GETEC
Getriebe Technik GmbH

NEWSLETTER

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ADVANCED TECHNOLOGY

Which is the best HEV/PHEV technical solution to face future requirements?

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Greeting Words

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Disruption and diversification of the powertrain in the automotive industry

What will the powertrain of the future look like? How can we achieve climate neutrality in automotive technology? How do we manage the turnaround and thus the transformation away from fossil fuels to electromobility without job losses? How do we get it financed? Will other players overtake us and do we have the right technology?

These are the essential questions of our time. Only a few years ago, Europe was leading in the field of complex thermodynamics of combustion engines and the development of efficiency-optimised and low-cost transmissions (10-speed DCT!). Within a few years, we have now gone from driving to driven technology companies (disruption). The great importance of the Chinese market, the technology pressure from Tesla in the person of Elon Musk, but above all the ecological market pressure is significantly accelerating the negative image of fossil (the word already says the opposite of innovative) combustion engine technology. The combustion engine will continue to exist for the next 30 years, but the volume growth will take place exclusively in the field of electromobility. For this reason, all car companies are busy with developments in electromobility and many new players are emerging. And the diversification of the various powertrain topologies is correspondingly large. High power densities require high speeds with subsequent (switchable!) reduction gears. The arrangement of the electric motor(s) has become a question of philosophy. In order to cushion the range problem, there are drivetrains in which an internal combustion engine no longer has any connection to the wheels and only has the task of operating a generator, which in turn directly drives an electric motor and charges a battery. As always in technology, there is never one golden road. The advantages and disadvantages always have to be balanced against each other.

To what extent this electromobility represents the bridging technology to the hydrogen-powered fuel cell, only time will tell. At present, a battery-powered vehicle with 1 KWh of energy achieves twice the range of a fuel cell vehicle. However, this comparison does not take into account the large-scale production of hydrogen or the development of a large charging infrastructure.

In this newsletter you will find some answers to pressing questions in the hybrid (HEV) and plug-in hybrid (PHEV) car segment. Mobility is and remains the engine of our economy.

I am excited and curious to see where the road ahead will take us.

Greetings

Ralf von Dahlen
Managing Director

GETEC Getriebe Technik GmbH

ADVANCED TECHNOLOGY
WHICH IS THE BEST HEV/PHEV TECHNICAL SOLUTION TO FACE FUTURE REQUIREMENTS?

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The market outlook in China shows a significant growth of hybrid electric vehicles (HEV) and plug-in hybrid electric vehicles (PHEV) for the following years. Whereas for HEV the technical solution applied is mainly defined as dedicated hybrid transmission (DHT) and for PHEV the DHTs are competing with conventional transmission with P2 (on transmission input) or P2.5 (on transmission main shaft) hybridization. Those applied conventional transmissions are dual clutch transmissions (DCTs), conventional automatic transmissions (AT) and continuously variable transmissions (CVT). The following figure shows the transmission sales growth for HEV and PHEV for the different types of technical solutions.

For the HEV/PHEV multiple technical solutions are available: Conventional transmission plus Px, Toyota Hybrid System Type (THS), 1-Speed DHTs e.g. Honda i-mmd or multi-speed DHTs. Question is: which technical solution is the best for DHT?

To provide an answer to this question, GETEC analyzed the technical solutions DCT+P2, THS, 1DHT and 2DHT from the following perspectives:

- Fuel consumption reduction potential,
- Performance,
- Driving quality,
- Package and
- Costs

