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Focusing on environmental pressures from long-distance transport

TERM 2014: transport indicators tracking progress towards environmental targets in Europe

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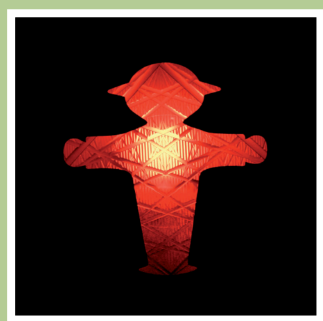

European Environment Agency

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Executive summary

The European Environment Agency's (EEA's) annual Transport and Environment Reporting Mechanism (TERM) report presents an overview of transport demand and pressures from the sector on the environment, as well as selected related impacts and policy responses. The report makes use of the latest available data in order to assess key trends and overall progress in meeting policy targets.

The 2014 TERM report includes two sections:

- Part A provides an assessment of the progress made in the environmental performance of the transport system as a whole. This section uses a core set of 12 TERM indicators; these indicators have been selected based on their links to key transitional processes in transport, their association with ongoing European policy targets, and data availability and reliability.
- Part B of the report presents a dedicated assessment of the impact of long-distance transport activities on the environment. This complements last year's TERM report (EEA, 2013a), in which the importance of health and environmental impacts of urban transport were assessed.

Policy context

Specific short and long-term targets have been designed by European policymakers to reduce the impacts of the transport sector on health and the environment, and to encourage a move towards greater sustainability in the sector consistent with the objectives of the European Union's (EU) Seventh Environment Action Programme (7EAP).

The *Roadmap to a Single European Transport Area: Towards a competitive and resource efficient transport system* (EC, 2011a) (referred to as the 2011 Transport White Paper) sets out a strategy for a longer term transition towards a low-carbon transport system. It envisions a 60 % cut in transport emissions by 2050, as compared to 1990. A substantial modal shift from road to rail and waterborne transport, of at least 50 % for medium-distance freight journeys, is necessary to achieve that goal, providing that the modes receiving demand operate under efficient circumstances. In addition, it is foreseen that the majority of medium-distance intercity passenger journeys should take place by rail by 2050. The 2011 Transport White Paper contains a number of non-binding targets associated with the longer term development of the sector, which it is expected will form the basis for regulatory developments and monitoring over the next decade.

Complementing such longer-term objectives, existing legislation has established a number of targets and requirements that must be met in the shorter term. This includes, for example, various regulations and directives addressing vehicle emission standards, carbon dioxide (CO_2) emissions from passenger cars and vans and the share of renewable energy in transport.

Part A: monitoring progress towards transport and environmental goals

An assessment of progress based upon the TERM indicators shows that the environmental performance of transport is improving. Various factors will have contributed to the improvements seen in recent years, including the on-going effects of legislation, changes in consumer behaviour and preferences, and the impacts of the economic recession. Future in-depth analyses are needed to explain the relative importance of the different explanatory factors in terms of the trends observed in key indicators. An overview of key trends and overall progress in meeting key environmental objectives associated with the transport sector is provided in Chapter 2 of this report. In general, progress is consistent with the respective target paths, except for the share of renewable energy in the transport sector. Progress in key areas is summarised below.

- Transport demand is an important issue addressed in each annual TERM report, as growing transport demand can negate many of the benefits of technology development designed to reduce the health and environmental impacts associated with transport. Over recent years transport demand growth has slowed down, and even decreased, for some modes. After a small increase (0.7 %) between 2010 and 2011 fuelled mainly by air transport, passenger transport demand decreased in 2012 (– 1.5 %), mainly due to the drop in car passenger travel. Following the trends in the road and maritime modes, EU-28 freight transport volumes also fell in 2012, by 2.1 %. As the gross domestic product (GDP) decreased by 0.4 % in 2012, this would suggest that for both passenger and freight transport, the intensity of transport in the economy is decreasing, and that some steady decoupling is taking place. Energy efficiency improvements, and to a lesser extent, increased use of less carbon-intensive fuels, have led to the better results. There are also signs of some changes in the travel behaviour and demand patterns for some social and economic areas. Whether this overall improvement is only temporary or will continue, even in periods of economic growth, remains a topic for further research and discussion.

- Transport greenhouse gas (GHG) emissions decreased again in 2012, coupled with a shrinking road transport demand. Nevertheless, GHG emissions remain 20.5 % above 1990 levels and would need to fall by 67 % by 2050 relative to 2012 in order to meet the 2011 Transport White Paper target. Maritime emissions fell sharply in 2012, but remain very much higher than the 2050 target (emissions will need to fall by 31.4 % by 2050 in order to meet the reduction target). The rate of reduction in oil consumption has increased slightly in the last two years, reaching − 4.3 % in 2012. It is now compliant with the linear target line to the 2050 goal of a 70 % reduction compared to 2008.

- For CO_2 emissions of new passenger cars, regulations are proving effective, with the 2015 target of 130 g/km already being achieved in 2013. Manufacturers similarly appear well placed to meet the 2020 to 2021 target of 95 g/km that was established by new legislation approved in February 2014. However, concerns remain regarding how to translate this laboratory-based monitoring into more significant on-road emission reductions. By 2015, the European Commission (EC) is expected to report on the possibility of setting a realistic and achievable target for 2025; it is also planning to implement a new test-cycle, the World Harmonised Light Duty Test Procedure (WLTP), by 2017. As for cars, the new vans fleet has already met its respective 175 g CO_2/km target for 2017, four years early. This success notwithstanding, significant progress will have to be made in order to achieve the target of 147 g CO_2/km by 2020.

- After the slight decrease in air pollutant emissions in 2011 (due mainly to an increase in international aviation emissions, which offset decreases in other modes), a clearer downward path was regained in 2012, influenced by reduced demand in transport activity and the progressive expansion of stricter Euro emission standards within road vehicle fleets. Aviation is the only subsector where air pollutant emissions (ammonia (NH_3) and sulphur oxides (SO_X)) increased in the last year of available data. Decreases were more significant in those pollutants that have traditionally been more difficult to reduce, such as fine particulate matter ($PM_{2.5}$) and nitrogen oxides (NO_X). Air quality levels in cities still pose a fundamental challenge for public health, particularly for the nitrogen dioxide (NO_2) annual limit value. The ever-increasing share of diesel vehicles in European cities remains the main cause of high NO_2 and particulate concentration in urban areas. Discriminatory fuel tax policies favouring diesel over gasoline in most European countries are at the root of the technological and market developments behind this trend.

- The average EU-28 share of renewable energy used in transport increased between 2011 and 2012, from 3.4 % to 5.1 %, including only those biofuels which fully meet the sustainability criteria. The use of electricity in road transport is still very low compared to the amount of biofuels consumed in transport: only 67 kilotonnes per oil equivalent (ktoe) in 2012 compared to 14 610 ktoe for biofuels in 2012; the positive aspect is that about 20 % of this corresponds to renewable electricity. Renewable electricity in other modes of transport remained more or less stable, showing only a marginal decrease.

- The number of alternative fuel car registrations in 2013 increased slightly, compared to the previous year. Taken together, battery electric and plug-in hybrid vehicles account for 0.5 % of the total new registrations in the EU-27. Many EU Member States already offer financial incentives such as tax reductions and exemptions for electrically chargeable vehicles, although these incentives are in some cases offset by scrappage schemes also offering benefits to conventional internal combustion engine (ICE) vehicles.

Part B: environmental pressures from long-distance transport

Long-distance transport is responsible for a relatively small proportion of the total number of journeys by shippers and passengers in Europe, but nevertheless these trips account for a significant proportion of the sector's overall environmental impacts. For example, freight and passenger long-distance transport demand together account for up to three-quarters of GHG transport emissions. International aviation and maritime transport alone are responsible for 19 % of Europe's NO_X emissions, 17 % of overall SO_X emissions and 11 % of $PM_{2.5}$ emissions.

Transport has however traditionally been considered a key instrument for European integration, and demand growth has been associated with the development of the single internal market and with increasing transboundary interaction among Europeans. Transport data suggest that a peak in this trend has been achieved during the last decade; further long-distance transport growth would rely mainly on extra-EU travel. To achieve Europe's long-term sustainability objectives in the transport sector, reducing the future impacts of long-distance travel will therefore be important.

There is still, however, a significant need for better information to allow an improved monitoring of the life-cycle environmental impacts of long-distance transport:

- Firstly, there is still a need for comprehensive assessment of GHG emissions, including the life cycles for infrastructure (from construction to maintenance and renewal), vehicles (from manufacturing to end-of-life disposal) and fuel (including extraction, processing and distribution), and also covering maritime and aviation emissions; this is complicated by data limitations such as international differences in the definitions of fuel categories.

- Secondly, there is a need to differentiate between GHG emissions of passengers and freight by transport mode.

- Thirdly, GHG emissions and other environmental impacts should be more clearly related to door-to-door trips, taking into account the actual transport modes and routes chosen within the travel chain, and the environmental footprint of activities associated with transport within the trip.

Understanding long-distance transport demand

The transport modes responsible for the most long-distance passenger transport demand (mainly cars for medium-range trips, and aviation for long-distance trips) appear to have peaked recently, aviation recorded its highest demand in 2011 and car travel demand remaining below its 2009 peak. Passenger rail is growing, although this increase is limited to the reduced number of corridors where high-speed rail is available. In spite of technical developments and attempts to raise occupancy rates, average specific emissions per passenger and kilometre across all modes have not significantly decreased in recent years.

Whereas long-distance passenger demand growth, especially for air travel, can be linked to higher household disposable income particularly in the new EU Member States, past passenger demand growth in many EU-15 Member States has been associated with migration patterns as the key component of past population growth. Induced demand is likely to be another influential component, as a consequence of falling prices due to the yield management strategies of a growing number of long-distance transport operators and certain types of unequal treatment (i.e. fuel tax exemption for air transport). Accordingly, the expectations for future significant growth of long-distance passenger transport demand, common over the past decade, are currently being revised, as the trends for these key drivers now appear more uncertain. Furthermore, shifts away from traditional rates of high car-ownership seem more likely in a part of the population, particularly the younger generation. Such developments in lifestyle patterns are being closely followed by researchers.

Three-quarters of total freight transport (tonne-kilometres (tkm)) in the EU-28 is associated with distances greater than 300 km. Total long-distance freight transport volumes decreased between 2005 and 2010, albeit with large fluctuations in-between. Modal shares have remained largely constant over the last decade, with shipping dominating long distances, accounting for 53 % of total freight transport volumes. Road and rail follow, with 37 % and 10 % respectively.

Options for reducing the health and environmental impacts of long-distance transport

Measures for improving the environmental performance of long-distance transport can be classified into three groups, although in practice, the distinction between the three approaches may not always be clear-cut:

1. 'avoid' measures aim to reduce transport trips or distances;

2. 'shift' measures enable and encourage transfer from road and aviation to more environmentally friendly modes; and

3. 'improve' measures aim to bring down energy consumption and emissions of all travel modes by introducing more efficient technologies and cleaner fuels.

In terms of 'avoid' measures, long-distance passenger travel is undertaken for both business and leisure purposes. Particularly in the case of business purposes, companies and workers may have a shared interest in limiting their trips and making more extensive use of information and communications technology (ICT) as a way to reduce costs and increase productivity. For freight transport, the development of improved logistics is viewed as an opportunity to reduce travel demand by improving the load factor of vehicles, and by making use of the appropriate mode at each link of the transport chain. Further cooperation among hauliers and shippers could lead to better information flows on available loads and means of transport. However, collaboration may give rise to difficult legal issues such as potential infringements of anti-trust legislation. One solution may lie in offering support to independent intermediaries, but progress in this direction has also proven to be difficult in the past.

For more than a decade, 'shift' measures in the EU have focused on confronting all transport modes with their full costs, including the costs of 'negative externalities' they cause (e.g. congestion, air pollution, GHG emissions). Policies have subsequently been developed such as charging road transport users for the use of the infrastructure, and revising fuel taxes to include a CO_2 component. In addition, a wide range of policy measures have been taken to improve the attractiveness of non-road modes, including financial support mechanisms and attempts to remove administrative and technical barriers. The Heavy Vehicle Fee, which has been implemented in Switzerland since 2001, is a successful example of road charging.

'Improve' measures in the EU typically refer to policies which establish technical standards and limit values e.g. limits on noise levels, emission limits for air pollutants for road vehicles, inland vessels and diesel locomotives and railcars; and CO_2 emission limits for road vehicles. In the international maritime and aviation sectors regulations are developed at the global level, and progress in establishing binding reduction targets has been slow. However, for the maritime sector, a first success was recorded through the 2011 agreement by the International Maritime Organization (IMO) on an Energy Efficiency Design Index (EEDI) for new ships. For aviation, some progress was achieved in 2013 when the International Civil Aviation Organization (ICAO) committed to designing a global CO_2 emissions offsetting scheme that could be implemented from 2020. The concrete emission savings that such schemes will deliver however remain unclear.

1 Introduction

Transport is a favourable area for assessing the transitional processes towards sustainability. The European Environment Agency (EEA) has been monitoring progress in integrating environmental objectives in transport since 1998, and has been providing this information to EEA member countries, the European Union (EU) and the public. The Transport and Environment Reporting Mechanism (TERM) includes 40 indicators used for tracking the environmental performance of the transport sector and measuring progress in meeting key transport-related policy targets.

The annual TERM report includes two sections. Part A provides an assessment of the progress made in the environmental performance of the transport system as a whole. This section makes use of a core set of 12 of the 40 TERM indicators (known as the core set of indicators, or TERM CSI); these indicators have been selected based on their links to key transitional processes in transport, their association with ongoing European policy targets, and data availability and reliability. Part B is dedicated to the analysis of the impact of long-distance transport activities on the environment.

1.1. Part A: monitoring progress towards transport and environmental goals

Transport-relevant European policy targets are identified in Annex 2.

Targets are set out in:

- the 2011 Transport White Paper (EC, 2011a) and its impact assessment (Accompanying document to the White Paper Roadmap to a Single European Transport Area — Towards a competitive and resource efficient transport system) (EC, 2011b);
- the Renewable Energy Directive (RED) (i.e. Directive 2009/28/EC on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC) (EU, 2009a);
- the Fuel Quality Directive (i.e. Directive 2009/30/EC amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC (EU, 2009b), currently under revision (Proposal for a Directive amending Directive 98/70/EC relating to the quality of petrol and diesel fuels and amending Directive 2009/28/EC on the promotion of the use of energy from renewable sources) (EC, 2012a);
- and the regulations on CO_2 emissions from cars and vans (i.e. Regulation (EC) No 443/2009 of the European Parliament and of the Council of 23 April 2009 setting emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO_2 emissions from light-duty vehicle; and Regulation (EU) No 510/2011 of the European Parliament and of the Council of 11 May 2011 setting emission performance standards for new light commercial vehicles as part of the Union's integrated approach to reduce CO_2 emissions from light-duty vehicles (EU, 2009c and 2011a).

Chapter 2 provides an assessment of the progress made in the environmental performance of the transport system as a whole. The information provided by the relevant TERM CSI is presented in boxes and includes a description of the relevant targets and an assessment of the key trends identified through the indicators. The boxes include a visual summary of each indicator's trends and the various targets.

Chapter 3 contains an assessment of general demand and modal split trends as drivers of the environment performance of transport. This is based on an analysis of the intensity of freight and passenger transport in the economy (passenger-kilometres (pkm) or tonne-kilometres (tkm) per unit of GDP); positive decoupling is defined as a decrease of transport intensity compared to the previous year. Modal split is another indicator analysed in this chapter: under EU policy, it is expected that the environmental performance of the transport sector will improve by reducing the share of road and air transport modes.

1.2 Part B: environmental pressures from long-distance transport

The annual TERM report is expected each year to provide an in-depth analysis of one particular dimension of transport, relevant to the environment. For 2014, Part B of the report is dedicated to long-distance transport. Despite forming a small part of total trips, long-distance transport accounts for some three-quarters of total GHG emissions from transport, and has traditionally been considered to be crucial for Europe's economic vitality. European policy goals aim mainly at favouring a shift from road transport to rail for medium-distance passenger transport, and to rail and waterborne transport for distances exceeding 300 km.

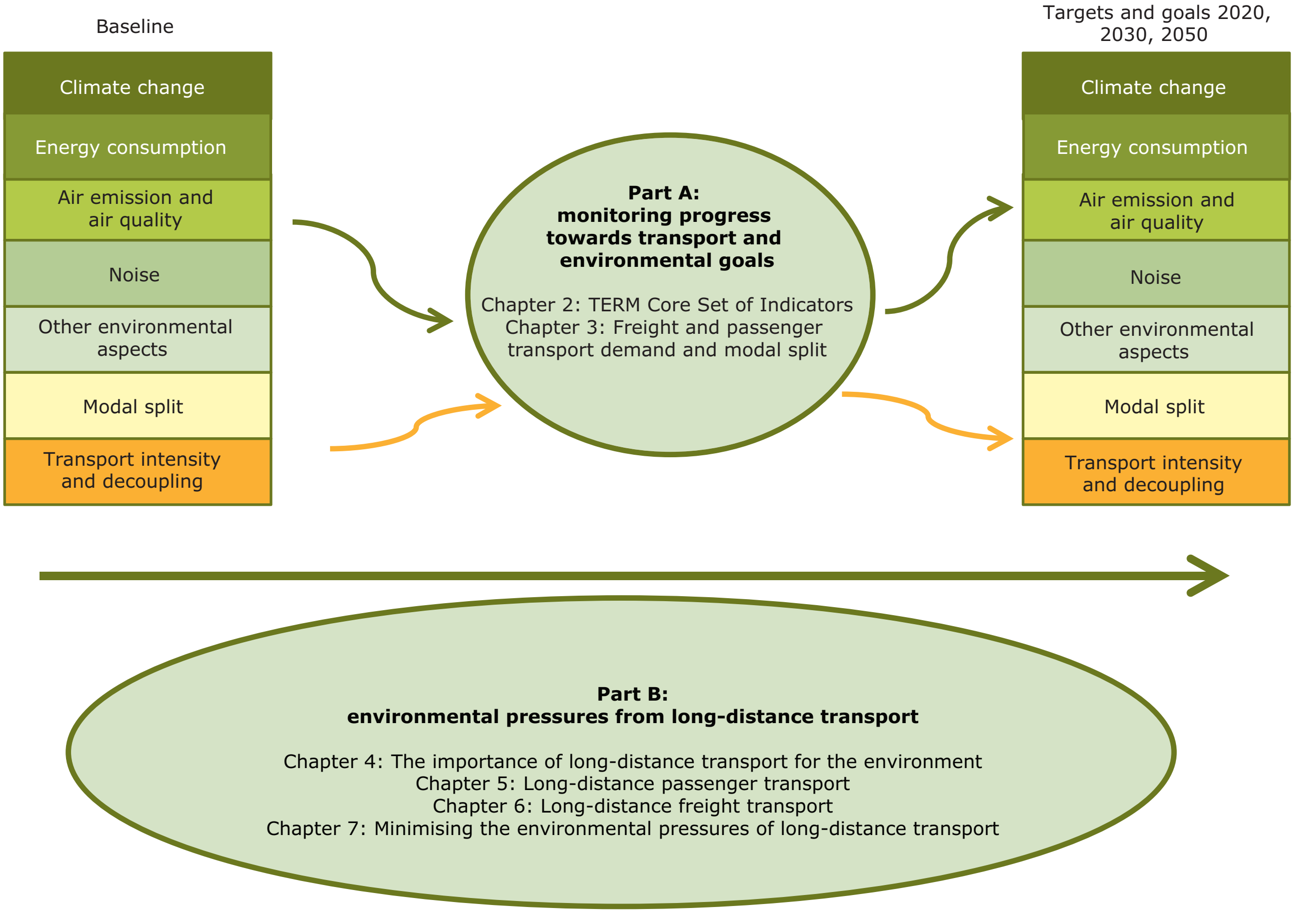
Chapter 4 provides an overview of the relationships between long-distance transport and the environment at local, regional and global levels. Long-distance transport demand and modal choice are influenced by a number of social and economic features, which are analysed in Chapters 5 and 6. Chapter 7 provides a summary of the policy options available for reducing the environmental impact of long-distance transport activities.

1.3 Scope of the report

The report covers all 33 EEA member countries, wherever information is available. All data sources and technical details for figures and boxes can be found in Annex 1.

The different country groupings are also described (see Box 1.1). For some indicators, EU-28 data have been prioritised, as policy targets and goals are specifically developed for these countries, but a brief assessment based on the available EEA data has been included as far as possible.

Figure 1.1 Conceptual map for the TERM approach: TERM 2014 structure



When Croatia joined the EU in July 2013, it also became the 33rd member country of the EEA. Where it has not been possible to include data from Croatia in this year's TERM report, this has been indicated. Data for the EU-28 excluding Croatia are referred to as EU-27 data.

Where appropriate, the EU-13 (Member States joining the EU after 2003) and the EU-15 (EU Member States prior to 2003) are compared; occasionally, information from particular countries or a particular grouping of countries is provided to illustrate particular issues.

Data for most indicators have been available since 1990. However, some member countries have only provided information covering recent years, and changes in statistical series may render comparisons irrelevant. This has been taken into account when selecting the time series for analysis.

Box 1.1 Country groupings

Throughout the report, abbreviations are used to refer to specific country groupings:

- EU-15: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom
- EU-13: Bulgaria, Croatia, Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia
- EFTA-4: Iceland, Liechtenstein, Norway and Switzerland
- EU-28: EU-15 and EU-13
- EU-27: EU-28 excluding Croatia
- EEA-33: EEA member countries (EU-28, EFTA-4 and Turkey).

Part A: monitoring progress towards transport and environmental goals

2 TERM Core Set of Indicators

Key messages

- The environmental performance of European transport is slowly improving. However, it remains uncertain the actual impact the economic crisis had on transport activity and therefore related environmental performance.
- Meeting long-term environmental targets will require substantial effort.
- Greenhouse gas (GHG) emissions fell by 3.3 % in 2012. This is in line with the target path. However, emissions are still 20.5 % higher than in 1990.
- There has been progress, but there is still some way to go in decreasing oil consumption in transport.
- The 2015 target for the average CO_2 emissions of new passenger cars was attained in 2013. However, the divergence between fuel consumption and resulting CO_2 emissions, when comparing tests against real-world conditions, remains a point of concern.
- The EU's share of renewable energy in transport rose to 5.1 % in 2012, i.e. less than that required according to the target path.

2.1 Overview of progress towards transport goals

Progress in meeting the transport goals set for EU Member States cannot yet be fully monitored, due to lack of data and the complicated nature of the evaluation. Table 2.1 presents the progress made for those goals that can be monitored.

The approach for assessing progress was described in detail in the TERM 2012 report (EEA, 2012). Annex 3 to this report provides a more thorough explanation of the comparison between the observations and the target path. To summarise, for each transport goal, a base year and corresponding value are determined, which serve as a starting point for the target trajectory. For transport GHG emissions, the 2011 Transport White Paper (EC, 2011a) formulated the preferred policy option to reach the objective. This forms the basis of the trajectory for the transport GHG emission reductions. For the other objectives, a linear trend is assumed towards the target, starting from the base year.

Transport GHG emissions to be reduced by 20 % from 2008 levels by 2030, and by at least 60 % from 1990 levels by 2050

Transport GHG emissions, including aviation but excluding maritime shipping, have fallen by 3.3 % in 2012. Road transport, which accounted for the largest share of these emissions, fell by 3.6 %, whereas international aviation, accounting for the second largest share, dropped by 1.3 %. The overall progress is faster than that indicated by the target path. However, emissions in 2012 are still 20.5 % higher than in 1990.

To explain developments in road transport, a first analysis (EEA, 2013b) points to the high increase in automotive gasoline and diesel prices in 2012 compared to 2011, and to the economic recession lowering freight transport demand. According to this analysis, more than 80 % of the emission reduction from road transport diesel in 2012 was due to lower freight transport as compared to (diesel) passenger cars. To a lesser extent, the reduced road transport emissions in 2012 can also be explained by an increased use of biofuels and energy efficiency improvements in new vehicles.

Keeping the values in line with or below the target path may become more difficult if the economy picks up in future years. The role of 'avoid', 'shift' and 'improve' policies will then become even more important.

Average passenger car emissions target of 130 g CO_2/km for the new car fleet by 2015, and a target of 95 g CO_2/km from 2020 onwards

CO_2 emissions from the new passenger car fleet in the EU-27 further decreased between 2012 and 2013, from 132 g to 127 g. Therefore, the 130 g CO_2/km target for 2015 has already been met, two years early. However, additional effort is required to meet the 95 g CO_2/km target by 2021. New cars' efficiency has been boosted despite an increase in their average mass. The average new car sold in 2013 was almost 10 % more efficient than in 2010.

The divergence between type approval and real-world fuel consumption and CO_2 emission reduction remains a point of concern. Current EU efforts aim at revising the type-approval procedure in order to better reflect vehicle operation on the road. In spite of the difference between the real-world and type-approval emissions, regulations have led to actual emission reductions. The improved testing method and increased attention on this issue are expected to lead to additional reductions in future.

All EU Member States to achieve a 10 % share in renewable energy by 2020 for all transport options

Only biofuels complying with the sustainability criteria under the RED are to be taken into account for this target. Recently, EU energy ministers also agreed to a 7 % cap on biofuels made from food crops for use in transport, following concerns that crop-based fuels can have a larger net environmental impact than conventional fuels.

The average EU-28 share of renewable energy consumed in transport rose between 2011 and 2012, from 3.4 % to 5.1 %, including only those biofuels which met the sustainability criteria. This is still less than that required in the target path. About 20 % of the 67 ktoe of electricity in road transport corresponds to renewable electricity, which is very small compared to the amount of biofuels consumed in transport (14 610 ktoe in 2012). Renewable electricity in other transport modes of transport remained almost stable, with a minor decrease.

Transport oil consumption to be reduced by 70 % by 2050 from 2008 levels

Transport oil consumption fell by 4 % in 2012, and by 1.7 % in 2013, according to the estimations. This is in line with the target path, but the additional efforts required are very challenging.

Maritime bunker GHG emissions to be reduced by 40 % from 2005 levels by 2050

EU CO_2 emissions of maritime bunker fuels first increased, from 2005 until 2007, and then decreased. In 2012, they were 12.5 % less than in 2005. The impact of the economic crisis cannot be disregarded in this respect. It therefore remains to be seen whether the downward trend will continue in future years.

Table 2.1 Transport goals overview in the EU-28, 2014

	Source	Target	Unit	Where we were: Base year		Where we want to be: Target		Where we are (current trends vs. target path): 2010		2011		2012		2013		Latest annual trend
				Year	Value	Year	Value	Target path	Observed	Target path	Observed	Target path	Observed	Target path	Observed	
Key target	European Commission's 2011 Transport White Paper (EC, 2011a)	Transport GHG (including international aviation, excluding international maritime shipping)	Mt CO_2	2008	1 117	2030	918 (– 20 %)	1 108	1 069	1 110	1 063	1 112	1 028	1 114	n.a.	– 3.3 %
				1990	852	2050	334 (– 60 %)									
	European Commission's 2011 Transport White Paper (EC, 2011a)	EU CO_2 emissions of maritime bunker fuels	Mt CO_2	2005	166	2050	99.8 (– 40 %)	159	156	158	161	156	146	155	n.a.	– 9.3 %
Indicative goals	Passenger car CO_2 EC Regulation 443/2009	Target average type-approval emissions for new passenger cars ([a])	gCO_2/km	2010	140	2015 2020	130.0 95.0	140	140	138	136	136	132	134	127	– 3.9 %
	Van CO_2 EC Regulation 510/2011	Target average type-approval emissions for new vans ([a])	gCO_2/km	2012	180	2017 2020	175 147	n.a.	n.a.	n.a.	n.a.	180	180	179	173	– 3.8 %
	Impact assessment accompanying document to the 2011 Transport White Paper	Reduction of transport oil consumption	million TJ	2008	17.3	2050	5.2 (– 70 %)	16.8	16.4	16.5	16.3	16.2	15.6	15.9	*15.4*	*– 1.7 %*
	Renewable Energy Directive 2009/28/EC	10 % share of renewable energy in the transport sector final energy consumption for each Member State (here EU-28 average as a proxy) ([b])	%	2010	4.81 %	2020	10.00 %	4.81 %	4.81 %	5.33 %	3.39 %	5.85 %	5.07 %	6.37 %	n.a.	49.8 %

Notes: Indicative targets: In order to assign a colour to cells containing the latest observed data, a comparison is made to the 'target path'. In the case of the key target, each year's data will be compared with the 'target path' defined in the European Commission's Policy Option 4 (the 'preferred policy option') in order to meet the transport GHG reduction target by 2030 and 2050.

For the other goals, there are no official estimates of the 'target path' to be followed, so this path is calculated by plotting a straight line from the base year data to the target year data, i.e. assuming a linear trend towards the target (Annex 3 for more details and for a graphical representation of the comparison between real data and the linear trend).

Figures in italic are EEA estimates (oil consumption in 2013) in terajoules (TJ).

([a]) EU-27 data. Data from Croatia will be available from 2014 onwards (TERM 2015 report).

([b]) In the case of the RED (EU, 2009a) target, Eurostat published for the first time (2011 data) the share of biofuels in transport energy use which meet the sustainability criteria of the directive. The notable increase in the last trend (49.8 %) is explained by the fact that in previous years, the new sustainability criteria were not fully applied. The system for certifying sustainable biofuels is increasingly operational across all Member States.

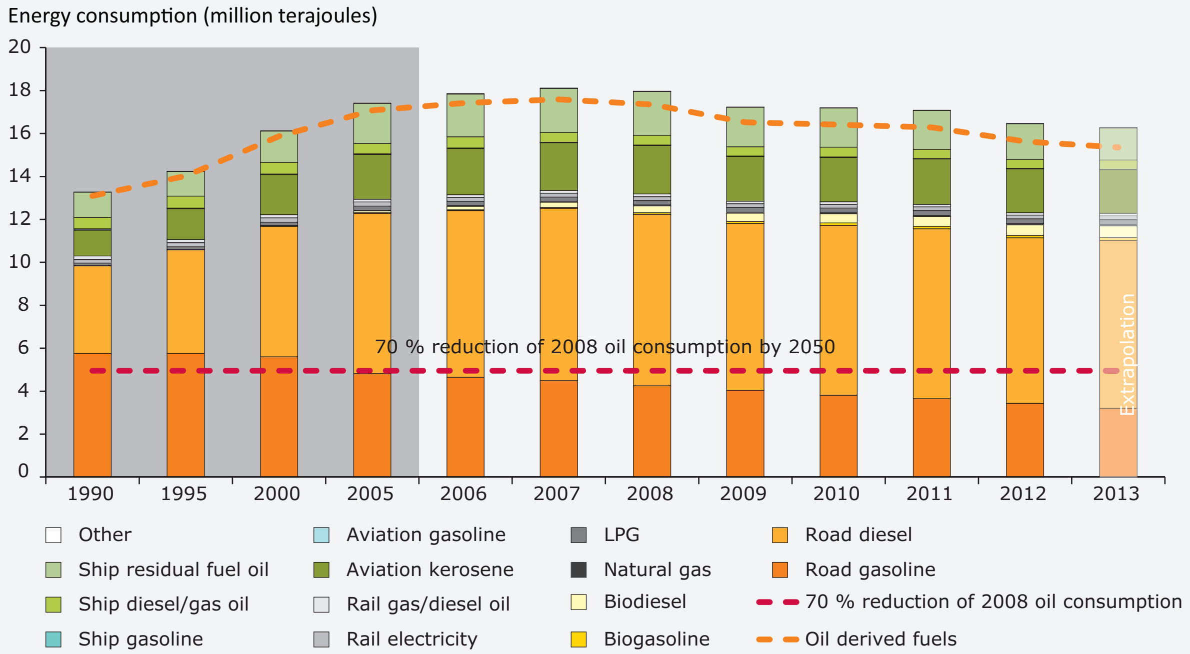
2.2 Overview of the 2014 TERM CSIs

Box 2.1 TERM Core Set of Indicators (TERM CSI)

- TERM 01 — transport final energy consumption by fuel in the EU-28
- TERM 02 — transport emissions of greenhouse gases
- TERM 03 — transport emissions of air pollutants
- TERM 04 — exceedances of air quality objectives due to traffic
- TERM 05 — exposure to and annoyance by traffic noise
- TERM 12 — passenger transport volume and modal split
- TERM 13 — freight transport volume and modal split
- TERM 20 — real change in transport prices by mode
- TERM 21 — fuel tax rates
- TERM 27 — energy efficiency and specific CO_2 emissions
- TERM 31 — share of renewable energy in the transport sector
- TERM 34 — proportion of vehicle fleet by alternative fuel type

Box 2.2 TERM 01 — transport final energy consumption by fuel in the EU-28

Transport energy consumption in the EU-28



Notes: Oil-derived fuels are all fuels excluding biodiesel, biogas, biogasoline, electrical energy, natural gas and solid biofuels. Biogasoline is almost all road, with a small share of domestic navigation from 2008. Biodiesel is mostly road, with some rail from 2004, and a small share of domestic navigation from 2009. Natural gas is all road. Liquefied petroleum gas (LPG) is all road, except for negligible amounts in domestic navigation over a few years (scattered).

Estimates for the year 2013 are based on the Eurostat indicator nrg_102m, using the categories 'gross inland deliveries observed' and 'international maritime bunkers' for a limited range of fuels. These include gasoline, road diesel, aviation kerosene and fuel oil. The proportionate change observed for these fuels between 2012 and 2013 is then used to estimate 2013 consumption figures for all oil-based road petrol and diesel, rail diesel, aviation kerosene and shipping fuels. Electricity, natural gas and biofuels are estimated by extrapolating the consumption trends of the previous years.

Related targets and monitoring

The impact assessment which accompanied the 2011 Transport White Paper (EC, 2011a) suggests that a 70 % reduction of transport oil consumption from 2008 levels should be achieved by 2050.

Key messages: Between 1990 and 2007, annual transport energy consumption grew by 37 % in the EU-28, and by 38 % in the EEA-33. However with improvements in energy efficiency and the onset of the recession, which led to lower activity levels, this trend has been reversed. Between 2007 and 2012, total energy demand in the transport sector declined by 9.1 % in the EU-28, and by 9.9 % in the EEA-33. Using current fuel sales as a proxy for energy consumption, it appears that transport energy consumption may have continued to decline in 2013, with a decrease of 1.2 % between 2012 and 2013.

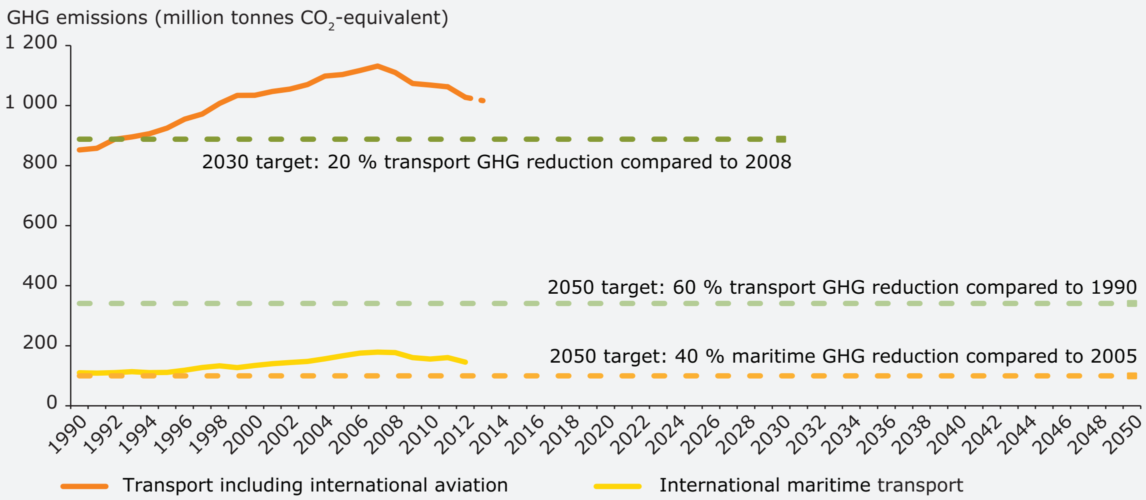
In the EU-28, road transport accounts for the largest amount of energy consumption, accounting for 73 % of total demand in 2012. Despite recent changes, total transport energy consumption in 2012 was still 24 % higher than in 1990. The fraction of road transport fuel that is diesel has continued to increase, and in 2012 it amounted to 70 %.

The EEA-33 member countries consumed approximately 17.3 million terajoules (TJ) for transport in 2012. The vast majority, 83 %, is consumed by the original EU-15 Member States, with 12 % consumed by the new EU-13, and the remaining 5 % by other EEA member countries.

Further information: Box 2.10 TERM 21 — fuel tax rates; Box 2.12 TERM 31 — share of renewable energy in the transport sector.

Box 2.3 TERM 02 — transport emissions of greenhouse gases

EU-28 transport emissions of greenhouse gases



Notes: Overall transport GHG emissions, including aviation but excluding international maritime, are represented by a dark orange line; including an EEA preliminary estimate for 2013 (EEA, 2014a) originally calculated excluding international bunkers, adding the 2013 value of international aviation emissions. This corresponds to the basic assumption that international aviation emissions did not change between 2012 and 2013. Latest available data: 2012.

Related targets and monitoring

The EU has the overall goal of achieving a 60 % reduction in transport GHG emissions (including international aviation but not maritime bunkers) from 1990 levels by 2050, with an intermediate goal of reducing 20 % transport GHG emissions from 2008 levels by 2030 (+ 8 % against 1990 levels). Similarly, shipping emissions (international maritime bunkers) are to be reduced by 40 % from 2005 levels by 2050.

Transport being a non-Emissions Trading Scheme (non-ETS) sector, Member States have the responsibility to reduce transport emissions through national policies (for non-ETS sectors all together, by − 10 % against 2005 levels by 2020), as opposed to sectors covered by the ETS (e.g. energy industries and industrial installations), where the emission reduction objective is to be achieved through an EU-wide trading scheme.

Key messages: The reduction trend seen from 2008 continued and actually increased in 2012: transport emissions including aviation fell by 3.3 % in 2012. This reduction is more acute for road transportation (3.6 %) than that of aviation (1.3 %). Remarkably, road transportation is the sector that has contributed the most to the 1.3 % overall reduction of EU-28 GHG emissions in 2012. However, transport emissions are still 20.5 % above 1990 levels, despite the current trend. Emissions will, therefore, need to fall by 67 % by 2050 in order to meet the 2011 Transport White Paper target.

Due to the notable increase in pkm and tkm compared to the values seen in 1990, international aviation experienced the largest percentage increase in GHG emissions from 1990 levels (93 %), followed by international shipping (32 %) and road transportation (17 %). In 2012, transport (including shipping and aviation) contributed 24.3 % of the total of GHG emissions in the EU-28; this figure drops to 19.7 % if bunkers are excluded from the overall value.

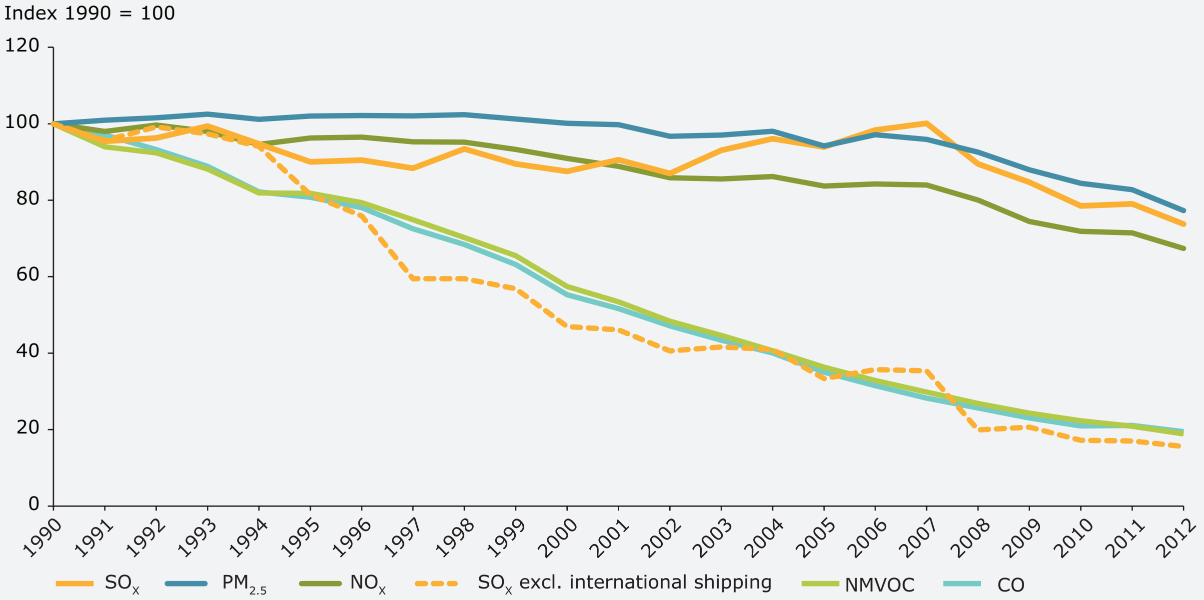
EU GHG emissions from international shipping decreased sharply in 2012 (by 9.3 %), reaching 2002 levels. Emissions will need to fall by 31.4 % by 2050 in order to meet its reduction target (a 40 % reduction from 2005 levels by 2050.)

In EFTA-4 countries, transport emissions (including aviation) since 1990 have increased above the EU-28 average in Norway and Iceland (54.2 % and 39.9 % respectively, compared with the 20.5 % EU-28 average), while Switzerland and Liechtenstein's emissions grew by 18.9 % and by 8.4 % respectively. In the last year available (between 2011 and 2012), values were generally stable in EFTA-4 countries, although aviation emissions increased significantly in Iceland, Liechtenstein and Norway (by 4.8 %, 34.7 % and 5.5 % respectively).

Further information: *Trends and projections in Europe — Tracking progress towards Europe's climate and energy targets for 2020* (EEA, 2014a) and Box 2.11.

Box 2.4 TERM 03 — transport emissions of air pollutants

Trend in emissions of air pollutants from transport in EEA-33



Related targets and monitoring

Directive 2008/50/EC on ambient air quality and cleaner air for Europe (EU, 2008) sets limit values (LVs) for the atmospheric concentrations of main pollutants, including sulphur dioxide (SO_2), nitrogen dioxide (NO_2), airborne particulate matter (PM_{10}, $PM_{2.5}$), lead (Pb), carbon monoxide (CO), benzene (C_6H_6) and ozone (O_3) for EU Member States. These limits are related to transport implicitly, but the introduction of progressively stricter Euro emission standards and fuel quality standards has led to substantial reductions in air pollutant emissions. Policies aimed at reducing fuel consumption and GHG emissions (see Boxes 2.3 and 2.11) may also help further reduce air pollutant emissions. Moreover, policies regulating fuel tax rates (i.e. how much diesel fuel is taxed compared with other (cleaner) road fuels) and alternative energy sources also reduce the emission of pollutants (see Boxes 2.10, 2.12 and 2.13). Directive 2001/81/EC on national emission ceilings for certain atmospheric pollutants (known as the National Emissions Ceilings Directive (NECD)) is currently under revision.

Iceland, Liechtenstein, Norway, Switzerland and Turkey are not members of the European Union and hence have no emission ceilings set under the NECD (EU, 2001). Norway and Switzerland as well as most of the EU Member States have ratified the 1999 United Nations Economic Commission for Europe Convention on Long-range Transboundary Air Pollution (UNECE LRTAP) Gothenburg Protocol, which required them to reduce their emissions to the agreed ceiling specified in the protocol by 2010.

Key messages: The latest year's available data show a continuation of the general trend for decreases in air pollutant emissions from transport: all transport-derived pollutants decreased between 2011 and 2012 (by 6 % in the case of NO_x, 7 % for SO_x, and by 6 % and 7 % in the case of PM_{10} and $PM_{2.5}$, respectively). The latest data show that non-exhaust emissions are 46 % of the exhaust emissions of primary PM_{10} in 2012, and 31 % of the exhaust emissions of primary $PM_{2.5}$.

