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Indicator Title

Indicator title:	Transport emissions of greenhouse gases
ETC/ACC Indicator ID	TERM 2006 02
Sub indicators, ID + title	TERM02 a CO2 emissions from transport in EEA32 TERM02 b Projections of CO2 from transport TERM02 c N2O emissions from (road) transport

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Indicator Fact Sheet

TERM 2006 02 EEA32 – Transport emissions of greenhouse gases by mode

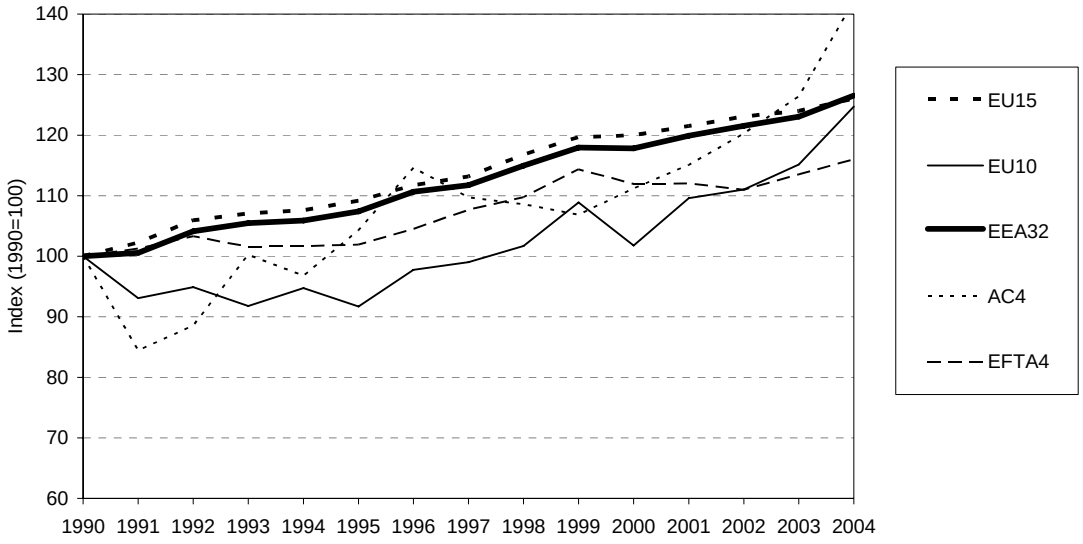
☹ **In the area of EEA32, emissions of greenhouse gases (GHGs) from transport (excluding international air and maritime transport) increased by 26.5 % between 1990 and 2004. The EU15 Member States make up 83 % of the total EEA32 transport emissions and they increased by 26 % in the period of 1990-2004. In the EFTA4 countries the emissions increased by 16 % while in the new EU Member States (EU10) the increase was 25 %. In the Acceding Countries (AC4) the emissions increased by 42.2 %.**

For several EU15 Member States and EFTA4 countries, rapidly rising GHG emissions from transport are a serious concern for meeting the Kyoto target.

In the EU15 and the EFTA4, domestic aviation was the fastest growing transport mode, while rail transport was the fastest decreasing one. Also GHG emissions from international aviation and navigation are increasing rapidly, but these emissions are, in accordance with UNFCCC guidelines, not included in the GHG emission totals relevant for the Kyoto targets.

In the EU15, the transport sector was responsible for 21 % of the total GHG emissions in 2004, while in the EU10 the transport sector contributed only by 11 % to the total GHG emissions.

