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Laying the foundations for greener transport

TERM 2011: transport indicators tracking progress
towards environmental targets in Europe

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European Environment Agency

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Foreword and summary

With the launch of the White Paper *Roadmap to a Single European Transport Area — Towards a competitive and resource efficient transport system* that proposes a clear quantitative target — 60 % compared to 1990 by 2050 — for the reduction of emission of carbon dioxide (CO_2), the European Commission has sent a clear signal to the sector regarding the role it must play in meeting economy-wide targets in this field. A decade ago, when the Transport and Environment Reporting Mechanism (TERM) was set up, the focus was on the integration of environmental objectives into transport policy. A key issue addressed in each annual TERM report since the start was how growing transport demand negates many of the benefits of technology development. The issue of CO_2 emissions was then, and still remains, one of the most difficult to address because it is so closely linked to growing transport volumes. But transport volume growth does not stem from transport policy as much as it does from economic development in the sectors using transport. Economic growth normally means more transport; growth means more goods and services to be produced and consumed.

Meeting the 60 % reduction target may thus seem a daunting challenge, but the fact that the white paper is coordinated with policies on greenhouse gas (GHG) emission reduction, roadmaps for a low-carbon society, etc., means that the policy integration from a decade ago can now really take shape across a much wider policy arena. All policies that impact on the EU's ability to meet its climate targets should be coordinated. This way, each sector delivers as best it can with respect for the differences between sectors. For the transport sector, this means focus on the cleanest possible technology and on low-carbon fuels, but also on using the most efficient transport modes and getting rid of economic inefficiencies stemming from uncovered external costs, among others.

With clearer quantitative reduction targets being proposed for a number of impacts, it is now possible to more clearly ascertain if developments are heading in the right direction. The TERM 2011 therefore contains a core set of indicators that will form the basis for an annual assessment of developments over the coming decade. This indicator set, derived from the original TERM indicator set, covers environmental pressure, state and impacts (e.g. emissions, noise nuisance and landscape fragmentation), as well as drivers behind trends such as transport demand changes, and response indicators such as vehicle fleet developments. Chapter 2 examines these indicators in detail; some of the points are set out below.

- Present transport GHG emissions as defined in the white paper are 27 % above 1990 levels (this covers the EU-27, excludes international maritime and includes international aviation). In 2009, GHG emissions from transport decreased for the second year in a row, mainly due to the effects of the economic recession. Nevertheless, a major effort is still needed in order to achieve targets, and emissions may grow again once economic growth resumes.

- Reduction in oil dependence is an objective of EU policy, not least because it is closely related to decreasing GHG emissions. Targets and measures included in the roadmap for moving to a competitive low-carbon economy in 2050 require efforts from all sectors. Although the new white paper has not stated any specific target for reducing oil dependency, the 60 % GHG emissions reduction target means that transport-sector oil dependence should be significantly reduced by 2050, compared with the 96 % level today. In addition, decarbonisation of the energy system is significantly linked with decarbonisation of transport.

- Significant progress has been made since 1990 in reducing the emissions of many air pollutants from the transport sector. Nevertheless, many cities are facing challenges in meeting concentration limits set in EU legislation for air pollutants — road transport in particular makes a large contribution to urban air quality.

- Noise from transport sources is a significant environmental problem; the latest evidence published by the World Health Organization (WHO) indicates that at least 1 million healthy life years are lost every year in Europe as a result of noise from road traffic alone.

- Transport is having a significant negative impact on ecosystems and biodiversity, and the white paper calls for the reduction of its negative impact on key natural assets like water, land and ecosystems. Due to the lack of reliable quantification and methodology, the white paper does not set a quantitative target but rather proposes an indicator calculated on the basis of the mesh size concept. This method has been applied to provide valuable information towards biodiversity policy's general targets.

Chapter 3 takes a closer look at the developments in transport demand. Although energy efficiency and exhaust emissions from transport have been improving, this has not been enough to outweigh the impact of rising transport volumes and a preference for road transport, and it has not resolved all of the issues.

Chapters 4, 5 and 6 follow the 'avoid, shift, improve' methodology developed in the TERM 2009 report to examine the different measures applied to address some of the impacts. The application of technology has been the primary means of reducing the environmental impacts of transport in the last two decades. It has also been identified as the most important means to achieve the European Commission's target of a 60 % reduction in GHGs from transport by 2050. But technical solutions alone cannot achieve the target. Demand optimisation including modal shifts will form an essential part of meeting this target, and can be very cost effective as well as offering environmental co-benefits such as air quality improvements and noise reduction.

Finally, Chapter 7 takes a look at the new reporting of emissions from light-duty vehicles (passenger cars and vans). With regulation on CO_2 emissions from cars and vans now agreed, a course towards a fleet of low emission vehicles has been set. The type-approval measurement procedure that forms the basis for the regulation does not, however, fully capture all energy-consuming technologies on a vehicle, and it will never be able to account for the influence of the driver and driver behaviour on fuel consumption. As a result, while there is correlation between the type-approval and in-use CO_2 emissions, the magnitude of the reductions gauged from the type-approval conditions does not necessarily lead to an equal reduction of the in-use consumption.

1 Introduction

The European Council, at its summit in Cardiff in 1998, requested that the Commission and transport ministers focus their efforts on developing integrated transport and environment strategies. At the same time, and following initial work by the European Environment Agency (EEA) on transport and environment indicators, the joint meeting of the Transport and Environment Council invited the Commission and the EEA to set up a Transport and Environment Reporting Mechanism (TERM), to enable policymakers to gauge the progress of their integration policies. Over the decade from 2000 to 2010, the EEA reported on the integration aspect as well as on the environmental performance of transport with reference to targets included in the Transport White Paper from 2001 (EC, 2001b).

With the launching of a new White Paper on Transport in 2011 (EC, 2011a), the TERM Steering Group (see acknowledgements below) agreed to adapt the structure of the TERM report to the different aims and targets of this new paper. Some of these aims and targets are in reality reflections of already existing regulations and policies, for example in the area of transport noise, air emissions and air quality, while the white paper's only new environmental target relates to greenhouse gas (GHG) emission reduction by 2030 and 2050.

A white paper is not a concrete policy measure, but rather an overall policy strategy. Looking back at the previous white paper on transport (EC, 2001b), one sees that it has to a large extent been the agenda-setting document for the decade. The 2011 white paper set 10 goals for a competitive and resource-efficient transport system which serve as benchmarks for achieving the 60 % GHG emission reduction target. When referring to 'targets' in the TERM report, these should be understood as 'goals' in most cases, in contrast to legally binding mandatory targets. In spite of their non-binding nature in many cases, it is expected that these targets will form the basis for regulatory developments over the next decade, and as such, will be subject to monitoring.

The TERM process with its original environmental integration aim was based on a set of indicators geared towards answering seven key questions:

- Is the environmental performance of the transport sector improving?
- Are we getting better at managing transport demand and at improving the modal split?
- Are spatial and transport planning becoming better coordinated so as to match transport demand to the need for access?
- Are we optimising the use of existing transport infrastructure capacity and moving towards a better-balanced intermodal transport system?
- Are we moving towards a fairer and more efficient pricing system that ensures that external costs are internalised?
- How rapidly are cleaner technologies being implemented, and how efficiently are vehicles being used?
- How effectively are environmental management and monitoring tools being used to support policymaking and decision-making?

The TERM indicator list covers the most important aspects of the transport and environment system (driving forces, pressures, state of the environment, impacts and societal responses — the so-called DPSIR framework). These indicators are still relevant, but in order to sharpen the focus on the targets a core set of indicators for transport (TERM CSIs) has been developed. These indicators — derived from the original TERM set — cover issues such as energy consumption, emissions, transport demand, price developments and fleet monitoring. The intention is that this set of indicators will provide snapshots both of 'what is happening' in the transport sector and of 'why it is happening'.

In addition to monitoring based on indicators, the annual TERM report will highlight a number of specific issues. These issues can be driven by the availability of new data sets, as is this year's feature on monitoring of carbon dioxide (CO_2) emissions for cars. They could also be driven by particular positive or negative development trends where a deeper analysis of cause and effect is needed. Finally, they could be driven by policy developments where the TERM can add depth to ongoing policy debate, as in the upcoming revision of air pollution regulation in the coming years, for example.

The TERM is built on work carried out in several other areas. Data on greenhouse gas emissions build on the monitoring of all member country emissions carried out by these countries and the EEA. In a similar manner, data on emissions of pollutants and on air quality build on the monitoring set up for that specific purpose. For this reason, the TERM report does not aim to provide an in-depth presentation on all aspects, but rather to provide the key facts needed in a policy debate.

Scope of the report

The report aims to cover all 32 EEA member countries. These are the 27 EU Member States, one candidate country (Turkey), and Iceland, Liechtenstein, Norway and Switzerland. Where data are not complete, this is generally noted in the metadata section, where different country groupings are also described. For some indicators, EU-27 data have been prioritised, as policy targets and goals are specifically developed for these countries.

In terms of time, most indicators cover the years since 1990, subject to data availability. But there are cases where data for some Member States have only become available recently, or where the transition from a centrally planned to market economy has led to such big changes that comparisons over time become irrelevant.

The underlying fact sheets used for this report have been developed by the European Topic Centre for Air and Climate Mitigation (ETC/ACM) and a consortium led by AEA Technology from the United Kingdom. Both have also been involved in drafting the text.

Acknowledgements

The TERM process is steered jointly by the European Commission (Eurostat, the Directorate-General for Environment (DG ENV), the Directorate-General for Mobility and Transport (DG MOVE), and the Directorate-General for Climate Action (DG CLIMA)) and the EEA. The EEA member countries and other international organisations provide input and are consulted on a regular basis.

The project was managed and the final version of the text written by Alfredo Sánchez Vicente (EEA). Substantial input and review was also provided by Peder Jensen, Cinzia Pastorello, Martin Adams, David Owain Clubb, Valentin Leonard Foltescu, Johannes Schilling, Peder Gabrielsen, David Simoens, François Dejean, Paul McAleavey, Branislav Olav, Colin Nugent, John van Aardenne and Anke Lükewille (all from the EEA). In addition, comments were received from a number of EEA member countries as well as from the European Commission.

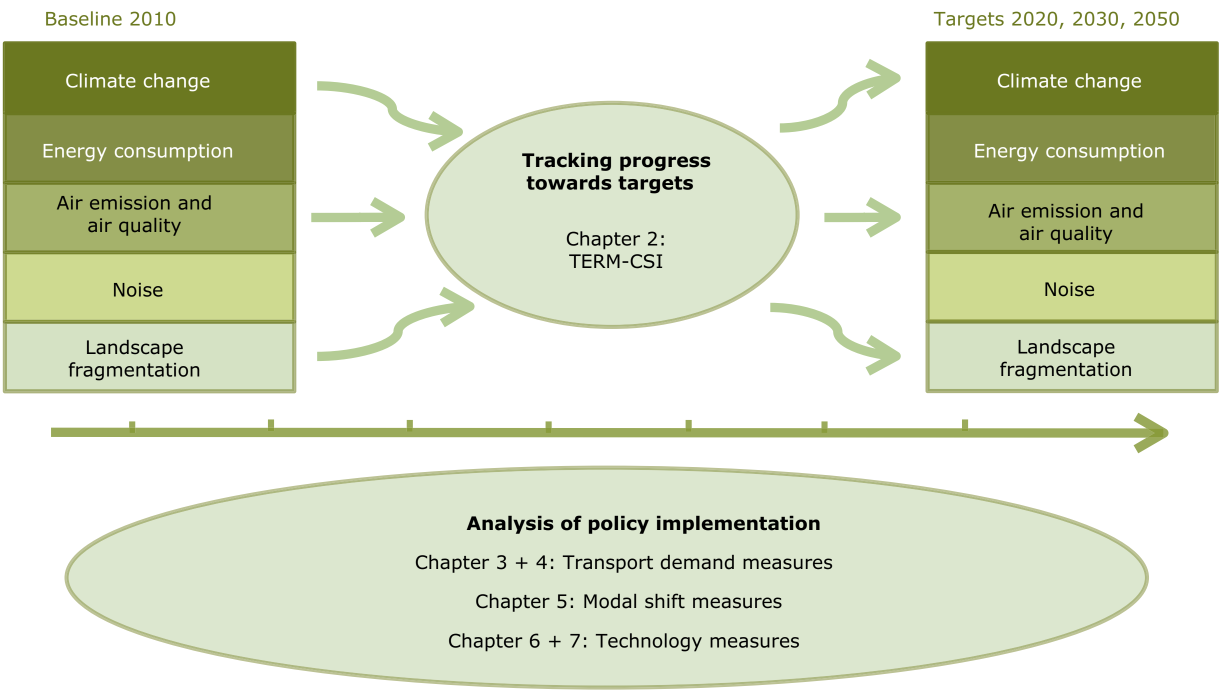
2 Environmental baseline and targets

The purpose of the TERM report is to provide an annual indicator-based assessment of how well transport and environment policy is performing. For the first time, the TERM 2011 addresses more comprehensive quantified environment-related targets in transport policy. The recent White Paper on Transport's (EC, 2011a) target on GHG emission reduction is included in the analysis, which also covers other relevant and important transport- and environment-related policy and legislation (see Section 2.1 for more information on current aims and targets).

Although monitoring of the White Paper on Transport is planned by the European Commission with a full evaluation after five years, the introduction of the TERM Core Set of Indicators (TERM CSIs) in the TERM 2011 will enable an annual assessment of a wider range of indicators and targets, whilst also monitoring the most relevant targets from the white paper (see Section 2.2 for more information on the TERM CSIs). Figure 2.1 presents the methodology designed for the TERM in order to cope with the aim of monitoring policy targets in the following years. The TERM 2011 presents the relevant aims and targets that are currently included in the environment and transport policy (see Section 2.1) as they drive the selection and design of the TERM CSIs.

The current state of the main environmental domains affected by transport are introduced in Section 2.3, 'Baseline'. Chapter 3 'Passenger and freight transport demand and modal split' provides details on the evolution of and latest figures on transport demand, which are considered the key drivers that set the context for understanding transport-related impacts. In addition, the TERM CSIs will be complemented with further information to assess progress towards targets, applying the

Figure 2.1 Conceptual map for the new TERM approach



Source: EEA, 2011.

avoid-shift-improve (ASI) approach that was introduced in the last TERM report (EEA, 2010a) in Chapters 4 'Optimising Transport Demand', 5 'Obtaining a more sustainable modal split' and 6 'Using the best technology available'.

The annual snapshot on the state of the environmental domains affected by transport and its 'progress towards targets' will be provided by the TERM CSIs, giving a comprehensive assessment year by year. The TERM CSIs will be assessed and monitored against the baseline data for the year 2010 (which is prior to the introduction of the white paper). However, the majority of full-year data sets for 2010 are not yet available at this time. The baseline data therefore consist of data from the latest available year (in most cases, this is 2008 or 2009). In some cases, it has been possible to use proxy data to extend the data series to later years, including to 2010 (e.g. for the transport final energy consumption TERM 01 indicator and the transport GHG emissions TERM 02 indicator). It is important to note that the years 2008 and 2009 corresponded to the height of the economic crisis in Europe, and this can be clearly seen in the identified transport and environment-related trends. Future editions of the TERM report will include further 2010 baseline data as they become available for each of the TERM CSIs, until there is a completed baseline.

This chapter sets the scene for the current transport- and environment-related aims and targets, and then introduces in detail the TERM CSIs. The environmental baseline is then presented, focusing on emissions of GHGs and pollutants from transport, air quality, noise, biodiversity and landscape issues. The aim is to show how things stand in the main environmental areas that are affected by transport.

2.1 Current aims and targets

Current transport and environment policy includes a wide range of targets for the coming decade and beyond. These define the standards of success by assigning values that specific indicators must reach by particular dates. Thus it allows for monitoring of both policy performance and progress towards the targets.

Specific targets and their related policy context are discussed in more detail in the remaining chapters of this report. These can range from the short to the long term (i.e. up to 2050). Environment-related targets in transport policy are primarily covered in the baseline (see Section 2.3). These include relevant targets from the White Paper on Transport (EC, 2011a), and from the communication *A Roadmap for moving to a competitive low carbon economy in 2050* (EC, 2011b), covering key aspects such as the reduction of GHG emissions and the reduction of oil dependence in the transport sector. Some targets are related to transport implicitly rather than explicitly; these have also been included in the TERM CSIs and in the environmental baseline. They include targets related to air quality, noise, biodiversity and land issues.

There are other, more transport-specific targets from policy and legislation that are covered in the TERM CSIs, in Chapters 4, 5 and 6. These include targets relating to CO_2 emissions standards for cars and vans (EC, 2009a and 2011c respectively); the share of renewable energy in the transport sector, including biofuels (EC, 2009b); and reductions of GHG life-cycle emissions from fuel and energy supplied (EC, 2009c). Other white paper targets are also relevant here, including reducing the use of 'conventionally fuelled' cars, increasing low-carbon sustainable fuels in aviation, reducing CO_2 emissions of maritime bunker fuels, and increasing the share of freight transported by rail or water. Table 2.1 summarises all these relevant targets.

Targets relating to the rest of the TERM CSIs are identified in the following tables. It is not currently possible to monitor all targets through the TERM, partly because data are not yet available. However, where it is possible, the most important targets and aims relevant to the TERM have been covered by selecting the TERM CSIs. Table 2.2 shows areas where targets exist, albeit not explicitly mentioned or specifically related to transport. In addition, Table 2.3 shows key signals that are relevant for the environmental performance of transport where it is considered useful to monitor evolution.

Table 2.1 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	White Paper *Roadmap to a Single European Transport Area* (EC, 2011a), communication *A Roadmap for moving to a competitive low carbon economy in 2050* (EC, 2011b).	TERM 02	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 White Paper on Transport on the basis of the 2050 roadmap.
EU CO_2 emissions of maritime bunker fuels 40 % ↓ (versus 2005)	 2050	White Paper *Roadmap to a Single European Transport Area* (EC, 2011a).	TERM 02	
40 % share of low carbon sustainable fuels in aviation	2050	White Paper *Roadmap to a Single European Transport Area* (EC, 2011a).	TERM 31	Potentially monitored through EU (Emissions Trading Scheme) ETS reporting.
Use of conventionally fuelled cars in urban transport 50 % ↓ 100 % ↓	 2030 2050	White Paper *Roadmap to a Single European Transport Area* (EC, 2011a).	TERM 34	The white paper goal relates not to vehicle numbers but to share in urban passenger kilometres (pkm). Not currently possible to monitor.
CO_2-free city logistics in major urban centres	2030	White Paper *Roadmap to a Single European Transport Area* (EC, 2011a).		Not currently possible to monitor.
Most of medium-distance passenger transport should be covered by rail	2050	White Paper *Roadmap to a Single European Transport Area* (EC, 2011a).	TERM 12a/b	Only indirectly monitored through modal shares.
Road freight over 300 km shift to rail/waterborne transport 30 % shift 50 % + shift	 2030 2050	White Paper *Roadmap to a Single European Transport Area* (EC, 2011a).	TERM 13a/b	Only indirectly monitored through modal shares.
10 % share of renewable energy in the transport sector, final energy consumption for each Member State	2020	Directive 2009/28/EC on renewable energy (RED) (EC, 2009b).	TERM 31	
Fuel suppliers to reduce life-cycle GHG of road transport fuel 6–10 % ↓ (versus 2010 fossil fuels)	 2020	Directive 2009/30/EC on fuel quality (FQD) (EC, 2009c).	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	EC Regulation 443/2009 on passenger car CO_2 (EC, 2009a).	TERM 27 and TERM 34	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	EC Regulation 510/2011 on van CO_2 (EC, 2011c).	TERM 27 and TERM 34	To be monitored in future indicator updates.
New maritime ship efficiency via the Energy Efficiency Design Index 10 % ↓ (versus current) 15–20 % ↓ (versus current) 30 % ↓ (versus current)	 2015 2020 2025	IMO MARPOL Annex VI EEDI Regulations (IMO, 2011).		Not currently monitored. There is a waiver for ships registered in developing countries until 2019.

Table 2.2 Other key transport-related targets relevant to the TERM

Target	Target date	Source	Relevant indicator	Comments
70 % reduction of transport oil consumption from today.	2050	Impact assessment — accompanying document to the White Paper on Transport (EC, 2011d).	TERM 01	This is interpreted as a 70 % drop in oil consumption in the transport sector from 2009 levels, as it is the latest data available.
Emission ceiling targets exists for total oxides of nitrogen (NO_x), oxides of sulphur (SO_x), non-methane volatile organic compounds (NMVOCs) and ammonia (NH_3) emissions.	2010	Directive 2001/81/EC on National Emission Ceilings (NECD) (EC, 2001a). United Nations Economic Commission for Europe (UNECE)/ European Monitoring and Evaluation Programme (EMEP) Convention on Long-range Transboundary Air Pollution (LRTAP) (UNECE, 1979).	TERM 03	No specific emission reduction target or objective exists for transport-related emissions of acidifying substances, ozone (O_3) precursors or particulates.
A number of limit values (LVs) (e.g. hourly LVs) have been set for the atmospheric concentrations of main pollutants, including SO_x, NO_x, airborne particulate matter (PM) (namely PM_{10} and $PM_{2.5}$), lead, carbon monoxide (CO), benzene (C_6H_6) and O_3.	n/a	Directive 2008/50/EC on ambient air quality and cleaner air for Europe (EC, 2008a).	TERM 04	No specific air quality targets have been set up for traffic or transport affected areas. Only NO_x/nitrogen dioxide (NO_2) and PM_{10} measures are indicated.
Reduce number of people exposed to and disturbed by traffic noise levels which endanger health and quality of life.	n/a	Directive 2002/49/EC on environmental noise (EC, 2002).	TERM 05	Monitoring of people exposed to noise levels above 55 dB L_{den} (day, evening and night) and 50 dB L_{night} (night time).

Table 2.3 Other key transport issues relevant to the TERM

Relevance	Indicator	Comments
Transport prices are themselves important drivers of individual and business transport decisions, affecting transport growth and modal split development, and can lead to changes in distribution management, location decisions, and spatial planning.	TERM 20	The data available can provide an idea of the trends of real price indices of passenger transport based on a fixed transport product in the EU Member States. Freight transport prices are not officially available.
Monitoring fuel prices is considered a relevant variable to assess whether the system is sending the appropriate signals.	TERM 21	Road transport fuel prices (including taxes) in EU Member States.

2.2 Defining the TERM Core Set of Indicators (TERM CSIs)

The aim of TERM is to ensure that relevant information is provided on a regular basis to answer the question 'Are we moving in the right direction?' Not all policies and targets are relevant to the TERM process so the TERM CSIs have been selected based upon their usefulness, relevance and ability to produce clear data. However, while all TERM indicators are in essence active (see Annex 2 for an overview of the TERM fact sheets), not all indicators are published every year.

The 12 TERM CSIs are listed in Box 2.1. Each is subsequently described in more detail in this section, including baseline information (presented graphically — for 2010 where available), related targets and monitoring, key messages and where further information can be found in the remainder of this report.

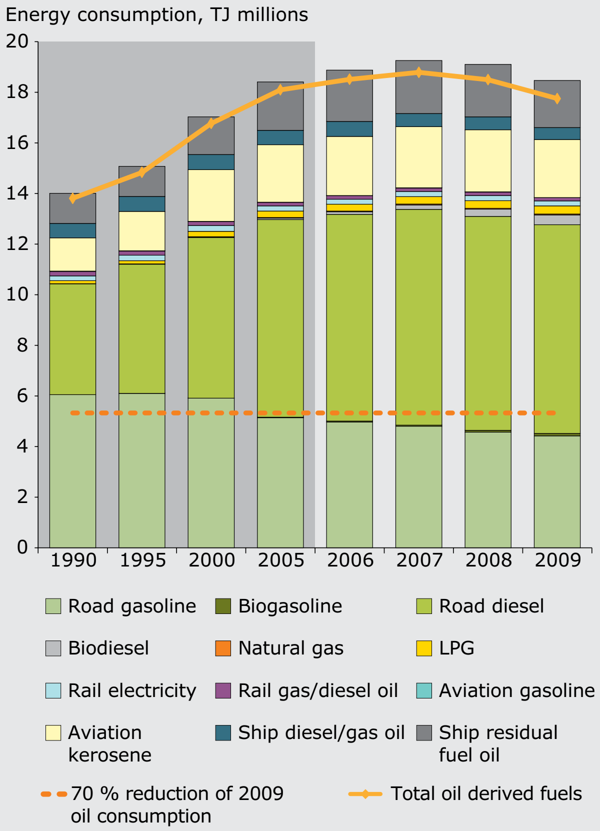
In future editions of the TERM report, this chapter on the TERM CSIs will provide a snapshot assessment of progress against the key targets. The information will show the progress from the baseline towards each target deadline. The baseline will continue to be developed over the next two years as more data for 2010 become available. Analysis of progress towards the achievement of targets will be carried out gradually as data for the years following the baseline year become available.

Box 2.1 TERM Core Set of Indicators (TERM-CSIs)

- TERM 01: Transport final energy consumption by mode
- 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 12a/b: Passenger transport volume and modal split
- TERM 13a/b: Freight transport volume and modal split
- TERM 20: Real change in transport prices by mode
- TERM 21: Fuel prices and taxes
- TERM 27: Energy efficiency and specific CO_2 emissions
- TERM 31: Uptake of cleaner and alternative fuels
- TERM 34: Proportion of vehicle fleet meeting certain emission standards

Box 2.2 TERM 01: Transport final energy consumption by mode

Transport energy consumption (EEA-30)



Note: EU-27 plus Norway, Switzerland and Turkey.

Source: Eurostat, 2011.

Related targets and monitoring

Analysis of the EC's *A Roadmap for moving to a competitive low carbon economy in 2050* suggests that a 70 % reduction of 2009 transport oil consumption will be needed. Total transport energy consumption is monitored in the TERM 01.

Key messages

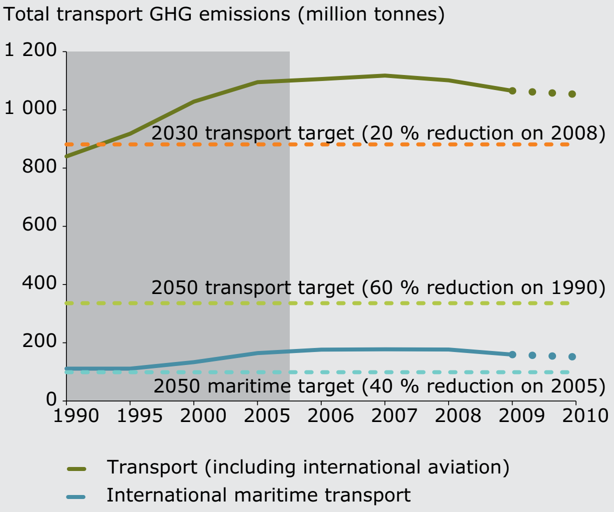
Between 1990 and 2007, annual transport energy consumption in the EEA member countries showed continual growth. However, this upward trend reversed in 2008 (with the economic recession likely to be the primary reason) and the most recent data for 2009 indicates an accelerating decline. Total energy demand in 2009 has fallen by over 4 % from its peak in 2007. Energy use for aviation, rail transport and domestic navigation also fell by 4.9 % to 5.6 %. Road transport represents the largest energy consumer, accounting for 73 % of total demand in 2009. It has also been the least affected by the downturn, falling by only 2.8 % between 2007 and 2009. Because the recent changes are so closely associated with the economic downturn, the long-term trend is still expected to be an upward one; total transport energy consumption has increased by 32 % between 1990 and 2009.

Further information

Environmental baseline (Section 2.3).

Box 2.3 TERM 02: Transport emissions of GHGs

EU-27 transport emissions of GHG, current baseline year: 2009



Note: Dotted line segments represent data series extrapolation from 2009 to 2010 using proxy data.

Source: EEA, 2011.

Related targets and monitoring

Transport GHG emissions are to be reduced by 20 % from 2008 levels by 2030, and by at least 60 % from 1990 levels by 2050; maritime bunker emissions are to be reduced by 40 % on 2005 levels by 2050 (EC, 2011a). This is monitored annually in the TERM 02.

The EU has committed to achieving a 30 % reduction in total GHG emissions in the event of an ambitious and comprehensive global agreement, and a 20 % reduction unilaterally by 2020 (from 1990 levels).

According to the latest estimates (EEA, 2011a), the European Union remains well on track to achieving its Kyoto Protocol target for reducing total GHG emissions despite a 2.4 % emissions increase in 2010. The 2010 increase follows a 7 % drop in 2009, largely due to the economic recession and to growth of renewable energy generation.

Key messages

In 2009, transport (including international maritime) contributed 24 % to GHG emissions from all sectors in the EU-27. Transport GHG emissions excluding international maritime, as defined in the white paper, were also 27 % above 1990 levels. This is the starting point for the baseline, and its progression will be monitored against the 60 % reduction target. It means that transport emissions will need to be reduced 68 % from 2009 to meet the 2050 target. The decline in GHG emissions from road transport over the past two years can be mainly explained by a decline in freight transport demand related to the economic recession and to higher fuel prices.

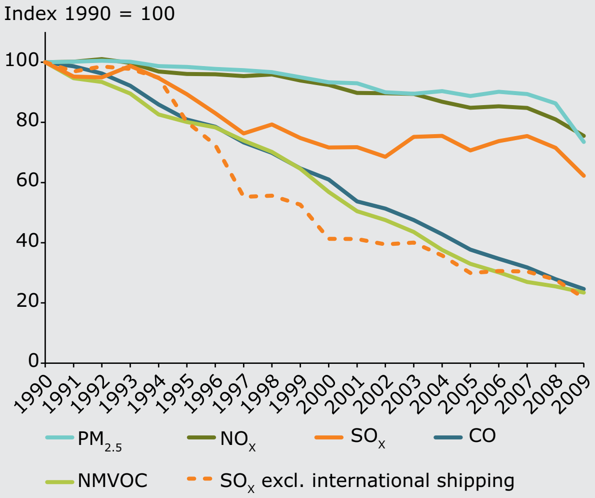
Non-EU EEA countries have followed a similar path to that of the EU-27, increasing by 28 % from 1990 levels.

Further information

Environmental baseline (Section 2.3); Optimising transport demand (Chapter 4); Obtaining a more sustainable modal split (Chapter 5); Using the best technology available (Chapter 6); and Monitoring CO_2 emissions from new vehicles (Chapter 7).

Box 2.4 TERM 03: Transport emissions of air pollutants

Trend in emissions of air pollutants from transport in EEA-32



Note: See Figure 2.6.

Source: EEA, 2011.

Related targets and monitoring

Iceland, Liechtenstein, Norway, Switzerland and Turkey are not members of the European Union and hence have no emission ceilings set under the NECD. Norway and Switzerland have ratified the UNECE LRTAP Gothenburg Protocol, requiring them to reduce their emissions to the agreed ceiling specified in the protocol by 2010. Liechtenstein has also signed, but has not ratified the protocol.

Directive 2008/50/EC sets LVs for the atmospheric concentrations of main pollutants, including SO_x, NO_x, airborne PM (PM_{10}, $PM_{2.5}$), lead, CO, C_6H_6 and O_3.

The progressive introduction of Euro emissions standards has substantially reduced emissions of NO_x, CO and PM. In addition, aiming to achieve long-term GHG reductions for the transport sector (see TERM 02) will help reduce emissions of air pollutants from transport.

The actual emissions from vehicles (often termed 'real-world emissions') may exceed the type-approval emissions for each vehicle type. This is particularly the case for NO_x emissions from diesel vehicles. The emission factors used in the emissions inventories by EU Member States have been regularly updated according to new findings. Thus, the reported developments in the emissions presented here should include the 'real-world driving' emission factors as far as is possible.

Key messages

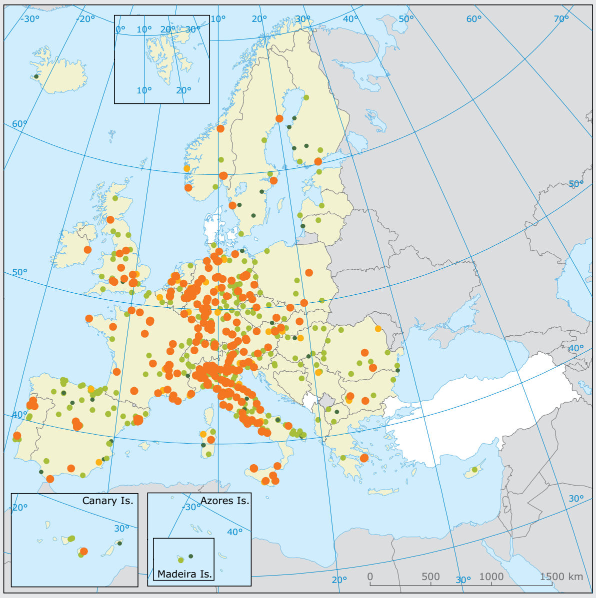
All main contributors to acidification, and particulate and O_3 formation decreased in the EEA-32 between 1990 and 2009, with the exception of NH_3 emissions from transport (not shown in the graph as they make up less than 2 % of total NH_3 emissions). Increases in shipping activity have partially offset reductions elsewhere for NO_x and PM, and for SO_x in particular (see the 'SO_x excl. international shipping' trend in the figure).

Further information

Environmental baseline and targets (Chapter 2); Optimising transport demand (Chapter 4); Obtaining a more sustainable modal split (Chapter 5); Using the best technology available (Chapter 6).

Box 2.5 TERM 04: Exceedances of air quality objectives due to traffic

Annual mean NO_2 concentration observed at traffic stations, 2009



Annual mean NO_2 concentration observed at traffic stations, 2009 (EEA-32)

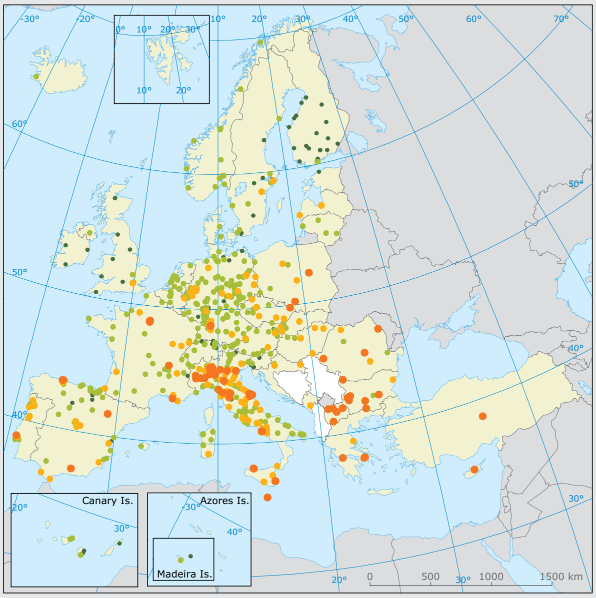
µg/m³ · ≤ 20 · 20–40 · 40–42 · > 42

No data | Outside data coverage

Note: The two highest NO_2 concentration classes (red and orange) correspond to the 2010 annual LV (40 µg/m³) and to the LV plus margin of tolerance (42 µg/m³).