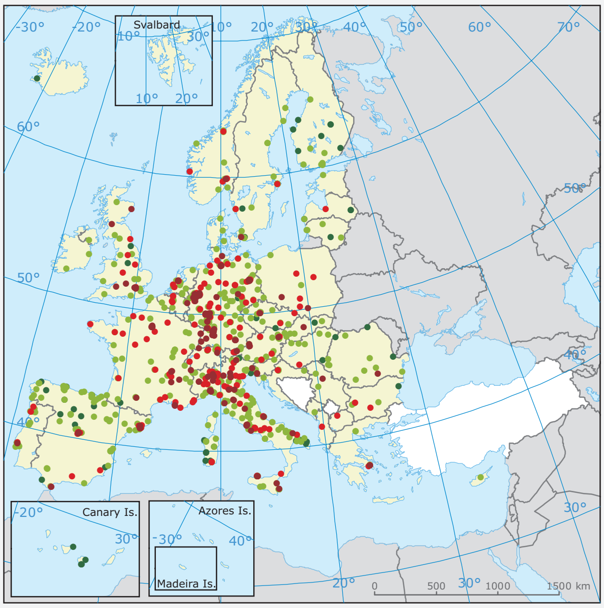
Aviation is the only subsector where emissions have increased in the last year available, by 7 % for NH_3 and by 9 % for SO_x emissions. Aviation and shipping are the two sectors where increases in activity since 1990 have offset reductions elsewhere, in particular for SO_x but also for NO_x and particulates. Road transport and aviation have also increased NH_3 emissions significantly over the last two decades, but while road transport has recently reduced its emissions, aviation has not yet been able to do so.

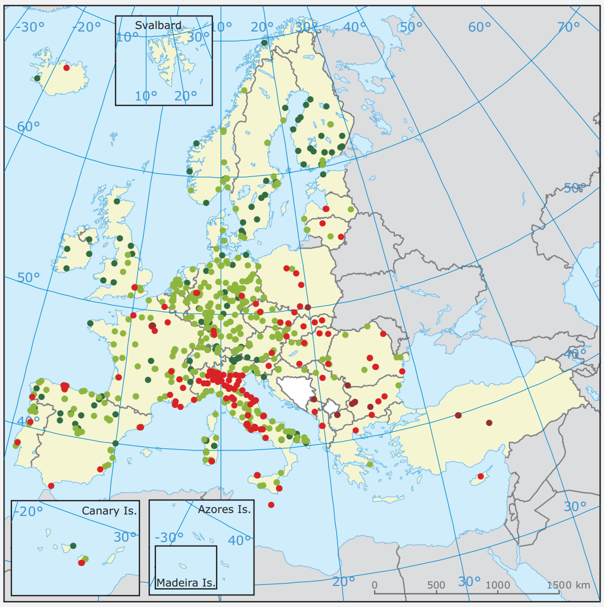
In general terms, the transport sector achieved important reductions in the period 1990 through 2012: reductions in CO and non-methane volatile organic compounds (NMVOCs) (both 81 %), but also in NO_x (33 %), SO_x (26 %) and particulates (by 23 % in the case of $PM_{2.5}$ and by 18 % for PM_{10}).

Further information: Box 2.5 and EEA, 2012.

Box 2.5 TERM 04 — exceedances of air quality objectives due to traffic

Annual mean NO_2 concentration observed at traffic stations, 2012 (left) and annual mean PM_{10} concentration observed at traffic stations, 2012 (right)





Annual mean NO_2 concentration observed at traffic stations, 2012 (EEA-33)

μg/m³ • ≤ 20 • 20–40 • 40–50 • > 50

No data | Outside coverage

Annual mean PM_{10} concentration observed at traffic stations, 2012 (EEA-33)

μg/m³ • ≤ 20 • 20–31 • 31–50 • > 50

No data | Outside coverage

Notes: The two highest PM_{10} concentration classes (dark red and red) correspond to the annual LV (40 μg/m³) and to a statistically derived level (31 μg/m³) corresponding to the daily LV. The lowest class corresponds to the World Health Organization (WHO) air quality guideline for PM_{10} of 20 μg/m³ as an annual mean (WHO, 2006).

Related targets and monitoring

For the EU, the New Air Quality Directive (EU, 2008) on ambient air quality and cleaner air for Europe regulates ambient air concentrations of SO_2, NO_2, PM_{10} and $PM_{2.5}$, Pb, (C_6H_6), CO and O_3.

EU limit values on concentrations of NO_2 in ambient air (LVs were to be met by 1 January 2010):

- an annual mean LV for NO_2 of 40 μg NO_2/m³ has been set for the protection of human health;
- an hourly LV of 200 μg NO_2/m³ not to be exceeded more than 18 times in a calendar year, has also been set.

EU limit values on concentrations of PM_{10} in ambient air (limit values were to be met by 1 January 2005):

- a LV for PM_{10} of 50 μg/m³ (24-hour mean, i.e. daily) has been set, not to be exceeded more than 35 times in a calendar year;
- a LV of 40 μg/m³ as an annual mean has also been set.

Key messages: Air quality levels in cities remain a fundamental challenge for attainment of EU air quality standards, particularly for the NO_2 annual limit value. The European Commission proposed a new clean air policy package in December 2013, including a Clean Air Programme for Europe,

Box 2.5 TERM 04 — exceedances of air quality objectives due to traffic (cont.)

with targets for 2030 (EU, 2013). Road transport is a significant part of the most worrying air quality problems in cities. In addition to direct NO_2 emissions, NO_X also promote tropospheric O_3 formation. Road transport in cities is also a substantial source of particulates.

Some cities in Europe show an increase in concentrations of NO_2 measured close to traffic. Although the annual limit value was exceeded in 2012 at only one rural background station, and at 2 % (17 stations) of all urban background stations in the EU-28, it was exceeded at 37 % of traffic stations, with a maximum observed annual mean concentration of 94 μg/m^3 in 2012. The decrease in NO_X emissions (30 % between 2003 and 2012) is greater than the fall in NO_2 annual mean concentrations (approximately 18 %). This is attributed primarily to the increase in NO_2 emitted directly into the air from diesel vehicles, and the increasing numbers of newer diesel vehicles. Exhaust emissions from such vehicles are lower for CO, NMVOCs and PM, but may be substantially higher for NO_2.

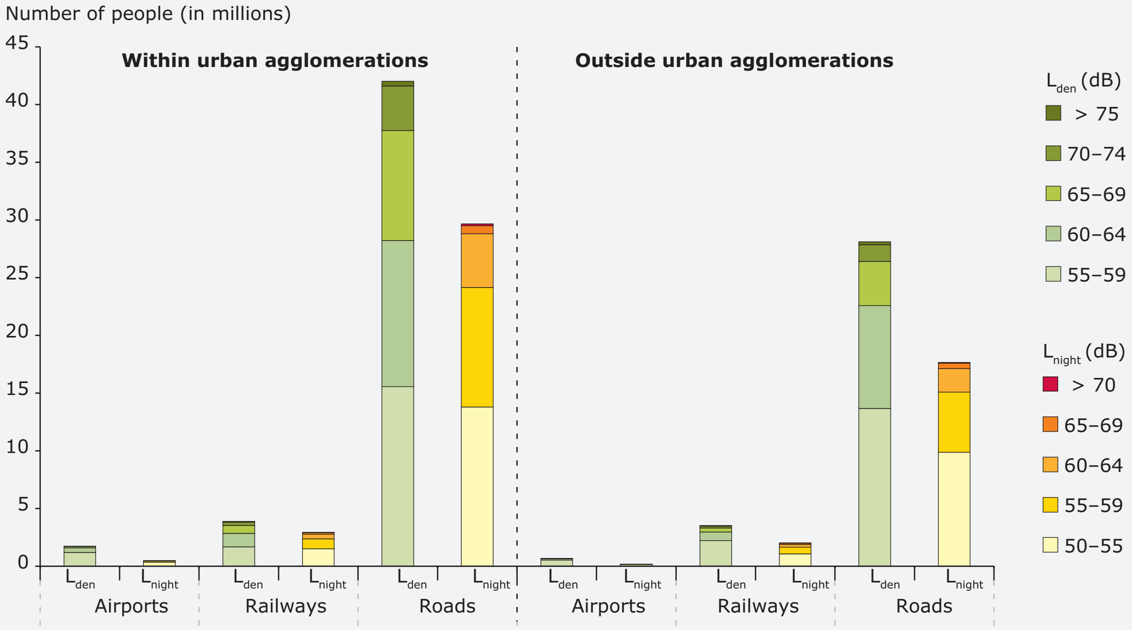
Of the EU-28, 21 % (38 % of the EEA-33) of the urban population lives in areas where the EU 24-hour limit value for PM_{10} concentrations was exceeded in 2012. The PM_{10} 24-hour limit value is more stringent than the annual limit value, and is more frequently exceeded. EU urban population exposure to PM_{10} levels exceeding the WHO Air Quality Guidelines is significantly higher, comprising 64 % and 92 % of the total EU-28 urban population in 2012 for PM_{10} and $PM_{2.5}$, respectively. The small reductions observed in ambient PM_{10} concentrations over the period from 2003 to 2012 reflect the slowly declining emissions of primary particulates emitted directly into the air. On average, a small decline of $PM_{2.5}$ was observed at traffic stations from 2006 to 2012.

In 2012, within the EU-28 (and EEA-33) countries, the PM_{10} 24-hour LV was exceeded at 27 % (31 %) of urban background sites, 22 % (22 %) of traffic sites, 17 % (18 %) of 'other' sites (mostly industrial) and even at 7 % (7 %) of rural sites. This corresponds to a considerable reduction of stations in exceedance compared to 2011, which was a 'peak year' in the period from 2008 to 2012.

Further information: Box 2.4; TERM 2012 (EEA, 2012a) and *Air quality in Europe — 2014 report* (EEA, 2014b).

Box 2.6 TERM 05 — exposure to and annoyance by traffic noise

Exposure to transport noise in Europe based upon the common indicators for L_{den} and L_{night}



Note: Based upon data reported from EEA-33 up to 28 August 2013. Latest available data: 2012.

Related targets and monitoring

This indicator aims to gauge progress towards a reduction in the number of people exposed to and annoyed by traffic noise levels that endanger human health and degrade quality of life.

The main legislative instrument for assessing exposure to noise in the EU is Directive 2002/49/EC relating to the assessment and management of environmental noise (known as the Environmental Noise Directive). Exposure to noise at night is particularly damaging to human health. WHO recommends a night-time noise guideline for Europe of not more than 40 dB $L_{night\text{-}outside}$ (decibel (dB) night noise level outside the façade), and an interim target level of not more than 55 dB $L_{night\text{-}outside}$ where the guideline cannot be achieved in the short term.

WHO has stated that at least 1 million healthy life years are lost each year, due to road traffic noise in Europe (WHO/JRC, 2011). This is more than any air pollutant, except pollution made up of very fine particles. Because the guideline level stipulated by WHO is not reflected in the directive, assessments cannot yet be made using data from the directive. The indicators introduced by the directive are: > 55 dB L_{den} (weighted average day, evening and night level) and > 50 dB L_{night} (average night level). These data for 2012 are presented above.

In addition, the 7EAP (COM (2012) 710 final) aims to ensure that noise pollution in the EU has significantly decreased by 2020, and is closer to WHO-recommended levels. An estimated 40 % of the EU's population lives in urban areas with levels of noise at night above the recommended WHO levels.

Distance to targets: A second round of noise-mapping was due for completion. This was to have delivered data pertaining to more than 400 cities in Europe and to provide an update of the first-round maps from 2007. Unfortunately, these data remain incomplete at the time of writing. Therefore, a trend analysis is not yet possible.

Key messages

Noise from road traffic impacts heavily on our health. Although only about 40 % of the expected data for 2012 has been reported, it is clear that at least 110 million Europeans are exposed to daily average road traffic noise levels that are detrimental to health, according to the indicator on annoyance (> 55 dB L_{den}). The total numbers of exposure to rail and aircraft noise are lower, but not inconsiderable. One of the most effective ways to change this may be to tackle noise reduction at source.

Further information: Noise Observation & Information Service for Europe (http://NOISE.eionet.europa.eu).

Box 2.7 TERM 12 — passenger transport volume and modal split

Passenger transport volume in the EU-28

Note: Figures on passenger-kilometres travelled by air are only available as an EU-28 aggregate. Air passenger-kilometres are a provisional estimate for domestic and intra-EU-28 flights. Figures for car, bus and rail are available, separately, for all EU-28 Member States. The sources used by DG Mobility and Transport (2014) include national statistics, estimates, the International Transport Forum and Eurostat.

Related targets and monitoring

In the EU, the majority of medium-distance passenger transport (50 % pkm over 300 km) should be by rail by 2050 (EC, 2011a).

Key messages: Passenger transport demand in the EU-28 decreased by nearly 1.5 % between 2011 and 2012, following a slight downward trend since its peak in 2009, broken only by a 1 % increase in 2011. Car passenger travel remains the dominant mode, with a share well above 70 %. Air transport grew by 10 % in 2011, but stabilised in 2012. However, it retained its pre-crisis modal share (9 %). Rail passengers' share has grown slightly in recent years, and accounted for 7 % in 2012, after the slight increase in the last two years (2011 and 2012).

Land passenger transport demand in non-EU-28 countries kept growing overall in 2012, with a 1.7 % growth in Iceland, and 1.5 % in Switzerland. Norwegian land transport demand figures remain stable, with car and rail demand growth (1.3 % and 3.6 % respectively) offsetting a 20.2 % loss in rail. The quick deterioration of rail passenger transport in Turkey (-22 % in 2012) was accompanied by a significant increase (6.2 % in 2012) in total land transport demand, sustained by a 10.5 % growth in car travel. It is worth noting that, according to EUROCONTROL (EUROCONTROL, 2014), Turkey is also the main driver of air passenger traffic growth in the European skies.

More information: Chapters 3 and 5.

Box 2.8 TERM 13 — freight transport volume and modal split

Freight transport volume in the EU-28

Note: Figures in tonne-kilometres for air and maritime are only available as an EU-28 aggregate. Air and maritime tonne-kilometres are provisional estimates for domestic and intra-EU-28 transport. Figures for road, inland waterways and rail are available separately for all EU-28 Member States. The sources used by DG Mobility and Transport (2014) include national statistics, estimates, the International Transport Forum and Eurostat.

Related targets and monitoring

In the EU, a total of 30 % of road freight over 300 km should shift to other modes such as rail or waterborne transport by 2030, and more than 50 % should shift by 2050, facilitated by efficient and green freight corridors (EC, 2011a).

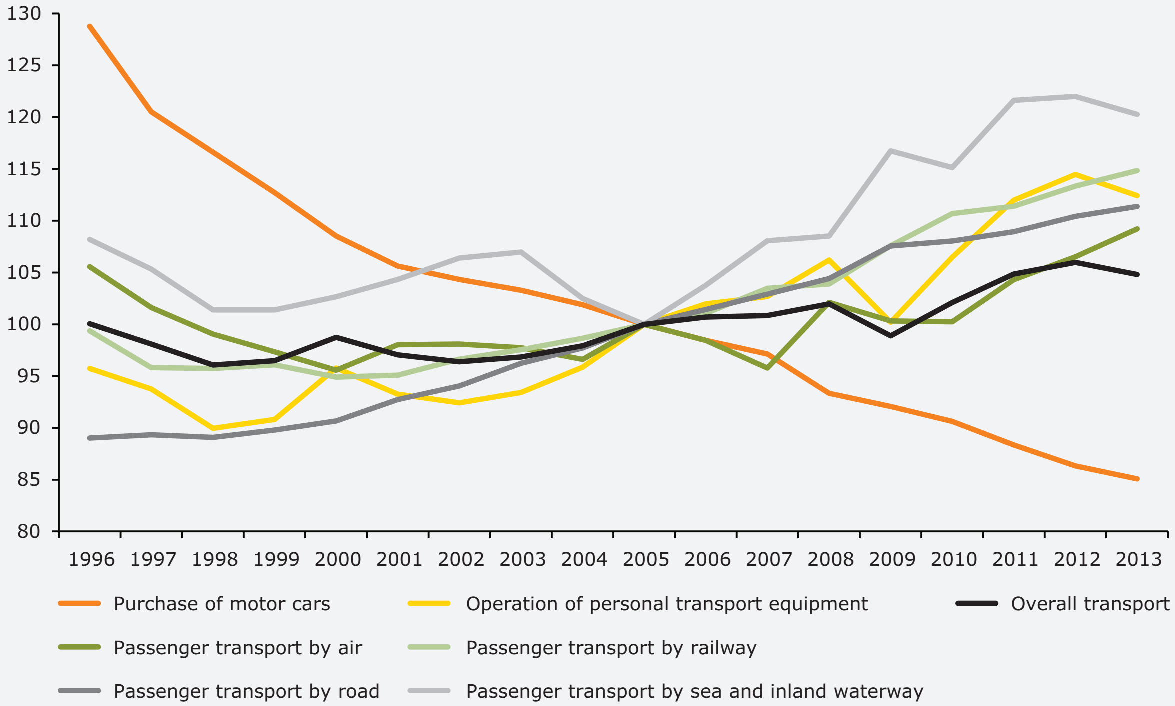
Key messages: Freight transport volumes in the EU-28 decreased by 2 % between 2011 and 2012, mainly due to a 3 % reduction in road freight transport (with Italy leading the road drop by 13.8 % compared to its 2011 figure). Rail transport also decreased by 4 % between 2011 and 2012, whereas inland waterways (IWW) transport increased by 6 %. Maritime and air transport did not vary significantly. Overall, total freight transport volumes in the EU-28 are now 10 % below the peak volumes experienced in 2007. The modal share remains constant; road transport dominates land freight transport at 75 %, followed by rail (18 %) and IWW (7 %).

Switzerland experienced a decrease of 4 % in road and rail transport, whereas Norway and Turkey's overall land freight transport increased (by 4 % and 6 % respectively), and Iceland's demand remained roughly constant between 2011 and 2012.

More information: Chapters 3 and 6.

Box 2.9 TERM 20 — real change in transport prices by mode

Real change in transport prices by mode in the EU-28



Note: Real change in passenger transport prices by mode, relative to average consumer prices based on the United Nations (UN) Classification of individual consumption by purpose (COICOP). Passenger transport by road exclusively includes transport of individuals and groups of persons and luggage by bus, coach, taxi and hired car with driver.

Related targets and monitoring

Passenger transport in Europe is predicted to grow by about 40 % between 2010 and 2050 (DG Energy, 2014). With this significant growth in transport use, it is important that prices are monitored to see if users are given appropriate incentives to use more environmentally friendly modes of transport. Changes in transport prices drive individual and business transport decisions; fair and efficient price signals are required.

The cost of transport reflects market changes such as vehicle technology developments, international energy price evolution and state interventions through regulations, subsidies and taxation. Government actions can internalise the environmental externalities of different transport modes, which can lead to users shifting between modes. The economic incentives for modal shifts can be monitored through the indicator of transport prices by mode.

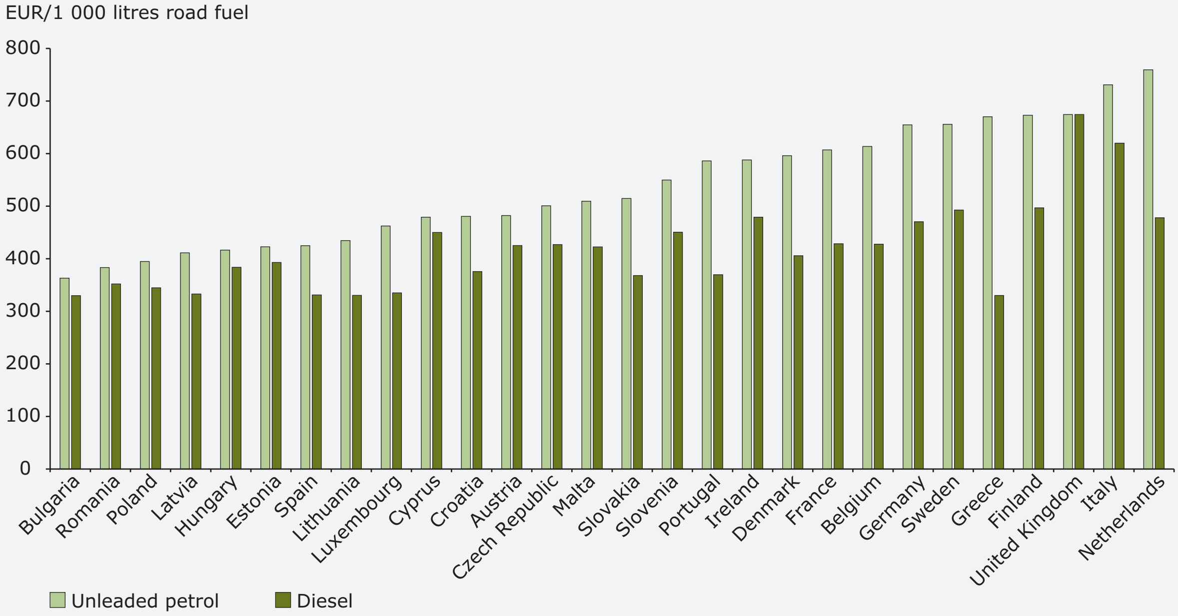
Key messages: With 2005 as the reference point, the cost of purchasing motor cars has steadily decreased since 1996, in comparison to average consumer prices. In contrast, the costs of passenger services and the operation of personal transport equipment has increased significantly.

The volatility of the transport market can be seen in the figure above; in 2009, overall transport prices fell at a faster rate than average consumer prices did, primarily due to a significant drop in the average crude oil price between 2008 and 2009, which led to reductions in fuel prices. Rail transport prices are less closely tied to the costs of fuel, as most services operate under 'public service obligation', and an increasing proportion of passenger rail is electric-powered.

Further information: Box 2.10.

Box 2.10 TERM 21 — fuel tax rates

Road fuel excise duties in the EU-28 (situation as of June 2014)



Note: Some Member States have higher tax rates for fuels with sulphur content > 10 parts per million (ppm) or biofuel shares below a given threshold.

Source: DG TAXUD, 2014 (http://ec.europa.eu/taxation_customs/resources/documents/taxation/excise_duties/energy_products/rates/excise_duties-part_ii_energy_products_en.pdf).

Related targets

The 2011 Transport White Paper (EC, 2011a) suggests that EU motor fuel taxation should be restructured, to clearly identify the energy and CO_2 components. In 2011, a proposal (COM/2011/169) for a revised Energy Taxation Directive called for the introduction of a CO_2 element into energy taxation, to bring energy taxation in line with the EU's climate change commitments, and for linking the level of the tax to the energy content of fuels (including those used in aviation), so as to create an incentive across all sectors for increased energy. This is a particular issue for diesel, where some freight vehicles travel further to buy fuel in countries where the fuel tax is lowest (fuel tourism). This proposal is still under discussion.

Key messages: The internalisation of external environmental costs through methods such as fuel taxation is important for economic efficiency and fairness considerations, and means that externalities are taken into account by transport users when making travel decisions. Fuel consumption is a good proxy for GHG emissions produced by the use of transport, and so fuel taxes provide a good basis for this internalisation.

Fuel taxes can also provide incentives for consumers to purchase more fuel-efficient vehicles; higher fuel prices in the EU mean that fuel-inefficient cars common in the United States are unaffordable, and as a result Americans consume more than double the volume of road fuel per head than Europeans (Transport & Environment, 2011).

Fuel prices are an important factor in transport demand; despite rising real prices over the last two decades (the average price is now 20 % more expensive than in 2000, and 33 % more expensive than in 1990), calculations using Eurostat (2014) and DG Energy (2014) data show that transport demand has increased.

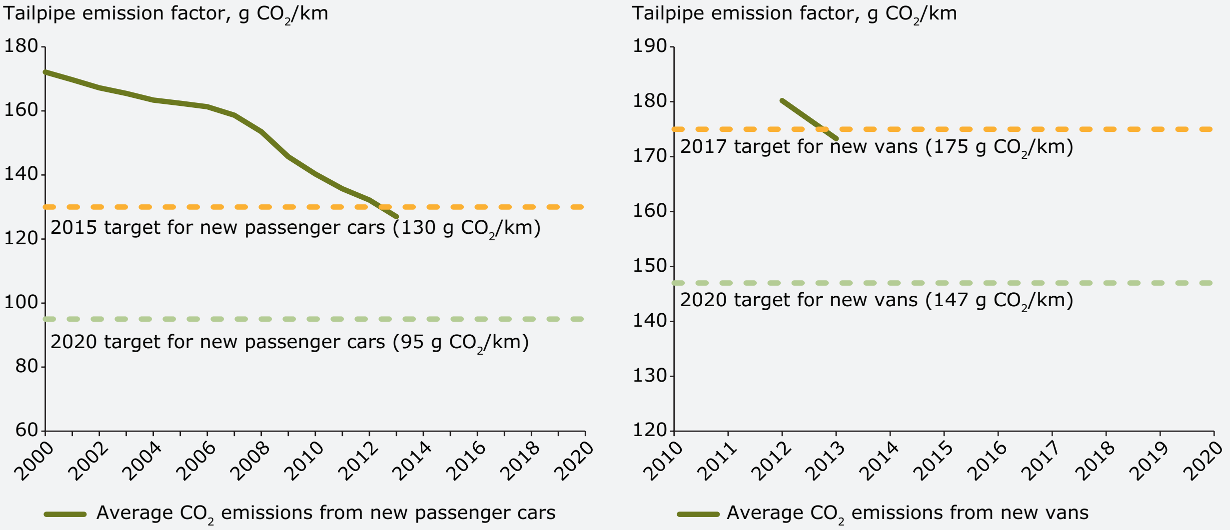
The level of internalisation of environmental externalities through fuel taxes has not significantly changed, with recent fuel price increases attributed to the rise in the price of base oil. The price per litre of Euro-Super 95 has increased 10 % without taxes over the past three years (since July 2011, EU-weighted average) and 8 % with taxes (excise duty and other indirect taxes plus value added tax (VAT)) (DG Energy, 2014).

In almost all EU-28 Member States, the excise duty on diesel is lower than that on gasoline. In June 2014, the weighted average share of taxes and duties on fuel prices in the EU-15 was 58 % for unleaded petrol and 51 % for diesel. In the EU-13, shares were 50 % and 47 %, respectively.

Further information: Box 2.9 TERM 20 — real change in transport prices by mode.

Box 2.11 TERM 27 — energy efficiency and specific CO_2 emissions

Average emissions (g CO_2/km) in the EU-27 for new passenger cars (left) and vans (right)



Note: Latest available data: 2013. Data from Croatia will be included from next year (2014 data).

Related targets and monitoring

The EU target for average passenger car emissions is 130 g CO_2/km for the new car fleet by 2015, and 95 g CO_2/km from 2021 onwards (average emissions of CO_2 for the new passenger cars sold in the EU (EC Regulation 443/2009). The target for vans is 175 g CO_2/km by 2017 (phased in from 2014) and 147 g CO_2/km by 2020 (average emissions of CO_2 for the new vans sold in the EU (EC Regulation 510/2011). Average emissions of CO_2 for the new car fleet have been monitored annually by the European Commission from 2000, but such data are available for vans for the last two years only (EEA, 2014c).

Key messages: CO_2 emissions from the new passenger car fleet in the EU-27 decreased significantly, by 5.5 g CO_2/km between 2012 and 2013, from 132.2 g to 126.7 g. The new passenger car fleet has already met the 130 g CO_2/km target for 2015, two years early, but additional effort is required to meet the 95 g CO_2/km target by 2020. Despite an increase in their average mass, new cars are becoming more efficient. The average car sold in 2013 was almost 14 % more efficient than the average car sold in 2010. In 2013, an average diesel car emitted 126.9 g CO_2/km, only 1.55 g CO_2/km less than a petrol car (in 2000, the emissions difference between diesel and petrol vehicles was 17.1 g CO_2/km).

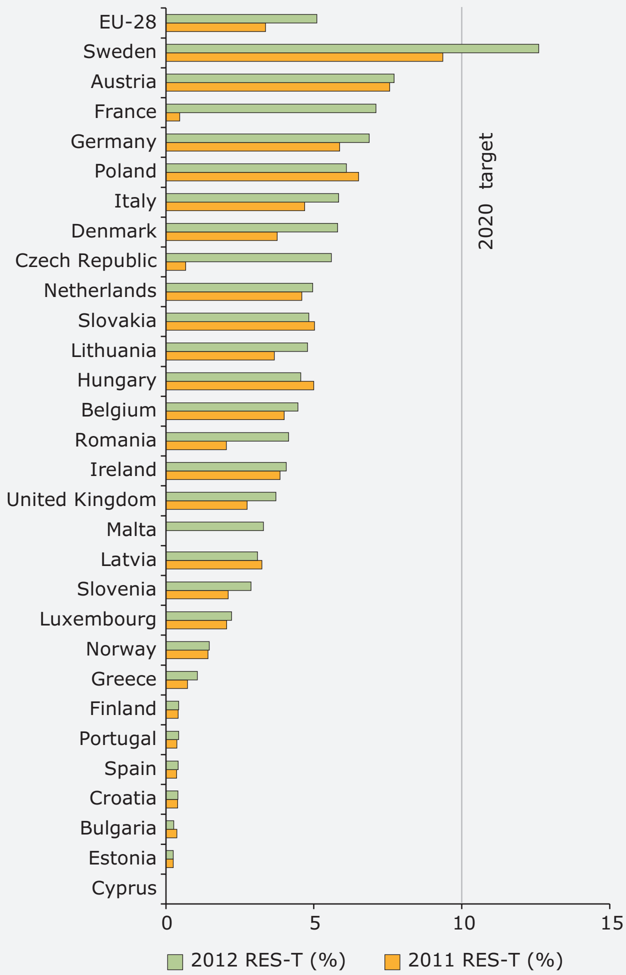
The first data for the year 2012 show a van fleet average of 180 g CO_2/km and the second provisional data for 2013 show an average of 173 g CO_2/km. Hence, the new vans fleet has already met the 175 g CO_2/km target for 2017, four years early. Despite this decrease, significant progress will have to be made in order to achieve the target of 147 g CO_2/km by 2020.

Numerous studies have documented the often-significant divergence between type-approval and real-world CO_2 emissions. It appears that there may indeed be an increasing divergence between type-approval and real-world fuel consumption, and hence, CO_2 emissions. A recent study (Ntziachristos et al., 2014) suggests that the difference is 11 % for petrol cars and 16 % for diesel cars. The study also stated that the difference can reach 60 % for newer vehicle models registered in the low 90 g CO_2/km to 100 g CO_2/km category. Another recent report (ICCT, 2014) suggests that the divergence increased from 10 % on average in 2001 to 23 % by 2011, and to more than 30 % in 2013. Despite the difference in CO_2 emissions when measured using real-world and type-approval approaches, real emission reductions have occurred as a result of regulations based upon the current type-approval monitoring regime. Using implied emission factors based on total consumption and activity, researchers (Papadimitriou et al., 2014) calculated a 2 % fleet-wide fuel consumption reduction for both diesel and gasoline passenger cars in 2010 compared to 2005. The improved testing method and the increased focus on real-world emissions are expected to bring about additional reductions in future.

Further information Box 2.3 and EEA, 2014c.

Box 2.12 TERM 31 — share of renewable energy in the transport sector

Share in % of renewable energy consumed in transport (RES-T) by country, including only those biofuels compliant with the Renewables Directive (RED)



Note: Eurostat's estimates (ESTAT 'SHARES 2012' database).

According to the RED (EU, 2009a), renewable electricity in electric road vehicles was accounted for 2.5 times the energy content of the input of electricity from renewable energy sources (RES) and the contribution of biofuels produced from wasted, residues, non-food cellulosic material, and lingo-cellulosic material was considered twice that of other biofuels. As of data year 2011, countries were to report as compliant only those biofuels and bioliquids for which compliance with Article 17 and Article 18 can be fully demonstrated.

Related targets and monitoring

For each EU Member State, 10 % of the energy consumed in the transport sector must be renewable by 2020 (EU, 2009a). Only biofuels complying with the sustainability criteria under the RED are to be counted towards this target, and therefore proper monitoring is only possible from 2010. In addition, to stimulate the growth of certain shares of RES in transport, when calculating the RES-T (%) of the complying biofuels, the renewable electricity in electric road vehicles is accounted for 2.5 times the energy content of the input of electricity from RES, while the contribution of biofuels produced from wastes, residues, non-food cellulosic material, and lignocellulosic material is considered twice that of other biofuels. Recently, EU energy ministers agreed to a 7 % cap on biofuels made from food crops for use in transport.

Low-carbon sustainable fuels in aviation are to reach 40 % by 2050, and EU CO_2 emissions of maritime bunker fuels by 40 % (if feasible 50 %) on 2005 levels (EC, 2011a).

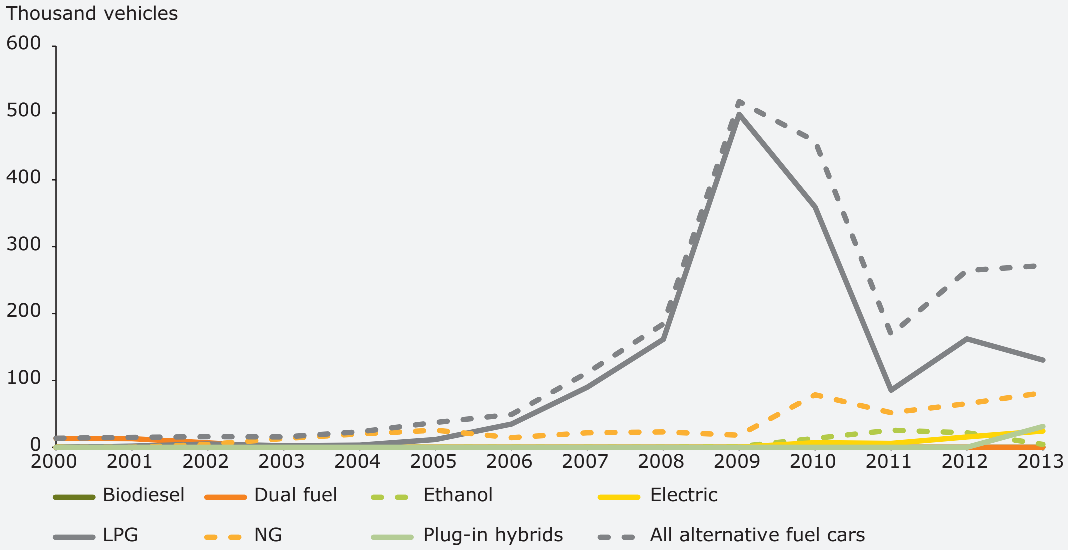
Key messages: For 2012, Eurostat published for the second time the share of biofuels in transport energy use which meet the sustainability criteria of the RED, despite systems for certifying sustainable biofuels not being fully operational in a number of Member States. The average EU-28 share of renewable energy consumed in transport increased between 2011 and 2012, from 3.4 % to 5.1 %, including only those biofuels which met the sustainability criteria. The consumption of energy from renewable sources would have met the 5.75 % target set in the original Biofuels Directive (i.e. Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport) when all biofuels (not only the sustainable ones) are taken into account, as its share is 5.9 % in 2012. The difference between nominal biofuels share (including all biofuels in transport, not only the sustainable ones) and biofuels share meeting the RED criteria following from the calculation method mentioned above is most notable for Finland, Portugal and Spain. Despite these countries having some of the highest biofuel shares in Europe, only a small fraction of them have been reported to meet the sustainability criteria.

The use of electricity in road transport has shown a slight increase, from 66 ktoe to 67 ktoe from 2011 to 2012. About 20 % of this corresponds to renewable electricity consumed in road transport, which is very low compared to the amount of biofuels consumed in transport (14 610 ktoe in 2012). Renewable electricity in other modes of transport remained more or less stable, showing a marginal decrease (from 5 449 to 5 440 ktoe).

Concerning non-EU countries, 60 % of electricity in Switzerland is from renewable sources, with only a very small biofuel share.

Box 2.13 TERM 34 — proportion of vehicle fleet by alternative fuel type

Number of car registrations by alternative fuel type in the EU-27



Note: Croatia will be included in 2015 (with 2014 data). All previous years refer to EU-27. Plug-in hybrids (petrol and diesel) are reported separately from 2013 onwards, but there are still uncertainties about the categorisation of fuel types. They were included under conventional petrol and diesel vehicles in previous years. Latest available data: 2013.

Related targets and monitoring

There are no specific targets for the percentage of the vehicle fleets that use alternative fuels, but the EC aim is for European cities to be free of conventionally fuelled cars by 2050 (EC, 2011a), to be measured by passenger-kilometres in urban areas. Current data availability do not allow monitoring of this target.

For both conventional and alternatively fuelled vehicles, Euro 6 emission standards are introduced from 2014 for passenger cars, and from 2014/2015 for light commercial vehicles. Euro VI standards were introduced from 2013 for heavy-duty engines used in heavy goods vehicles (HGVs), buses and coaches. These will reduce pollutant emissions, especially emissions of particulates and NO_x.

Key messages: Pure electric vehicles currently comprise only a very small fraction of the total fleet (0.04 %) and latest data show that their share in the EU-27 new car registrations is 0.20 % (i.e. LPG 1.1 % and compressed natural gas (NG in the graph) 0.7 %). The number of new electric vehicles sold in the EU-27 has increased in the last four years, from around 700 in 2010 to around 25 000 in 2013. France (more than 8 900 vehicles) and Germany (around 6 000 vehicles) are the countries for which the increase has been the highest over the last four years. The number of plug-in hybrid vehicles is comparable to the number of pure electric vehicles: more than 31 000 plug-in hybrid vehicles were registered in the EU-27 in 2013. Outside the EU, 7 858 electric vehicles were registered in Norway, accounting for 5.5 % of new vehicle registrations, the highest among EEA member countries. Collectively, battery electric and plug-in hybrid vehicles account for 0.5 % of the total new registrations in the EU-27. Many EU Member States already offer financial incentives. Such incentives include exemption from one-off purchase tax (making the cost comparable with conventional vehicles), VAT exemption, and use of bus lanes.

Detailed car stock data are not always available for all countries. Whereas stock data for LPG and compressed natural gas (CNG) cars are generally available for most countries, there is less information on electric vehicles. There is great variability across countries in the percentage of car stock by alternative fuel type. While it is understood that these shares are linked to specific incentives in different countries, there seems to be no pattern among groups of countries (EU-15 or EU-13); furthermore, in some countries, incentives for alternative fuel cars are offset by scrappage schemes offering benefits to conventional internal combustion vehicles as well. Within the EU-28, Poland has the highest share of LPG cars (a 15 % share in 2012. There are very few CNG cars circulating in EU Member States. Most of them are in Italy, and their share is about 2 % of the total passenger car fleet. Of all EEA member countries, the Netherlands has the highest share of electric vehicles, with almost 1 % of the vehicle stock, while Turkey has the highest share of cars running on LPG, at 50 %.

Further information: Box 2.11.

3 Freight and passenger transport demand and modal split

Key messages

- Freight transport activity has been increasing since 1990, peaking in 2007. A significant drop in 2009 was followed by a small increase in 2010, and then decreases in 2011 and 2012.
- Despite also losing traffic compared to 2007, rail has been marginally increasing its share of freight transport activity in recent years in the EU-15; however, it is far from ready to challenge the dominance of road transport.
- Passenger transport demand has been on a slight downward trend since 2008. Car passenger travel remains the dominant mode, with a share well above 70 %, but air transport has recovered its pre-crisis modal share.
- Separating transport demand from economic activity, referred to as decoupling, has progressed somewhat since 2008, for both freight and passenger transport (especially for the latter). However, it is unclear to what extent these trends will continue under sustained economic growth, particularly for freight.

3.1 Introduction

This chapter reviews freight and passenger transport demand trends in Europe, with a focus on modal split and decoupling. Transport demand and the modes and fuels used to meet this demand largely determine the resulting environmental impacts. The chapter summarises and assesses the available data on transport demand for road, rail, air and sea, and its relationship with GDP. The concept of decoupling refers to the relationship between transport demand and GDP, and whether it is possible to break this link — in other words, whether it is possible to achieve economic growth without increasing transport demand (environmental pressures) and related impacts. The decoupling indicator measures the variation of transport demand intensity, i.e. the pkm or tkm associated with the production of EUR 1 of GDP.

Freight and passenger volumes have stagnated or slightly shrunk in EU-28 since their peak in 2007 and 2009 respectively, and this reduction has mainly affected road transport, which has seen its modal share slightly reduced. However, this general trend covers many and diverse situations among European Member States. Many factors affect the evolution of transport in comparison to that of GDP; underlying factors for freight and passenger transport developments are discussed in Chapters 5 and 6.

3.2 Freight transport

Total land freight transport within the EU-28 (road, rail and IWW) increased steadily throughout the 1990s and the early 2000s. Before the start of the recession in 2008, total transport volumes had grown by 22.4 % compared to 2000. Then, between 2007 and 2009, volumes plummeted (by 1.6 % in 2008 compared to 2007, and by 11.5 % in 2009 compared to 2008). In 2009, freight volumes were barely higher than in 2003. In 2010, volumes started growing again, but in 2011 and 2012, they dropped back by 0.2 % and 2.6 % respectively. Between 2000 and 2010, freight volumes grew by slightly less than 10 %. In the non-EU EEA, cumulative growth between 2000 and 2012 exceeded 15 %, reaching 35 % in Iceland.

Road haulage accounted for 75 % of total inland freight movements within the EU-28 in 2012, slightly lower than in 2011. Total road freight volumes in 2012 were below their levels in 2004, but still 11 % higher than in 2000. In the EU-15, road freight transportation fell by 5.4 % in 2012 compared to 2011, varying from a 13 % drop in Italy to a 3.5 % increase in Denmark. In the EU-13, volumes grew by 4.1 %, varying from a 6.6 % drop in the Czech Republic to a 12.6 % and 14.9 % increase in Romania and Bulgaria, respectively. In the non-EU EEA member countries, road shares range from 54 % in Switzerland to 100 % in Iceland.

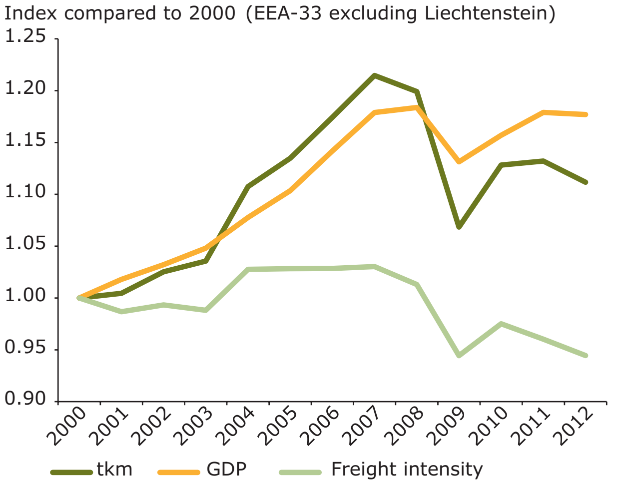
The tkm transported by rail have stabilised overall. In the EU-28, rail freight volumes were slightly higher in 2012 compared to 2000 (after having reached a peak increase of 11 % in 2007, compared to 2000). In 2012, the fall in rail tkm was larger than for road transport (− 3.6 % compared to − 3.0 %). The drop in rail in the EU-13 was larger than in the EU-15, with a 5.7 % decrease in tkm between 2011 and 2012. In the non-EU EEA members, rail freight volumes have fallen too, by up to 4 % in Switzerland.

In 2012, 150 billion tkm of goods were transported by IWW in the EU-28, an increase of 6 % compared to 2011. Throughout the years, a slow but steady increase can be observed in the volumes transported by IWW. Compared to 2000, total tkm in the EU-28 were up by 12 %. Here also, the EU-28 average masks important national differences. In the EU-15, tkm have remained stable compared to 2000, while they have almost tripled in the EU-13.