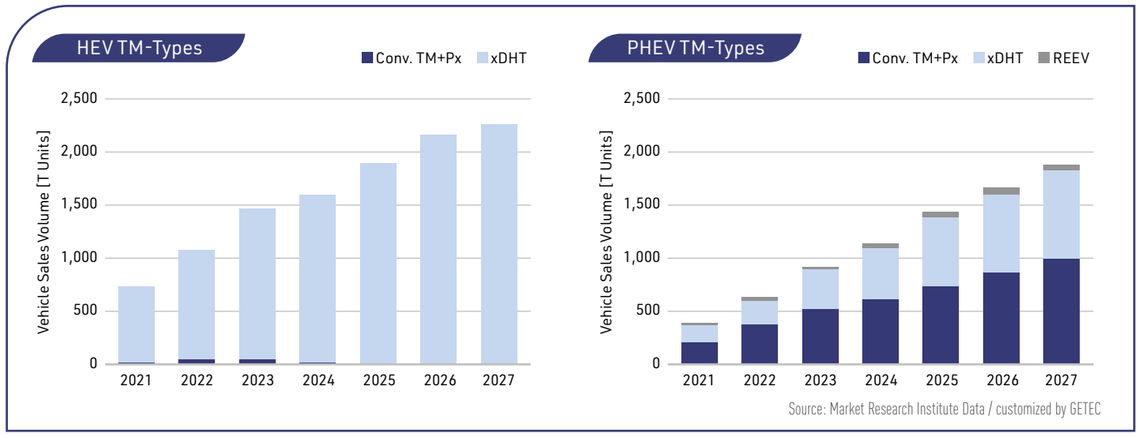

Fig. 1 | HEV & PHEV Market Outlook China

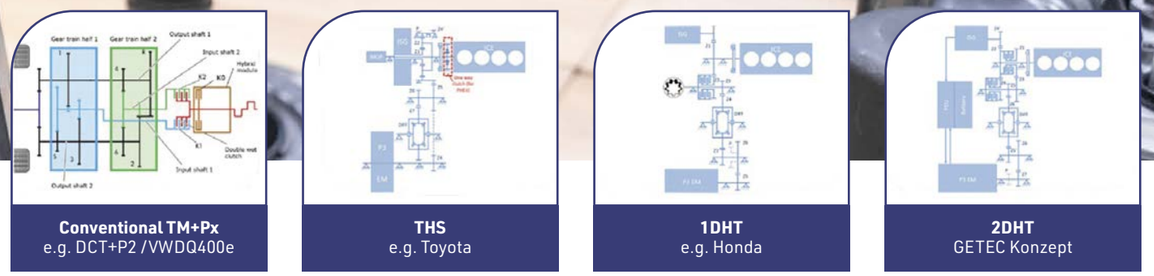

Fig. 2 | Main HEV / PHEV PHEV Technical Solutions

The biggest fuel consumption reduction potential can be achieved by multi speed DHTs: 2DHT reaches a 85 % fuel consumption reduction compared to the DCT base. 1DHT fuel consumption is ~1 % higher, followed by the THS and the DCT+P2 solution which can achieve about 75 % fuel consumption reduction compared to DCT base.

The reason for the good fuel consumption results of the 1DHT and 2DHT is the independency of engine operation to any driving condition / driver torque requirement.

Further fuel consumption reduction potential can be achieved by improving engine combustion technology e.g. by applying Atkinson or Miller cycle engines. Especially the engine technology influence is significant for the HEVs: 1DHT / 2DHT can achieve ~5 % better fuel consumption compared to the DCT+P2 solution.

