Rail Transport and Environment
FACTS & FIGURES

September 2015

CER
The Voice of European Railways

INTERNATIONAL UNION OF RAILWAYS

ISBN 978-2-7461-2400-4

Warning

No part of this publication may be copied, reproduced or distributed by any means whatsoever, including electronic, except for private and individual use, without the express permission of the International Union of Railways (UIC) and of the Community of European Railway and Infrastructure Companies (CER). The same applies for translation, adaptation or transformation, arrangement or reproduction by any method or procedure whatsoever. The sole exceptions – noting the author's name and the source – are «analyses and brief quotations justified by the critical, argumentative, educational, scientific or informative nature of the publication into which they are incorporated» (Articles L 122-4 and L122-5 of the French Intellectual Property Code).

© Copyright UIC / CER - Paris, 2015

UIC, the International Railway Association founded in 1922, counts 240 members across 5 continents, including railway companies, infrastructure managers & rail-related transport operators & research institutes. UIC's members represent over 1 million kilometers of tracks, 2,900 billion passenger-km, 10,000 billion tonne-km and a workforce of 7 million railway staff. The UIC mission is to promote rail transport at world level and meet the challenges of mobility and sustainable development.

The UIC Energy Environment & Sustainability (EES) Platform manages 5 expert networks (Energy & CO_2, Emissions, Sustainable Mobility, Noise and Sustainable Land Use) and a portfolio of projects focusing on the development of best practice, benchmarking for environmental sustainability and reporting of corporate and social responsibility.

For info www.uic.org

The Community of European Railway and Infrastructure Companies (CER) brings together more than 70 railway undertakings, their national associations as well as infrastructure managers and vehicle leasing companies. The membership is made up of long-established bodies, new entrants and both private and public enterprises, representing 73 % of the rail network length, 80 % of the rail freight business and about 96 % of rail passenger operations in EU, EFTA and EU accession countries. CER represents the interests of its members towards EU policy makers and transport stakeholders, advocating rail as the backbone of a competitive and sustainable transport system in Europe.

For more information, visit www.cer.be or follow us via Twitter at @CER_railways.

I must thank European rail companies for sharing their environmental performance data with UIC. These data underpin the majority of the figures presented in this publication and lay the foundation for the environmental case for rail transport.

In order to drive continuous improvement, CER and UIC members of the European region have agreed targets and a vision for sustainable mobility in the coming decades. These targets, adopted in 2010 and presented in this publication, have now been updated with increased ambition for greenhouse gas emissions. The targets set at the European level in partnership with CER are fully compatible with those adopted by the UIC global membership and announced at the United Nations Climate Summit in 2014.

This publication provides the evidence to demonstrate why rail is the backbone of sustainable transport.

Jean-Pierre Loubinoux
UIC Director-General

Transport, energy, and climate policies can play a very significant role in strengthening Europe's economic security, its competitiveness and its ability to pursue a robust external policy. Europe needs to move away from imported fossil fuels towards a low-carbon economy while also reaching high efficiency standards. A resilient transport and energy system is crucial to achieving this goal. Rail, as a low-oil and low-carbon transport mode, can make a vital contribution as the backbone of a sustainable transport system for Europe.

The Community of European Railway and Infrastructure Companies (CER) and the International Union of Railways (UIC) have joined forces to compile this booklet. It aims to support decision makers in shaping the future of the European transport system with up-to-date and comprehensive data for all transport modes.

Libor Lochman
CER Executive Director

Table of Contents

Climate change

Rail is the most emissions-efficient major mode of transport, and electric trains powered by renewable energy can offer practically carbon-free journeys and transport.

Rail contributes less than 1.5 % of the EU transport sector's total CO_2 emissions even though it has over 8.5 % of total market share.

The European railways will reduce their specific average CO_2 emissions from train operation by 40 % by 2020 and by 50 % by 2030 compared to the 1990 base year, measured per passenger-km (passenger service) and tonne-km (freight service).

The European railways will reduce their total CO_2 emissions from train operation by 30 % by 2030 and strive towards carbon-free train operation by 2050 in order to provide society with a climate-neutral transport alternative.

Impact of global warming

Evidence for global warming and the challenges caused by its impact continues to grow. In its Fifth Assessment Report in 2013, the Intergovernmental Panel on Climate Change (IPCC) established that warming of the climate system is "unequivocal", and it is "extremely likely" that human influence has been the dominant cause of warming since the mid-20th century. Continued emissions of greenhouse gases (GHG) will cause further warming it said, adding that "limiting climate change will require substantial and sustained reductions of greenhouse gas emissions."

There are six gases regulated under the Kyoto Protocol where action is focused: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6). By far the most significant of these is carbon dioxide which represents 82 % of emissions in the EU and 99 % of emissions from transport[1].

EU targets

EU policy supports cutting GHG emissions in line with the reductions considered necessary by the IPCC for developed countries, in order to keep the overall increase in average global temperature below 2 ºC. The EU aims to **reduce greenhouse gas emissions by 80-95 % by 2050** compared to 1990, and is actively pursuing a global climate agreement at the Paris Climate Change Conference in December 2015.

1. EC 2014a

During 2014, the European Commission worked on a 2030 Framework for Climate and Energy Policies Communication to replace the EU's existing climate and energy policies with more ambitious targets for the post-2020 period. The Commission Communication lists three key goals: a reduction in total domestic GHG emissions of 40 % on the 1990 level by 2030; an EU-level binding target for renewable energy of at least 27 % in total energy consumption; and reducing the EUs energy use by 30 % by 2030.

There are already existing targets set specifically for transport: in 2011, the EU Communication "Roadmap to a Single European Transport Area" (also known as the Transport White Paper) set, for the first time, EU-wide targets for the reduction of GHG emissions from transport. The roadmap envisages **a reduction of at least 60 % of GHG by 2050 with respect to 1990, and an interim target for 2030 of reducing GHG emissions to around 20 % below their 2008 level**. Unlike all other sectors, emissions have risen substantially in transport since 1990, and the proposed 2030 target would still likely leave emissions above their 1990 level. The EU still needs a formal confirmation in legislation of the 60 % reduction of transport emissions by 2050 with an additional binding target for 2030.

Future EU GHG range of reductions by sector compared to 1990 emissions

	2030	**2050**
Power	*- 54 to - 68 %*	*- 93 to - 99 %*
Industry	*- 34 to - 40 %*	*- 83 to - 87 %*
Transport	*+ 20 to - 9 %*	*- 54 to - 67 %*
Residential / services	*- 37 to - 53 %*	*- 88 to - 91 %*
Agriculture	*- 36 to - 37 %*	*- 42 to - 49 %*

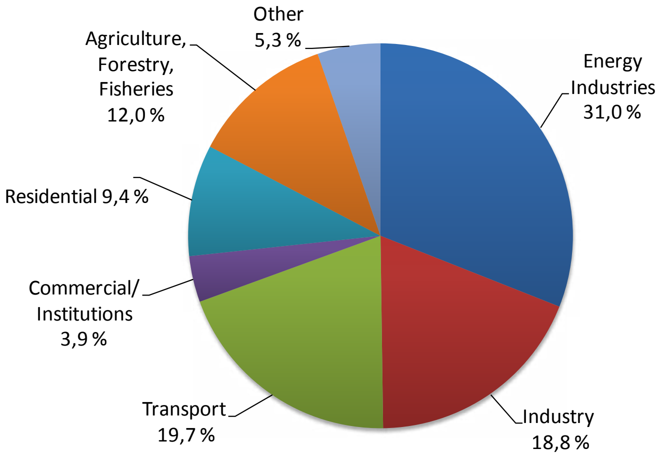
Note: Each sector was given a target range adaptable to whatever decarbonisation scenarios are ultimately adopted. Together the sectors must make a total reduction of at least 80 % by 2050.

EC 2011a

EU transport sector today

Transport is responsible for around **20 % of all GHG emissions** within the EU28, a figure that **rises to 24 %** if emissions from international aviation and maritime transport are fully taken into account (these currently fall outside Kyoto Protocol targets). It is the **only sector where emissions have continued to rise** since 1990: between 1990 and 2012, emissions from transport within the EU28 rose **by 14 %**.

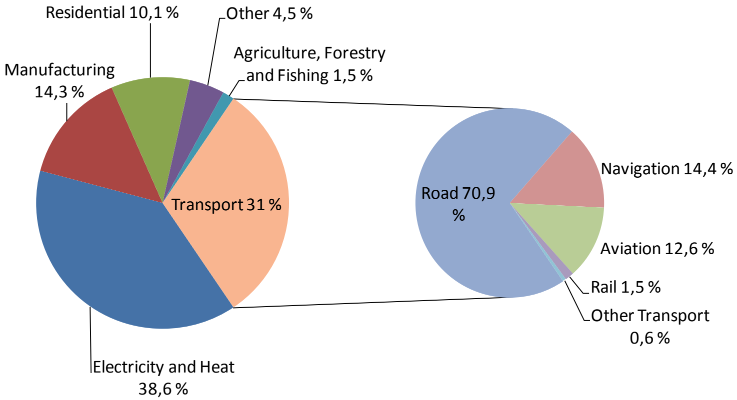
Greenhouse gas emissions by sector in EU28, 2012



Note: percentages exclude LULUCF (Land Use, Land Use Change and Forestry) emissions and international bunkers (international traffic departing from the EU)

EC 2014A

EU27 share of CO_2 emissions from fuel combustion by sector, 2011



Note: emissions from electric rail traction, aviation and navigation (maritime) international bunkers are included in the transport sector

UIC/IEA 2014

EU27 transport modal share, 2011

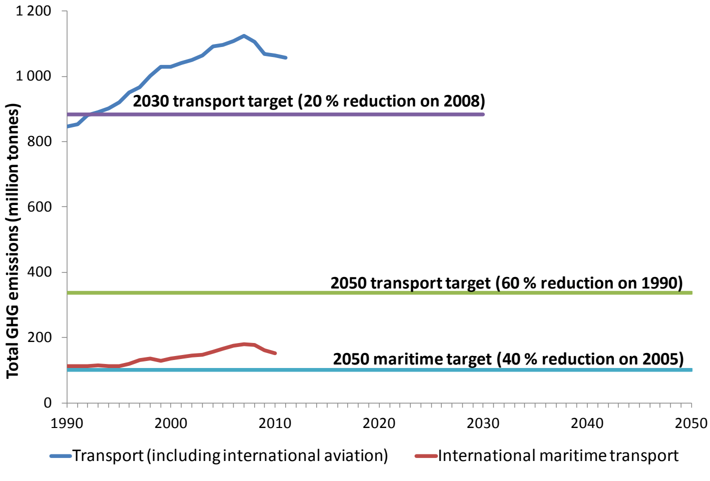
	Passenger (passenger-km)	Freight (tonne-km)	Total (TU)
ROAD	83.6 %	46.9 %	70.3 %
AVIATION	8.8 %	0.1 %	5.7 %
NAVIGATION	0.6 %	41.9 %	15.5 %
RAIL	7.0 %	11.1 %	8.5 %

UIC/IEA 2014

Rail accounts for just 0.6 % of transport's GHG emissions through direct usage (diesel) and **by around 1.5 %** if emissions from electricity generation are taken into account, even though railways represent 8.5 % of transport activity. In contrast, **the road sector accounts for 71.9 % of transport CO_2 emissions**, while aviation and shipping account for 12.6 % and 14.4 % respectively.

Total GHG emissions from transport in the EU28 peaked in 2007, reaching the equivalent to 1,310.6 million tonnes of CO_2 and had declined by around 10 % by 2012, although the fall in freight transport demand related to the economic recession and higher fuel prices was an important factor in this. A major step-change is still necessary if the 2050 emissions target is to be reached.

EU27 transport GHG emissions trends and targets



EEA 2013a

EU transport sector tomorrow

The European Commission made clear in “Roadmap to a Single European Transport Area” that the EU’s transport system is not sustainable, and that change is essential if the GHG reduction targets the roadmap outlined for 2030 and 2050 are to be met. “More resource-efficient vehicles and cleaner fuels are unlikely to achieve on their own the necessary cuts in emissions. They need to be accompanied by the consolidation of large volumes for transfers over long distances,” it said. This would mean greater use of modes that can easily carry large numbers of passengers such as rail, and multimodal solutions for freight that rely on rail and waterborne modes for long hauls.

