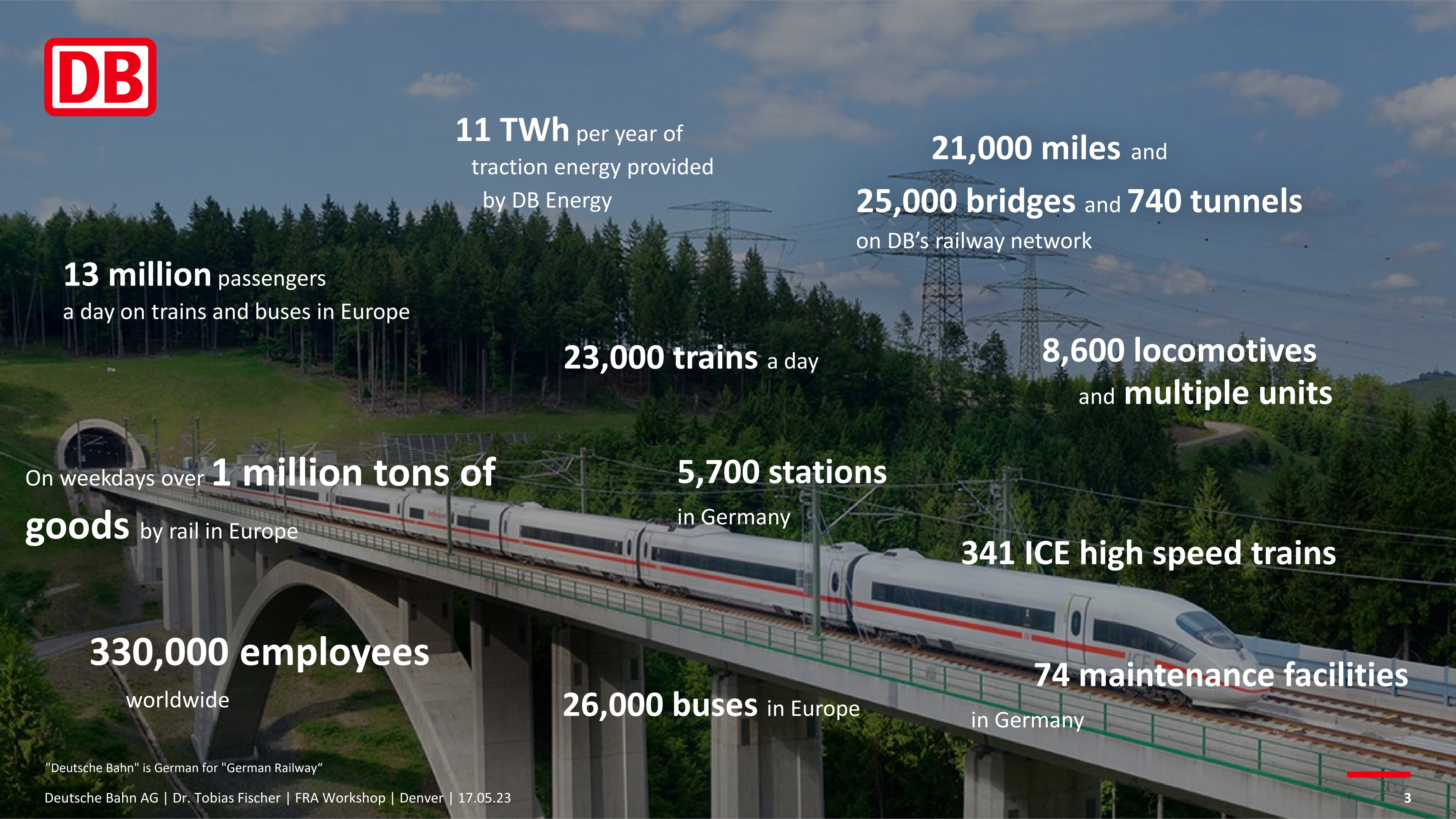
Deutsche Bahn‘s Global Decarbonization Strategies

