GETEC
Getriebe Technik GmbH

NEWSLETTER

04/2020

ADVANCED TECHNOLOGY

Virtual Road Load Data

Greetings

Author: Joachim Trumpff | Vice General Manager

A very challenging year for the worldwide automotive industry has just started. The COVID-19 virus and the related defence measures led to a huge impact to the economic development worldwide. Besides this challenge, it is necessary to rebalance the carbon footprint of the future mobility. The worldwide upheaval to electrified mobility is accelerated by traditional OEM's market start of a huge amount of electric or electrified vehicles within 2020.

In my opinion, the electrified mobility is a mid-term trend leading to a diversified mobility. Several powertrain options including those using synthetic fuels, hydrogen fuel cells, electric motors with batteries as well as hybrid solutions will exist in parallel.

Several powertrain configuration options, especially those that are new and complex, in combination with accelerated market entry are causing huge difficulties for the development and verification of those products. The OEMs and Tier 1 typically collect product usage profiles and end customer's usage behaviour in duty cycles for the development. For the verification & validation, this information is collected in the design and product verification plans and in detail represented in the test specifications. For the new energy powertrains there is not sufficient data and experience available yet, because most products are completely new developments.

GETEC Getriebe Technik GmbH has developed processes, technologies and tools to overcome the difficulty of unknown duty cycles for new products by applying Virtual Road Load Data (VRLD). The base for this is GETEC's long-term experience in the field of road load data (RLD) collection and evaluation. The VRLD allows to "re-drive" locations, driving conditions and driving behaviours with virtual vehicles containing the new powertrain. The benefit for the customers is to develop new tailored load cycles based on the real customer usage without the need for hardware. Excellent simulation-based data for the load collectives to optimize the design can be developed by using VRLD. This prevents under- or over design and leading to so called tailored development.

Beside the automotive industry also industrial trucks, construction and agricultural machines can benefit on VRLD.

The testing of new energy powertrains has high requirements for the testing facilities. GETEC invests into new high-speed testbenches in Germany and China. The increasing requirements of e-motor speeds above 20,000 rpm and torques up to 700 Nm are in GETEC's focus. Furthermore, vehicle energy simulation systems are established in GETEC as well as temperature conditioning systems for the coolant water and climate chambers for the DUT.

With our flexibility, experience and our capabilities, we deliver the best support to our customers from the development up to the production sign-off. We are looking forward to facing your challenges.

Best regards

Joachim Trumpff

GETEC
Getriebe Technik GmbH

ADVANCED TECHNOLOGY
GETEC's Virtual Road Load Data (VRLD)

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Calibration & Application Manager

1. Introduction of Road Load Data (RLD)

Durability and reliability is one of the key focus area in automobile industry. In order to match the consumer's usage behavior and profile, all OEMs, Tier 1 and (sub-) system suppliers have their obligates responsibility for the products' quality definition and insurance. The key tradeoff for the development of products is that the durability / reliability is directly linked to the costs: a more reliable design requires stronger material, increased component dimensions, advanced manufacturing technology and / or extensive quality management. Those methods will increase the safety factor of the component but also (in nearly all cases) increase the costs.

In order to balance the cost and durability / reliability, engineers need to estimate the usage conditions accurately. These usage conditions shall cover most of the end consumer's driving behavior and profile, but not overdesign into an unreasonable usage range. GETEC applies the methodology of Road Load Data (RLD) to quantify the end consumer's system, subsystem or component usage profile. For the RLD analyzation, engineers drive the target application/ benchmark vehicle in different road profiles (mountain, plain, high altitude,...), with multiple driving behaviors (economy, balanced, sporty,...), ride through varying areas of the target market (core cities, highway, rural,...), applying changing loading (with trailer, full loaded, half loaded,...) and maybe even consider the selectable driving modes (EV, hybrid, high

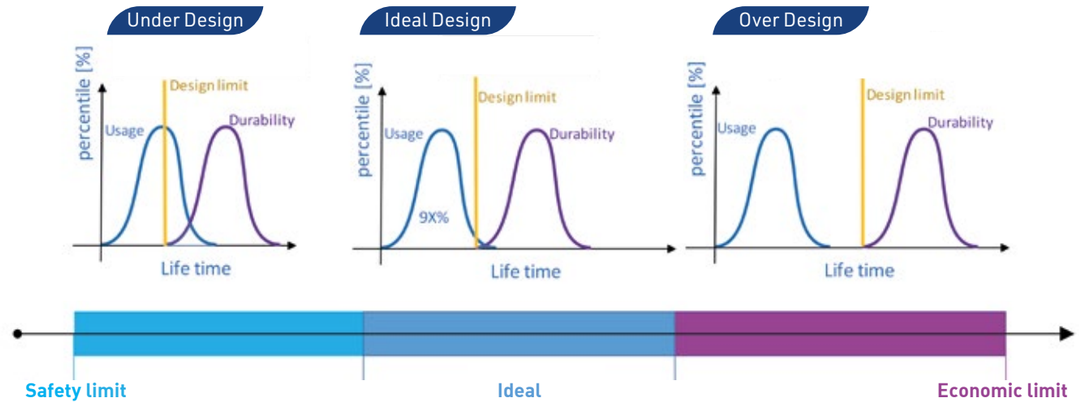


Fig. 1 | Key tradeoff – idea design

energy recuperation,...). After the collection of all kind of combinations, which consumers might possibly apply in the market, engineers analyze the data, extract the key influence of the system and component and generate the target lifetime requirement for each key system and component.