The Roadmap envisages that the **existing high-speed rail network should be tripled in length by 2030 and completed by 2050**, so that “the majority of medium-distance passenger transport should go by rail”. For freight, **30 % of road freight over 300 km should shift to other modes such as rail or waterborne transport by 2030, and more than 50 % by 2050**.

Rail GHG performance

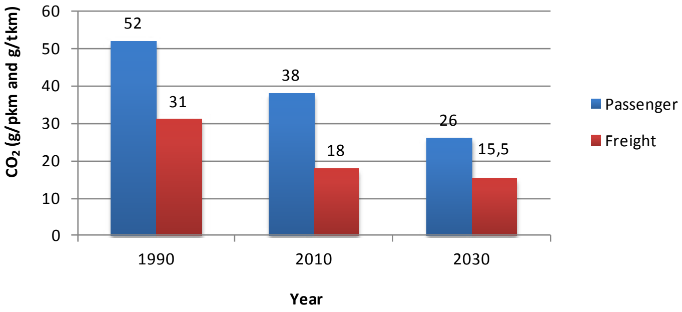
From 1990 to 2010, **the total** CO_2 **emissions from the European railway sector were reduced by 39 %**. This value was caused in part by the reduction of tonne-km from 1990 onwards, particularly in the freight sector. However, just as significantly, specific emissions (i.e. emissions per passenger-km or tonne-km) also fell during the same period, with passenger specific emissions falling by 27 % and freight specific emissions dropping by 41 %.

To help drive forward further improvement in the rail sector, in 2010 the strategy *“Moving towards Sustainable Mobility: European Rail Sector Strategy 2030 and beyond”* was jointly agreed and endorsed by members of UIC and CER to provide a unified approach in the European rail sector. It outlines how the rail sector should be performing in environmental terms in 2030 and 2050, and provides a framework to allow for suitable long-term plans.

The strategy commits European railways to **reduce their specific** CO_2 **emissions by 50 % by 2030**, compared to 1990. In addition, by 2030 the European railways will cut their total CO_2 emissions from train operation by 30 % compared to the 1990 base year. Furthermore, **by 2050 the European railways will strive towards complete carbon-free train operation**, providing society with a climate-neutral transport option.

Following strong performance achieved towards the 2020-2030 targets for CO_2 emissions, in 2015 the European railways decided to tighten the targets. European railway operators will reduce their specific average CO_2 emissions from train operation by 40 % by 2020 compared to the 1990 base year, measured per passenger-km (passenger-service) and tonne-km (freight service). The European railways also committed for a 30 % reduction of the total CO_2 emissions by 2030 relative to 1990.

Past and projected future railway CO_2 specific emissions

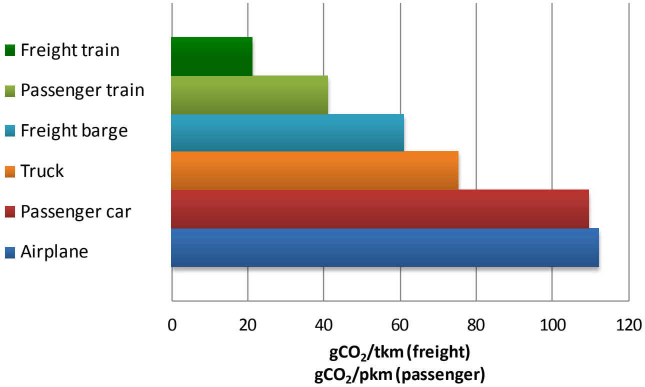


UIC Energy/CO_2 database, and CER/UIC 2012

Emissions comparisons by mode

On average, rail is clearly more emissions-efficient and emits significantly lower CO_2 emissions than comparable modes of transport. A doubling of rail freight transport, with the freight shifted from the road sector, **could result in a reduction of GHG emissions of around 45-55 million tonnes of CO_2 a year**[2]. The vision for much greater use of rail by 2050 outlined in "Roadmap to a Single European Transport Area" would equate to around a 38 % modal share for rail freight transport and a 27 % share for rail passenger transport. This would result in an **estimated reduction of 238 million tonnes of CO_2 a year**, equivalent to 19 % of EU27 transport emissions in 2010.

2. CE Delft/TRT 2011

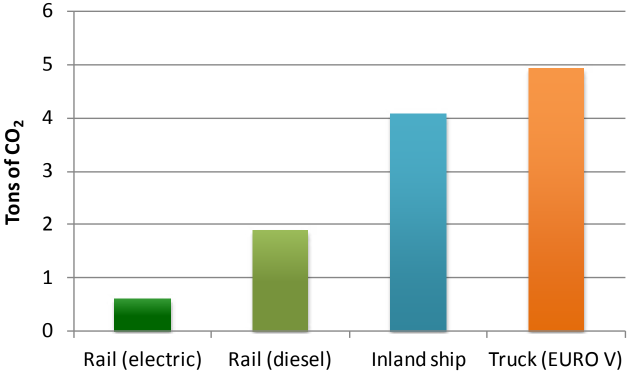


EEA 2013b

Comparing the emissions of different transport modes on a particular journey varies due to factors including fuel source of electricity, overall distance, speed, and weight. Additional indirect emission factors such as emissions caused by the production of vehicles can also be considered to have the full picture. For example, vehicle production accounts for 24 % of combined direct and indirect fuel related GHG emissions for road transport. The EcoPasenger and EcoTransIT webtools allow for detailed calculations to compare journeys by different modes across Europe.

Freight

The chart below compares the total CO_2 emissions emitted when transporting 100 tonnes of average goods from Basel, Switzerland to the port of Rotterdam, Netherlands. CO_2 emissions from rail are 8 times less than by road and almost 7 times less than inland shipping.

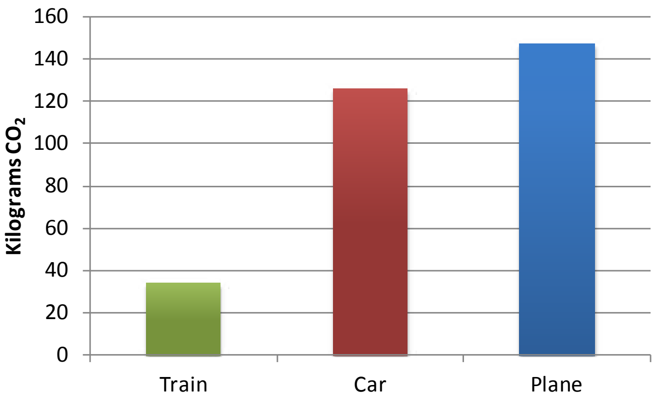


www.ecotransit.org

Passenger

The chart below compares the total CO_2 emissions from transporting one person between Brussels and Berlin city centres. For passenger transport, emissions from rail are nearly 3.7 times less than travelling by road, and almost 4.3 times less than flying.

CO_2 emissions: 1 person Brussels - Berlin (780 km by land)



(Train: ICE with average loading; Car: medium-size, diesel Euro IV; Aeroplane: typical aircraft type for European flights with average utilisation ratio, climate factor of effect of emissions at high altitude included.)

www.ecopassenger.org

Energy

Europe needs to reduce its import dependence for all fossil fuels. By using electricity, which can draw its power from a range of sources, rail is the only major transport mode not dependent almost entirely on fossil fuels.

Rail's share of transport energy consumption is less than 2 % despite a market share of over 8.5 %.

The European railways will reduce their specific final energy consumption from train operation by 30 % by 2030 and by 50 % by 2050 compared to the 1990 base year, measured per passenger-km (passenger service) and tonne-km (freight service).

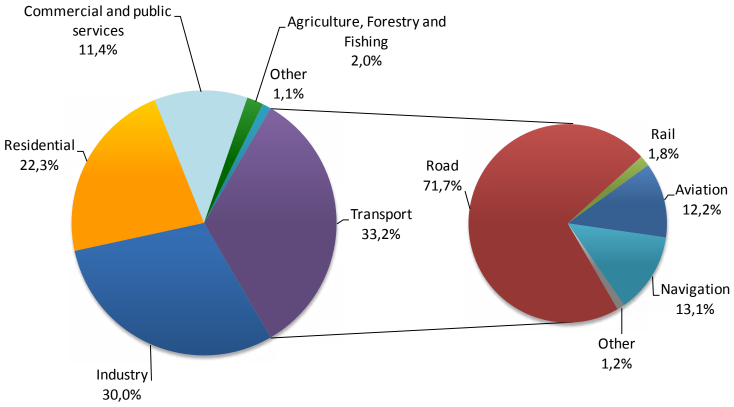
EU transport sector today

EU energy policy is closely related to policies on reducing greenhouse gas emissions. Building on the 20-20-20 targets, in 2014 the European Commission set targets for the post-2020 period with the 2030 Framework for Climate and Energy Policies. The EU will **increase the share of renewable energy to 27 %** and realise **energy savings of 30 %** in the EU's primary energy consumption compared to 2007. The long-term energy goals for energy envisage a major shift away from oil and gas use in order to meet the 2050 GHG emissions reduction target.

The transport sector poses a major challenge as it accounts for **32 % of final energy consumption** in the EU. While transport has become more energy efficient, in the EU it still depends on petrol and diesel for 96 % of its energy needs, and use of these rose by 35 % between 1990 and 2007 before falling back slightly due to the impact of the financial recession.

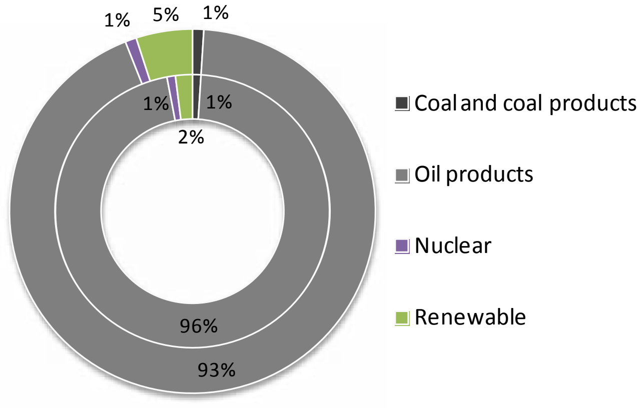
In 2011, the EU Communication "Roadmap to a Single European Transport Area" made clear that the challenge is now to "use less and cleaner energy" and to break the transport system's dependence on oil. This position was restated in the "Roadmap to a Resource Efficient Europe", also adopted by the Commission in 2011, which identified transport as one of **three crucial sectors** where action is needed. By 2020, overall efficiency in the transport sector needed to "deliver greater value with optimal use of resources", with transport using **less and cleaner energy, exploiting modern infrastructure, and reducing its negative impact on the environment**.

Final energy consumption 2012 in EU27 by sector and transport



EC 2014A

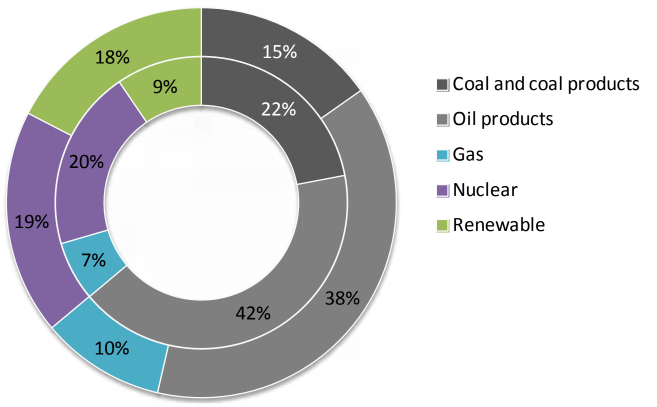
EU27 transport energy mix evolution (2010 outside - 2005 inside)



Note: "Oil" takes into account both the fuels used directly (e.g. oil and diesel) and the composition of the electricity mix for electric traction. Renewable energy sources include both renewable fuels directly used by transport (e.g. biofuels) and renewable sources of electricity that are then used in transport.