If we broaden the scope to include maritime transport and aviation, road was the dominant mode for freight transport in 2012 with a modal share in tkm of 45 % in the EU-28, followed by intra-EU sea transport estimated at 37 %. The modal share of road has increased from 42 % in 1995 to a peak of 46 % in 2009. Compared to 1995, the modal share of rail has decreased from 13 % to 11 %. Despite the increase in absolute volumes, the share of IWW has continued fluctuating around 4 %. The share of air transport for travel within the EU remains much lower than 1 %, but it is estimated that it will increase (DG Mobility and Transport, 2014).

If we look at the evolution of the intensity of freight transport in the economy (tkm per unit of GDP), with the year 2000 as a benchmark (Figure 3.1), we see that this intensity was lower from 2001 to 2003, but then increased from 2004 to 2008. Since 2009, the intensity of freight transport in the economy was lower than in 2000.

Figure 3.1 Freight transport volumes (tkm) and GDP



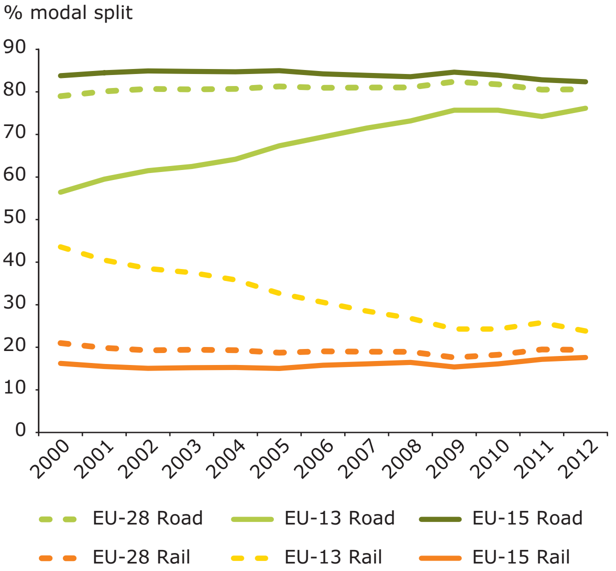
Note: Freight transport includes road, rail and inland waterways.

Decoupling has thus only occurred in periods of economic recession or stagnation. This is not surprising, as manufacturing tends to respond more than the service sector does to changes in economic activity (Foster-McGregor et al., 2012).

Figure 3.2 represent the development of decoupling for road transport only, splitting the overall results at EU-15 and at EU-13 level. For the EU-15, the

Figure 3.2 Freight road transport volumes (tkm) and GDP in EU-15 (left) and EU-13 (right)

Figure 3.3 Freight modal split between road and rail



road freight intensity of GDP has decreased steadily since 2004, and tkm have gone down since 2007 (with a small rebound in 2010). For the EU-13, road tkm have more than doubled since 2000. The road freight intensity of GDP has increased by 60 % over the same period, with just one small decrease in 2009 and a stabilisation in 2011. In interpreting these data, one should bear in mind that international transport is reported according to the country of registration of the vehicle, and not according to where transport takes place.

Figure 3.3 above shows that in the EU-13, the share of rail as a proportion of the combined road/rail total decreased from 43 % in 2000 to 24 % in 2012. Since 2009, this share seems to have stabilised. It still remains higher than in the EU-15 (18 %). Compared to 2000, the share of rail in the EU-15 has increased slightly (up from 16 %).

3.3 Passenger transport

For passenger transport, tendencies indicated by the statistics are generally smoother than for freight transport. This is related to the fact that many values are estimates rather than observations, something that should be kept in mind when interpreting the statistics. Passenger transport demand in the EEA-33, measured in pkm, experienced a sustained period of robust growth until 2005 for all modes. From that year until 2007, several countries, including France, Germany, Italy, the Netherlands and the United Kingdom showed a significant reduction in passenger car use (from 0.8 % in the United Kingdom, up to − 9.6 % in Italy) which may be associated with the impact of the economic downturn that affected some European Member States before the financial crisis. Other possible explanations for this decline in car use include the argument that these countries have reached and passed a societal 'peak' in demand for car travel. It is equally possible that some combination of the economic downturn and 'peak' car demand are responsible for the decline.

Since 2008, the impact of the economic crisis has been evident in passenger transport demand. Generally speaking, air transport seems more sensitive, and was the first to decrease — by − 1.9 % in 2008 and by − 6.9 % in 2009 — whereas car transport demand did not start to drop till 2010.

Focusing on passenger car transport, the total decrease over the last three years (2009–2012) is − 3.5 %; the decrease mainly affected EU-15 Member States, with a total decrease of − 4.2 %, whereas car transport in the EU-13 grew by 1.7 %. However, it is worth noting that there are striking differences among countries in this period, with demand decreasing significantly in some of them (such as Italy, Spain or the Netherlands) and growing boldly in others (such as Poland and Denmark).

In terms of per capita car travel, car mobility peaked in EU-15 in 2004, and most EU-15 Member States reached peak car travel values sometime between 1999 (Denmark) and 2007 (Sweden), before the economic downturn. In most EU-13 Member States, per capita car travel keeps growing, as in some non-EU countries such as Turkey, which experienced an impressive growth of 25.2 % between 2009 and 2012. The difference in per capita car travel among countries is reducing, suggesting a slow convergence among them (see Figure 5.1).

In the last four years (2008–2012), rail passenger traffic volumes have dropped significantly in many countries owing to the economic crisis, historic decline, or both. Traffic loss has been particularly high in eastern European countries such as Croatia (− 39.0 %), Romania (− 34.6 %), Latvia (− 23.3 %), Bulgaria (− 19.7 %), Greece (− 49.8) or Turkey (− 9.8 %), as well as in western European countries like Italy (− 9.9 %), Portugal (− 9.7 %) or Spain (− 6.2 %). However, passenger rail demand between 2008 and 2012 has continued growing in a few EU-15 countries, in some cases above 5 %, as in the United Kingdom (15.0 %), the Netherlands (11.7 %), Luxembourg (8.4 %), Denmark (7.5 %), Germany (7.2 %), Sweden (5.8 %) or Switzerland (8.4 %).

Trends in passenger demand for high-speed rail (HSR) are difficult to analyse, as traffic growth is greatly influenced by the opening of new services. Nevertheless, it seems that its share in total rail passenger traffic is still increasing in some countries (like Italy), while in others it peaked in 2010 (France and Spain) or earlier (Belgium, Portugal and Sweden).

Patterns for passenger demand for buses and coaches have some similarities with those for rail. Only a handful of countries showed significant growth in bus transport before the crisis, including Belgium, Ireland, France, Cyprus and Luxembourg (all of them indicating above 15 % growth between 2000 and 2012), and with more modest values, Italy and Spain. The economic crisis slowed down growth in most of these countries, and hit bus traffic in Spain particularly hard. In non-EU countries, bus and coach demand growth was significant in Turkey and Switzerland.

Air transport traffic has been particularly affected by the economic crisis. Traffic fell to record lows in 2009, with a decrease of 6.9 %, and after some gains in 2010, 2011 and 2012 were years of further air transport decline in Europe ([1]). Whereas traditional services have been particularly hit by this reduction, low-cost services have avoided demand decline, and have grown every year since 2008. However, at least for intra-EU-28 air travel, figures show a modest increase in passengers, and a more robust one in pkm suggesting higher average occupancies (or bigger planes being used) and longer trips.

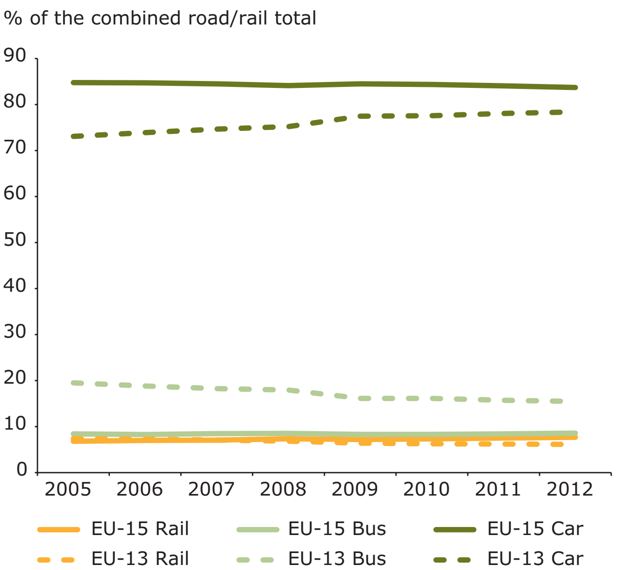
Within the EU-28, air traffic volumes have been redistributed, with some countries gaining traffic by more than 10 % since 2007, including Austria, Belgium, France, Estonia, Latvia, Lithuania, Luxembourg, Portugal, Malta, Poland and Romania. Countries such as the Czech Republic, Ireland, Greece, Slovenia and Slovakia lost air transport demand by more than 10 % in the same period; Spain, Cyprus and the United Kingdom experienced a more modest loss of demand. Turkey is the main driver of air passenger traffic growth in Europe (EUROCONTROL, 2013a).

Modal split analysis including air transport is limited to the EU-28, due to data availability restrictions. Modal shares trends have remained largely stable in the EU-28 in recent decades. Since 1995, air transport (including only intra-EU trips) has steadily increased its share, from 6.5 % in 1995 to 9.0 % in 2012, at the cost of land transport modes. The decrease in the car share is rather modest, from 73.3 % in 1995 to 72.2 % in 2012, after peaking at 74 % in 2002 and 2003. Rail retained a similar market share in 2012 compared to 1995 (6.5 %), after a slow but continuous recovery from its low at 5.9 % in 2003 and 2004. Buses and coaches kept losing market share at a very slow rate, from 9.4 % in 1995 to 8.2 % in 2012. There has been a steady trend in the EU-13 towards convergence with EU-15–average modal split values, mainly reflected in the quick growth in the car share compared with other modes (see Figure 3.4).

Trends in inland passenger transport demand and GDP (see Figure 3.5) show a general decreasing trend in intensity (pkm/EUR), originating in the mid-1990s, with the exception of 2009. That year, the sharp reduction in GDP in the EEA-33 was associated with a slight increase in transport volumes compared to previous years, suggesting that passenger transport demand reacts less (and more slowly) to changes in GDP than freight does.

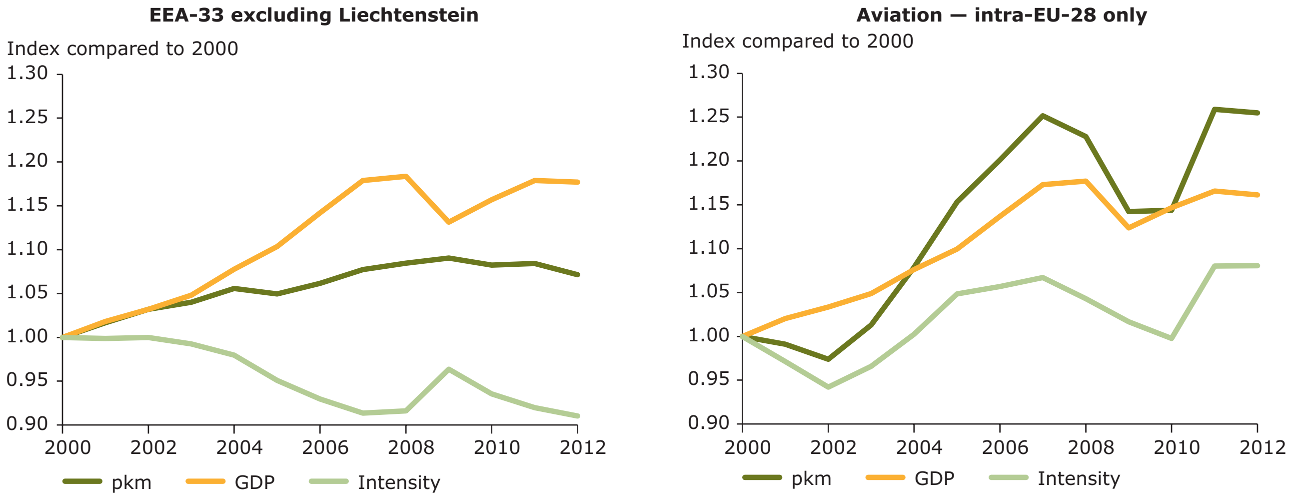
It is worth noting that current decoupling patterns, as illustrated in the figure, are consistent with the peak car travel hypothesis: the slow decoupling trend might suggest that countries are reaching an asymptotic value regarding car travel, which remains by and large the main component of inland travel demand. However, passenger statistics are

Figure 3.4 Passenger transport modal split



([1]) This refers to EUROCONTROL's Statistical Reference Area, which covers most of the EEA-33 and Ukraine. EU-28 air travel figures show an important increase in pkm in 2011 remaining stable in 2012.

Figure 3.5 Trends in passenger transport demand (pkm) and GDP, EEA-33 excluding Liechtenstein, inland transport (left) and EU-28, only aviation (right)



Note: Left graph: EEA-33, car, bus and rail; right graph: EU-28, only domestic and intra-EU-28 air transport; provisional estimates.

still mostly based on estimations, and the existing data is also not harmonized across member states, and therefore are not robust enough to extract a firm conclusion on decoupling patterns yet.

A similar analysis, for air transport demand in EU-28, suggests that there is no decoupling trend in this sector, in spite of recent demand reduction in recent years following the economic downturn. Despite the sharp decrease of the intensity of air passenger transport in the economy in 2010, the intensity has regained the level of pre-crisis years.

A more detailed analysis, at individual country level, shows that passenger transport intensities tend to decrease for those countries with higher per capita GDP, whereas in countries with lower per capita GDP, there is a huge range of intensity values. Decoupling trends are evident in virtually all the countries when considering the whole 2000 to 2012 period, with Cyprus, Greece, Ireland and Portugal being the only exceptions (for which the data are estimates). It does not seem that a loss in GDP is associated with a comparable loss in passenger transport demand.

Part B: environmental pressures from long-distance transport

4 The importance of long-distance transport for the environment

Key messages

- For freight transport, 75 % of the total volumes are allocated to long distances (greater than 300 km), while the picture is reversed for passenger transport, with only 20 % of the total volume allocated to distances exceeding 300 km.
- Freight and passenger long-distance transport demand account for a significant percentage of total transport emissions, and are crucial for attaining European emission reduction targets. International aviation and maritime transport alone are responsible for 19 % of overall NO_x emissions, 17 % of overall SO_x emissions and 11 % of overall $PM_{2.5}$ emissions.
- The reduction in freight transport during the economic crisis has led to better environmental performance, at least in terms of emissions; it is uncertain, however, whether these gains will be consolidated as the European economy improves.
- Long-distance transport may have a significant impact in environmentally sensitive areas around Europe; actions are in progress in many of these areas (i.e. the Alps, the Pyrenees and the Sulphur Emission Control Areas (SECAs) for the Baltic Sea).

4.1 How much transport is long-distance transport?

The concept of long-distance transport is not clearly defined by statisticians, policymakers or researchers. It may refer to a geographical scope (differentiating between urban and non-urban transport, or between domestic and international transport) or to transport activity over a certain distance.

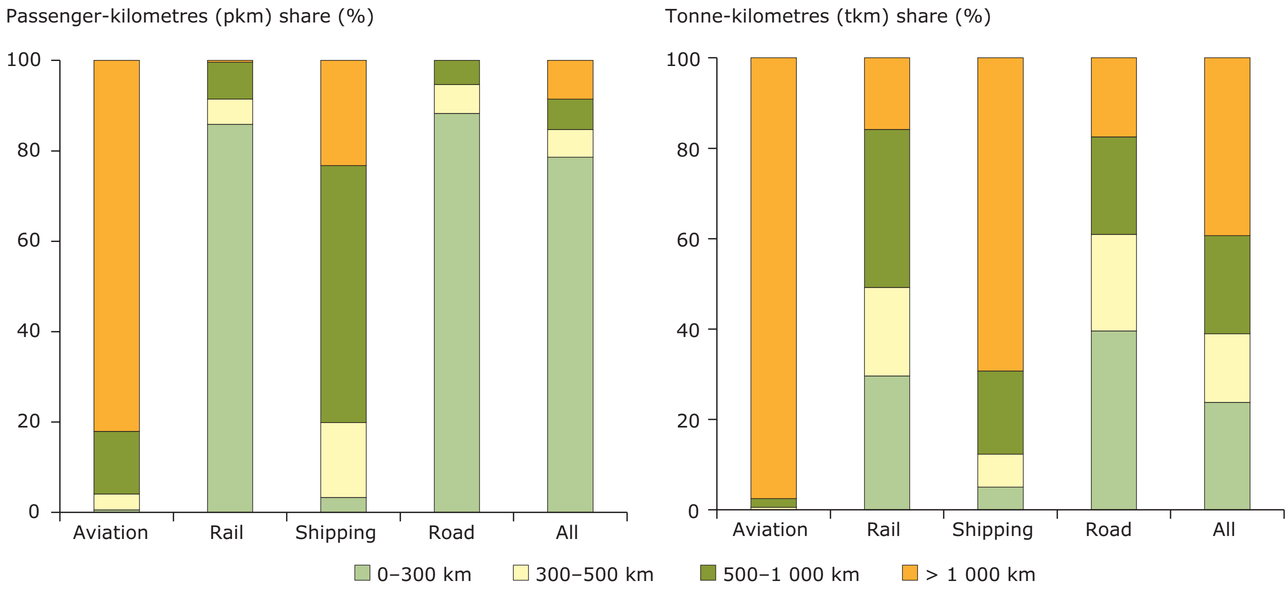
Some typical thresholds can be identified in statistics. For freight transport by road, Eurostat makes a distinction between haul distances 0–50 km, 50–150 km, 150–300 km, 300–500 km, 500–1 000 km, 1 000–2 000 km and beyond 2 000 km. For maritime and air transport, data can be classified by distance taking into consideration ports and airports of origin and destination. Information on distance travelled by passengers is provided by national transport surveys that are not harmonised at European level and are not available in all countries. The low threshold for long-distance transport varies from 80 km in the analysis of the French National Transport Survey (Grimal, 2010) to 400 km (Kuhnimhof et al., 2009). The 300 km limit is consistent with the 2011 Transport White Paper, which sets the goal of shifting 30 % of road freight transport of distances above 300 km to other modes such as rail or waterborne transport by 2030, and more than 50 % likewise by 2050. For passenger transport, the goal is for most medium-distance passenger transport (50 % over 300 km) to be by rail by 2050.

Figure 4.1 shows the allocation of total passenger (left-side graph) and freight (right-side graph) transport volumes into different distance bands for each transport mode (aviation, rail, shipping and road) for the year 2010, as estimated by the TRACCS project for EU-28 (Emisia, 2013).

For freight transport, 75 % of the total volumes are allocated to long distances (exceeding 300 km), half of which (37 %) is above 1 000 km. According to the latest data from Eurostat, 56 % of all EU-28 road freight journeys in 2012 exceed 300 km (Eurostat, 2013).

For passenger transport, the picture is reversed, with only 20 % of the total volume allocated to distances above 300 km. The vast majority of pkm (more than 85 %) in road and rail (which includes metro, trams and urban rail services) are in the

Figure 4.1 Passenger (left) and freight (right) transport shares in distance bands in the EU-28, 2010



Note: Data from TRACCS project (see http://www.traccs.emisia.com). Aviation and shipping include international intra-EU trips only. In the absence of recent robust statistical data, the split for road passenger transport is an estimate based on mobility surveys in a number of European countries (Eurostat, 2000).

lower distance band (below 300 km). The opposite is observed for aviation and shipping.

Emissions from long-distance transport

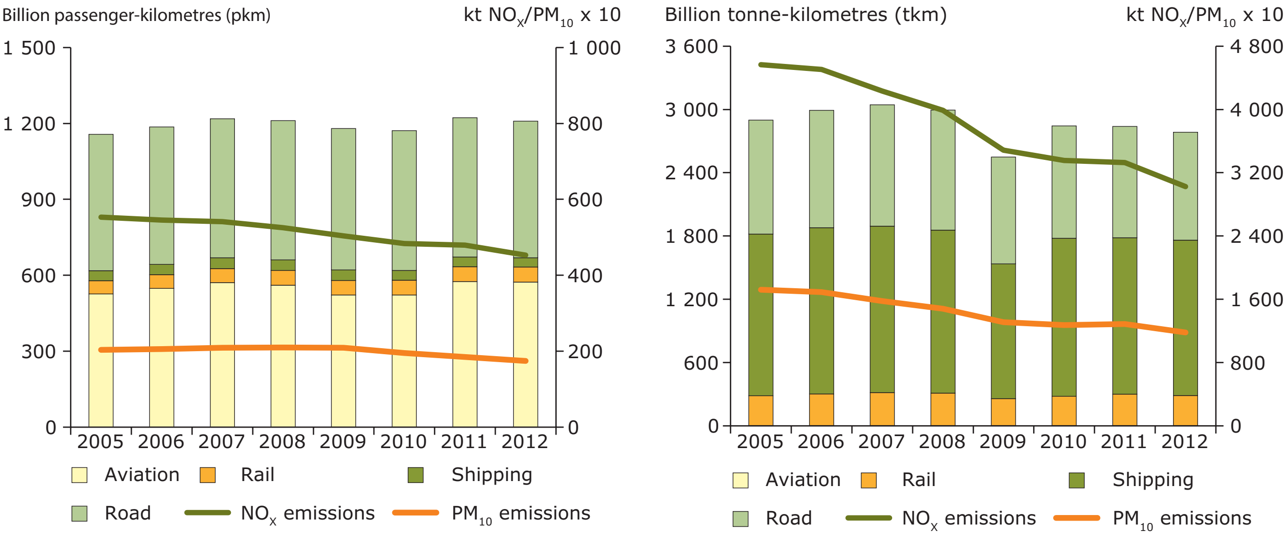
Figure 4.2 shows the changes between 2005 and 2012 in total NO_X and PM_{10} emissions against passenger and freight transport volumes for the different transport modes. Further analyses, related to specific emissions from passenger and freight transport modes, are included in Chapters 5 and 6 respectively.

Total NO_X emissions from long-distance passenger transport have decreased by 18 %, despite the 5 % increase in passenger transport volume. This is due to the combined effect of a reduction in specific emissions (in g/pkm) for road and aviation, and the slight shift in activity from road (47 % share in 2005, down to 45 % in 2012) to aviation (45 % share in 2005, up 47 % in 2012). The NO_X-specific emissions from aviation are about one-third compared to road (0.11 g vs 0.32 g of NO_X per pkm). PM_{10} emissions have also decreased by 15 % over the same period, mainly because of the reductions from road vehicles as a result of stricter emission limits. Shipping, despite its small contribution to total long-distance passenger transport volume (about 3 %), dominates PM_{10} emissions (62 % in 2012) and is responsible for almost half of the total NO_X emissions from long passenger transport (47 % in 2012). This is due to the very high specific emissions, one order of magnitude higher as compared to road.

Total PM_{10} and NO_X emissions from long-distance freight transport decreased considerably (by 31 % and 34 % respectively) as a result of the lower total freight volumes in 2012 compared to 2005, and of the reduction in the specific emissions from all transport modes, particularly for road and shipping. Despite the considerable improvement in emissions performance, shipping remains the largest polluter, being responsible for 64 % and 73 % of the total long-distance freight transport NO_X and PM_{10} emissions respectively, and for the majority of SO_2 emissions. Emissions from heavy-duty trucks have been also been reduced substantially due to the introduction of sophisticated aftertreatment devices (such as diesel particulate filters (DPFs) and selective catalytic reduction (SCR)); however, road still contributes roughly 33 % and 24 % in total NO_X and PM_{10} emissions respectively.

Overall emissions, and their related environmental impacts, are significantly influenced by long-distance transport, particularly by road, shipping and aviation. Data from the UNECE LRTAP Gothenburg Protocol (see also Box 2.4) show that international aviation and maritime transport together are responsible for 19 % of overall NO_X

Figure 4.2 NO_x and PM_{10} emissions from long-distance passenger (left) and freight (right) transport in the EU-28, 2012



Note: The figures above include only long-distance transport (exceeding 300 km). Own estimations based on total 2012 transport demand figures (DG Mobility and Transport, 2014), the TRACCS project for the allocation of total activity to different distance classes and hence for estimating the share of long-distance transport for all transport modes except road passenger transport, where Eurostat (2000) has been used. Aviation and shipping include international intra-EU trips only (the aviation share of tkm is imperceptible in the right graph). Calculation of air pollutant emissions is based on data from the EC4MACS project for road transport (see http://www.ec4macs.eu) and own estimations, using Tier 1 emission factors from the EMEP/EEA air pollutant emission inventory guidebook 2013 (EEA, 2013c) for the non-road transport modes.

emissions, 17 % of overall SO_x emissions and 11 % of overall $PM_{2.5}$ emissions (these shares apply to both the EU-28 and the EEA-33); long-distance road passenger transport has a lower, but still significant influence in total emissions compared to road freight.

The future achievement of further reductions is associated with regulatory changes aiming at encouraging environmentally friendly measures, including technological developments (see Chapter 7). For instance, it is worth recalling that European regulations have established pollutant emission targets for road vehicles (cars, vans and trucks) since 1970, and have regularly updated the original directives for light-duty vehicles (Council Directive 70/222/EEC on the approximation of the laws of the Member States relating to the space for mounting and the fixing of rear registration plates on motor vehicles and their trailers) and for heavy-duty vehicles (Council Directive 88/77/EEC on the approximation of the laws of the Member States relating to the measures to be taken against the emission of gaseous pollutants from diesel engines for use in vehicles). Emissions from rail diesel locomotives were first regulated by Directive 2004/26/EC amending Directive 97/68/EC on the approximation of the laws of the Member States relating to measures against the emission of gaseous and particulate pollutants from internal combustion engines to be installed in non-road mobile machinery, one of the 'daughter' directives following Directive 97/68/EC on emissions of non-road mobile machinery, and amended subsequently at various stages. Air pollutant standards for maritime transport are being discussed under the International Maritime Organization (IMO) and for air transport in the International Civil Aviation Organization (ICAO).

4.2 Environmental impacts of long-distance transport in Europe

The environmental impacts of long-distance transport in Europe can be described by considering their spatial scale. Rather than attempting a comprehensive review of environmental impacts, this section illustrates the influence of long-distance transport activity on particular ecosystems and communities (local level), on particularly sensitive areas (regional level) and on major environmental challenges (global level).

4.2.1 Local environmental impacts of long-distance transport

The local impact of transport activity has been already documented in past TERM reports (EEA, 2012 and

2013a). TERM 2012 reviewed the impact of transport on air quality. TERM 2013 analysed the influence of transport on the quality of life of cities.

Local communities may have mixed perceptions towards long-distance transport activity in their surroundings. On the one hand, transport activity may be considered an opportunity for economic and social development, through improved access to global markets and services, and development of supporting and associated activities, from logistics to tourism. On the other hand, long-distance transport requires high-capacity infrastructure, with significant land occupancy, and round-the-clock operation of high flows.

At local level, the effects of long-distance transport may result in a complex combination of environmental impacts, loss of quality in locally oriented transport services and accumulation to already existing problems, such as air quality and noise (see Boxes 2.5 and 2.6). As illustrated in Box 4.1, the expansion of infrastructure serving primarily long-distance transport usually is perceived as a threat to quality of life, giving rise to concern and provoking opposition from a wide range of local stakeholders, from residents to local businesses. In many cases, this has resulted in adding expensive compensatory measures to the project, to the point that it can be argued that its expected benefits no longer justify its final tag price. In other cases, public opposition has been successful in delaying or halting project implementation. The relevance of local environmental impacts for project acceptance can be viewed as a symptom of the complex power processes associated with project design and approval (Flyvbjerg, 2005a). Participatory processes serve as a means to properly identify these interactions and to integrate appropriate measures within the new project, providing more reliable implementation cost figures, and better estimates of the pros and cons of the project. These processes usually avoid underestimation of overall costs and local environmental impacts, and overestimation of benefits (Flyvbjerg, 2005b), becoming a crucial element for the provision of more collaborative and transparent planning frameworks.

Transport infrastructure is in itself another source of environmental concerns. It creates barriers to animal movement, leading to habitat fragmentation and possibly resulting in the isolation and extinction of vulnerable species and animal casualties (Damarad and Bekker, 2003). As transport

Box 4.1 Major transport infrastructure expansion and the local environment

There is a long list of major transport infrastructure schemes that have sparked controversy amongst a variety of groups owing to their local environmental impacts (see Flyvbjerg et al., 2003 for more examples).

- In spite of the opposition from a variety of local groups, plans to build a third runway at Heathrow airport (United Kingdom) were approved in 2009. It was later abandoned, following the change of government in May 2010; subsequently, the airport operator submitted a revised plan in 2013, which is generating much debate.
- The Betuwe rail line, a freight dedicated line linking the port of Rotterdam (the Netherlands) to Germany, has also generated much debate in the Netherlands since the concept was presented by the government in the late 1980s. The line was included in the Trans-European Transport Network (TEN-T) priority projects and was finally opened in 2007, after doubling its initial cost estimate of EUR 2.3 billion. The additional cost was partly due to the adoption of measures to mitigate impacts on the landscape, reducing noise and building wildlife passages to limit fragmentation of animal habitats. Even at its initial estimate, the economic feasibility of the project was doubted by its critics. The assessment of the project at the initial stages and its approval were probably favoured by the lack of proper consideration of existing cheaper alternatives (mainly waterways), and an adequate assessment of local environmental impact reduction costs (Priemus, 2008).
- Rail freight and passenger traffic has been growing rapidly in the Lyon area (France). The rail network layout means that nearly all freight trains travelling north–south have to pass through the centre of the town, on the same lines used to provide the daily Regional Express and High Speed services. Discussions on the new bypass project started in 2002. The project was seen as crucial for achieving the TEN-T vision of moving long-distance freight traffic from road to rail. The declaration of public interest (declaration d'intêret public (DIP)) was approved by the French government in 2012. Residents were concerned by rail noise, particularly at night, and by the increase in through freight train traffic in local rail stations. The public participatory processes have resulted in a commitment to assess a variety of mitigation measures, increasing the cost of the project.

infrastructure consists of mostly impervious surfaces, it also contributes to soil sealing, which affects the water balance and water regulation at local and watershed scales (increasing, for instance, the risk of floods) and contributes to the 'urban heat island' effect (DG Environment, 2012). The literature on emissions attributable to transport infrastructure construction and operation is limited and highly context dependent. However, a recent summary study concluded that GHG emissions linked to construction and operation of transport infrastructure could represent between 15 % and 30 % of the overall GHG footprint of individual modes (Hill et al., 2012), albeit with substantial differences among modes and depending on context. Total emissions from infrastructure construction and operation have been estimated at 3.2 % of lifecycle emissions from aviation. For HSR, estimated shares vary from 5 % to 80 % of lifecycle emissions, depending on the topography of the line and its actual traffic (Hill et al., 2012). A recent publication for Germany (UBA/Öko-Institut, 2013) shows similar shares of GHG emissions caused by construction, maintenance and operation of the infrastructure and vehicles for all means of transport (local passenger traffic between 12 % and 26 %, long-distance passenger traffic between 10 % and 29 % and freight traffic between 4 % and 29 %).

4.2.2 *Regional environmental impacts: sensitive areas*

Long-distance transport activity is responsible for various environmental impacts at regional level. This includes the impacts caused by some pollutants that undergo atmospheric transformation processes, such as NO_X, SO_2 and NH_3: they form secondary particulate matter, organic aerosols formed from the atmospheric oxidation of VOCs, and O_3 formed from the reaction of NO_X with VOCs and CO in the presence of sunlight. Emissions from road, maritime and air transport have the potential to increase background concentrations of key pollutants at a regional level: for example, at any given location, the background concentrations of $PM_{2.5}$, PM_{10} and NO_2 will be influenced by traffic emissions from the whole surrounding region including motorways, other towns and cities, and even other countries (EEA, 2012).

The impact of transport activity may be more acute in areas with particularly fragile environmental conditions such as mountains or maritime and coastal areas. Transport effects on mountainous areas have been closely monitored for some decades now, particularly in the Alps and other transboundary areas such as the Pyrenees (Molitor et al., 2001). These regions concentrate long-distance, international traffic flows in a few corridors crossing unique ecosystems, mostly in narrow valleys.

Large European rivers are also complex, sensitive ecosystems, subject to significant environmental pressure from inland waterway transport. Activities to reduce the environmental hazard of inland navigation include the protection against pollution resulting from accidents ('accidental pollution') and the protection at the level of working procedures on board vessels, including the treatment of waste produced ('operational pollution') (Panteia/NEA et al., 2013). Dredging (including the disposal of material) is another topic of potential environmental pressure. The EC has recently issued new guidelines on inland navigation and nature protection, in order to assist this sector in applying EU environmental legislation (EC, 2012b).

The IMO regulates emissions from ships with the International Convention for the Prevention of Pollution from Ships (MARPOL) Annex VI (the regulations for the prevention of air pollution from ships). This sets limits on NO_X and SO_X emissions and prohibits deliberate emissions of ozone-depleting substances. It also contains provisions allowing for special SECAs, where stricter emission limits apply. MARPOL defines these sea areas as 'special areas' in which, for technical reasons relating to their oceanographical and ecological condition and to their sea traffic, the adoption of special mandatory methods for the prevention of sea pollution is required. At European level, Directive 2005/33/EC amending Directive 1999/32/EC as regards the sulphur content of marine fuels designated the Baltic Sea, the English Channel and the North Sea as SECAs. It also limited the maximum sulphur content of the fuels used by ships operating in these sea areas, which, after a further amendment by Directive 2012/33/EU amending Council Directive 1999/32/EC as regards the sulphur content of marine fuels, is set at 1.00 % (% by mass) until 31 December 2014 (and 0.10 % as of 1 January 2015) as well as in sea areas outside SECAs (3.50 % as of 18 June 2014 and, in principle, 0.50 % as of 1 January 2020). However, there is currently no binding EU legislation on NO_X emission reductions from ships.

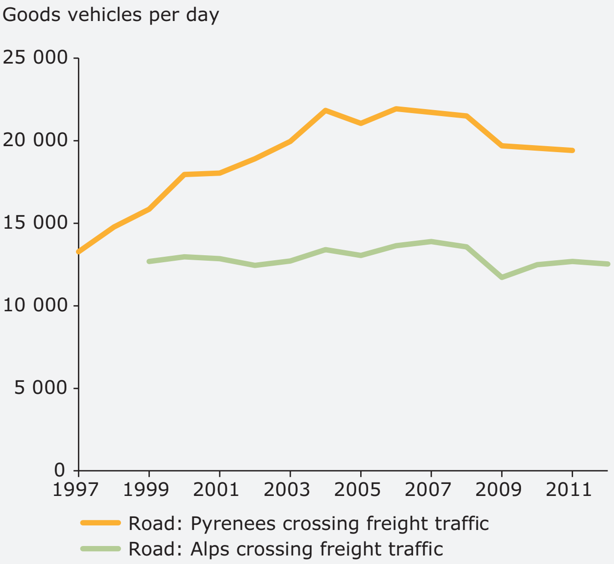
Transport can also lead to the release of hazardous substances in the environment, as the result of accidents or of deliberate discharges (EEA, 2011). Spills due to large-scale disasters are the most visible source of release of hazardous substances at sea (e.g. the *Prestige* incident in 2002), and the

Box 4.2 Increasing concentration of NO_2 in mountain valleys

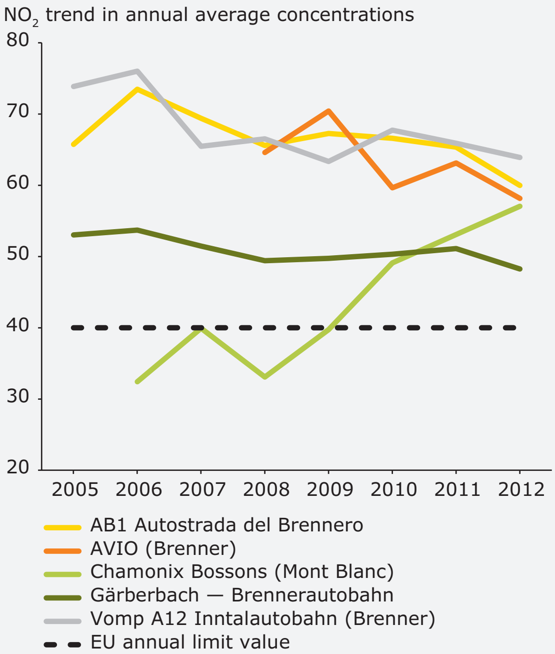
The morphological shape of narrow mountain valleys (U- or V-shape) means that emissions from combustion cannot escape, significantly affecting residents and natural ecosystems in those areas affected by heavy traffic. Studies show that the same traffic load contributes to a three-times-higher concentration of nitrogen oxides in the ambient air in mountainous areas than in lowland areas, due to the meteorological particularities (Kocsis, 2000).

Different observatories have been set in place to monitor traffic conditions through the Alps and the Pyrenees, with a focus on trends in road and rail freight transport. Freight transport volumes through the Alps show a clear association with GDP, growing between 1999 and 2007, falling between 2007 and 2009, and slightly increasing and stabilising afterwards (Lückge et al., 2014). A similar association between freight transport and GDP can be seen in the Pyrenees (Ministerio de Fomento, 2014) although the volumes are higher (see left graph below).

Goods vehicles per day (annual average)



NO_2 trend in annual average concentrations



In spite of a general improvement in air quality, due to the implementation of new engine technologies and to the recent reduction in traffic volumes, an increase of concentration of pollutants has been found in some cases (see right graph above for NO_2 in some Alpine traffic air-quality monitoring stations) in the main transalpine crossings. This is the case for NO_2 in the transalpine tunnels in France (*tunnel du Mont blanc-Chamonix Bossons station*), where the limit value for the annual average has not been complied with since 2010, despite some reduction in traffic volumes. In the case of the Brenner Pass between Italy and Austria, the limit value for the annual average has not been complied with since at least 2005 in the four traffic stations where data are available. This seems to be a consequence of the new Euro standards in place, which have imposed a dramatic reduction in NO_x emissions, but sometimes have simultaneously increased emissions of NO_2, as reported in Lückge et al. (2014). See Box 4.1 in TERM 2013 (EEA, 2013a) for more information.

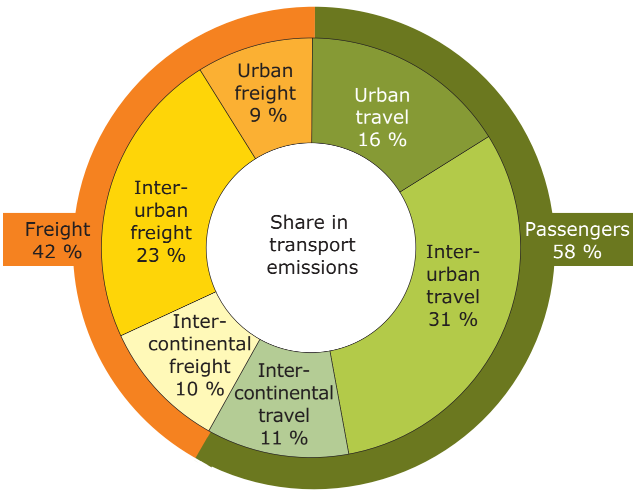
worldwide double-hull obligation to transport the most dangerous oil products was introduced back in 2003. The frequency of spills has abated over time, but systematic monitoring of minor spills should improve, as their cumulative impact constitutes a much more important environmental threat than major disasters (see Ng and Song, 2010 for an overview). In this respect, the systematic monitoring, since 2007, by the European satellite-based oil-spill monitoring and vessel-detection service CleanSeaNet, constitutes an important step forward. Between 2008 and 2013, the number of possible oil spills detected decreased from 3 311 to 2 176, with the most marked decrease in the first few years of operation (European Maritime Safety Agency, 2014).

4.2.3 Global impacts of long-distance transport

Climate change caused by GHG emissions is one of the main global impacts of transport activity. Globally, GHG emissions from the transport sector have doubled since 1970, reaching 7.0 gigatonnes CO_2-equivalent in 2010. Some 80 % of this increase is attributable to road transport (IPCC, 2013). Between 1990 and 2008, the average worldwide annual growth of transport GHG amounted to 2.05 % — for road, aviation and international shipping, the growth rate was even higher (2.18 %, 3.20 % and 2.75 % respectively) (ITF/OECD, 2010a). In the Organisation for Economic Cooperation and Development (OECD), the growth rate of transport GHG emissions was smaller (1.37 % per year in the period from 1990 to 2008), except for international aviation (3.64 %) (ITF/OECD, 2010b).

Within the EU-28, GHG emissions from the transport sector (including international bunkers) totalled 1 173 million tonnes of CO_2-equivalent in 2012. Non-urban transport has been estimated to account for around 75 % of the CO_2 transport emissions responsible for climate change (EEA, 2013a). Recent modelling including international travel has shown that 21 % of all CO_2 transport emissions come from inter-continental travel (over 500 km) as presented in Figure 4.3.

Figure 4.3 Shares in EU transport greenhouse gas emissions in 2010



Note: These are updated estimates for 2010 based on the PRIMES-TREMOVE model and are not from official statistics. A short description of the model is provided in the impact assessment accompanying the 2011 Transport White Paper (EC, 2011c).

Source: DG Mobility and Transport, 2013.

Transport GHG emissions in the EU-28 peaked in 2007 at 1 311 million tonnes of CO_2-equivalent and decreased by 10.5 % between 2007 and 2012. Overall, between 1997 and 2012, transport GHG emissions in the EU-28 grew by almost 7 %, while economy-wide emissions had decreased by 13.6 % over the same period. The share of transport (including international bunkers) in EU-28 GHG emissions now stands at 24.3 %. The strongest growth in consumption has come from the international bunkers for aviation (41.9 %) and maritime transport (14.2 %), while the growth in road transport was more limited (2.9 %).

The interpretation of figures related to maritime and aviation sectors should be considered carefully: they are reported based on fuel sales or on activity modelling, both of which are accompanied by uncertainty. For international maritime shipping, emissions are reported as memo items in the United Nations Framework Convention on Climate Change (UNFCCC) and LRTAP, based on top-down calculations using bunker fuel statistics known to be uncertain, and there are differences in definitions of fuel categories. Other studies (IMO, 2014) apply bottom-up methodologies to calculate ship emissions based on individual ship or ship-category activity data and fleet characteristics. Such approaches are based on assumptions regarding key parameters (installed engine power for a ship, number of hours at sea, bunker fuel consumed per power unit (kilowatt (kW)), average engine load, and emission factors). Spatial allocations of emissions are especially uncertain (Eyring et al., 2010). Moreover, one needs to take into account emissions at berth (EEA, 2013d).

The impact of aviation is driven not just by the long-term impacts from CO_2 emissions but also by the shorter-term impacts from non-CO_2 emissions and effects, which include the emissions of water vapour, particles and NO_X (Lee et al., 2010). Burkhardt and Kärcher (2011) have concluded that net radiative forcing due to contrail cirrus remains the largest single radiative forcing component associated with aviation. Chapter 6 of the latest report on air quality in Europe (EEA, 2014b) provides a summary of the air pollution effects on climate change.

Long-distance transport emissions can also cause air quality levels to deteriorate, affecting populations and ecosystems in places located very far away from where pollutants were emitted — some air pollutants are transported over long distances. This is the case of O_3 anthropogenic precursors: it is estimated that between 20 % and 25 % of them are transported over long distances. This is the case also for NH_3 produced by road traffic, that acidifies both land and surface waters well beyond the place where emissions are actually emitted (EEA, 2012).