Focus on Rail Transportation in Germany

17.05.2023 | Dr. Tobias Fischer | Denver FRA 2023 Workshop on Decarbonization of Rail Transportation | Deutsche Bahn AG

Bildquelle: https://www.pexels.com/de-de/foto/boot-auf-dock-mit-gebirgshintergrund-275538/

Agenda



11 TWh per year of traction energy provided by DB Energy

21,000 miles and **25,000 bridges** and **740 tunnels** on DB's railway network

13 million passengers a day on trains and buses in Europe

23,000 trains a day

8,600 locomotives and **multiple units**

On weekdays over **1 million tons of goods** by rail in Europe

5,700 stations in Germany

341 ICE high speed trains

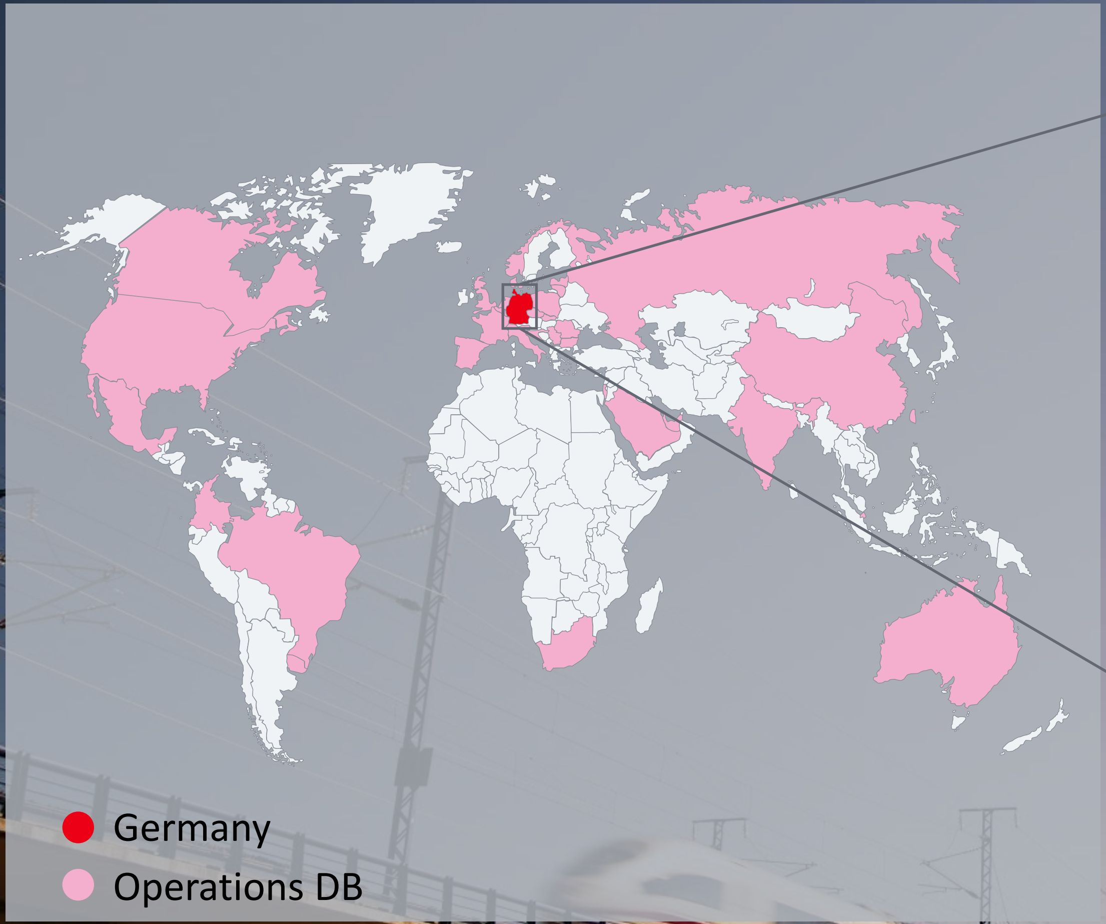
330,000 employees worldwide

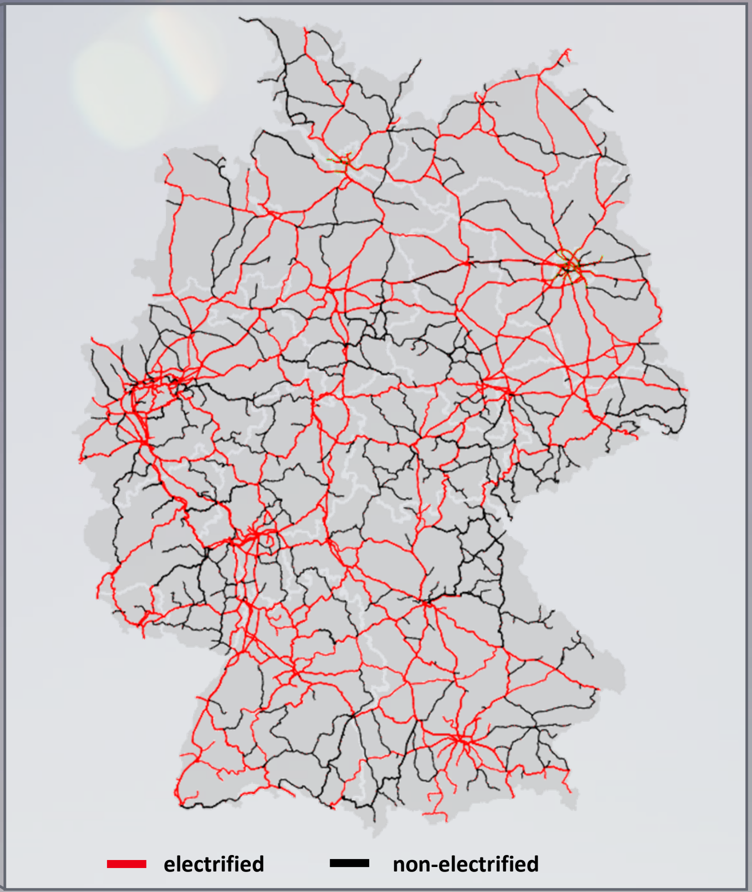
26,000 buses in Europe