UIC/IEA 2013

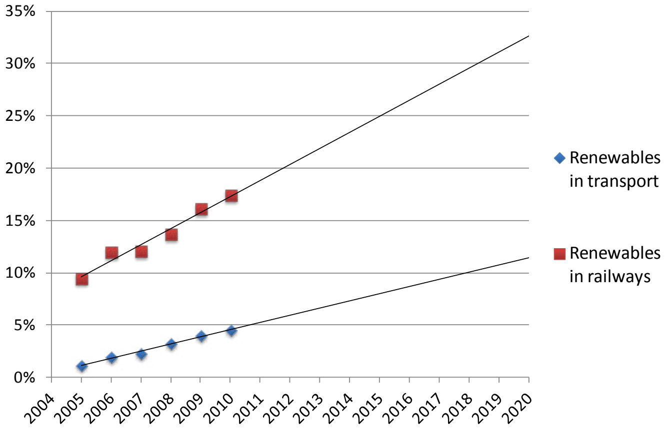
EU27 railway energy mix evolution (2010 outside - 2005 inside)



Note: This is the mix of fuels used by the EU railway sector. It takes into account both the fuels used directly (e.g. coal and diesel) and the composition of the electricity mix for electric traction

UIC/IEA 2013

Forecast of the share of renewables in transport and in railways in EU27, 2005-2020



UIC/IEA 2013

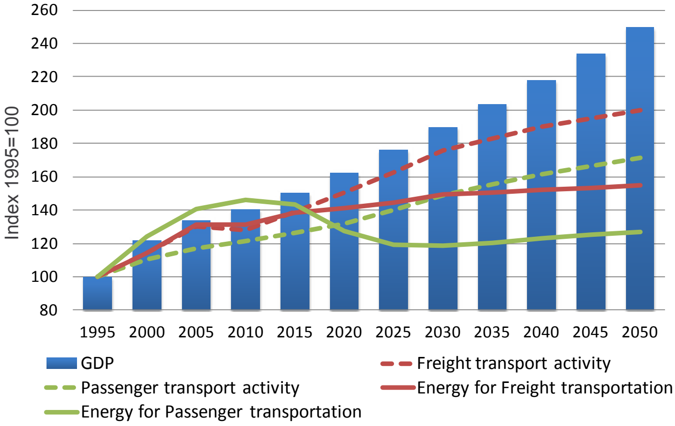
If the energy sources used by railways continue to follow the trends of past years, EU railways will use almost 35 % renewables by 2020. The fuel mix of the whole transport sector is now 5 % renewables and is set to reach 12 % in 2020. Railways used 14 % of renewables in 2011. It means that railways already met the 2020 EU target for the transport sector (10 % share of renewables).

EU transport sector tomorrow

Final energy demand in the transport sector has grown in line with transport activity over recent years. However, despite the projected upward trends in transport activity beyond 2010, the most recent forecasts for the European Commission predict that energy demand in 2050 will be marginally lower than in 2010, with demand decoupling from transport activity beyond 2015.

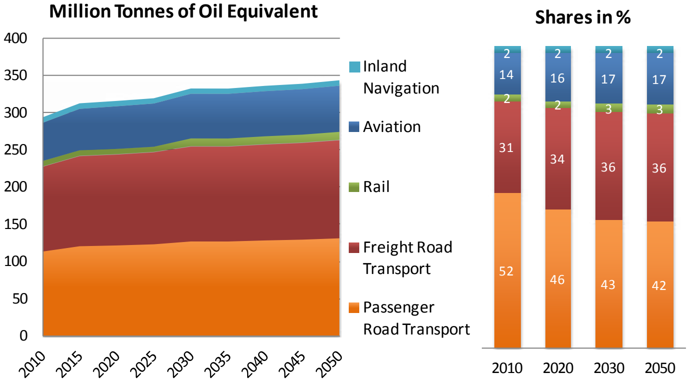
The main driver of low final energy demand from transport is predicted to be **improvements in fuel efficiency** and the **uptake of more efficient technologies**. Operational measures such as energy-efficient driving or optimisation of stabling and platforming can also be implemented.

Trends in transport activity and energy consumption 1995 - 2050



EC 2013

Final energy demand in transport 2010 - 2050



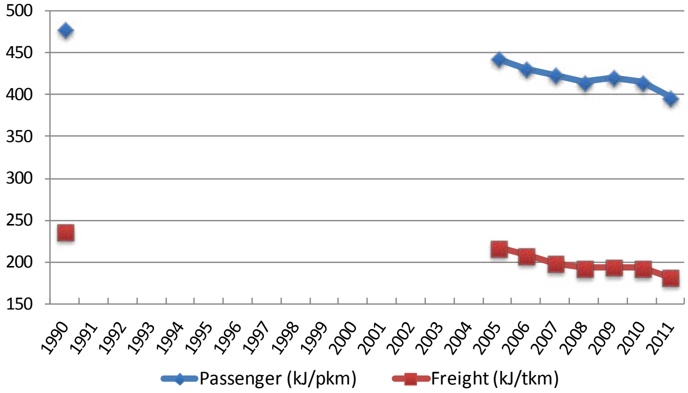
EC 2013

The EU aims for oil use in transport to be reduced by **70 % by 2050 from 2008 levels**. While transport oil consumption has reduced slightly, over the next few years the rate of reduction will need to accelerate in order not to fall behind the linear target line to the 2050 goal.

Rail traction energy

While rail's share of transport energy consumption is less than 3 %, its market share is around 8.5 %. Railways have improved their energy efficiency in both passenger and freight transport from 1990 to 2009: on average, 13 % less energy is needed now for one passenger-km and 19 % less energy for one tonne-km.

EU27 railway specific energy consumption 1990-2011



UIC/IEA 2014

In the 2010 strategy "Moving towards Sustainable Mobility: European Rail Sector Strategy 2030 and beyond" that was jointly agreed by members of UIC and CER, the rail sector agreed that by 2030 the European railways will have **reduced their specific final energy consumption from train operations by 30 %** compared to 1990. Furthermore, the European rail sector set a vision of reducing by 50 % their specific energic consumption by 2050.

Approximately 85 % of total energy consumed by the rail sector is used directly for rail traction as illustrated below.

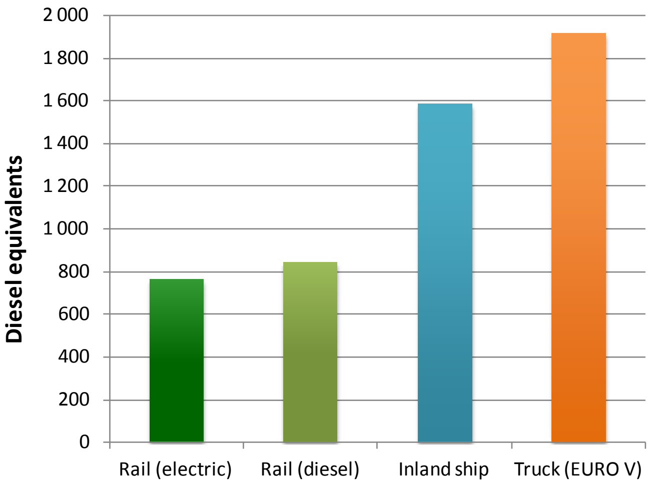
Primary energy production, transmission and conversion losses, input to rail grid from public substation outlet (100 %)	**>**	**Traction energy (85 %), of which catenary losses (5-10 %)**
		Workshops, buildings, signalling, etc. (15 %)

UIC 2012

Freight transport energy comparison

Rail is the most energy-efficient transport mode for freight: the bar chart below compares the total primary energy consumption involved in transporting 100 tonnes of average goods from Basel, Switzerland to the port of Rotterdam, Netherlands. As can be seen, rail consumes only 53 % of the energy used by inland waterways, and only 44 % of the energy used by truck.

Primary energy consumption (well-to-wheel): 100 tonnes cargo, Rotterdam - Basel (700 km by land)



www.ecotransit.org

Rail energy efficiency improvement

The rail sector is continuously seeking to improve energy efficiency performance, which is based on 3 pillars:

Driver advisory systems and eco driving

The rail sector is adopting more efficient operating methods such as Driver Advisory Systems and Eco Driving. A case study in Sweden comparing rolling stock equipped with Driver Advisory Systems to standard rolling stock not fitted with it found that the trains with the Driver advisory system consumed 19 % less energy.

Electricity meters

All electric trains operated by DB (Germany) have electricity meters installed. SNCF (France), SBB (Switzerland) and SNCB (Belgium) are intending to equip their complete fleet with on-board energy meters by 2019. In total, 25,000 energy meters will be installed by 2020. The new European Technical Specification on Interoperability regarding rolling stock will make on-board energy meters mandatory from 2019 on new, renewed and upgraded rolling stock. All member states must have arrangements by 2019 to collect data coming from such meters and exchange it with relevant parties in the energy market.

Recent EU-funded research and development projects:

- **Railenergy (2006-2010)** www.railenergy.eu

  The Railenergy project aimed to achieve a 6 % reduction of the specific energy consumption of the European rail system by 2020. Recommendations included predicting the energy performance of new rolling stock using the new technical standard TecRec 100_001, greater use of eco driving (saving potential between 5 % and 15 %), energy efficient traffic management (saving potential between 10 % and 20 %), and parked train management (saving potential of 4 % to 8 %).

- **Trainer (2006-2008)** tinyurl.com/iee-trainer
- **Hyrail (2007)** www.hyrail.eu
- **ECORailS (2009-2011)** www.ecorails.eu
- **MERLIN (2012-2015)** www.merlin-rail.eu

The MERLIN project is investigating and demonstrating the viability of an integrated management system to achieve a more sustainable energy usage in European electric mainline railway systems. MERLIN will provide an integrated optimisation approach towards a cost-effective intelligent management of energy and resources, and will also deliver the interface protocol and architecture for energy management systems in the railway domain. A 10 % reduction in energy consumption is expected to be achieved where the results of the project are implemented.

Electricity use

3

Electric traction accounts for over 80 % of rail activity (passenger-km and tonne-km) in Europe.

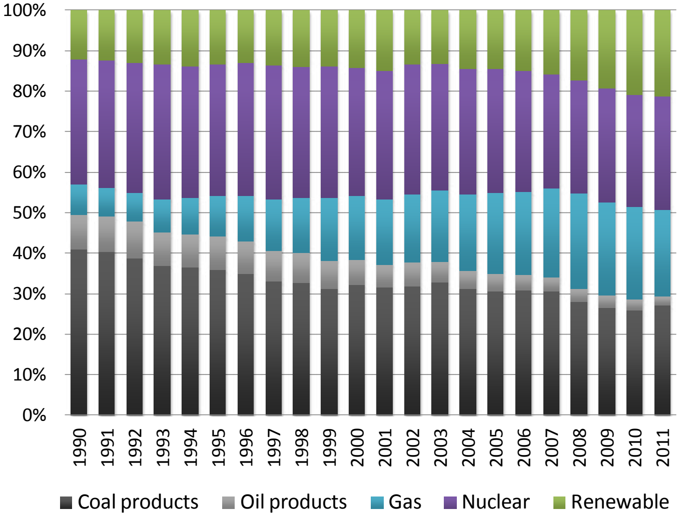
Electricity used by railways in Europe is already produced with an average of 30 % from renewable sources.

There are no technical obstacles to a fully-electric rail sector with zero CO_2 emissions if electricity is from practically carbon-free sources.

EU electricity generation today

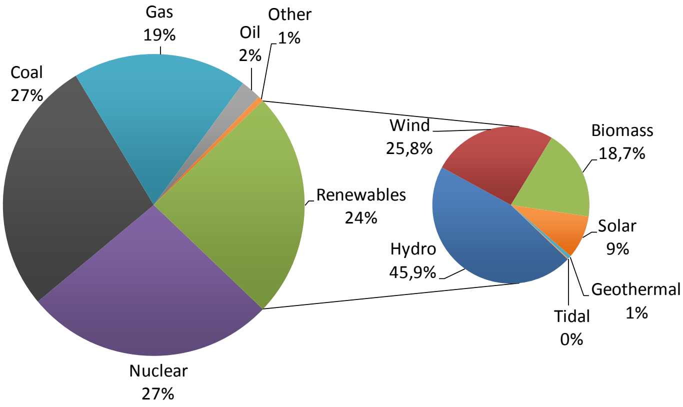
EU energy policy has been supporting a gradual shift towards low or zero-carbon forms of electricity (nuclear and renewables) over more carbon-intensive means of generating electricity (gas, coal and oil) for reasons of both lowering CO_2 emissions and improving energy security. Between 1995 and 2011, gross electricity generation in the EU27 rose by 20 % while the proportion of electricity from nuclear and renewable sources also rose, from 43 % in 1990 to 49 % in 2011.