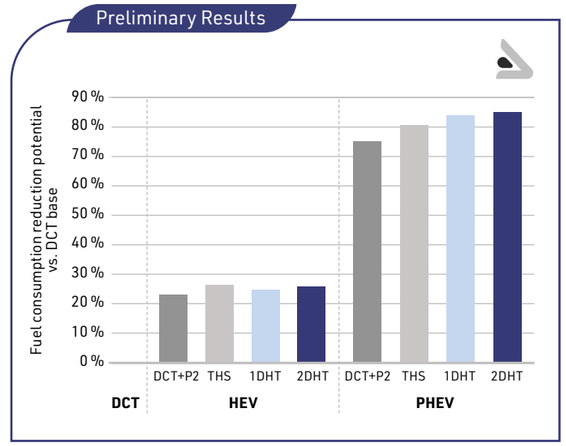

Fig. 3 | Fuel Consumption Simulation Results

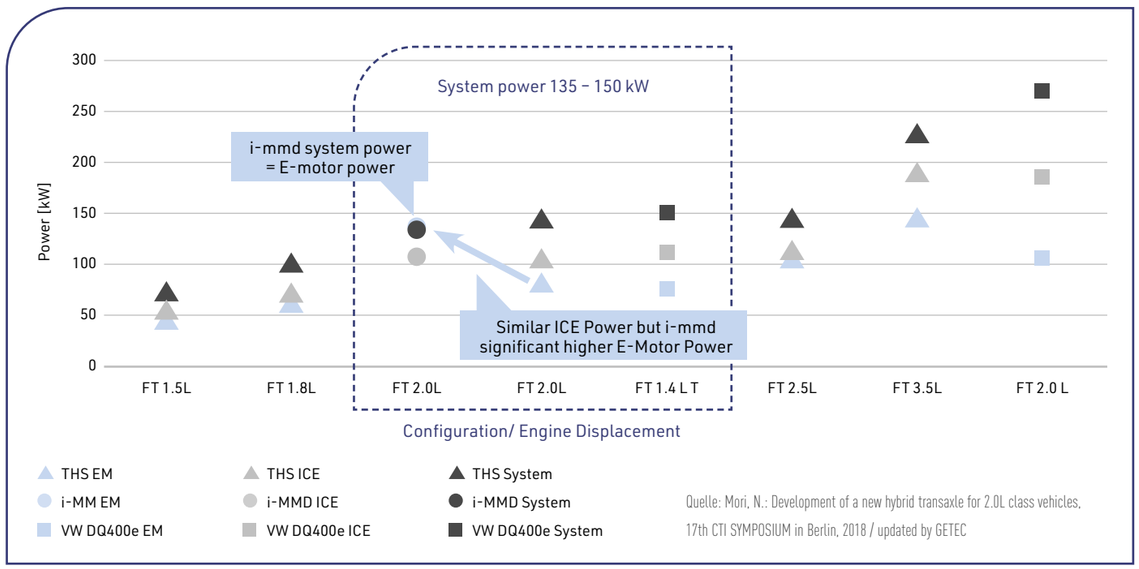

Fig. 4 | System Power of different DHT systems

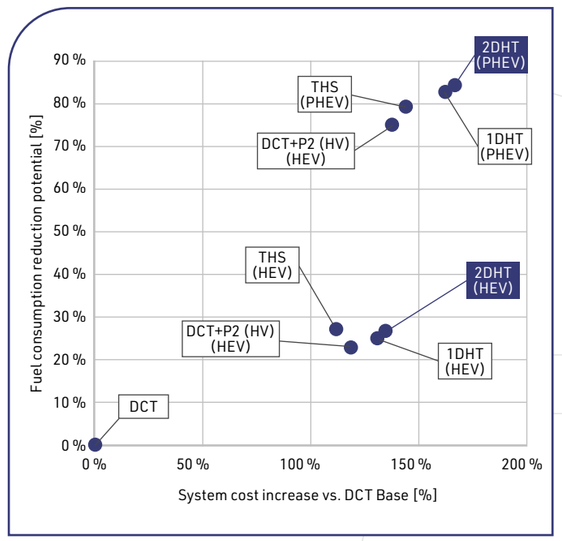

Abb. 5 | Fuel consumption reduction potential vs. system costs compared to DCT base

The performance of the HEV/PHEV technical solutions are defined by the available system power. The system power of the DCT+P2 and THS is a combination of the installed internal combustion engine (ICE) and traction motor power, this combined power is limited by the transmission torque capacity. For 1DHT and 2DHT the main drive is the traction motor and therefore the system power is identical with the traction motor power.

The installed electrical power for the traction e-motor for 1DHT and 2DHT is assumed within this assessment as identical, therefore those two technical solutions reach the same performance results. DCT+P2 and THS have a bit less performance for the 0-50 km/h EV acceleration time and for the climb ability. In the 0-100 km/h acceleration the performance values of DCT+P2 and THS are similar to those of the DHTs.

The system power distribution between ICE and traction motor is also the main influence to the driving quality.