The target lifetime requirement will be more accurate the more different consumers are considered and the more number of combinations are covered. Months of measurements, data collection and evaluation are resulting in big data. Unfortunately, the specific RLD result usage is typically limited to few applications e.g. considering similar vehicle dimensions and powertrain configurations.

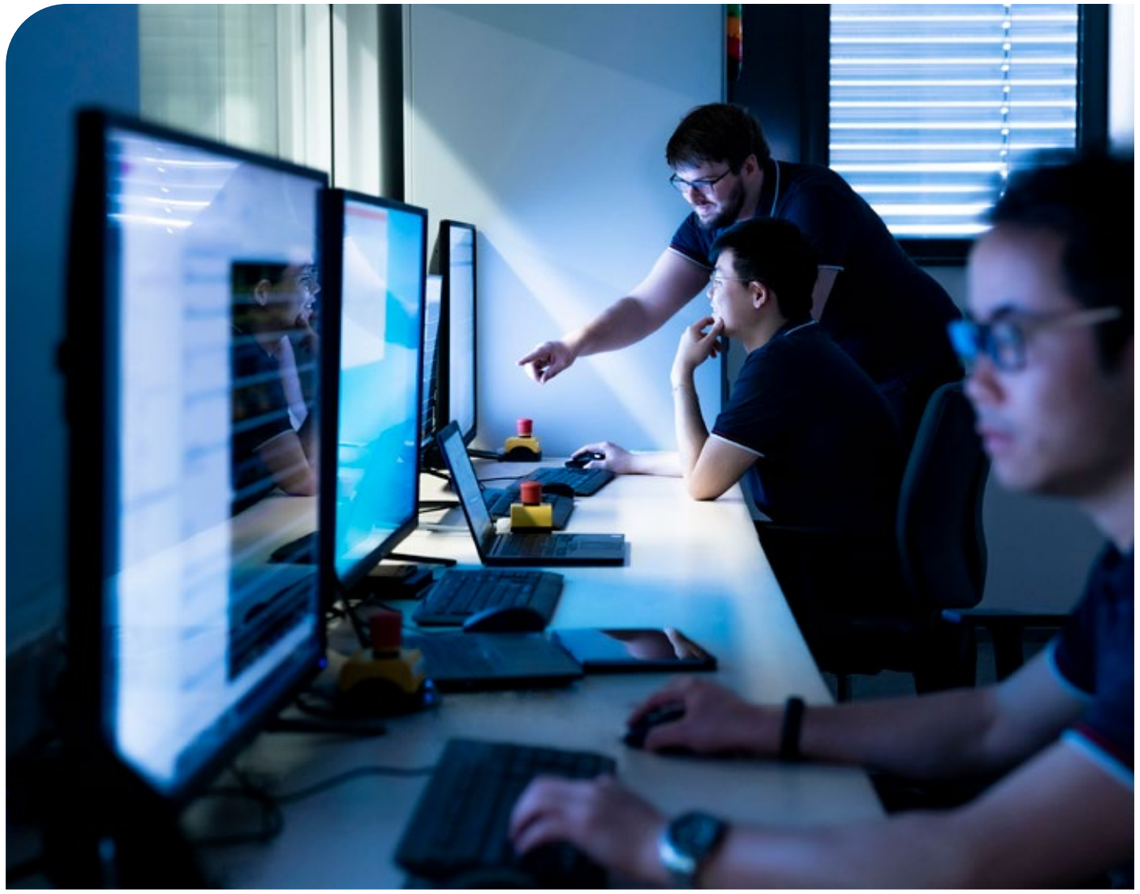
The extension of existing RLD to non-similar applications, e.g. different powertrain configuration, is highly beneficial for the development time, cost and future extendibility. GETEC's solution for this task is Virtual RLD (VRLD).

VRLD - as the name implies - uses virtual simulation or calculation in combination with an existing RLD database, to expand the results into applications, which do not have existing RLD measurements.

GETEC applies several levels of VRLD:

- Virtual Event RLD
- Virtual Power Output RLD
- Virtual Vehicle Driving Behaviour RLD
- Virtual Testing Routes

The task analyzation target, required accuracy and the degree of freedom defines the level of VRLD. The following chapters shall give a brief introduction into each method to extend the RLD usage.