EU27 electricity production mix evolution, 1990-2011



UIC/IEA 2014

EU27 gross electricity generation, 2012

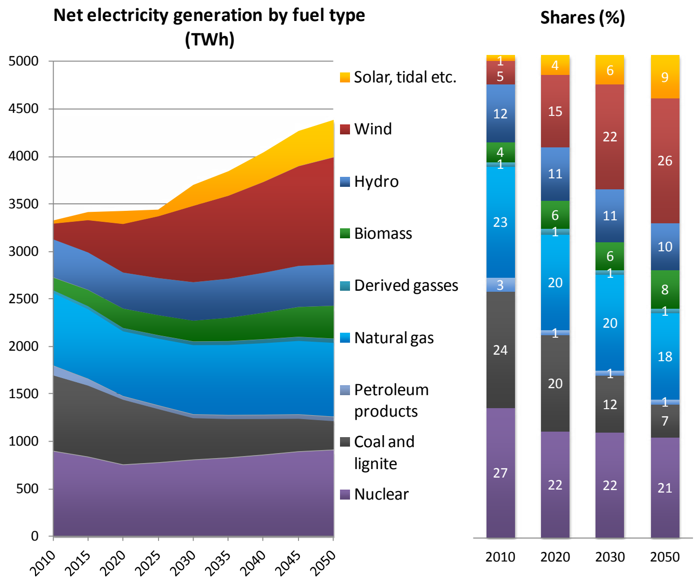


EC 2014b

EU electricity generation tomorrow

The EU proposes that electricity should play a central role in the future low carbon economy. Its analysis envisages that it will largely eliminate CO_2 emissions in electricity by 2050, and also offer the prospect of partially replacing fossil fuels with electricity in transport and heating, resulting in a lower environmental impact and less dependence on imported fuel. The increased use of electricity in these two sectors will be achievable as electricity consumption overall will only have to continue to increase at historic growth rates, due to continuous improvements in efficiency. However, in order to ensure that new electricity generation is low carbon, there will likely be a need to ensure that the cost of CO_2 in the EU Emissions Trading System is kept at a sufficiently high level that ensures it is not cheaper to produce electricity using coal.

Future EU electricity generation, by fuel type



EC 2013

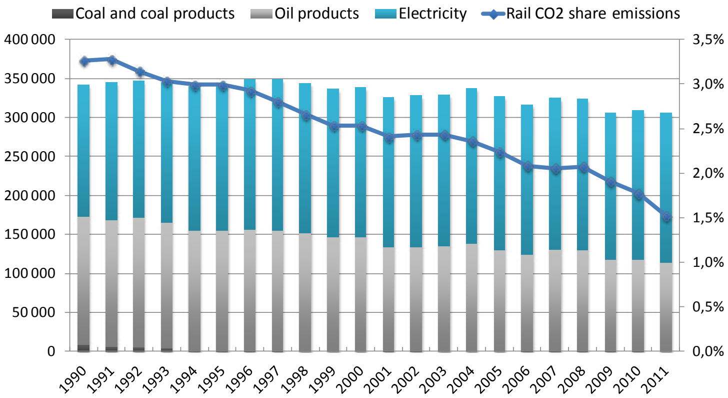
Rail's electricity use

Due to its established use of electricity, rail is the only major mode of transport that is principally and currently capable of shifting from using fossil fuels to renewable energy without the need for further major technological innovation. But therefore a massive investment is required in infrastructure. Over half of the European rail network is already powered by electricity, a figure that continues to increase. With sufficient funding and the political will, it would be possible to electrify the entire European rail network. If electricity is fully decarbonised by 2050 as the EU aims to achieve, then rail would become the first zero-carbon major transport mode.

The emissions from rail's electricity use are crucially linked with the energy supply in each member state, which is decided by the national energy sectors and by political objectives. However, some railways own dedicated railway electricity production facilities for historic and technical reasons and therefore can have a different mix. Yet again other railways in countries with fully deregulated electricity markets have made a conscious decision to procure electricity from renewable sources, dedicating this electricity (and its emissions) to rail and thus exempting it from being bought by another procurer.

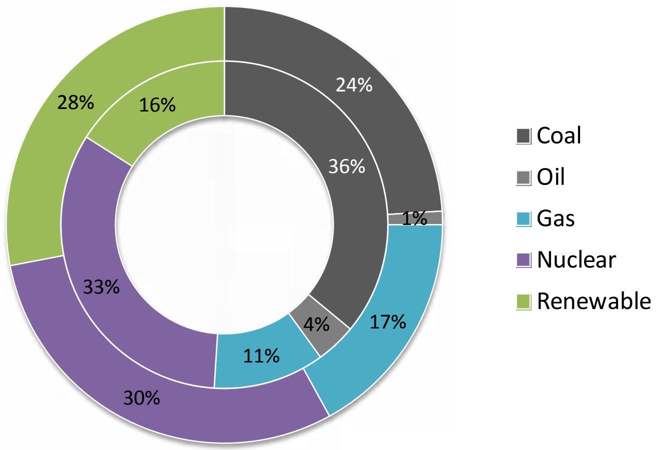
Furthermore, railways are often the biggest users of electricity in a country, so their purchasing decisions can help shift markets and encourage investment in cleaner forms of energy production. In this setting, a political will is also needed as many national railways are still state-owned.

EU27 railway energy consumption by fuel 1990-2011



UIC/IEA 2014

Railway electricity mix evolution in EU27 (2010 outside - 2005 inside)



UIC/IEA 2013

Land use

4

Railway infrastructure is responsible for around only 4 % of the total area of land used for transport.

Land take per passenger-km for rail is about 3.5 times lower than for cars.

EU transport sector today

The negative impact on land use is a significant but often overlooked consequence of transport, and can go beyond the land set aside specifically for infrastructure. The actual space taken for infrastructure leads to the sealing of topsoil, as well as disturbances resulting from noise, resource use, waste dumping and pollution. Transport networks can add to the fragmentation and degradation of the natural and urban environment due to the "barrier effects" of infrastructure. Furthermore, the land take by road transport is often disproportionate: land allocated exclusively to car transport and off-street car parking tends, in urban areas, to be out of proportion to the land actually available. This focus on supporting the movement and placement of cars conflicts with other priorities, such as the need for recreational space.

The growth in demand for new transport infrastructure caused in part by growing urbanisation means that land take for transport has been increasing in recent years. Road transport is by far the largest consumer of land for transport: the road network occupies 93 % of the total area of land used for transport in the EU15, while rail is responsible for only 4 % of land take. Land-take efficiency (the ratio between land used and the traffic carrying capacity of the infrastructure) varies significantly from one infrastructure type to another. Railways require far less land take per transport unit (passenger-km and tonne-km) than road transport, with land take per passenger-km by rail about 3.5 times lower than for cars.

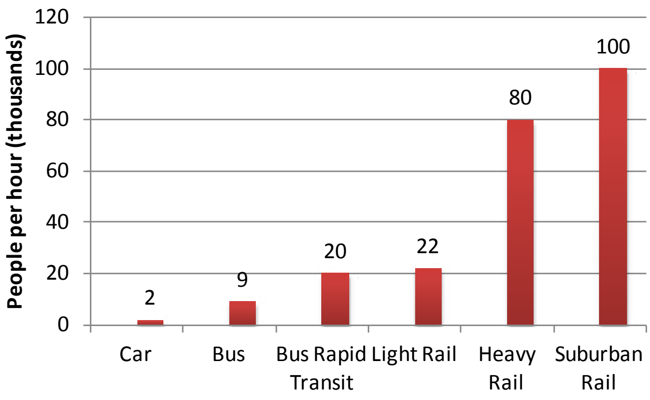
EU transport sector tomorrow

In the EU's 2012 Roadmap to a Resource Efficient Europe, transport was identified as one of three crucial sectors where stronger action was needed on increasing resource efficiency. It proposed that by 2020, EU policies should take into account their direct and indirect impact on land use, and the longer-term aim would be for no additional net land take by 2050. The roadmap made clear the need to minimise the impacts of transport infrastructure on the sealing of land, a problem most prevalent in road building.

Efficiency of land use

As the graph below shows, rail tracks permit a far higher throughput of people in a given unit of time than road, and usually require considerably less land than urban roads.

Capacity of a 3.5 m wide lane in a city



ADB/giz 2011

The same principle is true in longer, inter-city journeys. Due to high-speed rail's very high capacity, the land needed for the large traffic volumes carried is much reduced. On average, a high-speed line uses 3.2 ha/km, while an average motorway uses 9.3 ha/km. Furthermore, the impact on land use of new high-speed rail lines can be reduced by laying new lines parallel to existing motorways. Examples of where this has happened include Paris - Lyon (60 km, 14 % of the total line), Paris - Lille (135 km, 41 % of the total), Cologne - Frankfurt (140 km, 71 % of the total), and Milan - Bologna (130 km, 72 % of the total).

→ COMPARISONS IN LAND USE

MOTORWAY	HIGH-SPEED RAILWAY
2 x 3 lanes **75m**	Double track **25m**
1.7 passenger / car **1.7**	666 passengers / train **666**
4,500 cars per hour **4,500**	12 trains per hour **12**
2 X 7,650 PASSENGERS / H	**2 X 8,000 PASSENGERS / H**

UIC 2011

Local air pollution 5

Electric rail transport emits no local air pollution at the point of use.

European railways will reduce their total exhaust emissions of NO_x and PM_{10} by 2030 by 40 % in absolute terms, even with projected traffic growth compared to the 2005 base year.

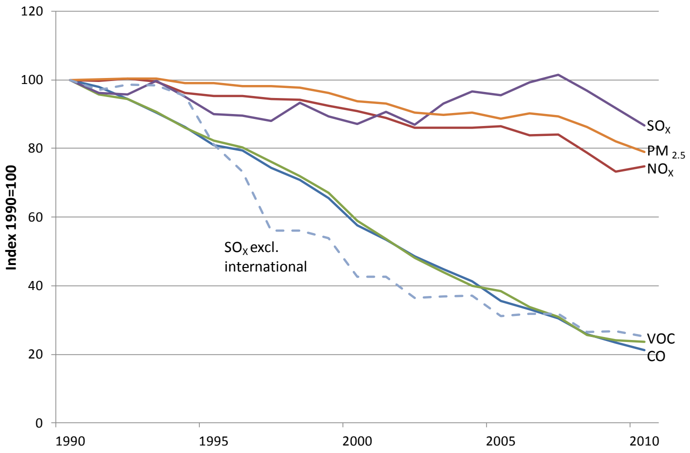
European railways will strive towards zero emission of nitrogen oxides (NO_x) and particulate matter (PM_{10}) from non-electric trains by 2050.

EU transport sector today

EU policies on air quality have led to significant reductions in concentrations of harmful pollutants, such as particulate matter (PM), sulphur dioxide (SO_2), lead, nitrogen oxides (NO_x), and carbon monoxide (CO). However, fine (PM_{10}) and very fine ($PM_{2.5}$) particulates, and ozone (O_3) continue to present significant health risks, and up to one-third of Europeans living in cities are still exposed to air pollutant levels exceeding EU air quality standards. The EU remains well short of its long-term objective outlined in the 7th Environmental Action Programme, which is to achieve levels of air quality that do not have significant negative impacts on human health and the environment.

Transport is one of the main sources of air pollution in Europe, particularly in cities and urban areas. Key air pollutants emitted from combustion engines in all modes of transport include NO_x, PM, CO, and volatile organic compounds (VOCs). Non-exhaust emissions of PM are also released due to the mechanical wear of brakes, tyres and road surfaces, but are not currently regulated. During the period 1990 to 2010, the pollutants showed a decreasing trend in transport emissions: the largest percentage decreases over this period were for carbon monoxide (76 %) and non-methane volatile organic compounds (NMVOC) (75 %). While changes to fuel and technological and efficiency improvements have reduced transport's impact on air pollution, transport, and in particular road traffic, continues to play a major role in the generation of particulates and ozone.