74 maintenance facilities in Germany

"Deutsche Bahn" is German for "German Railway"

Deutsche Bahn | A global company with key business in Germany





Deutsche Bahn | With its eight business units DB Group is active in all segments of the transport market

Passenger transport:
Domestic and European mobility services

- **DB Long-Distance**
  Long-distance passenger transport[1]
- **DB Regional**
  Regional and local passenger transport (Germany)
- **DB Arriva**
  Regional and local passenger transport (Europe)[2]

Transport and logistics:
Intelligent logistics services via land, air, and sea

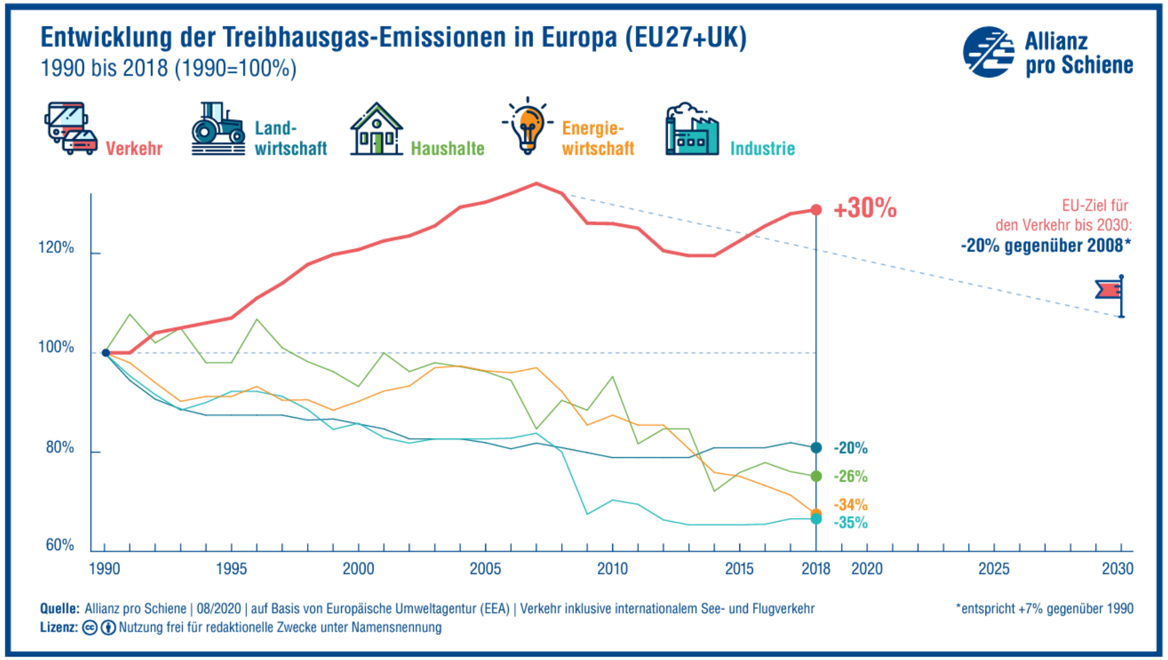
- **DB Cargo**
  European rail freight transport
- **DB Schenker**
  Global freight forwarding and logistics services