The DCT+P2 has multiple shifting and THS / DHTs have "CVT-style" driving characteristic with variable ratio selection. The DCT+P2 gear shifts will be carried out in electric vehicle mode (EV-mode) as well as in parallel mode. THS ratio adjustment will follow the vehicle speed to prevent "rubber band" feeling driving characteristic – the ratio adjustment itself is very comfortable. Similar like THS will the engine speed of 1DHT and 2DHT controlled by the generator motor to follow the vehicle speed and torque demand. 1DHT and 2DHT will close the clutch in case that the engine operates on a high efficiency level and therefore a direct engine driving to the wheels is beneficial. The clutch closing of the DHTs can be adjusted unnoticeable to the driver: as soon as the engine and input shaft speed are synchronized, the clutch will be closed without slip. Generally, the driving characteristic of DCT+P2, THS, 1DHT and 2DHT are very comfortable. Some drivers might prefer the CVT-style driving characteristic of THS, 1DHT and 2DHT.

Assuming similar package installation restrictions for all technical solutions in the vehicle the powertrain length will be for the DCT+P2 most challenging. THS, 1DHT and 2DHT are generally very compact but the radial size due to the two electric motors (traction motor and generator) and dual inverter will be more challenging for the installation. Typically, the vehicle engine bay package must be realigned for a hybrid powertrain if the base is a pure ICE powertrain. Considering this it will be the axial length restriction most concerning for the DCT+P2 solutions since the chassis shall typically remain unchanged. Assuming the same system power for all technical solutions then the DCT+P2 is a compromise of volume for traction motor and gear set. THS volume is more occupied by the electric motor with a comparable smaller gear set as DCT+P2. 1DHT and 2DHT most volume is occupied by the electric motors.

The system costs shall be compared to the fuel consumption reduction potential as main target for the hybridization of powertrains. System costs in this analysis shall contain the transmission, e-motors, inverters and battery. The assumed battery capacity of HEV is 1.3 kWh and PHEV is 11.3 kWh. The assumed battery costs for a HEV battery are 650 – 800 EUR/kWh and for PHEV 100 – 150 EUR/kWh. The significant higher costs per kWh of HEV batteries is caused by the higher peak discharging and charging currents per cell which must be available for the HEV's operation. Figure 5 shows the fuel consumption reduction potential vs. system costs compared to DCT base.

According to Figure 5 the most beneficial powertrain is the 2DHT as PHEV configuration with 85 % fuel consumption reduction vs. ~170 % cost increase compared to DCT. The 2DHT is followed by the 1DHT, THS and DCT+P2. For HEV also the 2DHT achieves a good compromise of fuel consumption reduction potential vs. system cost with 28 % fuel consumption reduction by increasing the system costs ~140 %:

As one answer GETEC developed the 2DHT concept. In this technical solution the ICE is connected to the integrated starter generator (ISG).

Via two clutches and related gears the ICE can be connected to the differential and drive the vehicle. The traction motor is connected to the differential as a separate part transmission in so called P3 layout. With this configuration, all hybrid modes can be realized including: ev-driving, serial mode, parallel mode, parking change and recuperation mode.

The above analysis of different technical solutions for HEV and PHEV has given a deep insight into the advantages and disadvantages of each solution. GETEC has developed the 2DHT concept as a well-balanced compromise of fuel consumption reduction, performance, drivability package and costs. This concept shall support the future portfolio strategies of OEMs and Tier1s.

5 Years GETEC

GETEC Getriebe Technik GmbH started on 1st of October 2015. How time goes fly!

We started from zero, having a good idea and extended to an excellent team, and achieved the development of DCT within a few months.
Within the last years, GETEC grows its business. GETEC is supporting its customers in all development stages of conventional drivetrains and e-mobility as an independent engineering and testing service provider. We offer our customers a highly modern test environment that is constantly being further developed.

2020 is a special year that requires a lot from everybody. New challenges had to overcome. With the great effort from our team, we will be led to the next challenging phase.

We keep in communication with industry friends in such a special period. Attending conferences like the Aachen Colloquium and CTI online, and releasing the technical & market posts via our LinkedIn and Facebook.