Transport emissions of $PM_{2.5}$, CO, SO_x, NMVOC, NO_x in EEA member countries, 1990-2010

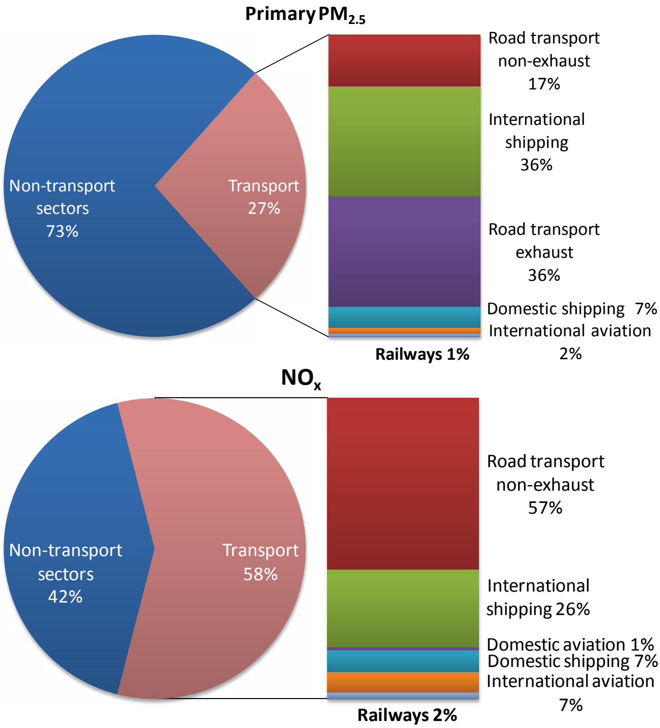


EEA 2012

The decline over the last 20 years has occurred in spite of a growth in transport activities reflected by various indicators such as energy consumption and passenger and freight transport volumes since 1990. The downward trend for most pollutants has followed the progressive introduction of tighter Euro emission standards on new road vehicles supplemented by improvements in fuel quality driven by EU Fuel Quality Directives. Tighter regulations in emissions from new diesel engines for railway locomotives and the sulphur content of marine fuels have also contributed to this downward trend.

However, the general trends in emissions of key pollutants NO_x and $PM_{2.5}$ have been countered by the increased market penetration of road diesel vehicles since 1990, which generally emit more of these pollutants per kilometre than their gasoline equivalents.

EEA-32 contribution of the transport sector to total emissions of $PM_{2.5}$ and NO_x, 2009



Note: Rail emissions only include those generated at the point of use (e.g. diesel engine locomotives) and not secondary sources (e.g. electricity power stations)

EEA 2012

EU transport sector tomorrow

The EU estimates that more than 400,000 people are estimated to have died prematurely from air pollution annually in the EU, with an economic cost of the health impacts alone estimated at EUR 330-940 billion (3-9 % of EU GDP). The EU's 2013 Clean Air Policy Package set out new interim objectives for reducing health and environmental impacts from air pollution up to 2030. The proposal included a revised National Emission Ceilings Directive, containing updated national ceilings for six key air pollutants (PM, SO_2, NO_x, VOCs, NH_3 (ammonia) and CH_4 (methane)) for 2020 and 2030. The main priority for transport policy will be to ensure that the existing legislation fully delivers on air pollution, in particular with regard to the new Euro 6 standards for road vehicles, and a revision of the Non Road Mobile Machinery Directive, which regulates diesel rail vehicles. Air pollutants and greenhouse gases (including CO_2) are often emitted by the same sources, so certain

GHG reduction measures can also deliver reductions in air pollutants such as NO_2, SO_2, and O_3. However, decarbonisation does not always reduce emissions of particulate matter (PM).

Rail sector targets

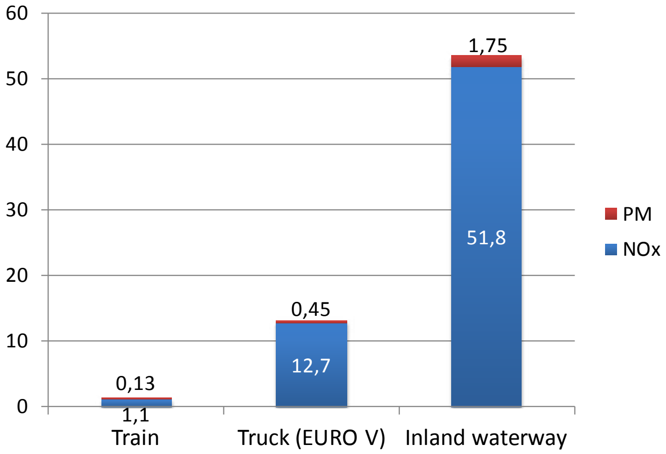
The total emissions from rail diesel traction have continuously decreased since 1990 and are extremely low today compared to the transport sector as a whole. Diesel traction only accounts for 20 % of European rail traffic but the rail sector is still looking at new combustion technologies, efficient transmission systems and exhaust after-treatment that will ensure that rail diesel traction will remain more environmentally friendly in the future than road or inland waterways. Electrification of remaining lines is also one of the many approaches that may be taken, although rail diesel propulsion is still expected to play an indispensable role for the European transport system in the coming years.

By 2030 the European railway sector has pledged to reduce their total exhaust emissions of NO_x and PM_{10} by 40 % in absolute terms, even with projected traffic growth, compared to 2005. By 2050, the European railways will strive to have zero emission of NO_x and PM_{10}.

Freight transport emissions comparison

The bar chart below compares the NO_x and PM caused by transporting 100 tonnes of average goods from the port of Rotterdam, Netherlands, to Basel, Switzerland (666 km by road).

NO_x and PM generated by 100 tonnes cargo, Rotterdam - Basel (700 km by land)

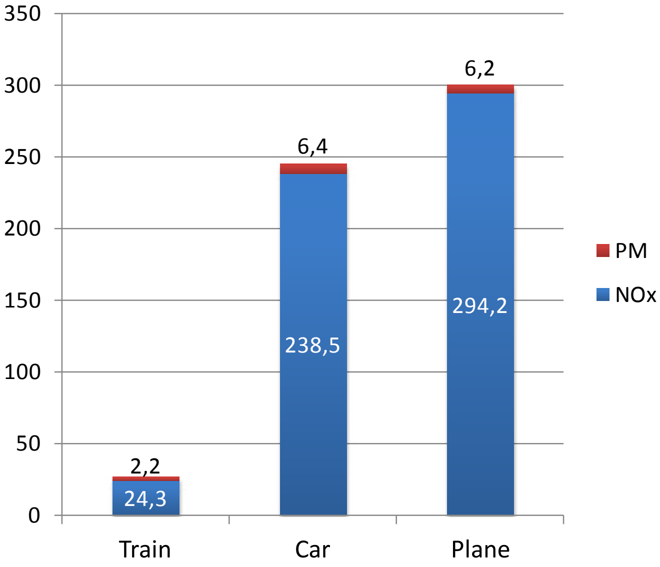


www.ecotransit.org

Passenger transport NO_x and PM comparison

As suburban and urban railway lines are frequently fully-electric across Europe, the local NO_x and PM emissions from rail in urban areas are often zero. The bar chart below compares the NO_x and PM caused by a passenger journey from Brussels to Berlin.

NO_x and PM generated by passenger transport, Brussels - Berlin (780 km by land)



(Train: average loading; Car: medium-size, diesel Euro IV, 1.5 passengers; Aeroplane: typical aircraft type for European flights with average utilisation ratio, effect of emissions at high altitude included, transport to and from airport by car included.)

www.ecopassenger.org

Rail sector air pollution reduction projects

The railways continuously seek to improve their technical, operational, commercial and procurement measures. Recent research and development projects to further reduce air pollution levels include:

- **GREEN (2006)** green.uic.org

GREEN (GREEn heavy duty ENgine) was an EU funded research project aiming to develop an intelligent flexible HD engine system able to achieve a maximum fuel conversion efficiency of 45 %, while complying with a zero-impact emission level.

- **CleanER-D (2011-2013)** www.cleaner-d.eu

Clean European Rail-Diesel (CleanER-D) was an EU-funded research project aiming to develop, improve and integrate emissions reduction technologies for diesel locomotives and rail vehicles. Furthermore, it used innovative methods and hybrid solutions for the best possible contribution to reductions in CO_2 emissions. The project has developed recommendations to all involved stakeholders on how to boost emission reduction of rail diesel traction.

6 Noise

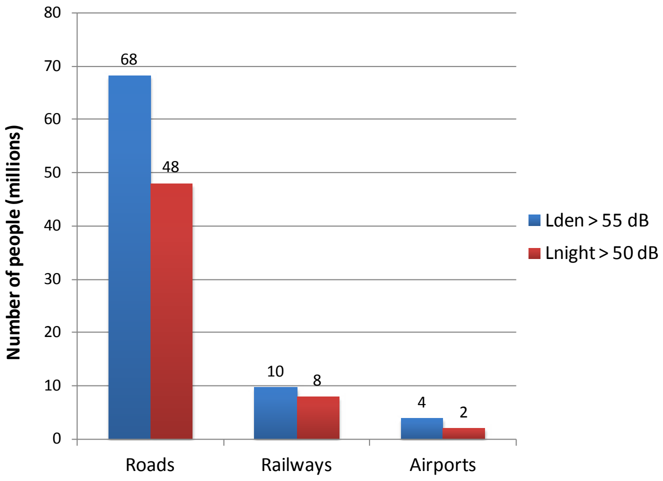
Retrofitting rail freight wagons with low-noise brake blocks can cut noise levels by 8-10 dB, reducing the perceived noise by up to 50 %.

The European railways will strive towards noise and vibrations no longer being considered a problem.

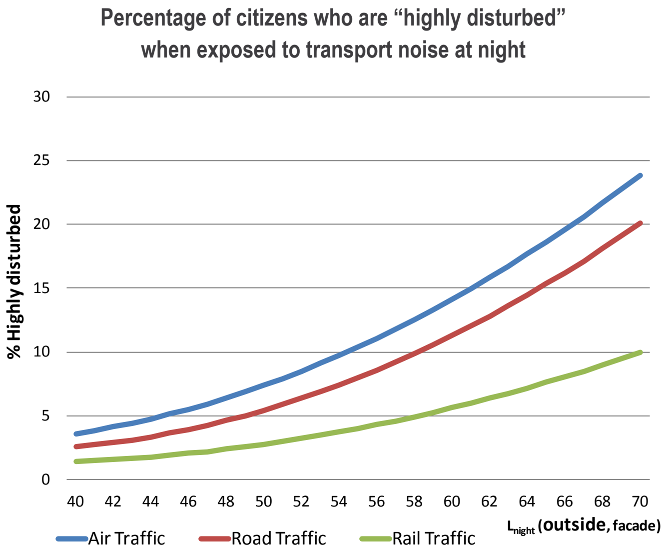
EU transport sector today

Noise is a consequence of all major modes of transport, and is one of the key concerns for people living near transport infrastructure. Half of the EU's urban population is exposed to noise levels above 55 decibels (dB) as a result of transport (mostly road traffic). In European cities with populations over 250 000, almost 70 million people are exposed to long-term average road traffic noise levels exceeding 55 dB L_{den} (a weighted average noise over 24 hours that marks the threshold for excess exposure). At night, more than 48 million people in the same urban areas are exposed to long-term average road noise levels higher than 50 dB L_{night} (the EU threshold for excess exposure at night time).

Exposure to transport noise in urban areas in Europe (EU27 plus Norway and Switzerland)



EEA 2007



UIC 2010

Current EU legislation distinguishes between noise creation (the emission of noise at source, best tackled on an EU-wide level), and noise reception (what to do once noise has been emitted, best addressed at national, regional or local levels). The Technical Specification for Interoperability relating to rolling stock noise (Noise TSI), which was published at the end of 2014, will ensure that all rolling stock complies with strict noise limits.