Source: EEA, 2011.

Annual mean PM_{10} concentration observed at traffic stations, 2009



Annual mean PM_{10} concentration observed at traffic stations, 2009 (EEA-32)

µg/m³ · ≤ 20 · 20–31 · 31–40 · > 40

No data | Outside data coverage

Note: The two highest PM_{10} concentration classes (red and orange) correspond to the 2005 annual LV (40 µg/m³), and to a statistically derived level (31 µg/m³) corresponding to the 2005 daily LV. The lowest class corresponds to the WHO air quality guideline for PM_{10} of 20 µg/m³.

Source: EEA, 2011.

Related targets and monitoring

Directive 2008/50/EC on ambient air quality and cleaner air for Europe regulates ambient air concentrations of sulphur dioxide (SO_2), NO_2 and NO_X, PM (PM_{10}/$PM_{2.5}$), lead, C_6H_6, CO and O_3.

EU LVs on concentrations of NO_2 in ambient air (LVs had 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. The graph also shows a class corresponding to the LVs plus margin of tolerance (42 µg/m³);
- an hourly LV of 200 mg NO_2/m³ not to be exceeded more than 18 times a calendar year has also been set.

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

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

Key messages

In 2009 the NO_2 annual LV plus margin of tolerance was exceeded at 41 % of the traffic stations.

The hourly LV of NO_2 is less stringent, and exceedances at about 1 % and 8 % of the (sub)urban and traffic stations, respectively, were observed.

The PM_{10} daily LV was exceeded at 30 % of the traffic sites, at 18 % of the 'other' sites (mostly industrial), at 31 % of the urban background sites, and even at 6 % of the rural sites. The highest concentration measured in EU-27 was almost three times the LV, and in EEA-32 member countries was almost four times the LV.

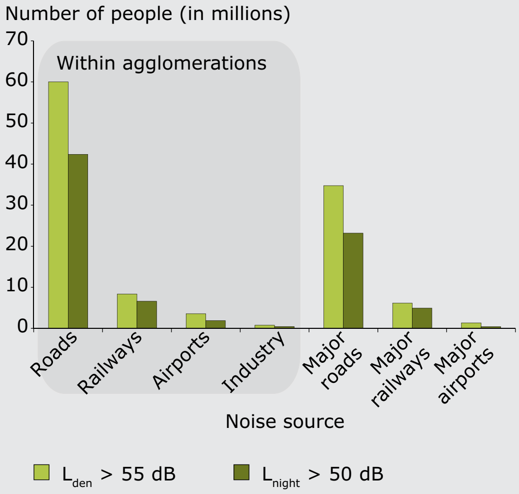
Differences between the actual emissions from vehicles and the type-approval emissions may affect the correlation between emission trends and expected air quality values.

Further information

Environmental baseline and targets (Chapter 2); Using the best technology available (Chapter 6).

Box 2.6 TERM 05: Exposure to and annoyance by traffic noise

Number of people (million) exposed to transport noise. Current baseline year: 2007 (reported up to June 2011) (EU-27, Norway and Switzerland)



Source: EEA, 2011.

Related targets and monitoring

These are to reduce the number of people exposed to and annoyed by traffic noise levels which endanger health and quality of life (EC, 2002), World Health Organization (WHO), Night Noise Guidelines for Europe (WHO, 2009).

Note that the WHO recommends night LVs not higher than 40 dB, but we have presented values higher than 50 dB according to Directive 2002/49/EC on environmental noise requirements (EC, 2002).

Key messages

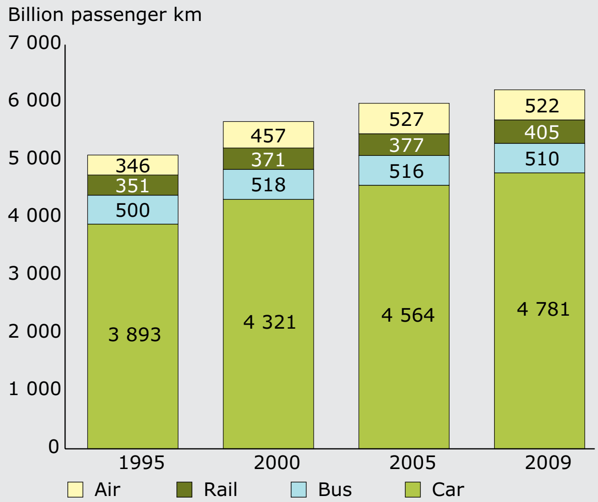
Noise from road transport affects a large number of people: in the largest European cities (with populations exceeding 250 000), nearly 60 million people are exposed to long-term average road traffic noise levels exceeding 55 dB L_{den} (weighted average day, evening, night). At night time, more than 40 million people are exposed to road noise levels higher than 50 dB in the same cities. Outside agglomerations, 35 million people are exposed to noise from major roads during the day, evening and night periods, and 26 million people are exposed at night. This means that almost 100 million people have damaging long-term average daily exposure to noise from road vehicles alone.

Further information

Environmental Baseline (Section 2.3). Data set still not complete as not all agglomerations have been reported.

Box 2.7 TERM 12a/b: Passenger transport volume and modal split within EU

Passenger transport volume (billion pkm) (EU-27)



Source: EC, 2011.

Related targets and monitoring

By 2050 the majority of medium-distance passenger transport should be undertaken by rail (EC, 2011a). Monitored in the TERM 12a/b.

While the TERM 12a/b has traditionally monitored decoupling between transport demand and GDP, there is now a move towards the more comprehensive concept of resource efficiency in transport. The communication *A Roadmap to a Resource Efficient Europe* (EC, 2011e) emphasises that the initiatives in the White Paper on Transport should be 'implemented consistently with resource efficiency objectives, particularly by moving towards internalisation of external costs'.

Key messages

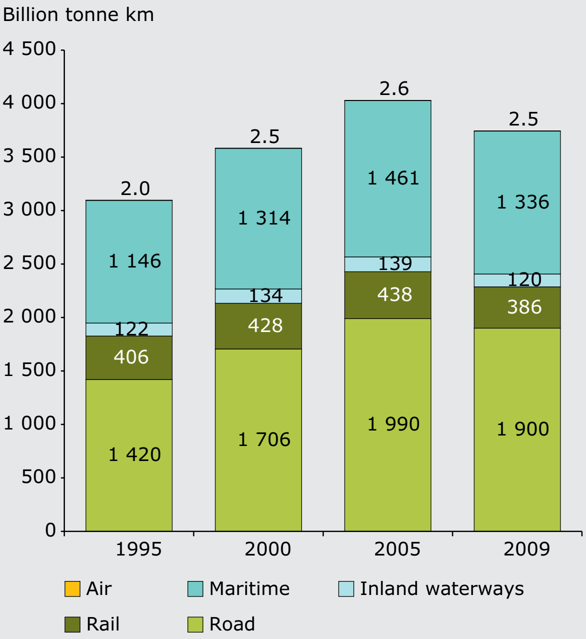
Passenger transport demand has grown steadily since 1995. The largest increases have been in air (51 %) and car (23 %) demand between 1995 and 2009. However, with the economic recession it declined very slightly in 2009 (0.1 %). The car dominates (land) passenger transport with a share of 83 %, followed by bus and coach (8 %) and rail (7 %).

Further information

Passenger and freight transport demand and modal split (Chapter 3); Optimising transport demand (Chapter 4); Obtaining a more sustainable modal split (Chapter 5).

Box 2.8 TERM 13a/b: Freight transport volume and modal split within EU

Freight transport volume (billion tkm) (EU-27)



Note: 'Air' is so small that it is not visible in the figure. The number above each column indicates 'Air freight transport volume'.

Source: EC, 2011.

Related targets and monitoring

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 % by 2050, facilitated by efficient and green freight corridors (EC, 2011a).

While TERM 13a/b has traditionally monitored decoupling between transport demand and GDP, there is now a move towards the more comprehensive concept of resource efficiency in transport. The communication *Roadmap to a Resource Efficient Europe* (EC, 2011e) emphasises that the initiatives in the White Paper on Transport should be 'implemented consistently with resource efficiency objectives, particularly by moving towards internalisation of external costs'.

Key messages

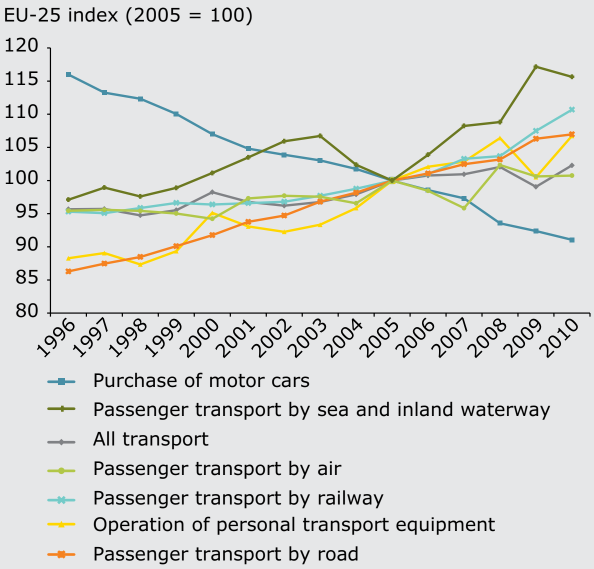
Freight transport volume (in tonne-kilometres (tkm)) has fallen significantly since 2007. This is likely due to the economic slowdown, although rising fuel prices in recent years may also have contributed. In 2009, road transport dominated (land) freight transport mode share at 74 %, followed by rail (16 %) and inland waterways (IWW) (5 %).

Further information

Passenger and freight transport demand and modal split (Chapter 3); Obtaining a more sustainable modal split (Chapter 5).

Box 2.9 TERM 20: Real change in transport prices by mode

Real change in transport prices by mode (EU-27, excluding Romania and Bulgaria)



Source: Eurostat, 2011.

Related targets and monitoring

Monitoring changes in transport prices by mode is considered a relevant variable to assess whether the system is sending the appropriate signals.

Key messages

From the reference point of 2005, the purchase price of motor cars has steadily reduced to that of 2010 in comparison to average consumer prices. Over the same period, the price of operating personal transport has fluctuated, but stayed higher than 2005 prices, as has passenger transport by air.

The price of passenger transport by sea and IWW, railways and roads has increased steadily over the same period.

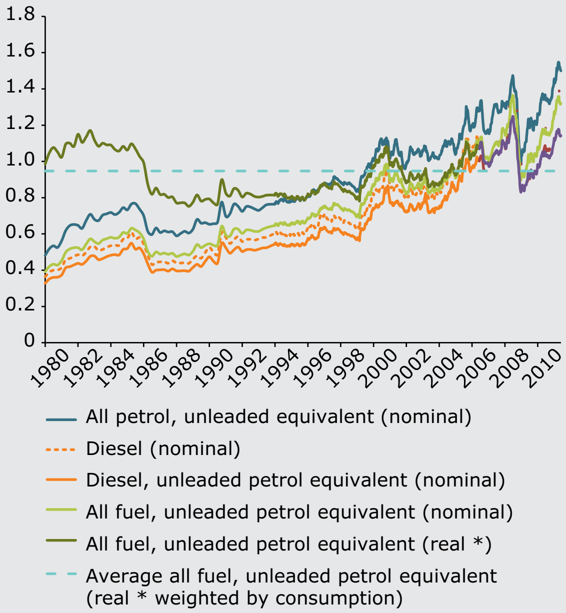
Further information

Optimising transport demand (Chapter 4); Obtaining a more sustainable modal split (Chapter 5).

Box 2.10 TERM 21: Fuel prices and taxes

Nominal and real fuel prices (EU-27) (EUR/litre)

Nominal and real fuel prices in the EU (EUR per litre)



Note: * real prices are indexed to 2005.

Source: DG ENER and Eurostat, 2011.

Related targets and monitoring

Fuel prices, including taxes, are seen as a useful signal of the internalisation of external costs.

Fuel taxation can be used to internalise climate-change–related externalities since fuel consumption is an excellent proxy for GHG emissions produced by transport use. The phase I stage (2011–2016) of the White Paper on Transport (EC, 2011a) therefore indicates that motor fuel taxation should be revised to take account of the energy and CO_2 component.

Key messages

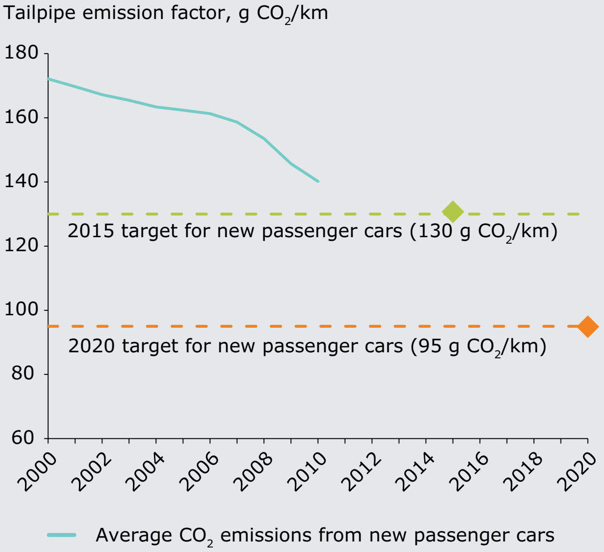
Since 1980, the real price of all road transport fuels (expressed as the equivalent consumption in unleaded petrol, corrected for inflation to 2005 prices) has fluctuated. Real prices per litre peaked in summer 2008 at around EUR 1.25, but then fell by around a third later that year, largely due to a significant drop in the price of crude oil. Since then, in 2009 and early 2010, real prices have recovered to just over EUR 1 per litre. The average real price in June 2011 (2005 level) was EUR 1.14 per litre, just 15 % higher than the price in 1980. There has therefore only been a small change in price signal given to consumers over a period of 30 years. The price of fuel influences the cost of transportation, and it is an important determinant of the efficiency with which fuel is used. While there is evidence that transport demand can be somewhat depressed by increases in fuel costs, it is clear that even at current fuel prices, there is growing demand for transport.

Further information

Optimising transport demand (Chapter 4); Obtaining a more sustainable modal split (Chapter 5).

Box 2.11 TERM 27: Energy efficiency and specific CO_2 emissions

Average emissions for new cars (gCO_2/km) (EU-27)



Source: DG CLIMA and EEA, 2011.

Related targets and monitoring

There is a passenger car target of 130 gCO_2/km as average emissions for the new car fleet by 2015, and a target of 95 gCO_2/km as average emissions for the new car fleet from 2020 onwards (EC, 2009a).

Vans have a target of 175 gCO_2/km by 2017 (phased in from 2014) and of 147 gCO_2/km by 2020 (EC, 2011c). Average emissions of CO_2 for the new car fleet are monitored annually by the EC and already are a key factor of the TERM 27. It will be possible to monitor the average emissions of CO_2 for the new van fleet in the future.

Data on 2010 CO_2 emissions from new passenger cars are provisional. Confirmed data will be published by the European Commission and the EEA at the end of 2011.

Key messages

The CO_2 emissions of new passenger car fleet in the EU-27 have decreased steadily since 2000, reaching 140.2 gCO_2/km in 2010; they appear to be on track to meet the 130 gCO_2/km target early on present development trends.

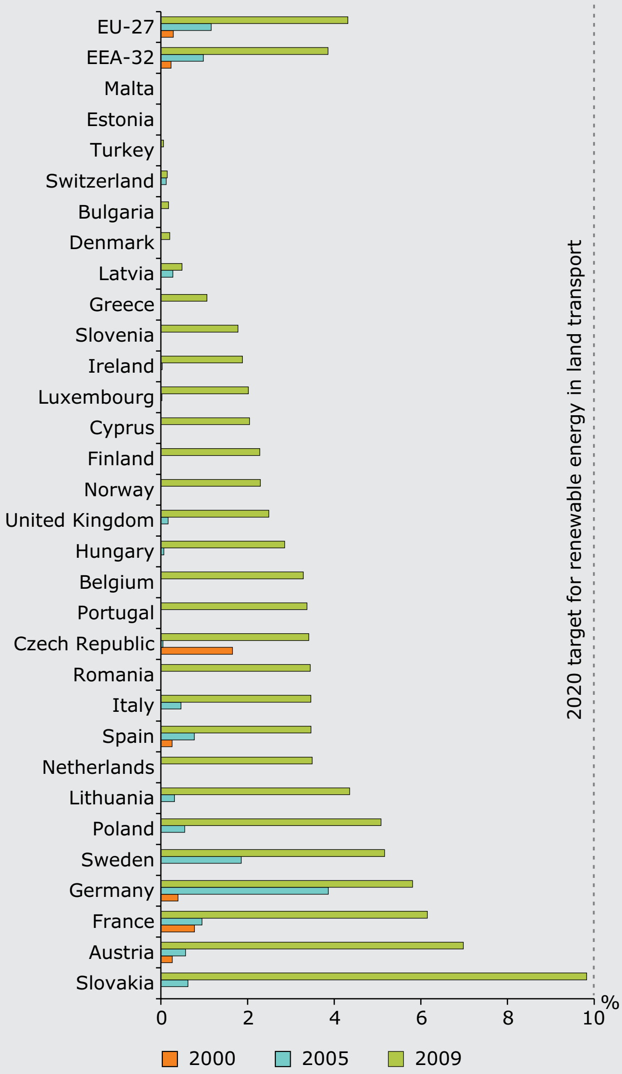
Rising concerns on the real fuel consumption of vehicles, and therefore CO_2 emissions, compared to the official tests (NEDC) have triggered research on quantifying these differences. Chapter 7 presents more information on this issue. In short, while there is a correlation between the type-approval and in-use CO_2 emissions, the magnitude of the reduction gauged from the type-approval conditions does not necessarily lead to an equal reduction of in-use consumption.

Further information

Using the best technology available (Chapter 6), Monitoring CO_2 emissions from new vehicles (Chapter 7).

Box 2.12 TERM 31: Uptake of cleaner and alternative fuels

Share of biofuels in transport fuels



Source: Eurostat, 2011b.

Related targets and monitoring

All EU Member States are to achieve a 10 % share of renewable energy by 2020 for all land transport (EC, 2009b). Bi-annual reporting on progress towards RED targets is required by EU Member States from 31 December 2011. The biofuels share is also monitored annually in the TERM 31.

Low-carbon sustainable fuels in aviation are to reach 40 % by 2050; also, by 2050, EU CO_2 emissions of maritime bunker fuels are to be reduced by 40 % (if feasible, 50 %) from 2005 levels (EC, 2011a). It should be possible to monitor aviation fuel through the EU ETS, and maritime bunker fuels via GHG reporting for bunkers under UNFCCC.

Fuel suppliers to reduce emissions of GHGs by 6–10 % by 2020 (relative to 2010 fossil fuels, FQD) (EC, 2009c). This will be monitored from 2012 and included in the TERM 31.

Key messages

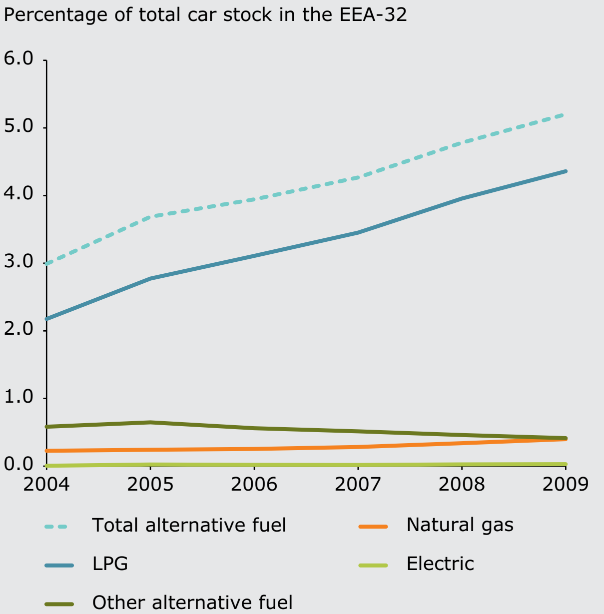
In 2009, the EU-27 had not yet met the target of Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport (EC, 2003) for the share of biofuels in road transport fuels (5.75 %). Reporting on GHGs under the FQD starts in 2012.

Further information

Using the best technology available (Chapter 6).

Box 2.13 TERM 34: Proportion of vehicle stock by alternative fuel type (selected EEA-32 member countries)

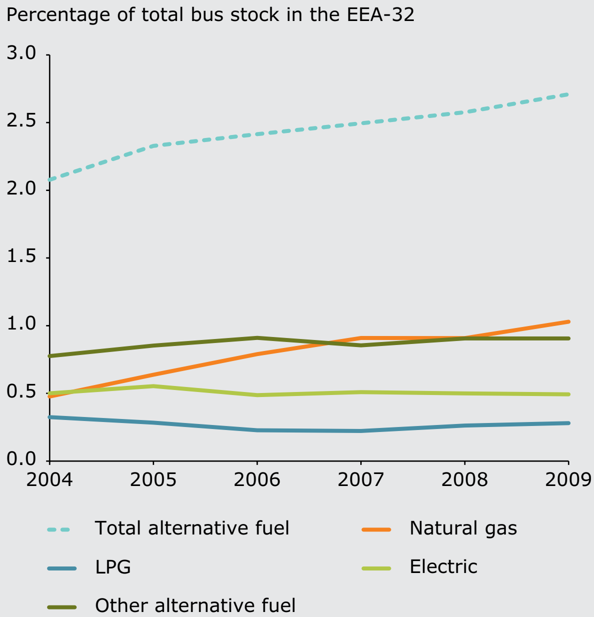
Percentage of car stock by alternative fuel type (AFV) (selected EEA-32 member countries)



Note: Car stock for Belgium, Estonia, France, Italy, Latvia, Luxembourg, Hungary, Netherlands, Austria, Poland, Finland, Sweden, United Kingdom, Liechtenstein, Norway, Switzerland, Turkey.

Source: Eurostat, 2011.

Percentage of total bus stock by alternative fuel type (selected EEA-32 member countries)



Note: Bus stock for Belgium, Bulgaria, Czech Republic, Germany, Estonia, France, Italy, Latvia, Lithuania, Luxembourg, Hungary, Netherlands, Austria, Poland, Slovakia, Finland, Sweden, United Kingdom, Liechtenstein, Norway and Switzerland.

Source: Eurostat, 2011.

Related targets and monitoring

Eurostat defines an alternative fuel as a type of motor energy other than the conventional mineral fuels, petrol and diesel. Alternative fuels include electricity, liquefied petroleum gas (LPG), natural gas (liquefied natural gas (LNG) or compressed natural gas (CNG)), alcohols, mixtures of alcohols with other fuels, hydrogen, biofuels (such as biodiesel), etc.

Alternative fuels do not include unleaded petrol or reformulated petrol. There are no specific targets for the percentage of the vehicle fleets that utilise alternative fuels.

For both conventional and alternatively fuelled vehicles, Euro 6/VI emissions will begin to be introduced for most vehicle types from 2013 for heavy goods vehicles and buses/coaches, from 2014 for passenger cars, and from 2015 for light-duty vehicles.

Key messages

Alternatively fuelled cars have grown steadily in the fleet, comprising just over 5 % of all vehicles in 2009. The majority of these are LPG vehicles. Electric vehicles currently comprise only 0.02 % of the total fleet.

The proportion of natural-gas–fuelled buses in the fleet grew from 0.5 % to 1 % between 2004 and 2009. The proportion of other types of alternatively fuelled buses has not changed significantly in the same period.

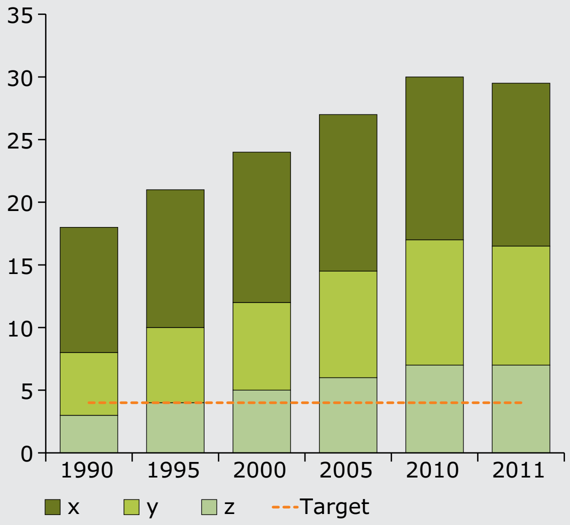
Further information

Using the best technology available (Chapter 6); Monitoring CO_2 emissions from new vehicles (Chapter 7). Note that it will not be possible to monitor the white paper target to phase out conventionally fuelled vehicles in cities.

In future years, we intend to display the information presented in Box 2.14 for each of the TERM CSIs. This will provide a clear and quickly accessible assessment of both the current status and the task necessary in the future to enable targets to be met.

Box 2.14 Future assessment of TERM CSIs

Key graph title: current baseline year/date: 2010



Related targets and monitoring

An overview of current targets and related monitoring will be provided.

Percentage change from baseline/trend

2010 baseline data may become available over the next couple of years. Therefore the percentage change from the previous year will be included, followed by the percentage change from the baseline when it becomes available. The data trend will be clearly indicated.

Distance to target

Where relevant, how much progress needs to be made in order to achieve the target (EU wide).

Further information

Relevant chapters of the TERM Report where further information can be found.

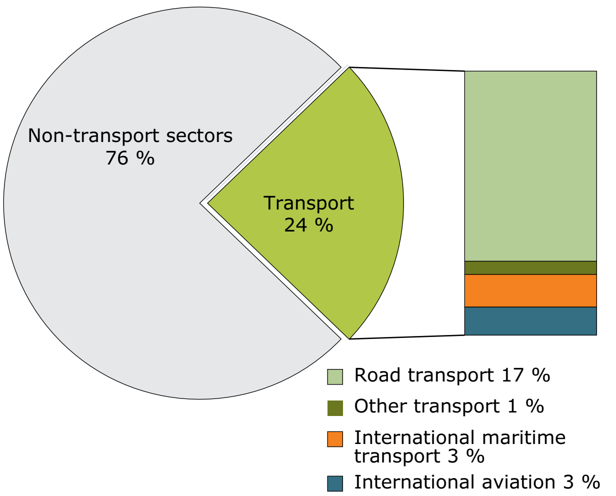
2.3 Baseline

2.3.1 *Climate change mitigation*

The new White Paper on Transport has proposed the quantitative target of reducing GHG emissions from transport by 60 % in 2050, compared to 1990 levels. Present transport GHG emissions as defined in the white paper (EU-27, excluding international maritime, including international aviation) are 27 % above 1990 levels. In 2009, GHG emissions from transport decreased for the second year in a row, mainly due to the effects of the economic recession. Nevertheless a major effort is still needed to achieve the target, and emissions may increase again with the resumption of economic growth.

In no other sector have GHG emissions increased as rapidly between 1990 and 2009 (23 % excluding bunkers and 30 % if included) in the 32 member countries of the EEA. The proposed reduction for the transport sector is less stringent (related to 1990 as the base year) than for other sectors of the economy, although transport emits 24 % of all GHG emissions in the EEA member countries, including bunkers (Figure 2.2). Overall, the EU-27 has the objective to reduce emissions by 80 % to 95 % by 2050, compared to 1990 levels.

Figure 2.2 Transport sector contribution to total GHG emissions, 2009 (EEA-32)



Note: Total GHG emissions are total emissions (sectors 1 to 7, excluding 5, LULUCF) plus bunkers. Other transport includes navigation, civil aviation (domestic aviation) and diesel rail. Electric rail, agricultural and fisheries related transport emissions are not included as transport.

Source: EEA, 2011.

Policy context

The adoption of the new White Paper on Transport and the communication *A Roadmap for moving to a competitive low carbon economy in 2050* (EC, 2011a and EC, 2011b respectively) complement the EU's 20/20/20 climate and energy targets for 2020, agreed by EU leaders in 2007 (EC, 2008b). The climate and energy package is a set of legislation adopted in April 2009 that followed these agreements (EC, 2009d). It already included an overall reduction of GHG emissions by 20 % in 2020 from 1990 levels, an increase in the share of renewables in overall energy consumption to 20 % (10 % of transport fuel from renewable sources by 2020), an energy efficiency improvement of 20 % compared to existing trends, and a legal framework to promote carbon capture and storage.

Resource efficiency is an overarching objective of the EU and a core part of the White Paper on Transport (EC, 2011a). The white paper sets, for the first time ever, a required reduction target for transport-related GHG emissions of 60 % by 2050 compared to their 1990 level. Establishing a precise target sends the clear message to all stakeholders that the reduction of GHG emissions is a priority alongside other aspirations. A significant reduction of GHG emissions in transport can lead to improvements in other areas, such as better air quality and lower noise levels, increased energy security, and lower impacts of the transport sector on biodiversity. In this sense, transport emissions of GHGs, along with energy consumption, can be seen as a proxy for resource efficiency in the transport sector until a more comprehensive indicator is developed.

Transport GHG emissions were defined in the Kyoto agreement as the emissions from the combustion and evaporation of fuel for all transport activity, regardless of the sector, but excluding international aviation and maritime transport (international bunker fuels).

International aviation emissions have recently been included in the ETS, to be made effective in 2012 (EC, 2008c). Aviation will therefore join most of the rail transport, as electrified rail traffic is indirectly included in the ETS through the power-generating sector. In addition, discussions on policy options which include the possible inclusion of shipping in the ETS are currently being held. The present framework for ETS stands until 2020, which means that some sub-sectors of transport face an overall cap with carbon price incentive at EU level, whereas other sub-sectors are subject to action at EU level (EC regulations 443/2009 and 510/2011 on CO_2 emissions for cars and vans respectively are examples), and further action at a national level, as set out in the Effort Sharing Decision (EC, 2009e). This decision requires a 10 % cut in EU GHG emissions from the non-ETS sectors over 2005 levels by 2020. International maritime emissions are not covered by either ETS or the decision, and therefore the white paper set a sub-sector–specific goal of 40 % reduction in international maritime emissions by 2050.

Box 2.15 EU ETS for aviation

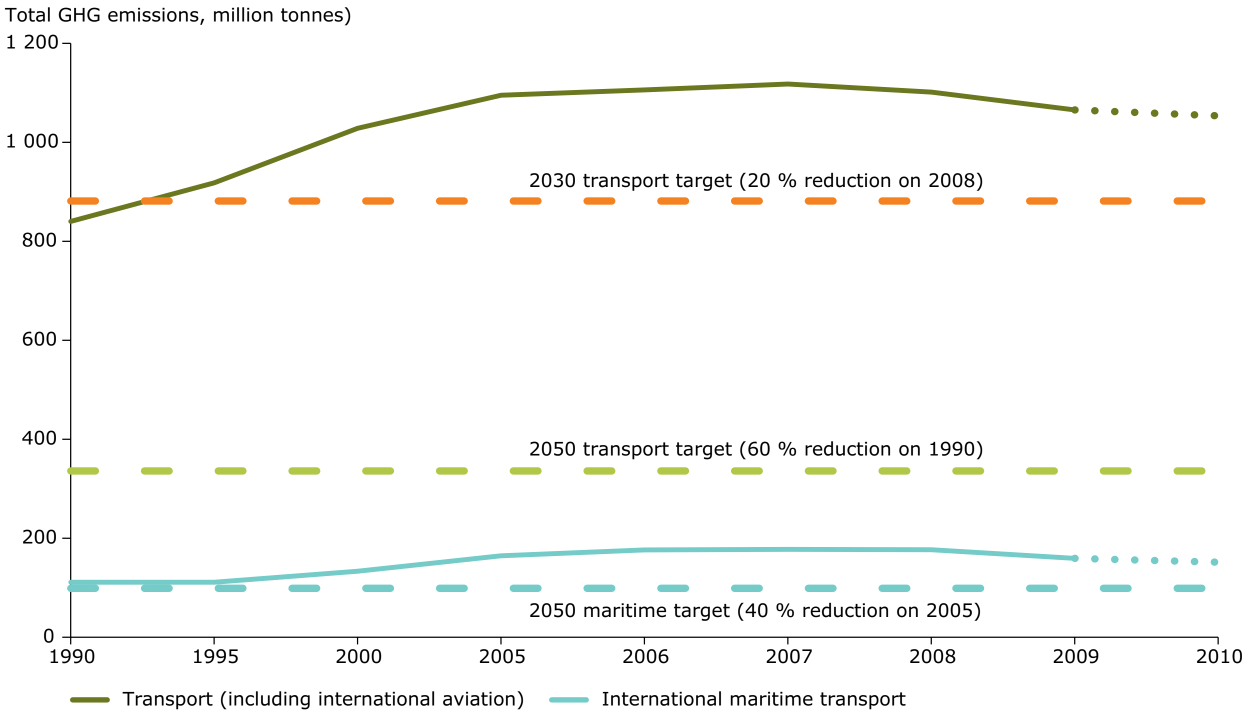
As part of the revision of the EU ETS Directive, aviation will be included in the EU ETS as of 2012. All domestic and international flights that arrive at or depart from an EU airport will be covered. This includes non-European airlines' flights arriving or departing from EU airports. The European Commission has stated that even assuming airlines fully pass on these extra costs to customers, by 2020 the ticket price for a return flight within the EU could rise by between EUR 1.8 and EUR 9. Although airline operators have questioned this assumption, it is believed that inclusion in the EU ETS will not affect demand substantially.

The white paper GHG emissions target for transport is subsequently defined as Kyoto plus international aviation (but excluding international maritime transport). Therefore, any GHG reductions from aviation as a result of its inclusion in the ETS would be incorporated in the broader 60 % reduction in transport. The general reduction target for transport (60 % including international aviation) has not been officially divided into different targets for each transport mode.