Infrastructure:
Efficient and future-oriented rail infrastructure in Germany

- **DB Netze Track**
  Rail network
- **DB Netze Stations**
  Passenger stations
- **DB Netze Energy**
  Traction energy and stationery energy supply

(1) Within Germany as well as cross-border traffic. (2) In the UK, with CrossCountry also long-distance passenger transport.

Transport in Europe | Greenhouse gas emission of the different modes of transport

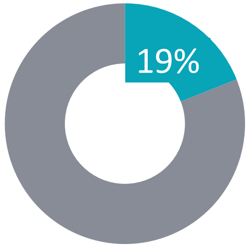


- Greenhouse gas emission in the transportation sector still rising in Europe
- Rail transport lowest specific greenhouse gas emission
- Rail freight transport share 19% in Germany
- High competitiveness in high-speed rail

No other form of motorized transport
is as eco-friendly as rail

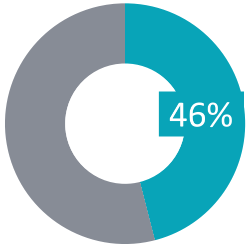
The lowest specific greenhouse gas emissions:

Modal Split in Germany for railway in **freight** transport



per tkm

Market share of passenger high-speed trains Berlin-Munich (360 mi)



passengers 2018

Agenda

Starting Point | DB’s climate goals and framework

DB

DB becomes climate neutral by 2040

In 2021 DB causes approx. 17.9 million t CO_2e[1], of which approx. 20% in the railway sector in Germany

approx. 3000 diesel rail vehicles currently in operation at DB

Today approx. 61% of the German rail network are electrified.
Electrification expansion planned up to 68% until 2030

DB's diesel consumption is currently around 250 million liters/year

(1) CO2-equivalents

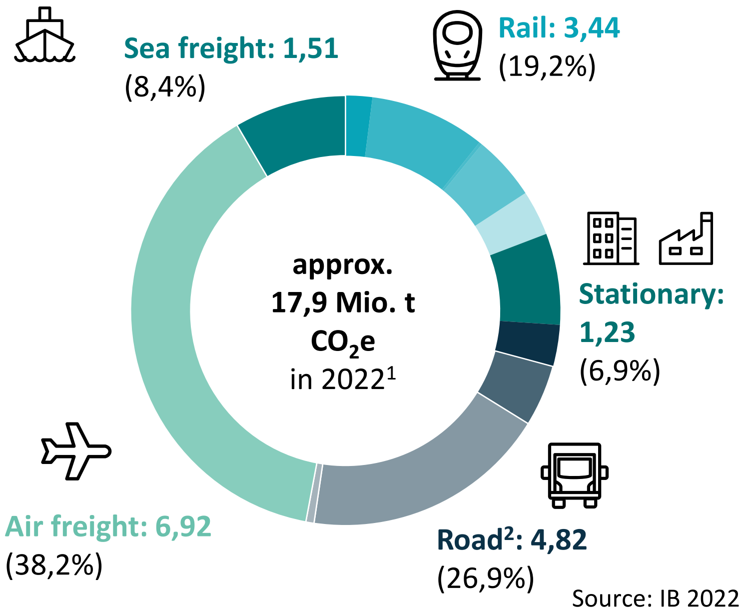
Starting Point | **Three** main fields of activities and two packages of measures contribute towards climate neutrality at DB in 2040