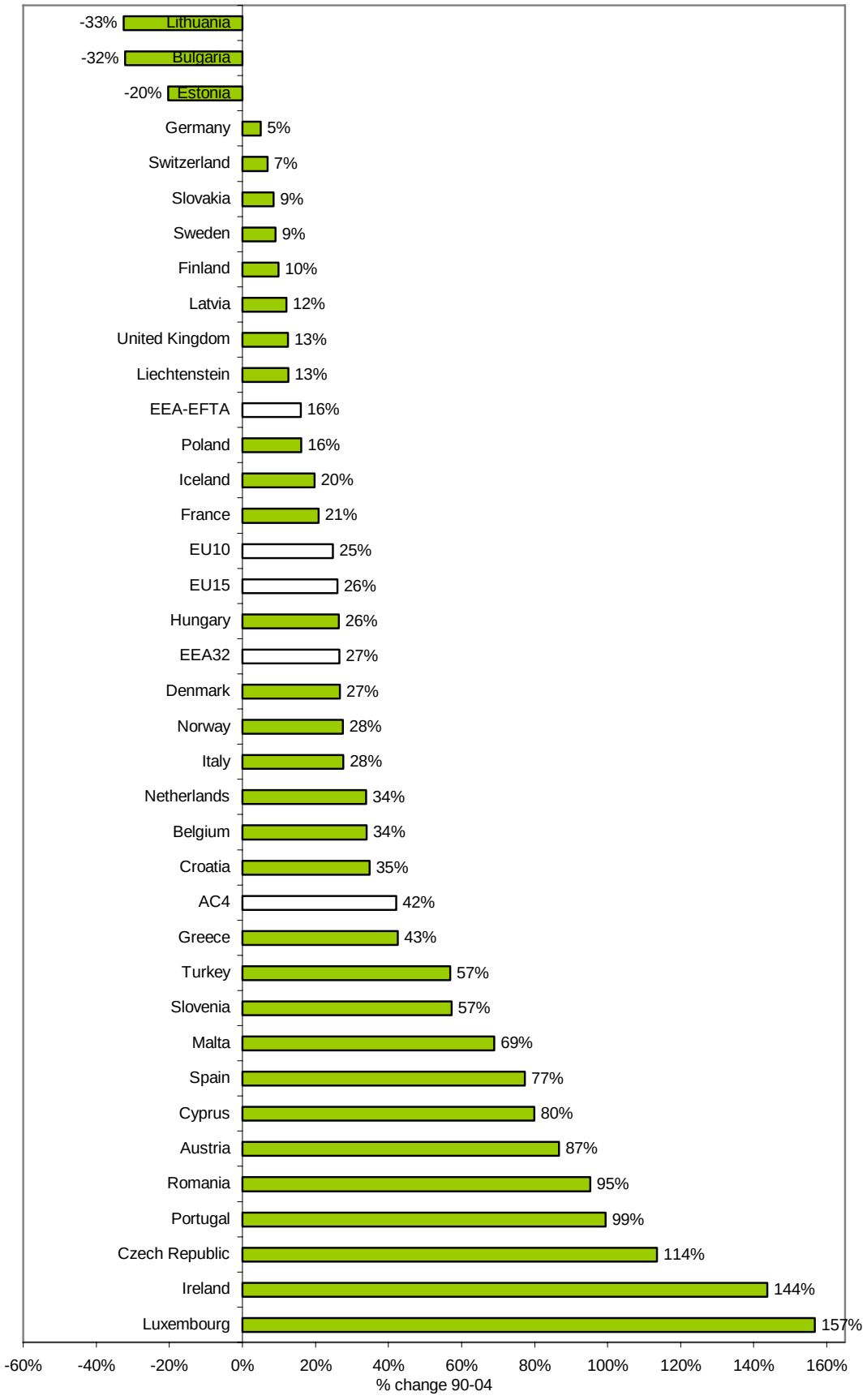
Figure 1: Total EEA32 GHG emissions from transport



Note: EU15 refers to EU Member States prior to May 2004 (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom), EFTA4 to the EFTA countries (Iceland, Liechtenstein, Norway and Switzerland), EU10 to new EU Member States as of May 2004 (Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia) and AC4 to Acceding Countries (Bulgaria, Romania, Croatia and Turkey)

Source: EEA, 2006b.

Figure 2: Change in total GHG emissions from transport



Note: EU15 refers to EU Member States prior to May 2004 (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom) EFTA4 to the EFTA countries (Iceland, Liechtenstein, Norway and Switzerland), EU10 to new EU Member States as of May 2004 (Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia) and AC4 to Acceding Countries (Bulgaria and Romania, Croatia, Turkey)

Source: EEA, 2006b; UNFCCC, 2006.

EEA32 GHG emissions from transport

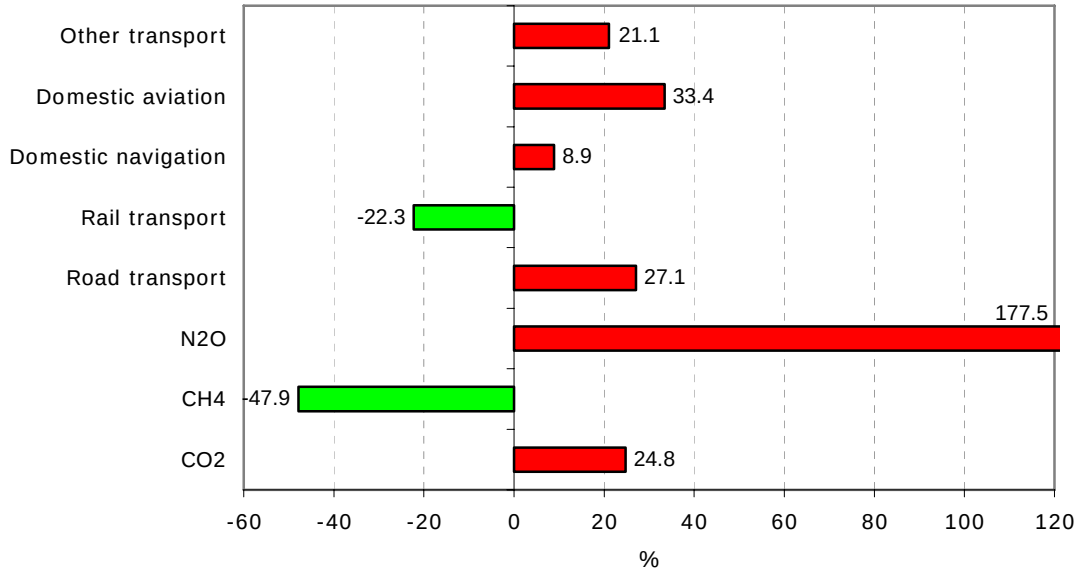
☹ **EU15: Emissions of GHGs from transport have increased by 26 % between 1990 and 2004, contributing to a fifth of the total GHG emissions in 2004 in the EU15. CO_2 is the main contributor to transport GHG emissions (97 %) and road transport is, in turn, the largest contributor to these emissions (93 % in 2004). Road transport and air transport are the fastest growing contributors to transport GHG emissions between 1990 and 2004. Transport is also a small, but rapidly growing source of N_2O emissions, though as it is not a large source of N_2O, it does not have a major impact on the overall trend of total EU15 GHG emissions.**