Current figures

In 2009, EU-27 transport GHG emissions, as defined in the white paper target, were 27 % above 1990 levels. This is the starting point for the baseline, and its progression will be monitored against the 60 % reduction target. It means that transport emissions will need to be reduced 68 % from 2009 to meet the 2050 target (Figure 2.3) and, according to the mid-term target, emissions should be cut 20 % by 2030 from 2008 levels. The contribution from different modes will most likely differ. For instance, it is estimated by the Commission that CO_2 emissions from aviation might not decrease by 60 % but by only 34 % between 2005 and 2050, as it is expected that the increase in air transport demand will be significant (public debate summarised in

Figure 2.3 Trends and targets: EU-27 GHG emissions



Note: Dotted line segments represent data series extrapolation from 2009 to 2010 using proxy data.

Source: EEA, 2011.

EurActiv, 2011). This means that other transport modes would need to contribute more than international aviation towards the 60 % target, even if the deployment of low-carbon fuels in aviation should reach 40 % by 2050, offering a portion on GHG emission savings. Further contribution to GHG reduction should come from a modal shift from road to rail passenger transport and from road to rail and waterborne freight transport.

Latest data show that road transport remains the main source of GHG emissions from transport in 2009, with a share of 93.5 % of all transport emissions excluding bunkers (the share is 72 %, if bunkers are included) in the EEA member countries. For the second year in a row, GHG emissions from road transport have decreased, mainly due to a decline in freight transport demand related to the economic recession and higher fuel prices. On the other hand, passenger car transport activity has never decreased, not even in 2008 and 2009, although the growth rate has slowed down, and even stagnated in the case of the EU-15. Overall, EEA-32 transport emissions excluding bunkers decreased 2.6 % in 2009, but it is still 22.7 % above 1990 levels.

As well as increasing transport emissions (including international aviation) in the last two decades, the graph (Figure 2.3) indicates the steep increase in international maritime transport GHG emissions. Both of these peak in 2007. As reported in the latest annual EU GHG inventory report (EEA, 2011b), the impacts of the economic recession can partly explain the decline of EEA-32 GHG emissions from international aviation and shipping activities since 2008. Between 2008 and 2009, emissions from these sectors decreased by 6.9 % for aviation and by 10.0 % for international shipping. Nevertheless, international aviation almost doubled GHG emissions (+ 92.2 %) in the period from 1990 to 2009. Today, international aviation represents 3.0 % of overall GHG emissions (all sectors).

Road transport is responsible for 17.5 % of overall GHG emissions. As a result, action is prioritised on reducing road transport emissions. Urban passenger transport can offer a significant portion of reductions, as estimations suggest that emissions of urban passenger transport could be cut by up to 88 % (EC, 2011f, p. 25). This is in line with results from the EEA study on transport scenarios for 2050 (EEA, 2010b) where a panel of users welcomed strict measures aimed to reduce urban transport emissions even if this implied changing their daily mobility habits. However, users expressed reservations on limiting long-distance travel (aviation), mostly linked to leisure and holiday trips.

Further developments

Overall, the EU has been active in setting EU-wide frameworks and legislation that supports reduction of GHG emissions from transport. Key actions at EU level include the already adopted legislation setting CO_2 emission standards for new cars and vans (EC, 2009a and EC, 2011c) — and the anticipated strategy for heavy-duty vehicles. Other legislation complementing these regulations has also been adopted, addressing issues such as gear shift indicators, tyre rolling resistance, car labelling, public procurement and fuel GHG intensity (EC, 2009f, EC, 2009g, EC, 1999a, EC, 2009h and EC, 2009c respectively). Member States, regions and cities could further develop their policies within the current long-term EU target, and even collaborate towards similar or even more stringent targets within their territories. One clear example where local action is essential is in achieving the objective of halving the use of 'conventionally fuelled' cars in urban transport by 2030 and phasing them out in cities by 2050, included in the white paper. The willingness of countries and cities to take actions to achieve this will play a fundamental role.

New technologies are expected to deliver further emission reductions in support of the long-term target. The white paper foresees an intermediate step for achieving the long-term goal, as it expects transport GHG emissions to be reduced by 20 % in 2030 compared to 2008 (equivalent to an increase of 8 % compared to 1990). This implies that reductions need to be higher between 2030 and 2050 than they do in the period before 2030. The underlying assumption is an increased availability of technologies contributing to lower GHG emissions after 2030, such as the electrification of transport and a more intense use of second-generation biofuels, which are believed to be medium- to long-term alternatives, as opposed to demand management.

Compliance with the target is also dependent on behavioural change and performance improvements, as it is unlikely that technological improvement alone will allow for the 60 % reduction by 2050 (EC, 2011f). There is an indisputable need for citizens to be willing to change their daily habits. Whether this behaviour change will result from voluntary actions rather than tighter policies is uncertain, but the former will undoubtedly mean that we are conscious of the changes needed, and have therefore become actively and individually responsible as opposed to laying the blame at the door of representatives.

2.3.2 *Transport energy consumption*

Reduction in oil dependency is an objective of EU policy, not least because it is closely related to decreasing GHG emissions. Targets and measures included in the roadmap for moving to a competitive low-carbon economy in 2050 (EC, 2011b) require an effort from all sectors. Although the new White Paper on Transport (EC, 2011a) has not stated any specific target for reducing oil dependency in the sector, the 60 % GHG emissions reduction target means that transport sector oil dependence should be significantly reduced by 2050, compared with the 96 % level today. In addition, decarbonisation of the energy system is significantly linked with decarbonisation of transport.

Maintaining the transport sectors dependence on oil is unsustainable. Reducing oil demand could reduce dependence on oil imports, which in turn would reduce cash outflow for Member States. At the same time, it has the potential to abate GHG emissions, and would likely improve general air quality levels and potentially reduce other environmental concerns such as noise. The EU has stated (EC, 2011d) that achieving Europe's targeted 60 % CO_2 reduction by 2050 compared to 1990 will require the consumption of oil in the transport sector to drop by around 70 % from today (GHG emissions will need to drop by approximately 68 % from 2009 values).

Greater efficiency achieved mainly through setting long-term efficiency targets for vehicles is expected to play a major role. As stated in the impact assessment accompanying the White Paper on Transport (EC, 2011d), the future decarbonisation of transport relies on technology development towards clean and energy-efficient vehicles based on conventional internal combustion engines (ICEs) and the deployment of breakthrough technologies in ultra-low–carbon vehicles. Beyond greater efficiency gains in the use of conventional fuels, electricity, advanced biofuels (second-generation and future biofuel developments) and potentially hydrogen are seen as the main alternatives as energy carriers and GHG cuts contributors. All alternative fuels have significant barriers to overcome. Therefore, determined and consistent transport and energy policies across Europe are needed. The recently released communication *A Roadmap for moving to a competitive low carbon economy in 2050* (EC, 2011b) and the White Paper on Transport (EC, 2011a) have suggested the way forward for a substantial change by, for example, targeting almost 100 % GHG reduction to the power sector, or aiming to limit the use of conventional cars in cities. These policy documents will be complemented by the energy roadmap which is expected at the end of 2011. Subsequent regulatory developments, such as the proposed revision of the Energy Taxation Directive, (EC, 2011g), would provide a common fiscal framework that could potentially make alternative fuel more cost attractive and increase consumer acceptance.

Transport is not only the most energy-consuming sector, accounting for almost one-third of final energy consumption in the EEA-30 (32.5 % share in 2009 for the EEA-32, excluding Iceland and Liechtenstein, and including international aviation but not international maritime), but it is also, in terms of energy consumption trends, the fastest growing sector (only reversing the trend from 2008 when the economic recession started). The growth rate is even higher in the EU-12 Member States, as the transport share in their energy consumption was much lower in the 1990s, but it is steadily reaching EU-15 levels (28 % in 2009). The reasons behind this growth have been well documented and detailed in previous TERM reports. Simply put, the gains in energy efficiency have been counteracted by the increasing demand for transport. Furthermore, no low-carbon alternative to oil has yet been deployed to the extent needed to drive a substantial change in the carbon intensity of fuels. Finally, a modal change towards more efficient modes has not occurred. Total final consumption of energy peaked in 2006 and decreased in the last years mainly due to the economic recession. In the case of transport, this peak occurred in 2007 (Figure 2.4). However, transport consumption during the last years has declined less than in other sectors, and therefore its share has continued to increase; it reached 33 % in 2009 for the EU-27 (including international aviation but not international maritime).

Looking to the share and evolution by transport modes (Table 2.4), the amount of energy consumed in long-distance transport (especially aviation) has grown the most since 1990 in the EEA member countries. However, it is interesting to point out that air transport energy consumption has increased much more in EU-15 Member States than in the EU-12. On the other hand, EU-12 Member States spend much less energy on inland navigation compared to 1990 levels, but a lot more on long-distance shipping (maritime bunkers). It is also noteworthy that road transport energy consumption has soared in the EU-12 while rail consumption keeps decreasing.

Nevertheless, energy consumption alone does not offer a complete picture; it should be correlated

Table 2.4 Distribution and change of transport energy consumption between modes

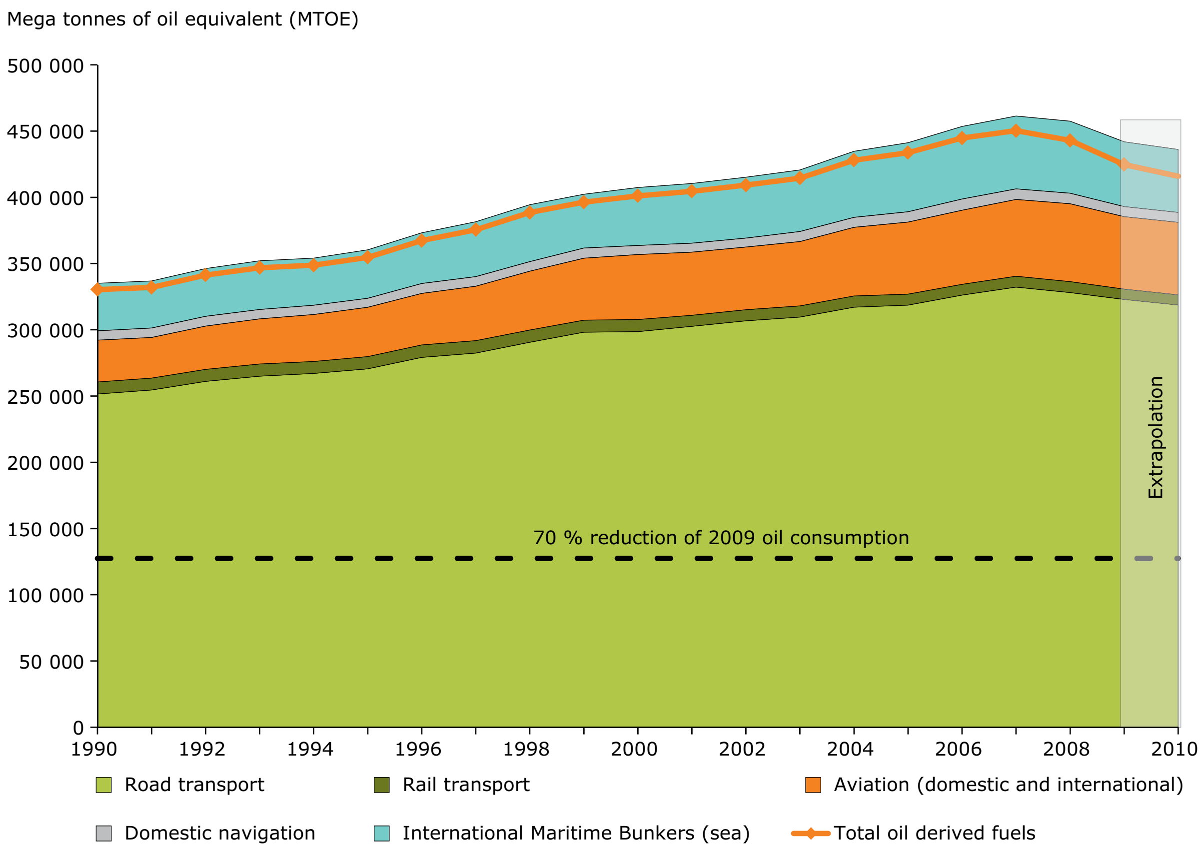
	Distribution between modes			Change 1990–2009		
	EEA-30	**EU-15**	**EU-12**	**EEA-30**	**EU-15**	**EU-12**
Road	73.1 %	71.0 %	87.3 %	28.4 %	22.0 %	79.8 %
Rail	1.7 %	1.7 %	2.6 %	– 14.1 %	– 3.9 %	– 44.6 %
Intra-EU aviation	12.4 %	13.2 %	4.6 %	73.2 %	74.3 %	23.1 %
Inland navigation	1.7 %	1.7 %	0.2 %	7.7 %	9.1 %	– 84.8 %
Bunkers	11.1 %	12.5 %	5.3 %	36.4 %	34.3 %	93.0 %
Total transport	**100 %**	**100 %**	**100 %**	**31.8 %**	**27.7 %**	**64.2 %**

Note: EEA-30 is EEA-32 without Iceland and Liechtenstein. Bunkers include international aviation and international marine bunkers.

Source: Eurostat, 2011.

with transport demand. Perhaps it more useful to consider the evolution of use of different modes of transport than the raw numbers on energy use in transport. For example, an increase in the energy consumption of the rail sector could be a positive indicator because of the lower average intensity of rail. A noteworthy decrease in total energy consumption in the transport sector could be achieved by shifting towards the most efficient transport modes, such as inland navigation and rail. But this is precisely the opposite of what we have seen on the ground since 1990.

Figure 2.4 Mega Tonnes of Oil Equivalent (MTOE) used by transport mode (EEA-30)



Note: EEA-30 is EEA-32 without Liechtenstein and Iceland. International maritime bunkers cover the quantities delivered to seagoing vessels of all flags from European area countries. This term includes all dutiable petroleum products loaded aboard a vessel for consumption by that vessel. Vessels engaged in inland and coastal water transport are not included.

Source: Eurostat, 2011.

As a result, transport is currently 96 % dependent on oil for its energy needs. However, as the *Future Transport Fuels* report (EEG-FTF, 2011) states, the degree of dependence between modes should be understood. In the case of aviation, more than 99.9 % of fuel is petroleum based, with high technical requirements, whereas road and marine transport do not face that major technical limitations regarding the type of fuel.

Aviation consumes just 12.5 % of energy for transport in the EEA-32 in 2009. Therefore it can only contribute to a part of the 70 % reduction target. The potential use of advanced biofuels (mainly second-generation synthetic biomass-derived fuel) in aviation coupled with efficiency improvements could secure this contribution.

2.3.3 *Transport emissions and their effect on air quality*

Significant progress has been made since 1990 in reducing the emissions of many air pollutants from the transport sector. Nevertheless, many cities and other urban areas are facing challenges in meeting concentration limits set in EU legislation for air quality pollutants — road transport in particular makes a large contribution to urban air quality. The European Commission has recently announced a comprehensive review of the EU's 'Air' legislation, to be undertaken by 2013 at the latest. Various short-term actions are also planned, including a revision of the sulphur content of marine fuels as already proposed in COM(2011) 439 final (EC, 2011h), and a prioritisation of various EU actions including addressing 'real-world' emissions.

Knowledge of the levels of air pollutants (and GHGs) emitted by different sources and activities is crucial to understanding and limiting the harm such emissions may cause to human health and the environment. Today, airborne PM ($PM_{2.5}$ and PM_{10}), and tropospheric (ground-level) O_3 are Europe's most problematic pollutants in terms of their potential to cause harm to human health. Further, some of the individual pollutants that contribute to the formation of PM and O_3 (e.g. NO_X) also contribute to harming Europe's environment, via acidification and eutrophication. The transport sector, while just one of the economic sectors from which emissions occur, contributes significantly to the emissions of the various pollutants that contribute to these different issues.

Figure 2.5 shows the contribution made in 2009 by the various transport modes to emissions of the main air pollutants. Transport is responsible for more than half of NO_X emissions, and contributes significantly (around 20 % or more) to the total emissions of the other pollutants. Road transport in particular makes a significant contribution to emissions of all the main air pollutants (with the exception of SO_X). Heavy-duty vehicles are the single most important individual source of NO_X, while passenger cars are among the top sources of CO, NO_X, $PM_{2.5}$ and NMVOCs. While emissions from road transport are mostly exhaust emissions arising from fuel combustion, non-exhaust releases contribute to both NMVOCs (from fuel evaporation) and primary PM (from tyre- and brake-wear, and road abrasion). While emissions of primary $PM_{2.5}$ from road transport have declined since 1990 (by 43 %) the relative importance of the non-exhaust emissions has increased, as the introduction of vehicle particulate abatement technologies has reduced exhaust emissions. In 2009, the non-exhaust emissions of $PM_{2.5}$ constituted 25 % of the emissions from the road transport sectors, compared to just 10 % in 1990 (for PM_{10} the contribution has increased from 20 % in 1990 to just below 40 % in 2009). The emissions of non-exhaust PM are not yet regulated.

The relative changes in emissions of pollutants from the transport sectors are shown in Figure 2.6. Emissions from all transport sectors have declined since 1990 despite the general increase in activity within the sector since this time. Across the EEA-32, transport emissions were reduced between 1990 and 2009 for NO_X by 25 %, $PM_{2.5}$ by 27 %, SO_X by 37 %, CO by 75 % and NMVOCs by 77 %.

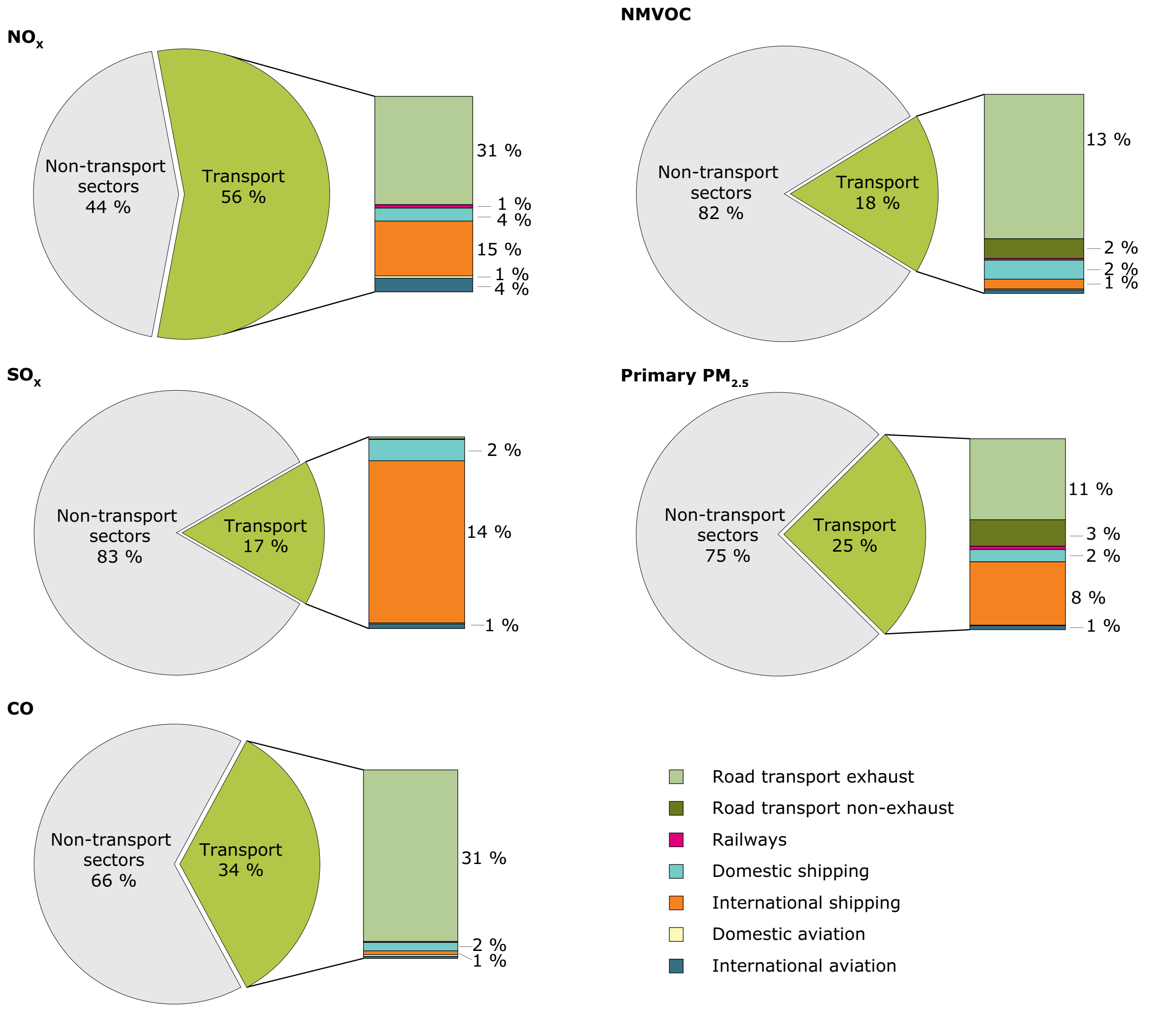
In the case of NH_3, emissions from road transport have risen from 1990 levels, reaching the maximum

Box 2.16 Real-world emissions

The actual emissions from vehicles (often termed 'real-world emissions') often exceed the test-cycle emissions as specified in the Euro emission standards for each vehicle type. This is particularly the case for NO_X emissions from diesel vehicles, both light-duty and heavy-duty vehicles. The emission factors used in the estimation of emissions inventories by EU Member States have been updated regularly according to new research findings and the earlier reported emissions are also to be updated by the Member States. Thus, the reported developments in the emissions presented in the TERM should include the 'real-world driving' emission factors as much as is feasible.

Chapter 7 deals with CO_2 differences, presenting the latest evidences between real-world and test-cycle driving.

Figure 2.5 The contribution of the transport sector to total emissions of the main air pollutants in 2009 (EEA-32)



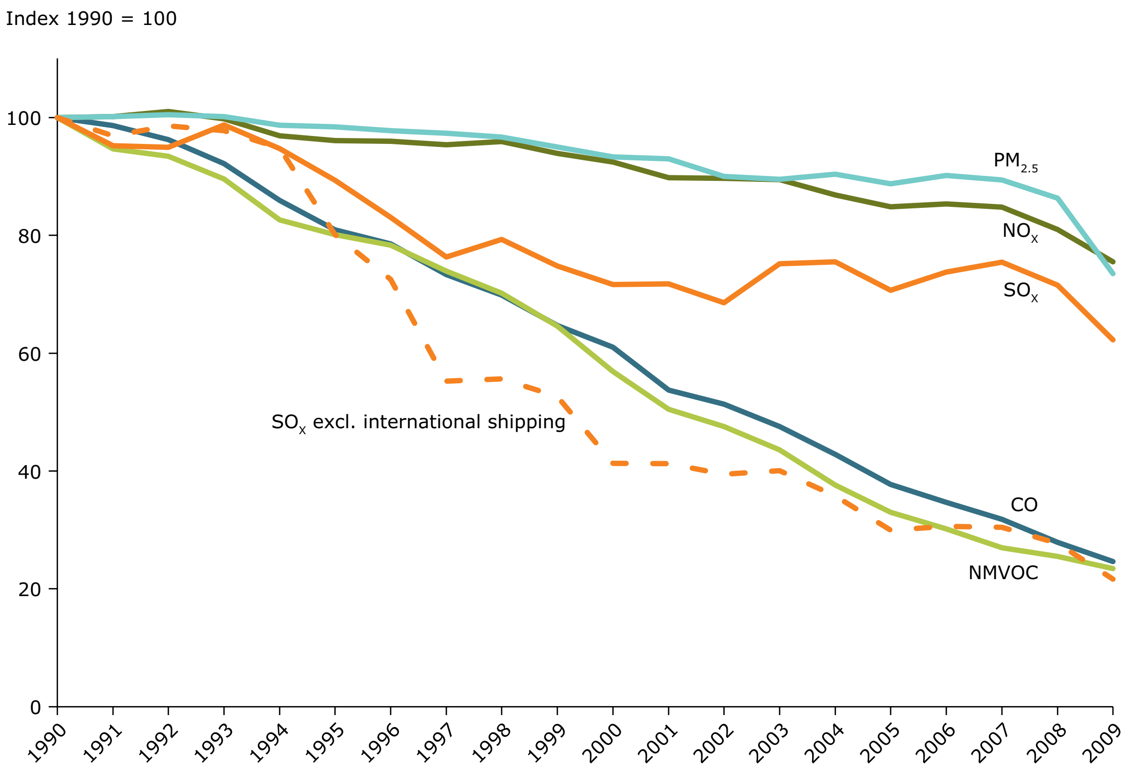
Note: Labels are not shown for those transport sub-sectors contributing <1 % to total emissions. The contribution made to total emissions by each of the various non-transport sectors can be found in the impact assessment accompanying the white paper (EEA, 2011d).

Source: EEA, 2011.

in 2000, as a result of the increasing use of three-way catalytic converters in the vehicle fleet (this is due to an unwanted reaction involving hydrogen which reduces nitrogen monoxide (NO) to NH_3), and the use of selective catalytic reduction of NO_X in heavy-duty vehicles with reagent (urea). However emissions have fallen since 2000, and are projected to fall in the future, as the second generation of catalysts (which emit lower levels of NH_3 than first-generation catalysts) penetrate the vehicle fleet. Overall, NH_3 emissions from transport are over 1990 levels, but are relatively small (less than 2 % of all sectors' NH_3 emissions), and therefore have not been included in Figure 2.6.

The scale of policy actions undertaken in Europe to specifically address issues concerning air pollution has increased over the past years. Local and regional air quality management plans including initiatives such as low-emission zones in cities or congestion charges are now undertaken in areas of high air pollution from transport. The different legal mechanisms for air quality management related to traffic comprise limit or target values

Figure 2.6 Change in emissions of main air pollutants 1990–2009 (EEA-32)



Note: SO_x (upper line) excludes emissions from international shipping for Spain due to a time-series consistency issue in the reported data. Spain will recalculate emissions from this source in their next inventory submission.

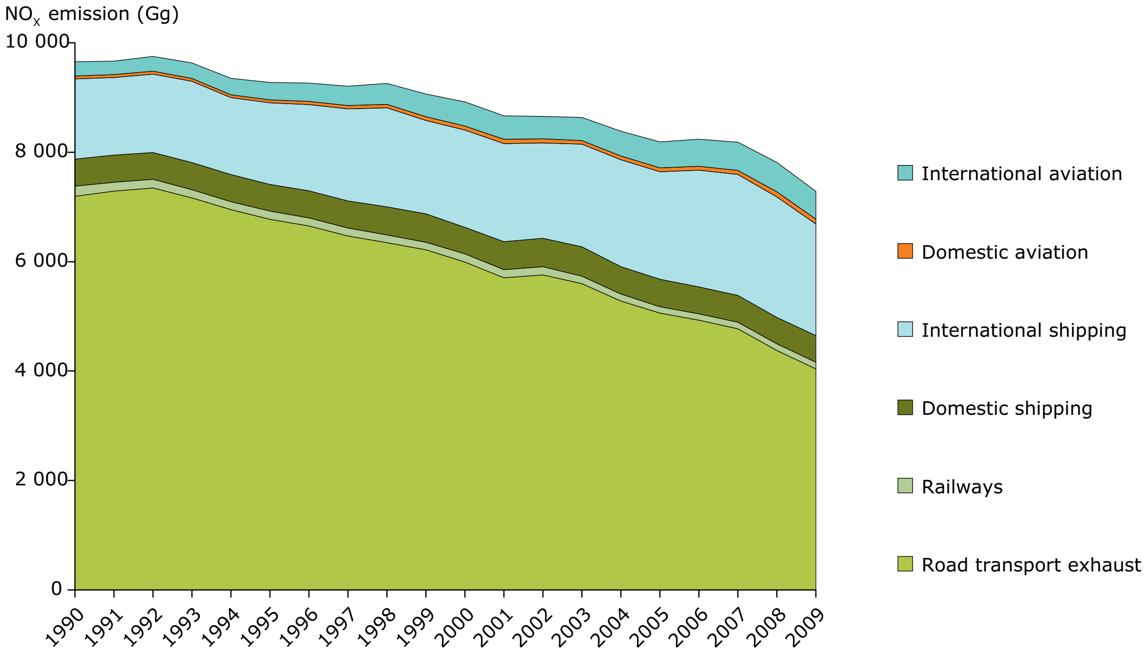
Source: EEA, 2011.

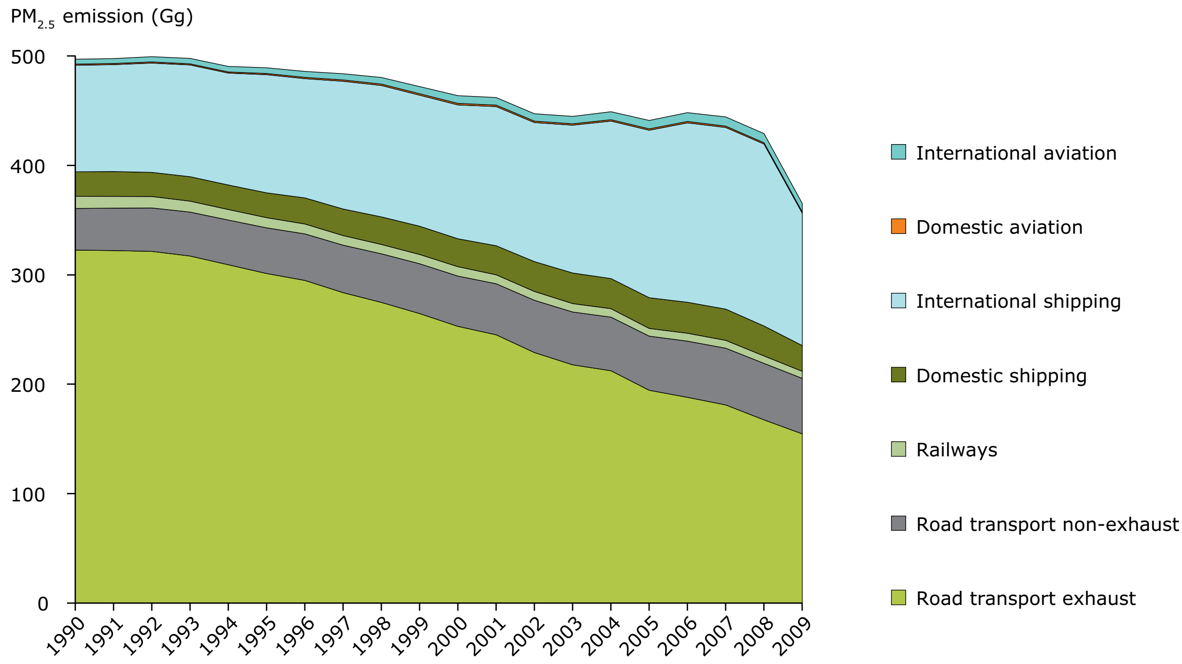
for ambient concentrations of pollutants; limits on total emissions (e.g. national totals); and regulating emissions from the traffic sector either by setting emissions standards (like EURO 1–6) or by setting requirements of fuel quality.

Reductions achieved in the road transport sector are responsible for the vast majority of the overall reductions shown in Figure 2.6 for each pollutant. In contrast, international aviation and shipping (excepting SO_x for the latter) are the only transport sub-sectors where emissions of each pollutant have actually increased since 1990. For example, NO_x emissions from international aviation have almost doubled since 1990, while NO_x and NMVOCs from international shipping have both increased by around 40 %, and $PM_{2.5}$ by 25 % (Figure 2.7). As emissions of pollutants such as NO_x and SO_x from land-based sources decreases, there is a growing awareness of the increasingly important contribution made to Europe's air quality by the national and international shipping sectors which now are responsible for 19 % and 16 % of NO_x and SO_x emissions, respectively.

Within the road transport sector, the introduction of reduced sulphur in fuels and catalytic converters on vehicles (the latter a process driven by introduction of the successive Euro standards that regulate exhaust emissions of CO, NO_x, NMVOC and primary PM) have contributed substantially to the reductions observed, offsetting the pressure from increased road traffic in the same period. Emissions of primary $PM_{2.5}$ and PM_{10} are also still expected to further decrease as vehicle efficiencies and abatement technologies are improved (see Box 2.18 for further details on $PM_{2.5}$ and PM_{10} differences and impacts). In addition, while abatement of air pollutants has reduced emissions from the road transport sector, it is clear that the underlying growth of transport demand has limited the potential reduction of air pollutants due to technical abatement measures, and in addition has led to increases in GHG emissions (see Section 2.3.1).

Figure 2.7 Change in emissions by transport sub-sector for NO_x (top) and $PM_{2.5}$ (bottom) (EEA-32)





Source: EEA, 2011.

Figure 2.8 shows how NO_2 and PM_{10} concentrations measured in ambient air have changed over the last decade in selected European cities. Time series of annual mean concentrations are shown for one urban background (non-traffic) station and one traffic-related (roadside) monitoring station for each city. The cities were selected on the basis of having a consistent pair of monitoring stations (both urban background and traffic stations) over the years (NO_2 since 1999, PM_{10} since 2002). This is

Box 2.17 Increasing proportion of NO_x emitted as NO_2

An important change has occurred in the direct NO_2 emissions from road traffic since early 2000s. The proportion of NO_x emitted directly as NO_2 from vehicles (the primary NO_2 fraction, f-NO_2) has been growing as a result of an increased market penetration of diesel cars in some countries and the fitting of pollution control devices such as particulate traps and oxidation catalysts for diesel Euro 3 (EEA, 2010c).

A typical f-NO_2 for petrol vehicles is less than 5 %. The historically typical f-NO_2 for conventional diesel vehicles was between 10 % and 12 %, while values are in the range of 20 % to 70 % for newer diesel vehicles. The f-NO_2 varies regionally and is dependent on the local vehicle fleet and traffic conditions.

This increase in direct NO_2 emissions from the traffic sector has an effect on concentration by partly or completely offsetting the effect of the NO_x emission reductions. This can lead to sustained NO_2 concentration levels, and sometimes, increasing NO_2 concentrations, especially in traffic exposed urban areas.