Intrusion of invasive species is another significant global environmental hazard. Invasive alien species (IAS) are considered important threats to biodiversity, agriculture, forestry and public health which also damage infrastructure and recreational facilities. It is estimated that they have cost the EU at least EUR 12 billion per year over the past 20 years and that EU Member States spend about EUR 1.4 billion per year tackling them (EC, 2013a). Worldwide economic losses from the damage caused by harmful invasive aquatic species alone have been estimated at more than 7 USD billion per year in 2004/2005 (WWF International, 2009), even excluding indirect economic losses caused by changes to marine biodiversity and habitats.

There are three important channels through which long-distance transport leads to their introduction (EC, 2013a). First, the deliberate import of IAS from their country of origin corresponds to just a quarter of IAS in the EU. The IAS that have been released unintentionally can appear as contaminants in a traded commodity such as weed seeds in pots of horticultural plants, or are released as stowaways in a transport vector (as the famous case of zebra mussels on ship hulls).

Global environmental pressures from transport are issues to be dealt with in the framework of multilateral cooperation. The EC includes within its 2011 Transport White Paper (EC, 2011a) an 'external dimension', which includes harmonisation, competition and environmental topics to be addressed at global level. This concerns mainly maritime and air transport, which are global in nature. Progress in both directions, under ICAO and the IMO, remains uncertain at this stage, as compared to EU ambitions. However, for maritime a first success was recorded through the 2011 agreement in IMO on an Energy Efficiency Design Index (EEDI) for new ships. In addition, in 2013 the European Commission proposed a regulation (under discussion in European Parliament/Council) setting up an EU system for monitoring, reporting and verification (MRV) of CO_2 emissions from international shipping. For aviation, in 2013 a breakthrough was achieved with a decision by the ICAO to design a global CO_2 emissions offsetting scheme that could be implemented from 2020.

4.2.4 *Improving the monitoring of impacts of long-distance transport*

There is still significant room for improvement in monitoring the environmental impacts of long-distance transport. In the case of GHG emissions, this mainly refers to three areas: first, there is still a need for comprehensive assessment of emissions for the whole transport sector, including the lifecycles for infrastructure (from construction to maintenance and renewal), vehicles (from manufacturing to end-of-life disposal) and fuel (including extraction, processing and distribution). Second, there is a need to differentiate GHG emissions from passenger and freight by transport mode. Third, in order to better inform policy decisions, access to more detailed information on GHG emissions, and other environmental impacts, should be more clearly related to door-to-door trips, taking into account the actual transport modes and routes followed within the travel chain, and the environmental footprint of the activities associated with transport within the trip. Regarding the second point, it is therefore positive that, according to the decisions taken under the UNFCCC (Decision 24/CP19), from 2015 onwards it will be possible to obtain GHG emissions data from different types of vehicles (including heavy-duty trucks and buses) separately.

A review by Hill et al. (2012), and also the UBA/Öko-Institut (2013), concluded that GHG emissions due to transport infrastructure and to vehicle manufacturing and disposal are significant components of the overall transport GHG footprint, and are likely to increase in the future. This is due to the increasingly sophisticated design of operations of infrastructure and vehicles, which in their turn will make it possible to achieve emission savings in transport operations. This could be the case, for example, for manufacturing of electric vehicles compared to conventional ones. Manufacturing and disposal could account for 16 % of total emissions for the lifecycle of passenger cars, to 8 % for high duty road vehicles, to 5 % for rail rolling stock, and to more variable values for ships and airplanes: 1.3 % to 12.5 % for the former, and 5 % to 11 % for the latter.

Information is also scarce on the disposal of end-of-life transport means. Directive 2000/53 on end-of-life vehicles tackles this issue for light-duty vehicles (cars and vans), and its technical annexes are regularly updated in line with technical progress. Eurostat data show that the percentage of recovery and reuse for end-of-life vehicles increased from 84.1 % in 2007 to 88.4 % in 2011 in the EU-27; the percentage for recycling and reuse increased in the same period, from 78.4 % to 84.1 %. The EU Ship Recycling Regulation (1257/2013) was approved in December 2013, putting into force an early implementation of the requirements of the 2009 IMO Convention for the Safe and Environmentally Sound Recycling of Ships. There is no specific European legislation for end-of-life disposal of rail rolling stock or airplanes. The Aircraft Fleet Recycling Association (AFRA) estimates that more than 12 000 aircraft will be retired in the next two decades (Perry, 2012).

Information currently available does not make it possible to link origins and destinations with the routes actually followed by passengers and freight. Current multimodal patterns are concentrating transport flows in a limited number of hubs or gateways in Europe and elsewhere. This trend often results in larger travelled distances and overall emissions, even if additional emissions associated with them might be offset by reduced specific emissions per kilometre (tkm or pkm) due to higher load factors and the use of bigger, more efficient vehicles. However, there is no factual evidence on how these factors are interacting. In the case of freight, the development of logistics is resulting in the integration of an increased number of operations within the transport chain, rendering attempts to measure environmental impacts even more complex. Green logistics try to provide a comprehensive view to the environmental performance of supply, production and distribution processes (McKinnon and Whiteing, 2012). Recent efforts include the EU project SuperGreen (see http://www.supergreenproject.eu) that has analysed a set of key performance indicators (KPIs) related to transport cost, CO_2 and SO_X emissions, average transport speed, frequency and reliability of service including CO_2/tkm, for a number of European corridors.

5 Long-distance passenger transport

Key messages

- The number of trips taken in urban areas is much greater than the number of long-distance passenger trips. Despite this, long-distance passenger transport volume (passenger-kilometres) accounts for up to 40 % of all journeys.
- The key drivers of transport demand are likely to be different across European countries: a reduction of transport prices (absolute or relative to disposable income) and population changes (natural or due to migration) have been influential in the past decade, but they seem to have lost relevance during the last decade.
- New, emerging factors, such as changes in lifestyles, could replace some traditional reasons for transport demand in future. Changes in lifestyles are the subject of increasing interest from researchers, as these changes could result in reducing private car use, particularly among young Europeans.
- Car and air travel are the main emission sources for long-distance passenger transport. In spite of technical developments and attempts to raise occupancy rates, average specific emissions per passenger and kilometre have not significantly decreased in recent years.
- High speed rail services offer great reliability, speed and comfort, as well as more flexible pricing management. This makes them very competitive for certain hub-to-hub long distance connections. However, expansion of high speed rail requires careful analysis, due to the large financial costs and potential environmental impacts involved in its construction.

5.1 Evolution of long-distance passenger transport and modal shares

Estimates on long-distance passenger transport activity (pkm) require distance-related information on car passengers that can only be estimated based on surveys. The 2008 French national survey (Grimal, 2010) estimated that long-distance trips (in this case, defined as those over 80 km) account for only 1.3 % of trips (non-motorised modes included), and for almost 40 % of the total distance travelled (pkm). This is in line with estimates shown in Figure 4.1, suggesting that slightly more than 20 % of pkm is allocated to distances above 300 km. Even if figures are lower in smaller countries, it can be concluded that, with existing technologies and the current modal split, long-distance transport accounts for a significant part of GHG emissions (Figure 4.3) and other environmental pressures.

Since the turn of the century, a number of emerging trends have challenged the traditional picture of long-distance passenger transport in Europe. According to that, growth in transport volumes was mainly driven by the expanding use of private cars and the exploding growth of air transport. Rail transport played a secondary role, without fully realising the expectations linked to high-speed services, and buses and coaches retained its modal share.

Three recent trends are worth highlighting.

- Private car use seemed to peak in some European countries in the first decade of the century (Millard-Ball and Schipper, 2010; ITF/OECD, 2013a; EEA, 2013a). The data available are not detailed enough to determine, however, to what extent urban and long-distance travel are behaving in the same way or are following different patterns.
- Air traffic growth seemed also to peak for short- to medium-range flights ('internal flights'), once low-cost strategies had generalised the access to air travel. Air companies were increasingly focusing their growth strategies on long-haul

flights between Europe and fast-growing countries and regions around the world.

- Rail renaissance, based on HSR, has materialised, albeit restricted to the few corridors around Europe providing these services, and with limited impact on total demand figures. Rail seemed to be attracting mainly — but not exclusively — professional trips.

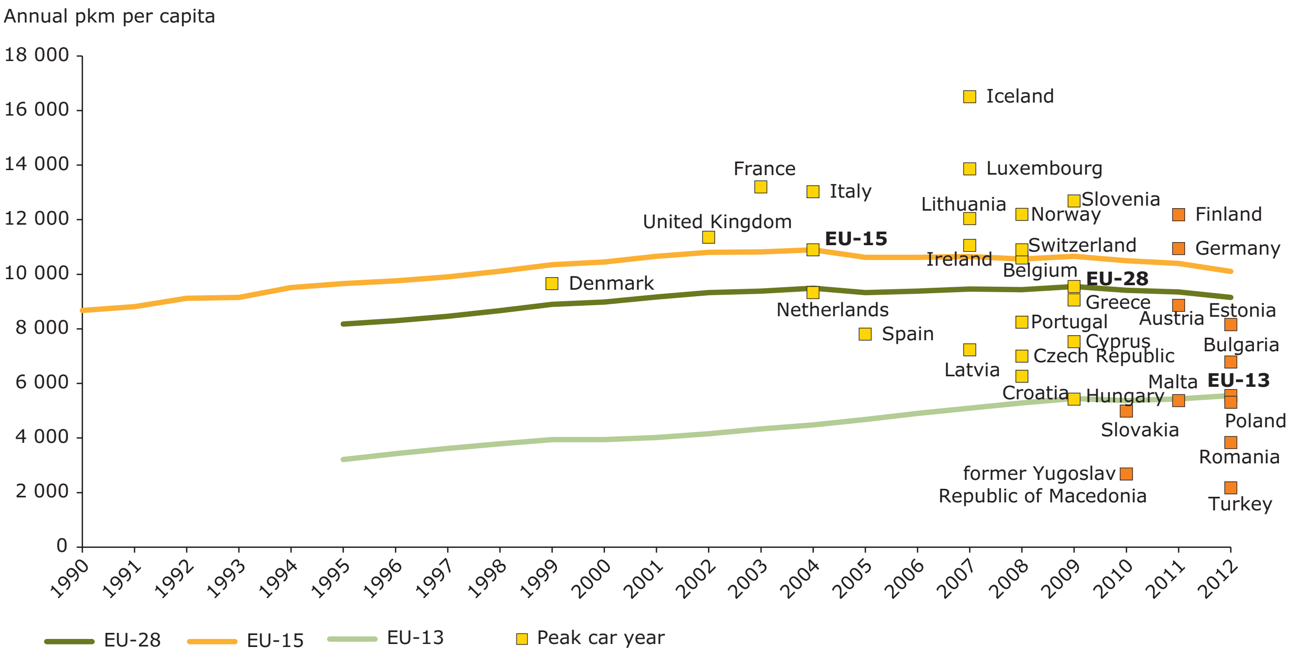
Figure 5.1 presents the evolution of the pkm travelled by car annually per capita. It also shows the year and value in which this variable has peaked in each country. Countries which peaked after 2009 are represented with dark orange symbols; for these countries, this peak may have been influenced by the economic downturn and may be overturned when the economic climate improves. For some of these countries, like Germany, values keep increasing, although at a very slow rate. Figures are consistent with the assumption of the International Energy Agency (IEA) MoMo model (Cuenot et al., 2012; ITF/OECD, 2013b) that estimates annual per capita travel at some 9 500 km per year for non-urban trips (trips longer than 100 km) in OECD countries.

For air transport, the European regions concentrating most of the passenger growth are those hosting fast-growing airports close to eastern capitals (such as Bucharest, Budapest or Riga), or airports with intense low-cost activity (Charleroi in Hainaut, Belgium; Beauvais in Picardy, France; Bremen in Germany, Luton in Bedfordshire, the United Kingdom, and several Norwegian regions).

Sustained rail growth in Europe is concentrated in a handful of countries, mainly the United Kingdom, Switzerland, Sweden, Belgium, Austria and France (ordered in descending order of growth), all of which demonstrate growth well above 25 % during the period from 2000 to 2012; most of the EU-15, however, are in positive values. But this growth does not necessarily imply a rise in modal share over road. Trends in rail passenger demand have become more unstable in recent years, following the economic downturn. Some countries experienced significant loss in 2012, of 4 % or more: Bulgaria, Croatia, Greece, Italy, Portugal, Romania, Slovenia and Turkey.

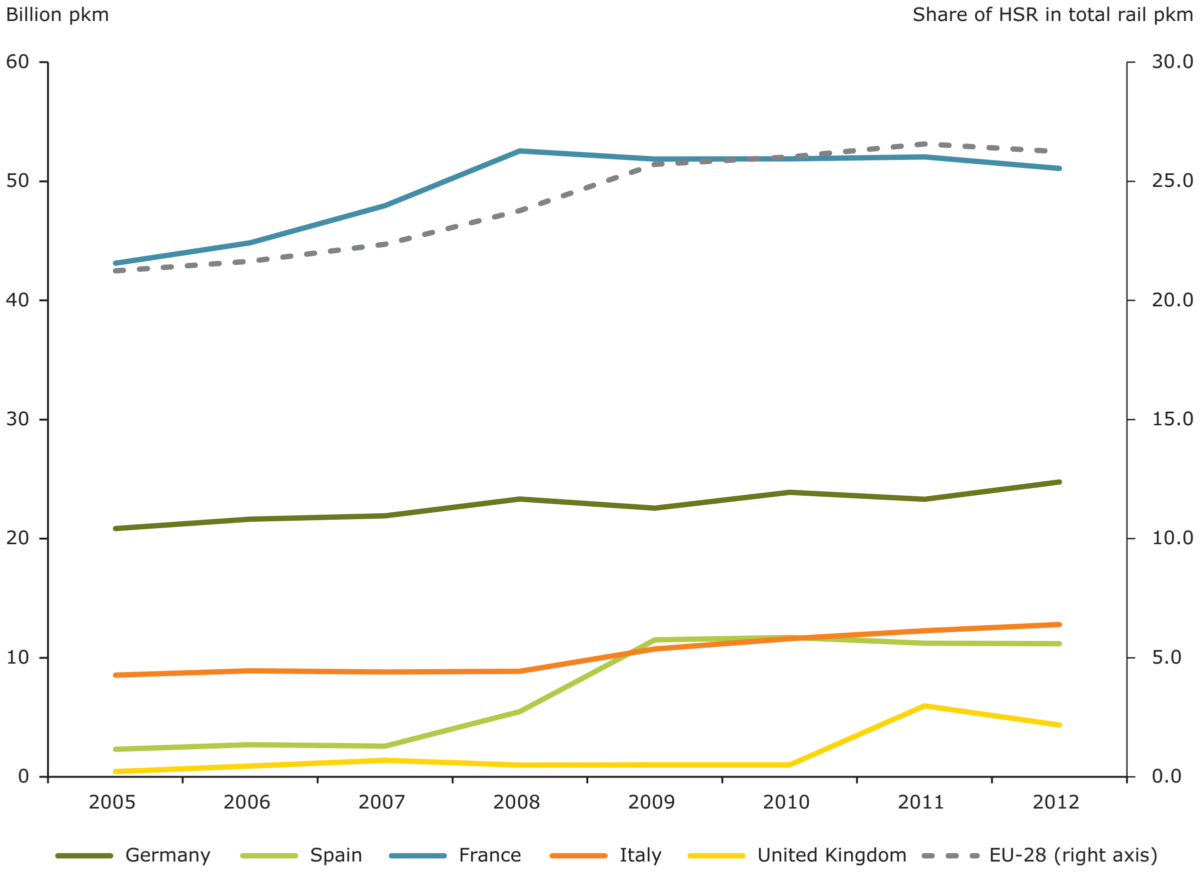
HSR demand in the EU-28 was increasing until 2011, and only declined slightly in 2012 (0.5 %). The share of HSR in total passenger-kilometres in rail transport also reached its peak in 2011 (27 %, see Figure 5.2) but had a consistent upward trend as new services were put in place. Offering reliability, speed and comfort, as well as more

Figure 5.1 Countries' peak in annual car passenger-kilometres travelled per capita



Note: Countries use different criteria for reporting vehicle-kilometres (vkm): those with lower values such as Spain or Portugal are including only long-distance (i.e. non-urban) pkm, which in most countries account for 25 % to 30 % of total pkm. Countries with maximum value after 2009 are indicated in dark orange.

Figure 5.2 High-speed rail transport in billion pkm (left axis) and the EU-28 share of high speed rail in total pkm in rail transport (right axis)



flexible pricing management (i.e. allowing operators to raise prices at time of peak demand, and lower prices when demand is weaker) has resulted in high attractiveness; it is very competitive for certain hub-to-hub long-distance connections (see Section 5.4). However, its expansion requires a careful analysis of its costs in terms of the sometimes huge investment and environmental impacts involved in its construction.

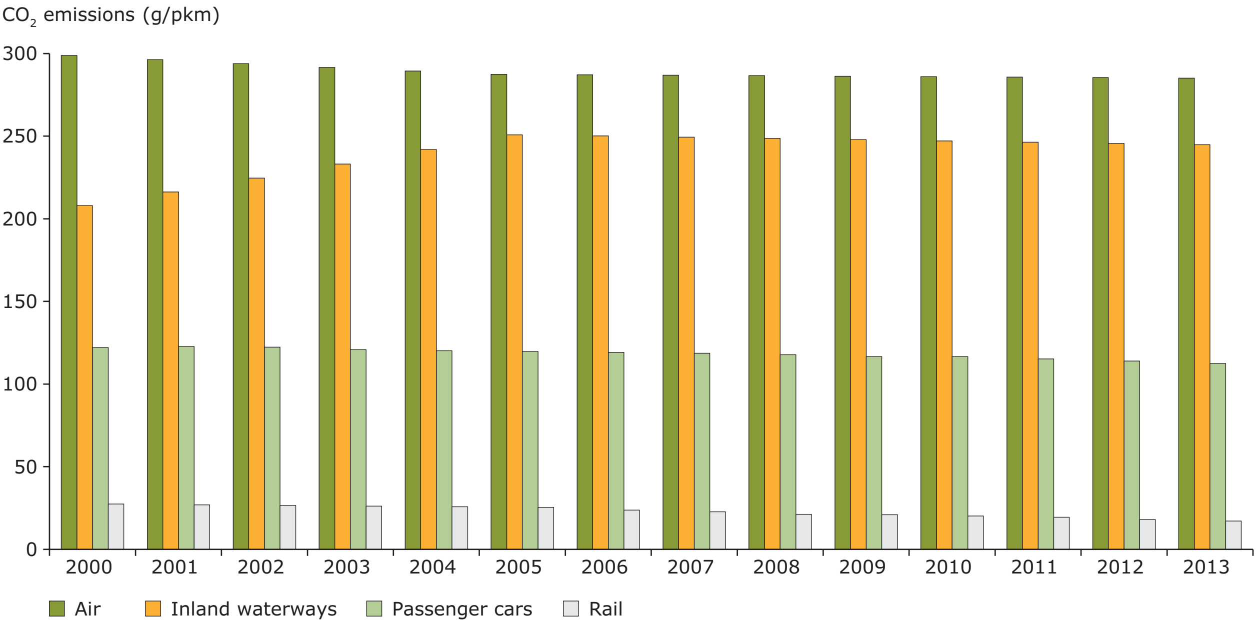
5.2 Passenger transport–specific emissions

Specific emission values measured in grams of pollutant/pkm are the result of assumptions in technological progress and its market penetration. Table A6.2 in Annex 6 provides estimated emission factors for different passenger transport modes. In the case of CO_2, the TERM-27 indicator compares specific emissions of the different modes based on estimations for EU-28, using different data sources (Figure 5.3). Indirect emissions are not included in these values. According to these estimates, specific CO_2 emissions would have slightly decreased in all passenger transport modes, and particularly in air transport.

Specific emissions are also related to operational practices, including vehicle occupancy. From this perspective, air carriers have been particularly efficient in increasing their occupancy rates (EUROCONTROL, 2013b), pushed by increased competition and limited availability of slots at busy European airports. Attempts to raise occupancy rates for long-distance car travel have focused on the potential of ride-sharing expansion (carpooling and car-sharing), but they have had limited impact thus far, due to the particular characteristics of that market: Furuhata et al. (2013) produced a comprehensive review of existing technical and regulatory barriers and means to overcome them. Rail services, particularly for high speed, have introduced yield management practices from air transport, resulting in higher occupancy rates (Finez, 2014).

The reduction achieved in CO_2 road vehicle emission regulations is not resulting in comparable

Figure 5.3 Specific CO_2 emissions from passenger transport modes



Note: EEA-33 excluding Iceland and Liechtenstein. Own estimations based on the EC4MACS/COPERT project for road CO_2 emissions and total road activity (pkm, being 'road'-only passenger cars (and not buses and coaches)) (see http://www.ec4macs.eu and http://www.emisia.com/copert) and PRIMES for non-road CO_2 emissions (calculated from energy consumption for the different fuels) and total non-road activity (pkm and tkm). Linear interpolation of the PRIMES data, available in five-year steps, is needed for the intermediate years.

'real-world' specific emissions reduction. Beyond the fact that the penetration of new technologies is limited by fleet renewal rates, this is also the effect of the divergence between vehicle test results and actual on-road vehicle performance for NO_X (EEA, 2013a; Weiss et al., 2012) and, for similar reasons, for CO_2. For NO_X, the divergence also exist in the most modern diesel vehicles. Recent research has estimated that the average on-road emission levels of NO_X is seven times the certified emission limit for Euro 6 vehicles, with a few vehicles performing substantially better than others (Franco et al., 2014). As the authors state, the fact that one of the vehicles tested is already compliant with the Euro 6 standard in real driving conditions indicates that the technologies for 'real-world–clean' diesels is already in place.

Long distance transport competition between modes is particularly relevant for distances between 300 km and 700 km, as it seems to be the only segment for which car, buses, trains (conventional and high speed) and planes contend (Kågeson, 2009). Emission reduction could be mainly achieved by transferring trips from planes to trains and coaches; a transfer from cars would also offer significant savings, but only for those car trips with low car occupancy (i.e. less than three occupants) (van Essen et al., 2009).

Direct comparison between specific emissions fails to take into consideration the fact that for some transport modes to become competitive, additional infrastructure may have to be built. These additional infrastructure needs may be marginal in many cases, but could require substantial investment if a completely new transport mode is to be introduced in one region or corridor. In that case, all impacts from infrastructure construction for that particular mode should be integrated in the comparisons to be made with already existing modes in the region or corridor (Kågeson, 2009).

Operators' practices can also have a significant impact on final emissions. This is the case for hub-and-spoke schemes, widespread in aviation, and to a more limited degree, in other passenger transport modes. Hub-and-spoke practices concentrate passengers in a reduced number of nodes (hubs) through the use of low-capacity feeder services, in order to make subsequently use of higher capacity vehicles for the main link of the transport chain, thus reducing transport costs while increasing travel times and distances for many passengers, as compared to direct services (Pels, 2010; Jara-Díaz et al., 2013). More decisively, feeding services can be highly inefficient on their own, even when offset by the optimisation of long-haul services (Givoni and Rietveld, 2010).

5.3 Factors affecting long-distance passenger volumes in Europe

Historic factors behind long-distance passenger demand have mainly included economic development and transport infrastructure endowment, as well as population growth. In fact, these are the main explanatory variables considered in recent demand forecasting exercises carried out at European level (Sessa and Enei, 2010; ITF/OECD, 2010a; Petersen, Sessa, et al., 2009; Petersen et al., 2009).

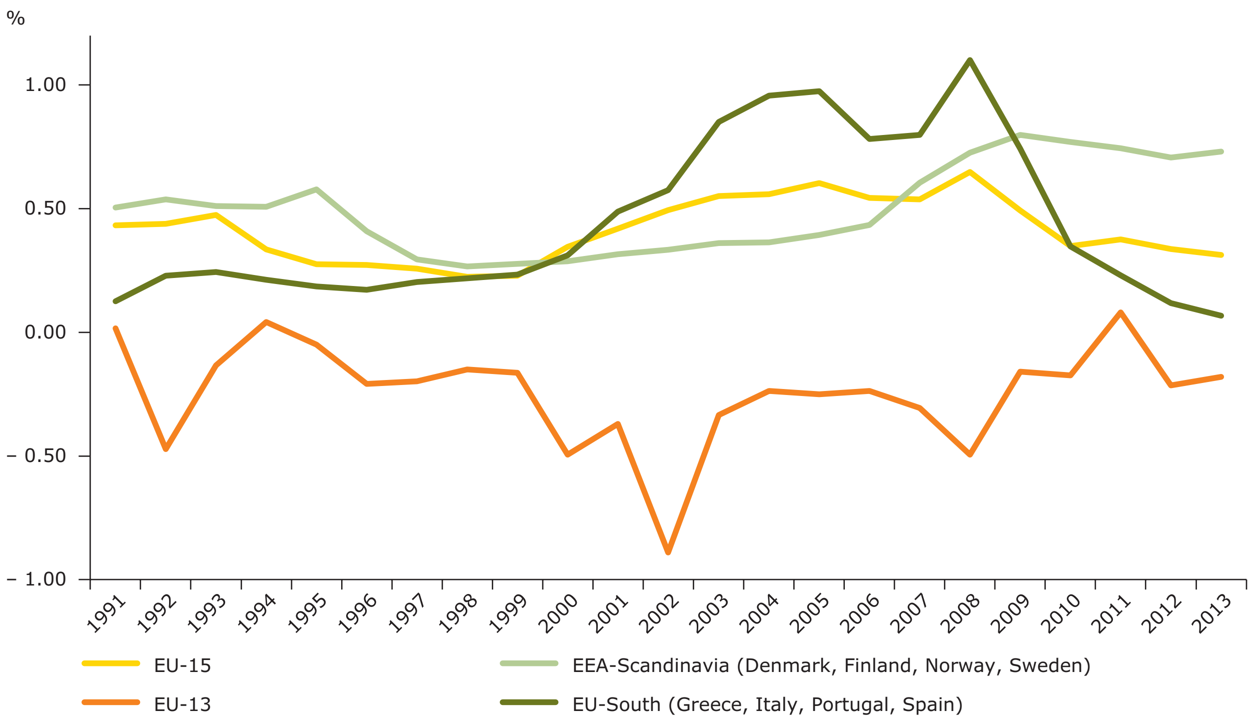
The economic downturn has challenged this perspective, as the shrinking GDP in many countries has not been associated with a comparable decline in passenger transport demand. Recent studies have revised some of the forecasts made at the end of the last decade, widening the range of variation expected for future transport demand, as illustrated by EUROCONTROL (2013b).

The association between long-distance passenger transport demand and economic growth has been mainly explained in terms of increase in disposable income of individuals, and was linked to lifestyles wherein long-distance travel was considered a desirable way of expending income and increasing leisure time (Sessa and Enei, 2010; EUROCONTROL, 2013b). Median disposable income increased between 2005 and 2008, more significantly in most of EU-13 Member States and Mediterranean countries. Increasing personal preferences for long-distance travel over other consumption goods encouraged by low-price strategies of some operators may also explain transport demand growth, particularly passenger air transport.

To illustrate this pattern, particular drivers, which seem to play a relevant role in long-distance passenger demand trends, are discussed in this section: migration patterns, as the key component of population growth in Europe; induced demand, as a consequence of yield management strategies of a growing number of long-distance transport operators; and secondary (holiday) homes, as an emerging driver of long-distance trips for personal purposes.

The European population grew slightly between 2000 and 2013 (an average of 0.3 % per year, 4.1 % in total). However, this average figure hides quite significant differences among countries, as illustrated by Figure 5.4. For example, population growth in southern Europe seem closely associated with economic growth patterns, whereas population trends in Scandinavian countries since 2000 seem more stable; patterns in the EU-13 reflect a consistent loss of population in the region.

Figure 5.4 Annual changes in population in Europe



Population trends in Europe are largely driven by migration patterns (Eurostat, 2011). Migrating populations adopt higher mobility patterns, both in the reception country as they often improve their economic status, and for long-distance travel, as they stay in contact with their countries of origin (EUROCONTROL, 2013b).

Passenger transport growth is also partially driven by induced demand, due to the availability of new or more convenient transport infrastructure and services or to more affordable prices. The expansion of high speed and the implementation of yield management strategies by rail and air operators (particularly low-cost companies) have resulted in long-distance transport demand growth, even in the absence of significant increase in disposable income in many European households. The evolution of transport service prices has been particularly striking in air transport. Despite showing an average increase slightly above the harmonised index of consumer prices for all items between 2001 and 2012 (41 % compared to 30 %), it has been kept well below fuels (71 %) and below the increase in other transport modes (55 % for road and rail passenger services). More decisively, prices have dramatically decreased for certain pairs of origins and destinations, generally associated with leisure trips (Lian and Denstadli, 2010; Narangajavana et al., 2014; Clewlow et al., 2014).

Technological innovations have played a relevant role in supporting yield management strategies. ICT has facilitated the development and implementation of innovative booking systems and direct contact between consumers and operators. Furthermore, ICT has also been instrumental for the development of teleworking and more autonomous working conditions for at least a part of the population, making short leaves/breaks possible, and facilitating the substitution of work travel (partly replaced by teleconferences) by leisure travel (EUROCONTROL, 2013c).

The expanding market of secondary homes in some parts of Europe may be considered another relevant driver of passenger transport. According to Eurostat, in 2012, trips with secondary homes as the destination accounted for 10 % of long-distance trips in EU-28, but this share is much higher in most southern European countries (36 % in Greece, 28 % in Spain and 19 % in Portugal) and in some EU-13 Member States (28 % in the Czech Republic and 19 % in Slovenia). Statistical information about ownership of secondary homes is scarce and difficult to compare among countries, although it seems to have substantially expanded in Europe before the economic crisis (UNECE, 2012).

5.4 Driving forces of modal choice in long-distance passenger transport in Europe

Travel time and distance, frequency, price and purpose are the variables usually considered in modal choice studies for intercity travel (see Dobruzskes (2011) for a review). The purpose of travel usually separates markets, with leisure travellers keener to trade lower fares for longer travel times and lower frequencies compared to business travellers (Behrens et al., 2012).

Competition among air and HSR services between major metropolitan areas in the range of 300 km to 700 km has received particular attention for many years (see Box 5.1). The main drivers seem to be travel time, frequency and prices (Behrens et al., 2012).

- For travel time, access time from the city centre and check-in time are usually added, which tends to penalise air services.

- Frequency is particularly valued by business travellers: although air transport would be in a better initial position to offer more frequent services, due to shorter operations and lower vehicle capacity compared to high speed trains, in practice shortages in slots at many key metropolitan airports limit the ability of air companies to compete (Behrens et al., 2012).

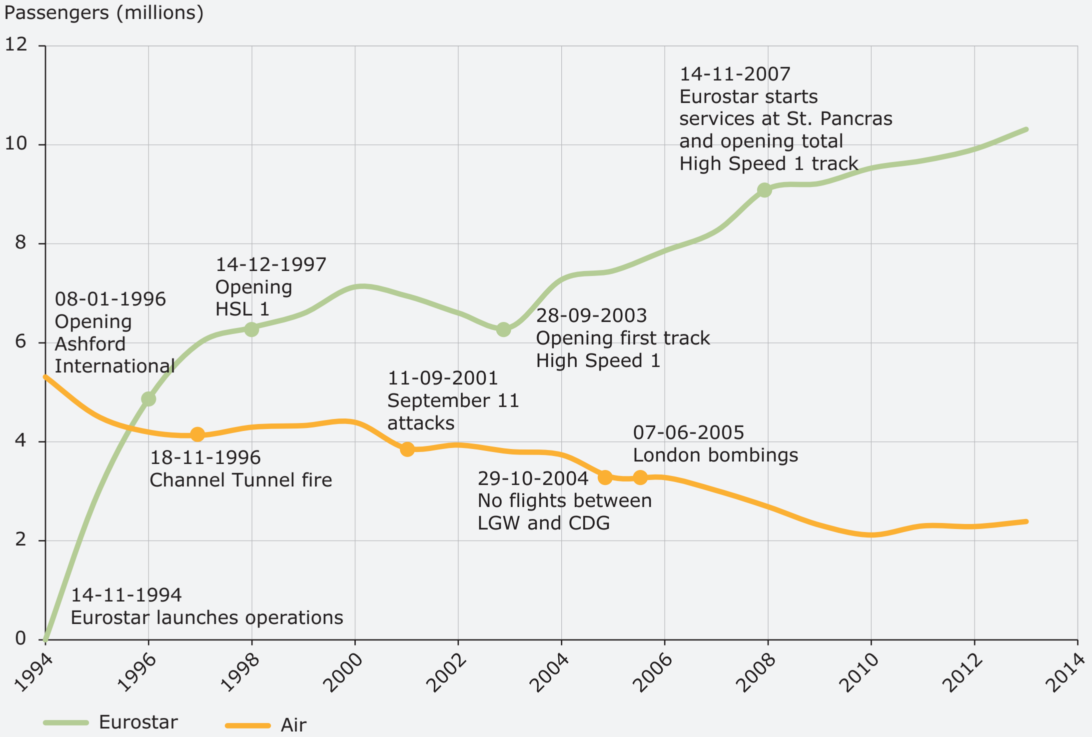
- Fares are relevant, of course, but more for leisure trips. Charges for use of the infrastructure can significantly influence the ability of transport modes to compete for leisure travellers on certain corridors. Access charges to rail infrastructure are generally lower than average costs, and sometimes also lower than marginal costs (Sánchez-Borrás et al., 2011; Beckers et al., 2009). Airport and air traffic fees are usually intended to cover infrastructure costs in full (Mancuso, 2013), but airlines may be offered a range of incentives for operating at certain airports or serving certain destinations, and some airports may receive state aid from public authorities for new investments or to support operations. Barbot (2006) analysed the case of Ryanair in Charleroi (Belgium), and the European Commission has recently issued guidelines on state aid to airports and airlines. Allroggen et al. (2013) provides a review of a sample of 194 European airports, finding that incentives are a part of the charges-setting strategy of airports, and that they are also influenced by airport-external factors. The particular fiscal system of air transport, with no fuel taxes, and VAT being applied only in a handful of European countries, has also an influence on the ability of air operators to compete for leisure travellers.

The role and competitive traits of intercity coach or bus services have not been studied as intensively. These services are generally viewed as addressing a niche market of low-income users, not much concerned about travel time (van Essen et al., 2009;

Box 5.1 Modal choice in the London–Paris corridor, the Eurostar HSR and air services

Behrens et al. (2012) studied the evolution of modal share between HSR and air services between London and Paris/Brussels. The figure below shows changes in passenger volumes for both transport modes. The study is based on data for the 2003–2009 period, once the first track High Speed 1 was opened in September 2003.

Number of passengers in the London–Paris/Brussels passenger market



Source: EEA, 2014, based on Behrens et al., 2012; data from DG Mobility and Transport, 2014, and UK Civil Aviation Authority, 2014.

The relative price of HSR versus air transport has remained fairly constant over time, but the relative ridership shows a large increase after the opening of all sections of the High Speed 1 track in November 2007, which reduced travel time by 21 minutes compared to 2004. This would indicate that the price is not the most important decision variable for travellers, and that accounting for other travel characteristics, such as travel time and convenience, is necessary. In fact, the results of this study show that travel time and frequency are the main variables explaining modal choice in this corridor. In addition to the Eurostar HSR services, Eurotunnel provides shuttle services between Folkestone and Calais, in competition with ferries. With this shuttle service, Eurotunnel carries a passenger volume similar to Eurostar (10.3 million passengers in 2013), most of which is on coaches and cars.

Air operators are limited in their ability to compete in this corridor, due to lack of availability of slots in the busy London and Paris airports. This means that air companies are unable to compete and gain passengers by increasing frequencies, which is a quite relevant drawback, considering that the elasticity of demand to frequency is quite high (above 1) for air services, according to this study. This may explain why some air alternatives have been withdrawn from the market.

Box 5.1 Modal choice in the London–Paris corridor (cont.)

The results of the mixed logit model used in the study also suggest that the Eurostar alternative has valuable non-observed characteristics (e.g. in-vehicle comfort and the use of electronic devices on board) that have been implemented during this period.

The ability of a particular transport mode to offer high frequencies can therefore be crucial for its competitiveness in the business trip market in Europe. Optimising high frequencies is easier if transport operators have at their disposal spare infrastructure capacity, high potential demand and flexibility in vehicle capacity, and can compensate for lower speeds, particularly for medium distances.

Lüttmerding and Gather (2013) have analysed the quality of passenger rail services around Europe, based on speed and frequency, and they found an enormous variety of strategies being employed by rail operators. Although the results of the study may be biased by the criteria used for the selection of the urban areas considered, the analysis found that the best connections are mainly the result of high and regular frequencies rather than high average speeds. In some countries, services are based on high and regular frequencies (associated with high demand), whereas in others (usually serving more distant relationships) high-speed services are provided, albeit with lower frequencies.

Sessa et al., 2010). However, regular intercity bus services keep serving a significant market share, particularly in southern and eastern Europe, and in the British Isles, and have probably been instrumental in the decline of conventional rail. There would be some prospects for an increase in intercity bus ridership if regulatory barriers were removed. These barriers may refer to the authorisation or concession process, to protective measures to existing rail services or to entry barriers for newcomers challenging incumbent operators. An extensive European review is provided by Van de Velde (2009), and specific barriers are analysed in the case of Germany (Walter et al., 2011) and Italy (Beria et al., 2013). In Germany, barriers were abolished in 2013 and changes in bus demand trends are expected in next year's data.

Competition among public transport modes and private car use has received some attention in the context of HSR forecasting and feasibility studies. It seems that intercity travel by car is highly inelastic, for two main reasons: first, many car users need a car at their destination; second, car occupancy would be higher for intercity trips, thus offering attractive costs, particularly for family and other personal trips. High car occupancies would also result in lower emissions, comparable to other inland modes (Sessa et al., 2010). However, practices like the provision of company cars and the fiscal incentives to do so may also distort competition between modes, providing little motivation to explore other modal options (see Box 5.2).

Better integration among transport modes could significantly change this traditional picture, and widen the scope of public transport modes compared with private car use. Progress in multimodality for intercity trips has been actively pursued by the EU's transport policy since the mid 1990s, although significant regulatory and operational barriers remain, such as access to multimodal traffic and travel data (EC, 2014a). Different research projects and studies have been supported by the EU in order to facilitate users' access to multimodal passenger transport solutions, such as the ongoing 'All Ways Travelling' consortium. Despite receiving scarce attention and lacking data on actual use, carpooling and car-sharing are considered an expanding transport mode for intercity travel in Europe, spurred by the application of ICTs, and are worth being integrated within future multimodal systems (EC, 2014c).

5.5 Expected trends in long-distance passenger transport

A succession of future transport scenarios have been produced in Europe in recent years, such as TRANSVISIONS (Petersen et al., 2009), *EU Transport GHG: Routes to 2050?* (Hill et al., 2012) and *EU Reference scenario 2013* (EC, 2013f). The research project FUTRE ([2]), within the Seventh Framework Programme (FP7), is currently developing long-term scenarios (up to 2050) from the perspective of the role that innovation can play in the future trends

([2]) Future Prospects on Transport Evolution and Innovation Challenges for the Competitiveness of Europe.

Box 5.2 The company car system and related pressures on the environment

The decision about buying or using a car is heavily dependent on the 'total cost of ownership', where the purchase price of the new car, the cumulative costs of fuel consumption, insurance, taxes and maintenance over the time horizon in which the car is used, and the resale value of the car at the end of the time horizon is under scrutiny. However, there are distortions in what should be a 'rational decision'. For example, most Member States apply more favourable tax regimes for company cars, which is estimated to be half of the total stock. In these cases, the car is bought (or leased) and registered by the employer, and used by the employee. The employee has to declare the in-kind benefit of using the company car as part of the taxable income. Most countries apply the catalogue price of the actual purchase price, and consider between 10–30 % of this value as taxable income (Máca et al., 2013). The employee is usually receiving some other benefits from the use of company cars, as most of the times the employer also cover the cost of the fuel, e.g. by providing a fuel card to the employee. In addition to this, the highest share of company cars in new car sales can be found in the high-end market, a segment where specific CO_2 emissions (measured in g of CO_2 per kilometre) tend to be higher. Company cars also tend to be driven longer distances. All in all, the employer benefits from the deductions of VAT paid when purchasing the car, but also fuel consumed, maintenance or repair costs, while offering in-kind benefits to the employee. However, there is little incentive for the employee to reduce the number of trips, distances driven, or fuel consumption in general. The system of company car subsidies in many EU Member States leads, overall, to increased GHG and air pollution emissions compared to the market for new private cars. Although many countries modulate deductions based on specific CO_2 emissions, there is still potential to drastically uptake low-carbon technology in company cars (Nijland et al., 2012).

of transport systems (Papanikolau et al., 2014). There is an interesting trend in the approach of these studies: they are increasingly interested in a wider array of socio-economic trends, something which could move the transport system away from current paradigms and established practices.

Prospects for long-distance transport demand growth are particularly high for aviation: up to 2.7 times more movements in 2050 compared to 2012, according to the recent revision of air traffic forecasts made by EUROCONTROL (2013c). However, compared to the previous forecasts, published in 2010, EUROCONTROL foresaw 'a lower starting point, due to the economic downturn and a rate of growth also lower, due to weaker economic outlook and reduced airport capacity plans'. Interestingly, EUROCONTROL also states that the 'weakest scenario', with a growth of just 20 % between 2012 and 2035, was now much closer to the actual trends in the past years than it had been in the 2010 forecast.

The interest of researchers on the prospects for changes in current drivers of transport demand seems to have increased in recent years, particularly concerning changes in lifestyles and demographic trends. The former are highlighted by the International transport Forum (ITF) (2013b), referring to new attitudes towards car use in young adults in European and other countries. Sessa and Enei (2010) state that long-distance travel can be greatly influenced by the way ICT is embedded in daily life, but do not further speculate on how demand might be affected.

In summary, a large consensus on further growth for long-distance transport demand seems to remain prevalent among experts, while, however, downsizing the high growth expectations of the last decade. Much uncertainty is shared about the trends on two key drivers: population growth and the relationship between disposable income and transport prices — it seems that it is no longer taken for granted that both drivers will keep growing in future. Prospects for changes in lifestyles are viewed with more interest than in the past, and they could be matched by the development of new mobility services based on the deployment of ICT in daily life and in transport operations.

6 Long-distance freight transport

Key messages

- Some 75 % of freight transport volumes occur over distances of 300 km. Of this volume, 86 % is transported by ship or road. Shipping, including inland waterways, dominates long-distance freight transport, with approximately 53 % of the total tonne-kilometres. In the EU-28, 56 % of all road freight journeys in 2012 exceed 300 km.
- Load factors for long-distance road transport are higher than for short distance transport, and have remained stable over time.
- The movement of goods increases more than proportionally compared to global economic activity. Around 90 % of the volume of world trade is carried by the international shipping industry, while air transport moves about 40 % of the value.
- Several socio-economic trends (such as the increased share of high-value products, rapidly changing consumer tastes, just-in-time logistics) will further increase the competitive advantage of fast modes such as air transport. However, policy can also affect modal choice and efficiency.
- Projections commissioned by the European Commission (EC, 2013b) show that freight transport in the EU is expected to grow in line with GDP until 2030. This growth is expected to slow down after 2030, as a result of lower GDP growth but also following further shifts to a service economy as well as limits to where products and resources could be sourced.
- Although energy demand is projected to decouple from transport activity, CO_2 emissions from freight transport would still increase by about 9 % between 2010 and 2050, mainly due to the growth in road freight.