2015 **FOUNDING OF** GETEC Getriebe Technik GmbH

2016 **GROUND-BREAKING IN ALDENHOVEN, GERMANY**

2017 **OPENING CEREMONY IN ALDENHOVEN, GERMANY**

2018 **TEAM EXTENSION**

2019 **HIGH SPEED TESTING FOR EV SUCCESSFULLY STARTED**

2020
5 YEARS

GETEC Getriebe Technik GmbH

THANK YOU
dear customers, partners, friends, and team for all your trust and support in us in the past 5 years.

New energy testing: LV123 & LV124 standards

The electrification of the drivetrains in vehicles is accelerating and irreversible. In 2021 many new electrified vehicles from well-known OEMs and newcomers will enter the market. To verify the functionality and reliability of the high-voltage components inside an electric vehicle, standards are created and applied by different institutes and European OEMs. LV123 and LV124 are two popular ones of these standards - they demand complex test conditions and validate the DUT alone as well as inside the ECU system.

How to increase the level of confidence?

How to increase the level of product confidence? What challenges you are facing? It is very necessary to carefully think about it. Especially when you are developing conventional Drivetrains or New Energy Powertrains.

The answer is a close link between engineering and testing. Issues found in the bench test or vehicle test need to be deeply analyzed and solutions can be jointly developed.

An air sucking on a dual-clutch transmission is a typical challenge for highspeed cornering, highest accelerations, or decelerations. Such difficulties can deeply be analyzed by transparent housings on our tilting test benches, efficient countermeasures can be developed, implemented, and verified.

We are facing new challenges now, which make us continuously optimize our engineering & testing. Besides the problem-solving strategies, we are thinking out of the box and generating new approaches for our customers.

No matter what the challenge is, we will develop the solution. Besides our standard testbench equipment, we also provide shift robots, robots to activate a brake, clutch, or gas pedal, and also special customized tools.

Increase your confidence by GETEC-Testing

Testing on Bench & Vehicle	Test A	Test B	Test C
			
Confidence:	**50 %**	**70 %**	**99 %**

High-Speed E-Motor Development – 22,000 rpm and the Challenges

How to develop a sustainable, space-saving, and cost-optimized powertrain? We suggest using the concept with a high-speed electric motor in connection with a gearbox for passenger vehicles.

Because higher speeds have a good potential for the future based development on the following reasons:

- Saving expensive and limited resources
- Reduce current without increasing voltage
- Avoid gear shifting or one-way-clutch

In the development, a permanent magnet synchro machine is chosen, since the initial concept analysis shows that the advantages for this technology combined with 22,000 rpm are predominantly.

GETEC Getriebe Technik GmbH is facing the challenges of optimized power-to-weight ratio, high-speed durable components, compact integration of e-motor and gearbox, and shortest timing by strictly following a modular strategy using the same components for different drivetrain configurations (see the figure).

This will help OEM to better convince end customers not only by innovation but also with a competitive price.

If you are interested in below topics, you can contact with us:

- High-speed e-motor development
- Concept analysis and design
- Testing for a high-speed e-motor

E-Mobility Development Portfolio

HOTSPOTS IN ASIA

1. On February 25, 2021 - Volvo Cars Limited and Geely Automobile Holdings Limited announced a merger proposal, in which the two companies will maintain their existing independent corporate structures, merge and collaborate in the business areas of powertrain, battery, inverter and e-motor technology and highly autonomous driving, while maintaining their existing independent corporate structures and focusing on the forward-looking technologies of the new four automotive technologies (electrification, intelligence, networking and sharing). The two companies will merge their powertrain businesses to form a new company in the form of an equity merger, focusing on the development of a new generation of dual-motor hybrid powertrain and high-efficiency internal combustion engines. Source: China Economic Network

2. On March 2, 2021 - Jidu Automotive Co., Ltd. was officially established, jointly funded by Baidu and Geely. The business scope of Jidu Auto includes technical services of new energy vehicles and related parts, sales of new energy vehicles, manufacturing of auto parts and accessories, etc. Source: Sina

3. On February 22, 2021 - Tesla Automotive Information Services (Dalian) Co., Ltd. has been registered in Dalian High-tech Zone, covering electric vehicles, solar panels, and energy storage equipment, providing overall services from energy generation, storage to transportation. Source: China News Network