Vehicle emission regulation deals with NO_x because vehicles emit both NO and NO_2. NO quickly reacts with oxygen from the atmosphere and creates NO_2. Therefore air quality regulation only deals with NO_2.

Source: EEA, 2011c.

intended to show concentration trends without any effects due to changes in the number or geographical distribution of monitoring sites.

The annual mean NO_2 and PM_{10} concentrations (Figure 2.8) at urban background sites show a decrease at most locations. In the proximity of the source (i.e. road traffic), the annual mean concentrations at traffic sites are generally higher than at urban background sites and show a less consistent downward trend. Beevers et al. (2009) reported that the ambient concentrations of NO_2 at traffic-influenced monitoring sites had increased at particular locations. Moreover, in the London area, the urban background concentrations of NO_2 and PM_{10} had decreased much less than would be predicted on the basis of emission reductions. A detailed analysis of traffic data suggested that flows of diesel vehicles had increased in such locations. Diesel vehicles are known to be significant emitters of both NO_2 and PM_{10}.

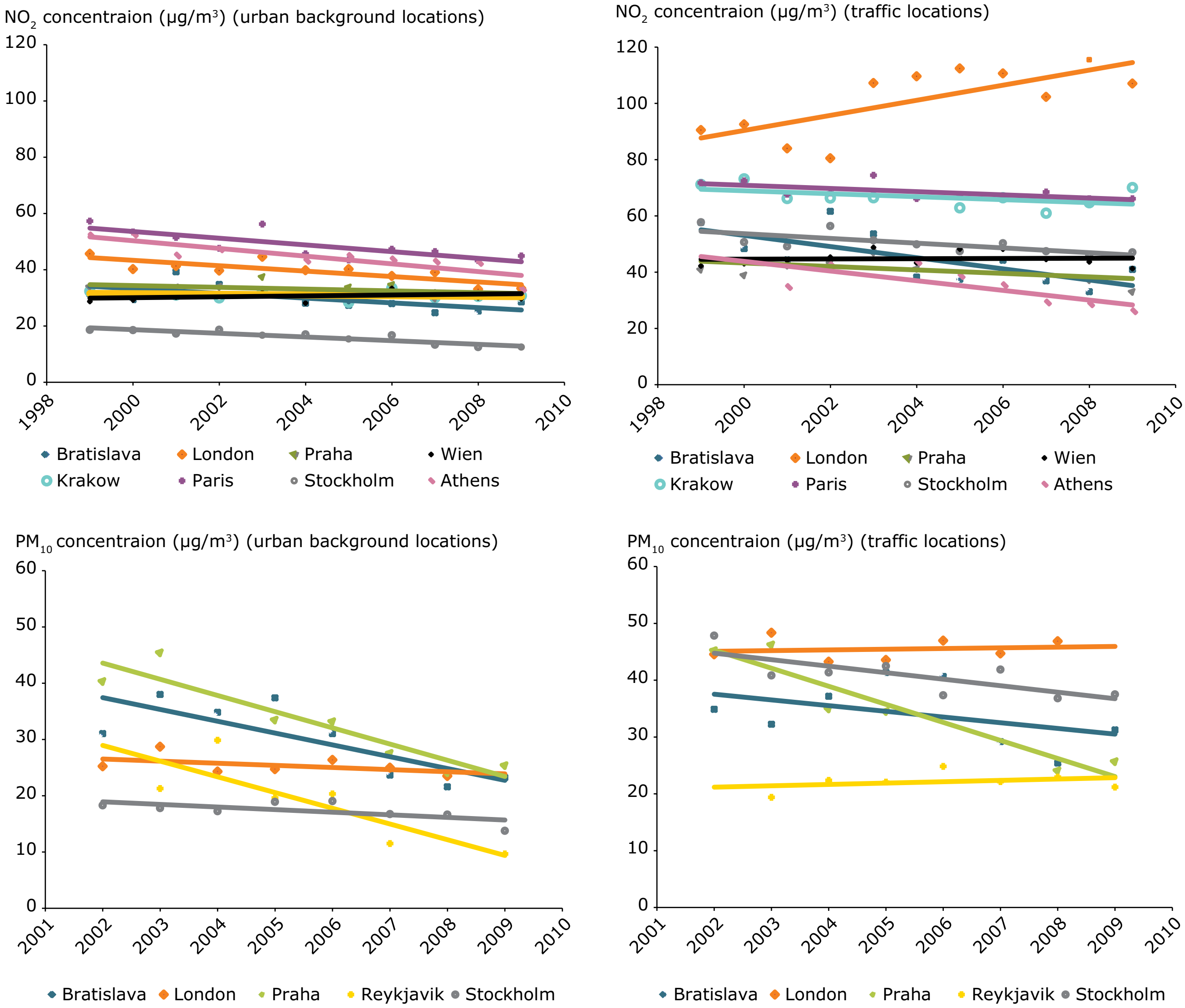
The 'European Annual Air Quality Report' (EEA, 2011c) for 2009 concluded that most EU Member States had difficulties in complying with EU LVs for PM_{10}, for which the attainment year was 2005. In 2009, the PM_{10} 24-hour LV was exceeded at 30 % of traffic sites, 31 % of urban background sites, 18 % of 'other' sites (mostly industrial) and 6 % of rural sites in the EU-27. The highest concentration measured in the EU-27 was almost three times the LV, and in EEA-32 almost four times the LV. For the majority of the monitoring stations in the EU-27 (83 %), a small negative trend of less than 1 $\mu g/m^3$ per year was nevertheless apparent for PM_{10}. The negative trend was estimated to be statistically significant at only 42 % of these stations (EEA, 2011c).

Europe wide, NO_2 ambient concentrations generally declined in the last decade, as NO_X emissions decreased by 27 % in the EEA-32 between 1999 and 2009. However, in 2009, as in previous years, nearly all European countries recorded exceedances of the annual NO_2 LV at one or more stations, with the highest concentrations and number of exceedances recorded by traffic stations. Exceedance of the annual LV was reported at 47 % of traffic stations, with a maximum observed concentration of 2.8 times the LV (EEA, 2011c). The increasing number of diesel cars has increased the fraction of direct NO_2 emissions in NO_X, partly counteracting the effects of generally reduced NO_X emissions from road transport. Guerreiro et al. (2010) provide a thorough discussion of NO_2 encountered at traffic hot spots in Europe.

There is a disparity between the general emission reductions and the limited changes in concentrations (EEA, 2011c). This has important implications for the management of air pollution: implementing and coordinating it across local, regional, national and European levels becomes complex.

These findings demonstrate that PM_{10} and NO_2 concentrations must be reduced substantially in larger areas of Europe, including the areas influenced by traffic, for the LVs to be met. In urban areas, the exceedances of the LVs for PM_{10} and NO_2 imply exposure to concentrations levels which are expected to have adverse effects on human health. Populations in urban areas are potentially more exposed to exceedances, since people move freely within the city, including areas with busy traffic.

Figure 2.8 NO_2 (top) and PM_{10} (bottom) concentration trends at urban background (left) and traffic (right) locations



Note: Top: NO_2 concentration in selected cities from 2002 to 2009. Bottom: PM_{10} concentrations in selected cities from 1999 to 2009. Values are presented for single monitoring stations that provide reliable time series data for the last years. Selected cities have at least one background and one traffic station that provide such reliability and can therefore be compared for analysis. Therefore, this figure does not represent air quality results citywide, but rather serves as a snapshot of the different trends in background and traffic stations wherever comparable long-term time-series data are available. Because the different lines represent individual measurement points, there can be a significant effect from local changes in traffic flows. According to sources, this is part of the background for the large change in the NO_2 levels in London.

Source: EEA, 2011.

Box 2.18 Major pollutants for which transport emissions are important

Particulate matter (PM)

PM is the general term used for a mixture of suspended particles in air, with a wide range in size and chemical composition. $PM_{2.5}$ refers to 'fine particles' that have a diameter of 2.5 micrometres or less. PM_{10} refers to the particles with a diameter of 10 micrometres or less; it includes the 'coarse particles' fraction in addition to the $PM_{2.5}$ fraction.

PM is either directly emitted as primary particles or is formed in the atmosphere from oxidation and transformation of primary gaseous emissions, as secondary particles. The most important precursors for secondary particles are SO_2, NO_x, NH_3 and volatile organic compounds (VOCs). PM is either of natural origin (e.g. sea salt, naturally suspended dust, pollen, volcanic ash) or from anthropogenic sources, mainly from fuel combustion in vehicles, thermal power generation, incineration, and domestic heating, for example. In cities, vehicle exhausts, road dust re-suspension, and burning of wood, fuel or coal for domestic heating are important local sources.

PM can cause or aggravate cardiovascular and lung diseases, heart attacks and arrhythmias. It can affect the central nervous system and the reproductive system, and can cause cancer. The outcome can be premature death. Animals are affected in the same way as humans. PM also affects plant growth and ecosystem processes. Its effect on climate varies depending on particle size and composition: some particles are reflective and lead to net cooling, while others absorb solar radiation, leading to warming. Deposition of particles can lead to changes in surface albedo which in turn influences climate.

Ozone (O_3)

Ground-level (tropospheric) O_3 is not directly emitted into the atmosphere but formed from a chain of chemical mechanisms following emissions of precursor gases: NO_x, CO and VOCs. NO_x are emitted during fuel combustion, for example by industrial facilities and road transport. NO_x plays a complex role in O_3 chemistry: close to its source NO_x will actually deplete O_3 due to the scavenging reaction between the freshly emitted NO and O_3. VOCs are emitted from a large number of sources including road transport, refineries, paint, dry-cleaning and other solvent uses. Biogenic VOCs are emitted by vegetation, with amounts dependent on temperature. Methane (CH_4), a VOC and an important O_3 precursor, is released from coal mining, natural gas extraction and distribution, landfills, wastewater, ruminants, rice cultivation and biomass burning. Fire plumes from wild forest and other biomass fires as well as traffic emissions contain CO and can contribute to O_3 formation. There is a global background concentration of O_3 in air, partly resulting from the downward transport of stratospheric O_3 to the troposphere and partly from photochemical O_3 formation globally.

O_3 irritates eyes, nose, throat and lungs. It can destroy throat and lung tissues, leading to decrease in lung function; respiratory symptoms, such as coughing and shortness of breath; aggravated asthma and other lung diseases. O_3 can lead to premature mortality. Vegetation is damaged by O_3 injuring leaves, reducing photosynthesis, impairing plant reproduction and growth, and decreasing crop yields. O_3 damage to plants can alter ecosystem structure, reduce biodiversity and decrease plant uptake of CO_2. O_3 is also a GHG contributing to warming of the atmosphere.

Nitrogen dioxide (NO_2)

NO_2 is a reactive gas that is mainly formed by oxidation of NO. High temperature combustion processes (e.g. those occurring in car engines and power plants) are the major sources of NO_x, the term used to describe the sum of NO and NO_2. NO makes up the majority of NO_x emissions. A small part is directly emitted as NO_2, typically between 5 % and 10 % for most combustion sources, with the exception of diesel vehicles. There are clear indications that for traffic emissions, the direct NO_2 fraction is increasing significantly due to increased penetration of diesel vehicles, especially newer diesel vehicles (Euro 4 and 5), which can emit up to 70 % of their NO_x as NO_2.

NO_2 can affect the liver, lung, spleen and blood. It can aggravate lung diseases leading to respiratory symptoms and increased susceptibility to respiratory infection. NO_2 is oxidised further to nitrates and contributes to the acidification and eutrophication of soil and water, leading to changes in species diversity. NO_2 enhances sensitivity to secondary stress on vegetation and also acts as a precursor of O_3 and PM, with associated environmental and climate effects.

Carbon monoxide (CO)

CO is a gas formed during incomplete combustion of fossil fuels and biofuels. Road transport used to emit significant amounts of CO, but the introduction of catalytic converters reduced these emissions significantly. CO concentrations tend to vary with traffic patterns during the day. The highest CO levels are found in urban areas, typically during rush hours at traffic locations.

Carbon monoxide can lead to heart disease and damage to the nervous system (e.g. personality and memory changes, mental confusion and loss of vision). It can cause headache, dizziness and fatigue. Carbon monoxide affects animals in the same way as humans, although concentrations capable of causing these effects are unlikely to occur in the natural environment, except in extreme events such as forest fires. CO contributes to the formation of GHGs such as CO_2 and O_3.

Box 2.18 Major pollutants for which transport emissions are important (cont.)

Non-methane volatile organic compounds (NMVOCs)

NMVOCs, important O_3 precursors, are emitted from a large number of sources including paint application, road transport, dry-cleaning and other solvent uses. Certain NMVOC species, such as C_6H_6 (benzene) and 1,3-butadiene, are directly hazardous to human health. Biogenic NMVOCs are emitted by vegetation, with amounts dependent on the species and on temperature.

For C_6H_6, incomplete combustion of fuels is the largest source. C_6H_6 is an additive to petrol and 80 % to 85 % of C_6H_6 emissions are due to vehicular traffic in Europe. Other sources are domestic heating, oil refining, and petrol handling, distribution and storage. Wood combustion can be an important local source of C_6H_6 in areas where wood burning can account for a large part of domestic energy needs.

C_6H_6 is a human carcinogen that can cause leukaemia and birth defects. It can affect the central nervous system and normal blood production, and can harm the immune system. C_6H_6 has an acute toxic effect on aquatic life. It bioaccumulates, especially in invertebrates, and can damage leaves of agricultural crops and cause death in plants. C_6H_6 is also a GHG contributing to the warming of the atmosphere. Moreover, it contributes to the formation of secondary organic aerosols, which can act as climate forcers.

Polycyclic aromatic hydrocarbons (PAHs)/Benzo(a)pyrene (BaP)

PAHs are a large group of persistent organic pollutants (POPs). BaP is an important PAH, found in fine PM originating from combustion. A main source of BaP in Europe is domestic home heating, in particular wood burning. Other sources include road traffic, rubber tyre wear and outdoor burning.

BaP is carcinogenic. Other effects may be irritation of the eyes, nose, throat and bronchial tubes. BaP is toxic to aquatic life and birds, and bioaccumulates, especially in invertebrates.

2.3.4 *Transport noise*

Noise from transport sources is a significant environmental problem; the latest evidence published by the WHO (WHO/JRC, 2011) indicates that at least 1 million healthy life years are lost every year in Europe as a result of noise from road traffic alone.

Measures are being taken to assess the scale of the impact of noise upon the health of Europe's citizens and to attempt to redress the problem where possible. European Directive 2002/49/EC (EC, 2002) relating to the assessment and management of environmental noise has led to large-scale mapping of noise levels across Europe. EU Member States are required to produce these noise maps for the largest cities with populations greater than 100 000 people and the busiest transport corridors throughout each country. For roads, this equates with an annual traffic flow of more than 3 million vehicles; for rail, more than 30 000 trains; and for airports, more than 50 000 air traffic movements, or flights.

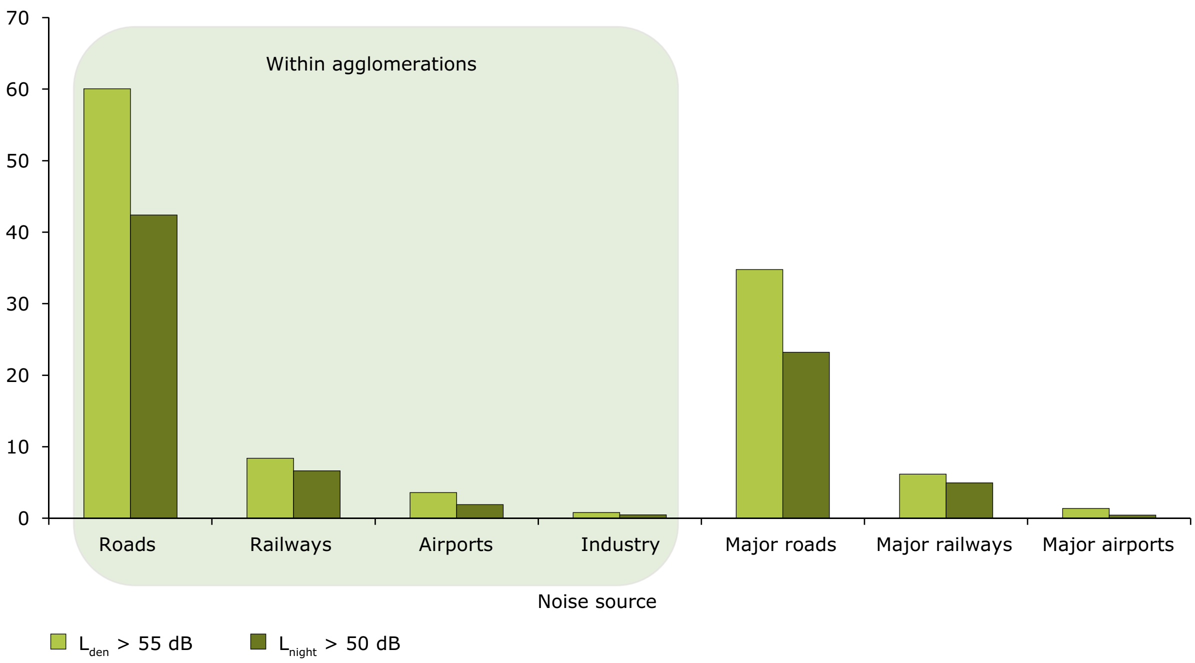
This requirement to map noise has been introduced in two initial stages. The first was due to have been completed in 2007, for only the very largest cities and the very busiest transport corridors. By the middle of 2012, all Member States are expected to have completed their noise maps for all the above mentioned sources, and thereafter the cycle of noise mapping assessments will continue every five years.

Linked to this, the directive requires that the same Member States adopt action plans based on the noise mapping results, with a view to preventing and reducing environmental noise where necessary, and particularly where exposure levels can have harmful effects on human health, and to preserving environmental noise quality where it is good. Member States are still dealing with this requirement to develop such action plans, which is also set against a backdrop of incomplete noise maps, even for the first phase of implementation.

Nevertheless, the EEA has attempted to build as clear a picture as possible of the state of the noise environment in Europe. The noise mapping data that have been reported to the EEA by its member countries is presented by the Noise Observation and Information Service for Europe (NOISE, 2011). This is an interactive online database through which it is possible to gain an overview of the scale to which Europe's citizens are exposed to the very highest levels of noise — the same levels that cause detrimental health effects and ultimately mortality in the exposed population. It is also possible to view detailed noise contour maps at a local level in cities and countries for which that data is available.

Figure 2.9 provides an overview of the number of people exposed to key noise sources both inside and outside the largest cities. These are termed agglomerations, and for the first phase of noise mapping, these are those cities with more than 250 000 people. Within these agglomerations, assessments have been conducted for all the main transport sources plus the main industrial installations. Outside these agglomerations, the assessments relate only to the very busiest transport corridors: for roads, those with greater than 6 million vehicles per year; and for railways, those with greater than 60 000 trains per year. In relation to airports, the threshold in Directive 2002/49/EC on environmental noise remains constant, with reference to those with 50 000 air traffic movements or more.

Figure 2.9 Number of people exposed to noise in Europe (EU-27, Norway and Switzerland)



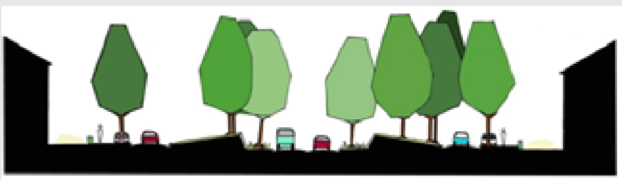
Source: EEA, 2011.

Box 2.19 Improving quality of life and winning the European Soundscape Award 2011: the Graafseweg in Alverna

The EEA, in collaboration with the Noise Abatement Society of the United Kingdom, wants to raise awareness about the health impacts of noise and to reward European initiatives that can help reduce excessive noise. Any product, campaign, innovation or scheme offering a creative solution to the problem of noise can be considered for the new European Soundscape Award.

The award was presented for the first time on 8th November, 2011 to the Municipality of Wjichen and Gelderland in the Netherlands for the historic and sustainable solution for traffic noise reduction in Alverna. This combined innovative measures including traffic lane management and quiet asphalt to reduce noise levels as effectively as traditional but unattractive noise barriers. The project also realised improvements in air quality whilst retaining key features of the original Roman road.

The runner up award was presented to the Dutch Noise Abatement Society for the 'Electric Heroes — Go smart, go electric' campaign to encourage the uptake of electric scooters in The Hague and Zaanstad.



Source: EEA, 2011.

As these data are related to only the first implementation phase of the directive, the base year should be considered as 2007, but it is accurate for all data reported by EEA member countries up to 30 June 2011 (at the time of publication, about 96 % of noise data from major transport corridors can be considered to be complete, as compared to only 75 % of agglomerations data). The headline indicator is that almost 100 million people are exposed to damaging levels of noise from the very busiest roads in Europe. The remaining noise sources clearly have a much lower impact in terms of absolute numbers exposed; however, they are still very significant.

The WHO utilised noise-mapping data as published by EEA in order to conduct an assessment of the burden of disease from environmental noise in Europe (WHO/JRC, 2011). Published in March 2011, this report highlighted that noise from road traffic alone accounts for at least 1 million healthy life years lost in the western part of Europe, making noise, behind $PM_{2.5}$ but ahead of most air pollutants, the second highest environmental health burden.

The WHO assessment was conducted during 2010, and so does not utilise the most up-to-date noise mapping data. Nor can this assessment account for combined exposure to multiple noise sources due to the manner in which the data has been calculated by the member countries.

Therefore, it is clear that once the second phase of noise mapping is completed in 2012, the likely burden of disease due to noise in Europe will have increased. It is the hope of EEA that these new data on noise will also enable the assessment of exposure to multiple noise sources, particularly in cities, and to levels that are consistent with the new evidence of detrimental health effects, particularly at night, e.g. down to 50 dB L_{den} (day-evening-night noise levels) and 40 dB L_{night} (night noise levels).

In the meantime, it is anticipated that noise action plans will be being drawn up and implemented across Europe, in accordance with Directive 2002/49/EC on environmental noise. These are due to be completed by 2013, and then revised every five years.

2.3.5 *Transport impacts on landscape fragmentation*

Transport has an important negative impact on ecosystems and biodiversity, and the white paper calls for the reduction of this negative impact on key natural assets like water, land and ecosystems. The impact on biodiversity and other environmental resources is assessed in the Impact Assessment accompanying the White Paper on Transport. Due to the lack of reliable quantification and methodology, the white paper sets no quantitative target but proposes an indicator calculated on the basis of the mesh size concept. This method has been applied to provide valuable information towards biodiversity policy general target.

The Environment Council on 15 March 2010 adopted the EU biodiversity policy, vision, and target beyond 2010 (EC, 2010). The vision implies that by 2050, European Union biodiversity and the ecosystem services it provides — its natural capital — are protected, valued and appropriately restored for biodiversity's intrinsic value and for their essential contribution to human well-being and economic prosperity. This vision is then translated to a qualitative target — halting the loss of biodiversity and the degradation of ecosystem services in the EU by 2020, and restoring them insofar as is feasible, while stepping up the EU contribution to avoiding global biodiversity loss.

In May 2006, the communication from the Commission on halting the loss of biodiversity by 2010 and beyond (EC, 2006a) highlighted the main pressures and drivers causing biodiversity loss: Habitat loss or change, Introduced species, Pollution, Over-exploitation and Climate change (HIPOC) (see also the 2010 EEA report on assessing biodiversity in Europe (EEA, 2010d)), stressing that the relative importance of these pressures is context sensitive,

Box 2.20 Effective mesh size methodology

The method of the effective mesh size (m_{eff}) is based on the probability that two points chosen randomly in a region are actually connected, i.e. located in the same patch (EEA/FOEN, 2011). It indicates the ability of animals to move freely in the landscape without encountering barriers such a road, urban area or major river, and therefore can be understood as a measure for landscape connectivity. The degree of fragmentation can be also expressed as the effective mesh density (s_{eff}), which it is interpreted as the effective number of patches per 1 000 km^2 ($s_{eff} = 1/m_{eff}$). s_{eff} is mainly used for reading trends from graphs due to its intuitive appreciation. See the EEA/FOEN study (2011, page 24) for details on methodology and further reading on landscape fragmentations.

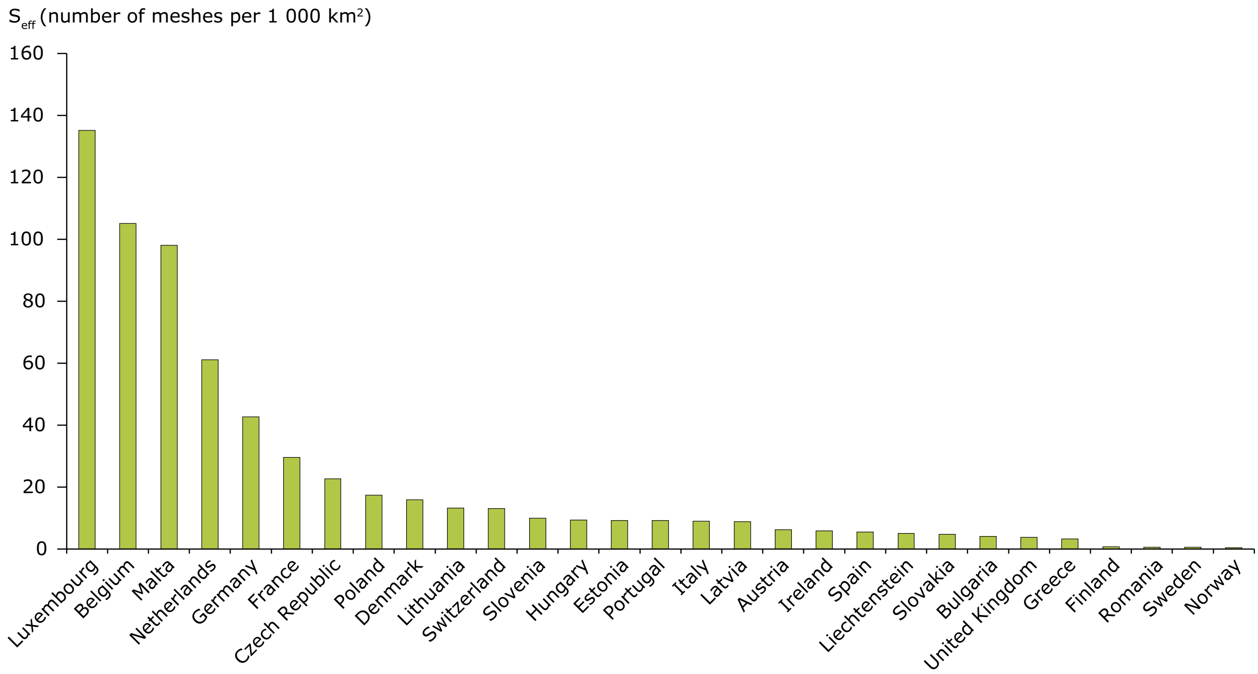
and that very often several pressures act in concert. The contribution of transport to these pressures is well known, and this allows for better integration of biodiversity and land issues in the transport policy.

Working towards a better integration of policies, the 2002 edition of the TERM (EEA, 2002) included several indicators designed to cover biodiversity and territorial issues: fragmentation of ecosystem and habitats by transport infrastructure; proximity of transport infrastructure to designated areas; and land take for transport infrastructure. Of the three, land fragmentation due to transport infrastructure is the most relevant, as it covers one of the main transport impacts in Europe. However, its calculation complexity together with data availability and lack of consensus around the best methodology to be used made its update unfeasible to date. A recent study (EEA/FOEN, 2011) applied the mesh size methodology in European 29 countries for the first time, providing the grounds to incorporate an update of the indicator in the present baseline. Mesh size methodology is proposed in the White Paper Impact Assessment (EC, 2011d) to measure fragmentation of land and ecosystems related to the construction of new or improved transport infrastructure.

From the different calculations available in the mentioned study, fragmentation geometry B2 'Fragmentation of Non-Mountainous Land Areas' was chosen to illustrate this impact. It is considered the most important fragmentation geometry, as it is suitable for comparing regions with differing geographical conditions (presence of mountains or lakes) and includes a set of physical barriers that may affect a large number of species. It includes roads up to class 4 (local roads), railways and urban areas.

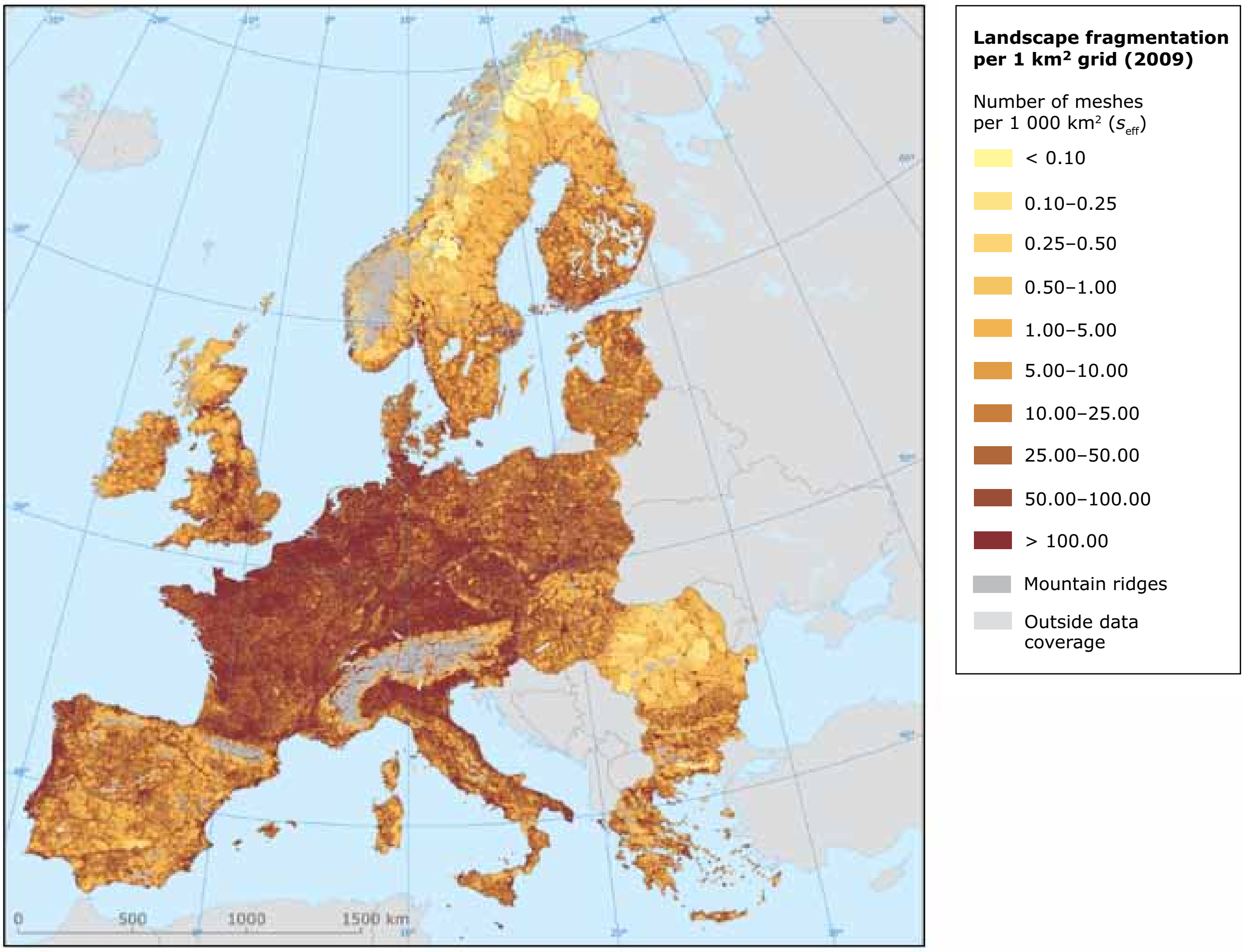
The density of the transportation network and the extent of landscape fragmentation are largely a function of interacting socio-economic drivers such as population density and geophysical factors such as topography. Results show that the s_{eff} values in Europe cover a large range from low values in the Iberian and Scandinavian peninsulas, to very high values in the Benelux countries and Germany. Considerable parts of Europe are highly fragmented by transportation infrastructure and urban development. High fragmentation values are found in the vicinity of large urban centres and along major transportation corridors. The value of the s_{eff} for all 29 investigated countries together is 1.75 meshes per 1 000 km^2. The Benelux countries are clearly the most fragmented part in Europe (s_{eff} > 60 meshes per 1 000 km^2), with one of the highest population densities in the world and a very dense road network, followed by Germany and France. On the other hand, Norway is the least fragmented country in Europe (see Map 2.1 and Figure 2.10).

Figure 2.10 Bar diagram and table of s_{eff} values by country for FG-B2 in 2009



Source: EEA/FOEN, 2011

Map 2.1 Map of s_{eff} values by per 1 km² grid for FG-B2 in 2009



Source: EEA/FOEN, 2011.

This indicator of landscape fragmentation should provide the starting point from which to monitor biodiversity and landscape fragmentation in the context of the European transport and environment policy. Assuring the monitoring process would call for an update of the indicator on a regular basis to detect trends in landscape fragmentation development.

Overall, results show that as the White Paper Impact Assessment (EC, 2011d) stressed, based on the EEA's European Topic Centre on Land Use and Spatial Information (ETC/LUSI-GISAT) research, the EU is the most fragmented continent in the world: nearly 30 % of land in the EU is moderately, highly or very highly fragmented (EEA, 2010e).

Fragmentation has a significant impact on habitats and ecosystems. It threatens many wildlife populations via reduced connectivity among the remaining habitat patches; these are broken apart, reduced in size, increasingly isolated (EEA/FOEN, 2011), and vulnerable to natural stress factors or external threats such as climate change. In addition to the direct loss of habitat due to long linear infrastructure (area taken up by the infrastructure), an even higher amount of core habitat is lost due to edge effects. Data also show that fragmentation due to transport infrastructure and urban sprawl constitutes a growing threat and also results in increased accessibility and disturbance (EEA, 2010e).