6.1 Evolution of long-distance freight transport and modal shares

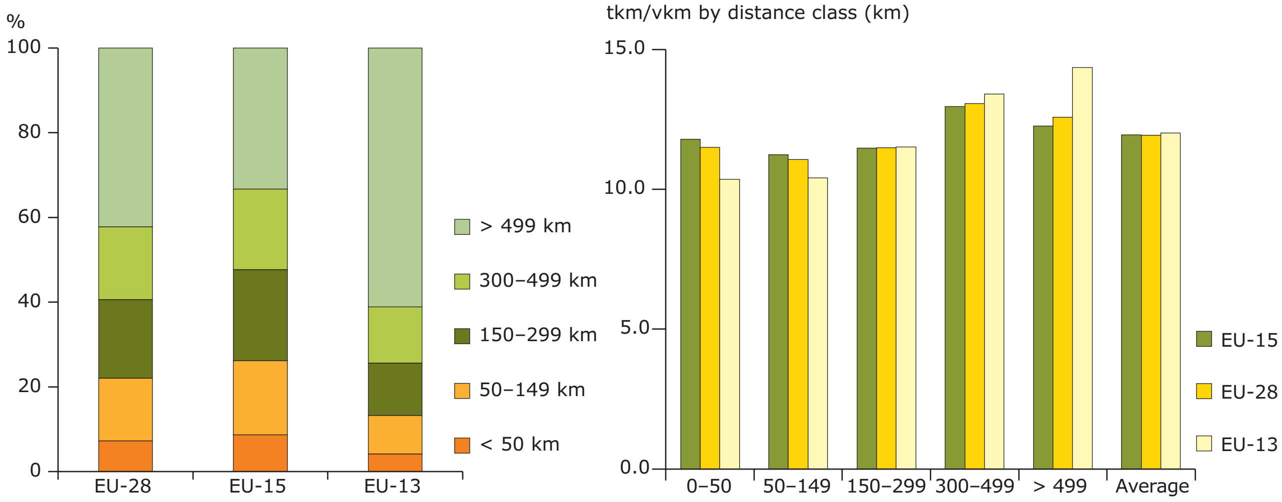
Figure 4.1 presented the allocation of total freight transport volumes to different distance bands for each transport mode (aviation, rail, shipping and road) for the year 2010. Some 75 % of the total volumes were allocated to long distances (above 300 km), half of which (37 %) were above 1 000 km. The shares are mainly constant in time but varied significantly across modes: for aviation and shipping (both IWW and short sea shipping), more than 95 % was long-distance transport, while for road and rail the shares were lower. Total long-distance freight transport volumes decreased significantly between 2008 and 2009, after a constant increasing trend. Volumes increased again in 2010, but have not yet reached the 2007 peak. Under the assumption that 2012 and 2011 distant bands shares for each mode are those in 2010, Figure 4.2 shows that shipping dominates long-distance freight transport, with approximately 53 % of total tonne-kilometres allocated to IWW and short sea shipping. Road follows with about 37 %, and rail with about 10 %. Aviation has a negligible share.

6.1.1 *Road transport*

Since the start of the financial crisis, road transport volumes have declined markedly for all distance classes, by 9 % on average between 2006 and 2012. Over time, the share of road transport over the distance of more than 300 km has increased. In 2012, 56 % of goods transported by road in the EU-28 was transported over more than 300 km (Eurostat, 2013). However, for vehicles registered in the EU-15, this share was 53 % — there are thus significant differences in the distance profiles between Member States (Figure 6.1 left).

The average load factor in 2012 was 11.9 tonnes per vehicle (Figure 6.1 right). Since 2003, this load factor has remained more or less stable, and there

Figure 6.1 Share of distance classes in road freight transport (tkm) in EU-28 (left), and load factor according to distance class (right), 2012



are no marked differences between Member States. Long-distance transport by road tends to be more efficient than short-distance transport.

As load factors expressed in weight units do not take into account the fact that volume may be the limiting factor in logistics in some cases, they may offer an overly optimistic view of the potential for further improvement. An alternative indicator is the level of empty running (EC, 2014b), which will be discussed in more detail in Section 7.1.

6.1.2 Maritime transport

Provisional estimates indicate that in 2012, 1 401 billion tkm were transported by sea between the EU-28 Member States, an increase of 21 % compared to 1995, However, this is 141 billion tkm less than in 2007, when volumes had increased by 33 % compared to 1995.

In 2012, 3.7 billion tonnes of goods were handled in EU-28 ports, an increase of 7.5 % compared to 2003. The share of EU-15 ports in this total volume was 91 %. As a result of the financial crisis, tonnes moved by sea from and to the EU-27 fell strongly in the second half of 2008 and the rebound was slower, so the tonnes moved are still lower than pre-crisis levels for most regions (ITF/OECD, 2013c).

6.1.3 Air transport

According to provisional estimates, 2.51 billion tkm were transported by air within the EU-28 in 2012, an increase of 25.8 % compared to 1995 — however, this is 0.24 billion tkm less than in 2007, when volumes had increased by 37.5 % compared to 1995 (DG Mobility and Transport, 2014). The ITF indicates that, after a quick rebound following the financial crisis, tonnes moved by air are on a downward path again (ITF/OECD, 2013b).

Aviation accounts for 0.6 % of the total volume for exchanges between the EU and third countries, but for 22 % of the total value (EC, 2011c). The market for freight transport by air is thus dominated by high value-to-volume ratio goods.

6.2 Specific emissions from long-distance freight transport

There are many environmental impacts of transport (see Chapter 4). The modal shift from road to other modes is an instrument to reduce the environmental impacts of transport. For illustrative purposes, we will therefore compare the modal performance for air pollutants and GHG emissions specific emissions (measured in grams of pollutant per tkm).

For non-land modes, CO_2 emissions can vary from 2 g per tkm for bulk shipping to 1 700 g per tkm for short haul aircraft (IPCC, 2013).

For land freight transport (see Annex 6) several points are worth noting:

- First, in terms of CO_2 emissions per tkm, rail (averaged over diesel and electricity) and inland shipping outperform trucks. For trucks, the smaller the truck, the higher its emissions per tkm: emissions factors for trucks under 7.5 tonnes are more than 10 times larger than for rail and inland shipping.

- Second, for NO_X, rail also performs best. The relative performance of inland ships is worse than for trucks over 7.5 tonnes. Again, the emissions of the worst performing modes are about 10 times as high as those of the best performers.
- Third, for PM_{10}, the ranking is largely similar to the ranking for NO_X.
- Fourth, rail is the best performer according to most criteria, although trucks over 32 tonnes perform best for SO_2 and VOC.

The focus here is on tailpipe emissions, except for rail transport, for which the emissions of electricity production are also taken into account.

In order to interpret these figures, it is important to keep in mind that these 'European averages' hide several important sources of variation in each mode, and can therefore be very misleading. For instance, for several vehicle types, the upper bound of the direct CO_2 emissions per tkm exceed the lower bound with a factor of two or more (IPCC, 2013). Moreover, these emissions per tkm cannot be used directly to compare total emissions for a given origin-destination pair. Indeed, they do not take into account that travel by rail or inland vessel is often longer than by road, and they do not include emissions attributable to pre- and end-haulage. Once these considerations are included in the analysis, the environmental performance of non-road modes is less impressive. For instance, diesel trains and inland waterway vessels emit more PM_{10} and NO_X than trucks if significant detouring is needed, and likewise in the case of small vessels (den Boer et al., 2011).

Another way to view this issue is to consider the monetised values of the external costs of transport (see Box 6.1 for internalisation rates for different transport modes and routes), which take into account a broader range of effects than just air pollution, such as congestion and accident costs, but also where and when transport takes place (and thus how many people are exposed to these harmful effects). Using this approach results in an even broader range of unit values, as illustrated in the recently produced *Update of the Handbook on External Costs of Transport, Final Report* (Korzhenevych et al., 2014) ([3]).

First, in EU legislation, air pollutant standards apply only to new engines. Therefore it is the combination of emission standards and the age structure of the fleet that determines the emissions per unit of work performed by the engine. For instance, for rigid trucks in the range of 28 to 32 tonnes, external costs per tkm on motorways vary from EURct 1.22 per tkm for a Euro 0 truck to EURct 0.03 per tkm for a Euro VI truck.

Second, actual emissions per tkm also depend on the load factor of the vehicle.

- The implicit load factors used in Korzhenevych et al. (2014) vary from 1.5 tonnes per truck in the 3.5 to 7.5 range, to 16 tonnes for trucks over 32 tonnes. This is why, for instance, on motorways, there is almost a factor six difference between the highest (EURct 0.15 per tkm under 7.5 tonnes) and lowest (EURct 0.027 per tkm over 32 tonnes) external costs of air pollution per tonne-kilometre for Euro VI rigid HGVs.
- Similarly, in the case of inland waterway vessels, external costs between engines with selective catalytic reduction and diesel particulate filters and those without these enhancements can reach in excess of a factor five. Depending on their capacity class, load factors can vary between 189 tonnes and 10 530 tonnes for heavy bulk ships, and the corresponding external costs per tkm can also vary by more than a factor two.
- For comparison, for a diesel train with a load factor of 500, this external cost is EURct 0.6 per tkm, and for an electric train, it is EURct 0.08 per tkm. Depending on the energy mix, external costs of electricity generation for rail transport can also vary substantially.
- Finally, for maritime transport, external costs per tonne-kilometre in the North Sea can vary from EURct 0.13 per tkm to EURct 0.91 per tkm, again depending on the type and the load factor of the ship. Similar differences apply to other regions as well.

Thus, the 'good' performance of a given mode may reflect stringent emissions standards for that

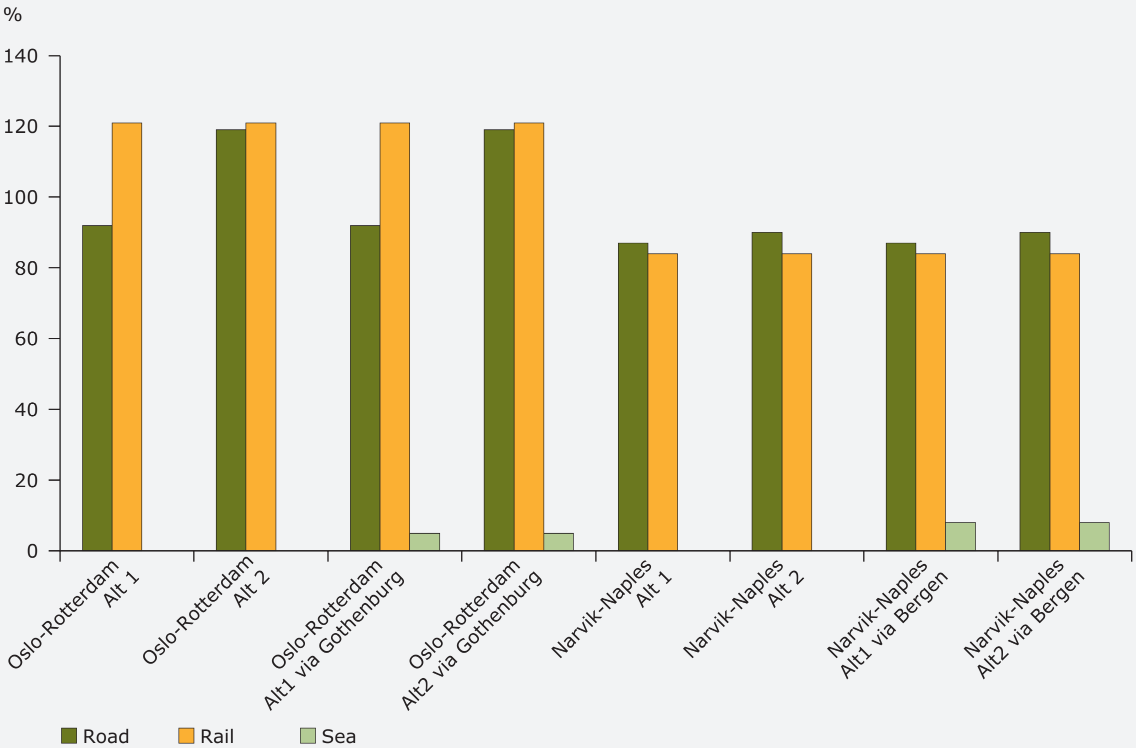
([3]) In the *Handbook*, external costs for road transport are expressed per vehicle-kilometres. In order to express these costs in tkm, one needs estimates of the average load factors. There is no consensus on which values to use (Korzhenevych et al., 2014; Hjelle, 2012). For the sake of consistency with the *Handbook*, we use the load factors from TREMOVE.

Box 6.1 Internalisation of external effects in European freight corridors

Mellin et al. (2013) studied the rate of internalisation of external effects through taxes and charges in two European freight corridors in 2012, for road, rail and sea transport. They considered the following external costs: air pollution, CO_2, noise, accidents and the wear and tear of infrastructure. The unit values in their analysis are mainly based on data presented in the Handbook on estimation of external costs in the transport (Maibach et al., 2008).

The internalisation rate (defined as variable taxes and charges divided by the marginal external cost) varies considerably across modes, countries and routes. Comparing the three transport modes, the internalisation rate is highest for road and rail transport, and lowest for sea transport. The low level of internalisation in maritime transport reflects that environmental policy in this sector is currently limited to regulation on the permitted sulphur in fuels, with the exception of fairway dues in Sweden and a NO_X tax in Norway. Road transport, in contrast, is subject to high variable taxes.

Internalisation rates for different transport modes and routes



Note: Alt: Alternative route(s)

Source: Mellin et al., 2013.

The internalisation rate also varies from route to route, reflecting differences in taxes and charges on the one hand, and in external costs on the other hand. Levels of internalisation in road transport, for instance, are very sensitive to the tax rates on diesel (see Box 2.10). Properly designed subsidies can also be used as regulatory instruments to reduce the external effects of transportation. In practice, they often provide incentives for environmentally harmful behaviour. See Withana et al. (2012) for examples, including in the transport sector.

mode, a 'young' age profile, high load factors, or a combination of the three.

Compared to trucks, inland vessels generally perform better in terms of load factors. However, the average lifetime of engines is very long and the NO_X and PM_{10} emissions standards for new engines are less stringent than for trucks. It is expected that, without new measures such as the development of ambitious emissions standards for inland vessels, the relative performance of IWW will deteriorate further (Panteia/NEA et al., 2013).

6.3 Factors affecting long-distance freight volumes in Europe

The value in volume terms (i.e. accounting for changes in prices and exchange rates) of world merchandise exports has increased more than fourfold between 1980 and 2011 (WTO, 2013). Moreover, since 1950, exports have systematically responded more than proportionally to changes in global economic activity.

The ensuing increase in transport demand has affected mostly international shipping and air transport. Seaborne trade has increased, from just over 11 trillion tonne-miles in 1970 to over 32 trillion tonne-miles in 2008 (UNCTAD, 2009), and around 90 % of world trade is carried by the international shipping industry (IMO, 2012). This is not surprising, as there are no direct substitutes for waterborne transport for many commodities and trade routes (Corbett et al., 2010). Air transport has increased in importance due to several factors, such as the deregulation of the aviation market, the move to higher-value products and an increasing demand for highly urgent goods or for products with limited durability (such as exotics, industrial components and legal documents). As a result, aircraft carry 40 % of world trade by value, even though they carry just 2 % by volume (Button and Pels, 2010).

According to the World Trade Organization (WTO, 2013) the factors behind this rapid growth in trade are as follows. First, multilateral and regional treaties have led to impressive reductions in both tariffs and non-tariff protectionist measures. The second major force has been a spectacular decrease in transportation costs. Contributory elements are the increasing power of the engines in all modes, the introduction of containers and the increasing size of ships. Third, advances in information technologies have reduced the cost of overseas telecommunications, facilitating the development of international trade in services. A final element has been the opening up of emerging markets, especially India and China.

In the last decade, total intra-EU trade has increased by 4 % annually on average, while exports from the EU to the rest of the world have increased on average by 7 % per annum. For imports from the rest of the world to the EU-27, the average growth rate is 6 %. Thus, despite expansion of the EU to include 13 new members since 2004, trade with the rest of the world has grown more rapidly than within the EU, suggesting a higher increase in (very) long-distance transport.

Between 2004 and 2012, the EU's share in world imports ranged between 11.5 and 12.8 %. In the same period, its share in world exports ranged between 11.1 % and 11.9 %.

6.4 Driving forces of modal choice in long-distance freight transport in Europe

Transport choices are embedded in a broader logistical system. For instance, the degree of centralisation of inventories follows from a trade-off between transport and inventory costs. It has been argued that the decrease in transportation costs has led to a further centralisation of inventories (Vierth, 2014). Also, the tendency to reduce stock by creating just-in-time assembly lines requires small and frequent deliveries of inputs, which calls for the use of trucks or vans. Road transport also allows firms to optimise their deliveries over any vehicle number or size, while rail only offers to carry goods in predetermined carriers. Finally, as most firms have no direct links to the rail or the waterways, road transport is still needed for the final delivery (Santos et al., 2010).

For a given network of depots, modal choice results from the minimisation of total transport cost, i.e. the sum of the monetary and time cost of transport (Tavasszy and van Meijeren, 2011). Both the monetary cost and the opportunity cost of time spent in transport vary from good to good, and this explains why, for a given origin–destination pair, different modes may be chosen. For instance, some goods are perishable, and their opportunity cost of transport time is very high. Depending on their final value compared to this opportunity cost, fast modes such as air transport might be preferred. Other goods have a low opportunity-cost of time, and a low value-to-weight ratio. For these goods, slow and high-volume transport modes with economies to scale (such as water modes or, to a lesser extent, rail) are preferred.

For each good and each pair of modes, a break-even point exists between the fast and the cheap mode. Several recent socio-economic trends (such as the increased share of high-value products in total consumption and rapidly changing consumer tastes) are likely to further increase the competitive advantage of fast modes.

Still, the relative advantages and drawbacks of the different transport modes also result from policy choices. The impact of some policies (such as public investment in specific infrastructure or subsidies for the transport operators) on the competitive position of individual modes is straightforward. However, there are also examples of policies where the link to the generalised costs is more indirect. For instance, in international trade, logistical costs are affected by factors such as the lack of transport interconnections between countries (see Braconier and Pisu (2013) for a recent discussion of road connectivity in Europe), the lack of interoperable equipment, administrative hurdles, etc. Some modes are more severely handicapped by these factors than others. Chapter 7 will discuss how the EU has been working steadily on removing these barriers, with mixed results.

6.5 Expected trends in long-distance freight

Under current trends and adopted policies, the European Commission (EC, 2013b) expects transport activity to grow significantly, with the highest growth rates occurring from 2010 to 2030. Growth in freight transport will be stronger than passenger transport growth, and more closely aligned with GDP growth.

The freight transport increase after 2030 is expected to slow down as a result of lower GDP growth, but also following further shifts to a service economy and limits to distant sourcing and offshoring. The highest growth in road freight transport activity is expected in the EU-13.

Beyond 2015, the European Commission expects energy demand to decouple from transport activity, due to factors such as the uptake of more efficient technologies (for instance, in vehicle design and vehicle powertrain), the substitution of diesel by electricity in the case of rail, the penetration of electric vehicles in some niche markets such as urban commuting and municipal fleets, and limited increases in the shares of LPG and natural gas (depending on the availability of re-fuelling infrastructure). European Commission (EC, 2013b) projections show that under current trends and adopted policies, CO_2 emissions from overall transport would drop by about 8 % by 2050 relative to 2010, in spite of a 9 % projected increase in CO_2 emissions from freight transport. Major efforts will be needed in order to achieve the ambitious emissions reductions of 60 % by 2050 from 1990 levels, under a scenario of increasing transport activity.

According to the most recent *ITF Transport Outlook* (ITF/OECD, 2013c), however, there is considerable uncertainty with respect to GDP growth and the freight intensity of such growth. Depending on the scenario, the ITF suggests that, over the 2010 to 2050 period, surface freight could grow by between 40 % and 125 % in the OECD and by between 100 % and 430 % elsewhere. In these scenarios, CO_2 emissions decrease by up to 4 % in the OECD under a scenario of slow economic development and decoupling scenario, but increase up to 50 % when assuming stronger growth and a one-to-one relationship between GDP and freight transport.

Box 6.2 Food miles

In the last few years, there has been an increasing interest in the concept of food miles, i.e. 'the distance food travels from where it is grown or raised to where it is consumed' (Van Passel, 2013). The concept usually emphasises the environmental costs (and more specifically the CO_2 emissions) of transporting food over long distances.

Using 'food miles' as an indicator of the sustainability of the transport system poses at least three problems. First, CO_2 emissions per unit of product (rather than food miles per unit of produce) are what really matters, from a climate point of view. It is therefore essential to note that some modes (such as international shipping) are characterised by important economies of scale, and thus by low CO_2 emissions per tonne-kilometre. One also needs to take into account that, even within a given mode, some vehicles have higher load factors than others (Coley et al., 2009; Grolleau et al., 2010). Second, sustainability is a broader issue than just CO_2 emissions (Avetisyan et al., 2014; Coley et al., 2009). Third, what matters is the environmental and economic sustainability of the whole supply chain, including production, storage, packaging and consumption. Van Passel (2013) refers, inter alia, to the following sources of complication: (a) the relative benefits and costs vary with the seasons, (b) the local differences in scale of production and in quality of the food, and (c) differences in technology across the whole chain.

Although one should exercise caution when generalising the findings of individual case studies, Van Passel (2013) uses three examples to illustrate these issues.

First, Coley et al. (2009) have compared the relative emissions of the following: (a) a system based on large-scale growing, bulk cold storage, mass distribution to regional hubs, then home delivery, and (b) the much simpler case of a supply system where the customer travels to a local farm shop. In order to focus on transport emissions, they have not considered the growing and sourcing of produce. They show that, for the large-scale system, the bulk of emissions arises not from chilling or mass transportation using HGVs, but from the final delivery phase using light goods vehicles (LGVs). If customers drive a round-trip distance of more than 7.4 km in order to purchase their organic vegetables, Coley et al. (2009) consider that their carbon emissions are likely to be greater than via the alternative method.

Second, Wong and Hallsworth (2012) have taken into account the carbon footprint associated with the heated greenhouse production of fresh vegetables. They estimate the difference in CO_2 emitted per kilogram of tomatoes consumed in Vancouver to be nearly 7 times greater between 'local' greenhouse-cropping and field-cropping 2 400 km away.

Third, Avetisyan et al. (2014) have also studied the implications of differences in emissions intensity of food production across regions, particularly of non-CO_2 GHG emissions. They conclude that, in most cases, the change in production emissions dominates the change in transport emissions. One of the exceptions are dairy products in the EU.

All in all, the main issue is not the distances travelled as such, but strong consumer preferences for a diversified, season-independent diet. Whether the CO_2 emissions implied by year-round consumption of fresh tomatoes are generated by heating greenhouses or by transporting them from far-flung places is irrelevant from an environmental perspective. They key is to consider all externalities, independently of their source, and the extent they are included in the final price. In this regard, the European Commission is currently working on 'Product Environmental Footprints', where transport is included in the current draft. The methodology is being tested with pilot projects in cooperation with voluntary stakeholders, and the second wave of pilots includes products from the food sector (see http://ec.europa.eu/environment/eussd/smgp/pef_pilots.htm).

7 Minimising the environmental pressures of long-distance transport

Key messages

- Options to minimise the environmental impacts of long-distance transport are conditioned by the vision of travel as a sign of a strong economy and as a stimulant of job creation: 'improve' and 'shift' measures are largely preferred to 'avoid' ones. However, the avoidance of unnecessary trips and decreasing the transport intensity of the economy are also indispensable contributors to minimising environmental pressures from transport.
- There is potential for improving load factors in long-distance freight transport through a wider uptake of innovative business models in logistics. The revision of regulatory constraints could also contribute to further optimisation, but may conflict with other policy objectives.
- Policies to promote a modal shift away from road and air transport have focused on trying to ensure that all transport modes are priced so as to reflect their full costs (including the costs on negative externalities), improving market conditions, and overcoming other administrative and technical barriers. Despite a plethora of policy initiatives in these fields, much work remains to be done. To date, a significant modal shift at European level has failed to materialise, even if non-road modes grow in absolute volumes. Beyond the question of whether and how far non-road modes can accommodate a substantial modal shift, the actual environmental benefits of such a shift would also depend on door-to-door routes, occupancy/load rates and other concrete details.
- Technical standards have led to significant improvements in the environmental performance of transport, but they do not cover all vehicle types and transport modes. Moreover, there is a divergence between the actual and the test-cycle emissions of vehicles. Measures to control GHG emissions of the maritime sector and of international aviation are being developed in line with various international frameworks.

The Avoid, Shift and Improve (ASI) framework

Three key approaches are available for improving the environmental performance of long-distance transport:

- 'avoid' policies reduce the need for travel and the number of trips and/or distance, by influencing origins and destinations through land use and regional planning, reducing the number and length of trips through logistics planning, or addressing accessibility needs without physical travel;
- 'shift' policies enable and encourage the development and use of those transport modes offering lower environmental impacts;
- 'improve' policies reduce the environmental performance of transport means, through the introduction of technological innovation, efficient fuels and vehicles, reducing energy consumption and emissions of all travel modes.

In practice, the distinction between the three approaches is not always clear-cut. For instance, pricing instruments can affect not just total travel demand and modal choice, but also vehicle choice (and thus also the energy consumption and emissions of vehicles).

European transport policy relies largely on two related premises: first, that transport is an enabler of economic growth, and second, that the desire of European citizens and the needs of the European economy to transport goods must be efficiently satisfied. The general relationship between transport and the economy has traditionally generated much controversy amongst academia. For instance, Banister (2012) states that transport systems in developed countries provide competitive accessibility with a variety of modes for most of the territory, and they stopped being a bottleneck for the economy a long time ago. In addition to this, recent research is suggesting positive correlations between mobility constraints (higher road use prices or traffic congestion) and productivity (Litman, 2014). Avoidance of unnecessary trips also reduces the resource (time, vehicles and fuel) costs of such movements, allowing them to be potentially dedicated to more productive activities.

The relationship between transport — and its related environmental pressures — and the economy is highly complex, and depends of multiple variables, including the potential competitiveness between modes. A study by Ecoplan (2011) for Switzerland has investigated the impact of the economic crisis on freight transport through the Alps. It concludes that without the economic crisis, freight transport would have been higher than the observed traffic flows: by 12 % to 16 % for road transport and by 25 % for rail transport. The observed switch from rail to road transport would not have taken place without the economic crisis. Based on a transport model, the study concludes that the modal shift towards road can be explained by a reduction in the price of road transport compared to rail transport. Air and road transport are indeed more able to adapt to economic circumstances (and bring down prices if needed) than are rail and maritime.

Finally, a large number of studies have recently claimed that accelerated uptake of electrical vehicles (EVs) and fuel-efficient cars in the market for automotive transport may have positive employment benefits, stimulating economic growth and mitigating climate change (de Bruyn et al., 2012, or UBA/INFRAS/IFEU, 2013).

7.1 Avoiding trips or reducing distances

In passenger transport, long-distance travel is undertaken for both business and leisure purposes. Whereas the former may be self-contained owing to economic reasons (managers and workers share a natural incentive to limit their trips, as a way to increase their productivity), the latter has been largely influenced by the operators' attempts to induce demand, within their 'yield management' strategies.

Reducing leisure travel has mainly been promoted in support of 'local' economy, with campaigns to inspire national residents to take more holidays in their respective countries and to boost local economies through growth in visitor spending, as opposed to choosing long-distance travel. On the other hand, teleconferencing has the potential to replace some long-distance travel for business purposes, when the subtleties of face-to-face interaction are not crucial. Free or low-cost Internet services have made teleconferencing more accessible, offering a growing array of options and increasingly presenting real alternatives for more sophisticated technologies or face-to-face meetings.

In freight transport, several measures can be taken by the logistical sector to reduce travel demand by improving the load factor of vehicles: backloading (the transportation of cargo or shipment on a return trip, using the space already paid for and used for the outward leg), the use of more space-efficient handling systems and packaging, the adaptation of more transport-efficient order cycles, and the consolidation of freight in larger and/or heavier vehicles. Others may actually reduce the number of trips or tonne-kilometres through improved integration of transport links and chains within production and distribution management (McKinnon, 2010; TRT, 2009).

The traditional approach to consolidating freight is for shippers to sign one-to-one contracts with logistics service providers, who will search for bundling opportunities on a geographic basis (Liimatainen et al., 2014). Another possible solution is horizontal collaboration between shippers. In practice, companies may be reluctant to work with parties they do not know. Online freight exchanges can facilitate the search for partners and manage a system of 'reputation management', directly or through independent intermediaries (see for example http://www.co3-project.eu/innovation and Jacobs et al., 2014).

Although levels of empty running have slightly decreased over recent years, in 2012, almost a quarter (23.2 %) of all vehicle-kilometres of HGVs in the EU involved an empty vehicle (EC, 2014b). This suggests that there is still considerable scope for improvement. In general, policy measures that increase the cost of transport (fuel taxation or road user charging) could provide stronger incentives for private parties to overcome coordination problems. Improved operations of freight transport are currently also held back by regulatory restrictions, such as the rules on cabotage (Regulation (EC) No 1072/2009) and the restrictions on truck size and weight (see Box 7.1). Removing these restrictions will lead to two opposing effects. Through their direct effect on the efficiency of road operators, they will lead to lower emissions. However, they are also likely to result

Box 7.1 Megatrucks

- Maximum common measures (including certain rules on weights and dimensions) exist for HGVs transporting goods in Europe, buses and coaches. For national transport, however, some derogations are expected. For instance, trials are allowed for local transport operations with vehicles or vehicle combinations applying new technologies or new concepts. In 2012, use of modular trucks was permitted in Finland and Sweden, and was being trialled in Denmark, the Netherlands and some German *Länder*. A trial in Denmark (The Danish Road Directorate, 2011) for using the European Modular System (EMS) with higher load factors concluded with a very marginal positive effect in terms of direct CO_2 emissions, but no effect on noise from the substitution of 'conventional trucks'.
- Christidis and Leduc (2009) carried out an independent evaluation of the impacts of longer and heavier trucks on the environment, safety and infrastructure. The overall environmental impact would depend on the net effects of two opposing forces. On the one hand, longer and heavier trucks would lead to the replacement of conventional trucks and to higher load factors. On the other hand, longer and heavier trucks would make road transport more attractive compared to rail, and could thus lead to a modal shift away from rail.
- The Commission has recently proposed a revision of existing rules on dimensions and weights. For instance, cross-border use of longer vehicles would become lawful for journeys that only cross one border, if the two Member States concerned already permit it and if certain conditions for derogations are met. Some Member States oppose this clause, reportedly out of fear that country after country would be pressured into accepting its neighbour's megatrucks.

in lower prices for road freight transport (making it even more difficult for other modes to compete) and further increasing environmental pressures, particularly at the local level.

7.2 Shifting to more environmentally friendly modes

According to the Commission (EC, 2011a), 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. As for passenger transport, most medium-distance passenger transport should travel by rail by 2050. The 2011 Transport White Paper wishes to further promote the attractiveness of non-road modes through a two-pronged strategy: first, to confront all modes with their full costs (including the costs of negative externalities); and second, to directly improve the market conditions in non-road modes.

7.2.1 Confronting all transport modes with their full costs

At the core of the first category of measures is the 'Eurovignette' (Directive 1999/62/EC and subsequent modifications; EU, 2011b) which lays down the rules under which Member States can charge for the use of road infrastructure. However, it does not make such charging mandatory and is limited to heavy good vehicles on the trans-European network and motorways. Member States are permitted to differentiate tolls according to a vehicle's emission category ('EURO' classification) and the level of damage it causes to roads, the place, the time and the amount of congestion; however, charges cannot be differentiated according to GHG emissions.

Because the charging is not mandatory, it is difficult to forecast the actual impacts of the most recent revision of the directive. Christidis and Brons (2010) analysed different possible scenarios for the actual charges. Increased charges would lead to changes in transport activities, such as modifications in the trip schedules, the vehicle technologies and the organisation of the transport operators. If set high enough, the charges could also induce some modal shift. These changes would bring noticeable reductions in the external costs of transport (see Box 7.2). Moreover, these benefits would come at a low cost to consumers: final product prices would increase by a maximum of 0.5 % on average. Two factors contribute to this impact: the low-cost pass-through rate assumed for the transport operators, and the relatively low share (maximum of 10 %) in the price of the final products (Christidis and Brons, 2010).

In the field of air transport, Directive 2009/12/EC on airport charges (known as the Airport Charges Directive) sets out rules on airport charges. Coupled to the liberalisation of air transport, European airports entered keen competition for attracting airlines and increasing traffic. Airport charges account for a significant part of airlines' operating costs, which are therefore influenced by the level of airport charges in the selection of their destinations (see Box 7.3). Whereas some airports are successful in applying environmental charges without impacting their competitive position, others try to attract traffic by offering low charges or different compensation packages (in cooperation with local and regional governments). The European Commission recently issued new guidelines for state aid to airports and airlines in order to avoid market distortions (EC, 2014c).

Fiscal instruments have also an influence on transport prices and the attractiveness of the various modes. The EU also indirectly influences the price instruments used by the Member States, by setting rules for the minimal taxation of fuels. However, progress in this direction is difficult to achieve: in 2011, the European Commission launched a proposal to amend Directive 2003/96/EC restructuring the Community framework for the taxation of energy products and electricity (the current Energy Taxation Directive); the proposal included a realignment of fuel taxes based on energy

Box 7.2 Heavy vehicle fee in Switzerland

Since 1994, the protection of the Alpine regions from the negative effects of transit traffic is enshrined in the Swiss constitution. The Federal Council is required to take measures to ensure that transalpine freight in border-to-border transit is carried by rail, and the capacity of transit roads in the Alpine regions may not be increased.

The central pillars in transferring traffic from road to rail are the introduction of a distance-related heavy vehicle fee (HVF) and the construction of new rail links through the Alps, including three new base tunnels. A crucial topic of debate prior to implementing the Swiss policy of transferring traffic from road to rail was the maximum weight limit of 28 tonnes for trucks. This turned out to be a contentious point when Switzerland negotiated a bilateral agreement with the EU in the field of land transport (the Overland Transport Agreement). The Swiss accepted a higher weight limit, conditional on the recognition by the EU of Swiss transport policy containing a HVF, which has meanwhile been levied in Switzerland since 1 January 2001 (Krebs and Balner, 2012).

Together with the ratification of the Land Transport Agreement, Swiss parliament passed a law in 1999 requiring a reduction to a maximum of 650 000 transalpine lorries per year, at the latest two years after the opening of the Lötschberg base tunnel (2007). When this objective was not achieved, the Goods Traffic Transfer Act (GTTA) extended the target to two years after the opening of the Gotthard base tunnel at the latest (presumably 2016). Swiss transport policy is accompanied by complementary measures such as financial subsidies for unaccompanied combined transport, i.e. the 'Rolling Motorway'), grants and loans for intermodal terminals or incentives to increase competition between railway companies and combined transport operators on transalpine rail freight axes. The above-mentioned HVF applies to HGVs with a permissible laden weight exceeding 3.5 tonnes, and is calculated on the basis of tkm on Swiss territory. It uses the permissible laden weight of vehicle, not the actual operating weight, and the Euro emission class. The cheapest rate actually is CHF centimes 2.05 per tkm for emission level Euro VI. The rates are set to cover the uncovered costs of road freight transport including the external costs (e.g. the cost of air pollution, noise, climate change, landscape fragmentation and congestion). In 2008, the net revenues amounted to CHF 1 441 million, close to the estimated external costs of CHF 1 554 million.

Thanks to the Swiss transfer policy, the number of Alpine-crossing HGV trips has been reduced and stabilised since 2001. The modal split remained stable, and the rail share was always more than 60 % (66 % in 2013). In 2013, the number of Alpine-crossing HGVs was 1.14 million, i.e. almost 19 % less than in the year 2000. However, the latest estimation shows that the target value of the GTTA to be reached two years after the opening of the Gotthard base tunnel will still be exceeded by about 490 000 trips.

From an environmental point of view, the effect of the HVF on transalpine road freight traffic is very positive. There has been a surge in the renewal of vehicle fleets, and thus also of their environmental performance. Initial data and informal analysis suggest that the discounts for Euro VI vehicles in Switzerland encourage freight traders to operate using the newest vehicles through Switzerland, whereas older Euro classes might be sent to other destinations in the lack of similar policies. As a result, between 2004 and 2012, the emissions of HGVs on the transit routes in the Alpine space dropped significantly. NO_x emissions from HGVs went down by − 58 % (reduction overall traffic − 43 %), PM_{10} exhaust from HGV's by − 72 % (overall traffic − 50 %). CO_2-emissions instead remained stable (overall traffic emissions decreased by − 2 %, whereas CO_2 by HGVs increased by + 2 %).

Box 7.3 Evaluation of the Airport Charges Directive

Airport charges are charged to airlines for the use their facilities: aircraft-landing charges, or charges for the processing of passengers and freight. These and are estimated to account for up to 10 % of airline operating costs (see http://europa.eu/rapid/press-release_IP-14-567_en.htm).

The Airport Charges Directive (Directive 2009/12/EC) sets out a number of principles on airport charges to be followed by the main airport in each Member State and all airports handling more than 5 million passengers per year. It does not contain explicit provisions on the internalisation of external costs. However, while it prohibits discrimination, it does allow for the adjustment of airport charges for issues of public and general interest, including environmental issues.

According to a report for the Commission on the application of the directive (Steer Davies Gleave, 2013), there is a large variation in the use and modulation of environmental charges. Although the number of airports including environmental charges has increased, about half the airports covered in the study did not include any form of environmental charging. Noise charges are differentiated according to the noise levels of individual aircraft, but there are significant differences between airports. Some also levy emission charges, which are all based on the emission values of NO_x and hydrocarbon (HC) in the landing and take-off cycle.

content and CO_2. However, the proposal has not yet been approved.

Similarly, the EU has also considered revising the current tax-free status of aviation fuels. This was raised at the 2001 Assembly of the ICAO, but debates highlighted difficulties in reaching an agreement. The option of taxing fuel in Europe gives rise to concerns about competition of European air companies with third country operators. Air transport also benefits from a zero-rating VAT for intra-EU and international flights, whereas some Member States apply VAT to intra-EU coach and rail passenger services. This variety of situations further distorts competition in intra-EU travel.

Until now, the use of economic instruments managed at the EU has been limited to the inclusion of aviation in the European Trading System (Directive 2008/101/EC amending Directive 2003/87/EC so as to include aviation activities in the scheme for greenhouse gas emission allowance trading within the Community). Following the agreement by the ICAO Assembly in October 2013 to develop a global market-based mechanism addressing international aviation emissions by 2016, the EU suspended the ETS requirements for flights in 2012 to and from non-European countries (Decision No 377/2013/EU).

7.2.2 *Improving market conditions of non-road modes*

The range of policy measures for improving the attractiveness of non-road modes is based on financial and regulatory mechanisms to increase their efficiency, with the associated effect of reducing their prices for users.

A first subcategory is the financial support to non-road modes through dedicated programmes. At European level, transport projects can benefit from numerous sources of financial assistance: examples are the European Structural and Investment Funds; the Connecting Europe Facility (CEF), where multimodal integration remains an overarching priority (EC, 2014d); and loans and guarantees from the European Investment Bank (Gese Aperte and Baird, 2013). Moreover, the successive European Framework Programmes for Research and Technological Development, and their successor, the Horizon 2020 Framework Programme for Research and Innovation, also provide support for transport projects. Promoting a modal shift away from road has been a major criterion in the selection of the priority TEN-T projects since the Treaty of Maastricht (EC, 1995; Sichelschmidt, 1999), and has remained so in the intervening years (EC, 2001 and 2011a).

A second subcategory consists in eliminating administrative and technical barriers that increase the generalised costs of specific modes. In the railway sector, the first three railway packages and the recast of Directive 2008/57/EC on the interoperability of the rail system within the Community (known as the Interoperability Directive) aimed at creating an internal market in rail transport, by opening up rail transport to regulated competition and removing operational barriers. Nevertheless, many barriers still exist, including those stemming from the incomplete and incorrect implementation of Community law by Member States (EC, 2011c). For example, a 1 577 km haul from Ljubljana to Istanbul involves five countries and eight changes of locomotive (NEA et al., 2010). The recast of the First Railway Package with Directive 2012/34/EU establishing a single European railway area and the proposals for a Fourth Railway Package (See http://ec.europa.eu/transport/modes/rail/packages/2013_en.htm) aims at further eliminating these hurdles.

Several concrete measures have also been taken to reduce administrative burdens in *Short Sea Shipping* (EC, 2006a) (see Boxes 7.4 and 7.5). Finally, the European inland waterway transport policy frameworks, NAIADES (EC, 2006b) and its successor NAIADES II package (EC, 2013c) include measures that reduce regulatory burdens on the sector, such

Box 7.4 Marco Polo

The 2001 White Paper *European Transport Policy for 2010: Time to decide* (EC, 2001) launched a large-scale programme, Marco Polo I (2003–2006), designed to provide financial support to projects wishing to transfer cargo from road to alternative modes. It envisaged three types of action: modal shift actions, catalyst actions and common learning actions. Marco Polo II (2007–2013) was expected to shift 54 billion tkm from the road, and introduced two new types of actions: traffic avoidance actions and motorways of the sea.

The actual performance of the programme is a topic of debate. The Commission has argued that, while the modal shift expected by the projects in Marco Polo I amounted to 47.7 billion tkm, the actual realisation was a modal shift of 21.9 billion tkm. It reports estimated environmental benefits of EUR 434 million, while EUR 32.6 million was paid to projects with a modal shift objective. In Marco Polo II, the volume of modal shift expected by projects awarded in the calls between 2007 and 2011 amounted to 87.7 billion tkm. As some projects will be running until 2020, no evaluation can be made yet of the actual realisations. Most services are expected to continue after the Grant Agreement, and thus the programmes are likely to generate additional benefits after the contractual lifetime (EC, 2013e).

The European Court of Auditors (ECA, 2013), in contrast, concluded that the programmes did not attain their output targets and had little impact in shifting freight off the roads; they also claimed that there are no data to assess the expected benefits. Moreover, not enough relevant project proposals were put forward, because the market situation and the entry conditions discouraged operators from taking advantage of the scheme. The ECA also found that there was uncertainty about the limited quantities reported shifted, that half of the audited projects were of limited sustainability and that projects would have started even without EU funding. These findings have been disputed by the Commission in its reply.

A follow-up of Marco Polo will be integrated within the revised TEN-T programme, and implemented using funding instruments provided by the CEF (EC, 2013e).

Box 7.5 Motorways of the sea

The 2001 White Paper (EC, 2001) first mentioned the ambition to develop the 'motorways of the sea' (MoS), requiring better connections between ports and the rail and inland waterway networks, together with improvements in the quality of port services. MoS projects can benefit both from Marco Polo funding (which targets the costs incurred in the initial provision of MoS services) and TEN-T funding (destined for ports infrastructure and equipment) (Gese Aperte et al., 2013).

Several criticisms have been levied against the EU's approach to short sea shipping (Ng et al., 2013). For instance, while rail and road infrastructure are subsidised by the Member States, the EU expected actions supported in the Marco Polo programme to be self-financing in the long term. Thus, it is difficult to argue that the Macro Polo programmes have created a level playing field with modes which receive public support. Moreover, improving the performance of ports is considered essential to the success of short sea shipping. However, ports compete mostly with each other rather than with other transport modes. Therefore, the Union's approach to state aid for ports must perform a difficult balancing act between promoting modal shift and distorting competition between ports (Ng et al., 2013).

as the recast of the technical requirements for vessels and the rules for transport of dangerous goods. Moreover, new initiatives such as the development of a policy framework for the 'Blue Belt' (EC, 2013d) have been developed to further reduce the technical and administrative constraints faced by non-road modes.

The question remains open as to whether these measures will be sufficient to realise the 2011 Transport White Paper's stated ambition to shift 30 % of road transport to rail and waterborne transport in the segment above 300 km. Although the tkm by rail and IWW have increased since 1995, the measures that have been taken up over this period have been insufficient to substantially impact the modal share of road (see Chapter 3). Tavasszy et al. (2011) point out that such a shift would correspond to merely 3.4 % of the road freight market, but would require almost a doubling of rail and inland navigation. Moreover, they find little evidence indicating that policy measures could help meet the target. For instance, a 60 % increase of the cost of long-distance transport would be needed to make a modal shift of this magnitude profitable for individual companies. Tavasszy et al. (2011) deem such an increase to be politically infeasible. On the supply side, the current rail network would not have the capacity to absorb an increase in freight volume by more than 30 % to 40 %, assuming an increase in passenger transport by 14 % (den Boer et al., 2011). The higher IWW transport volumes would lead to significant increases in waiting times at locks.