Our mission:

Climate Neutrality until 2040

Today:

CO_2e-emissions DB-Corporation (2022)



Source: IB 2022

Three main fields of activities to reach climate neutrality:

- Green Power Transformation
- Diesel Exit
- Renewable Heat

New: Two Starter packages

- **Starter package Diesel Exit**
- **Starter package Renewable Heat**

In alignment with SBTi[3] Reporting

- **Climate neutrality by 2040** requires 100% green power and innovative, sustainable solutions for the Diesel Exit as well as green heating supply
- **Measures** on Greening Power, Diesel Exit and Renewable Heat are planned for the **medium term**.
- **Starting in 2022**, DB will develop and implement specific projects and measures.

(1) 2020 approx. 16 Mio. t CO_2e due to the CoVid-Pandemic, 2019 20 Mio. t CO_2e;
(2) incl. Bus transports and fleet vehicles
(3) Science Based Target initiative

Starting Point | Our sustainability and environmental goals

We have set ourselves ambitious targets

2023

Glyphosate-free rail transportation

2024

30% of management positions held by **women**

2025

100% renewable power in DB's depots, office buildings and stations

100% sustainable BahnBonus world

2030

Reduction by 50% spec. CO_2e and 80% renewable power in DB's traction current mix

Reducing the impact of train noise **for 50% of all people affected** living along railway lines

Increase in recycled content:
Rail steel to 45%
Ballast to 40%
Concrete ties to 30%