In terms of direct land take, transport infrastructure itself represents a minor land use: about 0.1 % of all land in the EU. In addition to the fragmentation of natural areas, transport infrastructure also fuels urban sprawl when land use and urban planning policies are not optimised so as to avoid induced impacts, breaking down old distinctions between urban and rural land, and leading to a vast extension of urban uses in former rural areas. New transport routes are often followed by urban sprawl which requires even more technical infrastructure, which in turn further increases fragmentation. The extent of artificial areas, including transport infrastructure and urban areas, increased about 3 % in Europe between 2000 and 2006 (EEA, 2010f).

However, these figures should be considered with care, as land take for transport infrastructures is underestimated in surveys that are based on remote sensing, as is Corine Land Cover. Land take by linear features with a width below 100 m (majority of roads and railways) is not included in the statistics, which focus mostly on aerial infrastructures such an airports and harbours.

3 Passenger and freight transport demand and modal split

The environmental impacts of transport are determined strongly by overall transport activity and modal split. Although the energy efficiency and exhaust emissions of transport has been improving, it has not been enough to outweigh the impact of rising transport volumes and a preference for road transport, and does not resolve all of the issues at hand.

Transport demand is the key driver that sets the context for understanding transport-related impacts, responsibilities and the scope of potential actions. This chapter therefore sets the scene by reviewing the current situation, trends and drivers of demand and modal split in Europe. Subsequently, Chapters 4, 5 and 6 build on this to examine in more detail demand optimisation, the potential for moving to more sustainable modes, and the use of technology to reduce transport impacts.

3.1 Freight transport

Since the mid 1990s, demand for road and rail freight has grown rapidly. Overall tkm in EEA-32 member countries (excluding Liechtenstein) peaked in 2007, having grown by around 33 % over the decade from 1997 to 2007. However, between 2007 and 2009, total tkm declined by more than 12 %, reflecting the effects of the economic recesion. Latest preliminary data from 2010 have shown a 4 % increase from 2009, with volumes recovering almost to 2004 levels.

Road haulage accounted for 79 % of inland freight movements within the EEA-32 in 2009. New Member States have seen strong growth in demand, with a 109 % increase between 1999 and 2009 driven by the enlargement and the subsequent integration of markets within the EU, and a move away from heavy industry. Strong GDP growth, liberalisation of road freight markets and investment in road infrastructure may also have facilitated this growth (IEA, 2009). In contrast, road haulage demand in the EU-15 has increased by only 1.5 % over the past decade. The stronger growth in the new Member States is partly attributable to the fact that EU-12-based companies are increasingly carrying out transport services in the EU-15. Much of this is due to their relative cost advantage, as drivers are likely to earn lower wages: for example, a Romanian lorry driver may earn less than a quarter of a German lorry driver's salary (EC, 2011d). More growth can be expected given that special restrictions on the EU cabotage market were lifted on 1 May 2009 (Eurostat, 2011a).

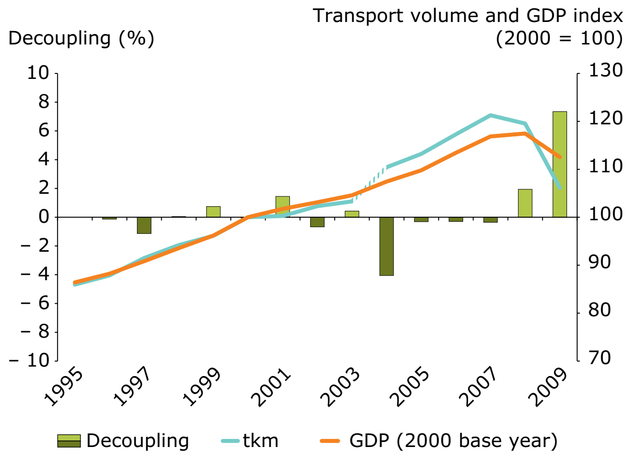
Rail freight tkm in the EEA grew steadily by 18 % between 1999 and 2007; most of this growth occurred in the EU-15, which saw a 22 % increase. By contrast, EU-12 Member States have undergone a long-term decline in rail freight since 1997. The economic recession saw steep declines in both EU-15 and EU-12, and in 2009, overall freight volumes were 5 % less than in 1999. Latest data from 2010 show a 6 % increase versus 2009, with volumes recovering back to 1999 levels. Underlying factors which may have contributed to declines in some countries include the fact that some Member States have moved away from coal as a primary energy source. Coal has traditionally accounted for a significant proportion of rail freight. The less flexible nature of rail is also less suited for just-in-time manufacturing requirements, compared to road freight (IEA, 2009). Domestic and intra-EU air freight has increased by 200 million tkm over the last decade, driven by demand for goods with high value, perishable goods and express parcels (Eurostat, 2010). However, as it is a relatively expensive mode, the contribution of aviation to total freight movements has remained at only 0.1 % over the past decade (Eurostat, 2010).

Maritime transport has shown strong growth due to globalisation, low cost and higher levels of containerisation, while intra-EU shipping has been boosted by feeder traffic from global connections. The weight of goods shipped increased by almost 22 % between 1999 and 2009 (Eurostat, 2011b). However, both imports and exports through the main EU-27 ports slipped into reverse in the third quarter of 2008 as the recession impacted consumer demand. A year later, imports had decreased by 19 % while exports had decreased by 14 %. Trade has started to show signs of recovery, although at the third quarter of 2010, inwards trade had only recovered to levels last seen in 2005.

Trends in GDP may explain some of the changes in freight transport demand. In years of economic growth, trade (and hence freight) tends to grow at a faster rate than does the GDP. Conversely, in recession years, trade falls faster than the GDP; see Figure 3.1

Figure 3.1 Freight transport volumes and GDP (EEA-32 excluding Liechtenstein)

Freight transport demand in terms of tkm has dropped dramatically in recent years, in contrast to the previous decade of growth. Between 2008 and 2009, total tkm for road, rail and IWW fell by 11 % to a level not seen since mid 2003. Total GDP in the EEA-32 fell to a lesser extent: a 4 % reduction between 2008 and 2009. Decoupling between freight demand and GDP has increased to over 7 % in 2009. It is likely that the recent decoupling is a temporary result of the economic recession. However, there is evidence that decoupling could arise due to shifts in GDP composition towards the service sector, shifts to demand for more expensive lighter goods (e.g. finished products), and offshoring of industrial capacity (IEA, 2009).

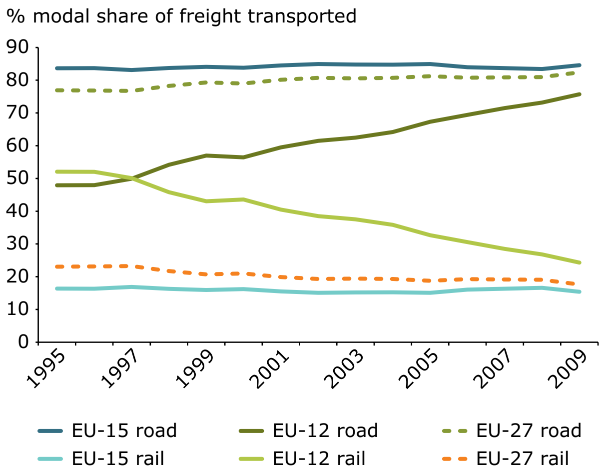


Note: The two curves show the development in GDP and freight transport volumes, while the columns show the level of annual decoupling. Light green indicates faster growth in GDP than in freight transport while dark green indicates stronger growth in freight transport than in GDP. The data refer to road, rail and bus modes of transport. The large change in 2004 is tied to a change in methodology, but no correction figure exists (see metadata for more details).

Source: Eurostat, 2011.

Figure 3.2 Road transport's market share increases strongly in EU-12

Although rail has traditionally had a higher modal share in the EU-12, this has been falling rapidly. Over the past decade, rails' share of the road/rail total has fallen from 43 % to 24 % in the EU-12. A change in the geographic orientation of markets for the EU-12 from east to west has contributed to the shift; the new markets are not well connected by rail infrastructure and offer much more adaptable road transport as an alternative. Although rail has a higher efficiency than road in terms of MJ/tkm (IEA, 2009), these efficiency benefits cannot contribute significantly to energy savings if its modal share remains low. The prioritisation of passenger trains over freight has contributed to the problem, as have a lack of capacity and flexibility (EC, 2008d). In the EU-15, the share of rail freight has not changed significantly; overall rail share in the EU-27 showed signs of stabilising at 19.1 % between 2007 and 2008. However, a year later in 2009, it dropped again to 17.6 %.



Source: Eurostat, 2011.

3.2 Passenger transport

Passenger transport demand (pkm) in the EEA increased by 12 % between 1999 and 2009. Growth has been much stronger in the EU-12 (33 %) compared to the EU-15 (9 %). It has been boosted by the liberalisation of European air traffic, investment in high-speed rail lines, and an increase in motorisation levels (EC, 2011d). However for the first time in the decade, overall demand levelled off, recording a small decrease of 0.1 % between 2008 and 2009. If the overall trend observed since 1999 had continued, a 1 % increase would have been expected. This was likely due to the effects of the economic recession. In the EU-27, unemployment rates reached nearly 10 % in early 2010 — the highest levels since records began (Eurostat, 2011b). However the reduction in demand is significantly less than the fall in GDP, indicating that many passenger journeys are unavoidable, and that options to reduce travel when income declines may be limited. Non-motorised data is not available to the extent that would make it comparable to the rest of the modes at EU level, and therefore cannot be presented here.

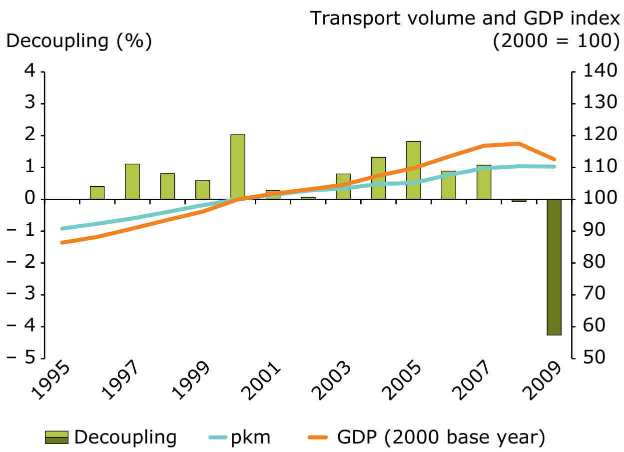
The car accounts for 77 % of all motorised intra-EU passenger transport (road, rail, air and sea) and is the only mode for which overall demand has not fallen in recent years. Between 1999 and 2009, passenger car demand in the EEA has increased by 14 %. This trend has been strongest in the EU-12, where demand swelled by 55 %, compared to a rise of 8 % in the EU-15. This may be because vehicle sales tend to develop in line with economic growth (ACEA, 2010). Between 1999 and 2009, GDP in the EU-12 grew by 44 %, while in the EU-15, GDP increased by 15 % (Eurostat, 2011b).

Over the past decade, rail passenger demand in EEA member countries has increased by nearly 14 %. The competitiveness of railways in Europe has been assisted by opening up the rail market, introducing common safety rules and improving the interoperability of national networks through the European Rail Traffic Management System (EC, 2011d). It was only between 2008 and 2009 that a small decrease (1 %) was seen. This overall growth was fuelled by the EU-15, where demand has risen by 20 % since 1999. This is in part due to the investment in high-speed rail in the EU-15, which many countries have credited as a key factor behind rail's resurgence. High-speed rail accounted for more than a quarter of all EU-27 rail passenger traffic in 2009 (EC, 2011i). In contrast, rail passenger travel in the EU-12 has fallen by 23 % over the decade; by and large, rail does not have the same quality standards on its networks and more convenient alternatives are available.

Air transport has shown the most growth over the past decade. Aviation is the dominant mode for passenger journeys exceeding 500 km, where it achieves a 55 % share of all trips, whereas cars achieve 30 %. For journeys under 500 km, aviation has only a tiny share (1 %), and cars make up the majority of trips (72 %) (TML, 2010). Short-haul flights may be unattractive compared to other modes due to the high proportion of time taken up by check-in procedures and travel between airports and city centres. For example, the link between Barcelona and Madrid (the largest intra-EU air route in terms of passengers carried) showed a 24 % decrease in demand when the high-speed rail link between the two cities was completed, and Brussels to Paris has almost no direct flights following the opening of a high-speed rail link. In the EU-27, domestic and intra-EU air pkm have increased by 23 % over the last decade (1999–2009). Low-cost carriers have contributed to some of this increase — evidence suggests that their market share is partly new traffic, and partly redistribution of existing traffic (Eurocontrol, 2011). Emerging economies worldwide have also had a substantial impact on European passenger traffic: for instance, the number of air passengers between China and the EU more than doubled between 2003 and 2007. The spike in oil prices during 2009, coupled with the financial crisis and global recession led to more than a year of contraction in air transport demand, where the number of aviation passengers decreased by nearly 9 % between 2008 and 2009. The volume of passenger transport fell less than the number of flights, likely due to higher occupancy levels (Eurostat, 2011b). Although in early 2010 there were signs of recovery, the industry was adversely affected by the Icelandic volcano eruption. The return to high oil prices has also driven airlines to raise their ticket prices. Uncertainties over the European economic framework and the weak euro could also have negative impacts (ICCSAI, 2010).

Figure 3.3 Trends in passenger transport demand and GDP (EEA-32 excluding Liechtenstein)

Despite a dip in demand in recent years, the overall trend is that passenger transport continues to grow. On average, the increase in passenger transport demand has been slower than GDP growth due to congestion, low population growth and saturation of car ownership/demand in some Member States (ISIS, 2010). Data for 2009 show a negative decoupling of over 4 %. This may be because lower household incomes tend to reduce demand for longer trips, but do not affect local trips which depend more on land use factors (ISIS, 2010).

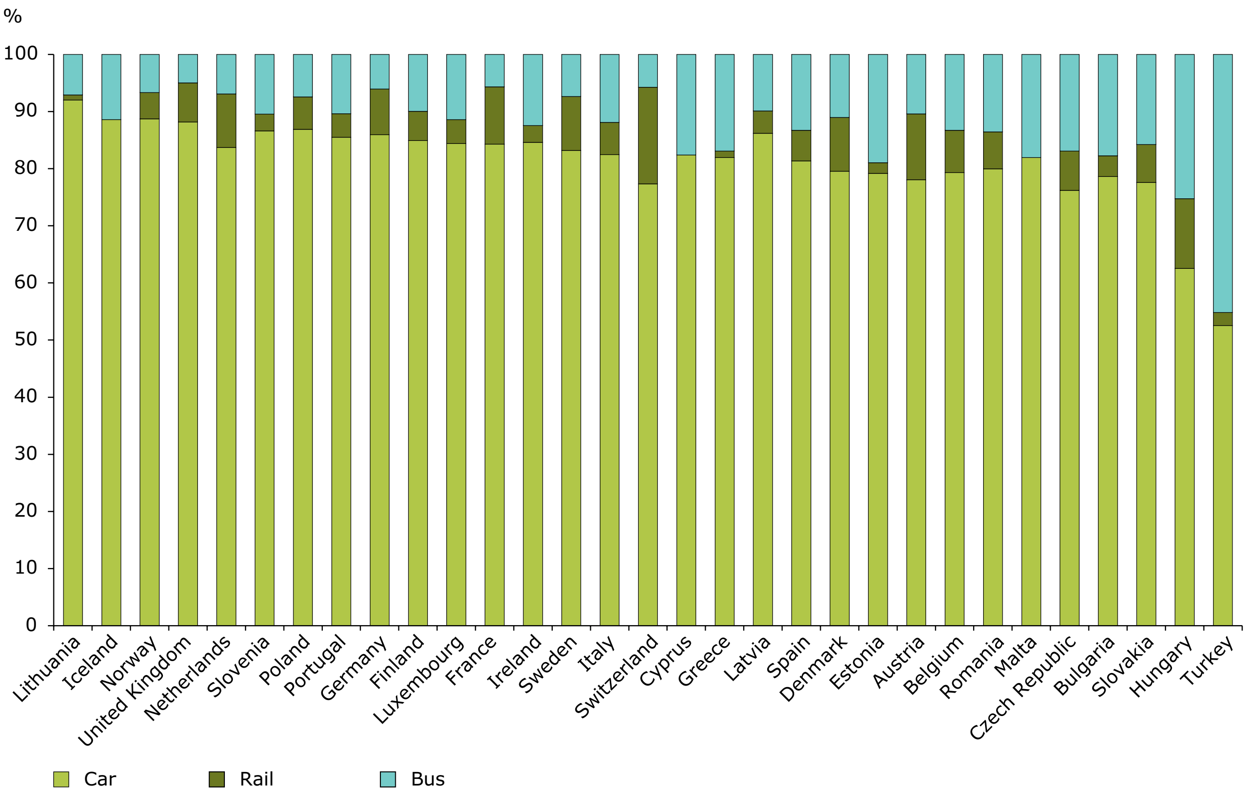


Note: The two curves show the development in GDP and passenger transport volumes, while the columns show the level of annual decoupling. Light green indicates greater growth in GDP than in transport while dark green indicates stronger growth in transport than in GDP. The data refer to road, rail and bus modes of transport.

Source: Eurostat, 2011.

Figure 3.4 Passenger transport modal split (without sea and aviation, 2009)

Cars have the largest share of inland passenger transport in all EEA member countries. Bus travel had the second largest modal share in all but six European countries where rail accounted for a higher percentage of pkm (Austria, France, Germany, the Netherlands, Sweden, Switzerland and the United Kingdom). During the last nine years (2000–2009), demand for rail remained fairly steady, or increased, in all EU-15 Member States but two (Greece and Italy). However, for the EU-12, rail transport declined considerably in most countries. This is potentially due to the poor upkeep of the rail network in the new Member States, which is suffering from years of underinvestment (EC, 2011d).



Source: Eurostat, 2011.

4 Optimising transport demand

Technical options alone cannot achieve the European Commission's target of a 60 % reduction in GHGs from transport by 2050. Demand optimisation will form an essential part of meeting this target; it can be very cost effective and can also offer environmental co-benefits such as air quality improvements and noise reduction.

The European Commission's 2011 White Paper on Transport sets a target of a 60 % reduction in direct GHGs from transport by 2050, compared to a 1990 baseline (EC, 2011a). Detailed modelling has demonstrated that it will be very difficult to reduce GHG emissions from transport by 50 % or more through technical options alone (AEA et al., 2010). Technical improvements can also have 'rebound' effects: for instance, improving fuel efficiency can lead to increases in vehicle use. For personal automotive transport, 10 % to 30 % of efficiency improvements may not be realised due to the rebound effect (UKERC, 2007). Demand optimisation in the form of better vehicle utilisation, avoidance of unnecessary trips and via modal shift, will therefore be indispensible, and could contribute to an overall reduction in GHGs as well as offer co-benefits such as improved air quality and reduced noise emissions.

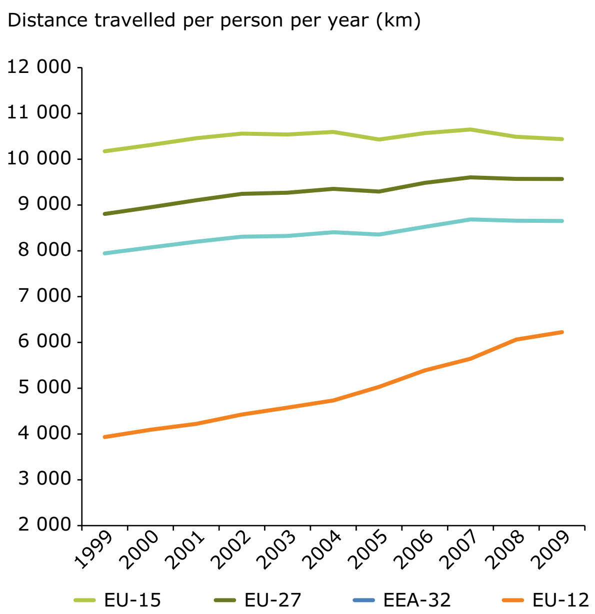
Figure 4.1 suggests that car use could have reached saturation levels in some countries. It is not clear what has caused this turnaround, but a combination of congestion, rising fuel prices and policies to discourage car use are likely to have contributed. Analysis also suggests that above an annual income of EUR 22 000 (USD 30 000), the correlation between increasing wealth and greater travel is no longer prevalent (Millard-Ball and Schipper, 2010). An ageing population demographic may also be a contributing factor, and recently the economic recession will have temporarily damped demand.

For younger generations, there is evidence that car ownership is becoming less attractive. A survey of young people in Germany shows going by bicycle, using a car pool or opting for public transport is becoming more popular than buying and driving cars (Roland Berger, 2011). One of the reasons

Figure 4.1 Personal car use in Europe

Chapter 3 showed that passenger transport is dominated by car use. However, there is evidence that in some countries car use has reached saturation levels and is now in decline. Between 1999 and 2009, distance travelled by car per capita increased by only 2.6 % in the EU-15. Usage peaked in Denmark in 1999. In France, Spain and the United Kingdom the peak year was 2002, and for Switzerland it was 2004. The phenomenon has been observed elsewhere, first in Japan, which has seen a decline since 1990, and more recently in both Australia and the United States (Millard-Ball and Schipper, 2010).

Source: Eurostat, 2011.



given for this was that premium cars are seen as materialistic and self-centred. The alternative of using information and communications technologies was identified as being much closer to their personal preferences.

There is evidence of the public recognition both of the damage caused by current travel patterns and of the need to change. In Europe, around two-thirds say they would make compromises when buying a car in order to reduce emissions (Eurobarometer, 2011). However there is limited evidence that this is indeed the case in practice. Known as the attitude-behaviour gap, this phenomenon constitutes a particular problem in transport policy (DfT, 2006).

The use of information and communications technology to reduce transport demand can be particularly cost effective and can have large environmental benefits. Teleconferencing can reduce transport demand and enable companies to control travel costs if air travel becomes more expensive, helping to maintain economic competitiveness. Some reported examples are a major medical company, which has employees in 120 countries. They invested in a variety of videoconferencing systems and reduced company flights by 37 804 between 2008 and 2009, saving 7.2 $MtCO_2e$ (WWF, 2011a). Similarly, in one year, a major telecom operator reduced their business flights by 3 749 (26 %) and cut travel costs by almost a third (WWF, 2011b).

Demand can also be optimised by ensuring the external costs of transport are internalised. This is particularly true in the case of road transport, for which there is increasing evidence that climate change, air and noise pollution, and health impacts outweigh existing taxes and charges (DfT, 2009) (Defra, 2010). It is accentuated by the fact that whereas access to most roads is free at point of use, many of the costs for private vehicle owners are fixed: depreciation, servicing, maintenance, circulation taxes and insurance. Satellite-based road pricing systems, which can adjust prices according to location and time, can address this, allowing price to be used to optimise demand at peak congestion times. Charging schemes which take into account the actual use of the car, replacing existing charges such as registration and circulation taxes, would be supported by half the EU citizens (Eurobarometer, 2010).

Trials of automated road pricing conducted in the Netherlands demonstrated that 70 % of drivers changed behaviour, choosing to avoid peak times for journeys. Full implementation of a national road-pricing scheme in the Netherlands is predicted to achieve a 15 % reduction in total distances driven with a 10 % reduction in CO_2 emissions, as well as a 58 % reduction in congestion delays (IBM, 2010).

Another policy option to reduce total vehicle kilometres travelled is to encourage increased occupancy. Data on average car occupancy across Europe are limited, but available evidence indicates a figure of 1.5 for EU-15 Member States since 2004, and that figures for EU-12 Member States are declining towards these levels. In Europe, policies have not generally been aimed at reducing single-car occupancy rates, but in the United States it has been given much greater attention. A review of American workplace travel plans found that direct financial incentives or subsidies were a very important factor in reducing single-car occupancy rates (Potter et al., 2006) alongside introducing parking permits or charges (UKERC, 2009).

Policies to encourage car-sharing could also be effective in optimising transport demand (see Box 4.1).

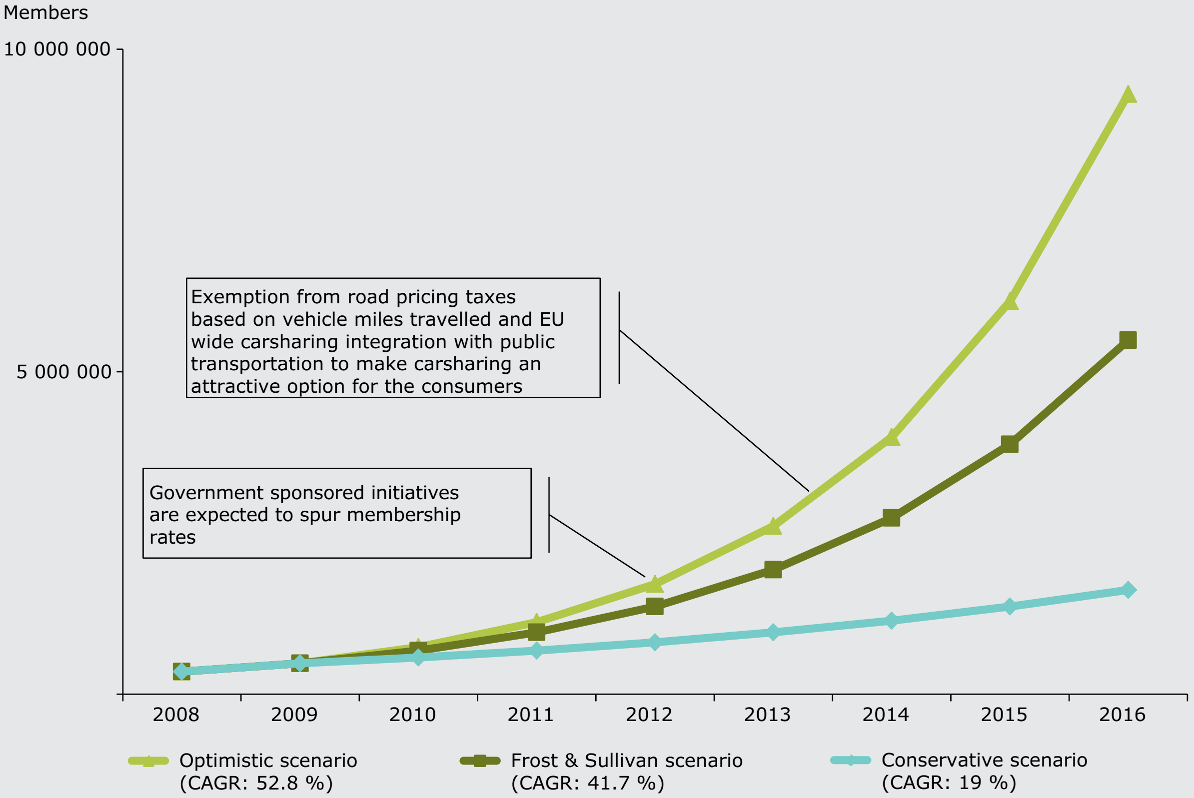
Box 4.1 Car-sharing

There were almost half a million car-sharing members across Europe in 2009, and this figure is predicted to grow to somewhere between 1.5 million and 5.5 million by 2015 (Frost & Sullivan, 2010). Switzerland has the most well-established car-sharing scheme in the world, with 7 times more members per 1 000 population than any other European country, and services available in 430 cities and communities (Momo, 2010).

European research found each car-sharing car replaces between 4.5 to 14 private vehicles; car-share members travel less by car, using public transport, bicycles, taxis and rental cars more than they had prior to joining the car-share (Momo, 2010). Car-share cars also typically emit between 15 % and 25 % less CO_2 than the fleet average (Momo, 2010).

Vehicle manufacturers are also involved in car-sharing schemes. Daimler runs the Car2go scheme using Smart cars in Ulm and Hamburg, Germany, as well as Austin, Texas in the United States and Vancouver, Canada. Likewise, BMW has introduced its DriveNow scheme, Peugeot has its Mu service, and Ford has a GoCar partnership. Rental companies are also starting to offer cars to be rented by the hour: Hertz On Demand, and WeCar, offered by Enterprise Rent-a-car, are examples. Thus car sharing is being mainstreamed and broad segments of the industry is involved.

Market for carsharing: scenario Analysis for Carsharing Members (Europe), 2008–2016



Note: All figures are rounded; the base year is 2009. CAGR = compound annual growth rate.

Source: Frost & Sullivan, 2010.

5 Obtaining a more sustainable modal split

The white paper sets out challenging targets for a shift to more sustainable modes for both passenger and freight transport. This chapter examines their feasibility and how this might be achieved.

The second area which must contribute to meeting the aims of the white paper over and above technological solutions is achieving a shift to more sustainable modes of transport. The focus is to move demand from road and aviation to rail and waterborne transport. Two targets are set out in the white paper (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'; and 'by 2050 the majority of medium-distance passenger transport should go by rail'. These targets represent an ambitious modal shift from current levels, which are dominated by road transport (see Chapter 3),

Policies to encourage shifting road freight to rail and waterborne transport generally focus on reducing administrative barriers, investing in infrastructure, and introducing road charges and taxes. Freight is likely to continue to rely on road haulage over short distances even if policies for modal shift are introduced, as other modes cannot compete in terms of speed, flexibility and reliability (EC, 2008d).

Rail is more competitive for long-distance freight, and the potential for rail to increase its market share is promising if problems concerning interoperability and national fragmentation are resolved (CE Delft, 2011a). Indicative values for a potential modal shift from road to rail are only 5 % for short distances (between 50 km and 150 km), but increase to 40 % for 150 km to 500 km, and 100 % for journeys exceeeding 500 km (ETC/ACC, 2008). However, use of rail may increase overall journey distances due to detours and transfers at rail stations.

Road freight could also shift to maritime transport on certain corridors, as major obstacles created by administrative barriers have recently been reduced (EC, 2009i). Additional support is provided by the Motorways of the Sea programme, which aims to increase the economic viability of frequent maritime services on key routes (EC, 2011d). However, potential for sea transport is limited in the landlocked EU-12 Member States, and further investment in hinterland transport is needed to alleviate congestion at major ports. The Commission has also encouraged a shift to IWW that still have free capacity, through an Action Programme, the Navigation and Inland Waterway Action and Development in Europe (NAIADES) (EC, 2006b). It has been suggested that demand for IWW could be further stimulated by modernising the ships and infrastructure and through better integration with ports (CCNR, 2010).

Box 5.1 Transalpine freight traffic — modal shift in Switzerland

The Swiss Article on Protection of the Alps aims to shift transalpine goods transport from road to rail. With the bilateral Land Transport Agreement between Switzerland and the EU, the objective of progressively shifting goods transport from road to rail and the associated instruments are accepted. A combination of measures, like the distance-related heavy vehicle fee (LSVA), for example, and modernisation of the railway infrastructure resulted in a significant modal shift. Since 2000, the number of heavy goods vehicles through the Swiss alps has dropped by 10 % from 1.4 million to 1.26 million vehicles per annum. Without these transport policy measures, the estimated number of heavy goods vehicles crossing the Swiss alps would result in an increase of additional 500 000 heavy goods vehicles per year. Between 2000 and 2010, the volumes in net tonnes of goods transported by rail has increased by 17 % (Swiss Federal Office of Transport (FOT), 2010).

Box 5.2 High-speed rail (HSR)

HSR is emphasised in the TEN-T programme, where 14 of the 30 priority projects relate to high-speed lines intended to provide a viable alternative to air travel. Where rail journey times are reduced below 4 hours, rail tends to have a market share of at least 70 % (SDG, 2006). On some links, HSR can significantly reduce aviation's modal share, e.g. Paris to Strasbourg (CE Delft, 2011a). Other examples of successful European HSR include links from Madrid to Barcelona, where rail had a share of 60 % in 2010 (CE Delft, 2011a), and between London, Paris and Brussels, where it has an 80 % share (Eurostar, 2011). However, while HSR is most competitive with other modes on journeys of between 400 km and 800 km, it offers limited benefits on journeys shorter than 150 km compared to road or conventional rail (MVV, 2009).

Charging systems for road transport are likely to be introduced more widely. The revised Eurovignette Directive (originally adopted in 1999 and currently under revision) would allow higher charging of heavy-duty vehicles for the external costs of air pollution, noise and congestion. The costs of climate change will be internalised by differentiating fuel taxes according to carbon content. Charging variable infrastructure costs and external costs on all modes could decrease road freight (tkm) by 7 % and increase rail freight (tkm) by up to 10 % (CE Delft, 2011a).

The white paper aims for most of passenger transport over medium distances to be carried out by rail. The expected saturation of passenger car demand in the EU-15 suggests that a large share of additional demand could be covered by rail. Provision of high-speed rail (HSR) will be an important factor, and construction is already underway to increase the network length by over 40 % between 2010 and 2017 (EC, 2011e). For travel exceeding 800 km, rail will be slower than aviation, and therefore must have other advantages (e.g. a lower price) in order to be competitive (CCC, 2009).

On shorter journeys, it may be possible to increase the modal share of non-motorised modes, particularly as levels of urbanisation and congestion increase (EC, 2011d). Currently, cycling and walking account for approximately 13 % of urban pkm in Europe, but best-practice examples show this share can be much higher (EC, 2011d). For example, in the Netherlands, 31 % of people describe their main means of transport as cycling (Eurobarometer, 2011). Cities such as Seville and Barcelona in Spain have achieved substantial increases in their share of cycling in recent years. Public bicycle-hire schemes are gaining popularity as a method for authorities to encourage cycling.

Box 5.3 Public bicycles

Public bicycle-hire schemes in which the user can pick up a bicycle from one automated docking station and return it to another have grown substantially in the last five years. In 2010 there were 436 schemes in Europe, compared to 128 schemes in 2005 (Beroud et al., 2010).

Such schemes can encourage a modal switch away from the private car. A survey of the Vélib' bicycle rental scheme in Paris showed 46 % of users report lower private car use (Beroud et al., 2010). However, the majority (65 %) of trips replace bus or metro journeys, with only 13 % replacing car and taxi trips (CSD, 2011). Initial results from the scheme in London suggest two-thirds of trips have replaced travel by car, taxi or public transport (TfL, 2010).

Generally speaking, public bike-hire schemes provide visible evidence of transport authorities' support for cycling. They also address three main barriers to cycling for citizens: fear of theft, inconvenience of home storage, and cost of maintenance. However, resulting reductions in car travel can be limited.