☹ **EFTA4: Iceland, Liechtenstein, Norway and Switzerland together account for 3 % of the total GHG emissions from transport in the EEA32 area. The GHG emissions from transport in these three countries were 16 % above the 1990 levels in 2004.**

☹ **EU10: Transport GHG emissions increased by 25 % in the EU10 between 1990 and 2004, as a consequence of increased road transport demand in the EU10 area. CO_2 is the most important GHG, with 97 % share on total GHG emissions from the transport sector. These CO_2 emissions increased by 24 % between 1990 and 2004. Road transport is a small, but rapidly growing source of N_2O emissions, due to the penetration of three-way catalysts.**

☺ **GHG emissions from transport in the AC4 increased by 42 % between 1990 and 2004, due to increases in road transportation and aviation. The AC4 countries account together for 7 % of the GHG emissions in the EEA32 area.**

Figure 3: Contribution to change in total EU15 GHG transport emissions by mode and pollutant, 1990-2004



Note: The modal split is based on EU15. Modal split excludes emissions from international bunkers. See the note on table 5 for details. 'Other transport' includes pipeline and some off-road transport. For changes in emissions from transport see table 4. See tables 4 and 5 for details on other country groups.

Source: EEA, 2006b.

Results and assessment

This indicator analyses the trend in transport GHG emissions from 1990 to 2004. Note that the emission totals relevant under the Kyoto Protocol do not include GHG emissions from international aviation and maritime transport. Therefore, in this fact sheet, all transport related GHG emissions exclude emissions from international aviation and maritime transport. The indicator is aimed to evaluate the trend in transport GHG emissions in the EEA32 region as well as to analyse relative importance of different GHGs and mode.

No targets for transport emissions of GHGs have been agreed in the EU15 or in other country groups.

Policy context

The Kyoto Protocol entered into force on February 16th, 2005. The Kyoto Protocol target 2008-2012 for EEA32 countries is emission reduction from 5% to 8% from the base year levels for the basket of six GHGs not controlled by the Montreal protocol. The exemptions are Iceland and Norway with foreseen growth of GHG emissions (+10% respectively +1%).

The Parties included in Annex shell also pursue limitation or reduction of emissions of GHGs from aviation and marine bunker fuels working trough the ICAO and the IMO respectively. .

In Bonn (May 2006) Parties to the UN climate change convention and Kyoto protocol continued discussion on developing framework for further GHG reductions after 2012. World governments agreed to continue their efforts of decreasing emissions and discussed how to consider developing countries and Kyoto refusing countries. There had been a "strong consensus on the need to reduce emissions" and support for the use of economic incentives and involvement of the private sector in climate protection. EU is promoting a goal of reducing emissions by 15-30% by 2020.

Policy context EU15

The EU15 Kyoto Protocol target for 2008-2012 is a reduction of 8% from 1990 levels for the basket of six GHGs. In June 1998, EU15 Member States agreed a system of 'burden sharing' or 'target sharing'. These targets for Member States were reaffirmed in Council Decision 2002/358/CE[1].

The main frame for policy action at EU level is the European Climate Change Programme (ECCP), which was established in June 2000 to help identify the most cost-effective additional measures (at costs less than EUR 20 per tonne of CO_2 equivalent) to meet the EU target, using a multi-stakeholder consultative process that focused on the energy, transport, industry and agriculture sectors and on the cross-cutting issue of emission trading within the EU. The ECCP is one of the instruments to implement the sixth Environmental Action Programme (6EAP). ECCP reports (European Commission, 2001a) identified a number of policies and measures, resulting in proposals for directives on emission trading; biofuels; promotion of renewable energy sources, energy performance of buildings, energy-efficient public procurement and proposals on fluorinated gases.

The second ECCP progress report (European Commission, 2003a) gives an overview of the latest results of the ECCP, including the status of implementation of the range of measures investigated since the start of the Programme. It forms the basis for the Commission to prepare further actions in those areas that are most promising and it keeps the focus on cost effective measures.

Furthermore, a directive on the principles and structure of an infrastructure-charging system for road transport (Heavy Duty Vehicles) including a common methodology for setting charging levels and cross financing was proposed by the Commission in 2003 (European Commission, 2003b). In October 2005, the Commission launched ECCP II as a continued programme for policy preparation and development. As well as the review and further work on the implementation of existing policies and measures, it investigates new policy areas such as adaptation, aviation and carbon capture and storage.

The directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport aims to achieve 20 % substitution of conventional automotive fuels by alternative fuels

[1] OJ L 130, 15.5.2002, p. 1

for road transportation and defines a set of measures to promote the use of biofuels (European Commission, 2003d). The biofuels directive contains two indicative targets of **2 and 5.75%** of petrol and diesel to be substituted by biofuels by **2005 and 2010,** whereas the level of consumption of biofuel in Member states is at present only 1,4% of total transport fuel[2]. Security of supply and GHG being the main drivers. Member States have to justify if they do not plan to meet the targets.

A proposal to introduce special tax arrangements for diesel fuel used for commercial purposes and to align the excise duties on petrol and diesel fuel was already proposed by the Commission in 2002 (European Commission, 2002) but has received a negative opinion from the European Parliament and has not so far been adopted by the Council.

However, in October 2003 the Council reached agreement on a directive (2003/96/EC) restructuring the Community framework for the taxation of energy products and electricity. The Directive will widen the scope of the Community minimum rate system, currently limited to mineral oils (including motor fuels), to all energy products, chiefly coal, gas and electricity, as well as updating the minimum rates for mineral oils which have not been revised since 1992. Member States will be allowed to differentiate between commercial and non-commercial diesel, which will allow them, for example, to provide for a lower rate of duty on commercial diesel, as long as the minimum levels set by the Directive are observed and as long as the rate for commercial diesel does not fall below the national level of taxation in force on 1 January 2003. This possibility to differentiate will also enable Member States to reduce the gap in excise duty levels between non-commercial diesel used in cars and petrol.

As far as commercial diesel is concerned, the Commission considers that it is necessary for Member States to continue working on the Commission proposal for a directive for the harmonisation of taxation of commercial diesel fuel. The energy tax directive only provides for minimum rates of taxation, and minimum rates do not remedy the problem of distortion of competition on road haulage markets, which stems from the significant differences in the rates of diesel taxation in the Member States.

In December 2003 the Commission proposed a new Directive on energy efficiency and energy services in the Union. The objective is to save an additional fixed amount of energy every year equal to at least 1% of previous consumption in each Member State, leading in 2012 to an annual improvement in energy efficiency of around 6%. Although not the main focus, transport energy consumption is within the scope of the Directive as proposed (European Commission 2003c).

The Communication on transport and CO_2 (European Commission, 1998) identifies a series of measures to reduce CO_2 emissions, such as: improved logistics and more efficient freight operations, technical improvements, promotion of rail, short sea shipping, walking, cycling and public transport, and air traffic management.

The Commission also adopted a strategy to reduce CO_2 emissions from passenger cars and improve fuel economy, which was endorsed by the Council in 1996. It aims at achieving an average CO_2 emission figure for new passenger cars of **120 g CO_2/km by 2005, and 2010** at the latest. An important element in the implementation of this strategy is the voluntary commitments made by the auto manufactures on achieving an average CO_2 emission of 140 g CO_2/km by 2008 for ACEA members (2009 for JAMA and KAMA) [3]. A midterm review was initiated in 2003 to consider the scope for further reductions towards reaching the Commission target of 120 g CO_2/km.The result of the midterm review was that ACEA is on track (ahead of schedule) while JAMA and KAMA are also doing well but still have a long way to go. (see TERM 27 – Overall energy efficiency and specific CO_2 emissions for passenger and freight transport per passenger-km and per tonne-km and by mode).

Policy context EFTA4

According to the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC), the EFTA4 countries are committed to emission growth limitations of 1 % (Norway), 10 % (Iceland) and a reduction of 8 % (Liechtenstein, Switzerland) from the base year levels by 2008-2012.

Policy context EU10

[2] EP resolution on promotion of crops for non-food purposes (2004/229(INI)

[3] The development in the emissions from new passenger cars are monitored in COM(2004)78 final.

According to the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC), adopted in 1997, the new EU Member States are committed to emission reductions of 6 % (Hungary and Poland) or 8 % (all other countries) by 2008-2012. In accordance with decision 9/CP.2 under the UNFCCC, some EU10 Member States use base years other than 1990: Hungary (average 1985-87), Poland (1988) and Slovenia (1986). Cyprus and Malta have no reduction targets.

Policy context Acceding Countries

According to the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC), Bulgaria and Romania are committed to emission reductions of 8 % from the base years 1988 and 1989 respectively by 2008-2012. Croatia's target is a reduction of 5 % from the base year 1990 by 2008-2012. Turkey has no reduction target.

Environmental context

There is mounting evidence that emissions of GHGs are causing global and European surface air temperature increases, resulting in climate change (IPCC, 2001). The potential consequences at the global level of further increased temperatures include rising sea levels, floods and droughts, changes in biota and food productivity and increase of infectious diseases. These effects will have impacts on socio-economic sectors, such as agriculture and on water resources. Efforts to reduce or limit the effects of climate change are focused on limitation of the emissions of all GHGs.