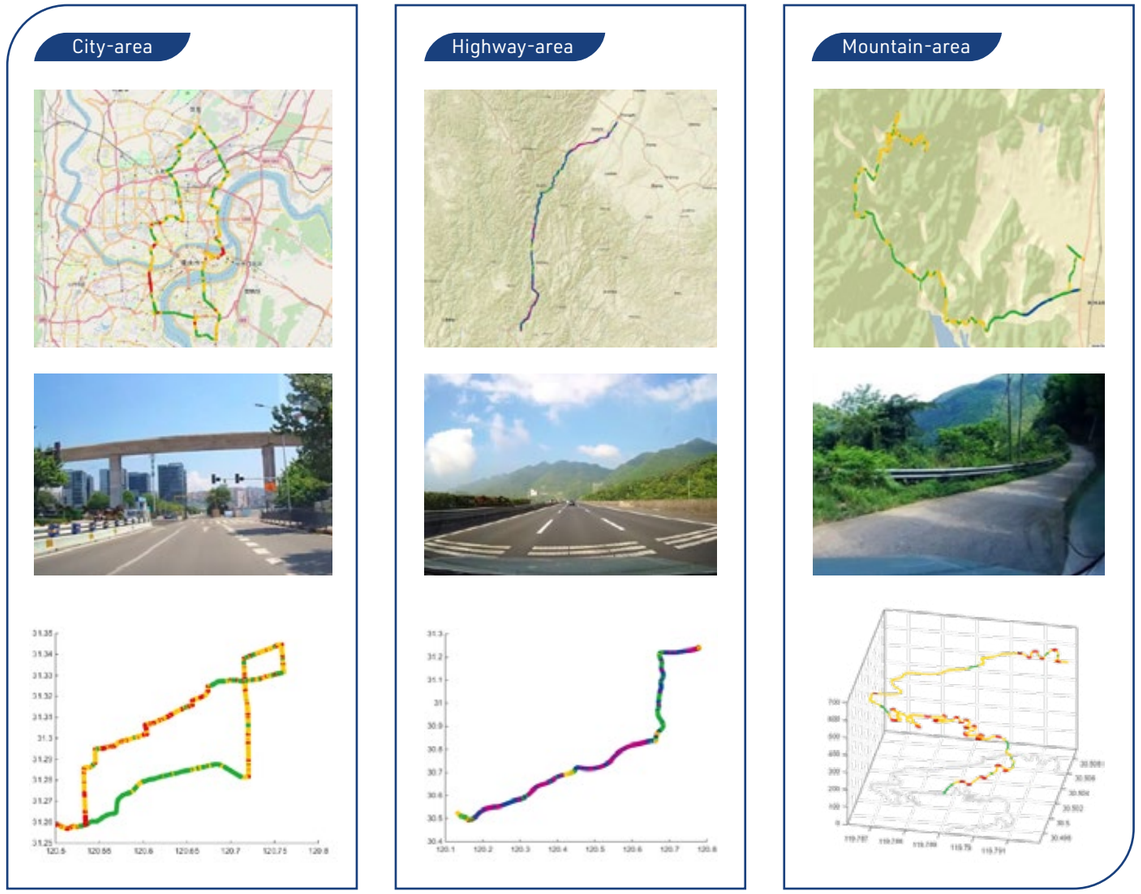


Fig. 2 | Test program definition – Drive style road types

2. Virtual Event RLD

Specific powertrain functions e.g. like start/stop, neutral idle and creep are only active in defined conditions or events. To explain the method of "Virtual Event RLD", the powertrain function "start/stop" is used. To trigger the engine auto stop, several environmental requirements and driving conditions must be fulfilled:

Environment requirements

- Warmed-up vehicle and engine
- Fastened seat belt
- Closed driver door
- Battery voltage over a threshold
- Inner temperature is in an allowed tolerance of the target temperature
- No special electrical consumer required (defogging, electric heating glass,...)

Driving conditions

- Vehicle speed smaller than certain speed with brake on or
- Vehicle speed =0 with certain brake pressure
- In a flat road (slope smaller than a threshold)

If in the normal RLD database a vehicle has been measured which had no start/stop functionality, the "Virtual Event RLD" allows re-evaluating the existing data for the above conditions. If the conditions are fulfilled, the engine start or stop would occur. By counting the number of conditions in the RLD, engineers can estimate the engine starter working frequency and evaluate the target lifetime requirements.

Advantage:
- Fast calculation – no requirement for a very detailed model
- High coverage for specific components which are working in the same condition as event occurs

Disadvantage:
- A detailed understanding of the target component behavior is required
- The target component load application is constant in the specific condition
- Requires a database with event measurements or event identification possibility

3. Virtual Power Output RLD

For the Virtual Power Output RLD firstly the engineer needs to build up a simulation model based on the target application specification input. The simulation model uses the output power from the RLD database as reference and "re-drives" the RLD cycles previously measured with another application. This allows e.g. running a vehicle with a different powertrain (but with similar drive power to weight ratio) all previously measured tracks. The different powertrain's key loads (speed and torque) of the input, gears, differential / axle and side shaft can be simulated. The result is accumulated damage and estimation of lifetime requirements under consideration of a specific target distance e.g. 300,000 km for a product.