6 Using the best technology available

The application of technology has been the primary means of reducing the environmental impacts of transport in the last two decades. It has also been identified as the most important means to achieve the European Commission's proposed target of a 60 % reduction in GHGs from transport by 2050. Biofuels and electricity (and potentially hydrogen) are expected to be the key energy carriers utilised to reduce GHG from transport in the long term; however, there are still issues to be addressed.

This chapter focuses on the potential benefits offered by improvements in fuels and technology in the transport sector. In the past, there has been a reliance on technological improvements to reduce the energy consumption and environmental impact of transport. Air quality pollutant emissions have decreased significantly since 1990, through technological improvements driven mainly by the tightening of successive Euro standards for new road vehicles (see Chapter 2 for more information on the real-world emissions issue). Although there have been recent reductions due to the recession, transport GHG emissions in 2009 (including international aviation and shipping) were 29 % higher than in 1990, despite actions having been taken to improve technological efficiency or utilise lower GHG fuels. Regulatory priorities and technological focus have therefore been shifting towards GHG abatement in recent years — illustrated by the emphasis placed in the White Paper on Transport's key measures (EC, 2011a).

Results from air quality monitoring stations show that road transport emissions of certain air pollutants have not decreased over the past decades as much as was expected due to the regulatory requirements for new vehicles (ETC/ACM, 2011). In recent years, it has been found via roadside monitoring and vehicle remote-sensing data that the real on-road emissions of air quality pollutants often exceed Euro vehicle emission standards, particularly for urban driving (Defra, 2011).

The explanations for this situation are complex, but mainly arise from differences between 'real-world' driving conditions and the regulatory test cycles. The lower than expected performance of the Euro standards is contributing substantially to the difficulties many Member States face in attaining both their national NO_x emission ceilings (EEA, 2011d) and NO_2 air quality LVs.

Similar issues also arise for fuel consumption and tailpipe CO_2 emissions, where it has been known for some time that existing test cycles underestimate performance compared to real-world use. This is commonly factored into analyses by using an average uplift in the order of 15 % on test-cycle-based CO_2/km data for light-duty vehicles. However, recent studies have presented evidence that the increases in real-world fuel consumption may often be even higher, particularly for some of the newer vehicles that obtained low test-cycle results, with an increase of up to 35 % for some hybrid cars (Ricardo, 2011), see also Chapter 7.

Work that is expected to help address such issues is being carried out on the worldwide harmonised light-duty test procedures (WLTPs) covering measurement of vehicle emissions and energy consumption. The European Commission is also working towards developing whole vehicle test-cycles for heavy-duty vehicles in order to facilitate the development of future regulation of their emissions (AEA, 2011).

Looking to the long term, the new White Paper on Transport lists 40 initiatives that will help us to reach the 2050 target of 60 % GHG reduction relative to 1990. Since transport activity increases in all modelled scenarios, the decarbonisation of the transport sector is in essence reliant on two major assumptions: the availability of sustainable and very low GHG biofuels, and the use of almost carbon-neutral electricity (in line with the target set for the power sector) in electrified road transport. Both assumptions are extremely important, but also face important barriers and uncertainties that require determined actions. These elements are discussed further in the next two sections. There will also be a need for future regulations of vehicle GHG performance to shift from direct tailpipe emissions to include full life-cycle emissions of transport energy carriers. The former elements will contribute substantially beyond the efforts made on improving efficiency. The use of hydrogen could eventually complete the picture for a substantial GHG reduction.

6.1 Fuel quality and energy sources

European transport is currently dependant on fuels derived from oil for around 96 % of total energy consumption (EC, 2011a). The upward trend in transport energy consumption peaked in 2007, with the subsequent decline due to the economic crisis showing signs of levelling off in 2010. Analysis for the European Commission 2050 roadmap indicates a reduction of 70 % on present levels of oil consumption in transport will be needed by 2050 in order to achieve the long-term GHG reduction target (EC, 2011a).

Whilst some of the life-cycle GHG reductions are expected to be made in upstream emissions from conventional fuels (e.g. reduced flaring and venting at oil production sites), it is currently anticipated that a significant part of the reductions will be achieved through the increased use of biofuels.

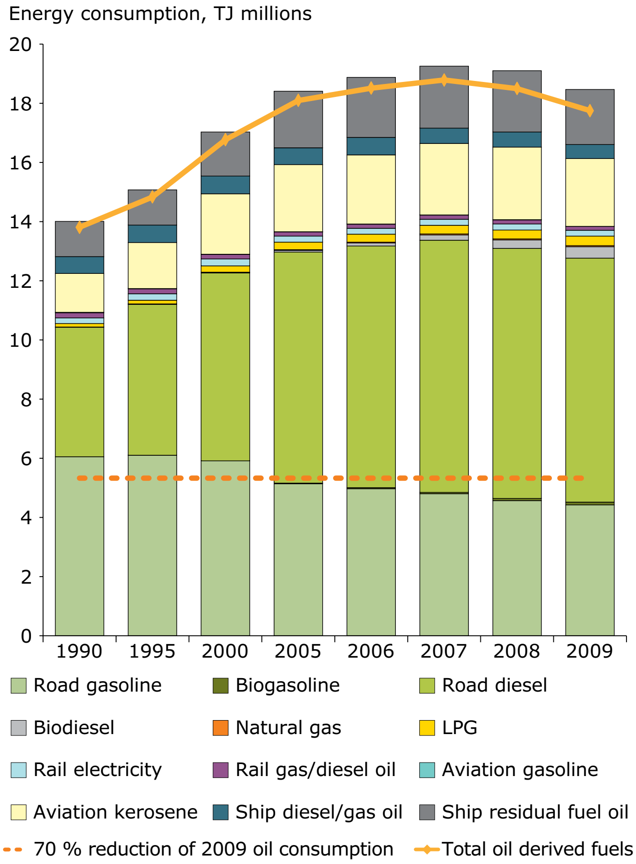
The RED (EC, 2009b) also set a target for all Member States to reach a 10 % share of renewable energy in transport by 2020. Current projections show that this will be almost completely fulfilled by biofuels providing that they meet the subsequent sustainability criteria — especially concerning land use change. Biofuels' share has increased substantially in the last 10 years, from 0.2 % to 4.3 % of petrol and diesel fuels; however, most EU Member States are likely to fall far short of the 2010 indicative targets for biofuel use (see Box 2.12).

The majority of biofuels are currently used within the road transport sector, although there is also some limited use for rail and inland shipping. The white paper (EC, 2011a) also provides objectives for decarbonising transport fuels beyond the road and rail sectors: 'Low carbon sustainable fuels in aviation

Figure 6.1 Transport energy consumption (EEA-30)

In recent years, there has been some limited progress in reducing oil dependence. This has been achieved primarily through the use of biofuels and vehicle technology improvements. Railway electrification has also reduced oil dependence, with the share of rail electrical energy consumption increasing to 61 % recently, from 51 % in 1990. There are important air quality drivers for switching to alternative fuels (historically this was the primary reason for the uptake of Liquid Petroleum Gas (LPG) and natural gas in transport). However, recent emphasis has moved primarily onto reducing life-cycle GHG emissions, although in many cases the use of low-carbon alternative fuels can also have air quality benefits — particularly for electricity (and potentially also through the use of hydrogen in the longer term).

Recent amendments to the FQD (EC, 2009c) have set a requirement for a reduction in the life-cycle GHG emissions from road transport fuels supplied to the EU market. This puts an obligation on fuel suppliers to reduce emissions by 6 % to 10 % by 2020 (relative to 2010 fossil fuels). Progress against the FQD target will be evaluated in future TERM reports once annual progress reporting begins in 2012.



Note: EU-27 plus Norway, Switzerland and Turkey.

Source: Eurostat, 2011.

to reach 40 % by 2050; also by 2050 reduce emissions from maritime bunker fuels by 40 % (if feasible, 50 %) compared to 2005 levels.' There are substantial possibilities for technical and operational efficiency improvements (particularly in maritime shipping). However, due to the substantial growth in activity expected in these sectors and the rate of penetration of improvements limited by the long lifetimes of aircraft and ships, the use of measures that offer very substantial GHG reduction in the entire fleet (i.e. not just in new stock) will be necessary. Therefore in both sectors, most of the emission reduction will probably need to be met through the utilisation of biofuels.

Due to the technical (and cost) constraints facing aviation fuel, it is expected that aviation will rely mostly on conventional fuels in the near future; although inclusion in the EU ETS from 2012 is expected to provide greater incentive for use of biofuels, this alone will not even out the currently substantial differential in price versus kerosene jet fuel. However, there are currently no direct mechanisms for tracking the introduction and use of biofuels in aviation and shipping, making this target difficult to monitor. In addition, the overall 60 % target in the White Paper on Transport relates to direct emissions from the transport sector according to IPCC accounting, where biomass is considered as CO_2 neutral, and therefore emissions from biofuels and electricity are counted as zero. In future, the greater use of electricity and biofuels by transport will therefore substantially increase emissions in other sectors within a country/region or in other countries/regions. However, power generation in the EU is in general included in EU ETS, and hence it is subject to a GHG emission cap.

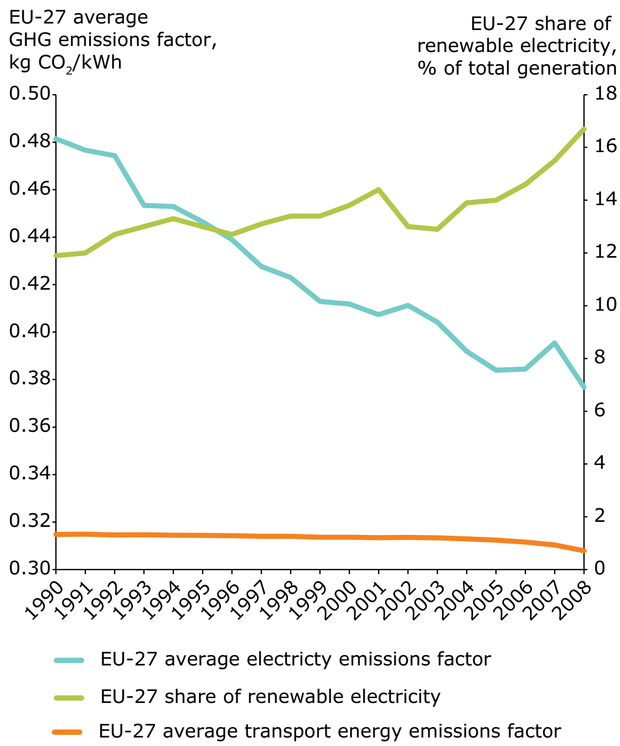
This reliance on biofuels as one of the key pillars to achieve long-term reductions in transport emissions does carry inherent risks. Critically, indirect land use change (ILUC) is not currently factored into the sustainability criteria and GHG assessment within the RED (EC, 2009b). This has the potential to substantially undermine the life-cycle effectiveness of biofuels and is the subject of a Commission impact assessment due for publication later in 2011. However, other recent research (IEEP, 2011) already suggests existing plans up to 2020 could potentially lead to an increase in GHG emissions overall, even using lower-end estimates of ILUC. A further concern is the long-term competition for a limited biomass/land resource across a range of alternatives, with impacts on both cost and sustainability. For example, there will be competition for biofuels not only among conventional uses (i.e. food, wood for construction, paper and other crop uses), but also for future bioenergy crops and other biomass uses

Figure 6.2 Trends in energy GHG emission factors and % renewable electricity (EU-27)

The other energy source that has been identified as crucial to achieving long-term GHG emissions reduction is electricity for road transport (potentially complemented with renewably produced hydrogen). Current low-carbon electricity generation options allow for substantial GHG emission savings, as well as other environmental benefits, such as noise reduction and air quality improvement in cities.

The emission factors for EU electricity have substantially decreased (by almost 22 %) since 1990 (IEA, 2011), in part due to an increase in renewable electricity generation. The latest official data show EU-27 renewable electricity accounts for 16.7 % of the total, while the share in the EU-10 Member States is still less than 8 %.

The Action Plans within the framework of the EU climate and energy package (EC, 2009d) commit Europe to obtain 20 % of its energy from renewable sources by 2020 under the RED (EC, 2009b).



Source: EEA, 2011.

(e.g. 'biomaterials') that are foreseen. In some cases, transport may not be the most effective use of such resources for minimal net impacts.

Analysis of these suggests that electricity will make up 42 % of total renewable energy production by 2020 (EEA, 2011f). It also shows that transport will use the smallest proportion of the renewable energy produced (12 %), although it is the fastest growing element between 2005 and 2020.

Since electrically powered vehicles are more efficient than conventional alternatives (AEA, 2009), their use will reduce overall GHG emissions when including those of the required additional electricity generation in most cases (Figure 6.2). Most importantly, the *A Roadmap for moving to a competitive low carbon economy in 2050* (EC, 2011b) has set the target of reducing GHG emissions from the power sector by at least 93 % from 1990 levels. A decarbonised electricity supply system will therefore contribute towards substantial further decarbonisation of transport, as long as electric transport modes grow to account for a sizeable proportion of overall transport demand.

Vehicles powered by hydrogen converted by on-board fuel cells into electricity are also considered a possibility for widespread use in the longer term, as they also offer substantial improvements in efficiency over conventional alternatives (though less so than fully electric vehicles). Hydrogen can be produced by a number of means including from electricity, although currently production is predominantly reliant on reforming natural gas. Hydrogen produced from decarbonised/renewable electricity offers a level of potential GHG reduction similar to that for the fully electric vehicle, although the end-to-end energy efficiency of the hydrogen pathway is substantially lower than for using the electricity directly, and so would require greater generation capacity.

Currently, there are a range of barriers to the uptake of alternative fuels, including price. As indicated in the TERM 2009 report (EEA, 2010a), whilst the continuing high oil prices have made conventional biofuels more economically attractive, they have also led to increased viability of higher GHG fossil fuels (such as those produced from oil sands or hydraulic fracking processes). Although LPG, electricity and natural gas are currently less expensive than conventional road fuels (Energy, 2011), advanced biofuels are more expensive. This is particularly true for the aviation and shipping sectors where international bunker fuels are tax free, and to a lesser extent for rail (where diesel is often cheaper than for road transport). This reduces the likelihood of these sectors utilising such fuels, although aviation's inclusion in the EU ETS is expected to provide a greater incentive.

A potential future barrier to alternative fuel consumption in transport (mainly electricity and biofuels) is the revenue which arises from current fuel-related taxes (applied to petrol and diesel). The likely progressive electrification of transport and the increasing use of alternative fuels will call for a reinforcement of fuel taxes towards fair energy-carbon taxes. The subject is being considered in the recent proposal to revise the Energy Taxation Directive (EC, 2011g), that aims to restructure the way energy products are taxed and takes into account both CO_2 emissions and energy content. The objective is to remove artificial barriers to energy transition such as fuel subsidies and the substantial revenue from taxation on fossil fuels that some Member States obtain.

6.2 Vehicle technology

As already discussed in Section 6.1, vehicle technology has performed a key role in reducing environmental impacts from transport in the last decades, particularly in road transport. Many of the technologies and fuels anticipated to be utilised in the pathway to meet the long-term GHG reduction target for transport are also expected to deliver co-benefits (e.g. use of hybrid and electric vehicles improving local air quality and reducing noise pollution).

From an air quality perspective, technological improvements have hitherto penetrated the truck fleet at a lower rate than they have for passenger cars, principally because this sector is more sensitive to fuel costs. The trade-off with air pollutant emissions control and fuel efficiency means that the Euro standards tend to be adopted much closer to the deadline for the majority of vehicles, in contrast to the passenger car market, although it is more the existence of regulation that eventually drives the penetration of new technology .

Railway and aviation have recorded reductions in specific emissions of air quality pollutants since 1995, while maritime passenger and freight transport emissions remained approximately constant over the same time period. Rail and water transport are still relatively clean forms of transport compared to road and air transport. Amendments (EC, 2004) in recent years to the 1997 Non-Road Mobile Machinery Directive will help maintain this position, ensuring future reductions of NO_X and PM. Maritime shipping emissions of NO_X and SO_X are regulated by the International Maritime Organisation (IMO) with MARPOL Annex VI, but the provisions appear to have led to little improvement in specific emissions over the last decade.

In terms of GHGs, the specific CO_2 emissions of road transport have decreased since 1995 (Figure 6.3). This is mainly due to an improvement in the fuel efficiency of passenger car transport, discussed further in Chapter 7 in the context of recent EU regulations setting CO_2 limits for new passenger cars and vans. The specific energy efficiency and CO_2 emissions of heavy-duty trucks has also improved at a lower rate, but road transport still consumes significantly more energy per tkm than rail or ship freight transport. The trade-off between reduction in air quality pollutants and fuel efficiency already mentioned has particularly impacted the heavy truck sector. Recent work for the Commission suggests that a potential future regulation beyond Euro VI (mandatory from 2013) may further impede GHG reduction progress (AEA, 2011).

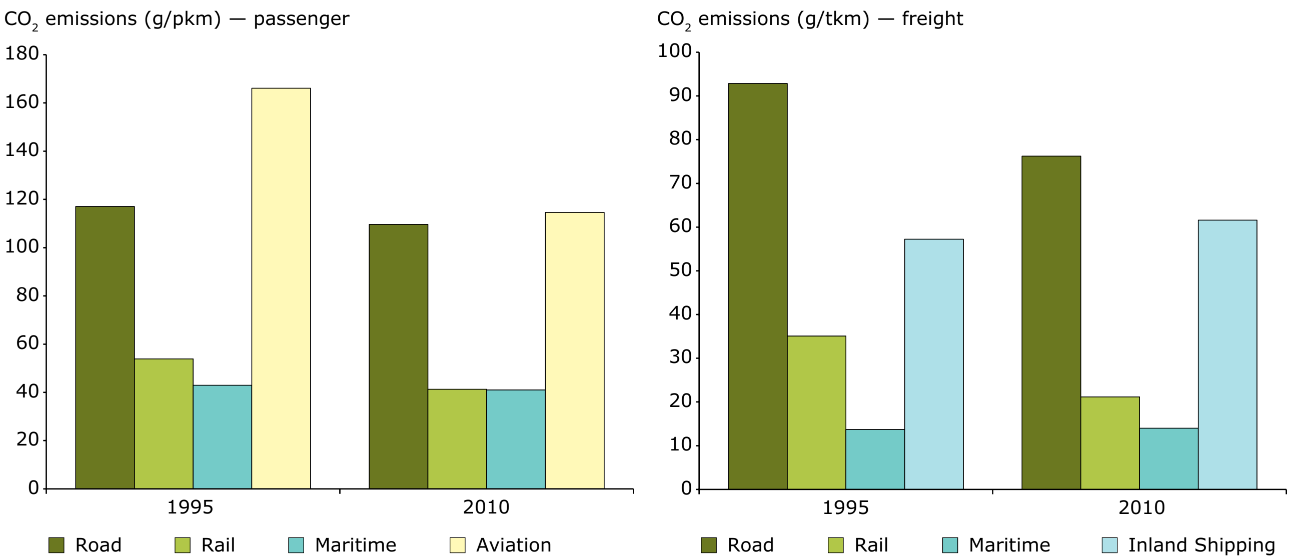
In particular, the number of new alternatively fuelled cars has rapidly increased in the last few years, possibly influenced by a combination of economic incentives and improved cost-effectiveness compared to conventional fuels, due to high oil prices and cost sensitivity arising from the economic recession. In spite of this, the total number of AFVs is still really small.

A factor that has limited the benefits of new technologies is the rate of market penetration of these technologies; the average age of most road vehicles in the EEA has increased by over 20 % from 1995 to 2010 for most vehicle types. For cars, this is due to greater rates of purchase versus scrappage, and the number of cars per head of population has also increased by over 30 % since 1995. The numbers of buses and trucks have also increased to a lesser degree — by 20 % (per head of population) and 10 % (per million euro GDP) respectively. This illustrates that new technologies need a long time to penetrate fully — an important influence for the future, particularly if vehicle lifetimes increase further.

Figure 6.3 Estimated specific emissions of CO_2 by mode of transport (EEA-30)

Although specific emissions from maritime shipping are low, they have not dropped significantly in the last decades, whilst activity has substantially increased. The recent amendments to MARPOL Annex VI Regulations with respect to GHG — discussed in this section — are expected to lead to improvements in the future.

The total numbers and fleet proportion of alternatively fuelled vehicles (AFVs) has steadily increased in the last decade (see Box 2.13), and it is anticipated that the trend will continue, with increasing numbers of electrified vehicles.



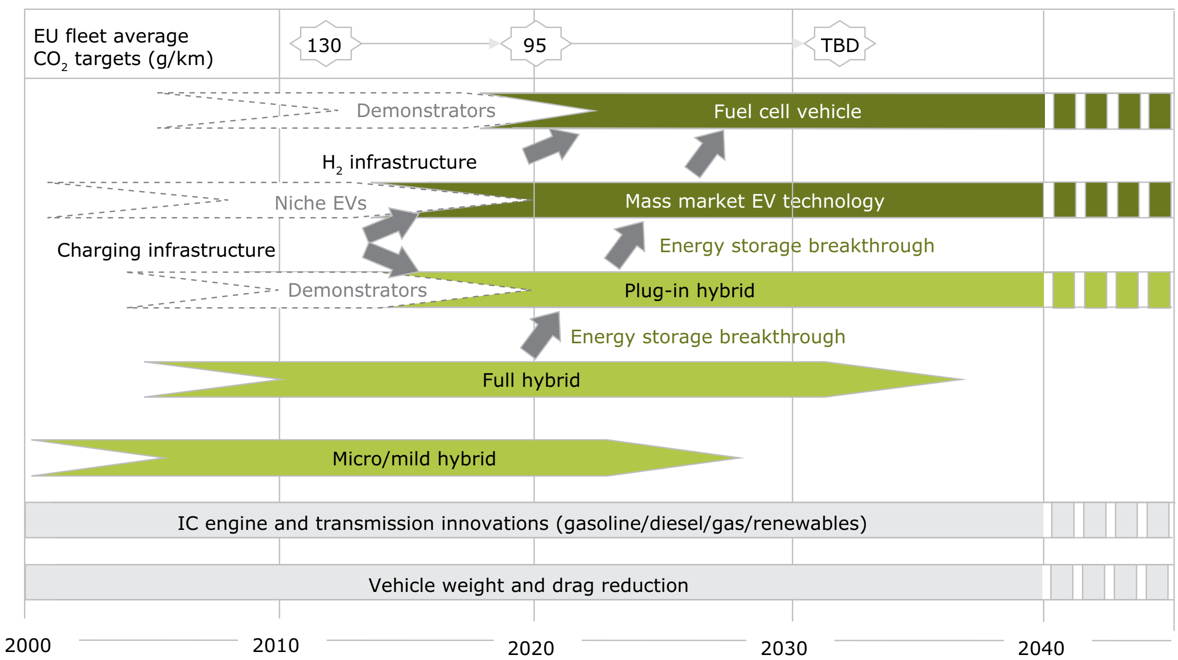
Note: EEA-30 = EU-27 plus Norway, Switzerland, Turkey. 2010 specific emissions for inland shipping are higher than in 1995. However, they increased from 1995 to 2000, but have been on a downward trend since 2000.

Source: TML, 2010.

The effect is somewhat mitigated by the fact that older vehicles are generally used less than newer ones. For example, this means that the emissions reductions achieved are higher than the penetration of Euro standards or other technologies in stock terms may suggest. Since lifetimes are much longer in other modes, i.e. rail, air and shipping, this effect is even more pronounced where lifetimes can range between 20 and 40 years. This is one of the largest barriers to making progress quickly enough to reduce GHG emissions from these modes. Action is therefore particularly urgently needed to ensure the introduction of more efficient vehicles and less GHG-intensive fuels into the fleets.

In terms of longer term developments, the White Paper on Transport includes an objective to: halve the use of 'conventionally fuelled' cars in urban transport by 2030; phase them out in cities by 2050; achieve essentially CO_2-free city logistics in major urban centres by 2030. However, at the moment there appears to be no obvious mechanism for evaluating progress against the objective, as the definition of the target clearly states that the use of 'conventionally fuelled' cars in urban transport is what should be monitored, and not the penetration of alternatively fuelled vehicles across the entire fleet. Monitoring this target will be dependent on the timely introduction of city-level actions, and eventually data availability (i.e. share of conventional ICE cars in passenger transport activity). Among the alternatives to current transport fuels, electric mobility is the most likely candidate to attain this objective, as well as contributing to the overall 60 % reduction target. Modelling carried out for the White Paper's Impact Assessment (EC, 2011d) show that almost all new cars should use some form of electric propulsion by 2050. The electrification of transport has many advantages, such as the highest engine efficiency of existing propulsion systems (ETC/ACC, 2009), life-cycle emissions from energy consumption that will decrease as power generation decarbonises (CE Delft, 2010), and partially existing electricity distribution infrastructure (versus the need for an entirely new infrastructure for hydrogen). Apart from rail (where the technology is mature), the debate on the electrification of transport is usually focused on passenger cars and light commercial vehicles. However, there are existing applications in bikes and motorbikes, trucks and buses; each vehicle type could play a role in the future. There is already emerging industry consensus around the electrification pathway for light-duty vehicles, as illustrated in Figure 6.4 (Automotive Council, 2011). This schematic provides, in a very generalised way,

Figure 6.4 Industry consensus passenger car technology roadmap



Note: The figure provides a representation of the inter-linkages between related technology areas and likely timings. The arrows in-between technologies depict the elements necessary to enable transition to an alternative option, and are not intended to provide a preference hierarchy or the likely distribution between different competing technologies.

Source: Automotive Council, 2011.

the inter-relationship and timing between different technical options without judgement on the likely relative contribution of different technologies. Other studies have produced scenarios that seek to assign more specific quantitative judgements on the potential development pathways and mix of technologies, such as in the GHG-TransPoRD (Akkermans et al., 2010), TOSCA (Schäfer et al., 2011), REACT (Bresciani et al., 2011) and EU Transport GHG: Routes to 2050 (AEA et al., 2010) projects.

At the moment, the extent of the role hydrogen fuel-cell vehicles might have is uncertain, as there are many obstacles to be overcome. On a total energy chain efficiency basis, hydrogen is less efficient, requiring greater amounts of primary energy. However, the current range issues for electric vehicles used in longer distance applications make hydrogen technologies more attractive if costs come down. Looking to the longer term (2040–2050), it seems that mass-market electric-vehicle technology and fuel-cell vehicles are two different development trends that remain options for automotive industry.

While the level of uncertainty around the electrification of transport is perhaps less than that for the sustainability of biofuels, risks remain. These have been explored in detail for both biofuels and electricity under a task for the EU Transport GHG: Routes to 2050 II project (Smokers et al., 2011). Besides the availability of low-carbon electricity, the other major risk revolves around breakthroughs in electrical energy storage that will be needed to make electric vehicles a more practical and cost-effective alternative. Substantial R&D resources are therefore being targeted towards resolving such issues worldwide.

Although there are sizeable barriers to overcome, the potential long-term benefits are believed to be so great that it is most likely a case of 'when' rather than 'if' for transport electrification. A further important consideration is the impact uptake of electric vehicles may have on electricity production and distribution. In 2008, the transport sector was responsible for just 2.5 % of total EU-27 electricity consumption (almost entirely due to rail). A recent study has found that the absolute increase in total electricity demand would be relatively small (between 10 % and 15 %) even with complete electrification of the European vehicle fleet (CE Delft, 2011b). There is also the potential for alternative business models (Better Place, 2011) and behavioural change to facilitate the uptake of alternative road transport technologies, through a shift from private vehicle ownership towards mobility services. Mobility service providers would be likely to be much more sensitive to the cost savings associated with new more efficient technologies and may be able to justify the associated higher initial vehicle costs. Developments in the charging infrastructure and electricity grid, including standardisation, communication and management technologies, are needed to encourage widespread use; different electric vehicle business models and examples across Europe show that these developments are currently underway. However, the challenge of a transition should not be underestimated, as it will involve significant structural changes in both the transport and the energy sector that will take several decades to start up, roll out and complete (Smokers et al., 2011).

There are also important technological challenges beyond land-based transport to consider. For aviation, IATA announced in 2010 it was targeting improvements in the aircraft fleet efficiency of 1.5 % per annum to 2020 and achieving carbon-neutral growth after 2020 (IATA, 2010). Later in 2010, ICAO went even further in producing a resolution which included an aspirational goal of annual energy efficiency improvements of 2 % up to 2050 and development of a CO_2 standard for aircraft engines by 2013, amongst other measures (ICAO, 2010).This compares to the historical trend of improvement at around 1 % per annum. However, these figures are really small compared to the 50 % growth in air passenger transport in the EU-27 between 1995 and 2009.

For international shipping, the white paper's target for maritime fuels complements the EU efforts in support of the IMO that in July 2011 agreed several amendments to MARPOL Annex VI Regulations to reduce emissions of GHGs from international shipping. The agreement makes energy efficiency standards mandatory for all new ships and is expected to save up to 50 million tonnes of CO_2 each year by 2020 and up to 240 million tonnes of CO_2 each year by 2030 from international maritime transport (IMO, 2011). For new ships, the Energy Efficiency Design Index (EEDI) will require a step-wise increase in efficiency from 10 % in 2015, through to 30 % from 2025 onwards. However, there is currently a waiver available for ships registered in developing countries until 2019. Due to the long lifetimes of ships (typically from 20 to 30 years), the effects will take a long time to penetrate through the world fleet and make a significant impact.

7 Monitoring CO_2 emissions from light-duty vehicles

With regulation on CO_2 emissions from cars and vans now agreed, a course towards a fleet of low-emission vehicles has been set. The type-approval measurement procedure that forms the basis for the regulation does not, however, fully capture all energy-consuming technologies on a vehicle, and it will never be able to account for the influence of the driver and his or her driving style on fuel consumption. As a result, while there is correlation between the type-approval and in-use CO_2 emissions, the magnitude of the reductions gauged from the type-approval conditions does not necessarily lead to an equal reduction of the in-use consumption.

7.1 Introduction

The voluntary commitment of the automotive industry to reduce average emissions of new cars, acknowledged by the European Commission in its Recommendation 1999/125/EC (EC, 1999b), was the first attempt of the European Union to set CO_2 emission targets for new passenger cars. Although significant emission reductions were achieved by the vehicle manufacturers, the industry failed to meet the targets it had itself defined (140 g/km in 2008/2009).

As a result, the European Parliament and the Council issued Regulation No 443/2009 (EC, 2009a) introducing mandatory CO_2 emissions limits for new passenger cars. The regulation specifies that vehicle manufacturer must achieve a fleet average CO_2 emission target of 130 g/km by 2015 for all new cars registered in the EU. In order to meet the CO_2 emission target of 120 g/km, a further reduction of 10 g/km is to be achieved via additional measures, e.g. tyre pressure indicators and low rolling resistance tyres. The regulation also defines a long-term target of 95 g/km to be reached by 2020.

According to the regulation, a so-called LV curve sets specific emissions targets for each manufacturer based on the average vehicle mass sold by the particular manufacturer. This is an empirical curve which has been developed in order to avoid distorting the market, taking into account the different market segments of various vehicle manufacturers. This curve is set in such a way that heavier cars will have to improve more than lighter cars compared to current standards, but that manufacturers will still be able to make cars with emissions above the LV curve provided these are balanced by cars which are below the curve.

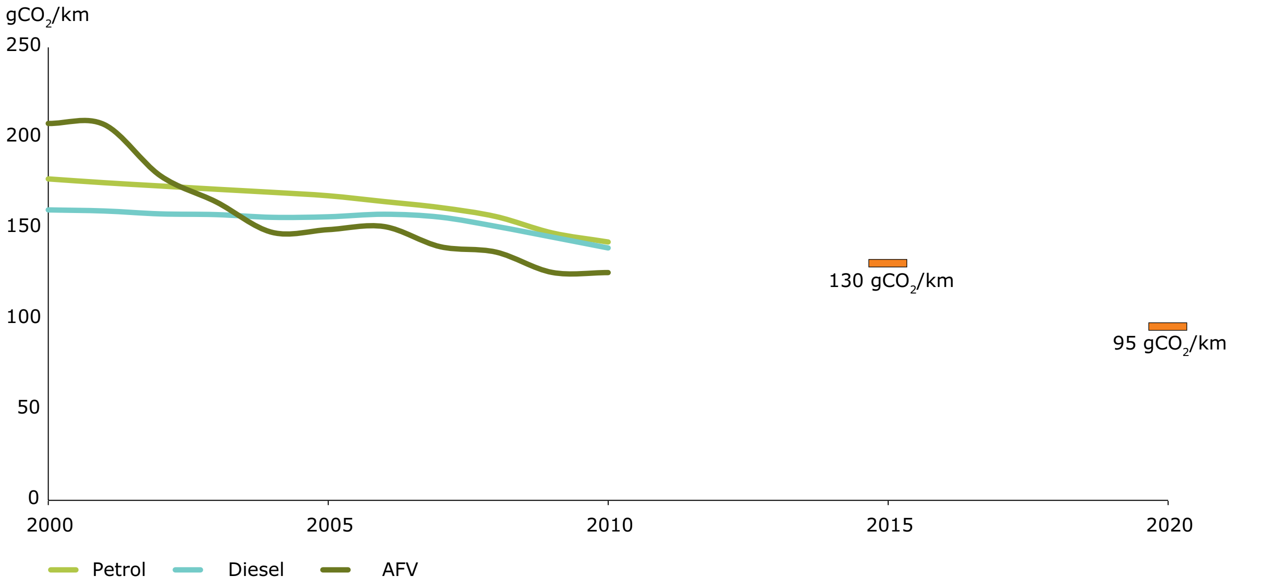
7.2 Summary of monitoring data for 2010

Manufacturers' progress is monitored each year by the Member States on the basis of new car registration data. On this basis, EEA aggregates a EU-wide data set as a basis for monitoring under the regulation. Detailed data are made available in a public EEA database. The database includes details on volumes of vehicle models registered in each Member State, providing information on the vehicle weight, engine capacity, footprint, fuel type and specific CO_2 emissions of each car. Data for the time series from 2001 to 2009 were gathered via the Monitoring Decision 1753/2000/EC (EC, 2000) which was repealed by Regulation No. 443/2009 in 2009 (EC, 2009a). Data for 2010 is provisional as data are still undergoing final review. Final data will be published in December 2011.

The EU-27 is improving its performance in terms of CO_2 emissions from passenger cars: average CO_2 emissions are currently 140.3 gCO_2/km, 5.4 gCO_2/km less than in the previous year. This is the second largest drop in specific emissions since the beginning of the monitoring scheme.