The environmental benefits of a large-scale modal shift are not precisely known, and may differ considerably from that suggested by the existing average performance per mode, depending on a number of factors (Box 7.6).

Box 7.6 Environmental benefits of a modal shift: a wide range of estimates

A rough estimate of the overall reductions in CO_2 emissions made possible by moving passengers and freight from one mode to another can be found in van Essen et al. (2009), using differences in unit emissions from two different modelling approaches.

		STREAM	TREMOVE
Long-range passenger transport	Car to intercity trains	31 %	67 %
	Air to high-speed train	76 %	78 %
Freight	Heavy-duty truck to rail	55 %	78 %
	Articulated lorry to rail	35 %	66 %
	Air to articulated lorry	89 %	n/a
	Air to rail	93 %	n/a

Note: The main differences are that in TREMOVE (economic transport and emissions model), transport emissions from trips to and from the access points (i.e. train stations) are accounted for using the mode with which they were performed. In STREAM (Study on TRansport Emissions of All Modes), these emissions have been attributed to the relevant non-road transport mode. Moreover, TREMOVE is based on European data, while STREAM is based on Dutch data.

However, the authors point out that these figures are estimates only, and cannot be interpreted as the actual savings that would be made under a 'real-world' modal shift.

- The large differences in average carbon intensity of the freight transport modes can mainly be attributed to differences in the type of goods (density and value), shipment size and requirements and characteristics of the transport (e.g. speed, flexibility, granularity of the network and energy efficiency of the vehicle). Hence, for a proper comparison, it is crucial to examine entire transport chains rather than comparing the modes as such, i.e. one also needs to consider the emissions from and to access points (VMM, 2011). In general, the greater the distance of land haul for freight, the more competitive the lower carbon modes become (IPCC, 2013).
- For passenger transport, differences within transport modes are often as high as differences between the modes. At one end of the spectrum, emissions linked to air travel are much larger than those from surface modes. At the other end of the spectrum, emissions are clearly lower for walking and

Box 7.6 Environmental benefits of a modal shift: a wide range of estimates (cont.)

cycling. Most public transport modes have lower emissions than cars and motorcycles, but only if the occupancy rates are high enough.

- The estimates do not take into account future improvements. Due the long life-cycle of ships, rail and aircraft, these improvements are likely to be faster for road modes. In some cases, a modal shift will require high investments in transport infrastructure. The resulting improvements in the overall capacity of the transport network may induce new transport demand that could vary the benefits of the modal split (van Essen et al., 2009; den Boer et al., 2011), depending on the concrete circumstances.

It is therefore not surprising that estimates of the net environmental effects of a modal shift vary across very broad ranges. For instance, in a summary of the literature until 2009, van Essen et al. (2009) report the following ranges for the estimates of GHG emission reduction potential: for passenger transport, from 2 % to 14 % (for a shift from road to rail transport), and for freight transport, from 4 % to 23 %, with most of the estimates being at the lower end of these ranges. Also, den Boer et al. (2011) reckon that a full utilisation of the main corridors and the primary rail network could lead to a reduction of 2 % to 7 % of freight transport CO_2-equivalent emissions (assuming a detour for rail services). For passenger transport, the maximal modal shift would lead to a reduction of 9 % of passenger transport CO_2-equivalent emissions.

7.3 Improving policies

Many EU 'improvement' policy instruments are technical standards: limits on noise levels; emission limits for air pollutants for road vehicles, inland vessels and diesel locomotives and railcars; CO_2 emission limits for light-duty vehicles; and targets for the reduction of lifecycle GHG emissions of fuels. Currently, heavy-duty vehicles (HDVs) are still exempt from CO_2 emission limits, but the Commission has recently proposed a comprehensive strategy to address these (from both freight and passenger transport). Standards can also be used as instruments to promote alternative fuels and quicker uptake of new technologies for all modes, if the necessary infrastructure is in place. Therefore, Directive 2014/94/EU on the deployment of alternative fuels infrastructure has been recently adopted, which, while not setting binding targets for Member States, does indicate the minimum requirements for deployment of the infrastructure with common standards (EU, 2014). It concerns alternative fuels such as electricity, hydrogen and natural gas (pure or blended with biogas). Labelling requirements such as the CO_2 labelling of cars (Directive 1999/94/EC relating to the availability of consumer information on fuel economy and CO_2 emissions in respect of the marketing of new passenger cars) aim to help consumers choose vehicles with low fuel consumption.

The maritime sector is also directly affected by the MARPOL, developed under the IMO. The EU also imposes limits on the sulphur content of marine fuels (Directive 2012/33/EU amending Council Directive 1999/32/EC as regards the sulphur content of marine fuels).

The IMO started working on GHG emissions in the maritime sector in 1997, at the initiative of the EU, but progress in meeting binding reduction targets has been slow. In 2011, the IMO adopted mandatory technical and operational energy efficiency measures which aim at reducing the amount of GHG emissions from ships. In 2013, the Commission proposed a regulation (under discussion in European Parliament/Council) setting up an EU system for MRV of CO_2 emissions from international shipping, which could constitute the first step towards the development of global instruments under the auspices of the IMO (EC, 2013f).

Similarly, aviation is covered by Annex 16 (Environmental Protection) to the Convention on International Civil Aviation, which deals with the protection of the environment from the effect of aircraft noise and aircraft engine emissions. The EU also sets rules and procedures with regard to the introduction of noise-related operating restrictions at Community airports (Directive 2002/30/EC on the establishment of rules and procedures with regard to the introduction of noise-related operating restrictions at Community airports). The competent authorities in Member States may prohibit or restrict the use of aircraft that are 'marginally compliant' with the ICAO noise standards. In 2013, a breakthrough was achieved with a decision by the ICAO to design a global CO_2 emissions offsetting scheme that could be implemented from 2020.

The environmental performance of transport can also be improved through efficient use of the capacity of vehicles (see Box 7.7). Increasing the load or occupancy of transport means is also a rational response of the operators to increasing market competition, to volatile energy costs or to the implementation of new, environmentally-related charges (from fuel taxation to infrastructure charges). As a complementary strategy, operators can also explore the use of vehicles with higher capacity. Although these strategies result in improved energy (and environmental) efficiency, they also may counterbalance 'avoid' policies by keeping transport prices low, or even by inducing additional demand.

Box 7.7 The potential for increased fuel efficiency in shipping

In the case of shipping, there are economies of scale in fuel consumption. Indeed, when a ship's cargo-carrying capacity is doubled, the required power increases with just two-thirds of the increase in ship size. As a result, unit fuel consumption decreases when smaller ships are replaced by larger ones. Ever-increasing ship sizes are likely to further improve fuel efficiency. Lindstad et al. (2012) claim that ship owners could reduce CO_2 emissions from shipping by up to 30 % and still save money by replacing existing fleets with larger vessels.

However, taking into account the expected lifetime of ships, it may take as long as 25 years before these benefits fully materialise. Moreover, there are financial limitations to further increases in ship size: each ship is in effect an 'inventory on the waves', and there is an opportunity cost for carrying large stocks on average, namely the interest on these stocks. Finally, size restrictions operate in ports and fairways. As a result, some ports will need to be served by feeder services using smaller ships, which will reduce the total environmental benefits of using larger ships in deep-sea shipping — this is similar to the impact of hub-and-spoke networks in aviation. An interesting question in this respect is the potential impact of the expansion of the Panama Canal locks. Lindstad et al. (2013) have considered the potential energy savings from modifying the design of ships' hulls, and they argue that the expansion of the Panama Canal locks will only marginally increase the standard bulk shipment sizes through the canal, compared with the existing bulk fleet. The main reasons are precisely the financial costs of holding stocks, and the capacity constraints in other ports and fairways. In order to estimate the impact of slenderer hull forms on fuel consumption, they therefore use the parameters of vessels operating in traditional Panamax bulk trades. Historically, the rule was that bulk vessels should be built with high block coefficients to maximise the cargo-carrying capacity. However, with higher fuel prices, the profitability of energy-efficient designs increases. Their conclusion is that, with a fuel price of USD 600 per tonne of fuel, emissions can be reduced profitably by between 15 % and 25 % through slenderer hull design.

Acronyms and abbreviations

7EAP	Seventh Environment Action Programme
AFRA	Aircraft Fleet Recycling Association
C_6H_6	Benzene
CEF	Connecting Europe Facility
CGDD	Commissariat Général au Développement Durable
CHF	Swiss franc
CNG	Compressed natural gas
CO	Carbon monoxide
CO_2	Carbon dioxide
COICOP	Classification of individual consumption by purpose
COPERT	COmputer Programme to calculate Emissions from Road Transportation
DG	Directorate-General
DIP	Declaration d'intêret public
DPF	Diesel particulate filters
EC	European Commission
ECA	European Court of Auditors
EEA	European Environmental Agency
EEDI	Energy Efficiency Design Index
EFTA-4	Iceland, Liechtenstein, Norway, Switzerland
EICB	En InnovatieCentrum Binnenvaart
EMS	European Modular System
EMSA	European Maritime Safety Agency
ETC/ACM	European Topic Centre on Air Pollution and Climate Change Mitigation
ETC/CCA	European Topic Centre on Climate Change impacts, vulnerability and Adaptation

ETS	Emissions Trading Scheme
EU	European Union
EUR	Euro
EV	Electrical vehicle
FP7	Seventh Framework Programme
FUTRE	FUture prospects on TRansport evolution and innovation challenges for the competitiveness of Europe
g	Gram(s)
GATT	General Agreement on Tariffs and Trade
GDP	Gross domestic product
GHG	Greenhouse gas
GTTA	Goods Traffic Transfer Act
HC	Hydrocarbon
HDV	Heavy-duty vehicle
HGV	Heavy goods vehicle
HSR	High-speed rail
HVF	Heavy vehicle fee
IAS	Invasive alien species
ICAO	International Civil Aviation Organization
ICE	Internal combustion engine
ICT	Information and communications technology
IEA	International Energy Agency
IMO	International Maritime Organization
IMPACT	Measures and Policies for All external Cost of Transport
IPCC	Intergovernmental Panel on Climate Change
ITF	International Transport Forum
IWW	Inland waterways
kg	Kilogram(s)
km	Kilometre(s)

KPI	Key Performance Indicator
ktoe	Kilotonne(s) oil equivalent
kW	kilowatt
$L_{night-outside}$	Decibel (dB) night noise level outside the façade
L_{den}	Weighted average day, evening and night noise level
L_{night}	Average night noise level
LGV	Light goods vehicle
LPG	Liquefied petrol gas
LRTAP	Long-range Transboundary Air Pollution
LV	Limit values
MARPOL	International Convention for the Prevention of Pollution from Ships
MoS	Motorways of the sea
MRV	Monitoring, reporting and verification
NG	Natural gas
NH_3	Ammonia
NMVOC	Non-methane volatile organic compound
NO_2	Nitrogen dioxide
NO_X	Oxides of nitrogen
NSR	North Sea Route
OECD	Organisation for Economic Cooperation and Development
O_3	Ozone
Pb	Lead
PEMS	Portable Emissions Measurement Systems
pkm	Passenger-kilometre(s)
$PM_{2.5}$	Particulate matter with a diametre of 2.5 micrometres or less
PM_{10}	Particulate matter with a diametre of 10 micrometres or less
ppm	parts per million
RED	Renewable Energy Directive
RES	Renewable energy sources

RES-T	Renewable energy sources — transport
RSS	Regular Shipping Services
SCR	Selective catalytic reduction
SECA	Sulphur Emission Control Areas
SO_2	Sulphur dioxide
SO_X	Sulphur oxides
SPB	Stichting Projecten Binnenvaart
STREAM	Study on TRansport Emissions of All Modes
TEN-T	Trans-European Transport Network
TERM CSI	Transport and Environment Reporting Mechanism Core Set of Indicators
TERM	Transport and Environment Reporting Mechanism
TJ	terajoules
tkm	Tonne-kilometre(s)
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNECE	United Nations Economic Commission for Europe
UNFCCC	United Nations Framework Convention on Climate Change
USA	United States of America
USD	US dollar
VAT	Value added tax
vkm	Vehicle-kilometre(s)
VOC	Volatile organic compound
WHO	World Health Organization
WLTP	World Harmonised Light Duty Test Procedure
WTO	World Trade Organization
WWF	Wide Fund for Nature

References

Allroggen, F., Malina, R. and Lenz, A.-K., 2013, 'Which factors impact on the presence of incentives for route and traffic development? Econometric evidence from European airports', *Transportation Research Part D: Transport and Environment,* (60) 49–61.

Avetisyan, M., Hertel, T. and Sampson, G., 2014, 'Is Local Food More Environmentally Friendly? The GHG Emissions Impacts of Consuming versus Domestically Produced Food', *Environmental and Resource Economics,* 58(3) 415–462.

Banister, D., 2012, 'Transport and economic development: reviewing the evidence', *Transport Reviews: A Transnational Transdisciplinary Journal,* 32(1) 1–2.

Barbot, C., 2006, 'Low-cost airlines, secondary airports, and state aid: An economic assessment of the Ryanair-Charleroi Airport agreement', *Journal of Air Transport Management,* 12(4) 197–203.

Beckers, T., Hirschhausen, C. von, Haunerland, F. and Walter, M., 2009, 'Long-distance rail services in Europe: concessions or free market?', in: OECD, *The Future for Interurban Passenger Transport: Bringing Citizens Closer*, OECD Publishing, Paris, pp. 287–310.

Behrens, C. and Pels, E., 2012, 'Intermodal competition in the London–Paris passenger market: High-Speed Rail and air transport', *Journal of Urban Economics,* 71(3) 278–288.

Beria, P., Grimaldi, R. and Laurino, A., 2013, '*Long distance coach transport in Italy: state of the art and perspectives*', in: WCTRS, Rio de Janeiro, Brazil.

Den Boer, E., van Essen, H., Brouwer, F., Pastori, E. and Moizo, A., 2011, *Potential of modal shift to rail transport, Study on the projected effects on GHG emissions and transport volumes*, Commissioned by the Community of European Railway and Infrastructure Companies (CER).

Den Boer, E., Otten, M. and van Essen, H., 2011, *STREAM International Freight 2011 Comparison of various transport modes on a EU scale with the STREAM database Delft,* CE Delft.

Braconier, H. and Pisu, M., 2013, *Road Connectivity and the Border Effect: Evidence from Europe*, OECD Economics Department Working Papers, No 1073, OECD.

De Bruyn, S., Brinke, L., Kampman, B. and Koopman, M., 2012, *Literature review on employment impacts of GHG reduction policies for transport*, CE Delft, Commissioned by the European Climate Foundation.

Burkhardt, U. and Kärcher, B., 2011, 'Global radiative forcing from contrail cirrus', *Nature Climate Change,* 1(1) 54–58.

Button, K. and Pels, E., 2010, 'International Air Transport: The Impact of Globalisation on Activity Levels', in: OECD, *Globalisation, Transport and the Environment*, Paris, OECD Press, pp. 81–120.

Christidis, P. and Brons, M., 2010, *Impacts of the proposal for amending Directive 1999/62/EC on road infrastructure charging: An analysis on selected corridors and main impacts*, No JRC54766, Institute for Prospective and Technological Studies, Joint Research Centre (JRC-IPTS).

Christidis, P. and Leduc, G., 2009, *Longer and Heavier Vehicles for freight transport*, Sevilla: European Commission Joint Research Centre Institute for Prospective Technological Studies (JRC-IPTS).

Clewlow, R. R., Sussman, J. M. and Balakrishnan, H., 2014, 'The impact of high-speed rail and low-cost carriers on European air passenger traffic', *Transport Policy,* (33) 136–143.

Coley, D., Howard, M. and Winter, M., 2009, 'Local food, food miles and carbon emissions: A comparison of farm shop and mass distribution approaches', *Food Policy,* 34(2) 150–155.

Corbett, J.J., Winebrake, J.J., Endresen, O., Eide, M., Dalsoren, S., Isaksen, I.S.A. and Sorgard, E., 2010, 'International maritime shipping: the impact of globalisation on activity levels', in: OECD, *Globalisation, Transport and the Environment*, Paris, OECD Press, pp. 55–79.

Cuenot, F., Fulton, L. and Staub, J., 2012, 'The prospect for modal shifts in passenger transport worldwide and impacts on energy use and CO_2', *Energy Policy*, (41) 98–106.

Damarad, T. and Bekker, G.J., 2003, *Habitat Fragmentation due to Transportation Infrastructure: Findings of the COST Action 341*, Office for Official Publications of the European Communities, Luxembourg.

DG Energy, 2014, 'Market observatory and statistics: Oil bulletin', Statistics, EC, DG Energy (http://ec.europa.eu/energy/observatory/oil/bulletin_en.htm) accessed 17 November 2014.

DG Environment, 2012, *Soil Sealing*, Science for Environment Policy, In-depth Reports, March 2012.

DG Mobility and Transport, 2014, *EU transport in figures — Statistical pocketbook 2014*, European Commission, Directorate-General for Mobility and Transport, Luxembourg: Publications Office of the European Union.

Dobruszkes, F., 2011, 'High-speed rail and air transport competition in Western Europe: A supply-oriented perspective', *Transport Policy*, 18(6) 870–879.

EC, 1995, *The Trans-European Transport Network. Transforming a Patchwork into a Network*, European Commission, Luxembourg, Office for Official Publications of the European Communities.

EC, 2001, White Paper — European Transport Policy for 2010: Time to Decide (COM(2001) 370 final of 12 September 2001).

EC, 2006a, Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions 'Mid-Term Review of the Programme for the Promotion of Short Sea Shipping' (COM(2006) 380 final of 13 July 2006).

EC, 2006b, Communication from the Commission on the Promotion of Inland Waterways Transport 'NAIADES' An Integrated European Action Programme for Inland Waterway Transport (COM(2006) 6 final of 17 January 2006).

EC, 2011a, White Paper — Roadmap to a Single European Transport Area — Towards a competitive and resource efficient transport system (COM(2011) 144 final of 28.3.2011).

EC, 2011b, Commission Staff Working Paper — Impact Assessment, Accompanying document to the White Paper Roadmap to a Single European Transport Area — Towards a competitive and resource efficient transport system (SEC(2011) 358 final Brussels of 28 March 2011).

EC, 2011c, Commission Staff Working Document Accompanying the White Paper — Roadmap to a Single European Transport Area — Towards a competitive and resource efficient transport system (SEC(2011) 391 final of 28 March 2011).

EC, 2012a, Proposal for a Directive of the European Parliament and of the Council amending Directive 98/70/EC relating to the quality of petrol and diesel fuels and amending Directive 2009/28/EC on the promotion of the use of energy from renewable sources (COM(2012) 595 final of 17 October 2012).

EC, 2012b, *Guidance document on Inland waterway transport and Natura 2000*, European Commission, 2012.

EC, 2013a, Commission Staff Working Document — Impact Assessment Accompanying the document Proposal for a Council and European Parliament Regulation on the prevention and management of the introduction and spread of invasive alien species (SWD(2013) 321 final of 9 August 2013).

EC, 2013b, *EU Energy, Transport and GHG Emissions, Trends to 2050, Reference Scenario 2013*, European Commission, Luxembourg, Office for Official Publications of the European Communities.

EC, 2013c, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions 'Towards quality inland waterway transport — NAIADES II' (COM(2013) 623 final of 10 September 2013).

EC, 2013d, Communication from the Commission 'Blue Belt, a Single Transport Area for shipping' (COM(2013) 510 final of 8 July 2013).

EC, 2013e, Communication from the Commission to the European Parliament, the Council, the European

Economic and Social Committee and the Committee of the Regions 'The Marco Polo programme — Results and outlook' (COM(2013) 278 final of 14 May 2013).

EC, 2013f, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions 'Integrating maritime transport emissions in the EU's greenhouse gas reduction policies' (COM(2013) 479 final of 28 June 2013).

EC, 2014a, Commission Staff Working Document — *Towards a roadmap for delivering EU-wide multimodal travel information, planning and ticketing services* (SWD(2014) 194 final of 13 June 2014).

EC, 2014b, Report from the Commission to the European Parliament and the Council on the State of the Union Road Transport Market (COM(2014) 222 final of 14 April 2014).

EC, 2014c, Communication from the Commission 'Guidelines on State aid to airports and airlines' (OJ C 99, 4 April 2014, pp. 3–34).

EC, 2014d, Communication from the Commission 'Building the Transport Core Network: Core Network Corridors and Connecting Europe Facility' (COM(2013) 940 final of 7 January 2014).

ECA, 2013, *Have the Marco Polo Programmes been Effective in Shifting Traffic off the Road?*, Special Report No 3/2013, European Court of Auditors, Luxembourg: Publications Office of the European Union.

Ecoplan, 2011, *Alpenquerender Güterverkehr 2009: Einfluss der Konjunkturkrise. Auftraggeber: Bundesamt für Verkehr.*, Ecoplan, Altdorf UR.

EEA, 2011, *Hazardous substances in Europe's fresh and marine waters*, EEA Technical report No 8/2011, European Environment Agency.

EEA, 2012, *The contribution of transport to air quality. TERM 2012: transport indicators tracking progress towards environmental targets in Europe*, EEA Report No 10/2012, European Environment Agency.

EEA, 2013a, *A closer look at urban transport TERM 2013: transport indicators tracking progress towards environmental targets in Europe*, EEA Report No 11/2013, European Environment Agency.

EEA, 2013b, *Why did greenhouse gas emissions decrease in the EU in 2012? EEA analysis*, European Environment Agency.

EEA, 2013c, *EMEP/EEA air pollutant emission inventory guidebook 2013*, Technical report No 12/2013, European Environment Agency.

EEA, 2013d, *The impact of international shipping on European air quality and climate forcing*, EEA Technical report No 4/2013, European Environment Agency.

EEA, 2014a, *Trends and projections in Europe 2014 — Tracking progress towards Europe's climate and energy targets for 2020*, EEA Report No 6/2014, European Environment Agency.

EEA, 2014b, *Air quality in Europe — 2014 report*, EEA Report No 5/2014, European Environment Agency.

EEA, 2014c, *Monitoring CO_2 emissions from passenger cars and vans in 2013*, EEA Technical report No 19/2014, European Environment Agency.

Emisia, 2013, *TRACCS: Transport data collection supporting the quantitative analysis of measures relating to transport and climate change. Final Report to DG Climate Action*, Emisia.

Van Essen, H., Rijkee, X., Verbrakk, G., Quak, H. and Wilmink, I., 2009, *Modal split and decoupling options,* Paper 5, Produced as part of contract ENV.C.3/SER/2008/0053 between European Commission Directorate-General Environment and AEA Technology plc.

EU, 2001, Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants (OJ L 309, 27.11.2001, pp. 22–30).

EU, 2008, Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe (OJ L 152, 11.6.2008, pp. 1–44).

EU, 2009a, Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (OJ L 140/16, 5.6.2009, pp. 16–62).

EU, 2009b, Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC (OJ L 140/88, 5.6.2009, pp. 88–113).

EU, 2009c, Regulation (EC) No 443/2009 of the European Parliament and of the Council of 23 April 2009 setting emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO_2 emissions from light-duty vehicles (OJ L 140, 5.6.2009, pp. 1–15).

EU, 2011a, Regulation (EU) No 510/2011 of the European Parliament and of the Council of 11 May 2011 setting emission performance standards for new light commercial vehicles as part of the Union's integrated approach to reduce CO_2 emissions from light-duty vehicles (OJ L 145, 31.5.2011, pp. 1–18).

EU, 2011b, Directive 2011/76/EU of the European Parliament and of the Council amending Directive 1999/62/EC on the charging of heavy goods vehicles for the use of certain infrastructures (OJ L 269, 14.10.2011, pp. 1–16).

EU, 2013, Communication from the Commission to the European Parliament, the Council, the European Economic and social Committee and the Committee of the Regions 'A Clean Air Programme for Europe' (COM/2013/0918 final of 18 December 2013).

EU, 2014, Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure (OJ L 307, 28.10.2014, pp. 1–20).

EUROCONTROL, 2013a, *Challenges of growth — Summary repor*t, European Organisation for the Safety of Air Navigation.

EUROCONTROL, 2013b, *Task 4: European Air Traffic in 2035,* European Organisation for the Safety of Air Navigation.

EUROCONTROL, 2013c, *Task 7: European Air Traffic in 2050*, European Organisation for the Safety of Air Navigation.

EUROCONTROL, 2014, *Market segments in European air traffic 2013*, Brussels, European Organisation for the Safety of Air Navigation.

European Maritime Safety Agency, 2014, *EMSA's 2013 report to the European Commission and the* Administrative *Board regarding Regulation (EC) No 2038/2006 on the multi-annual funding of the Agency's pollution preparedness and response activities*, European Maritime Safety Agency.

Eurostat, 2000, *Development of EU Passenger Mobility Statistics Final Report*.

Eurostat, 2011, *Population projections 2010–2060: EU27 population is expected to peak by around 2040*, 80/2011 — 8 June 2011, Eurostat Press Office, Brussels.

Eurostat, 2013, 'Road freight transport statistics' (http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Road_freight_transport_statistics) accessed 8 November 2014

Eyring, V., Isaksen, I.S.A., Berntsen, T., Collins, W.J., Corbett, J.J., Endresen, O., Grainger, R.G., Moldanova, J., Schlager, H. and Stevenson, D.S., 2010, 'Transport impacts on atmosphere and climate: Shipping', *Atmospheric Environment,* 44(37), 4 375–4 771.

Finez, J., 2014, 'Fare setting by the French National Railway Company (SNCF), a social history of pricing, From uniform fares to yield management (1938–2012)', *Revue Francaise De Sociologie,* 55(1) 5–39.

Flyvbjerg, 2005a, 'Design by deception: the politics of megaproject approval', *Harvard Design Magazine* (22), 50–59.

Flyvbjerg, B., 2005b, 'Machiavellian Megaprojects', *Antipode,* 37(1) 18–22.

Flyvbjerg, B., Bruzelius, N. and Rothengatter, W., 2003, *Megaprojects and Risk: An Anatomy of Ambition*, Cambridge University Press.

Foster-McGregor, N., Hanzl-Weiss, D., Leitner, S., Leitner, S., Rabemiafara, N., Sanoussi, F., Stehrer, R. and Ward, T., 2012, *Sectoral Employment Effects of Economic Downturns*, wiiw Research Reports, 379, The Vienna Institute for International Economic Studies, wiiw.

Franco, V., Francisco, P., German, J. and Mock, P., 2014, *Real-world exhaust emissions from modern diesel cars. A meta-analysis of PEMS emissions data from EU (Euro 6) and US (TIER 2 BIN 5/ULEV II) diesel passenger cars. Part 1: aggregated results*, International Council on Clean Transportation, Washington DC, USA.

Furuhata, Masabumi, Dessouky, Maged, Ordóñez, Fernando, Brunet, Marc-Etienne, Wang, Xiaoqing and Koenig, Sven, 2013, 'Ridesharing: The state-of-the-art and future directions', *Transportation Research Part B: Methodological,* (57) pp. 28–46.

Gese Aperte, X.G. and Baird, A.J., 2013, 'Motorways of the sea policy in Europe', *Maritime Policy & Management,* 40(1), 10–26.

Givoni, M. and Rietveld, P., 2010, 'The environmental implications of airlines' choice of aircraft size', *Journal of Air Transport Management,* 16(3) 159–167.

Grimal, R., 2010, 'Mobilité à longue distance : plus de voyages s'effectuent en train, mais les seniors restent adeptes de la voiture', in: Bruno Tregouët (ed.), *La mobilité des Français, panorama issu de l'enquête nationale transports et déplacements 2008*, Service de l'Observation et des Statistiques (SOeS) du Commissariat Général au Développement Durable (CGDD).

Grolleau, G., Sirieix, L. and Schaer, B., 2010, 'Les «kilomètres alimentaires»: de la compréhension du concept à la complexité de la réalité', *Revue d'Économie Régionale & Urbaine* décembre (5), pp. 899–911.

Hill, N., Brannigan, C., Richard Smokers, Schroten, A., Essen, H. van and Skinner, I., 2012, *EU Transport GHG: Routes to 2050 II: Developing a better understanding of the secondary impacts and key sensitivities for the decarbonisation of the EU's transport sector by 2050*, European Commission (DG Climate Action).

Hill, N., Brannigan, C., Wynn, D., Milnes, R., van Essen, H., den Boer, E., van Grinsven, A., Lightart, T. and van Gijlswijk, T., 2012, *The role of GHG emissions from infrastructure construction, vehicle manufacturing, and ELVs in overall transport sector emissions.* Task 2 paper produced as part of a contract between European Commission Directorate-General Climate Action and AEA Technology plc.

Hjelle, H. M., 2012, 'The Comparative Environmental Performance of Freight Transport Chains — Why Do the Models Provide Different Answers?', European Transport Conference, 8–10 October, Glasgow.

ICCT, 2014, *From Laboratory to road, a 2014 update of official and "real-world" fuel consumption and* CO_2 *values for passenger cars in Europe*. International Council on Clean Transportation, Washington DC, USA.

IMO, 2012, *International Shipping Facts and Figures — Information Resources on Trade, Safety, Security, Environment*, Maritime Knowledge Centre.

IMO, 2014, *Reduction of GHG emissions from ships — Third IMO GHG Study 2014 — Final Report,* MEPC 67/INF.3, 25 July 2014, International Maritime Organization (IMO).

IPCC, 2013, 'Transport', in: IPCC, *Climate Change 2014: Mitigation of Climate Change*, Intergovernmental Panel on Climate Change, p. 117.

ITF/OECD, 2010a, *Reducing Transport Greenhouse Gas emissions: Trends & Data 2010*, International Transport Forum, Organisation for Economic Co-operation and Development.

ITF/OECD, 2010b, *Transport Greenhouse Gase Emissions: Country Data 2010*, International Transport Forum, Organisation for Economic Co-operation and Development.

ITF/OECD, 2013a, *Global Transport Trends in Perspective*, International Transport Forum, Organisation for Economic Co-operation and Development.

ITF/OECD, 2013b, *Long-Run Trends in Car Use*, International Transport Forum, Organisation for Economic Co-operation and Development.

ITF/OECD, 2013c, *ITF Transport Outlook, Funding transport,* International Transport Forum, Organisation for Economic Co-operation and Development

Jacobs, K., Van Lent, C., Verstrepen, S. and Bogen, M., 2014, *CO*[3] *Test Project Report: Horizontal Collaboration in Fresh & Chilled Retail Distribution*, Deliverable D 4. 3,

Jara-Díaz, S. R., Cortés, C. E. and Morales, G. A., 2013, 'Explaining changes and trends in the airline industry: Economies of density, multiproduct scale, and spatial scope', *Transportation Research Part E: Logistics and Transportation Review,* (60) 23–26.

Kågeson, P., 2009, *Environmental Aspects of Inter-City Passenger Transport*, Discussion Paper 2009-28, OECD/ITF, Paris.

Kocsis, O., 2000, *Auswirkungen des Alpentransitverkehrs auf die Luftbelastung in den Alpentälern*, Ökoscience.

Korzhenevych, A., Dehnen, N., Bröcker, J., Holtkamp, M., Meier, H., Gibson, G., Varma, A. and Cox, V., 2014, *Update of the Handbook on External Costs of Transport, Final Report*, European Commission, DG Mobility and Transport.

Krebs, P. and Balmer, U., 2012, *Fair and efficient — The Distance-related Heavy Vehicle Fee (HVF) in Switzerland*, Federal Office for Spatial Development (ARE), Department of the Environment, Transport, Energy and Communications (DETEC).

Kuhnimhof, T., Armoogum, J. and Madre, J.-L., 2009, 'Generating Internationally Comparable Figures on Long-Distance Travel for Europe', *Transportation Research Record: Journal of the Transportation Research Board*, No 2105, pp. 18–27, Transportation Research Board, Washington DC.

Lee, D.S., Pitari, G., Grewec, V., Gierens, K., Penner, J.E., Petzold, A., Prather, M.J., Schumann, U., Bais, A., Berntsen, T., Iachetti, D., Lim, L.L. and Sausen, R., 2010, 'Transport impacts on atmosphere and climate: aviation', *Atmospheric Environment,* (44) 4 678–4 734.

Lian, J. I. and Denstadli, J., 2010, 'Booming Leisure Air Travel to Norway - The Role of Airline Competition', *Scandinavian Journal of Hospitality and Tourism,* 10(1) 1–15.

Liimatainen, H., Nykänen, L., Arvidsson, N., Hovi, I. B., Jensen, T. C. and Østli, V., 2014, 'Energy efficiency of road freight hauliers — A Nordic comparison', *Energy Policy,* (67) 378–387.

Lindstad, H., Asbjørnslett, B. E. and Strømman, A.H., 2012, 'The importance of economies of scale for reductions in greenhouse gas emissions from shipping', *Energy Policy*, (46) 386–398.

Lindstad, H., Jullumstrø, E. and Sandaas, I., 2013, 'Reductions in cost and greenhouse gas emissions with new bulk ship designs enabled by the Panama Canal expansion', *Energy Policy,* (59) 341–349.

Litman, T., 2014, *The mobility-productivity paradox — Exploring the negative relationships between mobility and economic productivity*, I-TED 2014 International Transportation Economic Development Conference, Victoria Transport Policy Institute.

Lückge, H., Heldstab, J., Wagner, M., Muscella, C., Kistler, R. and Joos-Widmer, N., 2014, *iMONITRAF! Annual Report 2013: The way ahead for the iMONITRAF! Network*, INFRAS/Climonomics, Zürich.

Lüttmerding, A. and Gather, M., 2013, *Level of service on passenger railway connections between European metropolises*, Transport and Spatial Planning Institute (Institut Verkehr und Raum), University of Applied Sciences Erfurt (Fachhochschule Erfurt).

Máca, V., Eberle, A., Pearson, A., Ridgway, M., Braun Kohlová, M., Görlach, B., Novák, J. and Ščasný, M., 2013. *Climate Policies and the Transport Sector. Analysis of Policy Instruments, their Interactions, Barriers and Constraints, and resulting Effects on Consumer Behaviour.* Berlin, Ecologic Institute.

Maibach, M., Schreyer, C., Sutter, D., van Essen, H.P., Boon, B.H., Smokers, R., Schroten, A., Doll, C., Pawlowska, B. and Bak, M., 2008, *Handbook on estimation of external costs in the transport sector — Internalisation Measures and Policies for All external Cost of Transport (IMPACT) Version 1.1*, Delft, CE.

Mancuso, P., 2013, 'An analysis of the competition that impinges on the Milan–Rome intercity passenger transport link', *Transport Policy,* (32) 42–52.

McKinnon, A., 2010, 'Green Logistics: The Carbon Agenda', *LogForum* 6(3) (http://www.logforum.net/pdf/6_3_1_10.pdf) accessed 8 May 2014.

McKinnon, A. and Whiteing, A., 2012, *Green Logistics: Improving the Environmental Sustainability of Logistics*, Kogan Page.

Mellin, A., Wikberg, A., Vierth, I. and Karlsson, R., 2013, *Internalisation of External Effects in European Freight Corridors*, International Transport Forum Discussion Papers, Organisation for Economic Co-operation and Development, Paris.

Millard-Ball, A. and Schipper, L., 2010, 'Are We Reaching Peak Travel? Trends in Passenger Transport in Eight Industrialized Countries', *Transport Reviews,* 31(3) 357–378.

Ministerio de Fomento, 2014, *Observatorio hispano-francés de tráfico en los Pirineos. Suplemento al documento nº6*, Secretaría General de Transporte, Ministerio de Fomento.

Molitor, R., Käfer, A., Thaller, O., Samaras, Z., Tourlou, P.M. and Ntziachristos, L., 2001, *Road freight transport and the environment in mountainous areas: Case studies in the Alpine region and the Pyrenees*, 68, EEA.

Narangajavana, Y., Garrigos-Simon, F.J., Garcia, J.S. and Forgas-Coll, S., 2014, 'Prices, prices and prices:

A study in the airline sector', *Tourism Management,* (41) 28–42.

NEA, University of Leeds, Price Waterhouse Coopers and Significance, 2010, *Situation and Perspectives of the Rail Market, TREN/R1/350-2008 Lot 2*.

Nijland, H., Mayeres, I., Manders, T., Michiels, H., Boete, M. and Gerlagh, R., 2012, *Use and effectiveness of economic instruments in the decarbonisation of passenger cars*, ETC/ACM Technical Paper 2012/11.

Ng, A.K. and Song, S., 2010, 'The environmental impacts of pollutants generated by routine shipping operations on ports', *Ocean & Coastal Management,* (53) 301–311.

Ng, A.K.Y., Saurí, S. and Turro, M., 2013, 'Short sea shipping in Europe: issues, policies and challenges', in: eds M. Finger and T. Holvad, *Regulating Transport in Europe*, Edward Elgar, Cheltenham, pp. 196–217.

Ntziachristos, L., Mellios, G., Tsokolis, D., Keller, M., Hausberger, S., Ligterink, N.E. and Dilara, P., 2014, 'In-use vs. type-approval fuel consumption of current passenger cars in Europe', *Energy Policy,* (67) 403–411.

Panteia/NEA, Stichting Projecten Binnenvaart (SPB)/ Expertise- en InnovatieCentrum Binnenvaart (EICB), Planco, via donau and Central Commission for the Navigation of the Rhine (CCNR), 2013, *Contribution to Impact Assessment of Measures for Reducing Emissions of Inland Navigation*, written on behalf of the European Commission's Directorate-General for Transport.

Papadimitriou, G., Wüthrich, P., Notter, B., Fridell, E., Winnes, H., Styhre, H., Sjödin, Å. and Ntziachristos, L., 2014, *A detailed transport stock and activity dataset for policy assessment purposes*, 20th International Transport and Air Pollution Conference, September 18–19, Graz, Austria.

Papanikolau, A., Boile, M., Reichenbach, M. and Schippl, J., 2014, *Long-term future analysis on transport demand market and drivers. FUTRE Project Deliverable 3.2*.

Van Passel, S., 2013, 'Food miles to assess sustainability: A revision', *Sustainable Development,* 21(1), pp. 1–17.

Pels, E., 2010, 'International Air Transport: Environmental Impacts of Increased Activity Levels', in: *Globalisation, Transport and the Environment*, pp. 185–196, Paris, OECD Press.

Perry, J., 2012, 'Sky-High Potential for Aircraft Recycling', *Recycling* (http://www.afraassociation.org/NewsDocs/12_Mar_RecyclingIntl.pdf) accessed 3 November 2011.

Petersen, M. S., Bröcker, J., Enei, R., Ulied, A., Larrea, E., Timms, P. M., Hansen, C.O., Hansen, H. K., Rich, J., Pearman, A., Shires, J., Korchenevych, A., Leder, P., Gohkale, R., Merten, T., Granberg, T. and Jovanvic, R., 2009, *Traffic flow: Scenario, Traffic Forecast and Analysis of Traffic on the TEN-T, Taking into Consideration the External Dimension of the Union. Final Report*, Funded by DG Energy and Transport, European Commission, Copenhagen, Denmark.

Petersen, M.S., Sessa, C., Enei, R., Ulied, A., Larrea, E., Obisco, O., Timms, P.M. and Hansen, C.O., 2009, *Report on Transport Scenarios with a 20 and 40 year Horizon, Final report*, Funded by DG Energy and Transport, European Commission, Copenhagen, Denmark.

Priemus, H., 2008, 'How to improve the early stages of decision-making in megaprojects', in: *Decision-making on Mega-projects: Cost-benefit Analysis, Planning and Innovation*, Edward Elgar Publishing.

Sánchez-Borrás, M., Nash, C., Abrantes, P. and López-Pita, A., 2011, 'Rail access charges and the competitiveness of high speed trains', *Transport Policy,* 17(2) 102–109.

Santos, G., Behrendt, H. and Teytelboym, A., 2010, 'Part II: Policy instruments for sustainable road transport', *Research in Transportation Economics,* 28(1), 46–91.

Sessa, C. and Enei, R., 2010, *EU transport demand: Trends and drivers,* ISIS, paper produced as part of contract ENV.C.3/SER/2008/0053 between European Commission Directorate-General Environment and AEA Technology plc.

Sichelschmidt, H., 1999, 'The EU programme 'trans-European networks'—a critical assessment', *Transport Policy,* 6(3) 169–181.

Steer Davies Gleave, 2013, *Evaluation of Directive 2009/12/EC on airport charges*, Final report, Prepared for DG Mobility and Transport.

Tavasszy, L. A. and van Meijeren, J., 2011, 'Modal Shift Target for Freight Transport Above 300 km: An Assessment', Discussion Paper, ACEA, Brussels.

The Danish Road Directorate, 2011, *Evaluation of trial with European Modular System*.

Transport & Environment, 2011, *How clean are Europe's cars? An analysis of carmaker progress towards EU CO_2 targets in 2010*, T&E, Brussels.

TRT, 2009, '*Green logistics' — Logistics as an instrument for tackling climate change*, report for the European Parliament, Directorate-General for Internal Policies, Trasporti e Territorio.

UBA/INFRAS/IFEU, 2013, *Economic aspects of non-technical measures to reduce traffic emissions*, 11/2013, Federal Environment Agency (Umweltbundesamt).

UBA/Öko-Institut, 2013, *Treibhausgas-Emissionen durch Infrastruktur und Fahrzeuge des Straßen-, Schienen- und Luftverkehrs sowie der Binnenschifffahrt in Deutschland*, Umweltbundesamt.

UNCTAD, 2009, *Review of Maritime Transport 2009*, United Nations Conference on Trade and Development.

UNECE, 2012, *Guide on Impact of globalization on national accounts*, United Nations Economic Commission for Europe.

Van de Velde, D., 2009, 'Long-distance bus services in Europe: Concessions or free market?', in: *Discussion paper nº 2009-21*, International Transport Forum, Paris.

Vierth, I., 2014, 'Why do CO_2 emissions from heavy road freight transports increase in spite of higher fuel prices?', in: *Transport Research Arena 2014*, Paris.

VMM, 2011, *Milieurapport Vlaanderen. Achtergronddocument Transport 2010 (Environmental Report Flanders. Background report Transport 2010)*, Vlaamse Milieumaatschappij (Flemish Environmental Agency).

Walter, M., Haunerland, F. and Moll, R., 2011, 'Heavily regulated, but promising prospects: Entry in the German Express Coach Market', *Transport Policy*, 18(2) 373–381.

Weiss, M., Bonnel, P., Kühlwein, J., Provenza, A., Lambrecht, U., Alessandrini, S., Carriero, M., Colombo, R., Forni, F., Lanappe, G., Le Lijour, P., Manfredi, U., Montigny, F. and Sculati, M., 2012, 'Will Euro 6 reduce the NO_X emissions of new diesel cars? — Insights from on-road tests with Portable Emissions Measurement Systems (PEMS)', *Atmospheric Environment*, (62) 657–665.

WHO, 2006, *Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide. Global update 2005. Summary of risk assessment*, World Health Organization, Geneva, Switzerland.

WHO/JRC, 2011, *Burden of disease from environmental noise*, World Health Organization, Regional Office for Europe, Copenhagen, Denmark.

Withana, S., ten Brink, P., Franckx, L., Hirschnitz-Garbers, M., Mayeres, I., Oosterhuis, F. and Porsch, L., 2012, *Study supporting the phasing out of environmentally harmful subsidies*, Institute for European Environmental Policy (IEEP), Institute for Environmental Studies — Vrije Universiteit (IVM), Ecologic Institute and VITO for the European Commission – DG Environment.

Wong, A. and Hallsworth, A., 2012, 'Farm-to-Fork: A Proposed Revision of the Classical Food Miles Concept', *International Journal on Food System Dynamics*, 3(1) 74–81.

WTO, 2013, *World Trade Report 2013: Factors shaping the future of world trade*, World Trade Organization, Geneva: WTO Publ.

WWF International, 2009, *Silent Invasion – The spread of marine invasive species via ships' ballast water*, World Wildlife Fund International, Gland, Switzerland (http://www.wwf.de/fileadmin/fm-wwf/Publikationen-PDF/Study_Silent_Invasion.pdf) accessed 12 November 2014.