Advantage:
- Strictly covering the similar power to weight ratio
- Usable for different application reaching similar output power (e.g. with more or less gears, different transmission concept, different input drive)
- Key component highly focus on the output torque & speed (e.g. side shaft, differential,...)
- Accurate simulation of torque oscillation possible
- Misuse could be covered (e.g. stall)

Disadvantage:
- Dynamic wheel torque from a database is required
- Could not cover different power to weight ratio of applications
- Limited from the control (e.g. cannot cover very different-regeneration torque controls)

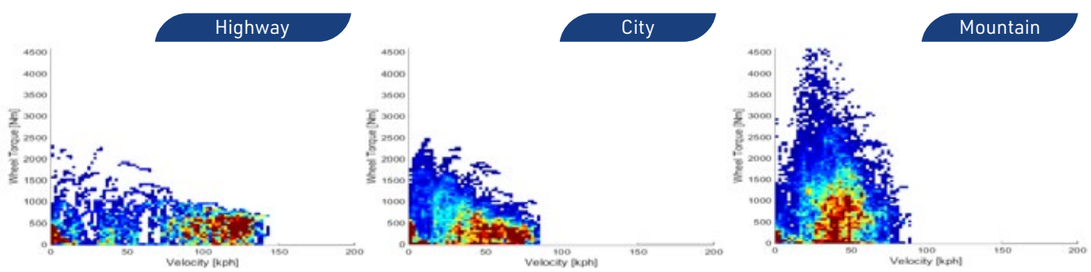


Fig. 3 | Different Powertrains key-loads – speed and wheel torque

4. Virtual Vehicle Driving Behavior RLD

Using the RLD database, GETEC can extract from the tracks the target vehicle speed, vehicle acceleration and slope as the simulation input. This "track information" can be used for the "Virtual Vehicle Driving Behavior RLD" as input for the simulation with the target vehicle application. In other words, this means the simulation of the target vehicle "driving" in the same routes and traffic condition.

Advantage:
- Covers similar power to weight ratio of RLD database and target application
- Covers similar vehicle type usage (SUV, family car, sports car)
- For hybrid or EV the brake pedal status & deceleration could be used to simulate different regeneration logics

Disadvantage:
- Dynamic slope from the database is required
- The acceleration peak from the road (not driver purpose, e.g. drive over bumps) need to be filtered out before simulation
- Wheel slipping condition caused from road need to be filtered out before simulation

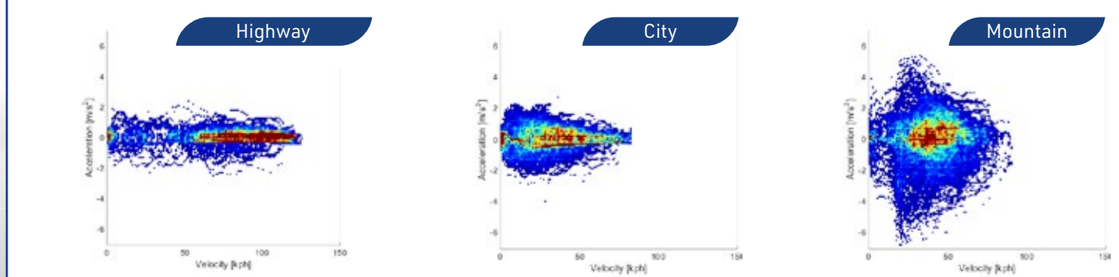


Fig. 4 | Travel information – velocity, acceleration and slope as simulation input

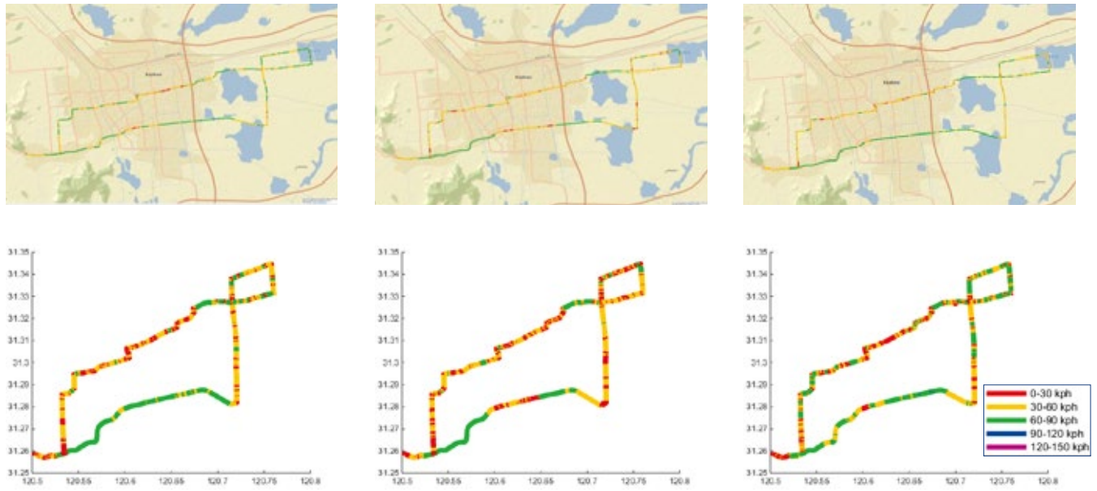
5. Virtual Testing Routes

Considering further step with simulation tool, even the test routes could be re-build with "extra" texture. After collection of a huge database with RLD, some of the key characteristic can be extracted and re-build a new testing route. GETEC develops in the moment specific cycles considering shortest possible distance but at the same time highest coverage. These can be applied for the simulation of critical component usage in a very early stage of the development. The first field GETEC applied this successfully is the heat balancing requirement simulation for new energy powertrains.