As observed in the previous years (except 2009), dieselisation of the fleet is continuing. However, the relative benefits of dieselisation are decreasing (as shown in Figure 7.1); the emission gap between diesel and petrol vehicles (3.3 gCO_2/km) is considerably lower than it was a decade ago, when

Figure 7.1 Evolution of CO_2 emissions from new passenger cars by fuel type



Note: Data for 2000 and 2001 are less reliable due to missing data from some countries. From 2004 onwards 10 new EU Member States included; 2010 data are provisional.

Source: EEA, 2011.

the difference was 17 gCO_2/km. The decreasing efficiency advantage of diesel over petrol should be assessed against the increases in emissions of NO_X and PM that diesel is responsible for.

Compared to the last year before the economic recession (2007), vehicle registrations decreased by around 2.3 million in 2010. The majority (95 %) of the registrations took place in the EU-15, where a new passenger car emitted 7.9 gCO_2/km less than the average vehicle in the EU-12. Compared to the previous year, the decrease of CO_2 emissions from new passenger cars was greater in 2010 in the EU-12 (6.0 gCO_2/km) than in the EU-15 (5.3 gCO_2/km).

The weight of cars increased considerably after a sharp decrease in 2009, and is now back at the level seen in the years prior to the economic crisis. Despite this, advances in vehicle technology helped in improving the fuel efficiency and in cutting the average CO_2 emissions per kilometre travelled.

7.3 Alternative fuel vehicles

AFVs exhibit significant reductions in their CO_2 emissions over the years, falling from 208 g/km in 2000 to 126 g/km in 2010. Until 2009, the reporting for this category of vehicles was less complete — in particular in the earliest years of the reporting — and the uncertainty is therefore greater. Table 7.1 explores this part of the data set.

The registration of AFVs has been increasing substantially over the years. In the early 2000s, AFVs were dominated by dual fuel vehicles, i.e. vehicles mostly able to operate on petrol and ethanol blends. This trend gradually changed as a result of the increasing introduction of petrol-LPG and petrol-NG cars that have greatly outnumbered cars running on petrol-ethanol blends. LPG cars can be provided by all manufacturers and are particularly popular in Italy, Poland and Slovakia. The average engine capacity of AFVs dropped from about 1 700 cm^3 in the beginning of the 2000s to less than 1 400 cm^3 in 2010. Hence, the significant drop in CO_2 emissions from AFV vehicles over the years is the result of a large number of factors; these are not only technology oriented, but are also owing to market-related reasons.

Table 7.1 Evolution of AFV characteristics (2000–2010, EU-27)

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Biodiesel	Registrations	0	0	0	0	0	0	0	0	0	0	52
	Average engine capacity	0	0	0	0	0	0	0	0	0	0	1 943
Dual fuel	Registrations	13 416	12 914	6 679	0	0	0	0	0	0	0	0
	Average engine capacity	1 431	1 583	1 600	0	0	0	0	0	0	0	0
Ethanol	Registrations	0	0	0	0	0	0	0	0	8	1 172	13 220
	Average engine capacity	0	0	0	0	0	0	0	0	1 798	1 811	1 741
Electric	Registrations	0	0	1	145	75	0	9	0	38	158	663
	Average engine capacity	0	0	0	0	0	0	0	0	0	0	1 279
LPG	Registrations	0	1 817	4 928	2 292	3 307	11 574	34 786	89 942	161 544	497 983	359 271
	Average engine capacity	0	1 736	1 658	1 426	1 584	1 528	1 469	1 341	1 330	1 313	1 312
NG	Registrations	117	108	4 301	13 101	19 904	25 458	14 410	21 654	22 876	17 943	78 989
	Average engine capacity	1 581	1 709	1 801	1 682	1 587	1 576	1 789	1 768	1 790	1 704	1 389

Note: Dual fuel includes petrol-LPG, petrol-NG cars and possibly other dual-fuel vehicles. Up to 2009, ethanol may include various petrol-ethanol blends. For 2010, it refers to E85 only.

Source: EEA, 2011.

7.4 Trends within individual engine capacity classes

Figure 7.2 (top) illustrates that petrol registrations are dominated by small cars (< 1 400 cm^3), followed closely by medium-sized cars (1 400–2 000 cm^3), whereas large cars (> 2 000 cm^3) are rated third by a large difference. Interestingly, the difference between small and medium-sized cars increases with time, and reaches a maximum in 2009 and 2010. The most important factor behind the 2009 peak in small car registrations is the introduction of incentives (scrappage schemes), primarily in Germany. The registrations of medium and large petrol cars exhibit a significant and monotonic drop after 2005.

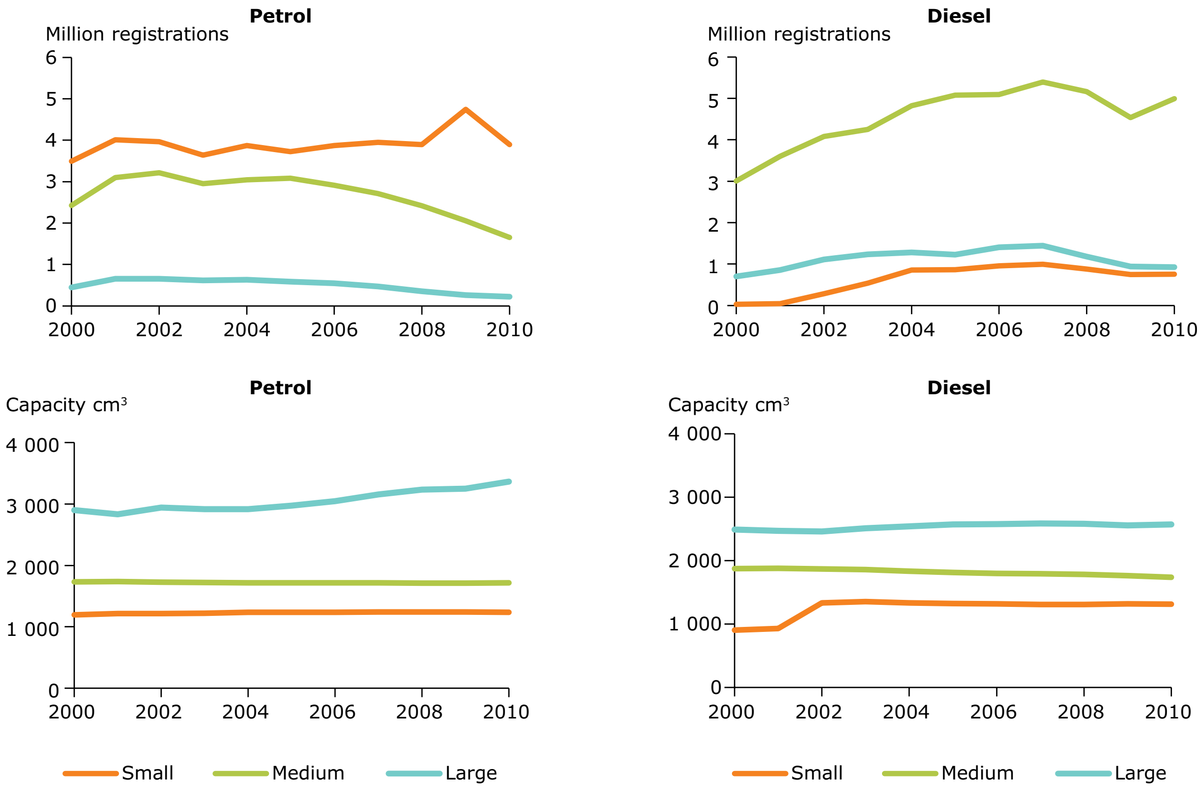
On the contrary, diesel registrations are dominated by medium-sized cars. The small ones are third in numbers. The significant difference in the relative contribution of the various engine capacity classes between petrol and diesel vehicles is the main reason for a mere marginal difference in their specific CO_2 emissions, despite the overall better efficiency of diesel engines.

Average engine capacity also varies from year to year within each vehicle class, as shown in Figure 7.2 (bottom). Large petrol cars in particular exhibit an increasing trend, increasing from 2 900 cm^3 in 2000 to 3 360 cm^3 in 2010. The small petrol-car class also increased slightly in average capacity from 1 197 cm^3 in 2000 to 1 243 cm^3 in 2008. Only over the two last years, i.e. 2009 and 2010, a relative stabilisation or slight decrease in capacity has been observed, when it marginally dropped to 1 238 cm^3 in 2010. This trend is important as a variety of new models of capacity less than 1 000 cm^3 have started to appear, and will be expected to bring down the mean capacity in this class even further.

The diesel trend has been somewhat different. In principle, the small category did not exist before 2002. After this, capacity was rather stable without any particular trends, around 1 300 cm^3. The capacity in the medium-diesel class has dropped over time from 1 900 cm^3 to 1 740 cm^3. This is mainly because many more engines in the 1 400 cm^3 to 1 600 cm^3 size category have started to appear lately. The large diesel category exhibited an increase in the years 2007 and 2008, reaching about 2 600 cm^3 (less than the equivalent petrol one), but has stabilised or marginally dropped since then.

The data set contains information about individual manufactures' performance, but the data is still provisional. Therefore firm conclusions on the performance of individual ones will only be published in December together with the final data set.

Figure 7.2 Evolution of capacity classes over the years (EU-27)



Note: Small: < 1 400 cm³; medium: 1 400–2 000 cm³; large: > 2 000 cm³.

Source: EEA, 2011.

7.5 Laboratory testing versus real-life driving

Regulation No. 443/2009 (EC, 2009a) does not specify the technology by which the average CO_2 levels should be reached (technology-neutral approach) by each manufacturer, i.e. whether small, petrol, diesel, hybrid, plug-in hybrids, electric or alternative fuel vehicles should be introduced, as long as the average CO_2 emission level is reached.

The CO_2 emission levels referred to are the ones found in the certification test procedure (i.e. the New European Driving Cycle (NEDC) to be used for emission measurement). These levels are measured under laboratory conditions assuming a specific mix of different driving styles. In this sense, measurements are comparable, but they are not necessarily representative of real-world conditions. There are at least two sources of error, explained below.

- Each new technology has advantages and disadvantages. Some are better for urban driving and others for long-distance driving. For example, a hybrid petrol vehicle is a very good performer (low CO_2 emissions) in urban driving through the frequent involvement of the electric motor and the regeneration of braking energy back to the batteries. However, in highway driving where the electric motor has only a secondary role to play and braking is infrequent, a small diesel vehicle may actually be a better performer due to the higher efficiency of the diesel engine over the petrol engine in the hybrid vehicle.

- The assumptions underlying the NEDC do not properly represent actual driving styles of average car users: this is seen in terms of accelerations and speeds, for instance. It is commonly reported in motor magazines that it is difficult to achieve the energy efficiency claimed in advertising of new vehicles, even though the values used are taken from type-approval testing.

Table 7.2 Test-cycle and real-world emissions for vehicles in the Netherlands

Test value gCO_2/km	Real-world emissions for diesel vehicles gCO_2/km	Real-world emissions for gasoline vehicles gCO_2/km	Difference in %
160	193	188	+ 18–21 %
130	169	167	+ 28–30 %
100	142	142	+ 42 %

Source: TNO, 2010.

With the aim to shed some light to the above issue, the research centre TNO (TNO, 2010) carried out a study based on reported fuel consumption and mileage of 240 000 vehicles in the Netherlands. This study led the researchers to conclude that lower emissions during testing do not correspond to a proportional reduction in real-world emissions. This means that the effect of technology development may be smaller than that expected by regulators. Table 7.2 illustrates results.

The survey illustrates that the gap between real-world and test-cycle emissions are more pronounced for the lowest emitting cars, but also that there is still an emission benefit in moving towards lower emissions. An improved test cycle that better represents real-world conditions may be part of the answer, but it will not necessarily solve the problem of different technologies being better suited for specific driving situations (urban, inter-urban, etc.).

7.6 Light commercial vehicles

The EU has recently adopted Regulation No. 510/2011 (EC, 2011c), setting a 175 gCO_2/km short-term and 147 gCO_2/km long-term target for light commercial vehicles (LCVs). The LCV legislation mirrors the CO_2 regulation for passenger cars with each manufacturer having its own overall European fleet average CO_2 target. The short-term target will be phased in between 2014 and 2017, with 70 % of each manufacturer's LCVs to be taken into account in 2014, 75 % in 2015, 80 % in 2016 and 100 % from 2017 onwards.

Emission limits are set according to the mass of vehicle, using a LV curve. The curve is set in such a way that a fleet average of 175 gCO_2/km can be achieved. The LV curve means that heavier vans are allowed higher emissions than lighter vans, while preserving the overall fleet average. Only the fleet average is regulated, so manufacturers will still be able to make vehicles with emissions above the LV curve provided these are balanced by vehicles below the curve.

Under the legislation, the Commission will lay down rules on the data required to monitor the CO_2 emissions of new vans. The Member States will be required to monitor and deliver this data to the EEA as of 2012.

As mentioned above for the passenger cars, the mean CO_2 targets for LCVs refer to the certification test procedure, and thus CO_2 emissions under real-world operation may differ. Obtaining a realistic picture for real-world CO_2 emissions by LCVs is much more difficult than for passenger cars due to the lack of information on in-use fuel consumption from LCVs. In addition to this, the LCV market in Europe is very diverse: there are several vehicle types sold per manufacturer. These types are further distinguished into different vehicle configurations (transmission, chassis configuration, vehicle weight, etc). For example, one common European LCV is offered in 140 variants by the manufacturer, while further variants built by local dealers/garages cannot be excluded.

In order to obtain a picture of the LCV sector that is as representative as possible, a study conducted on behalf of the JRC (JRC, 2011) has collected detailed vehicle specifications and type-approval data for a representative sample of vehicles. These vehicles were then used for simulations to derive their expected in-use fuel consumption. The simulations showed that mean real-world fuel consumption — and hence also CO_2 emissions — was higher than type approval by about 18 % for petrol LCVs, and from 5 % to 15 % for diesel LCVs, depending on the weight class (higher differences for lighter vans).

The first full data set for LCVs will be available for reporting in the TERM 2013.

Acronyms and abbreviations

AFV	Alternatively fuelled vehicle
ASI	Avoid-Shift-Improve
BaP	Benzo(a)pyrene
C_6H_6	Benzene
CH_4	Methane
CNG	Compressed natural gas
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
dB	Decibel
DG	Directorate-General
DG CLIMA	Directorate-General for Climate Action
DG ENER	Directorate-General for Energy
DG ENV	Directorate-General for Environment
DG MOVE	Directorate-General for Mobility and Transport
DPSIR	Driving forces, Pressures, State of the environment, Impacts and societal Responses
E85	Blended fuel, 85 % ethanol, 15 % petrol
EEA	European Environment Agency
EEDI	Energy Efficient Design Index
EMEP	European Monitoring and Evaluation Programme
ETC/ACM	European Topic Centre for Air and Climate Mitigation
ETS	Emissions Trading Scheme
EU ETS	European Emissions Trading Scheme
EV	Electric vehicle
FG-B2	Fragmentation of non-mountainous land areas
f-NO_2	Primary nitrogen dioxide fraction
FQD	Fuel Quality Directive (Directive 2009/30/EC)
gCO_2	Grams of carbon dioxide equivalent
GDP	Gross domestic product
GHG	Greenhouse gas

H_2	Hydrogen
HICP	Harmonised Index of Consumer Prices
HIPOC	Habitat loss or change, Introduced species, Pollution, Over-exploitation and Climate change
HSR	High speed rail
IATA	International Air Transport Association
IC	Internal combustion
ICAO	International Civil Aviation Organisation
ICE	Internal combustion engine
IEE	Intelligent Energy Europe
ILUC	Indirect land use change
IMO	International Maritime Organisation
IPCC	Intergovernmental Panel on Climate Change
IWW	Inland waterways
JRC	Joint Research Centre
LCV	Light commercial vehicle
L_{den}	Day-evening-night noise levels
LNG	Liquefied natural gas
L_{night}	Night time noise levels
LPG	Liquefied petroleum gas
LRTAP	Long-range Transboundary Air Pollution
LSVA	distance-related heavy vehicle fee
LULUCF	Land Use, Land-Use Change and Forestry
LV	Limit value
MARPOL	International Convention for the Prevention of Pollution from Ships
MIT	Massachusetts Institute of Technology
MJ	Megajoule
$MtCO_2e$	Million tonnes of CO_2-equivalent
MTOE	Mega tonne oil equivalent
n/a	not available, not applicable
NAIADES	Navigation and Inland Waterway Action and Development in Europe
NEC	National Emission Ceilings
NECD	National Emission Ceilings Directive (Directive 2001/81/EC)
NEDC	New European Drive Cycle
NG	Natural gas
NH_3	Ammonia
NMVOC	Non-methane volatile organic compound

NO	Nitrogen monoxide
NO_2	Nitrogen dioxide
NO_X	Oxides of nitrogen
NRMM	Non-road mobile machinery
NTUA	National Technical University Athens
O_3	Ozone
PAH	Polycyclic aromatic hydrocarbons
pkm	Passenger-kilometre
PM	Particulate matter
PM_{10}	Particulate matter with a diameter of 10 micrometres or less
$PM_{2.5}$	Particulate matter with a diameter of 2.5 micrometres or less
POPs	Persistent organic pollutants
PSI	Paul Scherrer Institute
R&D	Research and development
REACT project	Supporting Research on Climate-friendly Transport
RED	Renewable Energy Directive (Directive 2009/28/EC)
SO_2	Sulphur dioxide
SO_X	Oxides of sulphur
TEN-T	Trans-European Transport Network
TERM CSIs	Transport and Environment Reporting Mechanism Core Set of Indicators
TERM	Transport and Environment Reporting Mechanism
TJ	Terajoule
tkm	Tonne-kilometre
TOSCA project	Technology Opportunities and Strategies towards Climate friendly transport
TRENDS	TRansport and ENvironment Database System
UNECE	United Nations Economic Commission for Europe
UNFCCC	United Nations Framework Convention on Climate Change
VOC	Volatile organic compound
WHO	World Health Organization
WLTP	Worldwide harmonised light-duty test procedure

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Annex 1 Metadata and supplementary information

Throughout the report, abbreviations are used to refer to specific country groupings. The following definitions are used:

- EU-15: Belgium, Denmark, Germany, Ireland, Greece, Spain, France, Italy, Luxembourg, the Netherlands, Austria, Portugal, Finland, Sweden and the United Kingdom;
- EU-10: the Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Slovenia and Slovakia;
- EU-12: EU-10, Bulgaria and Romania;
- EFTA-4: Iceland, Liechtenstein, Norway and Switzerland;
- EU-25: EU-15 and EU-10;
- EU-27: EU-15 and EU-12;
- EEA-32: EU-27, EFTA-4 and Turkey.

Chapter	Supplementary information	
1 Introduction	No metadata for Chapter 1	
2 Environmental baseline and targets	**Table 2.1** **Note:** **Source:**	**Relevant transport targets up to 2050** Transport-specific targets from policy and legislation that are covered in the TERM CSIs, from different sources EEA, 2011
	Table 2.2 **Note:** **Source:**	**Other key transport-related targets relevant to the TERM** Other important targets and aims relevant to the TERM, albeit not explicitly mentioned or specifically related to transport EEA, 2011
	Table 2.3 **Note:** **Source:**	**Other key transport issues relevant to the TERM** Key signals that are relevant for the environmental performance of transport where it is considered useful to monitor evolution. EEA, 2011
	Figure 2.1 **Source:**	**Conceptual map for the new TERM approach** EEA, 2011
	Box 2.2 **Note:** **Source:**	**TERM 01 Figure: Transport final energy consumption by fuel** EU-27 plus Norway, Switzerland and Turkey. Covers the years 1990, 1995, 2000, 2005 and 2009. EEA indicator, TERM 01. Based on data from Eurostat (2011)
	Box 2.3 **Note:** **Source:**	**TERM 02 Figure: Transport emissions of greenhouse gases** EU-27 EEA indicator, TERM 02. Data from http://dataservice.eea.europa.eu/PivotApp/pivot.aspx?pivotid=475 online.
	Box 2.4 **Note:** **Source:**	**TERM 03 Figure: Transport emissions of air pollutants** EEA-32 data for 1990–2009 from reporting under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP). EEA indicator, TERM 03.

Chapter	Supplementary information	
	Box 2.5	**TERM 04 Figures. Exceedances of air quality objectives due to traffic**
	Note:	EEA-32 Annual mean NO_2 and PM_{10} concentrations observed at urban background stations, 1999–2009. Only urban and sub-urban background monitoring stations have been included in the calculations. The two highest NO_2 concentration classes (red and orange) correspond to the 2010 annual LV (40 µg/m³) and to the LV plus margin of tolerance (42 µg/m³). The two highest PM_{10} concentration classes (red and orange) correspond to the 2005 annual LV (40 µg/m³) and to a statistically derived level (31 µg/m³) corresponding to the 2005 daily LV. The lowest class corresponds to the WHO air quality guideline for PM_{10} of 20 µg/m³.
	Source:	EEA indicator, TERM 04. Based on data from AirBase v5.
	Box 2.6	**TERM 05 Figure: Exposure to and annoyance by traffic noise**
	Note:	Current baseline year/date: 2007
	Source:	EEA indicator, TERM 05. Based on data from Noise Observation and Information Service — NOISE
	Box 2.7	**TERM 12a/b Figure: Passenger transport volume and modal split within EU**
	Note:	Passenger transport pkm for the EU-27 for 1995, 2000, 2005 and 2009.
	Source:	EEA TERM 12a/b indicator, EC, 2011i.
	Box 2.8	**TERM 13a/b Figure: Freight transport volume and modal split within EU**
	Note:	Freight transport tkm for the EU-27 for 1995, 2000, 2005 and 2009.
	Source:	EEA TERM 13a/b indicator, EC, 2011i.
	Box 2.9	**TERM 20 Figure: Real change in transport prices by mode**
	Note:	Only EU-25 included as inclusion of Bulgaria and Romania distorts the figure due to very low real prices (total Harmonised Index of Consumer Prices (HICP)) in the 1990s. Data series covers 1996–2010.
	Source:	EEA indicator, TERM 20. Based on data from Eurostat (2011).
	Box 2.10	**TERM 21 Figure: Fuel prices and taxes**
	Note:	Coverage is EU-27 for 1980–2010.
	Source:	EEA indicator, TERM 21. Based on data from Energy DG and Eurostat (2011).
	Box 2.11	**TERM 27 Figure: Energy efficiency and specific CO_2 emissions**
	Note:	Average CO_2 emissions for new cars sold in the EU-27 for 2000–2010.
	Source:	EEA indicator, TERM 27. Based on data from European new passenger car CO_2 monitoring from (EC, 2009a) compiled by EEA.
	Box 2.12	**TERM 31 Figure: Uptake of cleaner and alternative fuels**
	Note:	EEA-32 member countries excluding Iceland and Liechtenstein.
	Source:	EEA indicator, TERM 31. Based on data from Eurostat (2011)
	Box 2.13	**TERM 34 Figure: Proportion of vehicle stock by alternative fuel type, selected EEA-32 Member states (cars)**
	Note:	Includes data for 17 of the EEA-32 member countries. The following Member States were excluded due to insufficient data being available: Bulgaria, Czech Republic, Cyprus, Denmark, Germany, Greece, Iceland, Ireland, Lithuania, Malta, Portugal, Romania, Slovenia, Slovakia and Spain.Data covers the period 2004–2009, since data prior to this (back to 2000) had significant additional data gaps.
	Source:	EEA indicator, TERM 34. Based on data from Eurostat (2011)
	Box 2.13	**TERM 34 Figure: Proportion of vehicle stock by alternative fuel type, selected EEA-32 Member states (buses)**
	Note:	Includes data for 21 of the EEA-32 member countries. The following Member States were excluded due to insufficient data being available: Cyprus, Denmark, Iceland, Ireland, Lithuania, Malta, Portugal, Romania, Slovenia, and Spain. Data for Turkey were also excluded as they significantly distorted the overall trend. Data covers the period 2004–2009, since data prior to this (back to 2000) had significant additional data gaps.
	Source:	EEA indicator, TERM 34. Based on data from Eurostat (2011).
	Figure 2.2	**The contribution of the transport sector to total emissions of GHG 2009, EEA-32**
	Note:	Total GHG emissions are total emissions (sectors 1–7, excluding 5. LULUCF) plus bunkers. Other transport includes navigation, civil aviation (domestic aviation) and diesel rail. Electric rail, agricultural and fisheries related transport emissions are not included as transport.
	Source:	EEA indicator, TERM 02. EEA 2011. Data from http://dataservice.eea.europa.eu/PivotApp/pivot.aspx?pivotid=475 online.

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	Figure 2.3 Trends and targets, EU-27 GHG emissions **Note:** Dashed lines represent data series extrapolation from 2009 to 2010 using proxy data **Source:** EEA indicator, TERM 02. EEA 2011. Data from http://dataservice.eea.europa.eu/PivotApp/pivot.aspx?pivotid=475 online.
	Table 2.4 Distribution and change of transport energy consumption between modes **Note:** EEA-30 is EEA32 without Iceland and Liechtenstein. Bunkers include international aviation and international maritime bunkers **Source:** Eurostat 2011, Table NRG_100A, Supply, transformation, consumption — all products — annual data available from the website of Eurostat.
	Figure 2.4 Mega Tonnes Oil Equivalent (MTOE) used by transport mode, EEA-30 **Note:** EEA-30 is EEA-32 without Liechtenstein and Iceland International Maritime Bunkers cover the quantities delivered to sea-going vessels of all flags. Vessels engaged in inland and coastal water transport are not included. **Source:** EEA indicator, TERM 01. EEA 2011. Data from Eurostat, 2011.
	Figure 2.5 The contribution of the transport sector to total emissions of the main air pollutants in 2009, EEA-32 **Note:** Labels are not shown for those transport sub-sectors contributing < 1 % to total emissions. The contribution made to total emissions by each of the various non-transport sectors can be found in (EEA, 2011d). **Source:** EEA indicator, TERM 03. EEA 2011. Data from LRTAP dataviewer. http://dataservice.eea.europa.eu/PivotApp/pivot.aspx?pivotid=478 online.
	Figure 2.6 Change in emissions of the main air pollutants 1990–2009, EEA-32 **Note:** SO_x (upper line) excludes emissions from international shipping for Spain due to a time-series consistency issue in the reported data. Spain will recalculate emissions from this source in their next inventory submission. **Source:** EEA indicator, TERM 03. EEA 2011. Data from LRTAP data viewer http://dataservice.eea.europa.eu/PivotApp/pivot.aspx?pivotid=478 online.
	Figure 2.7 Change in emissions by transport sub-sector for NO_x (top) and $PM_{2.5}$ (bottom), EEA-32 **Note:** Labels are not shown for those transport sub-sectors contributing < 1 % to total emissions. The contribution made to total emissions by each of the various non-transport sectors can be found in (EEA, 2011a). Significant progress has been made since 1990 in reducing the emissions of many air pollutants from the transport sector. Nevertheless, many cities and other urban areas are facing challenges in meeting concentration limits set in EU legislation for air quality pollutants — road transport in particular makes a large contribution to urban air quality. The European Commission has recently announced a comprehensive review of the EU's 'Air' legislation, to be undertaken by 2013 at the latest. Various short-term actions are also planned, including a revision of the sulphur content of bunker fuels, and a prioritisation of various EU actions including addressing 'real-world' emissions. **Source:** EEA indicator, TERM 03. EEA 2011. Data compiled by European Topic Centre for Air and Climate Change.
	Figure 2.8 NO_2 (top) and PM_{10} (bottom) concentration trends at urban background (left) and traffic locations (right) **Note:** NO_2 concentration in selected cities in 2002–2009. Bottom: PM_{10} concentrations in selected cities in 1999–2009. Values are presented for single monitoring stations that provide reliable time series data for last years (see previous note). Cities are selected as they have at least one background and one traffic station that provide such reliability and therefore can be compared for analysis. The analysis is therefore not presenting air quality results citywide, but just a snapshot of the different trends in background and traffic stations wherever we have comparable — long time series - data. Because the different lines represent individual measurement points there can be a significant effect from local changes in traffic flows. According to sources, this is part of the background for the large change in the NO_2 levels in London. **Source:** EEA indicator, TERM 04. EEA 2011. Based on data from AirBase v5.
	Figure 2.9 Number of people exposed to noise in Europe (EU-27, NO and CH) **Source:** EEA 2011. Based on data from Noise Observation and Information Service — NOISE.
	Map 2.1 Map of seff values by per 1 km² grid for FG-B2 in 2009 **Source:** EEA/FOEN, 2011.
	Figure 2.10 Bar diagram and table of seff values by country for FG-B2 in 2009 **Source:** EEA/FOEN, 2011.

Chapter	Supplementary information
3 Passenger and freight transport demand and modal split	**Figure 3.1 Freight transport volumes and GDP (EEA-32 excluding Liechtenstein)** **Note:** Data from Liechtenstein is not included as it was not available as part of the data set. GDP is expressed in euros at 2000 prices. Freight transport is defined as the amount of inland tkm (road, rail, IWW) travelled every year in the EEA-32. Data for short-sea shipping and pipelines are not included. The two curves show the development in GDP and freight transport columns, while the columns show the level of annual decoupling. Light green indicates faster growth in GDP than in transport while dark green indicates stronger growth in transport than in GDP. The large change in 2004 appears to be tied to a change in methodology but no correction figure exists. **Source:** TERM 13a/b. EEA Core Set Indicator 036 (based on Eurostat, 2011).
	Figure 3.2 Road transport's market share increases strongly in EU-12 **Note:** Percentage share of land freight transport between road and rail transport mode for EU-12, EU-15 and combined EU-27. **Source:** TERM 13a/b. EEA Core Set Indicator 036 (based on Eurostat, 2011).
	Figure 3.3 Trends in passenger transport demand and GDP (EEA-32 excluding Liechtenstein) **Note:** Data from Liechtenstein is not included as it was not available as part of the data set. GDP is expressed in euros at 2000 prices. Passenger kilometres includes transport by road, rail and bus. There is no agreement among the EU Member States on how to attribute the passenger kilometres of international intra-EU flights, therefore aviation data are not included in the figure. The two curves show the development in GDP and passenger transport volumes, while the columns show the level of annual decoupling. Light green indicates faster growth in GDP than in transport while dark green indicates stronger growth in transport than in GDP. The data refer to road, rail and bus modes of transport. **Source:** TERM 12a/b. EEA Core Set Indicator 035 (based on Eurostat, 2011).
	Figure 3.4 Passenger transport modal split (without sea and aviation), 2009 **Note:** Passenger transport modal split, excluding Liechtenstein. **Source:** TERM 12a/b. EEA Core Set Indicator 035 (based on Eurostat, 2011).
4 Optimising transport demand	**Figure 4.1 Personal car use in Europe** **Note:** Data from Liechtenstein is not included as it was not available as part of the data set. Curves show results of car passenger demand in 1 000 million km divided by population. **Source:** EEA indicator TERM 12, car passenger demand, (cites EC, 2011i.) and population (Eurostat).
5 Obtaining a more sustainable modal split	No metadata for Chapter 5
6 Using the best technology available	**Figure 6.1 Transport energy consumption, EEA-30** **Note:** EEA-32 member countries excluding Iceland, Liechtenstein and Switzerland. **Source:** EEA indicator, TERM 01 and TERM 31. Based on data from Eurostat (2011), (AEA, 2010).
	Figure 6.2 Trends in energy GHG emission factors and % renewable electricity, EU-27 **Note:** The figure displays the percentage of renewables in electricity generation for the total EU-27 countries, plus estimates of the carbon intensity of grid electricity and average transport energy in the EU-27. **Source:** EEA TERM 31 indicator. Based on data from Eurostat (2011), IEA (2010) and AEA, (2010).
	Figure 6.3 Estimated specific emissions of CO_2 by mode of transport, EEA-30 **Note:** TREMOVE results refer to 30 EEA member countries (that is EU-27 plus Norway, Switzerland, Turkey), while TRENDS covers only EU-15. **Source:** EEA TERM 27 indicator. Specific CO_2 emissions data for road, rail and inland shipping transport, 1995–2010 from TREMOVE v3.3.1. Specific CO_2 emissions data for air and maritime transport, 1995–2010 from TRENDS.
	Figure 6.4 Industry consensus passenger car technology roadmap **Note:** The figure provides a representation of the inter-linkages between related technology areas and likely timings. The arrows in between technologies depict the elements necessary to enable transition to an alternative option, and are not intended to provide a preference hierarchy or the likely distribution between different competing technologies **Source:** Reproduced from Automotive Council, 2011 — see reference list.
7 Monitoring CO_2 emissions from light-duty vehicles	**Figure 7.1 Evolution of CO_2 emissions from new passenger cars by fuel type** **Note:** Data for 2000 and 2001 are less reliable due to missing data from some countries; From 2004 onwards 10 new EU Member States included; 2010 data are provisional. **Source:** EEA 2011. Data collected by EEA. Data available at http://www.eea.europa.eu/data-and-maps/data/co2-cars-emission online.