4. On February 8, 2021 - Great Wall Motor Company Limited has completed its strategic investment in Beijing Horizon Robotics Technology R&D Co., a leading automotive smart chip company in the industry. Since then, it marks Great Wall Motor's official entry into the chip industry. Focusing on the direction of advanced assisted driving (ADAS), high-level autonomous driving and intelligent cockpit, the company will jointly explore automotive intelligent technology, develop market-leading intelligent car products, quickly layout intelligent core technologies such as autonomous driving and intelligent network connection, and accelerate the development and mass production of intelligent cars to the ground. Source: China News Network

5. Chery announced its latest sales snapshot, exporting 114,000 units in 2020 and remaining the No. 1 Chinese brand in passenger car exports for 18 consecutive years. Source: China News

6. On February 2, 2021 - Dongfeng Motor Group Co. has officially signed a contract with Foshan and Nanhai governments and other four parties to cooperate in the field of hydrogen fuel cell vehicles and intelligent networked vehicles. Dongfeng has core technology advantages in the field of intelligent networked and new energy vehicles, and has developed medium-power and high-power hydrogen fuel cell systems independently, established a more complete electrochemical laboratory and a leading domestic fully automated fuel cell reactor and system pilot line. Source: Sohu

7. On February 25, 2021 - Shanghai released the „Shanghai Implementation Plan for Accelerating the Development of New Energy Vehicle Industry (2021-2025)". It is proposed that by 2025, the annual output of new energy vehicles in Shanghai will exceed 1.2 million units; the output value of new energy vehicles will exceed 350 billion yuan, accounting for more than 35 % of the city's auto manufacturing output. Source: Shanghai Municipal Government

8. In order to implement the State Council executive meeting deployment, to further promote consumption potential, the Ministry of Commerce and other 12 departments jointly issued a document referred to as the „Notice", which proposed the need to stabilize and expand auto consumption. Release the potential of auto sales, encourage the cities concerned to optimize the purchase restriction measures and increase the number plates. Source: China Ministry of Commerce

9. As of the end of 2020, there were 280.87 million civilian vehicles (including 7.48 million three-wheeled vehicles and low-speed trucks) nationwide, an increase of 19.37 million vehicles compared with the end of the previous year. Among them, 243.93 million private cars, an increase of 17.58 million. Civilian car ownership of 156.4 million units, an increase of 9.96 million units, including private car ownership of 146.74 million units, an increase of 9.73 million units. China's annual production of new energy vehicles 1.456 million units, an increase of 17.3 % over the previous year. Source: National Bureau of Statistics

10. On February 22, 2021 - it is reported that the mandatory national standard of „Fuel Consumption Limits for Passenger Cars" (GB 19578-2021) will be officially implemented from July 1, 2021. Among them, the test conditions for conventional energy passenger cars and plug-in hybrid electric passenger cars will be switched from NEDC to WLTC before 2025, and the change of conditions will affect the comprehensive fuel consumption of vehicles. The standard also stipulates the fuel consumption limit requirements for M1 vehicles burning gasoline or diesel fuel, which is one of the important support standards for China's automobile energy-saving management. Source: Aika Auto

UPCOMING EVENTS

IKA-MEETUP E-MOBILITY

E-mobility- 2 speeds Powershift EDS:
facing the challenge of shifting for e-drive

Date: 24.06.2021
Time: 18:00
Speaker: GETEC | Mr. Joachim Trumpff

https://www.ika.rwth-aachen.de/de/institut/veranstaltungen/meetup.html

THE 13TH TM SYMPOSIUM CHINA

Which is the best HEV/PHEV technical solution to face future requirements?

Date: 08-09.07.2021
Speaker: GETEC | Mr. Sven Steinwascher

http://en.transmission-china.org/

AACHEN COLLOQUIUM GERMANY 2021

2DHT – The answer to highest requirements on sustainable drivetrains for HEV/PHEV

Date: 04-06.10.2021
Speaker: GETEC | Mr. Joachim Trumpff

https://www.aachener-kolloquium.de/en

CTI BERLIN 2021

GETEC will present newest and advanced technology

Date: 29.11-02.12.2021

https://www.drivetrain-symposium.world/en

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