Example from Germany

Global Alliance Powerfuels

powered by dena German Energy Agency

Non-electrified railway transport

In non-electrified railway transport, hydrogen fuel cells are an eco-friendly, low-cost alternative to diesel-powered trains with regard to achieving climate protection targets.

Over 40 per cent of the German railway network is currently non-electrified and will continue to lack overhead wiring in the long term.[1] On these routes (mainly local routes and freight transport), diesel-powered trains are used almost exclusively. Route electrification is often not viable for financial reasons.
The use of alternative, environmentally friendly propulsion technologies – such as the hydrogen fuel cell drive – is therefore a more cost-effective option for reducing CO_2 emissions in railway transport.

The demand for energy for diesel-powered trains currently amounts to 264 million litres of diesel in rail passenger transport and 148 million litres of diesel in rail freight transport per year. The complete substitution of all diesel-powered trains with hydrogen fuel cells would lead to an annual demand of around 120,000 tons of hydrogen.[2] This could be covered by installed electrolysis output of 1.0 to 1.5 GW.[3]

1 Approximately million tons of CO_2 equivalent were emitted by diesel trains in 2015.[4]

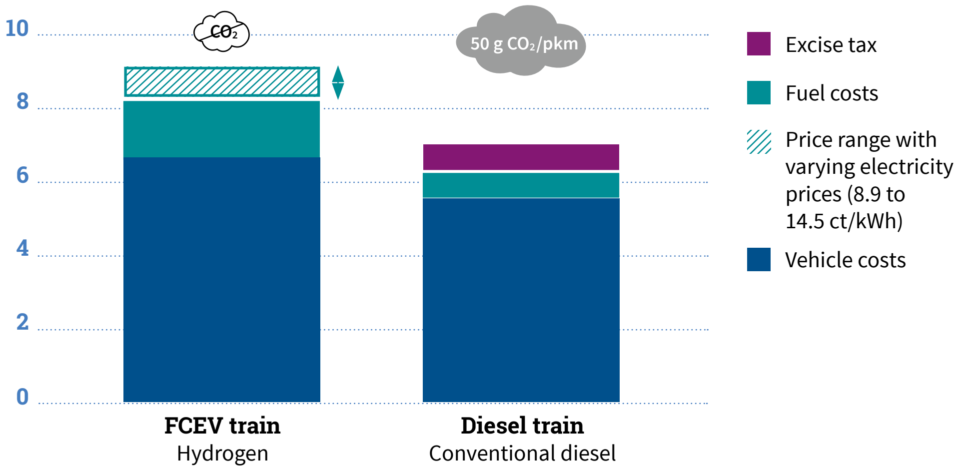
40-42 % of CO_2 emissions are to be saved in the transport sector by 2030 relative to 1990.[5]

H_2 Hydrogen

- CO_2-free, quiet vehicle operation compared to diesel-powered trains[6]
- Suitable for market introduction: refuelling infrastructure only required in places; regular, predictable demand for hydrogen
- Trains still at the prototype stage
- No uniform regulatory incentives for contract awarding (or invitations to tender) for GHG reduction in railway transport

Full costs of the various types of propulsion, current status in Germany[7] for passenger railway transport in ct/pkm

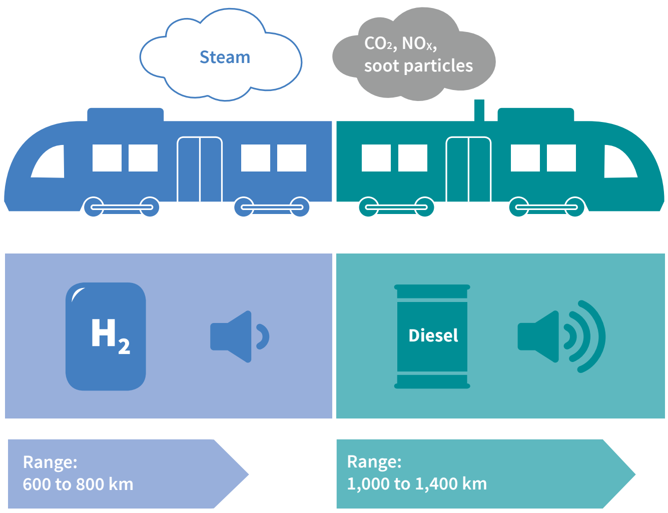
In the calculation of economic viability, the costs of the vehicle, the provision of fuel, the fuel consumption of the propulsion system and the excise duties are taken into account. Infrastructure-related costs are not included.