The main EU legislative instrument for providing a coherent overview on dealing with noise reception is the Environmental Noise Directive (END). The END provides a common basis for tackling noise across the EU by identifying hotspots. While there are no binding targets at the EU level, the END requires that member states must calculate noise exposure levels, publish noise maps, and adopt action plans to prevent or reduce noise exposure where necessary.

EU transport sector tomorrow

Noise will remain one of the key environmental problems for EU transport for a long time due to the inherent nature of the problem and its link to transport growth. To help push forward action in member states, the EU's 7th Environment Action Programme (2012) stated that it aimed to ensure that by 2020 noise pollution in the EU will have "significantly decreased", moving closer to World Health Organisation (WHO) recommended levels. While the biggest priority in transport noise is road traffic, the EU is nonetheless making sure that rail noise is also tackled. The European Commission aims to reduce the level of rail noise without jeopardising the competitiveness of the rail sector. A review of the END is ongoing and in the future a revision of the Directive may be realised.

In the Directive 2012/34/EU, a provision on the possible use of track access charges to account for environmental externalities was enhanced in order to develop an economic incentive to tackle rail freight noise. This type of measure is commonly referred to as Noise-Differentiated Track Access Charges (NDTAC). The introduction of such charges is currently voluntary for each EU member state. However, with the upcoming implementing act of the Commission, harmonised arrangements for NDTAC should be applicable to those member states that have introduced or will in the future introduce infrastructure charging due to railway noise. Currently NDTAC systems, have already been established in Germany and the Netherlands, and also in non-EU Switzerland – these three countries together represent 23 % of the European rail network. Other countries such as Belgium, Italy and Czech Republic are also examining NDTAC systems to consider introducing them in the future.

In 2013, the European Commission issued a roadmap specifically targeting noise generated by rail freight wagons that laid out a series of policy options for further measures. The Commission is expected to produce a Communication in 2015 to set a mid-term strategy for significantly reducing rail freight noise. By 2020, some European countries are likely to impose regulatory measures for noisy freight wagons, in particular Switzerland which is planning to ban cast-iron brake blocks.

Rail's noise reduction activity

The European rail sector has long recognised that noise from rail activity needs to be further reduced. In particular, the rail sector has made the commitment that, by 2030, noise mitigation measures will be integrated naturally in all relevant processes of the railway, offering sustainable and bearable solutions, implemented using a toolbox of various innovative and homologated techniques.

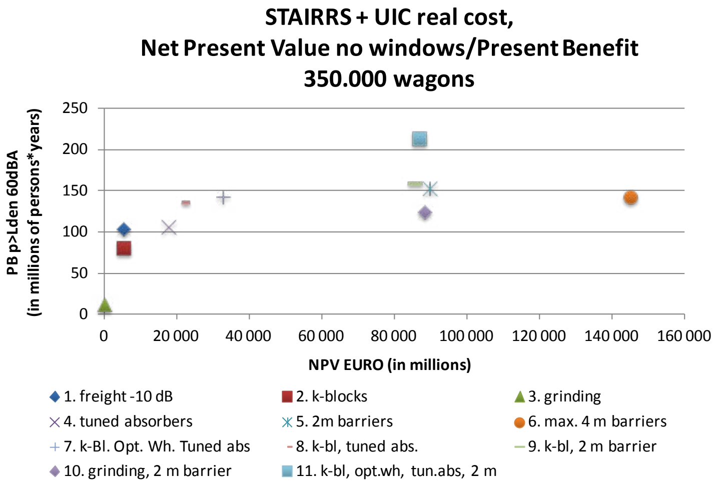
Railway noise measures can be divided into two main categories: rolling stock-related measures such as modified brakes or damped wheels, and infrastructure-related measures such as rail dampers and noise barriers. The larger potential lies in treating the noise problem at source, which is recognised as the most effective solution both in technical and economical terms.

The biggest challenge in the rail sector is the noise caused by the large remaining fleets of older freight wagons. Passenger traffic (high-speed rail and intercity) is considered to have no noise problem. Since 2006, new and upgraded wagons must be equipped with composite brake blocks reducing pass-by noise, but tens of thousands of older freight wagons continue to operate using cast-iron brake blocks, which in turn cause rough wheels and rails. Noise is a local issue by definition, and rail noise is considered a particular nuisance in densely populated central European countries such as the Netherlands, Germany and Switzerland.

Retrofitting existing freight wagons with low-noise “LL” brake blocks offers a noise reduction potential of 8-10 dB, reducing the perceived noise by up to 50 %. This impact is particularly beneficial at night when a major percentage of freight trains operate. However, there are significant costs involved in retrofitting existing wagons. The expected cost to retrofit all existing wagons is at least €1 billion. One also has to consider higher operational costs in retrofitted wagons, which is estimated at almost €2 billion over the next 7 years.

To have an overview on the operational experience and lifecycle costs of the LL-blocks, the rail sector commissioned the €15 million EuropeTrain project. The test train consisted of 32 wagons fitted with LL-blocks, and spent over a year traversing the continent experiencing the most extreme weather conditions found in Europe. The EuropeTrain project was successfully concluded in 2013. Two types of LL-blocks were homologated in July 2013.

Cost-benefit analysis of railway noise reduction measures



UIC 2013

As the graph above shows, solutions that involve composite brake blocks both on their own and combined with other measures can save considerable amounts of money in comparison to noise abatement with only noise barriers.

Railway noise reduction projects

The rail sector has developed various sector funded or EU co-funded research and development projects to understand and mitigate railway noise. Recent significant rail noise projects include:

- **Acoutrain (2011-2014)** www.acoutrain.eu

  Acoutrain is a research programme, which aims at simplifying and improving the acoustic certification process of new rolling stock. The goal of the project is to speed up product authorisation by introducing elements of virtual testing while retaining the same degree of reliability and accuracy.

- **Rivas (2011-2013)** www.rivas-project.eu

  RIVAS (Railway Induced Vibration Abatement Solutions) aimed to reduce the environmental impact of ground-borne vibration and to provide solutions to vibration issues for surface lines. The project developed world-leading technologies to ensure efficient control of exposure to vibration and vibration-induced noise from rail.

External costs

Road's average external costs are more than four times higher than rail for passenger services, and more than six times higher for freight services.

Rail accounts for just 2 % of the total external costs of transport in Europe.

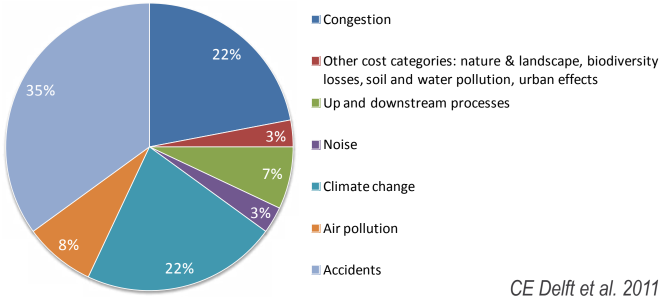
The external costs of transport are the negative effects of transport that are not internalised into the price paid by the user, such as air pollution, accidents and congestion. They cannot be disregarded as they lead to real costs to society, such as climate change, health problems, and delays. If consistent monetary signals are given to users, operators and investors, the most appropriate choices from the point of view of wider society on issues such as the mode of travel, the deployment of new technologies, and the development of infrastructure, will be made.

Various studies have attempted to put values on external costs. The IMPACT report on internalisation of the external costs of transport, carried out for the European Commission in 2007 said: "Although the estimation of external costs has to consider several uncertainties, there is consensus at scientific level that external costs of transport can be measured by best practice approaches and that general figures (within reliable bandwidths) are ready for policy use."

EU transport sector today

In 2008, the total external costs in the EU27 (excluding Malta and Cyprus, but including Norway and Switzerland) were estimated at €510 billion, excluding congestion. When congestion was added in, the costs rose to €660-760 billion, depending on whether low or high congestion values were used. The total represented 4 % of the total GDP of the 27 countries considered if congestion was excluded, or between 5 % and 6 % of GDP if congestion was included.

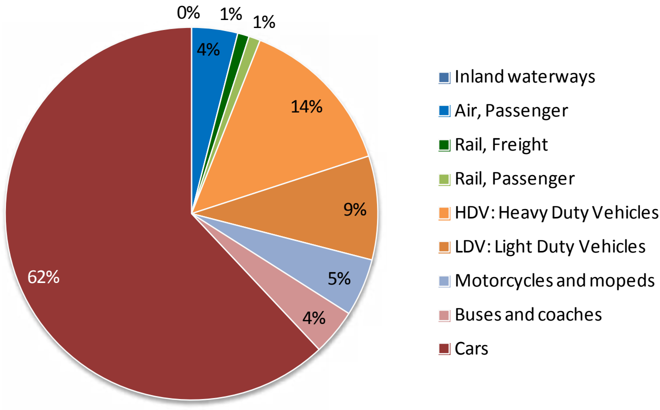
Total external costs of transport by externality



CE Delft et al. 2011

The road sector generates 93 % of total external costs in transport: passenger cars have a share of about 62 %, followed by trucks (14 %), vans (9 %), motorcycles (5 %) and buses (4 %). Rail accounts for just 2 %, the aviation passenger sector (intra-EU flights only) 4 %, and inland waterways a negligible amount (0.3 %).

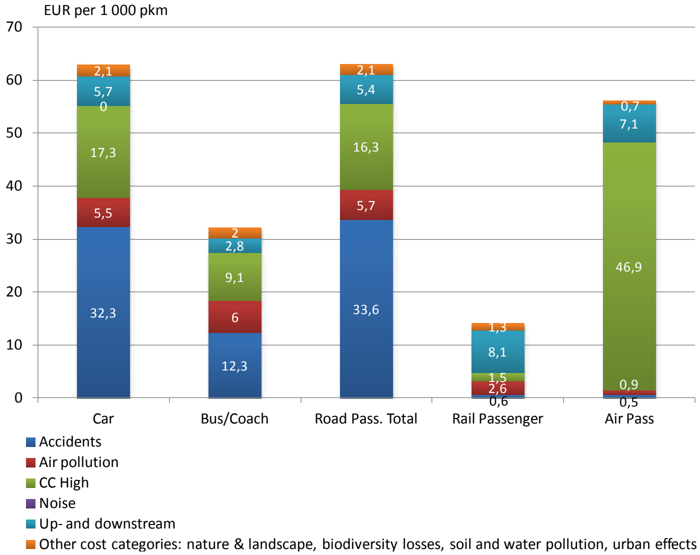
Total external costs by transport mode



CE Delft et al. 2011

The total costs divided by traffic volumes indicate the average costs for each transport mode. This provides an intermodal comparison, showing the costs that could be avoided by shifting from one mode to another.

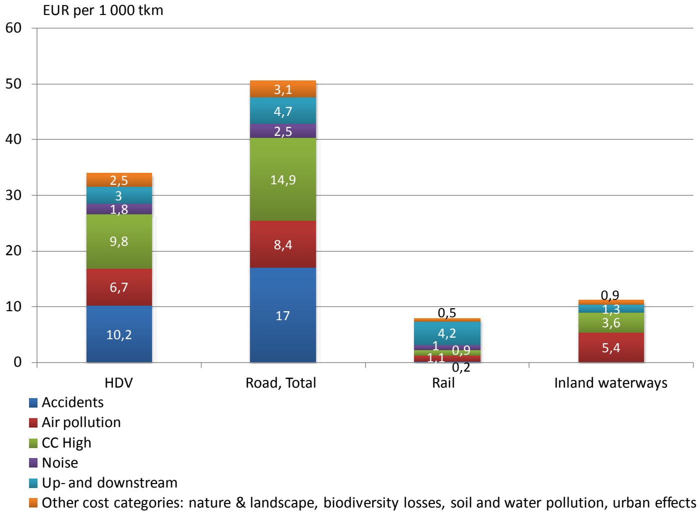
Average EU27 external costs (excluding congestion): passenger transport



CE Delft et al. 2011

Average external costs (excluding congestion) for road transport are more than four times higher than rail for passenger services and more than six times higher for freight services.

Average EU27 external costs (excluding congestion): freight transport



CE Delft et al. 2011

The current level of internalisation of external costs varies across the different modes of transport. **For road freight transport**, charging is restricted under EU law for HGVs (lorries) in particular. The charging of HGVs is regulated by Directive 1999/62/EC (the "Eurovignette" Directive). In the most recent revision of the Eurovignette Directive, completed in 2011, EU member states were finally allowed to set charges for air pollution and noise if they wish.