In the transport sector, GHG emissions are the result of burning petrol, diesel and kerosene in internal combustion engines.

CO_2 is the most important anthropogenic GHG. The links between transport, energy use and CO_2 emissions can be characterised by the following equation: CO_2 emissions from transport are equal to the product of transport activity (measured as passenger-kilometres or tonne-kilometres), modal structure (the share of each activity by transport mode), modal energy intensity (energy use per unit of passenger or freight travel by mode), and the emission rate (CO_2 emissions per unit of energy consumed) (IEA, 2000).

Developed countries typically show rising CO_2 emissions from transport, which are mainly due to rising transport activities and an increase in the share of road transport. Fuel efficiency increases have not been able to outweigh this increase.

The transport sector is a small, but rapidly rising source of N_2O as the implementation of the three-way catalysts fitted to petrol-engine motor vehicles increases N_2O emissions. Fluorinated gases are as well a very small part of the total GHG emissions from the transport sector as they are emitted from automotive air conditioning (European Commission, 2003e). (These emissions have not been quantified separately at EU level). Methane (CH_4) from transport is a negligible GHG source.

Assessment

. The EU25 transport sector accounts for more than 30% of the total energy consumption in the Community[4] and it is 98% dependent on fossil fuels. The growing transport sector is considered to be one of the main reasons for EU failing to meet Kyoto targets. GHG emissions from transport increased by 26.5 % between 1990 and 2004 in the EEA32 countries[5]. Emissions increased faster in the EU25 Member States than in the EFTA4 countries. For several EU15 Member States and EFTA4 countries rapidly rising GHG emissions from transport are a serious concern for meeting the Kyoto target.

In the EU15 GHG emissions from transport increased by 26 %; they contribute by 83 % to the total EEA32 transport emissions. The transport emissions increased due to continuous increases in road transport volume (both passenger and freight).

Figure 2 shows that between 1990 and 2004, GHG emissions from transport increased in all EU15 Member States. Germany and Finland limited their emission increases below 10 %. Spain, Austria and Portugal registered emission increases of more than 60 %. Ireland and

[4] Biofuels in the European Union, report of Biofuels Research Advisory Council (14-3-2006)

[5] Note that, in accordance with UNFCCC guidelines, this increase does not include GHG emissions from international aviation and navigation which, in general, increase more rapidly than GHG emissions from domestic transport (see Box 2).

Luxembourg more than doubled their emissions. The main reasons for the large increase in Ireland are growth in road transport volumes and 'fuel tourism' (e.g. road fuels bought in Ireland, where fuel prices are relatively low, but consumed outside Ireland, particularly in Northern Ireland). 'Fuel tourism' due to comparatively low fuel prices is also an important reason in other EU15 Member States such as Austria and Luxembourg.

Explanations for the relatively small changes in emissions in Finland, Sweden and the UK may be high per capita GHG emissions from transport in 1990 and high and/or rapidly growing road fuel prices. For the cohesion countries (Greece, Ireland, Portugal and Spain), the opposite is true: low starting points in terms of per capita emissions and low road fuel prices. They have experienced strong growth in transport demand, particularly road, driven by economic growth, and have therefore also experienced large increases in GHG emissions.

In Germany, which is the largest emitter within EU15, GHG emissions from transport decreased between 1999 and 2003, but increased between 2003 and 2004 by 0.5 %. One reason for the overall decreasing effect might be the annual increases of road fuel taxes in the framework of the ecological tax reform, although evasive reactions to higher fuel prices may be more important than reduced road transport demand, as a recent study suggests (DIW, 2004).

The second largest group is the EU10, with a share of 8 % on total EEA32 transport emissions and an increase of 25 % between 1990 and 2004. There was a slow reduction in emissions until 1995. Since 1995, GHG emissions from transport have been rising again, with a small reduction in 2000. The main reason for the emission reductions in the first half of the decade, was the economic downturn after the fall of the iron curtain. In recent years emissions from transport increased mainly due to growing road transport demand which, at least partly, resulted from declining rail transport (modal shift from rail to road).

The AC4, with a share of 7 % in total EEA32 transport emissions, increased their emissions by 42 % between 1990 and 2004. Whereas emissions decreased in Bulgaria by 32 %, they increased in Croatia by 35 %, in Romania by 95 % and in Turkey by 57 %. The reasons for the decline in Bulgaria are the same as in many other East European countries, namely, economic recession during the early nineties. The change in emissions compared to last year is mainly due to the availability of Turkish emission data.

The EFTA4 countries Norway, Iceland, Liechtenstein and Switzerland together account for 3 % of the total GHG emissions from transport in the EEA32 area. The GHG emissions from transport in these four countries were 16 % above the 1990 levels in 2004. In Switzerland, GHG emissions from transport did not increase since 2000 and were only 7 % above 1990 levels in 2004. One reason for the stabilisation since 2000 seems to be the introduction of road pricing for heavy duty vehicles in 2001.