Chapter	Supplementary information
	Table 7.1 **Evolution of AFV characteristics (2000–2010, EU-27)** **Note:** Dual fuel includes petrol-LPG, petrol-NG cars and possibly other dual-fuel vehicles. Up to 2009, ethanol may include various petrol-ethanol blends. For 2010, it refers to E85 only. Data for 2000 and 2001 are less reliable due to missing data from some countries; From 2004 onwards 10 new EU Member States included; 2010 data are provisional. **Source:** EEA 2011. Data collected by EEA. Data available at http://www.eea.europa.eu/data-and-maps/data/co2-cars-emission online.
	Figure 7.2 **Evolution of capacity classes over the years (small: < 1 400 cm^3, medium: 1 400–2 000 cm^3, large: > 2 000 cm^3)** **Source:** EEA 2011. Data collected by EEA with support from the European Topic Centre for Air Pollution and Climate Mitigation ETC/ACM. Data available at http://www.eea.europa.eu/data-and-maps/data/co2-cars-emission online.
	Table 7.2 **Test-cycle and real-world emissions for vehicles in the Netherlands** **Source:** TNO, 2010.
Annex 3 Data	**Table A3.1** **Freight inland transport volume by country (1 000 million tkm) (1995–2009)— excluding pipelines** **Source:** EU transport in figures- Statistical pocketbook 2011, Directorate-General for Mobility and Transport , in cooperation with Eurostat. Publications Office of the European Union, Luxembourg (http://ec.europa.eu/transport/publications/statistics/doc/2011/pocketbook2011.pdf). Accessed 19 October 2011.
	Table A3.2 **Modal split of freight transport (% in total inland freight tkm) (1995, 2000, 2005, 2009) —excluding pipelines** **Source:** EU transport in figures- Statistical pocketbook 2011, Directorate-General for Mobility and Transport, in cooperation with Eurostat. Publications Office of the European Union, Luxembourg (http://ec.europa.eu/transport/publications/statistics/doc/2011/pocketbook2011.pdf). Accessed 19 October 2011.
	Table A3.3 **Sea transport of goods (1 000 tonnes) (1997–2009)** **Source:** 'Eurostat Transport Database' (http://epp.eurostat.ec.europa.eu/portal/page/portal/transport/data/database) accessed 19 October 2011.
	Table A3.4 **Total inland passenger transport (1 000 million pkm) (1995–2009): cars, trains, buses, trolley buses and motor coaches by country (1995–2009)** **Source:** EU transport in figures- Statistical pocketbook 2011, Directorate-General for Mobility and Transport, in cooperation with Eurostat. Publications Office of the European Union, Luxembourg (http://ec.europa.eu/transport/publications/statistics/doc/2011/pocketbook2011.pdf). Accessed 19 October 2011.
	Table A3.5 **Modal split of passenger inland transport (cars, trains, buses and motor coaches) by country (1995, 2000, 2005, 2009)** **Source:** EU transport in figures- Statistical pocketbook 2011, Directorate-General for Mobility and Transport, in cooperation with Eurostat. Publications Office of the European Union, Luxembourg (http://ec.europa.eu/transport/publications/statistics/doc/2011/pocketbook2011.pdf). Accessed 19 October 2011
	Table A3.6 **Air passenger transport in EU-27 (1 000 million passenger kilometres) (1995–2009).** **Note:** These data are estimations, not actual statistics. Only domestic and intra-EU-27 transport; provisional estimates. **Source:** EU transport in figures — Statistical pocketbook 2011, Directorate-General for Mobility and Transport, in cooperation with Eurostat. Publications Office of the European Union, Luxembourg (http://ec.europa.eu/transport/publications/statistics/doc/2011/pocketbook2011.pdf). Accessed 19 October 2011.
	Table A3.7 **Number of passenger cars per thousand inhabitants (1990, 1995, 2000, 2005, 2008, 2009)** **Note:** Passenger car stock at end of year n has been divided by the population on 1 January of year n+1. **Source:** EU transport in figures- Statistical pocketbook 2011, Directorate-General for Mobility and Transport, in cooperation with Eurostat. Publications Office of the European Union, Luxembourg (http://ec.europa.eu/transport/publications/statistics/doc/2011/pocketbook2011.pdf). Accessed 19 October 2011.
	Table A3.8 **Greenhouse gas emissions from transport in Europe (million tonnes, unless otherwise stated) Emissions of GHGs by country and sub-sector (1990, 2009)** **Note:** National emissions reported to the UNFCCC and to the EU Greenhouse Gas Monitoring Mechanism. **Source:** EEA data viewer, 2011. (http://dataservice.eea.europa.eu/PivotApp/pivot.aspx?pivotid=475). Accessed 19 October 2011.

Annex 2 Overview of the TERM fact sheets

The TERM indicators have been published annually since 2000, subject to data availability. In 2000, the indicators appeared only in the annual TERM report but they have since been published individually on the EEA website (EEA, 2011e).

When the indicator set was originally defined, it was foreseen that the data that was at that point limited, would eventually become available over time. For this reason, not all indicators have been published every year.

		2000–2004					2005–2009					2010–2011	
TERM 01	Transport final energy consumption by mode	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
TERM 03	Transport emissions of air pollutants	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
TERM 05	Exposure to and annoyance by traffic noise	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
TERM 13a/b	Freight transport volume and modal split (CSI 036)	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
TERM 19	Infrastructure investments	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
TERM 21	Fuel prices and taxes	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
TERM 28	Specific air pollutant emissions	x	x		x		x		x	x	x	x	x

		2000–2004					2005–2009					2010–2011	
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
TERM 31	Uptake of cleaner and alternative fuels (CSI 037)	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
TERM 33	Average age of the vehicle fleet	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
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 3 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 Mobility and Transport DG transport statistical pocketbook. For a full explanation of the data sources, see metadata in Annex 1.

Table A3.1 Freight inland transport volume by country (1 000 million tkm) (1995–2009)— excluding pipelines. EC, 2011i.

Table A3.2 Modal split of freight transport (% in total inland freight tkm) (1995, 2000, 2005, 2009) — excluding pipelines. EC, 2011i.

Table A3.3 Sea transport of goods (1 000 tonnes) (1997–2009). Eurostat, 2011b.

Table A3.4 Total inland passenger transport (1 000 million pkm) (1995–2009): cars, trains, buses, trolley buses and motor coaches by country (1995–2009). EC, 2011i.

Table A3.5 Modal split of passenger inland transport (cars, trains, buses and motor coaches) by country (1995, 2000, 2005, 2009). EC, 2011i.

Table A3.6 Air passenger transport in EU-27 (1 000 million passenger kilometres) (1995–2009). EC, 2011i, only domestic and intra-EU-27 transport; provisional estimates.

Table A3.7 Number of passenger cars per thousand inhabitants (1990, 1995, 2000, 2005, 2008, 2009). EC, 2011i.

Table A3.8 Greenhouse gas emissions from transport in Europe (million tonnes, unless otherwise stated) Emissions of GHGs by country and sub-sector (1990, 2009). EEA data viewer, 2011.

Table A3.1 Freight inland transport volume by country (1 000 million tkm), excluding pipelines

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Austria	42	43	45	47	51	54	57	58	59	60	58	62	61	59	49
Belgium	59	55	57	55	51	66	68	68	66	64	61	60	60	56	50
Bulgaria	14	13	14	13	11	12	13	14	15	18	20	20	21	21	22
Cyprus	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
Denmark	24	23	23	23	25	26	24	24	25	25	25	23	23	21	19
Estonia	5	6	8	10	11	12	13	14	14	16	16	16	15	13	11
Finland	34	34	36	38	40	42	40	42	41	43	42	41	40	42	37
France	233	236	243	251	268	271	267	264	260	267	255	262	271	256	214
Germany	372	368	382	396	418	430	435	430	434	459	470	501	523	521	459
Greece	24	25	26	28	28	29	30	31	33	37	33	35	29	30	29
Hungary	23	23	24	28	28	29	27	27	27	31	36	43	48	48	45
Iceland	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	13
Italy	196	197	201	203	199	208	208	213	194	219	235	211	205	204	185
Latvia	12	15	17	17	16	18	20	21	25	26	28	28	32	32	27
Lithuania	12	12	14	14	16	17	16	20	23	24	28	31	35	35	30
Luxembourg	6	4	5	6	7	9	10	10	10	11	10	10	10	10	9
Malta	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
Norway	12	15	17	18	18	18	18	18	19	20	21	23	23	24	22
Poland	120	125	132	132	127	130	126	128	134	156	162	182	205	217	224
Portugal	34	35	38	39	40	41	43	42	42	43	45	47	49	42	38
Romania	41	48	48	37	31	33	37	44	49	61	77	81	83	80	52
Slovakia	31	29	29	31	30	27	26	26	27	29	33	33	38	40	36
Slovenia	6	6	7	7	7	8	10	10	10	12	14	15	17	20	18
Spain	113	113	122	136	146	160	173	196	204	233	245	253	270	253	219
Sweden	51	52	54	52	52	55	53	56	57	58	60	62	64	65	54
Switzerland	18	17	18	19	19	21	21	21	21	22	22	23	22	26	24
Turkey	121	145	149	161	159	171	159	158	161	166	176	187	191	192	187
United Kingdom	175	181	186	189	185	184	183	183	186	185	184	193	198	185	161

Source: EC, 2011i.

Table A3.2 Modal split of freight transport (% in total inland freight tkm) — excluding pipelines

	Road (%)				Rail (%)				IWW (%)			
	1995	**2000**	**2005**	**2009**	**1995**	**2000**	**2005**	**2009**	**1995**	**2000**	**2005**	**2009**
Austria	63.5	64.8	64.1	59.5	31.6	30.6	32.8	36.4	4.9	4.5	3.0	4.1
Belgium	77.8	77.4	72.4	72.9	12.5	11.6	13.4	12.8	9.8	10.9	14.1	14.3
Bulgaria	36.3	52.3	70.8	82.5	60.0	45.2	25.4	14.6	3.7	2.6	3.7	2.9
Cyprus	100.0	100.0	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Czech Republic	57.8	68.0	74.4	77.8	41.7	31.9	25.5	22.1	0.5	0.2	0.1	0.1
Denmark	91.9	92.2	92.2	90.8	8.1	7.8	7.8	9.2	0.0	0.0	0.0	0.0
Estonia	28.7	32.7	35.4	47.3	71.3	67.3	64.6	52.7	0.0	0.0	0.0	0.0
Finland	71.7	75.8	76.5	75.7	28.1	24.0	23.3	24.1	0.2	0.3	0.2	0.2
France	76.4	75.3	80.5	81.0	20.7	21.3	16.0	15.0	2.8	3.4	3.5	4.1
Germany	63.9	65.3	66.0	67.0	18.9	19.2	20.3	20.9	17.2	15.5	13.6	12.1
Greece	98.8	98.5	98.1	98.2	1.2	1.5	1.9	1.8	0.0	0.0	0.0	0.0
Hungary	58.9	66.4	69.2	78.8	35.9	30.5	25.0	17.1	5.2	3.1	5.8	4.1
Iceland	100.0	100.0	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ireland	90.1	96.2	98.3	99.4	9.9	3.8	1.7	0.6	0.0	0.0	0.0	0.0
Italy	88.9	88.9	90.3	90.4	11.1	11.0	9.7	9.6	0.1	0.1	0.0	0.0
Latvia	15.8	26.5	29.8	30.2	84.2	73.5	70.2	69.8	0.0	0.0	0.0	0.0
Lithuania	41.9	46.6	56.1	59.9	58.0	53.4	43.9	40.1	0.1	0.0	0.0	0.0
Luxembourg	86.4	88.3	92.3	94.6	8.3	7.3	4.1	2.3	5.3	4.4	3.6	3.1
Malta	100.0	100.0	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	63.5	63.5	63.6	63.8	2.9	3.6	4.4	4.9	33.6	32.9	31.9	31.3
Norway	78.2	83.5	85.3	83.4	21.8	16.5	14.7	16.6	0.0	0.0	0.0	0.0
Poland	42.6	57.6	69.0	80.5	56.7	41.5	30.8	19.4	0.7	0.9	0.2	0.1
Portugal	94.1	94.7	94.6	94.3	5.9	5.3	5.4	5.7	0.0	0.0	0.0	0.0
Romania	48.4	42.9	67.3	66.0	44.0	49.1	21.7	21.3	7.6	7.9	11.0	12.7
Slovakia	51.0	53.2	68.9	77.9	44.3	41.7	28.9	19.6	4.7	5.1	2.3	2.5
Slovenia	51.8	65.0	77.3	84.0	48.2	35.0	22.7	16.0	0.0	0.0	0.0	0.0
Spain	90.3	92.8	95.2	96.6	9.7	7.2	4.8	3.4	0.0	0.0	0.0	0.0
Sweden	62.0	64.7	64.0	64.4	38.0	35.3	36.0	35.6	0.0	0.0	0.0	0.0
Switzerland	50.6	46.8	46.0	55.4	49.2	53.0	53.8	44.4	0.3	0.2	0.2	0.2
Turkey	93.0	94.3	94.8	94.6	7.0	5.7	5.2	5.4	0.0	0.0	0.0	0.0
United Kingdom	92.3	90.0	87.8	86.7	7.6	9.8	12.1	13.2	0.1	0.1	0.1	0.1
EU-27	71.7	73.9	76.4	77.8	21.5	19.6	17.6	16.6	6.8	6.5	5.9	5.5

Source: EC, 2011i.

Table A3.3 Sea transport of goods (1 000 tonnes)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
EU-27	:	:	:	:	:	3 334 802	3 452 336	3 570 238	3 718 675	3 835 939	3 937 489	3 918 647	3 433 043
Belgium	161 621	171 026	165 557	179 381	174 181	173 824	181 110	187 889	206 539	218 941	236 320	243 819	203 368
Bulgaria	:	:	:	:	20 192	20 390	21 358	23 125	24 841	27 513	24 900	26 576	21 893
Cyprus	:	:	:	:	:	7 220	7 258	6 837	7 290	7 645	7 476	7 939	6 770
Denmark	124 010	104 966	97 213	96 533	93 972	94 283	103 954	100 373	99 688	107 674	109 660	106 096	90 636
Estonia	:	:	:	:	40 383	44 682	47 048	44 808	46 546	49 998	44 964	36 191	38 505
Finland	:	:	:	:	96 150	99 099	104 439	106 524	99 577	110 536	114 819	114 725	93 239
France	305 079	319 000	315 153	325 789	318 188	319 032	330 135	334 035	341 470	350 334	346 825	351 976	315 534
Germany	213 318	217 388	221 623	242 535	246 050	246 353	254 834	271 869	284 865	302 789	315 051	320 636	262 863
Greece	:	:	:	:	:	147 692	162 534	157 892	151 250	159 425	164 300	152 498	135 451
Iceland	:	4 728	5 034	5 164	4 966	4 771	4 981	5 308	5 653	5 917	:	:	:
Ireland	36 333	39 958	42 928	45 273	45 795	44 919	46 165	47 720	52 146	53 326	54 139	51 081	41 829
Italy	434 295	444 956	425 914	446 641	444 804	457 958	477 028	484 984	508 946	520 183	537 327	526 219	472 499
Latvia	:	:	:	:	56 827	51 978	54 652	54 829	59 698	56 861	61 083	61 430	60 088
Lithuania	:	:	:	:	20 953	24 405	30 242	25 842	26 146	27 235	29 253	36 379	34 344
Malta	:	:	:	:	:	4 990	5 215	5 303	5 283	5 452	5 254	5 501	5 507
Netherlands	402 162	405 384	395 664	405 802	405 853	413 312	410 330	440 722	460 940	477 238	507 463	530 359	468 051
Poland	:	:	:	:	46 210	48 111	51 020	52 272	54 769	53 131	52 433	48 833	45 079
Portugal	54 734	57 619	58 794	56 404	56 164	55 599	57 470	59 071	65 301	66 861	68 229	65 275	61 714
Romania	:	:	:	:	27 619	32 698	35 925	40 594	47 694	46 709	48 928	50 458	36 094
Slovenia	:	:	:	:	9 146	9 305	10 788	12 063	12 625	15 483	15 853	16 554	13 356
Spain	:	:	:	:	315 120	326 001	343 716	373 065	400 019	414 378	426 648	416 158	363 536
Sweden	149 892	155 618	156 349	159 291	152 830	154 626	161 454	167 350	178 122	180 487	185 057	187 778	161 823
United Kingdom	558 530	568 502	565 614	573 050	566 366	558 325	555 662	573 070	584 919	583 739	581 504	562 166	500 863
Norway	:	:	:	:	:	190 034	186 781	198 199	201 678	196 818	198 507	193 368	182 635

Source: Eurostat, 2011b.

Table A3.4 Total inland passenger transport (1 000 million pkm): cars, trains, buses, trolley buses and motor coaches, by country

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Austria	81	82	81	82	84	85	85	86	87	88	89	89	91	94	93
Belgium	118	118	120	123	126	127	129	131	132	134	136	137	141	139	141
Bulgaria	41	40	42	42	44	45	46	49	48	48	51	53	56	59	59
Cyprus	4	5	5	5	5	5	5	5	5	6	6	6	7	7	7
Czech Republic	81	83	82	82	85	87	88	88	90	89	91	93	95	95	95
Denmark	61	62	63	63	64	64	63	62	63	64	63	64	65	66	66
Estonia	8	8	8	9	9	10	9	10	10	10	13	13	13	13	13
Finland	61	62	63	64	66	67	68	69	71	72	73	73	75	75	76
France	737	751	763	786	808	812	840	849	853	855	848	848	856	855	859
Germany	955	956	957	969	990	976	997	1 001	997	1 009	999	1 007	1 011	1 016	1 032
Greece	66	69	73	76	81	87	92	96	100	103	109	114	119	124	124
Hungary	70	71	71	72	73	75	75	76	75	75	74	74	67	68	66
Iceland	3	4	4	4	4	4	4	5	5	5	5	5	6	6	6
Ireland	38	39	41	43	44	46	48	48	49	50	52	54	57	59	57
Italy	749	764	775	797	802	870	863	858	858	865	841	899	921	889	859
Latvia	11	11	12	13	14	15	15	16	16	15	16	18	20	20	19
Lithuania	21	23	24	26	28	29	29	30	32	35	39	44	43	42	39
Luxembourg	6	6	6	6	6	7	7	7	7	7	7	8	8	8	8
Malta	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3
Netherlands	160	159	162	163	167	167	167	169	171	178	176	176	177	176	175
Norway	51	53	54	56	57	58	59	60	60	61	61	62	64	65	66
Poland	171	175	185	196	198	206	211	217	222	230	245	266	286	320	328
Portugal	69	72	76	80	84	87	88	92	96	98	100	100	101	102	101
Romania	71	74	74	73	74	75	75	74	76	78	81	84	87	91	94
Slovakia	37	36	35	35	36	36	36	37	36	36	37	37	37	36	34
Slovenia	21	23	24	24	25	25	25	25	26	26	26	27	28	29	29
Spain	307	320	329	344	363	373	380	386	392	404	413	412	424	427	431
Sweden	104	105	105	106	108	110	111	114	114	115	115	115	118	118	120
Switzerland	91	92	92	93	95	97	97	99	100	101	103	104	106	108	110
Turkey	144	154	164	169	170	172	163	167	171	185	200	213	225	235	234
United Kingdom	694	700	713	719	728	727	742	765	763	761	757	767	773	772	771

Source: EC, 2011i.

Table A3.5 Modal split of passenger inland transport (cars, trains, buses and motor coaches), by country

	Cars (%)				Buses and coaches (%)				Rail (%)			
	1995	**2000**	**2005**	**2009**	**1995**	**2000**	**2005**	**2009**	**1995**	**2000**	**2005**	**2009**
Austria	76.8	78.8	78.9	78.1	10.7	10.9	10.4	10.4	12.5	10.3	10.6	11.5
Belgium	83.2	83.4	80.3	79.3	11.1	10.5	12.9	13.3	5.7	6.1	6.8	7.4
Bulgaria	60.6	59.8	68.6	78.6	28.0	32.4	26.7	17.7	11.4	7.7	4.7	3.6
Cyprus	77.3	77.7	79.2	82.4	22.7	22.3	20.8	17.6	0.0	0.0	0.0	0.0
Czech Republic	67.2	73.1	75.5	76.2	22.9	18.5	17.2	16.9	9.9	8.4	7.3	6.9
Denmark	79.9	79.6	79.1	79.5	12.0	11.7	11.4	11.0	8.1	8.7	9.4	9.4
Estonia	67.6	69.8	77.0	79.2	26.9	27.5	21.1	19.0	5.5	2.7	1.9	1.9
Finland	81.7	83.4	84.9	84.9	13.1	11.5	10.3	10.0	5.2	5.1	4.8	5.1
France	86.8	86.1	85.8	84.3	5.6	5.3	5.2	5.7	7.5	8.6	9.0	10.0
Germany	85.4	85.2	85.8	86.0	7.2	7.1	6.7	6.0	7.4	7.7	7.5	8.0
Greece	66.9	72.8	78.3	81.9	30.7	25.1	20.0	16.9	2.4	2.2	1.7	1.1
Hungary	64.4	61.9	62.7	62.5	23.6	25.1	24.0	25.3	12.0	13.0	13.3	12.2
Iceland	88.6	88.6	88.6	88.6	11.4	11.4	11.4	11.4	0.0	0.0	0.0	0.0
Ireland	83.0	83.7	83.6	84.6	13.6	13.3	12.9	12.5	3.4	3.0	3.4	2.9
Italy	82.1	83.5	82.0	82.5	11.6	10.8	12.0	11.9	6.2	5.7	6.0	5.6
Latvia	70.0	79.0	76.2	86.2	17.1	16.1	18.2	9.9	12.8	4.9	5.6	3.9
Lithuania	75.1	88.5	89.4	92.0	19.6	9.4	9.5	7.1	5.3	2.1	1.1	0.9
Luxembourg	85.0	85.5	85.5	84.4	9.8	9.5	10.9	11.4	5.2	5.1	3.6	4.2
Malta	80.6	79.6	80.3	81.9	19.4	20.4	19.7	18.1	0.0	0.0	0.0	0.0
Netherlands	82.3	84.5	84.7	83.7	7.5	6.7	6.7	6.9	10.2	8.8	8.6	9.4
Norway	87.9	88.3	88.5	88.7	7.4	7.1	7.1	6.7	4.7	4.5	4.5	4.6
Poland	64.6	72.8	80.6	86.9	19.9	15.4	12.0	7.4	15.5	11.7	7.4	5.7
Portugal	76.5	81.7	85.1	85.5	16.5	13.6	11.1	10.4	7.0	4.6	3.8	4.1
Romania	56.2	68.3	75.5	80.0	17.3	16.1	14.6	13.6	26.5	15.6	9.9	6.5
Slovakia	49.1	66.3	70.7	77.6	39.4	25.8	23.4	15.8	11.5	7.9	6.0	6.6
Slovenia	77.6	82.9	85.4	86.6	19.5	14.3	11.6	10.5	2.8	2.9	2.9	2.9
Spain	81.7	81.1	81.9	81.3	12.9	13.5	12.9	13.3	5.4	5.4	5.2	5.4
Sweden	84.1	83.8	84.6	83.2	9.3	8.6	7.6	7.4	6.6	7.5	7.8	9.5
Switzerland	81.0	81.5	78.9	77.3	6.1	5.4	5.5	5.7	12.9	13.1	15.6	16.9
Turkey	36.5	45.9	50.0	52.5	59.4	50.7	47.5	45.2	4.0	3.4	2.5	2.3
United Kingdom	89.0	88.0	89.2	88.2	6.6	6.7	5.0	5.0	4.4	5.3	5.9	6.8

Source: EC, 2011i.

Table A3.6 Air passenger transport volume for the EU-27 (1 000 million pkm)

	1 000 million pkm
1995	346
1996	366
1997	390
1998	409
1999	425
2000	457
2001	453
2002	445
2003	463
2004	493
2005	527
2006	549
2007	572
2008	561
2009	522

Note: These data are estimations, not actual statistics. Only domestic and intra–EU-27 transport; provisional estimates.

Source: EC, 2011i.

Table A3.7 Number of passenger cars per thousand inhabitants

	1990	1995	2000	2005	2008	2009	Change 2008–2009 %
EU-27	345	380	417	448	470	473	0.7
Austria	388	452	511	504	513	521	1.5
Belgium	387	421	456	468	477	479	0.4
Bulgaria	152	196	245	329	311	331	6.3
Cyprus	304	335	384	463	557	573	3.0
Czech Republic	234	295	335	386	423	422	– 0.1
Denmark	309	320	347	362	381	383	0.6
Estonia	154	269	339	367	412	407	– 1.1
Finland	388	371	412	462	507	519	2.3
France	476	481	503	497	498	500	0.4
Germany	461	495	475	493	504	510	1.3
Greece	170	207	292	387	446	454	1.7
Hungary	187	218	232	287	305	301	– 1.2
Iceland	468	445	561	625	657	646	– 1.6
Ireland	228	276	348	400	439	432	– 1.6
Italy	483	533	572	590	601	605	0.5
Latvia	106	134	236	324	413	402	– 2.5
Lithuania	133	199	336	428	499	509	2.1
Luxembourg	477	556	622	655	667	660	– 1.0
Malta	337	487	483	525	555	570	2.7
Netherlands	367	364	409	434	458	460	0.5
Norway	380	386	411	437	458	462	0.9
Poland	138	195	261	323	422	432	2.5
Portugal	185	255	336	397	415	419	1.0
Romania	56	97	124	156	187	198	5.6
Slovakia	166	189	237	242	285	293	2.6
Slovenia	294	357	435	479	514	517	0.6
Spain	309	360	431	463	483	478	– 1.1
Sweden	419	411	450	459	462	460	– 0.4
Switzerland	442	457	492	518	518	515	– 0.6
United Kingdom	361	378	425	469	472	470	– 0.3

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

Source: EC, 2011i.

Table A3.8 Greenhouse gas emissions from transport in Europe (million tonnes, unless otherwise stated), by country and sub-sector

	Total transport excluding international aviation and navigation			Domestic civil aviation			Road			Rail			Navigation		
	1990	2009	Growth %	1990	2009	Growth %	1990	2009	Growth %	1990	2009	Growth %	1990	2009	Growth %
EU-27	771.49	932.13	21	14.28	17.59	23	714.21	878.42	23	14.40	7.48	– 48	18.00	19.18	7
EU-15	693.74	809.99	17	13.88	17.36	25	647.62	760.93	17	8.20	5.35	– 35	17.48	19.04	9
EEA-32	824.19	1011.39	23	16.17	23.98	48	761.10	945.51	24	15.06	8.01	– 47	20.38	23.03	13
Austria	14.01	21.65	54	0.03	0.07	112	13.52	20.95	55	0.20	0.16	– 17	0.04	0.04	4
Belgium	20.47	26.72	31	0.01	0.01	– 25	19.61	25.99	33	0.24	0.10	– 57	0.41	0.42	1
Bulgaria	6.78	8.22	21	0.14	0.07	– 48	6.08	7.76	28	0.36	0.07	– 81	0.06	0.00	– 100
Cyprus	0.78	2.27	190	0.00	0.00		0.78	2.27	190	0.00	0.00		0.00	0.00	
Czech Republic	7.73	18.51	140	0.17	0.01	– 92	6.35	18.03	184	0.66	0.30	– 54	0.06	0.02	– 72
Denmark	10.79	13.26	23	0.25	0.16	– 36	9.43	12.26	30	0.30	0.23	– 22	0.81	0.61	– 25
Estonia	2.49	2.16	– 13	0.01	0.00	– 69	2.31	2.02	– 12	0.16	0.11	– 31	0.02	0.02	8
Finland	12.76	12.92	1	0.39	0.28	– 28	11.06	11.43	3	0.19	0.09	– 52	0.45	0.52	15
France	119.93	130.57	9	4.29	4.50	5	112.57	122.03	8	1.08	0.54	– 50	1.77	2.87	62
Germany	163.88	153.31	– 6	2.34	2.13	– 9	152.24	145.69	– 4	2.90	1.13	– 61	2.08	0.73	– 65
Greece	14.75	25.67	74	0.72	1.47	103	11.95	21.26	78	0.23	0.11	– 52	1.84	2.83	54
Hungary	8.17	12.68	55	0.00	0.00	– 100	7.62	12.41	63	0.52	0.27	– 49	0.03	0.00	– 89
Iceland	0.62	0.95	52	0.03	0.02	– 31	0.53	0.89	69	0.00	0.00		0.06	0.03	– 47
Ireland	5.13	13.12	156	0.06	0.10	73	4.78	12.73	166	0.15	0.14	– 8	0.09	0.00	– 100
Italy	102.90	119.26	16	1.63	2.22	36	94.87	111.17	17	0.50	0.21	– 58	5.49	4.82	– 12
Latvia	3.00	2.78	– 7	0.00	0.00	365	2.40	2.51	5	0.60	0.26	– 57	0.00	0.01	1 125
Liechtenstein	0.08	0.08	11	0.00	0.00	107	0.08	0.08	11	0.00	0.00		0.00	0.00	
Lithuania	7.67	4.45	– 42	0.00	0.00	265	5.33	4.03	– 24	0.35	0.18	– 50	0.02	0.02	7
Luxembourg	2.64	6.08	130	0.00	0.00	152	2.62	6.07	132	0.03	0.01	– 58	0.00	0.00	2
Malta	0.34	0.54	58	0.00	0.00		0.34	0.51	52	0.00	0.00		0.01	0.03	272
Netherlands	26.44	34.56	31	0.04	0.04	0	25.90	33.84	31	0.09	0.07	– 28	0.41	0.61	51
Norway	11.10	14.32	29	0.69	1.08	58	7.76	9.77	26	0.11	0.05	– 53	1.71	2.07	21
Poland	25.31	44.44	76	0.06	0.09	53	21.61	42.49	97	2.09	0.41	– 80	0.14	0.01	– 91
Portugal	10.07	18.86	87	0.24	0.34	42	9.39	18.24	94	0.18	0.06	– 69	0.26	0.23	– 14
Romania	7.69	14.55	89	0.02	0.04	66	6.51	14.08	116	0.96	0.39	– 59	0.19	0.02	– 87
Slovakia	5.04	6.21	23	0.01	0.01	– 19	4.59	6.10	33	0.43	0.10	– 77	0.00	0.00	75
Slovenia	2.75	5.34	94	0.00	0.00	44	2.68	5.29	98	0.07	0.04	– 42	0.00	0.00	
Spain	55.12	94.47	71	1.93	3.67	91	51.24	87.03	70	0.42	0.27	– 35	1.51	3.32	120
Sweden	19.03	20.35	7	0.69	0.54	– 21	17.51	19.05	9	0.12	0.07	– 35	0.55	0.51	– 8
Switzerland	14.62	16.46	13	0.26	0.13	– 51	14.17	16.14	14	0.03	0.04	30	0.11	0.12	4
Turkey	26.29	47.44	80	0.91	5.16	464	24.35	40.20	65	0.52	0.44	– 15	0.50	1.64	228
United Kingdom	115.82	119.19	3	1.27	1.83	44	110.94	113.20	2	1.59	2.14	35	1.76	1.53	– 13

Source: EEA data viewer, 2011.

Table A.8. Greenhouse gas emissions from transport in Europe (million tonnes, unless otherwise stated), by country and sub-sector (cont.)

	Other transport			International bunkers			International aviation			International maritime		
	1990	2009	Growth %	1990	2009	Growth %	1990	2009	Growth %	1990	2009	Growth %
EU-27	10.59	9.47	– 11	179.75	292.50	63	68.86	133.26	94	110.89	159.25	44
EU-15	6.56	7.31	11	170.29	278.73	64	64.59	127.14	97	105.70	151.59	43
EEA-32	11.48	10.86	– 5	185.35	302.06	63	72.81	139.93	92	112.54	162.12	44
Austria	0.22	0.43	90	0.92	1.95	113	0.90	1.91	114	0.02	0.03	66
Belgium	0.20	0.20	3	16.41	27.12	65	3.10	4.42	43	13.32	22.70	71
Bulgaria	0.15	0.32	118	0.97	1.17	21	0.72	0.46	– 36	0.25	0.71	188
Cyprus	0.00	0.00		0.94	1.06	12	0.75	0.82	9	0.19	0.24	26
Czech Republic	0.50	0.15	– 69	0.68	1.11	63	0.68	1.11	63	n/a, NO	n/a, NO	
Denmark	0.00	0.00		4.82	3.86	– 20	1.76	2.34	33	3.06	1.52	– 51
Estonia	0.00	0.00		0.69	0.82	19	0.11	0.10	– 5	0.58	0.71	23
Finland	0.67	0.61	– 10	2.88	2.41	– 16	1.02	1.59	56	1.86	0.82	– 56
France	0.22	0.62	184	16.59	23.95	44	8.64	15.99	85	7.95	7.95	0
Germany	4.34	3.63	– 16	20.13	34.03	69	12.14	25.20	108	7.99	8.82	10
Greece	0.00	0.00		10.57	11.01	4	2.47	2.64	7	8.10	8.36	3
Hungary	0.00	0.00		0.50	0.72	44	0.50	0.72	44	n/a	n/a	
Iceland	0.00	0.00		0.32	0.50	57	0.22	0.34	52	0.10	0.17	66
Ireland	0.06	0.15	143	1.13	2.52	123	1.07	2.22	107	0.06	0.30	434
Italy	0.41	0.84	102	8.63	16.37	90	4.20	9.04	115	4.43	7.33	65
Latvia	0.00	0.00		1.78	1.22	– 32	0.22	0.32	41	1.56	0.90	– 42
Liechtenstein	0.00	0.00		0.00	0.00	107	0.00	0.00	107	n/a, NO	n/a, NO	
Lithuania	1.97	0.23	– 89	0.71	0.52	– 27	0.41	0.11	– 73	0.30	0.41	35
Luxembourg	0.00	0.00		0.40	1.27	218	0.40	1.27	218	0.00	0.00	59
Malta	0.00	0.00		n/a, NE	3.65		n/a, NE	0.04		n/a, NE	3.61	
Netherlands	0.00	0.00		39.01	56.15	44	4.56	10.25	125	34.46	45.90	33
Norway	0.84	1.34	61	2.12	2.91	38	0.63	1.10	77	1.49	1.81	21
Poland	1.40	1.44	2	1.94	2.22	14	0.58	1.42	147	1.37	0.80	– 41
Portugal	0.00	0.00		2.86	4.24	48	1.47	2.45	67	1.39	1.79	29
Romania	0.01	0.02	172	1.05	0.96	– 9	0.17	0.83	391	0.88	0.12	– 86
Slovakia	0.01	0.00	– 78	0.13	0.15	15	0.06	0.11	77	0.07	0.04	– 45
Slovenia	0.00	0.00		0.08	0.20	145	0.08	0.08	– 2	n/a	0.12	
Spain	0.02	0.16	703	17.35	40.59	134	5.72	12.69	122	11.63	27.90	140
Sweden	0.16	0.17	9	3.62	9.42	160	1.35	2.02	49	2.26	7.40	227
Switzerland	0.05	0.04	– 12	3.15	4.11	30	3.10	4.08	32	0.06	0.03	– 54
Turkey	0.00	0.00		n/a, NE, NO	2.03		NE	1.15		n/a, NE, NO	0.87	
United Kingdom	0.25	0.50	95	24.96	43.86	76	15.80	33.11	110	9.16	10.75	17

Note: n/a = not available/applicable, NE = not estimated, NO = not occurring.

Source: EEA data viewer, 2011.

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