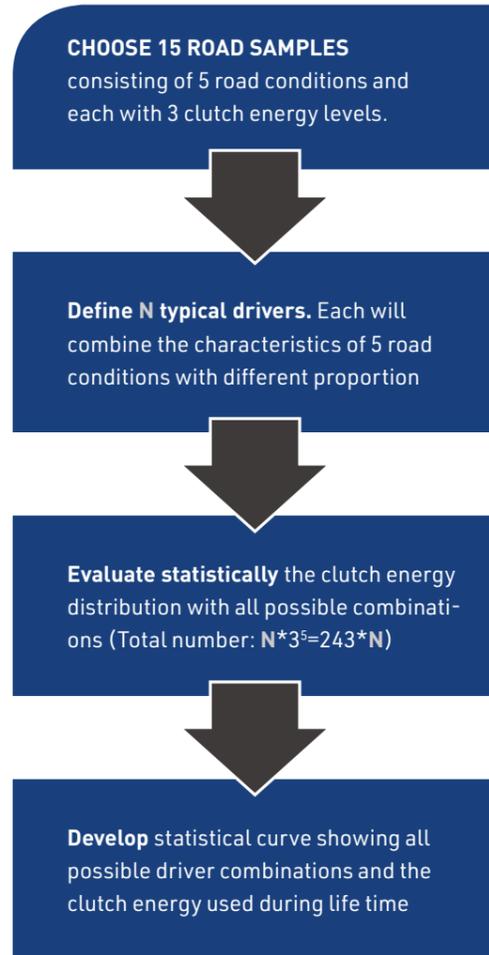


Fig. 4 | Duty Cycle Development

Fig. 5 | Duty Cycle Development



with a choice of drivers. These measurements are the base to mix the data and build a "most critical" driver which covers usually 9x% of all drivers. A tailor made test cycle can be programmed and tested.

Within this case the target mileage is 300,000 km and the focus is clutch energy. The road conditions are divided into city, highway, rural, mountain and extreme conditions. Each condition has three different kinds of energy level. In a next step "N" typical drivers are defined and each driver will combine the characteristics of the 5 road conditions and three energy levels with different portions. The total number is $N \times 3^5 = N \times 243$. To ensure all the possible driver types will be considered, GETEC applies equiprobable enumeration to generate N (millions) of different drivers. The result is a statistical curve, which is showing all the possible driver combinations and the clutch energy during the lifetime. To find a suitable design and test method, the 9x% method will be used. Otherwise the design would be an overdesign.

GETEC has several times adopted this method with excellent results in the past. Regarding clutch energy for example it can be seen that the standard design from the older days is not matching the increased weight of vehicles (SUV) equipped with turbo charged engines and the severe traffic overload are leading to more stop and go. The total transferred energy on clutches is significantly increased within the last years.

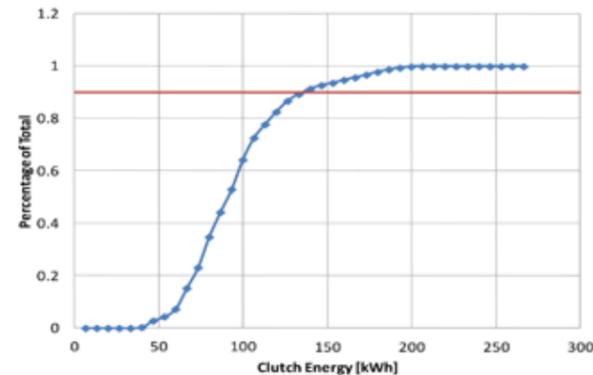
Beside the test cycles, the requirements on the testing facilities is rapidly increasing with respect to the new energy development and testing demands. Better efficiency, high performance, increasing quality requirements, etc. are inquiring high performance test benches. These benches have to be equipped with a high number of additional equipment like a climate simulation, current measurement systems, battery simulators, telemetry and so on.