Annex 1 Metadata and supplementary information

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Introduction		
	Figure 1.1	**Conceptual map for the TERM approach: TERM 2014 structure**
	Source:	EEA own elaboration.
	Box 1.1	**Country groupings**
	Source:	EEA own elaboration.
2 TERM Core Set of Indicators (TERM CSI)		
	Table 2.1	**Transport goals overview in the EU-28, 2014**
	Note:	Progress towards meeting transport specific targets from policy and legislation. Data from various sources.
	Source:	EEA own elaboration.
	Box 2.1	**TERM Core Set of Indicators (TERM CSI)**
	Source:	EEA own elaboration.
	Box 2.2	**TERM 01 — transport final energy consumption by fuel in the EU-28**
	Note:	Data for EU-28. Covers the years 1990, 1995, 2000, 2005 to 2012, and proxy data for 2013. Oil-derived fuels are all fuels excluding biodiesel, biogas, biogasoline, electrical energy, natural gas and solid biofuels. Biogasoline is almost all road, with a small share of domestic navigation from 2008. Biodiesel is mostly road, with some rail from 2004, and a small share of domestic navigation from 2009. Natural gas is all road. Liquefied petroleum gas (LPG) is all road, except for negligible amounts in domestic navigation over a few years (scattered). Estimates for the year 2013 are based on the Eurostat indicator nrg_102m, using the categories 'gross inland deliveries observed' and 'international maritime bunkers' for a limited range of fuels. These include gasoline, road diesel, aviation kerosene and fuel oil. The proportionate change observed for these fuels between 2012 and 2013 is then used to estimate 2013 consumption figures for all oil-based road petrol and diesel, rail diesel, aviation kerosene and shipping fuels. Electricity, natural gas and biofuels are estimated by extrapolating the consumption trends of the previous years.
	Source:	EEA Indicator, TERM 01, based on energy data from Eurostat (nrg) avaiblable in 2014 (http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database).
	Box 2.3	**TERM 02 — transport emissions of greenhouse gases**
	Note:	EU-28 data for the 1990 to 2012 period. Overall transport GHG emissions, including aviation but excluding international maritime, are represented by a blue line; this includes proxy data for 2013. This is an EEA preliminary estimate (EEA, 2014a) originally calculated excluding international bunkers, adding the 2013 value of international aviation emissions. This corresponds to the basic assumption that international aviation emissions did not change between 2012 and 2013. Latest available data: 2012.
	Source:	EEA indicator, TERM 02, based on data available in the Annual European Union greenhouse gas inventory 1990–2012 and inventory report 2014: http://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer, 2014.
	Box 2.4	**TERM 03 — transport emissions of air pollutants**
	Note:	EEA-33 data for the 1990 to 2012 period.
	Source:	EEA indicator, TERM 03, based on data contained in the EU emission inventory report 1990-2012 under the UNECE Convention on LRTAP. http://www.eea.europa.eu/data-and-maps/data/data-viewers/air-emissions-viewer-lrtap, 2014.

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	Box 2.5	**TERM 04 — exceedances of air quality objectives due to traffic**
	Note:	Annual mean NO_2 and PM_{10} concentrations observed at traffic stations (2012). The two highest PM_{10} concentration classes (dark red and red) correspond to the annual LV (40 µg/m³) and to a statistically derived level (31 µg/m³) corresponding to the daily LV. The lowest class corresponds to the World Health Organization (WHO) air quality guideline for PM_{10} of 20 µg/m³ as an annual mean (WHO, 2006).
	Source:	EEA indicator, TERM 04, based on data from AirBase and the *Air quality in Europe — 2014* report (EEA, 2014b).
	Box 2.6	**TERM 05 — exposure to and annoyance by traffic noise**
	Note:	Noise data reported from EEA-33 up to 28 August 2013. Latest available data year is 2012.
	Source:	EEA indicator, TERM 05, based on data from the Noise Observation & Information Service for Europe. http://NOISE.eionet.europa.eu.
	Box 2.7	**TERM 12 — passenger transport volume and modal split**
	Note:	Figures on passenger-kilometres travelled by air are only available as an EU-28 aggregate. Air passenger-kilometres are a provisional estimate for domestic and intra-EU-28 flights. Figures for car, bus and rail are available, separately, for all EU-28 Member States. The sources used by DG Mobility and Transport (2014) include national statistics, estimates, the ITF and Eurostat.
	Source:	EEA indicator, TERM 12, based on data from DG Mobility and Transport, 2014 (EU transport in figures — statistical pocketbook 2014).
	Box 2.8	**TERM 13 — freight transport volume and modal split**
	Note:	Figures in tonne-kilometres for air and maritime are only available as an EU-28 aggregate. Air and maritime tonne-kilometres are provisional estimates for domestic and intra-EU-28 transport. Figures for road, inland waterways and rail are available separately for all EU-28 Member States. The sources used by DG Mobility and Transport (2014) include national statistics, estimates, the ITF and Eurostat.
	Source:	EEA indicator, TERM 13, based on data from DG Mobility and Transport, 2014 (EU transport in figures — statistical pocketbook 2014).
	Box 2.9	**TERM 20 — real change in transport prices by mode**
	Note:	EU-28. Covers the years 1996 to 2013. Real change in passenger transport prices by mode, relative to average consumer prices based on the United Nations (UN) Classification of individual consumption by purpose (COICOP). Passenger transport by road exclusively includes transport of individuals and groups of persons and luggage by bus, coach, taxi and hired car with driver. 2005 as a reference point
	Source:	EEA indicator, TERM 20. Based on data from Eurostat available in 2014 (Harmonised indices of consumer prices/HICP (2005 = 100) — annual data (average index and rate of change) (prc_hicp_aind)).
	Box 2.10	**TERM 21 — fuel tax rates**
	Note:	Coverage is EU-28 for June 2014. Some Member States have higher tax rates for fuels with sulphur content > 10 parts per million (ppm) or biofuel shares below a given threshold.
	Source:	EEA indicator. TERM 21. Based on data from DG TAXUD, 2014 (http://ec.europa.eu/taxation_customs/resources/documents/taxation/excise_duties/energy_products/rates/excise_duties-part_ii_energy_products_en.pdf).
	Box 2.11	**TERM 27 — energy efficiency and specific CO_2 emissions**
	Note:	EU-27, data from Croatia will be included from next year (2014 data). The graph covers years 2000 to 2013 (cars) and 2012 to 2013 (vans).
	Source:	EEA indicator, TERM 27. Based on data from EEA (2014c).
	Box 2.12	**TERM 31 — share of renewable energy in the transport sector**
	Note:	EU-28. Covers years 2011 and 2012. Data are preliminary; Eurostat's estimates (ESTAT 'SHARES 2012' database). According to the RED (EU, 2009a), renewable electricity in electric road vehicles was accounted for 2.5 times the energy content of the input of electricity from renewable energy sources (RES) and the contribution of biofuels produced from wasted, residues, non-food cellulosic material, and lingo-cellulosic material was considered twice that of other biofuels. As of data year 2011, countries were to report as compliant only those biofuels and bioliquids for which compliance with Article 17 and Article 18 can be fully demonstrated.

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	Source:	EEA indicator, TERM 31. Based on data from Eurostat (nrg_ind_335a) avaiblable in 2014 (http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database).
	Box 2.13	**TERM 34 — proportion of vehicle fleet by alternative fuel type**
	Note:	EU-27. Covers years 2000 to 2013. Croatia will be included in 2015 (with 2014 data). All previous years refer to EU-27. Plug-in hybrids (petrol and diesel) are reported separately from 2013 onwards, but there are still uncertainties about the categorisation of fuel types. They were included under conventional petrol and diesel vehicles in previous years. Latest available data: 2013.
	Source:	EEA indicator, TERM 34. Based on data from EEA (2014c) and Eurostat-Stock of vehicles (road_eqs) available in 2014 (http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database).
3 Freight and passenger transport demand and modal split		
	Figure 3.1	**Freight transport volumes (tkm) and GDP**
	Note:	Freight transport includes road, rail and inland waterways.
	Source:	EEA own elaboration, based on data from DG Mobility and Transport, 2014 (EU transport in figures — statistical pocketbook 2014).
	Figure 3.2	Freight road transport volumes (tkm) and GDP in EU-15 (left) and EU-13 (right).
	Note:	EU-15 and EU-13. Covers years 2000 to 2012. Only road.
	Source:	EEA own elaboration, based on data from DG Mobility and Transport, 2014 (EU transport in figures — statistical pocketbook 2014).
	Figure 3.3	**Freight modal split between road and rail**
	Note:	Road national and international haulage bu vehicles registered in the EU-28.
	Source:	EEA own elaboration, based on data from DG Mobility and Transport, 2014 (EU transport in figures — statistical pocketbook 2014).
	Figure 3.4	**Passenger transport modal split**
	Note:	Covers years 2005 to 2012.
	Source:	EEA own elaboration, based on data from DG Mobility and Transport, 2014 (EU transport in figures — statistical pocketbook 2014).
	Figure 3.5	**Trends in passenger transport demand (pkm) and GDP, EEA-33 excluding Liechtenstein, inland transport (left) and EU-28, only aviation (right)**
	Note:	Left graph: EEA-33, car, bus and rail; right graph: EU-28, only domestic and intra-EU-28 air transport; provisional estimates.
	Source:	EEA own elaboration, based on data from DG Mobility and Transport, 2014 (EU transport in figures — statistical pocketbook 2014).
4 The importance of long-distance transport for the environment		
	Figure 4.1	**Passenger (left) and freight (right) transport shares in distance bands in the EU-28, 2010**
	Note:	Data from TRACCS project (see http://www.traccs.emisia.com). Aviation and shipping include international intra-EU trips only. In the absence of recent robust statistical data, the split for road passenger transport is an estimate based on mobility surveys in a number of European countries (Eurostat, 2000).
	Figure 4.2	**NO_x and PM_{10} emissions from long-distance passenger (left) and freight (right) transport in the EU-28, 2012**
	Note:	EU-28. Covers the year 2012. The figures above include only long-distance transport (exceeding 300 km). Own estimations based on total 2012 transport demand figures (DG Mobility and Transport, 2014), the TRACCS project for the allocation of total activity to different distance classes and hence for estimating the share of long-distance transport for all transport modes except road passenger transport, where Eurostat (2000) has been used. Aviation and shipping include international intra-EU trips only (the aviation share of tkm is imperceptible in the right graph). Calculation of air pollutant emissions is based on data from the EC4MACS project for road transport (see http://www.ec4macs.eu) and own estimations, using Tier 1 emission factors from the EMEP/EEA air pollutant emission inventory guidebook 2013 (EEA, 2013c) for the non-road transport modes.
	Box 4.1	**Major transport infrastructure expansion and the local environment**
	Source:	Own elaboration based on Flyvbjerg et al., 2003 and Priemus, 2008.
	Box 4.2	**Increasing concentration of NO_2 in mountain valleys**

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	Source:	Own elaboration based on the referenced sources. Figures have been produced with data from the EEA Airbase (http://www.eea.europa.eu/themes/air/air-quality/map/airbase) and freight data from DG Mobility and Transport, 2014.
	Figure 4.3	**Shares in EU transport greenhouse gas emissions, 2010**
	Note:	These are updated estimates for 2010 based on the PRIMES-TREMOVE model and are not from official statistics. A short description of the model is provided in the impact assessment accompanying the EC 2011 Transport White Paper (EC, 2011b).
	Source:	DG Mobility and Transport, 2013.
5 Long-distance passenger transport		
	Figure 5.1	**Countries' peak in annual car passenger-kilometres travelled per capita**
	Note:	Countries use different criteria for reporting vehicle-kilometres: those with lower values such as Spain or Portugal are including only long-distance (i.e. non-urban) passenger-kilometres, which in most countries account for 25 % to 30 % of total pkm. Countries with maximum value after 2009 are indicated in dark orange.
	Source:	Own calculations based on transport data from DG Mobility and Transport (2014) and polulation data from Eurostat (populat) http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database.
	Figure 5.2	**High-speed rail transport in billion pkm (left axis) and the EU-28 share of high speed rail in total pkm in rail transport**
	Note:	Covers the 2005–2012 period.
	Source:	Own elaboration based on DG Mobility and Transport (2014) data.
	Figure 5.3	**Specific CO_2 emissions from passenger transport modes**
	Note:	EEA-33 excluding Iceland and Liechtenstein. Covers years 2000–2013. Own estimations based on the EC4MACS/COPERT project for road CO_2 emissions and total road activity (pkm, being 'road'-only passenger cars (and not buses and coaches)) (see http://www.ec4macs.eu and http://www.emisia.com/copert) and PRIMES for non-road CO_2 emissions (calculated from energy consumption for the different fuels) and total non-road activity (pkm and tkm). Linear interpolation of the PRIMES data, available in five-year steps, is needed for the intermediate years.
	Source:	EEA indicator, TERM 27 available http://www.eea.europa.eu/data-and-maps/indicators/energy-efficiency-and-specific-co2-emissions/energy-efficiency-and-specific-co2-5.
	Figure 5.4	**Annual changes in population in Europe**
	Note:	EU-15, EU-13, EEA-Scandinavia (Denmark, Finland, Norway, Sweden), EU-South (Greece, Italy, Portugal, Spain). Covers years 1991 to 2013.
	Source:	Own calculations based on polulation data from Eurostat (populat) http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database.
	Box 5.1	**Modal choice in the London–Paris corridor, the Eurostar HSR and air services**
	Source:	Own elaboration using the references sources. Figure adapted from Behrens et al, (2012) with data from DG Mobility and Transport (2014) and UK Civil Aviation Authority (2014).
	Box 5.2	**The company car system and related pressures on the enviornment**
	Source:	Own elaboration using the referenced sources.
6 Long-distance freight transport		
	Figure 6.1	**Share of distance classes in road freight transport (tkm) in EU-28 (left), and load factor according to distance class (right), 2012**
	Note:	EU-28, 2012.
	Source:	Own elaboration based on Eurostat data [road_go_ta_dc] http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database.
	Box 6.1	**Internalisation of external effects in European freight corridors**
	Note:	Alt: Alternative route(s)
	Source:	Own elaboration using the referenced sources. Figure adapted from Mellin et al., 2013

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	Box 6.2	Food miles
	Source:	Own elaboration using the referenced sources.
7 Minimising the environmental pressures of long-distance transport		
	Box 7.1	**Megatrucks**
	Source:	Own elaboration using the referenced sources.
	Box 7.2	**Heavy vehicle fee in Switzerland**
	Source:	Own elaboration with substantial input from Klaus Kammer (Bundesamt für Umwelt BAFU).
	Box 7.3	**Evaluation of the Airport Charges Directive**
	Source:	Own elaboration using the referenced sources.
	Box 7.4	**Marco Polo**
	Source:	Own elaboration using the referenced sources.
	Box 7.5	**Motorways of the sea**
	Source:	Own elaboration using the referenced sources.
	Box 7.6	**Environmental benefits of a modal shift: a wide range of estimates**
	Source:	Own elaboration using the referenced sources.
	Box 7.7	**The potential for increased fuel efficiency in shipping**
	Source:	Own elaboration using the referenced sources.

Annex 2 Relevant transport targets up to 2050

Target	Target date	Source	Relevant indicator	Comments
Transport GHG (including international aviation, excluding international maritime shipping): 20 % ↓ (versus 2008) 60 % ↓ (versus 1990)	2030 2050	2011 Transport White Paper (EC, 2011a), 2050 Roadmap (EC, 2011a)	TERM02	The 2050 Roadmap is the broader strategy that sets the most cost-effective ways to reduce GHG emissions based on the outcome from modelling to meet the long-term target of reducing domestic emissions by 80 % to 95 %. The target for the transport sector was set out in the 2011 Transport White Paper on the basis of the 2050 Roadmap
EU CO_2 emissions of maritime bunker fuels: 40 % ↓ (versus 2005)	2050	2011 Transport White Paper (EC, 2011a)	TERM02	n/a
40 % share of low-carbon sustainable fuels in aviation	2050	2011 Transport White Paper (EC, 2011a)	TERM31	Potentially monitored through EU ETS reporting
Use of conventionally fuelled cars in urban transport: 50 % ↓ 100 % ↓	2030 2050	2011 Transport White Paper (EC, 2011a)	TERM34	The White Paper goal relates not to vehicle numbers but to share in urban passenger-kilometres
CO_2-free city logistics in major urban centres	2030	2011 Transport White Paper (EC, 2011a)		Not currently possible to monitor
The majority of medium-distance passenger transport should go by rail	2050	2011 Transport White Paper (EC, 2011a)	TERM12a/b	Only indirectly monitored through modal shares
Road freight over 300 km shift to rail/waterborne transport: 30 % shift 50 %+ shift	2030 2050	2011 Transport White Paper (EC, 2011a)	TERM13a/b	Only indirectly monitored through modal shares
10 % share of renewable energy in the transport sector final energy consumption for each Member State	2020	Renewable Energy Directive 2009/28/EC (EU, 2009a)	TERM31	
Fuel suppliers to reduce life-cycle GHG of road transport fuel: 6–10 % ↓ (versus 2010 fossil fuels)	2020	Fuel Quality Directive 2009/30/EC (EU, 2009b)	TERM 31	To be monitored in future indicator updates
Target average type-approval emissions for new passenger cars: 130 gCO_2/km 95 gCO_2/km	2012–2015 2020	Passenger Car CO_2 EC Regulation 443/2009 (EU, 2009c)	TERM27 and TERM34	Phased in between 2012 (65 %) and 2015 (100 %)
Target average type-approval emissions for new light vans: 175 gCO_2/km 147 gCO_2/km	2014–2017 2020	Van CO_2 EC Regulation 510/2011 (EU, 2011b)	TERM27 and TERM34	
70 % reduction of transport oil consumption from 2008	2050	Impact assessment accompanying document to the White Paper (EC, 2011b)	TERM01	This is interpreted as a 70 % drop in oil consumption in the transport sector from 2008 levels, as it is the latest data available

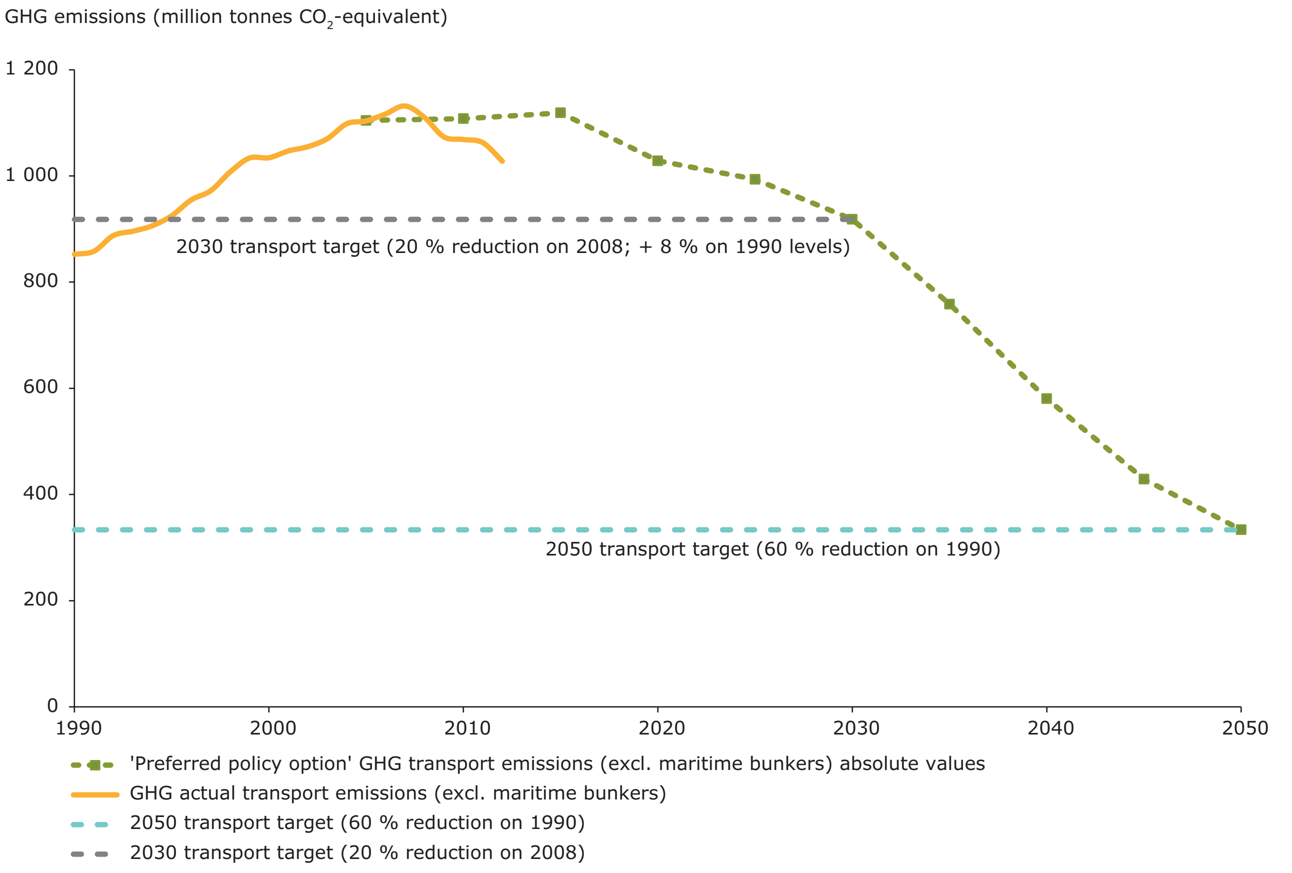
Annex 3 Explaining the 'target paths'

This annex provides an overview of the method used to assess progress towards targets and assign colours to cells in Table 2.1.

Reducing transport GHG emissions: in the case of the key target, each year's data will be compared with the 'trajectory' based on the 'preferred policy option' for achieving reductions as set out in the impact assessment accompanying the 2011 Transport White Paper (EC, 2011a) in order to meet the transport GHG reduction target by 2050. The following graph compares real data and the 'target path', defined accordingly. In the column 'Observed' under each given year, and under the title 'Where we are (current trends vs 'target path')', a green colour indicates when the latest data show a value equal or below that of the 'target path' for that year. In other words, the reduction achieved is in line with — or better than — the estimations. Because concrete 'preferred policy option' estimations are only available every five years (up to 2050), an interpolation of the values is still needed for the years in-between, prior to the comparison.

In the final column, 'latest annual trend', the colour green indicates when the latest data show improvements compared to the previous year in which data are available.

Figure A3.1 Transport GHG emissions



Indicative targets: In order to assign a colour for the cells for the indicative targets, a similar methodology was followed. However, as there were no official estimations on the 'target path' to be followed, this path is calculated by plotting a straight line from the base year data to the target year data, i.e. assuming a linear trend towards the target. At this point, it is clear that this is a subjective assessment of progress, aiming only to give an approximate indication of whether the target will be met. Assuming a linear trend could lead to incomplete conclusions, because for most of the targets, improvements are not expected in the first years. This is a consequence of fleet renewal and technology uptake, among other circumstances, including temporal breakdowns or recessions. However, these circumstances will be explained when assessing annual progress, and can also be checked against the progression of different TERM CSIs. In addition, assumed linear trends have been calculated, bearing in mind midterm targets if available (i.e. CO_2 emissions from new passenger cars for the 2015 and 2020 targets); therefore, different speeds in meeting targets, forecast in official scenarios and documents, are taken into account.

Figure A3.2 EU CO_2 emissions of maritime bunker fuels

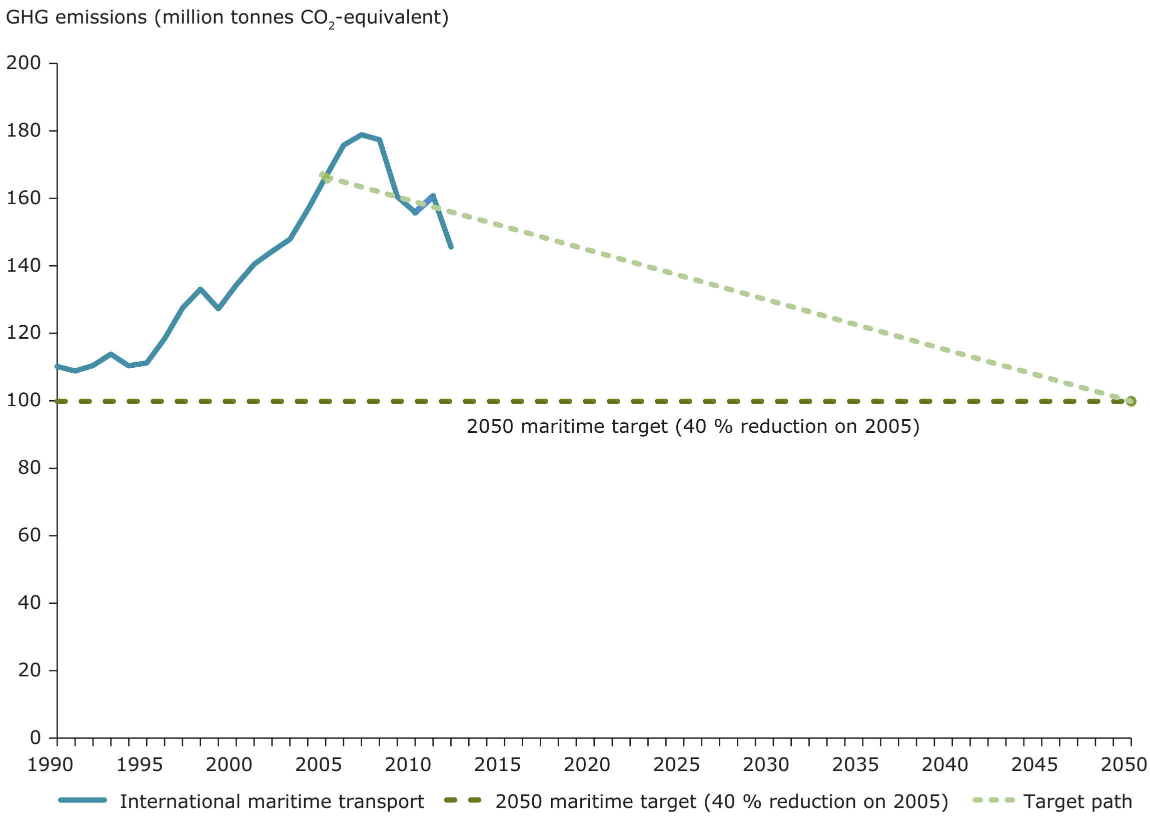


Figure A3.3 Target average type-approval CO_2 emissions for new passenger cars

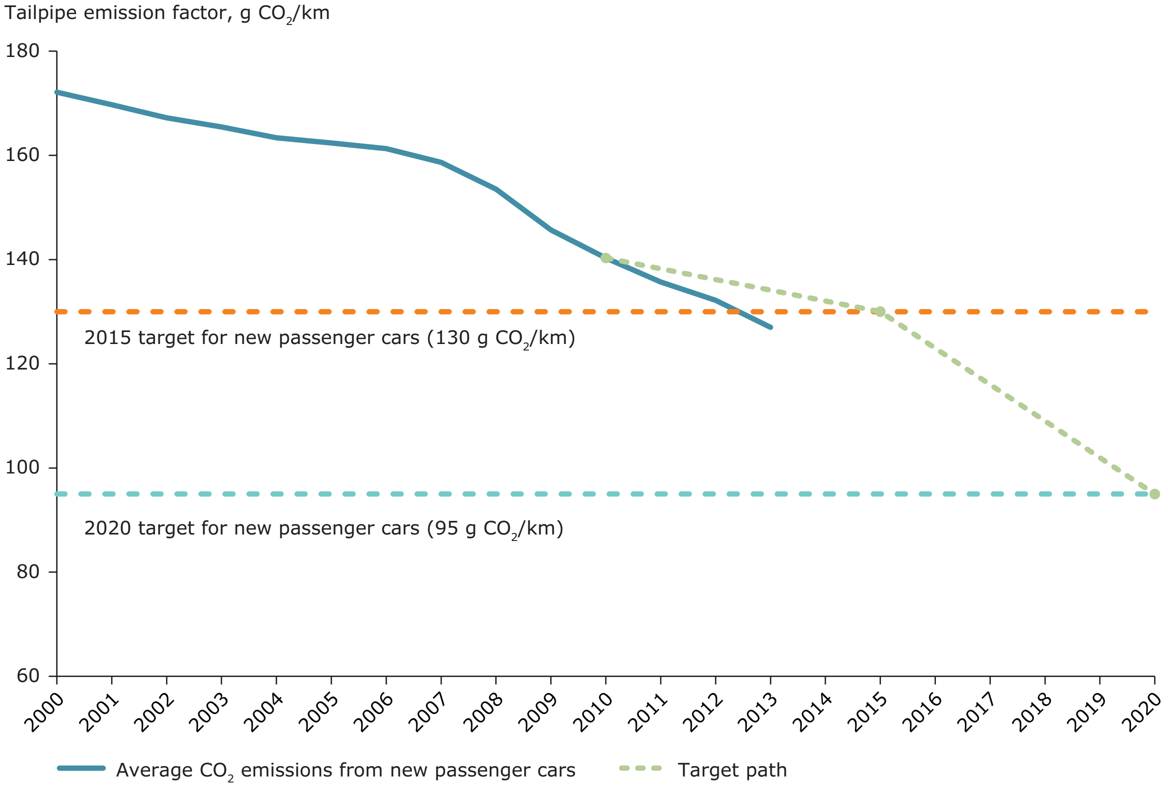


Figure A3.4 Target average type-approval CO_2 emissions for new vans

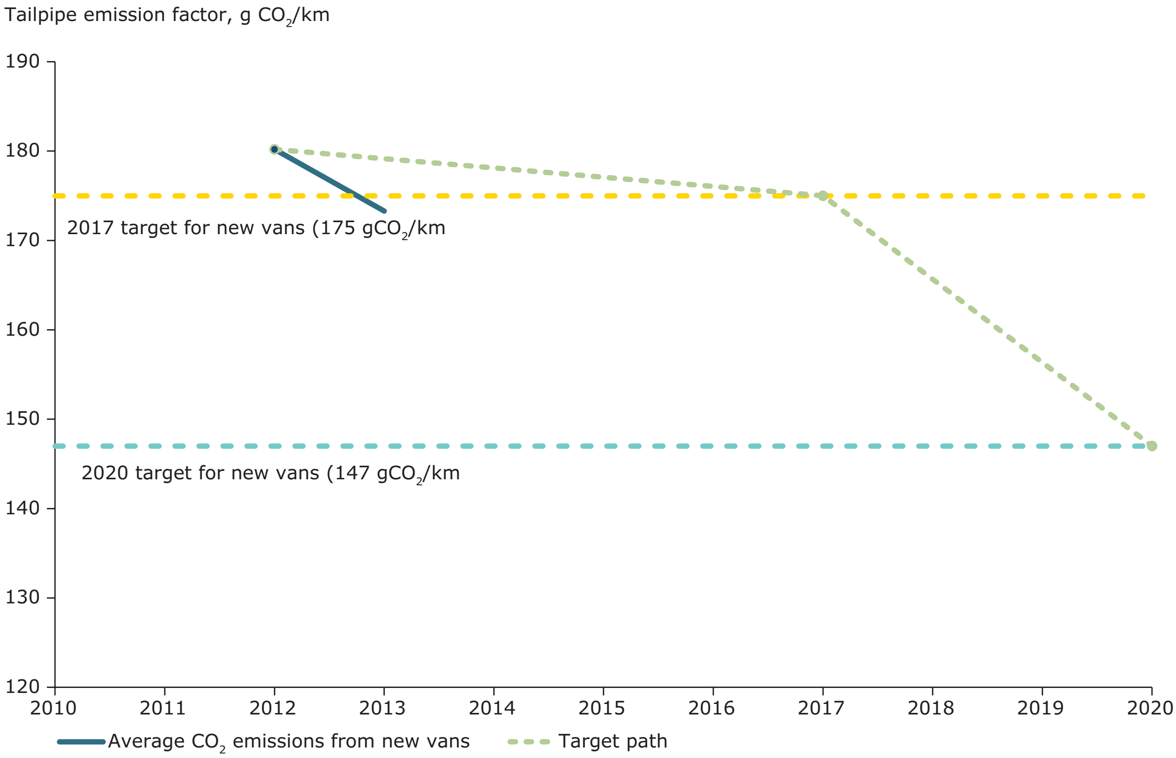


Figure A3.5 Reduction of transport oil consumption (incl. maritime bunkers)

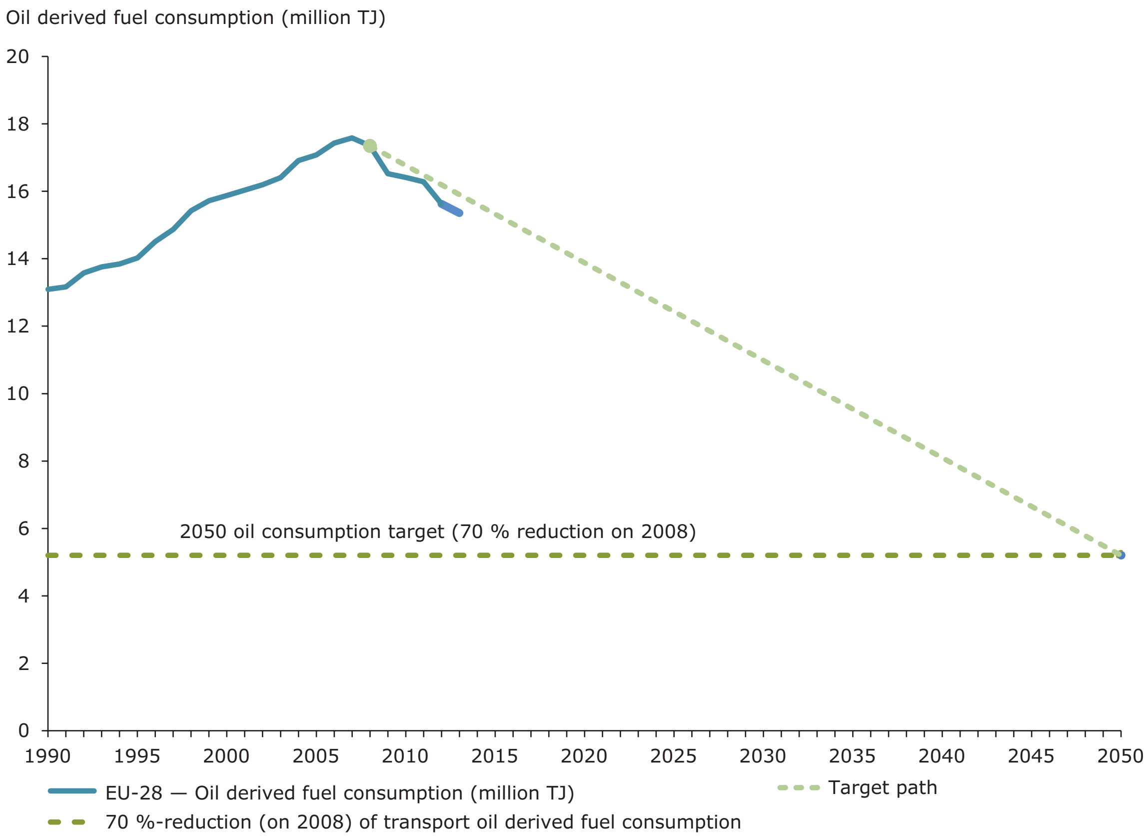
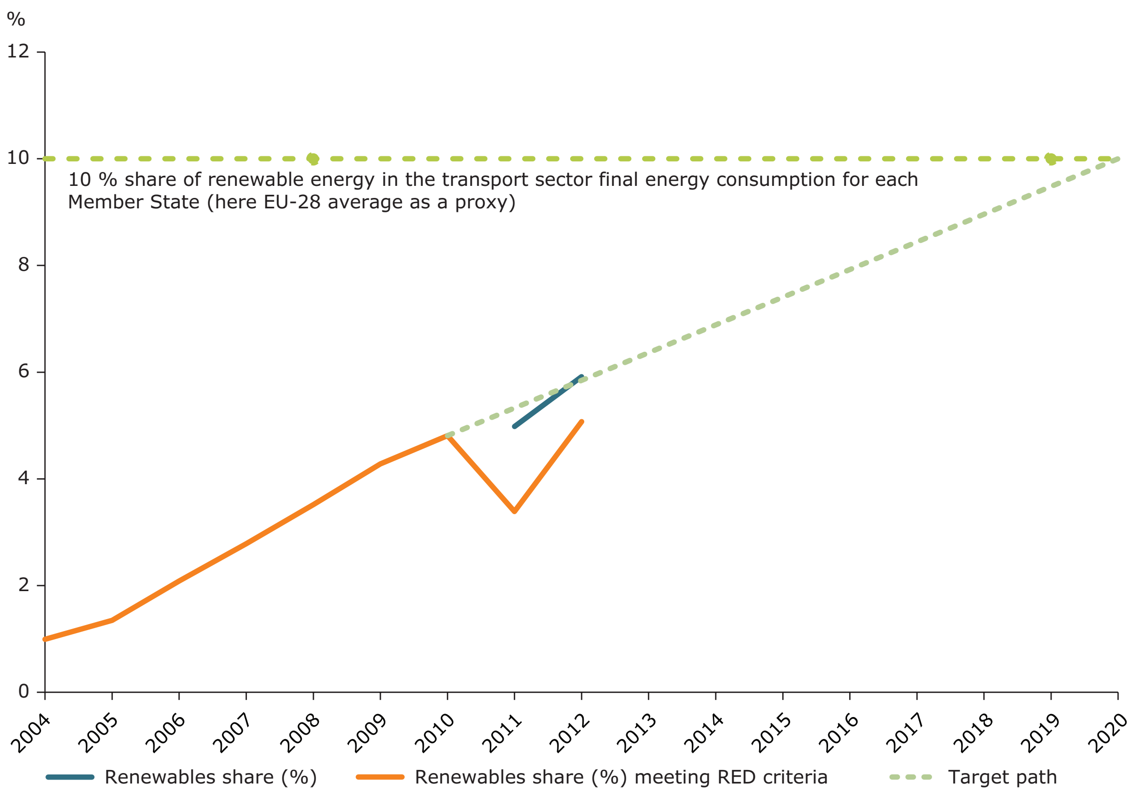


Figure A3.6 Share of renewable energy in the transport sector



Annex 4 Overview of the TERM fact sheets

The TERM indicators have been published annually since 2000, subject to data availability. In 2000, the indicators appeared in the annual TERM report only, but they have since been published individually on the EEA website (with titles as listed below). When the indicator set was originally defined, it was expected that the data, despite being limited at that point, would eventually become available over time. For this reason, not all indicators have been published every year.

		2000–2004					2005–2009					2010–2014				
TERM 01	Transport final energy consumption by mode	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
TERM 02	Transport emissions of greenhouse gases		x	x	x	x	x	x	x	x	x	x	x	x	x	x
TERM 03	Transport emissions of air pollutants	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
TERM 04	Exceedances of air quality objectives due to traffic	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
TERM 05	Exposure to and annoyance by traffic noise	x	x										x	x		x
TERM 06	Fragmentation of ecosystems and habitats by transport infrastructure	x	x	x									x			
TERM 07	Proximity of transport infrastructure to designated areas		x	x												
TERM 08	Land take by transport infrastructure	x	x	x												
TERM 09	Transport accident fatalities	x	x	x	x	x	x		x		x		x			
TERM 10	Accidental and illegal discharges of oil at sea		x	x		x										
TERM 11	Waste oil and tires from vehicles		x													
TERM 11a	Waste from road vehicles (ELV)	x	x	x												
TERM 12a/b	Passenger transport volume and modal split (CSI 035)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
TERM 13a/b	Freight transport volume and modal split (CSI 036)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
TERM 14	Access to basic services	x	x		x											
TERM 15	Regional accessibility of markets and cohesion		x		x											
TERM 16	Access to transport services	x	x													
TERM 18	Capacity of infrastructure networks	x	x	x	x	x	x				x		x	x		x
TERM 19	Infrastructure investments	x	x	x					x		x	x	x			x
TERM 20	Real change in transport prices by mode	x	x	x		x	x		x		x	x	x	x	x	x
TERM 21	Fuel prices and taxes	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
TERM 22	Transport taxes and charges			x	x	x	x		x	x	x					
TERM 23	Subsidies						x									
TERM 24	Expenditure on personal mobility by income group				x	x		x		x	x	x	x			
TERM 25	External costs of transport	x	x	x	x	x		x		x	x					
TERM 26	Internalisation of external costs	x	x	x	x	x	x	x		x		x				
TERM 27	Energy efficiency and specific CO_2 emissions	x	x	x			x		x	x	x	x	x	x	x	x
TERM 28	Specific air pollutant emissions	x	x		x		x		x	x	x	x	x	x	x	x
TERM 29	Occupancy rates of passenger vehicles	x	x	x		x	x			x	x		x			
TERM 30	Load factors for freight transport	x	x	x		x	x			x	x		x			
TERM 31	Uptake of cleaner and alternative fuels (CSI 037)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
TERM 32	Size of the vehicle fleet	x	x	x	x	x		x		x	x	x	x	x	x	x
TERM 33	Average age of the vehicle fleet	x	x	x	x		x		x	x	x	x	x	x	x	x
TERM 34	Proportion of vehicle fleet meeting certain emission standards	x	x	x	x	x		x		x	x	x	x	x	x	x
TERM 35	Implementation of integrated strategies	x	x	x		x										
TERM 36	Institutional cooperation		x	x		x										
TERM 37	National monitoring systems	x	x	x		x										
TERM 38	Implementation of SEA	x	x	x		x										
TERM 39	Uptake of environmental mgt. systems by transport companies	x														
TERM 40	Public awareness	x	x			x										

Annex 5 Data

This annex provides an overview of the key statistics that underpin the assessment in the report. It is generally based on data from sources such as Eurostat and the European Commission's Directorate-General for Mobility and Transport's statistical pocketbook. For a full explanation of the data sources, see metadata in Annex 1.

- Table A5.1 Freight inland transport volume by country (1 000 million tkm) (1995–2012) — road, rail and inland waterways. EC DG Mobility and Transport, 2014.
- Table A5.2 Modal share of freight transport (% in total inland freight tonne-kilometres) (1995–2012) — road, rail and inland waterways. DG Mobility and Transport, 2014.
- Table A5.3 Sea transport of goods (1 000 tonnes) (2002–2012). Eurostat 2014.
- Table A5.4 Total inland passenger transport (1 000 million pkm) (1995–2012): cars, trains, buses and coaches, trams and metros, by country. DG Mobility and Transport, 2014.
- Table A5.5 Modal split of passenger inland transport (cars, trains, buses and coaches), by country (1995–2012). DG Mobility and Transport, 2014.
- Table A5.6 Air passenger transport in EU-28 (1 000 million pkm) (1995–2012). DG Mobility and Transport, 2014, only domestic and intra-EU-28 transport.
- Table A5.7 Motorisation: number of passenger cars per thousand inhabitants (1990, 1995, 2000, 2005, 2010, 2011, 2012). DG Mobility and Transport, 2014.
- Table A5.8 Greenhouse gas emissions from transport in Europe, by country and subsector, in million tonnes (unless otherwise stated) (1990, 2012). EEA data viewer, 2014.