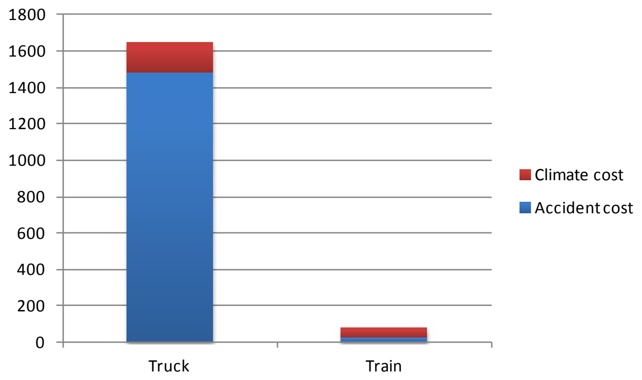
EU transport sector tomorrow

The European Commission has acknowledged that greater internalisation of external costs using market-based instruments would lead to a more efficient use of infrastructure, reduce the negative side effects of transport, and improve fairness between modes. In 2008, the European Commission laid down a common methodology for the charging of all external costs across the whole transport sector. This was developed further in the 2011 Transport White Paper, which emphasised the role that price signals can play. "Transport charges and taxes must be restructured in the direction of wider application of the "polluter-pays" and "user-pays" principle, … the overall burden for the sector should reflect the total costs of transport including infrastructure and external costs," it stated. It added that full cost charging would generate revenues and allow for a funding stream to finance future transport investments. The White Paper envisages the full and mandatory internalisation of external costs for road and rail transport taking place by 2020.

Road-rail comparison

The bar chart below compares the accident and climate costs generated by 100 tonnes of average goods being transported from London to Warsaw by train and by road. The values are calculated using the online External Cost calculator, which calculates the climate change and accident costs of any freight journey across Europe.

Accident and climate costs generated by road and rail freight, London - Madrid



(Calculations assume low IMPACT handbook values for climate costs, and marginal accident IMPACT costs for lorries and average accident IMPACT cost for rail.)

www.externalcost.eu

The average external accident costs for rail for this journey are nearly 50 times lower than for road, while the climate costs are four times lower.

Targets and vision

In 2008 CER adopted voluntary targets for greenhouse gas emissions. These were later developed and expanded in partnership with UIC to include targets to be achieved by 2020 and 2030 in addition to a vision for 2050. In 2010 both UIC and CER formally approved the targets and vision for the four most important environmental impacts associated with the European rail sector. Following a decade of strong performance, in 2015 the sector agreed to a greater level of ambition for reducing green house gas emissions.

The Sustainable Mobility targets are summarized in the table below.

Topic	Baseline	Horizon	Targets and vision
Climate protection	1990	2020	- 40 % CO_2 pkm and tkm*
	1990	2030	- 50 % CO_2 pkm and tkm
	1990	2030	Total CO_2 emissions 30 % below the baseline*
		2050	Carbon Free Operation
Energy efficiency	1990	2030	- 30 % consumption pkm and tkm
	1990	2050	- 50 % consumption pkm and tkm
Air quality	2005	2030	- 40 % total PM and NO_x
		2050	Zero Emission
Noise and vibration		2050	No longer a problem for the railways

* targets updated in 2015

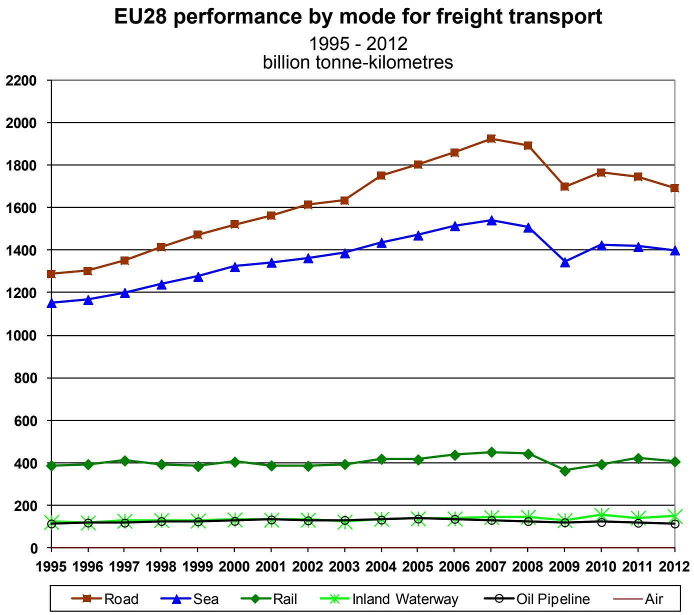
The rail sector vision for 2050

- Rail is at the heart of an integrated, attractive transport system in which each mode plays to its strengths, enabling a more competitive European economy
- Rail is central to delivery of a strategy that has resulted in a massive cut in Greenhouse Gas (GHG) emissions, reduced oil dependency and mitigated the challenge of congestion
- Rail is the enabling factor for sustainable mobility that underpins economic growth and a dynamic society

European transport: core statistics

9

Freight transport



EC 2014a

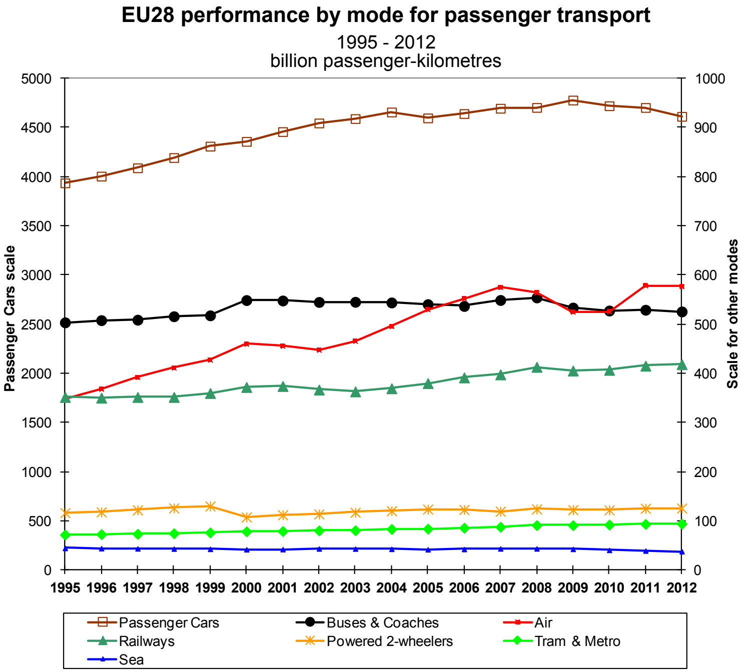
Freight transport in the EU28 experienced an overall growth of 22.8 % in the 1995-2012 period. Road, sea, and air transport saw the biggest growth levels, with the rail sector experiencing a relatively modest growth of 4.9 %. The peak year for most modes was in 2007, after which freight levels fell back by around 10 % on average due to the Europe-wide recession. While there have been some improvements since 2009, the sector as a whole has struggled to return to previous levels of growth.

Freight Transport in EU28
billion tonne-kilometres

	Road	Rail	Inland Water- ways	Pipe- lines	Sea	Air	Total
1995	1289	388	122	115	1154	2	3069
2000	1522	405	134	127	1323	2	3513
2005	1803	416	139	138	1471	3	3969
2010	1764	394	156	122	1424	3	3862
2011	1745	422	142	118	1417	3	3847
2012	1693	407	150	115	1401	3	3768
1995 - 2012	31.3 %	4.9 %	22.8 %	- 0.1 %	21.4 %	25.8 %	22.8 %
per year	1.6 %	0.3 %	1.2 %	- 0.0 %	1.1 %	1.4 %	1.2 %

EC 2014a

Passenger transport



EC 2014a

Passenger activity grew slightly slower than freight, at 19 % over the 1995-2012 period, but it weathered the 2007-09 financial downturn much better. The aviation sector experienced the biggest growth, helped by the lack of fuel tax or VAT on ticket sales, although it was also the only sector to experience a significant drop in traffic in the two years following the financial crisis of 2007. The rail sector saw an overall growth of 19 % during 1995-2012 while tram and metro systems saw a growth of nearly 31 %.

Passenger Transport in EU28
billion passenger-kilometres

	Passenger cars	Two-wheel engine	Bus & Coach	Railway	Tram & Metro	Air	Sea	Total
1995	3 937	116	504	352	72	348	44	5 372
2000	4 358	108	549	372	78	460	42	5 966
2005	4 597	124	541	380	84	530	42	6 297
2010	4 721	122	528	407	92	526	40	6 435
2011	4 703	125	529	415	93	579	39	6 484
2012	4 613	126	526	418	94	577	38	6 391
1995 -2012	17.2 %	8.1 %	4.4 %	19.0 %	30.9 %	65.8 %	- 15.1 %	19.0 %
per year	0.9 %	0.5 %	0.3 %	1.0 %	1.6 %	3.0 %	- 1.0 %	1.0 %

EC 2014a

Railway track length in use by country

The reduction in the length of railway lines within Europe over the last four decades - railway lines in the EU28 have shrunken by 13 % since 1970 - is clearly shown in this table. The increases in passenger-km and tonne-km that have occurred over the last 20 years are a sign of the increased efficiency of the European railways, as they have taken place despite a shrinking infrastructure.

	1970	1980	1990	2000	2010	2012	of which electri-fied 2012	%
EU28	248,269	240,629	237,671	220,583	215,519	*215,734*	*115,508*	*54*
EU15	175,274	168,150	162,132	152,446	151,559	*151,981*	*86,957*	*57*
BE	4,605	3,971	3,479	3,471	3,582	3,582	3,064	86
BG	4,196	4,341	4,299	4,320	4,097	4,070	2,862	70
CZ				9,444	9,468	9,469	3,217	34
DK	2,352	2,015	2,838	2,787	2,646	2,628	621	24
DE	43,777	42,765	40,981	36,588	33,707	33,509	19,830	59
EE	1,227	993	1,026	968	787	792	132	17
IE	2,189	1,987	1,944	1,919	1,919	1,919	52	3
EL	2,602	2,461	2,484	2,385	2,552	2,554	438	17
ES	15,850	15,724	14,539	14,347	15,837	15,922	9,654	61
FR	37,582	34,362	34,070	29,272	29,871	30,581	16,583	54
HR	2,411	2,437	2,429	2,726	2,722	2,722	984	36
IT	16,073	16,138	16,066	16,187	17,022	17,060	12,126	71
CY	-	-	-	-	-	-	-	-
LV	2,606	2,384	2,397	2,331	1,897	1,860	250	13
LT	2,015	2,008	2,007	1,905	1,767	1,767	122	7
LU	271	270	271	274	275	275	262	95
HU	8,487	7,836	7,838	8,005	7,893	7,877	3,014	38
MT	-	-	-	-	-	-	-	-
NL	3,147	2,880	2,798	2,802	3,013	3,013	2,266	75
AT	5,901	5,857	5,624	5,665	5,039	4,894	3,468	71
PL	26,678	27,181	26,228	22,560	19,702	19,617	11,860	60
PT	3,588	3,609	3,064	2,814	2,842	2,541	1,630	64
RO	11,012	11,110	11,348	11,015	10,777	10,777	4,032	37
SI	1,055	1,058	1,196	1,201	1,228	1,209	500	41
SK			3,660	3,662	3,622	3,593	1,578	44
FI	5,804	6,075	5,867	5,854	5,919	5,944	3,172	53
SE	12,203	12,006	11,193	11,037	11,160	11,136	8,194	74
UK	19,330	18,030	16,914	17,044	16,175	16,423	5,597	34
ME					249	239	214	90
MK		673	696	699	699	699	234	33
RS					3,809	3,809	1,279	34
TR	7,985	8,387	8,429	8,671	9,594	9,642	2,840	29
IS	-	-	-	-	-	-	-	-
NO	4,242	4,242	4,044	4,413	4,199	4,264	2,489	58
CH	3,161	3,178	3,215	3,216	3,597	3,551	3,550	100

UIC data; EC 2014a. Figures in italics are estimates

High-speed rail network

High-speed lines continue to be built across Europe as they are popular with passengers and politicians alike, and offer a credible alternative to flying. If the EU successfully decarbonises electricity generation by 2050 as is planned, the rail sector will be able to offer carbon-free train operation and provide society with a fast, climate-neutral transport option.