2038

100% renewable power in DB's traction current mix

2040

Climate-neutral company

Full **circular economy**

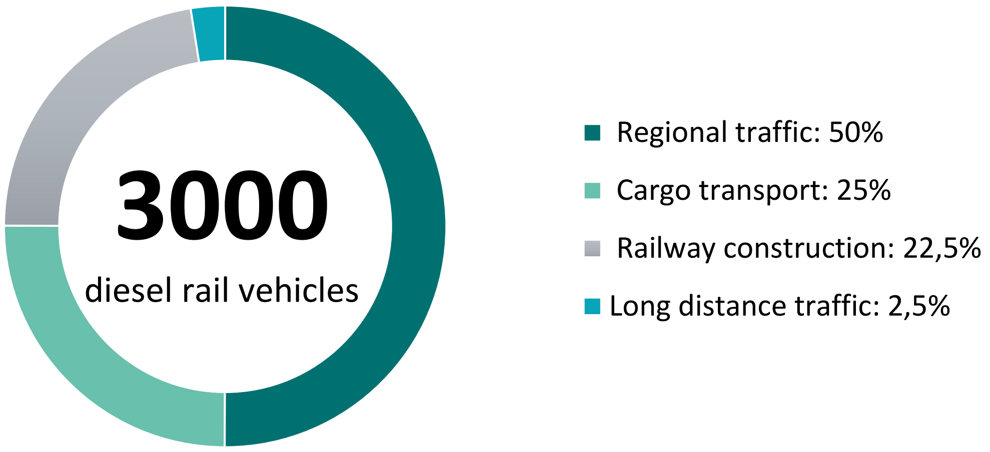
2050

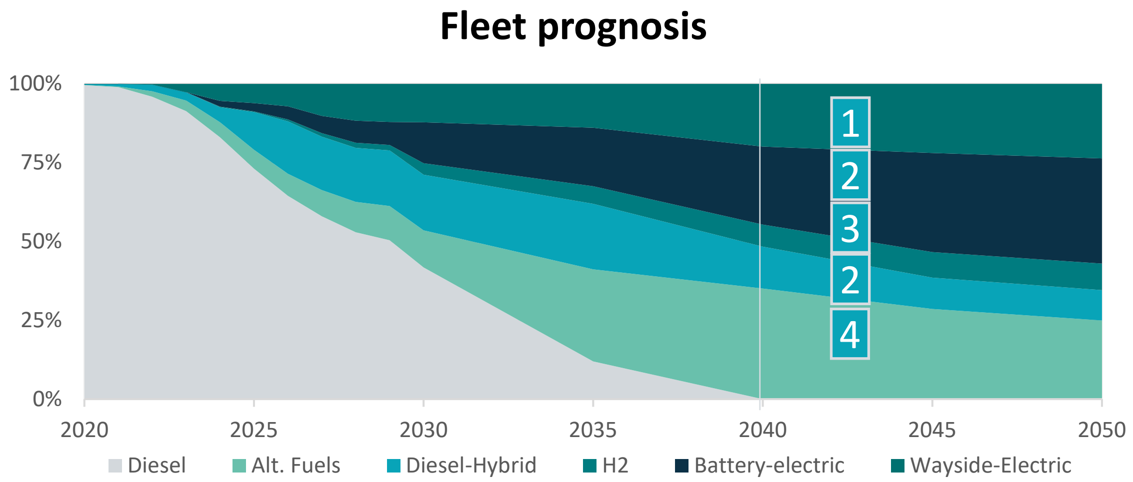
Reducing the impact of train noise **for all people affected** living along railway lines

2023–2050

Recycling level over 95%

Starting Point | 68 % of the network will be electrified in the future. Alternative propulsion systems and fuels are needed





Fleet

- Currently approx. 3000 diesel rail vehicles with a consumption of approx. 250 million liters of diesel p.a. at DB. Yet further diesel vehicles will be delivered.
- Current estimation: Approx. 50% of the diesel rail fleet can be converted to e-traction or battery-electric traction by 2040.
- Approx. 40% combustion vehicles still in use in 2040 (approx. 800 - 1000 vehicles, because e.g. no technical alternatives available)
- Long vehicle life cycle of 30+ years normally

Technological alternatives to Diesel

1 Wayside-Electric

2 Battery: Batterie-electric

3 Hydrogen:H2 Fuel Cell

2 Battery: Diesel-Hybrid

4 Alt. Fuels

Agenda

01	Introduction and DB overview
02	DB net zero strategy
03	**Technologies to achieve diesel exit**
04	Outlook

Alternative fuels as a short-term solution | What is HVO?

- HVO stands for " Hydrotreated vegetable oils" aka renewable diesel
- HVO is a second-generation bio**fuel** (**NOT biodiesel** !)
- HVO complies DIN EN 15940 for "synthetic fuels"

Main advantages and properties of HVO

- The use of HVO saves up to 90% CO_2e[1] compared to fossil diesel
- For production of HVO, only biological **residues and waste materials** are used as raw materials – No plate tank discussion. HVO is furthermore palm oil-free! DB has set highest procurement standards to assure the use of the "greenest" HVO
- "Drop-In" fuel - Engine compatibility proven through several tests!
  Several engine manufacturers approved the use of HVO
- Diesel fleets can continue to operate without costly retrofitting or hybridization. Solution for applications where battery or fuel cell technology is not an alternative
- Migration of refueling infrastructure comparatively simple and inexpensive
- **+30 cents/liter** additional costs compared to fossil diesel
- Short-/middle- term switch from fossil diesel to HVO possible
- Short-term Availability of **several million liters/year**

(1) CO2-equivalents

Alternative fuels | Alternative fuels are currently being introduced in various DB business units on the basis of aTL trials

- DB is playing a pioneering role in Europe with the trials on the advanced TrainLab
- After the successful tests by TecLab, HVO is currently being rolled out in the business units
  - DB Long-Distance: entire fleet of the Sylt Shuttle
  - DB Cargo: Approval of entire fleet in Germany
  - DB Regional: Conversion of two networks, further networks planned
- DB will use 17 Mio. litres of HVO in 2023