Table A5.1 Freight inland transport volume by country (1 000 million tkm) (1995–2012) — road, rail and inland waterways

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Austria	42	43	45	47	51	54	57	58	59	60	58	62	61	59	49	51	51	48
Belgium	59	55	57	55	51	66	68	68	66	64	61	60	60	56	50	52	50	50
Bulgaria	14	13	14	13	11	12	13	14	15	18	20	20	21	23	26	29	29	33
Croatia	2	2	2	2	4	5	9	10	11	11	12	14	14	15	13	12	12	12
Cyprus	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Czech Republic	54	53	52	53	54	55	56	60	62	61	58	66	64	66	58	66	69	66
Denmark	24	23	23	23	25	26	24	24	25	25	25	23	23	21	19	17	19	19
Estonia	5	6	8	10	11	12	13	14	14	16	16	16	15	13	11	12	12	11
Finland	34	34	36	38	40	42	40	42	41	43	42	41	40	42	37	39	36	35
France	233	236	243	251	268	271	267	264	260	267	255	262	271	256	214	222	229	214
Germany	372	368	382	396	418	430	435	430	434	459	470	501	523	521	459	483	492	476
Greece	24	25	26	28	28	29	30	31	33	37	33	35	29	30	29	30	21	21
Hungary	23	23	24	28	28	29	27	27	27	31	36	43	48	48	45	45	45	45
Iceland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Ireland	6	7	8	9	11	13	13	15	16	18	18	18	19	18	12	11	10	10
Italy	196	197	201	203	199	208	208	213	194	219	235	211	205	204	185	194	163	144
Latvia	12	15	17	17	16	18	20	21	25	26	28	28	32	32	27	28	34	34
Lithuania	12	12	14	14	16	17	16	20	23	24	28	31	35	35	30	33	37	38
Luxembourg	6	4	5	6	7	9	10	10	10	11	10	10	10	10	9	9	9	8
Malta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Netherlands	106	108	115	123	129	125	125	122	124	139	132	132	131	130	114	128	127	121
Norway	12	15	17	18	18	18	18	18	19	20	21	23	23	24	22	23	23	24
Poland	120	125	132	132	127	130	126	128	134	156	162	182	205	217	224	260	262	271
Portugal	34	35	38	39	40	41	43	42	42	43	45	47	49	42	38	38	39	35
Romania	41	48	48	37	31	33	37	44	49	61	77	81	83	80	57	53	52	56
Slovakia	31	29	29	31	30	27	26	26	27	29	33	33	38	40	36	37	38	38
Slovenia	6	6	7	7	7	8	10	10	10	12	14	15	17	20	18	19	20	19
Spain	113	113	122	136	146	160	173	196	204	233	245	253	270	254	220	219	217	209
Sweden	51	52	54	52	52	55	53	56	57	58	60	62	64	65	55	60	60	56
Switzerland	18	17	18	19	19	21	21	21	21	22	22	23	23	26	24	24	25	24
Turkey	121	145	149	161	159	171	159	158	161	166	176	187	191	192	187	202	214	227
United Kingdom	175	181	186	189	185	184	183	183	186	185	183	188	192	182	159	165	175	180

Source: DG Mobility and Transport, 2014.

Table A5.2 Modal share of freight transport (% in total inland freight tkm) (1996–2012) — road, rail and inland waterways

	Road (%)					Rail (%)					Inland waterways (%)				
	1995	2000	2005	2010	2012	1995	2000	2005	2010	2012	1995	2000	2005	2010	2012
Austria	63.5	64.8	64.1	56.3	54.6	31.6	30.6	32.8	39.0	40.8	4.9	4.5	3.0	4.7	4.6
Belgium	77.8	77.4	72.4	67.9	64.5	12.5	11.6	13.4	14.5	14.6	9.8	10.9	14.1	17.6	20.9
Bulgaria	36.3	52.3	70.8	68.1	74.7	60.0	45.2	25.4	10.7	8.9	3.7	2.6	3.7	21.2	16.4
Croatia	0.0	60.7	76.0	71.2	73.6	98.4	38.0	23.1	21.2	19.8	1.6	1.3	1.0	7.6	6.6
Cyprus	100.0	100.0	100.0	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Czech Republic	57.8	68.0	74.4	79.0	78.2	41.7	31.9	25.5	21.0	21.8	0.5	0.2	0.1	0.1	0.1
Denmark	91.9	92.2	92.2	87.0	88.0	8.1	7.8	7.8	13.0	12.0	0.0	0.0	0.0	0.0	0.0
Estonia	28.7	32.7	35.4	45.8	53.0	71.3	67.3	64.6	54.2	47.0	0.0	0.0	0.0	0.0	0.0
Finland	71.7	75.8	76.5	75.0	73.0	28.1	24.0	23.3	24.8	26.6	0.2	0.3	0.2	0.2	0.4
France	76.4	75.3	80.5	82.2	80.6	20.7	21.3	16.0	13.5	15.2	2.8	3.4	3.5	4.3	4.2
Germany	63.9	65.3	66.0	64.9	64.6	18.9	19.2	20.3	22.2	23.1	17.2	15.5	13.6	12.9	12.3
Greece	98.8	98.5	98.1	98.0	98.7	1.2	1.5	1.9	2.0	1.3	0.0	0.0	0.0	0.0	0.0
Hungary	58.9	66.4	69.2	75.1	75.1	35.9	30.5	25.0	19.6	20.5	5.2	3.1	5.8	5.3	4.4
Iceland	100.0	100.0	100.0	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ireland	90.1	96.2	98.3	99.2	99.1	9.9	3.8	1.7	0.8	0.9	0.0	0.0	0.0	0.0	0.0
Italy	88.9	88.9	90.3	90.4	85.9	11.1	11.0	9.7	9.6	14.0	0.1	0.1	0.0	0.1	0.1
Latvia	15.8	26.5	29.8	38.1	35.8	84.2	73.5	70.2	61.9	64.2	0.0	0.0	0.0	0.0	0.0
Lithuania	41.9	46.6	56.1	59.1	62.3	58.0	53.4	43.9	40.9	37.7	0.1	0.0	0.0	0.0	0.0
Luxembourg	86.4	88.3	92.3	92.7	93.7	8.3	7.3	4.1	3.4	2.8	5.3	4.4	3.6	3.8	3.4
Malta	100.0	100.0	100.0	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	63.5	63.5	63.6	59.1	55.8	2.9	3.6	4.4	4.6	5.1	33.6	32.9	31.9	36.3	39.1
Norway	78.2	83.5	85.3	85.0	85.3	21.8	16.5	14.7	15.0	14.7	0.0	0.0	0.0	0.0	0.0
Poland	42.6	57.6	69.0	81.2	81.9	56.7	41.5	30.8	18.8	18.0	0.7	0.9	0.2	0.1	0.0
Portugal	94.1	94.7	94.6	93.9	93.2	5.9	5.3	5.4	6.1	6.8	0.0	0.0	0.0	0.0	0.0
Romania	48.4	42.9	67.3	49.2	53.3	44.0	49.1	21.7	23.5	24.2	7.6	7.9	11.0	27.2	22.5
Slovakia	51.8	65.0	77.3	82.3	82.1	48.2	35.0	22.7	17.7	17.9	0.0	0.0	0.0	0.0	0.0
Slovenia	51.0	53.2	68.9	74.8	77.6	44.3	41.7	28.9	22.0	19.8	4.7	5.1	2.3	3.2	2.6
Spain	90.3	92.8	95.3	95.8	95.2	9.7	7.2	4.7	4.2	4.8	0.0	0.0	0.0	0.0	0.0
Sweden	62.0	64.7	64.0	60.7	60.3	38.0	35.3	36.0	39.3	39.7	0.0	0.0	0.0	0.0	0.0
Switzerland	50.6	46.8	46.5	54.4	53.9	49.2	53.0	53.3	45.5	46.0	0.3	0.2	0.2	0.2	0.2
Turkey	93.0	94.3	94.8	94.4	95.1	7.0	5.7	5.2	5.6	4.9	0.0	0.0	0.0	0.0	0.0
United Kingdom	92.3	90.0	88.2	88.7	88.0	7.6	9.8	11.7	11.2	11.9	0.1	0.1	0.1	0.1	0.1

Source: DG Mobility and Transport, 2014.

Table A5.3 Sea transport of goods (1 000 tonnes) (2002–2012)

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
EU-28	3 353 386	3 472 656	3 595 484	3 744 892	3 862 295	3 967 626	3 947 892	3 468 898	3 669 940	3 770 121	3 732 638
Belgium	173 824	181 110	187 889	206 539	218 941	236 320	243 819	203 368	228 228	232 789	223 987
Bulgaria	20 390	21 358	23 125	24 841	27 513	24 900	26 576	21 893	22 946	25 185	26 012
Denmark	94 283	103 954	100 373	99 688	107 674	109 660	106 096	90 636	87 068	92 613	87 827
Germany	246 353	254 834	271 869	284 865	302 789	315 051	320 636	262 863	275 953	296 037	298 758
Estonia	44 682	47 048	44 808	46 546	49 998	44 964	36 191	38 505	46 026	48 479	43 503
Ireland	44 919	46 165	47 720	52 146	53 326	54 139	51 081	41 829	45 071	45 078	47 649
Greece	147 692	162 534	157 892	151 250	159 425	164 300	152 498	135 430	129 059	135 314	153 124
Spain	326 001	343 716	373 065	400 019	414 378	426 648	416 158	363 536	376 376	403 694	422 152
France	319 032	330 135	334 035	341 470	350 334	346 825	351 976	315 534	313 593	322 251	302 997
Italy	457 958	477 028	484 984	508 946	520 183	537 327	526 219	469 879	494 091	499 885	476 823
Cyprus	7 220	7 258	6 837	7 305	7 676	7 516	7 962	6 808	6 954	6 564	6 236
Latvia	51 978	54 652	54 829	59 698	56 861	61 083	61 430	60 088	58 691	67 016	72 723
Lithuania	24 405	30 242	25 842	26 146	27 235	29 253	36 379	34 344	37 869	42 661	41 033
Malta	4 990	5 215	5 303	5 283	5 452	5 254	5 501	5 507	6 004	5 578	5 511
Netherlands	413 312	410 330	440 722	460 940	477 238	507 463	530 359	483 133	538 702	532 717	543 247
Poland	48 111	51 020	52 272	54 769	53 131	52 433	48 833	45 079	59 507	57 738	58 825
Portugal	55 599	57 470	59 071	65 301	66 861	68 229	65 275	61 714	65 981	67 506	67 875
Romania	32 698	35 925	40 594	47 694	46 709	48 928	50 458	36 094	38 122	38 918	39 520
Slovenia	9 305	10 788	12 063	12 625	15 483	15 853	16 554	13 356	14 591	16 198	16 907
Finland	99 099	104 439	106 524	99 577	110 536	114 819	114 725	93 239	109 326	115 452	105 120
Sweden	154 626	161 454	167 350	178 122	180 487	185 057	187 778	161 823	179 579	177 093	172 976
United Kingdom	558 325	555 662	573 070	584 919	583 739	581 504	562 166	500 863	511 875	519 495	500 860
Croatia	18 584	20 320	25 246	26 201	26 325	30 097	29 223	23 377	24 329	21 862	18 972
Iceland	4 771	4 981	5 308	5 653	5 917	:	:	:	:	:	:
Norway	190 034	186 781	198 199	201 678	196 818	198 507	193 368	182 635	195 132	198 970	205 959
Turkey	:	:	:	:	:	:	305 271	293 906	338 078	359 082	374 714

Source: Eurostat, 2014.

Table A5.4 Total inland passenger transport (1 000 million pkm) (1995–2012): cars, trains, buses and coaches, trams and metros by country

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Austria	81	82	81	82	84	85	85	86	87	88	89	89	91	94	92	94	95	95
Belgium	118	118	120	123	126	127	129	131	132	134	135	135	138	141	142	142	144	144
Bulgaria	41	40	42	42	44	45	46	49	48	48	51	53	56	59	59	60	61	62
Croatia	18	20	22	23	23	25	26	27	27	28	29	30	31	33	32	31	30	31
Cyprus	4	5	5	5	5	5	5	5	5	6	6	6	7	7	7	7	7	7
Czech Republic	81	83	82	82	85	87	88	88	90	89	91	93	95	95	95	87	88	87
Denmark	61	62	63	63	64	64	63	62	63	64	63	63	65	65	64	64	66	67
Estonia	8	8	8	9	9	10	9	10	10	10	13	13	13	13	13	12	13	13
Finland	61	62	63	64	66	67	68	69	71	72	73	73	75	75	76	76	77	77
France	768	781	797	825	848	856	888	901	906	911	907	912	926	922	924	933	939	942
Germany	955	956	957	969	990	976	997	1001	997	1009	1001	1009	1011	1017	1025	1033	1041	1043
Greece	66	69	73	76	81	87	92	96	100	103	109	114	119	124	124	122	120	119
Hungary	70	71	71	72	73	75	75	76	77	78	77	80	80	80	79	77	77	77
Iceland	3	4	4	4	4	4	4	5	5	5	5	5	6	6	6	6	5	5
Ireland	38	39	41	43	44	43	45	47	49	52	54	56	58	59	59	58	57	56
Italy	749	764	775	797	802	857	868	878	887	898	828	829	829	828	870	848	815	726
Latvia	11	11	12	13	14	15	15	16	16	15	16	18	20	18	16	15	15	15
Lithuania	21	23	24	26	28	29	29	30	32	35	39	44	43	42	39	36	33	34
Luxembourg	6	6	6	6	6	7	7	7	7	7	7	8	8	8	8	8	8	8
Malta	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3
Netherlands	160	159	162	163	167	167	167	169	171	178	176	176	177	175	174	163	169	165
Norway	51	53	54	56	57	58	59	60	60	61	61	62	64	65	66	66	68	68
Poland	171	175	185	196	198	213	210	209	213	217	220	224	230	240	245	248	256	262
Portugal	69	72	76	80	84	87	88	92	96	98	95	96	97	97	96	94	93	92
Romania	71	74	74	73	74	75	75	74	76	78	81	84	87	91	94	93	92	94
Slovakia	37	36	35	35	36	36	36	37	36	36	37	37	37	36	34	34	35	35
Slovenia	21	23	24	24	25	25	25	25	26	26	26	27	28	29	30	30	30	29
Spain	307	320	329	344	363	373	380	386	392	404	413	412	424	427	431	415	413	398
Sweden	104	105	105	106	118	119	120	123	124	125	125	125	128	128	128	128	129	130
Switzerland	87	88	89	89	91	92	94	95	97	98	99	101	102	104	106	108	110	112
Turkey	144	154	164	169	170	172	163	167	171	185	200	213	225	235	218	232	248	263
United Kingdom	694	700	713	719	728	725	739	761	758	759	755	761	766	763	759	746	744	747

Source: DG Mobility and Transport, 2014.

Table A5.5 Modal split of passenger inland transport (cars, trains, buses and coaches) by country (1995–2012)

	Cars (%)					Buses and coaches (%)					Rail (%)				
	1995	2000	2005	2010	2012	1995	2000	2005	2010	2012	1995	2000	2005	2010	2012
Austria	76.8	78.8	78.9	78.3	78.1	10.7	10.9	10.4	10.2	10.0	12.5	10.3	10.6	11.4	11.9
Belgium	83.2	83.4	80.2	80.3	80.4	11.1	10.5	13.0	12.2	12.4	5.7	6.1	6.8	7.4	7.1
Bulgaria	60.6	59.8	68.6	78.7	80.1	28.0	32.4	26.7	17.8	16.9	11.4	7.7	4.7	3.5	3.0
Croatia	70.7	81.4	83.7	83.7	85.7	22.9	13.6	11.9	10.6	10.7	6.4	5.1	4.4	5.7	3.6
Cyprus	77.3	77.7	79.2	82.1	81.3	22.7	22.3	20.8	17.9	18.7	0.0	0.0	0.0	0.0	0.0
Czech Republic	67.2	73.1	75.5	73.0	74.1	22.9	18.5	17.2	19.5	17.6	9.9	8.4	7.3	7.6	8.3
Denmark	79.9	79.6	79.2	79.4	80.2	12.0	11.7	11.3	10.7	9.7	8.1	8.7	9.5	9.9	10.1
Estonia	67.6	69.8	77.0	81.4	81.4	26.9	27.5	21.1	16.6	16.8	5.5	2.7	1.9	2.0	1.8
Finland	81.7	83.4	84.9	84.9	84.9	13.1	11.5	10.3	9.9	9.8	5.2	5.1	4.8	5.2	5.3
France	87.4	86.9	86.9	85.4	85.1	5.4	4.9	4.7	5.3	5.5	7.2	8.2	8.4	9.2	9.5
Germany	85.4	85.2	85.6	85.9	85.8	7.2	7.1	6.7	6.0	5.7	7.4	7.7	7.7	8.1	8.5
Greece	66.9	72.8	78.3	81.6	81.6	30.7	25.1	20.0	17.3	17.7	2.4	2.2	1.7	1.1	0.7
Hungary	64.4	61.9	64.1	68.5	67.7	23.6	25.1	23.1	21.4	22.2	12.0	13.0	12.8	10.0	10.1
Iceland	88.6	88.6	88.6	88.6	88.1	11.4	11.4	11.4	11.4	11.9	0.0	0.0	0.0	0.0	0.0
Ireland	83.0	80.6	82.1	82.6	82.8	13.6	16.2	14.6	14.5	14.4	3.4	3.2	3.3	2.9	2.8
Italy	82.1	83.3	81.8	82.4	79.7	11.6	10.9	12.2	12.1	14.2	6.2	5.8	6.0	5.6	6.1
Latvia	70.0	79.0	76.2	80.1	78.9	17.1	16.1	18.2	15.0	16.1	12.8	4.9	5.6	4.9	5.0
Lithuania	75.1	88.5	89.4	91.4	90.6	19.6	9.4	9.5	7.6	8.2	5.3	2.1	1.1	1.0	1.2
Luxembourg	85.0	85.5	85.5	83.5	83.0	9.8	9.5	10.9	12.1	12.4	5.2	5.1	3.6	4.5	4.6
Malta	80.6	79.6	80.3	81.5	82.5	19.4	20.4	19.7	18.5	17.5	0.0	0.0	0.0	0.0	0.0
Netherlands	82.3	84.5	84.7	83.1	82.7	7.5	6.7	6.7	7.5	6.9	10.2	8.8	8.6	9.5	10.4
Norway	87.9	88.3	88.5	88.6	89.8	7.4	7.1	7.1	6.8	5.6	4.7	4.5	4.5	4.6	4.6
Poland	64.6	61.0	69.3	76.0	78.0	19.9	27.7	22.4	16.8	15.2	15.5	11.3	8.3	7.2	6.8
Portugal	76.5	81.7	89.3	89.1	89.3	16.5	13.6	6.7	6.5	6.6	7.0	4.6	4.0	4.4	4.1
Romania	56.2	68.3	75.5	81.3	82.2	17.3	16.1	14.6	12.9	12.9	26.5	15.6	9.9	5.9	4.9
Slovakia	49.1	66.3	70.7	78.0	77.3	39.4	25.8	23.4	15.3	15.6	11.5	7.9	6.0	6.7	7.1
Slovenia	77.6	82.9	85.4	86.5	86.4	19.5	14.3	11.6	10.7	11.1	2.8	2.9	2.9	2.7	2.5
Spain	81.7	81.1	81.9	82.3	80.7	12.9	13.5	12.9	12.3	13.7	5.4	5.4	5.2	5.4	5.6
Sweden	84.1	85.1	85.9	84.6	84.3	9.3	7.9	7.0	6.7	6.7	6.6	6.9	7.1	8.7	9.1
Switzerland	80.1	81.1	78.4	77.2	77.6	6.4	5.2	5.3	5.1	5.1	13.5	13.7	16.3	17.7	17.3
Turkey	36.5	45.9	50.0	59.3	61.6	59.4	50.7	47.5	38.3	36.6	4.0	3.4	2.5	2.4	1.7
United Kingdom	89.0	88.0	88.3	86.4	86.0	6.6	6.7	5.8	6.2	5.8	4.4	5.3	5.9	7.5	8.2

Source: DG Mobility and Transport, 2014.

Table A5.6 Air passenger transport in EU-28 (1 000 million passenger kilometres) (1995–2012)

	1 000 million pkm
1995	347.9
1996	368.0
1997	392.1
1998	411.2
1999	427.3
2000	459.5
2001	455.5
2002	447.4
2003	465.5
2004	495.7
2005	529.9
2006	552.0
2007	575.1
2008	564.2
2009	525.0
2010	525.6
2011	578.6
2012	576.7

Note: Only domestic and intra-EU-28 transport; provisional estimates.

Source: DG Mobility and Transport, 2014.

Table A5.7 Motorisation: number of passenger cars per thousand inhabitants (1990, 1995, 2000, 2005, 2010, 2011, 2012)

	1990	1995	2000	2005	2010	2011	2012
Austria	388	452	511	504	528	537	542
Belgium	387	421	456	468	480	487	487
Bulgaria	152	196	245	329	353	368	385
Croatia	121	155	262	321	353	355	339
Cyprus	304	335	384	477	551	545	549
Czech Republic	234	295	336	387	429	436	448
Denmark	309	320	347	362	389	394	399
Estonia	154	269	333	366	416	433	456
Finland	388	371	412	462	535	551	563
France	476	481	503	497	509	510	512
Germany	461	495	475	493	517	534	539
Greece	170	207	292	387	469	468	467
Hungary	187	218	232	287	299	299	301
Iceland	468	445	561	625	643	645	653
Ireland	228	276	348	400	416	417	415
Italy	483	533	572	597	619	625	621
Latvia	106	134	237	333	307	299	305
Lithuania	133	199	336	442	554	570	590
Luxembourg	477	556	622	655	659	658	663
Malta	337	487	483	525	581	592	592
Netherlands	367	364	409	434	464	470	472
Norway	380	386	411	437	469	477	484
Poland	138	195	261	323	447	470	486
Portugal	185	255	333	400	424	429	429
Romania	56	97	124	158	214	216	224
Slovakia	166	189	237	243	310	324	337
Slovenia	294	357	435	479	518	519	518
Spain	309	360	431	460	475	476	476
Sweden	419	411	450	459	460	464	465
Switzerland	442	457	492	518	518	523	529
Turkey		49	65	80	102	109	114
United Kingdom	361	378	425	467	465	463	464

Note: Passenger car stock at end of year n is divided by population on 1 January of year n+1.

Source: DG Mobility and Transport, 2014.

Table A5.8 Greenhouse gas emissions from transport in Europe, by country and subsector, in million tonnes (unless otherwise stated) (1990, 2012)

	Total transport excluding international aviation and maritime						Civil aviation					
	1990	2000	2010	2011	2012	Change 1990–2012 (%)	1990	2000	2010	2011	2012	Change 1990–2012 (%)
Austria	14.0	19.0	22.4	21.7	21.6	54 %	0.0	0.1	0.1	0.1	0.1	71 %
Belgium	20.7	24.7	27.2	27.0	24.9	21 %	0.0	0.0	0.0	0.0	0.0	107 %
Bulgaria	6.8	5.7	7.9	8.1	8.4	24 %	0.1	0.1	0.0	0.1	0.0	– 75 %
Croatia	4.1	4.6	6.0	5.9	5.7	39 %	0.2	0.1	0.1	0.1	0.1	– 39 %
Cyprus	1.2	1.8	2.3	2.2	2.1	73 %	0.0	0.0	0.0	0.0	0.0	49 %
Czech Republic	7.8	12.4	17.4	17.3	16.9	118 %	0.2	0.0	0.0	0.0	0.0	– 95 %
Denmark	10.8	12.4	13.2	12.9	12.2	14 %	0.2	0.2	0.2	0.1	0.1	– 45 %
Estonia	2.5	1.7	2.2	2.3	2.3	– 7 %	0.0	0.0	0.0	0.0	0.0	– 39 %
Finland	12.8	12.8	13.4	13.2	12.7	– 1 %	0.4	0.4	0.2	0.2	0.2	– 47 %
France	121.2	140.0	133.0	133.9	132.5	9 %	4.3	6.2	4.7	5.0	5.1	19 %
Germany	164.7	183.0	155.0	157.0	155.5	– 6 %	2.3	2.4	2.1	1.9	1.9	– 19 %
Greece	14.5	18.8	22.3	19.8	16.1	11 %	0.3	0.6	0.6	0.5	0.5	54 %
Hungary	8.5	9.1	11.7	11.4	10.8	27 %	0.0	0.0	0.0	0.0	0.0	– 1 %
Iceland	0.6	0.7	0.9	0.9	0.9	37 %	0.0	0.0	0.0	0.0	0.0	– 34 %
Ireland	5.1	10.8	11.6	11.3	10.9	113 %	0.1	0.1	0.0	0.0	0.0	– 78 %
Italy	103.1	122.4	118.4	117.4	106.1	3 %	1.6	2.7	2.3	2.3	2.2	34 %
Latvia	3.0	2.2	3.3	2.9	2.8	– 7 %	0.0	0.0	0.0	0.0	0.0	3334 %
Lithuania	7.5	3.4	4.5	4.5	4.5	– 39 %	0.0	0.0	0.0	0.0	0.0	– 81 %
Luxembourg	2.7	4.9	6.4	6.8	6.5	140 %	0.0	0.0	0.0	0.0	0.0	130 %
Malta	0.3	0.5	0.6	0.6	0.6	58 %	0.0	0.0	0.0	0.0	0.0	83 %
Netherlands	26.3	32.8	35.0	35.2	34.0	29 %	0.0	0.0	0.0	0.0	0.0	– 23 %
Norway	11.1	12.9	15.2	15.0	15.2	37 %	0.7	1.1	1.1	1.2	1.2	81 %
Poland	20.6	27.7	47.7	48.2	46.8	128 %	0.1	0.1	0.1	0.1	0.1	– 4 %
Portugal	10.3	19.5	18.9	17.6	17.0	65 %	0.2	0.3	0.4	0.4	0.4	61 %
Romania	12.7	9.8	14.3	14.5	15.1	18 %	0.0	0.0	0.3	0.2	0.1	390 %
Slovakia	5.0	4.2	6.7	6.4	6.6	31 %	0.0	0.0	0.0	0.0	0.0	– 35 %
Slovenia	2.7	3.9	5.3	5.7	5.8	111 %	0.0	0.0	0.0	0.0	0.0	60 %
Spain	59.1	87.3	92.0	86.7	80.7	36 %	2.0	3.8	3.9	3.7	3.2	57 %
Sweden	19.3	19.8	20.8	20.3	19.1	– 1 %	0.7	0.7	0.5	0.5	0.5	– 24 %
Switzerland	14.6	15.9	16.3	16.2	16.3	12 %	0.3	0.2	0.1	0.1	0.1	– 46 %
Turkey	26.3	35.5	45.1	47.9	61.6	134 %	0.9	3.1	3.0	3.4	3.8	311 %
United Kingdom	115.3	122.8	116.7	115.2	114.8	0 %	1.3	2.0	1.7	1.6	1.5	15 %

Table A5.8 Greenhouse gas emissions from transport in Europe, by country and subsector, in million tonnes (unless otherwise stated) (1990, 2012) (cont.)

	1.A.3.B. Road transportation						1.A.3.C. Railways					
	1990	2000	2010	2011	2012	Change 1990–2012 (%)	1990	2000	2010	2011	2012	Change 1990–2012 (%)
Austria	13.6	18.4	21.9	21.1	21.0	55 %	0.2	0.2	0.2	0.1	0.1	– 29 %
Belgium	19.8	23.9	26.3	26.1	24.2	22 %	0.2	0.2	0.1	0.1	0.1	– 59 %
Bulgaria	6.1	5.2	7.5	7.5	7.8	29 %	0.4	0.1	0.1	0.1	0.1	– 79 %
Croatia	3.7	4.4	5.8	5.6	5.4	48 %	0.1	0.1	0.1	0.1	0.1	– 44 %
Cyprus	1.2	1.8	2.3	2.2	2.0	73 %	0.0	0.0	0.0	0.0	0.0	n.a.
Czech Republic	6.4	12.0	17.0	16.8	16.5	159 %	0.7	0.3	0.3	0.3	0.3	– 58 %
Denmark	9.4	11.4	12.2	11.9	11.4	20 %	0.3	0.2	0.2	0.3	0.3	– 16 %
Estonia	2.3	1.5	2.1	2.1	2.2	– 5 %	0.2	0.1	0.2	0.1	0.1	– 40 %
Finland	11.1	11.0	11.9	11.7	11.2	2 %	0.2	0.2	0.1	0.1	0.1	– 48 %
France	114.6	131.3	126.0	126.7	125.1	9 %	1.1	0.8	0.5	0.5	0.5	– 51 %
Germany	152.6	173.2	146.9	149.0	147.4	– 3 %	2.9	1.9	1.1	1.1	1.1	– 64 %
Greece	12.0	16.4	19.2	17.5	13.8	15 %	0.2	0.1	0.1	0.1	0.1	– 61 %
Hungary	7.8	8.8	11.6	11.2	10.7	37 %	0.5	0.3	0.2	0.1	0.1	– 76 %
Iceland	0.5	0.6	0.8	0.8	0.8	55 %	0.0	0.0	0.0	0.0	0.0	n.a.
Ireland	4.8	10.3	11.1	10.8	10.4	119 %	0.1	0.1	0.1	0.1	0.1	– 11 %
Italy	95.1	112.6	109.5	109.3	98.2	3 %	0.5	0.4	0.2	0.2	0.0	– 90 %
Latvia	2.4	1.9	3.0	2.6	2.5	4 %	0.6	0.2	0.2	0.3	0.3	– 53 %
Lithuania	5.3	2.9	4.1	4.1	4.1	– 23 %	0.4	0.2	0.2	0.2	0.2	– 48 %
Luxembourg	2.7	4.8	6.4	6.8	6.5	142 %	0.0	0.0	0.0	0.0	0.0	– 59 %
Malta	0.3	0.5	0.5	0.5	0.5	46 %	0.0	0.0	0.0	0.0	0.0	n.a.
Netherlands	25.7	32.0	34.2	34.4	33.2	29 %	0.1	0.1	0.1	0.1	0.1	– 7 %
Norway	7.8	8.5	10.1	10.1	10.1	30 %	0.1	0.1	0.0	0.0	0.0	– 56 %
Poland	18.7	26.9	46.7	47.2	45.8	145 %	1.6	0.5	0.4	0.4	0.4	– 79 %
Portugal	9.6	18.8	18.3	16.9	16.4	70 %	0.2	0.1	0.0	0.0	0.0	– 81 %
Romania	11.1	8.5	13.3	13.5	14.2	28 %	0.4	0.9	0.4	0.6	0.6	27 %
Slovakia	4.6	4.1	6.5	6.3	6.5	41 %	0.4	0.2	0.1	0.1	0.1	– 81 %
Slovenia	2.7	3.8	5.2	5.7	5.7	116 %	0.1	0.0	0.0	0.0	0.0	– 42 %
Spain	51.4	78.7	84.3	79.9	74.3	44 %	0.4	0.3	0.3	0.3	0.3	– 39 %
Sweden	17.6	18.2	19.4	19.0	17.9	2 %	0.1	0.1	0.1	0.1	0.1	– 42 %
Switzerland	14.2	15.5	16.0	15.9	16.0	13 %	0.0	0.0	0.0	0.0	0.0	38 %
Turkey	24.4	31.3	40.0	41.7	55.7	129 %	0.5	0.5	0.5	0.5	0.4	– 15 %
United Kingdom	109.9	116.2	110.1	108.6	108.4	– 1 %	1.5	1.7	2.0	2.1	2.1	44 %

Table A5.8 Greenhouse gas emissions from transport in Europe, by country and subsector, in million tonnes (unless otherwise stated) (1990, 2012) (cont.)

	1.A.3.D. Navigation						1.A.3.E. Other transportation					
	1990	2000	2010	2011	2012	Change 1990–2012 (%)	1990	2000	2010	2011	2012	Change 1990–2012 (%)
Austria	0.0	0.0	0.0	0.0	0.0	– 19 %	0.2	0.3	0.3	0.4	0.4	75 %
Belgium	0.4	0.5	0.5	0.5	0.5	14 %	0.2	0.2	0.3	0.2	0.2	– 16 %
Bulgaria	0.1	0.0	0.0	0.0	0.0	– 85 %	0.1	0.4	0.3	0.5	0.5	218 %
Croatia	0.1	0.1	0.1	0.1	0.1	– 17 %	0.0	0.0	0.0	0.0	0.0	n.a.
Cyprus	0.0	0.0	0.0	0.0	0.0	n.a.	0.0	0.0	0.0	0.0	0.0	n.a.
Czech Republic	0.1	0.0	0.0	0.0	0.0	– 72 %	0.5	0.1	0.2	0.1	0.1	– 86 %
Denmark	0.8	0.6	0.6	0.6	0.5	– 37 %	0.0	0.0	0.0	0.0	0.0	n.a.
Estonia	0.0	0.0	0.0	0.0	0.0	– 42 %	0.0	0.0	0.0	0.0	0.0	n.a.
Finland	0.4	0.6	0.6	0.5	0.5	9 %	0.7	0.7	0.6	0.7	0.6	– 4 %
France	1.1	1.2	1.2	1.2	1.3	17 %	0.2	0.5	0.5	0.5	0.5	151 %
Germany	2.1	0.9	0.8	0.9	1.0	– 53 %	4.8	4.6	4.1	4.2	4.2	– 13 %
Greece	2.0	1.7	2.4	1.8	1.7	– 11 %	0.0	0.0	0.0	0.0	0.0	n.a.
Hungary	0.2	0.0	0.0	0.0	0.0	– 91 %	0.0	0.0	0.0	0.0	0.0	n.a.
Iceland	0.1	0.0	0.0	0.0	0.0	– 77 %	0.0	0.0	0.0	0.0	0.0	n.a.
Ireland	0.1	0.2	0.2	0.2	0.2	114 %	0.1	0.1	0.2	0.2	0.1	129 %
Italy	5.5	5.9	5.3	4.9	4.9	– 10 %	0.4	0.9	1.1	0.7	0.7	73 %
Latvia	0.0	0.0	0.0	0.0	0.0	1192 %	0.0	0.0	0.0	0.0	0.0	n.a.
Lithuania	0.0	0.0	0.0	0.0	0.0	– 4 %	1.8	0.3	0.2	0.2	0.2	– 86 %
Luxembourg	0.0	0.0	0.0	0.0	0.0	1 %	0.0	0.0	0.0	0.0	0.0	n.a.
Malta	0.0	0.0	0.0	0.0	0.0	290 %	0.0	0.0	0.0	0.0	0.0	n.a.
Netherlands	0.4	0.6	0.6	0.7	0.7	73 %	0.0	0.0	0.0	0.0	0.0	n.a.
Norway	1.7	2.2	2.2	2.1	2.0	17 %	0.8	1.1	1.7	1.6	1.8	113 %
Poland	0.2	0.0	0.0	0.0	0.0	– 92 %	0.0	0.1	0.5	0.5	0.6	n.a.
Portugal	0.3	0.2	0.2	0.2	0.2	– 13 %	0.0	0.0	0.0	0.0	0.0	n.a.
Romania	1.1	0.3	0.2	0.2	0.1	– 88 %	0.0	0.1	0.0	0.0	0.0	123 %
Slovakia	0.0	0.0	0.0	0.0	0.0	4837 %	0.0	0.0	0.0	0.0	0.0	84 %
Slovenia	0.0	0.0	0.0	0.0	0.0	n.a.	0.0	0.0	0.0	0.0	0.0	n.a.
Spain	5.2	4.3	3.3	2.6	2.7	– 49 %	0.0	0.1	0.3	0.3	0.3	1300 %
Sweden	0.6	0.6	0.5	0.5	0.3	– 44 %	0.3	0.3	0.3	0.3	0.3	9 %
Switzerland	0.1	0.1	0.1	0.1	0.1	8 %	0.0	0.0	0.0	0.0	0.0	44 %
Turkey	0.5	0.6	1.7	2.4	1.6	224 %	0.0	0.0	0.0	0.0	0.0	n.a.
United Kingdom	2.3	2.5	2.4	2.4	2.3	1 %	0.3	0.4	0.5	0.5	0.5	97 %

Table A5.8 Greenhouse gas emissions from transport in Europe, by country and subsector, in million tonnes (unless otherwise stated) (1990, 2012) (cont.)

	International aviation						International maritime transport					
	1990	2000	2010	2011	2012	Change 1990–2012 (%)	1990	2000	2010	2011	2012	Change 1990–2012 (%)
Austria	0.9	1.7	2.1	2.2	2.1	134 %	0.0	0.1	0.1	0.0	0.1	18 %
Belgium	3.1	4.7	4.1	4.4	4.1	31 %	13.3	16.1	24.6	21.9	19.6	47 %
Bulgaria	0.7	0.2	0.5	0.5	0.5	– 31 %	0.2	0.2	0.4	0.3	0.2	– 10 %
Croatia	0.3	0.2	0.2	0.3	0.3	– 24 %	0.1	0.1	0.0	0.1	n.a.	n.a.
Cyprus	0.7	0.8	0.8	0.9	0.8	11 %	0.2	0.6	0.6	0.6	0.6	239 %
Czech Republic	0.6	0.6	1.0	1.0	1.0	69 %	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Denmark	1.8	2.4	2.4	2.5	2.5	45 %	3.1	4.1	2.1	2.1	1.5	– 50 %
Estonia	0.1	0.1	0.1	0.1	0.1	6 %	0.6	0.3	0.7	0.6	0.5	– 6 %
Finland	1.0	1.1	1.7	2.0	1.9	87 %	1.9	2.1	0.7	0.6	0.4	– 81 %
France	8.7	14.5	16.2	16.8	16.3	87 %	7.9	9.5	7.9	8.5	8.0	1 %
Germany	12.1	19.7	24.7	23.8	25.6	110 %	8.0	7.0	9.0	8.8	8.2	3 %
Greece	2.5	2.5	2.1	2.3	2.5	3 %	8.3	11.8	8.9	9.1	7.4	– 11 %
Hungary	0.5	0.7	0.7	0.7	0.5	4 %	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Iceland	0.2	0.4	0.4	0.4	0.4	101 %	0.1	0.2	0.2	0.2	0.2	84 %
Ireland	1.1	1.8	2.3	2.1	1.8	63 %	0.1	0.5	0.4	0.3	0.4	600 %
Italy	4.2	8.1	9.5	9.8	9.4	124 %	4.4	4.2	7.0	7.3	5.7	29 %
Latvia	0.2	0.1	0.4	0.4	0.4	65 %	1.6	0.0	0.8	0.7	0.8	– 49 %
Lithuania	0.4	0.1	0.1	0.2	0.2	– 52 %	0.3	0.3	0.4	0.5	0.4	27 %
Luxembourg	0.4	1.0	1.3	1.2	1.1	182 %	0.0	0.0	0.0	0.0	0.0	59 %
Malta	0.2	0.3	0.3	0.3	0.3	50 %	0.3	1.2	3.4	4.3	3.7	1323 %
Netherlands	4.6	9.8	10.2	10.5	10.2	123 %	34.5	42.8	43.3	48.4	43.6	26 %
Norway	0.6	0.9	1.3	1.2	1.2	99 %	1.5	2.6	1.5	1.5	1.6	5 %
Poland	0.6	0.8	1.5	1.5	1.7	157 %	1.3	0.9	0.7	0.5	0.5	– 63 %
Portugal	1.5	2.0	2.6	2.7	2.7	86 %	1.4	1.7	1.6	1.9	2.1	50 %
Romania	0.8	0.4	0.5	0.4	0.4	– 49 %	n.a.	n.a.	0.0	0.0	0.0	n.a.
Slovakia	0.1	0.0	0.1	0.1	0.1	41 %	0.1	n.a.	0.0	0.0	0.0	– 84 %
Slovenia	0.0	0.1	0.1	0.1	0.1	38 %	n.a.	n.a.	0.1	0.1	0.2	n.a.
Spain	5.6	10.2	12.8	14.1	13.6	142 %	11.6	19.2	26.9	27.5	26.9	131 %
Sweden	1.4	2.0	2.1	2.3	2.2	62 %	2.3	4.8	6.8	6.0	5.9	159 %
Switzerland	3.1	4.7	4.3	4.7	4.7	52 %	0.1	0.0	0.0	0.0	0.0	– 54 %
Turkey	n.a.	n.a.	0.4	7.5	7.8	n.a.	n.a.	n.a.	0.8	6.1	2.6	n.a.
United Kingdom	15.7	30.5	31.7	33.2	32.3	106 %	8.8	6.8	9.3	10.4	8.8	1 %

Source: EEA data viewer, 2014.

Annex 6 Emission factors for freight and passenger transport

Table A6.1 Emission factors for freight transport

Vehicle	CH_4 (g/tkm)	CO (g/tkm)	CO_2 (g/tkm)	N_2O (g/tkm)	NMVOC (g/tkm)	NO_x (g/tkm)	PM_{10} (g/tkm)	SO_2 (g/tkm)	VOC (g/tkm)
Truck 3.5–7.5 t	0.014	1.03	693–366	0.023	0.137	3.45	0.063	0.003	0.151
Truck 7.5–16 t	0.004	0.31	184–105	0.009	0.039	1.09	0.019	0.001	0.043
Truck 16–32 t	0.004	0.30	172–100	0.006	0.030	1.00	0.017	0.001	0.034
Truck > 32 t	0.001	0.18	102–64	0.004	0.016	0.57	0.010	0.000	0.018
Freight train	0.004	0.07	52	0.002	0.025	0.30	0.010	0.014	0.029
Inland ship	0.007	0.82	53	0.002	0.267	1.24	0.058	0.056	0.274

Note: The above figures have been estimated with an average load factor per vehicle, which equals 4.1 tonnes for road trucks and 427 tonnes for rail (no data for ships). For heavy-duty trucks, the effect of vehicle load is important in determining the emission factor. By default, a 50 % load is usually considered in emission models (e.g. COPERT). In general, a fully loaded truck would emit about 50 % less in grams per tonne-kilometre for the pollutants listed above. However, additional payload also results in fuel consumption — and hence also CO_2 emissions — penalties as the vehicle becomes heavier. This effect has been estimated for CO_2 emissions, and a range of values is provided above (the higher value corresponds to a half-loaded and the lower value to a fully loaded truck). For non-road modes, this is not relevant as trains and ships are usually fully loaded with cargo.

Source: TRACCS database for heavy-duty trucks; National emission inventories (UNFCCC and Convention on Long-range Transboundary Air Pollution (LRTAP)) and PRIMES for rail and inland shipping, 2013.

Table A6.2 Emission factors for passenger transport

Vehicle	CH_4 (g/pkm)	CO (g/pkm)	CO_2 (g/pkm)	N_2O (g/pkm)	NMVOC (g/pkm)	NO_x (g/pkm)	PM_{10} (g/pkm)	SO_2 (g/pkm)	VOC (g/pkm)
Small petrol car	0.017	1.73	42–103	0.002	0.229	0.120	0.001	0.000	0.247
Medium petrol car	0.015	1.18	49–123	0.002	0.152	0.084	0.001	0.000	0.167
Large petrol car	0.017	1.28	62–158	0.002	0.173	0.119	0.001	0.000	0.190
Small diesel car	0.001	0.07	42–104	0.005	0.013	0.459	0.018	0.000	0.013
Large diesel car	0.001	0.07	55–138	0.005	0.019	0.458	0.018	0.001	0.019
Bus	0.003	0.15	68	0.001	0.019	0.511	0.009	0.000	0.022
Two-wheeler	0.074	5.27	72	0.001	1.701	0.147	0.026	0.000	1.775
Aircraft	0.000	0.32	285	---	0.026	0.109	0.000	---	0.026
Passenger train	0.001	0.02	14	0.001	0.005	0.058	0.002	0.004	0.006
Inland ship	0.023	2.07	245	0.009	0.686	5.87	0.305	3.102	0.709

Note: The above figures have been estimated with an average number of passengers per vehicle, which is 1.52 for cars, 12.7 for buses and 1.16 for two-wheelers, 88 for aircrafts and 156 for rail (no data for ships). The addition of more passengers results in fuel consumption — and hence also CO_2 emissions — penalties as the vehicle becomes heavier, but the final figure in grams of CO_2 per passenger is obviously lower. This effect has been estimated for CO_2 emissions from passenger cars, and a range of values is provided above (the higher value corresponds to the average number of passengers, and the lower value to a car with the driver, three passengers and luggage). For other vehicles (except two-wheelers), which are generally much heavier than passenger cars, this effect is insignificant.

Source: TRACCS database, 2013.

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