With 97 % in the EEA32, CO_2 is by far the most important GHG within the transport sector, followed by N_2O (3 %) and CH_4 (0.3 %). As catalytic converters lead to a decrease in CH_4 emissions, the emissions fell by 48 % between 1990 and 2004. In contrast, the introduction of the catalytic converter has increased N_2O emissions from transport.

Sub-indicator: CO_2 emissions from transport in EEA32

☹ **Emissions of CO_2 from transport (excluding international aviation and maritime transport) increased by 25 % in the EEA32 between 1990 and 2004. In 2004, CO_2 emissions constituted 97 % of total EEA32 GHG emissions from transport. CO_2 emissions from transport increased in all countries except Lithuania, Bulgaria and Estonia.**

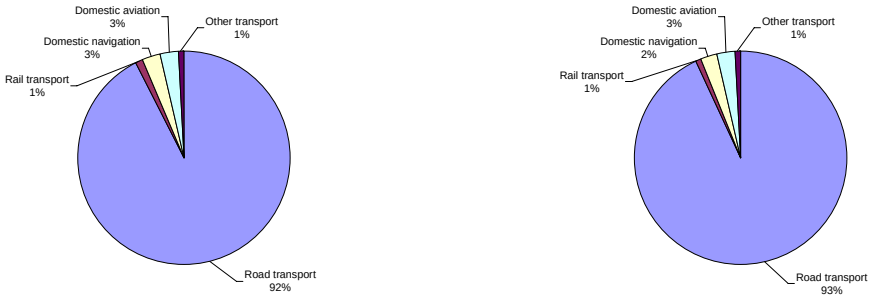
☹ **In the EU15, the CO_2 emissions from transport were 25 % above the 1990 levels in 2004. Similarly, in the EU10, emissions of CO_2 from transport increased by 24 % in the same period. Since 1995, CO_2 emissions from transport have been rising again.**

☹ **In the AC4, CO_2 emissions from transport increased by 42 % between 1990 and 2004.**

☹ **The emissions from Norway, Iceland, Liechtenstein and Switzerland increased by 16 % in the same period.**