Nowadays speeds up to 18.000 rpm are often demanded which requires beside a high-speed dyno also a driver system to run this dyno within the required speed and with the necessary power in all conditions. For more power, one approach in GETEC is to combine battery simulator systems in parallel.

Clutch Friction Energy kWh / 300,000 km			
Road Condition	Energy Level		
	Level 1 - Low	Level 2 - Medium	Level 3 - High
City	Energy_City1	Energy_City2	Energy_City3
Highway	Energy_HW1	Energy_HW2	Energy_HW3
Rural	Energy_RR1	Energy_RR2	Energy_RR3
Mountain	Energy_MT1	Energy_MT2	Energy_MT3
Extreme Condition	Energy_EX1	Energy_EX2	Energy_EX3

X

Road Combination List							
Road Condition	Upper Limit	City Driver	Highway Driver	Rural Driver	Mountain Driver	Extreme Driver	...
City	0.8	0.8	0.15	0.2	0.2	0.2	...
Highway	0.8	0.1	0.7	0.1	0.2	0.2	...
Rural	0.8	0.05	0.12	0.55	0.1	0.3	...
Mountain	0.8	0.03	0.02	0.1	0.45	0.2	...
Extreme Condition	0.1	0.02	0.01	0.05	0.05	0.1	...
SUM		1.00	1.00	1.00	1.00	1.00	1.00



N to ensure all the possible driver types will be considered, GETEC Getriebe Technik GmbH use equiprobable enumeration to generate N (millions) of different drivers

SUMMARY

A couple of solutions for the new energy drivetrain development are discussed above. The market challenge is the trade-off between reducing the package, weight and costs and increased requirements for functionality, performance and economy.

GETEC Getriebe Technik GmbH developed many measures to face these challenges.