Analyzing each of the typical key characteristics of the testing routes extracted from the database, GETEC can prepare thousands of sample measurements. By considering multiple factors of the key characteristics, different kinds of the test routes could be generated and adjusted. This variable test routes simulation can cover all possible driving behavior and environments and this makes the Full Size VRLD possible – this means cover all kind of the possible condition and identify the boundary of system & key component.

The following samples shall give a simplified introduction in some of those cycles and the characteristics

CITY CYCLE



Key characteristics:

1. **Stop and takeoff** — base on the vehicle speed
2. **Traffic congestion** — based on the average vehicle speed
3. **Complexity** — turning amount and turning degree, based on the $|V_{left}-V_{right}|$ / V
4. **Driving mode** — normal/aggressive, based on vehicle acceleration
5. **...**

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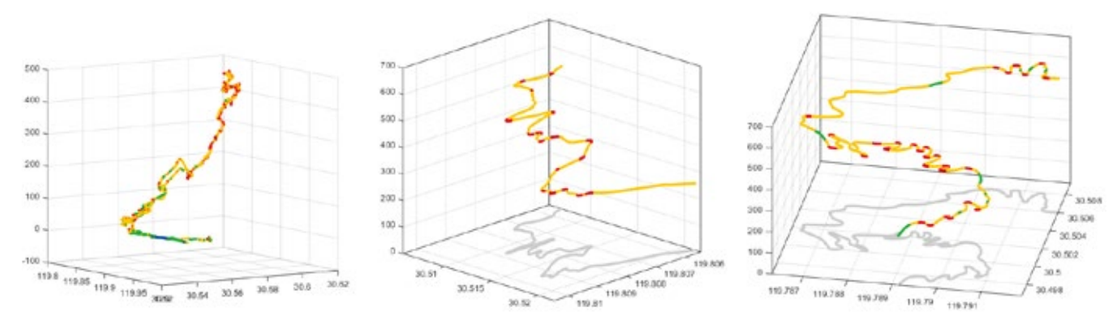
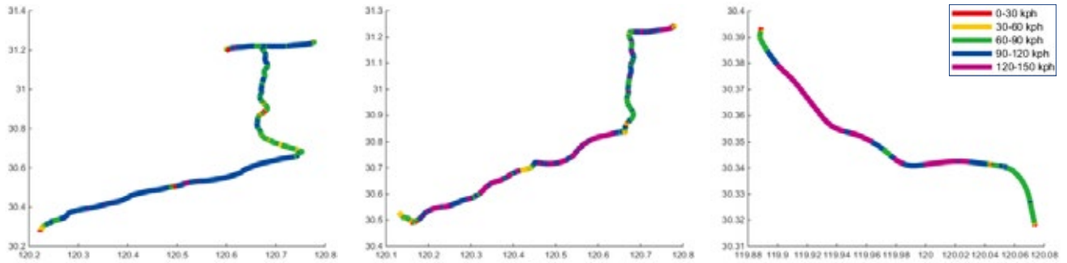
MOUNTAIN CYCLE



Key characteristics:

1. **Slope** — slope signals/∑ | ΔAltitude | / distance
2. **Complexity** — turning amount and turning degree, based on the $|V_{left}-V_{right}|$ / V
3. **Driving mode** — yaw rate at different vehicle speed
4. **...**

HIGHWAY CYCLE



Key characteristics:

1. **Traffic congestion** — based on the average vehicle speed
2. **Driving mode** — normal/aggressive, based on vehicle acceleration
3. **Take over** — tip-in duration & power on downshift frequenc
4. **...**

6. Summary

Engineers can apply RLD methodology for the lifetime requirement analysis of system and component durability / reliability targets. This covers driving environments and driving profiles. By applying the VRLD big data, the analysis is not limited to the real RLD testing and environment anymore. VRLD expands the usage of RLD to virtual driving environments, driving profiles and customers. The key of GETEC RLD engineering is to extract key information from the big data, and use it to develop products with an ideal match of usage requirement versus product development effort.