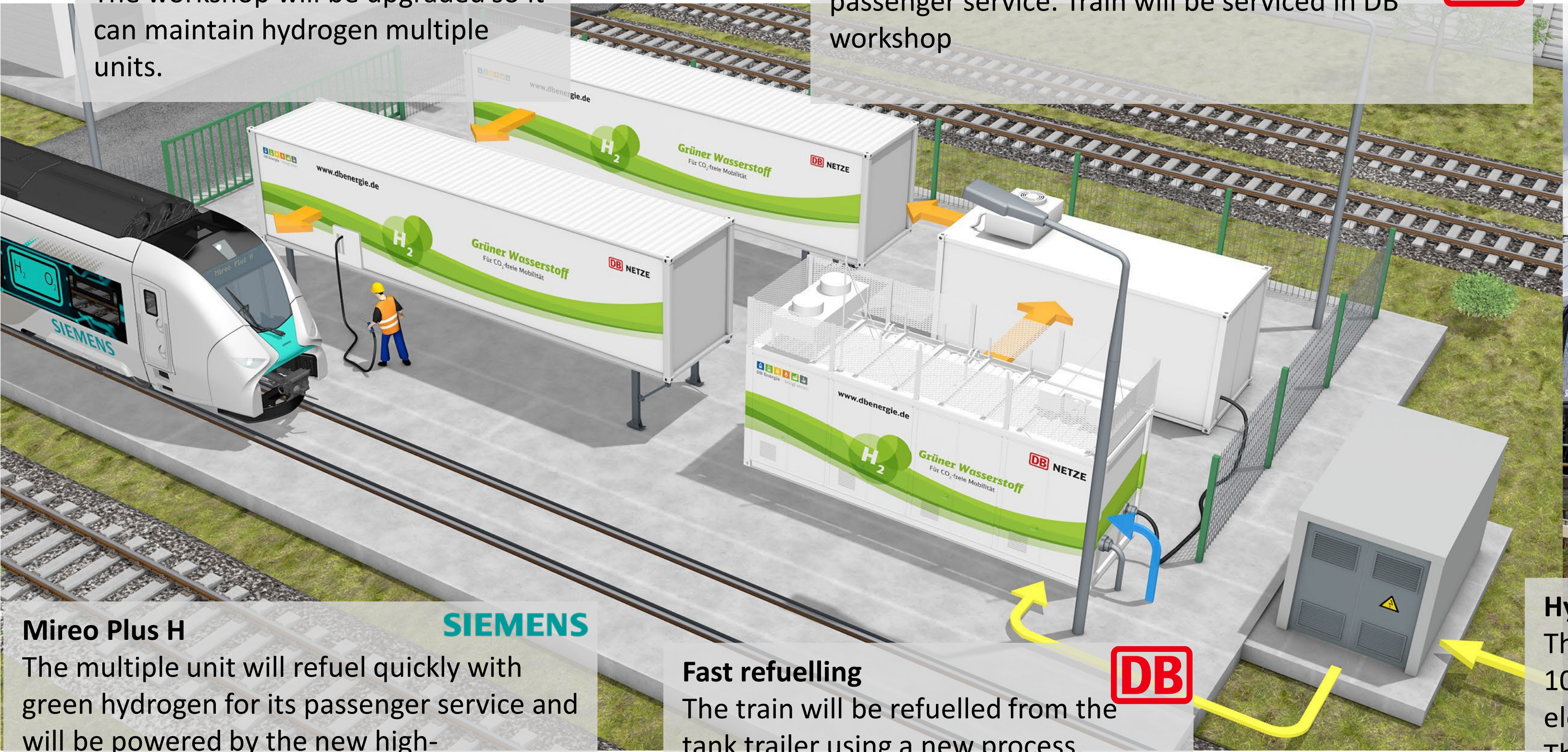
Aug 19
Start testing R33 on aTL

Jun 20
HVO-filling station established
Start testing HVO on aTL

today
Testing with HVO completed on aTL

future
Engine rig tests with E-Fuel on aTL-engine

Fuel Cell | The H2goesRail joint funding project brings renewable hydrogen onto the rails with DB Regio



Workshop infrastructure (DB)
The workshop will be upgraded so it can maintain hydrogen multiple units.