Joachim Trumpff

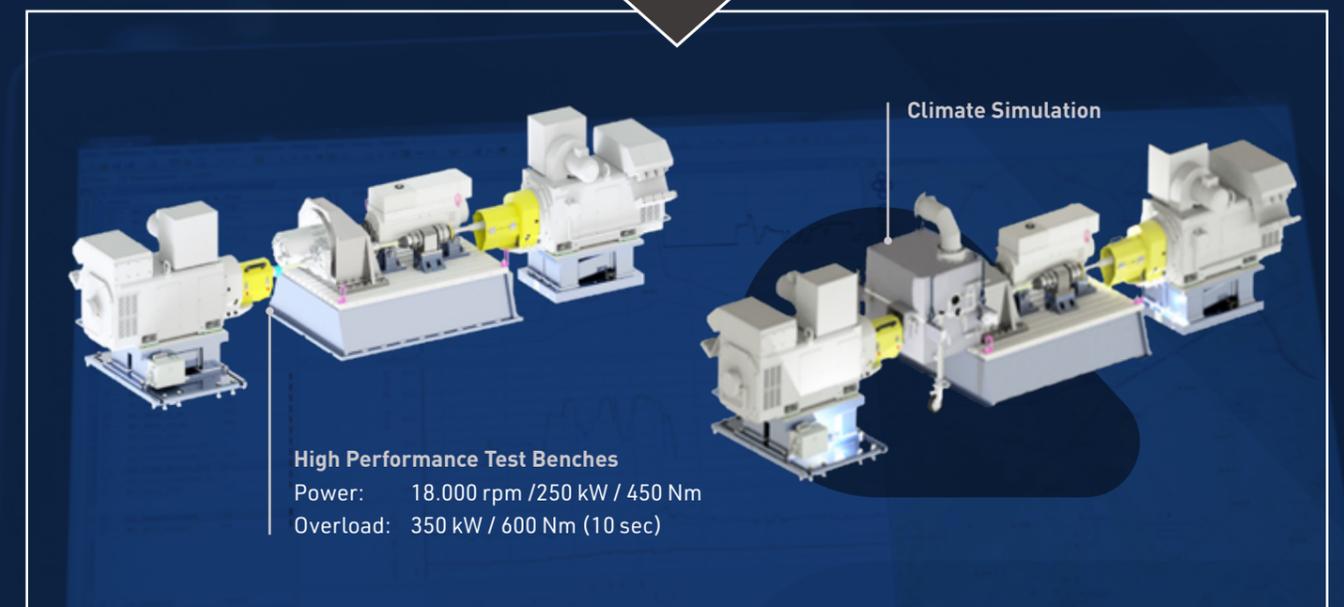


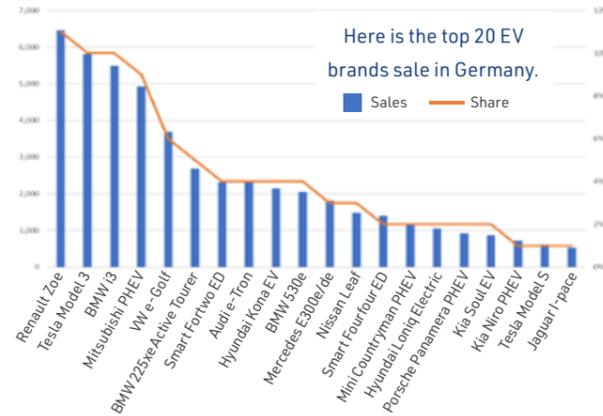
Fig. 6 | Verification Facilities

EV Sales in Germany 1-7, 2019

Report from Gasgoo, Data from EV Sales

According to the German electric vehicle sales data released on the EV Sales website, after the good results in the first half of the year, the number of electric vehicle registrations in Germany continued to climb in July, with 9,233 units sold, of which pure electric vehicle sales surged by 136% year-on-year. Sales of plug-in hybrid vehicles increased slightly by 6%. Last month, the German electric vehicle market accounted for 2.8% of all new car sales, of which the pure electric vehicle market share was 1.8%.

From January to July in 2019, the cumulative sales of EV in Germany is 56,817.



Oliver Zipse officially served as CEO of BMW, sending an internal letter urging employees to accept the change to catch up with the Mercedes-Benz

Report from Reuters

According to Reuters, BMW's new CEO, Oliver Zipse, urged employees to embrace change and find innovative ways to help the company outperform its rival Mercedes-Benz.

In the past few years, BMW has lost ground in competition with Mercedes-Benz. In 2016, Mercedes-Benz's global sales surpassed BMW after 12 years.

According to Zipse, BMW's flexible production methods offer a major competitive advantage, as it will enable BMW

to expand or slow down the production of electric vehicles as needed.

BMW predicts that there will be a steep growth curve for electric vehicles by 2025, and sales will grow at an average annual rate of 30%. By 2021, sales of BMW's electric vehicles (battery powered and plug-in hybrids) will be more than 2019.

GETEC comments

Both Europe and China are vigorously developing new energy vehicles. At the same time, the market is increasingly accepting new energy vehicles with low fuel consumption, especially pure electric vehicles. Because of policy-driven and market-driven, new energy vehicles will be main trend in the future. However, new energy vehicles, especially electric vehicles, have a high degree of ho-

mogenization. How to be better differentiated in the market and accepted by customers, stability and safety are still the primary considerations for customers to choose new energy vehicles. Pre-marketing tests, such as performance testing and functional testing, can better verify their quality and ensure that they are highly recognized by the market.

GETEC Getriebe Technik GmbH (Germany) New Energy Testing Capability available for Europe market

Report from GETEC official website

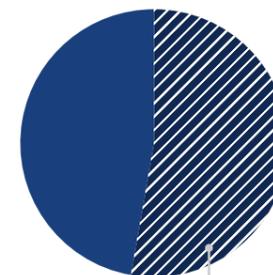
Recently, GETEC Getriebe Technik GmbH (Germany) has finished the set up and commission of Bench No.1 and successfully completed the 1st project from our customer. Bench No.1 is available for testing of high-speed E-Motor and Inverter up to 18.000 rpm, and equipped with battery simulator, climate chamber for inverter, conditioning system and power analyzer. 2nd and 3rd test bench was finished in August.