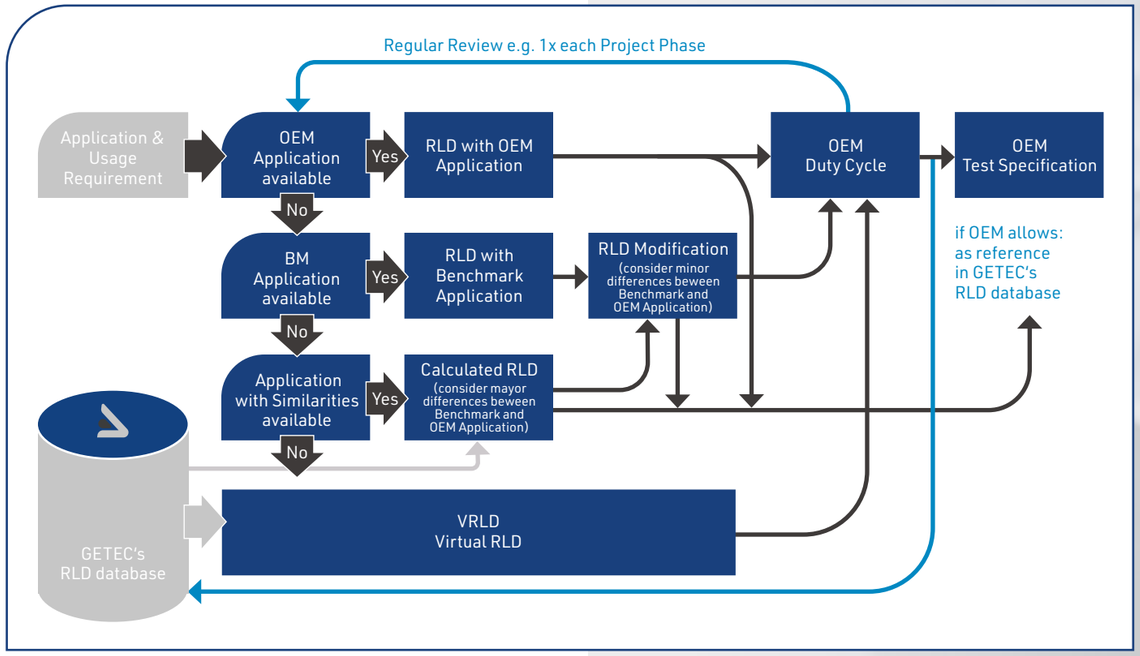


Fig. 5 | GETEC's RLD Management

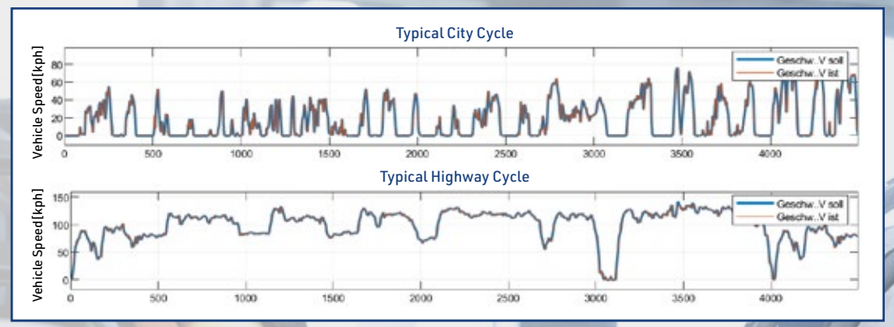
7. Case study

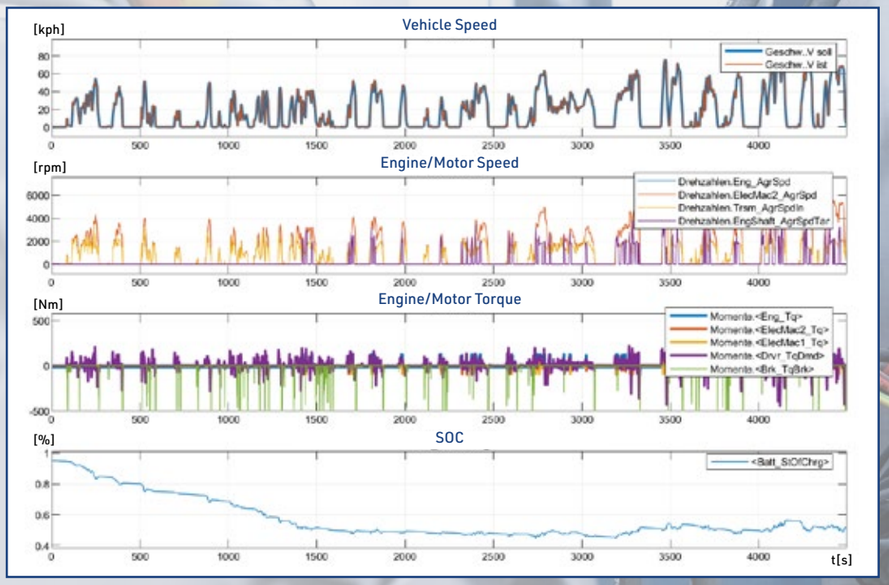
In a Dedicated Hybrid Transmission development project, the duty cycle is one of the key the target for all the key components. However, in the beginning of the project, there is no prototype or mule car for the RLD measurement available.