Figure 4: EU15 CO_2 emissions from transport by mode, 1990 and 2004

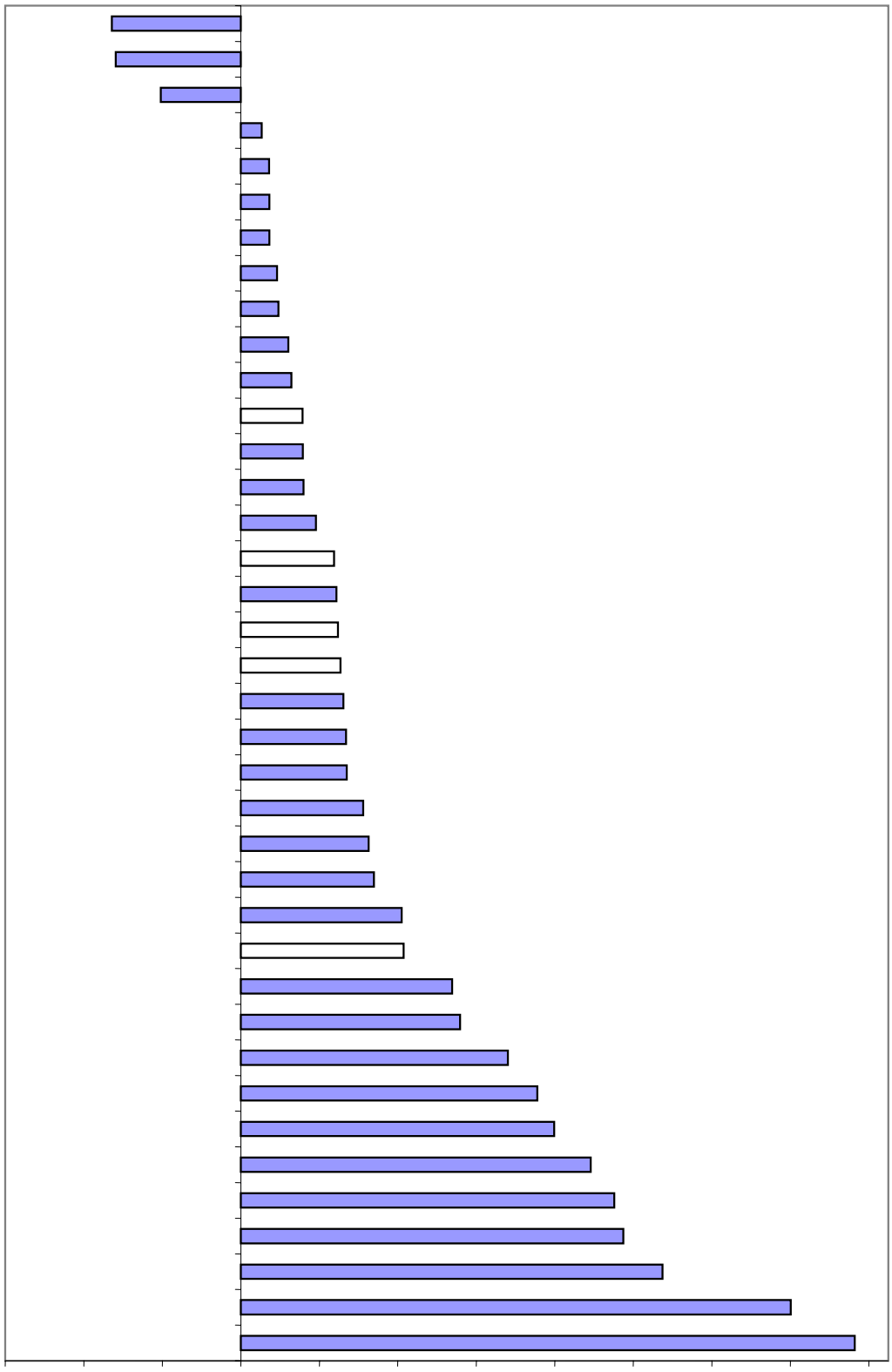
EU15 **1990** **2004**



Note: Modal split excludes emissions from international bunkers. See table 5 for details on other country groups. 'Other transport' includes pipeline and some off-road transport.

Source: EEA, 2006b.

Figure 5: Change in CO_2 emissions from transport in the EEA32, 1990-2004 (%)



Note: Change 1990-2004 refers to last available year, see table 7.

Note: EU15 refers to EU Member States prior to May 2004 (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom), EFTA4 to the EFTA countries (Iceland, Liechtenstein, Norway and Switzerland), EU10 to new EU Member States as of May 2004 (Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia) and AC4 to Acceding Countries (Bulgaria, Romania, Croatia and Turkey)

Source: EEA, 2006b.

Results and assessment EEA32

EU15: In 2004, road transport was the main source of CO_2 emissions contributing by 93 % to the EU15 transport CO_2 emissions. Domestic air transport is the second main source with 3 %, while inland navigation (2 %), other transportation (1 %) and rail transport (1 %) have a comparatively smaller contribution to the total EU15 transport CO_2 emissions.

The mode with the largest increase in CO_2 emissions between 1990 and 2004 is domestic air transport (33 %). Road transport emissions increased by 26 % in the same period.

The general upward trend in CO_2 emissions from transport is due mainly to growing traffic volumes (see TERM 2006 12 EU – Passenger transport and TERM 2006 13 EU – Freight transport), as there has been relatively little change in average energy use per vehicle-km. In the future, policies such as the voluntary commitments made by ACEA, JAMA and KAMA are expected to result in the decrease in average energy use (see also TERM 2006 27 EU – Energy efficiency and specific CO_2 emissions).

In 2004, the largest emitter of CO_2 from transport in the EU15 was Germany accounting for 20 % of total EU15 CO_2 emissions from transport, followed by France (17 %), and the UK and Italy (15 % each). Although all Member States saw their CO_2 emissions from transport increase between 1990 and 2004, there are significant differences between the Member States. In Finland, Sweden and Germany emissions grew by less than 10 % from 1990 to 2004, whereas Ireland and Luxembourg doubled their CO_2 emissions from transport.

EU10: In 2004, road transport was the main source of CO_2 emissions contributing 96 % to total transport related CO_2 emissions. Rail transport is the second largest sources with 2 % share. Domestic navigation (0.4 %), 'Other transport' (including e.g. pipeline transport) (1.5 %) and domestic aviation (0.2 %) have comparatively low shares on total transport CO_2 emissions. Compared with the EU15, the share of road transport is about the same in the EU10, the share of rail is higher, whereas the share of domestic aviation is lower than in the EU15.

The EU10 showed a great variety in change of transport related CO_2 emissions. Large decreases occurred in the Baltic States (Lithuania –33 % and Estonia –20 %). In contrast to this, the Czech Republic increased CO_2 emissions from transport by 107 % and Cyprus by 80 %. The largest economy in the region, Poland, showed an increase of 16 % from 1990 levels by 2004.

AC4 and EFTA4: The AC4 increased CO_2 emissions by 3 % and in the area of Norway, Iceland, Liechtenstein and Switzerland there was an increase of 16 % between 1990 and 2004. The only CO_2 emission reduction from transport was achieved in Bulgaria (-32 %). The change to last years report in emissions of the AC4 is mainly due to the availability of Turkish emission data.