Length of lines (km) or sections of lines on which trains can go faster than 250 km/h at some point during the journey

	Belgium	Germany	Spain	France	Italy	Nether-lands	Austria	United King-dom	EU
1981				301	150				451
1983				417	150				567
1984				417	224				641
1985				419	224				643
1986				419	224				643
1987				419	224				643
1988		90		419	224				733
1989		90		710	224				1,024
1990		90		710	224				1,024
1991		199		710	224				1,133
1992		199	471	710	248				1,628
1993		199	471	831	248				1,749
1994		447	471	1,177	248				2,343
1995		447	471	1,281	248				2,447
1996		447	471	1,281	248				2,447
1997		447	471	1,281	248				2,447
1998	72	636	471	1,281	248				2,708
1999	72	636	471	1,281	248				2,708
2000	72	636	471	1,281	248				2,708
2001	72	636	471	1,540	248				2,967
2002	137	833	471	1,540	248				3,229
2003	137	875	1,069	1,540	248			74	3,943
2004	137	1,196	1,069	1,540	248			74	4,264
2005	137	1,196	1,090	1,540	248			74	4,285
2006	137	1,285	1,272	1,540	876			74	5,184
2007	137	1,285	1,511	1,872	562			113	5,480
2008	137	1,285	1,599	1,872	744			113	5,750
2009	209	1,285	1,604	1,872	923	120		113	6,126
2010	209	1,285	2,056	1,896	923	120		113	6,602
2011	209	1,285	2,144	2,036	923	120		113	6,830
2012	209	1,334	2,144	2,036	923	120		113	6,879
2013	209	1,334	2,515	2,036	923	120	93	113	7,343

UIC high speed department; EC 2014a

Rail passenger usage by country

Country	Rail Operator	Passenger-km (millions)	Year
EU			
Austria	ÖBB	10,667	2014
	WB	789	2014
Belgium	SNCB/NMBS	10,848	2014
Bulgaria	BDZ	1,702	2014
Croatia	HZ Passenger	927	2014
Czech Rep.	CD	6,952	2014
Denmark	DSB	5,765	2014
Estonia	EVR	237	2012
Finland	VR	3,874	2014
France	SNCF	83,914	2014
Germany	DB AG	79,340	2014
Greece	TRAINOSE	1,413	2014
Hungary	GvSEV/RÖEE	298	2014
	MAV	5,491	2014
Ireland	CIE	1,695	2014
Italy	FS	38,612	2014
Latvia	LDZ	71	2014
Lithuania	LG	372	2014
Luxembourg	CFL	373	2012
Netherlands	NS	17,018	2014
Poland	PKP	11,865	2014
Portugal	CP	3,518	2014
Romania	CFR Calatori	4,526	2014
Slovakia	ZSSK	2,503	2014
Slovenia	SZ	696	2014
Spain	Euskotren	279	2011
	FEVE	183	2011
	FGC	804	2012
	RENFE	23,753	2014

Sweden	SJ	6,132	2014
United Kingdom	ATOC	59,170	2013
	Eurostar	4,364	2011
	NIR	321	2011

EFTA			
Norway	NSB	2,965	2014
Switzerland	BLS	920	2014
	SBB/CFF/FFS	17,570	2014

CEEC			
Bosnia-Herzegovina	ZFBH	22	2014
	ZRS	12	2014
FYR of Macedonia	MZ-T	99	2012
Montenegro	ZICG	101	2008
Serbia	ZS	617	2014

CIS			
Belarus	BC	7,796	2014
Moldova	CFM	347	2012
Russian Fed.	RZD	128,820	2014
Ukraine	UZ	49,203	2012

Turkey	TCDD	4,393	2012

Note: figures given are for the companies listed only, and will not necessarily cover all operators in each country.

UIC database

Rail freight usage by country

Country	Rail Operator	Tonne-km (millions)	Year
EU			
Austria	ÖBB	15,653	2014
	GKB	9	2011
Belgium	SNCB/NMBS	5,439	2012
Bulgaria	BDZ	1,778	2014
	BRC	794	2014
Croatia	HZ CARGO	2,119	2014
Czech Rep.	CD	9,871	2014
Estonia	EVR	4,807	2012
Finland	VR	9,597	2014
France	SNCF	32,012	2014
Germany	DB AG	74,818	2014
Greece	OSE	538	2009
Hungary	FLOYD	243	2011
	GySEV CARGO	433	2014
	GySEV/RÖEE	692	2012
Ireland	CIE	100	2014
Italy	FS	10,322	2014
Latvia	LDZ	15,257	2014
Lithuania	LG	14,307	2014
Luxembourg	CFL Cargo	189	2009
Poland	PKP	32,017	2014
Portugal	CP Carga	2,063	2014
Romania	CFR MARFA	5,327	2014
	CTV	632	2014
	GFR	3,548	20142
	TFG	319	2009
Slovakia	ZSSK Cargo	6,888	2014
Slovenia	SZ	3,847	2014

Spain	Euskotren	14	2011
	FEVE	388	2011
	FGC	46	2014
	RENFE	7,557	2014
EFTA			
Switzerland	BLS Cargo	1,035	2013
	SBB/CFF/FFS	8,266	2014
CEEC			
Bosnia-Herzegovina	ZFBH	885	2014
	ZRS	425	2014
FYR of Macedonia	MZ-T	423	2012
Montenegro	MONTECARGO	150	2010
Serbia	ZS	2,589	2014
CIS			
Belarus	BC	44,997	2014
Moldova	CFM	944	2012
Russian Fed.	RZD	2,298,564	2014
Ukraine	UZ	237,722	2012
Turkey	TCDD	11,145	2014

Note: figures given are for the companies listed only, and will not necessarily cover all operators in each country.

UIC database

Glossary

Term	Explanation
Bunker (fuel)	Fuel that powers the engine of a ship or aircraft
CO_2 (carbon dioxide)	A greenhouse gas, and by-product of any carbon combustion process (mostly involving fossil fuels) also exhaled by every living organism
Direct emissions	Emissions related directly to the on-board combustion of diesel or use of electricity
Electrified track	Track provided with an overhead catenary or a third rail to permit electric traction
EU15	Members of the European Union as of the 1995 expansion (inclusion of Austria, Sweden and Finland)
EU27	Members of the European Union as of the 2007 expansion (inclusion of Romania and Bulgaria)
EU28	Members of the European Union as of the 2013 expansion (inclusion of Croatia)
Euro IV, V	Emission standards for exhaust emissions from heavy duty vehicles sold in EU member states
Final energy demand	The energy (diesel or electricity) to be directly consumed by motive power units: the final energy consumption can be measured in terms of the volume of diesel consumed or electricity consumed at the pantograph
GHG (greenhouse gases)	Atmospheric gases that have a global warming potential. The Kyoto Protocol specifies six greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydro-fluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF6)
HGVs	Heavy Goods Vehicles (lorries)
High-speed rail	Generally assumed to be trains that travel above 250 km/h on new lines and above 200 km/h on upgraded lines
Indirect emissions	Emissions related to the initial energy provision (diesel production or electricity generation)
IPCC	Intergovernmental Panel on Climate Change, the United Nations' scientific advisory panel on climate change (www.ipcc.ch)
K-blocks	Low-noise composite brake blocks fitted to all new freight wagons
Kyoto Protocol	A 1997 international agreement linked to the United Nations Framework Convention on Climate Change, which sets internationally binding reduction targets to reduce greenhouse gas emissions

Term	Explanation
Land take	Area of land needed for a certain activity, e.g. railway tracks or stations, highways, cities, etc.
Lden	A weighted average noise level over 24 hours that marks the threshold for excess exposure
Lnight	A weighted average night-time noise level as defined in the Environment Noise Directive (2002/49/EC), and calculated over all the night periods of a year, typically 22:00 - 06:00
LL-blocks	Low-noise composite brake blocks that can be retrofitted onto existing rail freight wagons
NO_x (nitrogen oxides)	Generic term covering NO (nitric oxide) and NO2 (nitrogen dioxide), produced from the reaction of nitrogen and oxygen in the air during fuel combustion
Passenger-km (pkm)	Passenger-kilometres: 1 pkm = 1 passenger transported 1 kilometre
PM_{10}, $PM_{2.5}$	Particulate Matter – microscopic airborne particles, up to 10 and 2.5 microns in diameter respectively
Rolling stock	Collective term for all powered and unpowered vehicles on a railway, including freight wagons, locomotives, passenger coaches, and multiple units
Specific emissions, specific consumption	The average emission or consumption rate, expressed in the rail sector per passenger-km or tonne-km
Tonne-km (tkm)	Tonne-kilometres: 1 tkm = 1 tonne transported 1 kilometre
Train-km	Train-kilometre: unit of measurement representing the movement of a train over one kilometer
TSI (Technical Specification for Interoperability)	Technical and operational standards that must be met in order to satisfy the essential requirements and ensure the interoperability of the European railway system
VOCs (Volatile Organic Compounds)	Chemicals used in many products that can evaporate into the air at room temperature
WTW (well-to-wheel)	The full life-cycle analysis of transport fuels and vehicles from extraction to final use

References

Identifier	Details
ADB/giz 2011	Changing course in urban transport, Asian Development Bank / Deutsche Gesellchaft fűr Internationale Zusammenarbeit, 2011
UIC 2011	External costs of transport in Europe, CE Delft, INFRAS, Fraunhofer ISI, 2011
CER/UIC 2011	Potential of modal shift to rail transport, CE Delft/ TRT 2011
CER/UIC 2012	Moving Towards Sustainable Mobility: A strategy for 2030 and beyond for the European Railway Sector (Summary), CER/UIC 2012
EC 2011a	A Roadmap for moving to a competitive low carbon economy in 2050, European Commission 2011
EC 2013	EU Energy, Transport and GHG emissions trends to 2050, European Commission 2013
EC 2014a	EU transport in figures: EU statistical pocketbook, European Commission 2014
EC 2014b	EU energy in figures: EU statistical pocketbook, European Commission 2014
EEA 2007	Noise Observation and Information Service for Europe, European Environment Agency 2007
EEA 2012	TERM 2012: The contribution of transport to air quality, European Environment Agency 2012
EEA 2013a	TERM 2013: Transport indicators tracking progress towards environmental targets in Europe, European Environment Agency 2013
EEA 2013b	Energy efficiency and specific CO_2 emissions (TERM 027) - Assessment, European Environment Agency 2013
UIC 2010	The railway noise bonus, UIC 2010
UIC 2011	High Speed Rail and Sustainability, UIC 2011
UIC 2012	Study on non-traction energy consumption and related CO_2 emissions from the European railway sector, UIC 2012
UIC 2013	The real cost of railway noise mitigation, UIC 2013
UIC/IEA 2013	Railway Handbook 2013: Energy Consumption and CO_2 Emissions, UIC / International Energy Agency 2013
UIC/IEA 2014	Railway Handbook 2014: Energy Consumption and CO_2 Emissions, UIC / International Energy Agency 2014

ETF
Editions Techniques Ferroviaires
Railway Technical Publications
Eisenbahntechnische Publikationen

16 rue Jean Rey - F 75015 PARIS
www.uic.org/etf

Published by:
UIC - ETF (Railway Technical Publications)
16, rue Jean Rey 75015 Paris - France

Coordination: Andrea Braschi, UIC - Ethem Pekin, CER
Content: Matthew Ledbury
Design: Coralie Filippini, UIC-ETF

Photo credit: Fotolia

Dépôt légal September 2015

ISBN 978-2-7461-2400-4

UIC
16 rue Jean Rey | 75015 Paris
Tel : +33 (0) 1 44 49 20 20
Fax : +33 (0) 1 44 49 20 29
www.uic.org

CER
53 Avenue des Arts | 1000 Brussels
Tel : +32 (0)2 213 08 70
Fax : +32 (0)2 512 52 31
www.cer.be