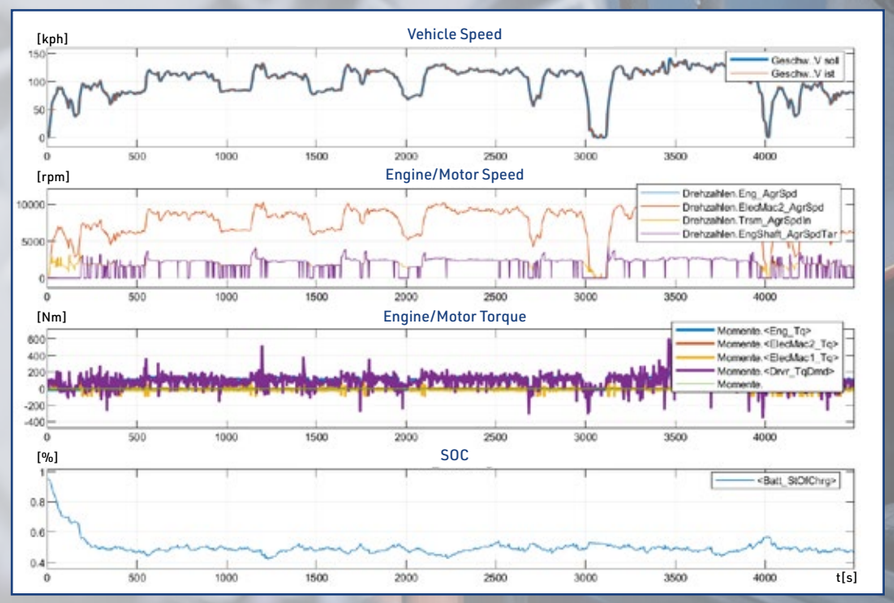
In GETEC's RLD database, there exists no similar hybrid structure RLD measurements. It is also impossible to estimate the duty cycle because of the complexity control logic of the multiple power sources in the hybrid transmission. GETEC has a database of RLD measurements in different locations with specific road profiles, which indicate the driver demand behavior.

Based on the hybrid structure and the function of the transmission, GETEC build up the simulation model. Using the vehicle speed and slope as the target reference of the model, GETEC lets the virtual mule car 'run' the test cities, highways, mountains.

The key components signals are extracted from the simulation result. The last next step is the normal RLD job – finish the duty cycle and define the reasonable life target.





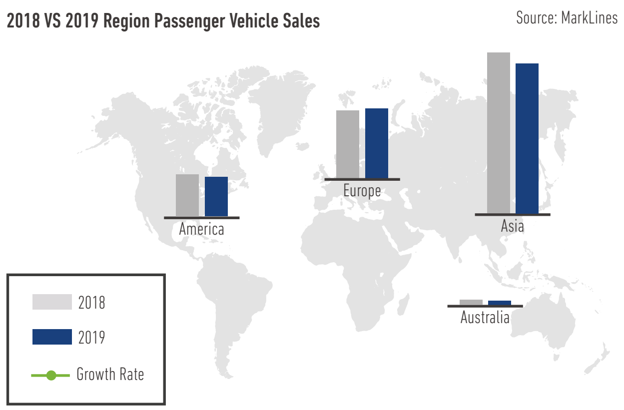


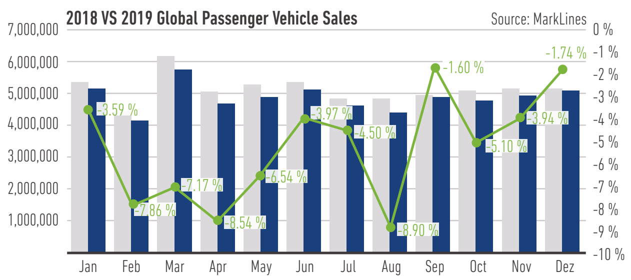
VEHICLE SALES IN EUROPE
2019

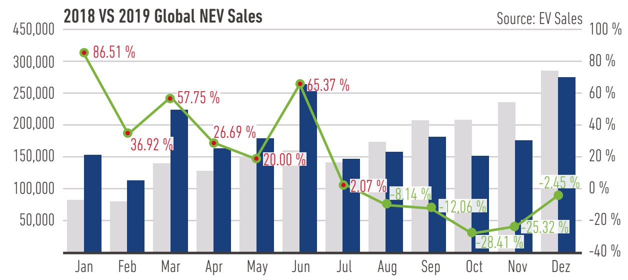
The global auto market shows a downward trend in 2019, with annual sales of 58,592,544 vehicles, 5.27% decrease from last year.

In 2019, the global new energy passenger car sales reached 2.21 million units (BEV, PHEV), an increase of 10% year-on-year, the penetration rate of the new energy passenger car market increased from 2.1% in 2018 to 2.5% in 2019. In terms of power type, pure electric is still the main force, accounting for 74% of new energy; plug-in type is 26% . European new energy electric passenger vehicles reached 558,600 units, an increase of 45% year-on-year, far exceeding the entire Europe passenger vehicle market of 1.21 % increase.

In 2019, the passenger vehicle sales in Asia, Australia and America decreased except Europe market.