Passenger service and maintenance (SIEMENS, DB)
The service will operate for one year in DB passenger service. Train will be serviced in DB workshop

Mireo Plus H (SIEMENS)
The multiple unit will refuel quickly with green hydrogen for its passenger service and will be powered by the new high-performance hydrogen drive.

Fast refuelling (DB)
The train will be refuelled from the tank trailer using a new process, roughly comparable to the refuelling time of diesel multiple unit.

Hydrogen supplies (DB)
The green hydrogen will be produced using 100% DB renewable energy by means of electrolysis and will be stored in a tank trailer. The mobile structure is an innovative fast refuelling station for further test projects.

Battery | First Trains and locomotives with batteries have been ordered and will soon be put into service

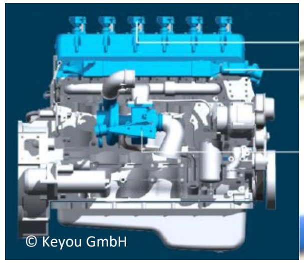
- Winning of two tenders by DB Regio: a total of **58 BEMU[1]s** with an approximate milage of **3,7 Mio. Miles/a** starting **2024**

- Construction of **charging island systems** by DB Energie and DB Netz after TecLab has carried out simulations

- Order of **50 hybrid shunting locomotives** by DB Cargo

(1) BEMU: Battery Electric Multiple Unit

Hydrogen Combustion | On the basis of feasibility studies, piloting of the use of hydrogen and ammonia engines is being prepared



Advantages

- CO_2-free operation with minimal exhaust emissions (NO_X)
- Equivalent **power density and efficiency of diesel engines**
- **high tolerance to low purity hydrogen** in comparison to FC technology
- **Integration into existing vehicle concepts is simple** and hybridization is not necessary

Feasibility studies

Hydrogen engine

- First studies show no **insurmountable obstacles**
- There are still challenges to be solved in detail before prototyping and fleet implementation
- **Same hydrogen infrastructure** can be used as for fuel cell trains
- Manufacturers are already developing hydrogen combustion engines
- Currently limited range

Ammonia engine

- First feasibility study is ongoing, **no insurmountable obstacles** have been identified until now
- Only minor engine modifications are required. However, extra safety equipment is required since ammonia is toxic
- With current technology, **higher ranges** can be achieved with ammonia **in comparison to hydrogen** due to a higher volumetric energy density

Piloting

Hydrogen engine

- Preparing the upgrading of the MoW[1] vehicle
- Project start early 2023

Ammonia engine

- Preparing of engine rig tests with MoW vehicle engines
- Completion planned end 2022

(1) MoW Maintenance of Way

Agenda

Diesel Exit | Outlook: Implementation of the diesel exit will be driven forward consequently

Wayside electrification	▪ 68% until 2030
Alternative Fuels	▪ Entire DB fleet to be approved for use of HVO ▪ Rollout of HVO to be continued ▪ Next Step: Testing of E-Fuels on the advanced TrainLab
HEMU	▪ Further trials and testing in regular service ▪ Gradual replacement of vehicles at the end of their lifecycle
BEMU	▪ Further Trials and Testing in regular service ▪ Gradual replacement of vehicles at the end of their lifecycle
H2 Combustion	▪ Research project with industry starting in 2023 ▪ Possible solution for heavy haul traffic (e.g. ammonia)

Contact – Deutsche Bahn AG
Diesel-Exit Rail in Germany

Dr. Tobias Fischer
Head of Technic TecLab

Europaplatz 1, 10557 Berlin, Germany
Mobile: +49 160 97573239
E-mail: Tobias.Fischer@deutschebahn.com
E-mail: sittipan.reinold@deutschebahn.com

Andreas Hoffrichter
DB Engineering & Consulting USA Inc.

555 Capitol Mall, Suite 1250,
Sacramento, CA 95814
USA
E-mail: Andreas.Hoffrichter@deutschebahn.com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