Alternative technologies

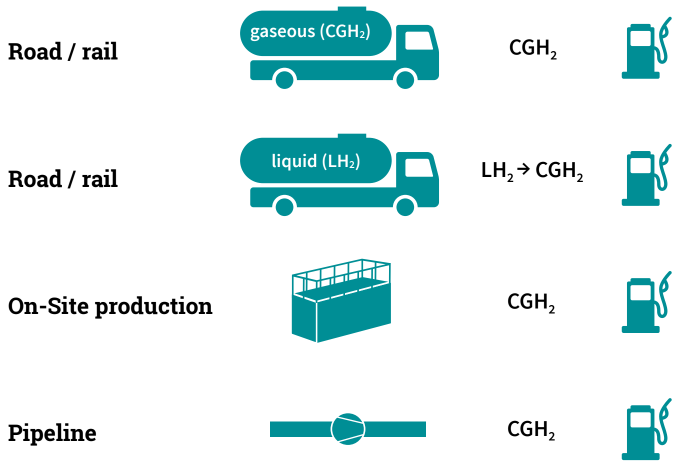
In order to achieve the climate protection targets in the transport sector, the electrification of unelectrified subsections is to be driven forward. This requires a continual increase in the share of renewables in the current rail power mix.[8] However, in view of the high share of the non-electrified network (approximately 40 per cent of the route length) and the relatively low share of the transport services provided (approximately 8 per cent) by the diesel-powered trains operated on those routes, full expansion does not seem economically viable.[9]

Fuel cell vs. diesel



Source: Own presentation according to Alstom (2017)

H_2 supply possibilities for fuel cell train fleets



CGH_2: Compressed hydrogen (gaseous)
LH_2: Liquid hydrogen (liquid)

Source: Own presentation according to Alstom (2017)

Infrastructure

The challenge lies in the production, transportation, storage and finally the economical provision of the high volumes of hydrogen required by fuel cell trains. For example, the hydrogen demand on the reference route Frankfurt – Königstein – Frankfurt amounts to 0.34 kg/km. For a fleet of ten trains, that results in a requirement of approximately two tons of hydrogen per day.[10]

The use of an “on-site electrolyser” which generates the hydrogen on a stationary basis in the railway infrastructure, eliminating the need for hydrogen transport to the filling point, is also a possibility.[11]

Legislative framework

As a rule, the production of green hydrogen from renewable electricity involves high electricity purchase costs. In individual cases, various exemption and reduction options for electrolysers are possible.[12] A reduction of the Renewable Energy Sources Act surcharge in the case of hydrogen trains for the electricity used for electrolysis is as yet not envisaged.

In principle, it would be conceivable to introduce such a reduction scenario in Article 65 Renewable Energy Sources Act (EEG) 2017, which provides for a reduction of the EEG surcharge for railways.

In the current legal framework, the approval of hydrogen facilities for the production, transportation and filling of hydrogen trains according to appropriate approval procedures is already possible.[13]

Awarding of public contracts in (local) passenger rail transport may be linked to minimum requirements relating to CO_2 emissions.[14]

Furthermore, with regard to rail freight transport, taxation via the infrastructure usage fees[15] could be considered.[16]

1 Federal Ministry of Transport and Digital Infrastructure (BMVI) (2018), Alstom (2017). **2** Approx. 79,000 t hydrogen in passenger transport, approx. 44.000 t hydrogen in freight transport, expert survey (Vattenfall, 2018) **3** At 4000-6000 full load hours. **4** Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) (2017). **5** BMUB (2016) **6** A diesel locomotive generates a noise level of over 80 dB, Lutzenberger, Gutmann (2012). **7** For the calculation regarding the production of power fuels, the data of the relevant PtX technologies is used. **8** Currently, the renewable energy share amounts to 42 per cent, BMVI (2018). **9** BMVI (2018). **10** For a distance driven of 600 km, Alstom (2017), NOW (2016). **11** NOW (2016). **12** E.g. Article 118 (6) sentence 7 of the Energy Industry Act (EnWG) or Article 9a of the Electricity Tax Act (StromStG). **13** NOW (2016). **14** NOW (2016). **15** See e.g. Article 35 of the Railway Regulation Act (ERegG): infrastructure fees may take environmental effects into account. **16** Comparable with emission-related take-off and landing fees in aviation; see e.g. the Fee Regulation for Hannover Airport.

Publisher: Deutsche Energie-Agentur GmbH (dena), German Energy Agency, Chausseestrasse 128 a, 10115 Berlin, Germany, Tel: +49 (0)30 66 777-0, www.powerfuels.org, powerfuels@dena.de. **Date:** 07/2019.