GETEC comments

The global economy is currently in a state of simultaneous slowdown. The economic growth rate in 2019 is once again lowered to 3%, which is the lowest level since the global economic crisis. This is a serious setback since the economic growth rate reached 3.8% during the global synchronous recovery in 2017.

The reasons for the sluggish economic growth are:

- Increasing trade barriers,
- Rising trade- and geopolitical uncertainties,
- Some special factors causing macroeconomic pressures in several emerging market economies
- Slow productivity growth in advanced economies, and aging population factor.

A significant feature of the sluggish economic growth in 2019 is that manufacturing and global trade have slowed sharply globally. There are several drivers behind this feature. Increased tariffs and trade policies.

The long-term existence of policy-related uncertainties has led to a decline in both investment and demand for large quantities of traded capital goods. The auto industry has also contracted due to special shocks, including those caused by the new emission standards introduced by the euro zone and China, which have lasting effects. Therefore, the growth rate of trade volume in the first half of 2019 was 1%, the lowest level since 2012.

Reasons for the recession in the automotive industry include the effects of supply disruptions and demand-China's vehicle demand has fallen after tax incentives have been cancelled; Eurozone (especially German) and Chinese automakers have adjusted production lines to comply with newly implemented emission standards; technology and emission standards implemented in many countries are changing rapidly and vehicle travel and sharing ways are constantly changing. In this context, consumers are adopting a wait-and-see attitude and consumer preferences may be changing.

2020 Outlook

We expect no growth of auto industry in 2020. Because of the trade war between China and U.S., sluggish economy and the unexpected COVID-19 Virus, have added to the uncertainties of the economy. We also expect high costs from Auto OMEs for the new energy vehicles development in the following 2 years and lower production from suppliers in this industry.

HOTSPOTS IN ASIA

1. Domestic Tesla will be fully localized by the end of 2020. The localization of Tesla's off-line vehicles in 2019 is 30%, and it is expected to reach 80% next year. Asian Times
2. The SAIC Group and the GAC Group cooperation framework agreement, will discuss joint investment in strategic core technologies and platforms in the fields of new energy, intelligent, networked, and lightweight. Development; the two parties will explore synergies and cooperation in the field of manufacturing. SAIC Group
3. Great Wall BMW joint venture project will put into production EV. The base is located in Zhangjiagang. The project is planned to start in 2020, involving the full export manufacturing of fuel vehicles and the development of pure electric passenger vehicles. D1EV
4. South Korea announced that it would allow the sale of L3 autonomous vehicles from July 2020, becoming the first country in the world to develop commercialization standards for L3 autonomous vehicles. Sohu
5. In 2019, China's auto production and sales were 25.712 million and 25.769 million, a year-on-year decrease of 7.5% and 8.2%, respectively. Production and sales continued to rank first in the world. CAAM
6. In 2019, China's overall sales of NEV was 1.022 million, accounting for 6.1%, of which BEV and PHEV were 819,000 and 203,000 respectively. EID
7. Affected by the Spring Festival holiday and virus situation in January 2020, the China passenger car market retailed 1.699 million units, down 21.5% compared with January 2019. CPAP
8. Toyota will launch a new miniature EV for mobility in 2020. Its battery pack is easy to disassemble and reusable. Autohome
9. Based on the current 150kW three-in-one electric drive system, Nidec has released two new electric motors of 200kW and 50kW for medium and large and micro and small electric vehicles. Mass production is expected to begin in 2023 and 2022, respectively. Some models of GAC New Energy will take the lead. ZHEV
10. Wanliyang and Bosch strategically cooperate to jointly develop and launch CVT technology and products for pure electric and hybrid models. Sohu


Das Warten auf den Flieger aus Deutschland

Rund 90 Deutsche sitzen in Wuhan fest. Die Metropole ist von der Außenwelt abgeschottet. Außenminister Maas erwägt eine Rückholaktion.

MR. TRUMPFF GOT THE INTERVIEW FROM AACHENER ZEITUNG AND MADE COMMENTS ON COVID-19.

The Covid-19 crisis is expanding rapidly. But we believe that virus will be stopped!

At the same time, we take any required measure in China branch and also in German headquarters to prevent further spreading of the virus. Meanwhile, in such special period, we would like to thank our great team for the full support and dedication to our partners and the company.

COMING EVENTS

TESTING EXPO STUTTGART 2020

GETEC will present newest and advanced technology

Time: **Postponed due to COVID-19 Virus**
Booth: 1682

https://www.testing-expo.com/

TMC

Application of Virtual Road Load Data (VRLD) for the development of an EV / REEV / DHT Product Family

Time: **Postponed due to COVID-19 Virus**
Speaker: GETEC | Mr. Joachim Trumpff

http://en.transmission-china.org

AACHEN COLLOQUIUM GERMANY 2020

High Speed E-Motor Development – 22.000 rpm and its challenges

Time: **05.-07.10.2020**
Speaker: GETEC | Mr. Joachim Trumpff
Booth: 49

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

CTI BERLIN 2020

GETEC will present newest and advanced technology

Time: **07.-09.12.2020**
Speaker: GETEC | Mr. Sven Steinwascher
Booth: will be released soon

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

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