Further test benches will be commissioned within 2019 and following year. GETEC's testing capability will be available for all new energy testing. With the increasing and leading testing capability, GETEC Germany will support the improvement of customer products and assist customers worldwide in the transformation to new drivelines in the auto industry.

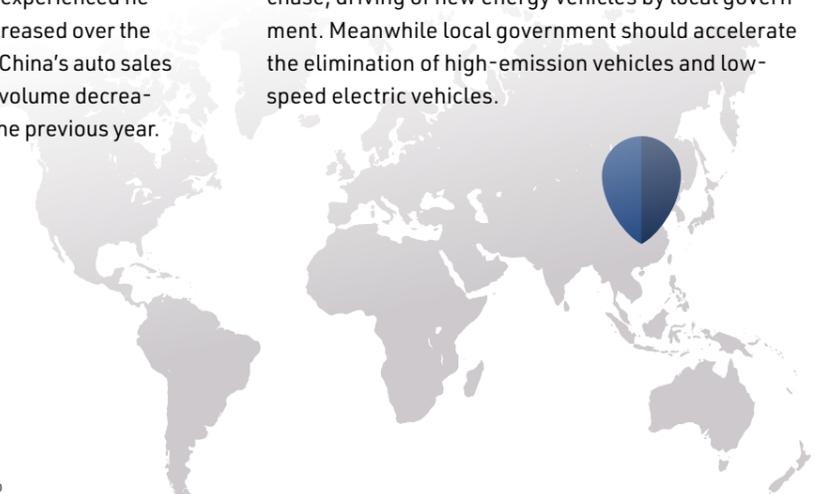


HOTSPOTS IN CHINA

- **Geely (China Local Auto OEM) and Daimler** form a joint venture to cooperate in the production of electric Smart, Geely is responsible for engineering research and development
- On July 1, 2019, China Implement "CN VI" fuel emission standard policy
- Tesla Model 3 is made in China at the end of 2019.
- Guangdong, Beijing, Shanghai, Tianjin and other regions directly implemented the "National VI" emission standard.
- China has 53% market share on new energy vehicles worldwide.
- The Chinese government has issued a series of notices focusing on promoting the purchase and use of new energy vehicles. It is not allowed to restrict the purchase, driving of new energy vehicles by local government. Meanwhile local government should accelerate the elimination of high-emission vehicles and low-speed electric vehicles.
- In 2019 China's passenger car sales experienced negative growth, and sales volume decreased over the same period. From January to June, China's auto sales were 12.323 million units, and sales volume decreased 12.4% from the same period of the previous year.



NEW ENERGY VEHICLE | China 53%



COMING EVENTS

CTI CHINA 2019

Speech topic | Facing the Market Challenge –
Solutions for New Energy Drivetrain
Product Development



Time: 23.-25.09.2019

Speaker: GETEC | Mr. Joachim Trumpff

More information, please link:

<https://drivetrain-symposium.world/cn/>

AACHEN COLLOQUIUM GERMANY 2019

Speech topic | Dual electrification inside –
A multistage DHT



Time: 07.-09.10.2019

Speaker: GETEC | Mr. Florian Stallforth

Booth: No. 62

More information, please link:

<https://aachener-kolloquium.de/en/>

CTI BERLIN 2019

Speech topic | Concept of a 4-speed DHT
with high efficiency



Time: 09.-11.12.2019

Speaker: GETEC | Mr. Florian Stallforth

Booth: No. G04

More information, please link:

<https://drivetrain-symposium.world/de/>

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