

The World Steel Association (worldsteel) case studies use a life cycle assessment (LCA) approach to measure the potential greenhouse gas impacts from all stages of manufacture, product use and end-of-life. worldsteel has developed this case study to demonstrate the reduction of CO₂ emissions through the use of high-performance steels.

High-speed rail networks: A sustainable steel solution

The need for efficient and sustainable transport infrastructure has led to significant growth in the development of high-speed rail networks. High-speed rail offers competitive door-to-door travel times and reduces traffic congestion on heavily used routes. Rail helps to reduce the environmental impact of transport and contributes to a low-carbon economy.

This case study demonstrates the role of high-speed rail in a sustainable transport system. It highlights the importance of steel, as a material, in supporting growth in this sector.

The advantages of train travel

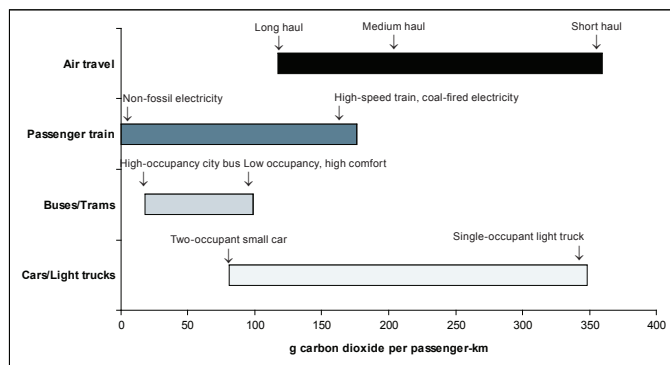
The global trend towards urbanisation has resulted in more movement between cities and towns. Rail is an attractive travel option for short distances because of the convenience of city-centre railway stations. By contrast, air travel requires access to airports that are usually located at a significant distance from city-centres. Adding to this, check-in time, security checks and queuing before boarding contribute to making the journey considerably longer.

Studies have shown that travel by rail can be faster than air travel for short journeys. For example, the introduction of a high speed rail link between Brussels and Paris has reduced door-to-door travel times by around 50% compared to air travel. For business travellers, rail is more convenient because it minimises disruption to the working day. The combination of speed, safety and convenience result in increased economic activity and sustainable transport.



A TGV train on a high-speed track in France

The environmental impact of transport



CO₂ intensity of passenger transport, adapted from the IPCC special report, 'Aviation and the Global Atmosphere'¹

Transport accounts for nearly 23% of energy-based CO₂ emissions worldwide², mainly due to road traffic. Total CO₂ emissions from transport have constantly increased since 1990 and all transport modes - except railways - have increased their GHG emissions from fuel combustion.³

The graph above shows the CO₂ emissions (grammes of carbon dioxide per passenger-km) associated with different modes of transport.

There are clear benefits to rail transport over the alternatives, especially for regions that use a high proportion of non-fossil fuel based electricity. The figure shows that (for short-haul distances of up to 500 km) high-speed electric trains can reduce CO₂ emissions by over 50% per passenger and per km compared to a single occupant vehicle or an aircraft.

The role of steel in high-speed rail

Steel is an essential material in a high speed rail network. Steel makes up 20-25% of the mass of high speed trains.⁴ The main steel components of high speed trains are bogies (the structure underneath the trains including wheels, axels, bearings and motors). Freight or goods wagons are made almost entirely of steel. Steel is also in the rail track sleepers and fasteners, overhead power lines (catenary poles), bridges and stations.



Rail tracks

Over time, developments in the grades and quality of steels have allowed the construction of lighter, safer and more efficient networks. Innovations such as longer and straighter steel rails mean that trains can now reach much greater speeds.

Environmental benefits

The high-speed network line (Ligne Grande Vitesse - LGV) linking Dijon to Mulhouse will significantly reduce journey times in the eastern region of France. Work started on the east branch in 2006. The first section of the track runs 140 km and was opened in December 2011. When completed, the track will be 190 km long.

A study of the east branch of the LGV by the French Environment and Energy Management Agency and French railway operators showed that there are significant carbon footprint benefits associated with the transfer of passengers from road and air transport⁵

According to the study, steel applications on the network include:

- 27,000 tonnes of steel for structures (bridges, viaducts)
- 600 km of rails, i.e. 46,000 tonnes of steel, including rails and catenary poles
- 56,000 tonnes of steel bar for reinforced concrete (civil works, railway infrastructure).

For the lifetime of the rail line (30 years), the carbon footprints in the various life cycle phases were calculated as follows:

- planning phase: 22 ktCO₂ equivalent
- construction phase: 1.17 MtCO₂ equivalent
- operation and maintenance phase: 685 ktCO₂ equivalent (including 635 ktCO₂ equivalent for traction energy, based on the French electricity mix).

The total carbon footprint of the rail line over 30 years of operation is therefore estimated to be 1.87 MtCO₂ equivalent.

There is a clear carbon footprint benefit from the east branch of the LGV compared to the region's existing transport system. Throughout the lifetime of the track, carbon savings from the displacement of alternative transport options is approximately 4 MtCO₂ equivalent emissions. Taking into account the carbon footprint of the materials, construction and maintenance, the shift in transport mode saves 2 MtCO₂ equivalent emissions. This saving is equivalent to the annual CO₂ emissions from a large French city with 200,000 inhabitants, such as Dijon.

Footnotes

1. IPCC Special Report on Aviation and the Global Atmosphere, 1999, <http://www.ipcc.ch/ipccreports/sres/aviation>, accessed April 2013.
2. International Energy Agency, CO₂ Emissions from Fuel Combustion Highlights, 2014 Edition, p 10.
3. Railway Handbook 2012, Energy Consumption and CO₂ Emissions, International Energy Agency (IEA) and the International Union of Railways (UIC).
4. Email 26 April, 2012, Siemens AG, Rail Systems Division, Communications.
5. 1er Bilan Carbone ferroviaire global, ADEME, RFF and SNCF, first presented in 2009, Besançon, France.
6. Le Journal de Saint-Germain, No. 506, 6 April 2007, p.20. Corus, now Tata Steel.

There are further benefits with respect to lowering the local environmental impact of building the LGV line. Measures have been taken to reduce the impact on biodiversity and natural resources, to reduce potential noise impacts, and to minimise the impact on the landscape. The use of steel for the civil engineering works here has the advantage of adopting dry construction methods and minimising on-site waste.

Reuse and recycling

Steel's durability enables rails to be reused by swapping over the left and right rails on the track. When no longer suitable for main-line use, rails can be tested for cracks and then reused on secondary lines with lower traffic. Rails can also be recapped or redesigned to extend their useful life.

Another important attribute of steel is that it is infinitely recyclable without loss of properties. By recycling the steel track at the end its life there is a significant reduction in the environmental impact and energy cost associated with the material. When the rail and track components reach the end of their useful life (typically 30 years⁶), almost 100% of the steel will be recovered.

Did you know?

- On 21 April 2015, a Japanese bullet train set a new world record by travelling at 603 km/h.
- High-speed steel rail can be manufactured in continuous lengths of 120m, which reduces the number of welds and joints and allows trains to travel at greater speeds.
- Rail track is regularly reused by swapping over the left and right rails on a track.

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