Testing of alternative fuels with DB's advanced TrainLab
Alternatives to the fossil diesel are needed in order to achieve the climate targets where electrification is no option.

More than 2000 diesel vehicles in operation at DB

- **Fuel cell**: Fuel cell trains running on "green" hydrogen can be used on routes entirely without catenary
- **Battery**: Use of traction batteries to bridge short sections with no catenary
- **Alternative fuels**: Substitution of fossil fuels by biogenic or synthetic alternatives mainly for long heavy duty services

Regional trains
Shunters
Locomotives
Three main technologies to replace fossil diesel.

- **Fuel cell**
  - Hydrogen as an energy source can be **carried or produced on board**
  - Hydrogen is converted to water vapour using (atmospheric) oxygen with the released energy being available as electric power
  - **Batteries are required** for load peaks and energy recovery

- **Battery**
  - Battery storage systems provide traction energy
  - **Use/recovery of braking energy**
  - Hybridisation of established vehicle concepts (combustion-engine and electric traction)

- **Alternative fuels**
  - Substitution of fossil fuels by **biogenic or synthetic alternatives**
  - Direct combustion in conventional engines allows the continued **use** of diesel vehicles with **minimal adaptation**
Alternative fuels as an **ideal** complement for transport of heavy loads and challenging driving profiles.

### Development status:
- Biogenic and synthetic fuels available in **limited quantities**
- Lack of raw materials and production capacity for widespread use
- **If demand rises** use of synthetic fuels is **conceivable from mid-2020s**
- Use in **rail** transport **not tested yet**

### Advantages
- Continued operation of diesel fleets **without expensive upgrades**
- **Solution** for areas of application in which battery/fuel cell technology is not an alternative
- Alternative fuels have the potential to be **CO₂-neutral** depending on production process
- **Migration** of tank infrastructure relatively simple and inexpensive

### Disadvantages
- **Local emissions** from combustion process
- Production **capacity** for renewable fuels **must be set up**
- Synthesis process is **very energy-intensive**
- Profitable fleet application difficult at the moment due to **high price**
Roadmap: DB has **started testing** of alternative fuels with the **advanced TrainLab** by August this year.

**Alternative fuels for more sustainability**

DB’s advanced **TrainLab promotes the strategy** to phase-out fossil fuels and contributes the ambitious **climate goals** of Deutsche Bahn.

- Fuel **trials with advanced TrainLab** with up to **33% renewable** fuels without changes to the diesel engine
- Engine **bench tests** with up to **100% renewable** fuels
- Trails with **100% renewable** fuel using the advanced **TrainLab** commence in **2020**
- **DB Energy** is partner for fuel **supply** and fueling stations
Detailed engine bench tests for proving **compatibility of alternative fuels** with a **railway diesel engine**.

### Background
- Fossil diesel (max. 7% FAME) meets EN 590 and engines are optimised for EN 590 certified fuels only
- Renewable fuels act chemically similar but have some different properties (e.g. density) and meet EN 590 (R33) or EN 15490 (HVO)

### Proof of compatibility and pre-analysis of emissions
- Bench test comparison of fossil diesel, a blend with 33% renewable BlueDiesel and a 100 % renewable HVO diesel
- Check engine compatibility, performance and consumption by using standard testing cycle
- Measure all relevant engine parameters and exhaust emissions
- For CO2-reduction a detailed environmental balance will be prepared ("Well-to-Wheel")
Results: A one week bench test cycle shows that **combability with unmodified engine** for both alternative fuels is given.

- **No performance degradation** with both alternative fuels detected
- **+6% fuel consumption with HVO** by using standard testing cycle
- **Still equal local CO2 emissions** but reduced CO2 footprint due to production process but
- **No significant changes in limited exhaust emissions** compared to fossil diesel
- To utilise the full emission reduction potential of alternative fuels, **modifications to the engine controller** are **advisable**
Further applications requires defined framework conditions.

- **Gain long-term experience** e.g. maintenance of gaskets
- Field tests for **small fleets** e.g. in regional services
- Complete change to renewable fuels currently not possible due to **restricted amounts**

**Framework conditions to enable broader usage**

- **Cooperation with** Karlsruher Institut of Technology (KIT) in “reFuels” initiative: develop a strategy for broader usage and research with automotive and oil companies
- Take account to **the political and economic interests** - today **synthetic fuels** are only available for high prices and in small amounts
- Setting up **fuelling stations**
Thank you for your attention!
Any questions?

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The *advanced TrainLab* will cover the considerable need for testing new technology for use in vehicles.

### Research and partner models
- Testing environment for partnerships with universities and research institutions
- Operational collaboration as part of pilots

### Testing of on-board components
- ETCS components of various manufacturers
- Component testing from automotive sector (e.g. sensor technology)
- Basic technology required for automatic train operation

### Automatic train operation
- Automatic train operation GoA level 2-4
- Part of LivingLab

### Sensor technology and geolocation
- Supplier selection
- Recording condition of vehicles and infrastructure
- Track-specific geolocation

### Testing of driving assistance systems
- Smart traffic management
- Simulation and train control systems
- Saving of traction power

### Real environmental influences
- Aerodynamic measurements
- Acoustic measurements
- Interdisciplinary trials and tests

### Supplier qualification
- Qualification of manufacturers from e.g. the automotive sector
- Provisioning as test and trial vehicle for technology partners

### Data communication
- Improvement of vehicle IT and software
- Mobile broadband radio data communication (5G)
- Testing of new radio technology and components

### Homologation
- Execution of type tests
- Proof of compliance