Sub-indicator: Projections of CO_2 from transport

☹ **Projections for EU15 suggest that the transport sector will continue to counteract the attempts to reach the overall GHG emission reduction targets. GHG emissions from transport are projected to be 35 % above 1990 levels in 2010.**

☹ **In the EU10, CO_2 emissions from transport will strongly increase in the Czech Republic, Latvia, Slovenia, Slovakia and Hungary. Only Lithuania projects emission decreases.**

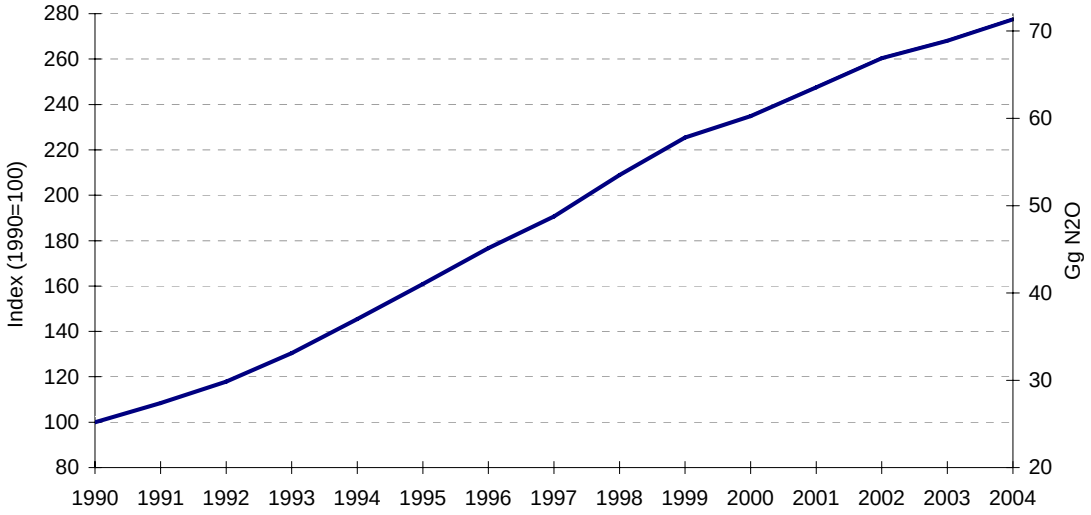
Results and assessment for EU15: Fourteen EU15 Member States provided emission projections for the transport sector in their fourth National Communications to the UNFCCC. Based on these data, EU15 transport emissions are projected to increase by 35% compared to 1990 with the existing policies and measures (excluding emissions from international transport). Ireland, Portugal and Spain project the strongest growth; they are expecting that emissions will more than double by 2010. Austria, Belgium and Italy expect that additional measures will significantly reduce the projected growth in emissions.

Results and assessment for EU10: Six EU10 Member States provided emission projections for the transport sector in their fourth National Communications to the UNFCCC. The Czech Republic, Latvia, Slovenia, Slovakia and Hungary project a strong growth of emissions, the Czech Republic and Slovenia expect that emissions will double by 2010. Only Lithuania projects emission reductions by 2010 compared to 1990.

Sub-indicator: N_2O emissions from (road) transport

☹ **The transport sector is a small (7 % of total N_2O emissions) but rapidly increasing source of nitrous oxide emissions, a side effect of the use of three-way catalysts fitted to petrol-engined motor vehicles, which caused a more then doubling of emissions between 1990 and 2004.**

Figure 9: EU15 emissions of N_2O from transport, 1990-2004



Source: EEA, 2006b.

Results and assessment

N_2O emissions from the transport sector, although only responsible for 7% of total N_2O and 0.5 % of total GHG emissions, increased from 26 to 72 Gg between 1990 and 2004, due to the introduction of catalytic converters, which reduce cars' exhaust emissions of certain air pollutants but produce N_2O as a by-product. This occurs mainly during the period when the converter is heating up. The first catalytic converters emitted some 0.05 g N_2O per km while the three-way catalytic converters are estimated to emit some 0.03 g/km. It is likely that the 'light-off' phase – the time needed for the catalytic converter to reach the appropriate temperature it needs to work – of the newer catalytic converters (EURO III and IV) is somewhat shorter, and the emissions will be smaller. There is also some evidence that by lowering the sulphur content of fuels, N_2O emissions would be reduced. Thus, the lowering of sulphur content in petrol in the EU might have a positive impact on N_2O emissions (European Commission, 2001b).

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EMISSION OF GREENHOUSE GASES

Table 1: Total GHG emissions from national transport, 1990–2004

Unit: Million tonnes of CO_2 equivalent

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	% change 1990-2004
Austria	13	14	14	15	14	15	16	15	18	17	18	19	21	23	24	86.8%
Belgium	20	21	23	23	22	22	23	23	24	24	25	25	26	26	27	34.0%
Denmark	11	11	11	11	12	12	12	12	12	13	12	12	13	13	13	26.8%
Finland	13	12	12	12	12	12	12	13	13	13	13	13	13	14	14	9.9%
France	122	124	129	129	130	133	134	137	139	142	142	146	147	146	147	20.8%
Germany	164	168	174	179	175	179	179	179	183	188	184	180	178	172	173	5.1%
Greece	16	16	17	17	17	17	18	18	20	20	20	21	21	22	22	42.6%
Ireland	5	5	6	6	6	7	7	8	9	10	11	12	12	12	13	143.8%
Italy	104	107	111	113	113	115	116	118	122	124	124	127	129	130	133	27.6%
Luxembourg	3	3	4	4	4	3	4	4	4	4	5	5	5	6	7	156.8%
Netherlands	26	27	28	29	29	30	31	31	32	33	33	33	34	35	35	33.8%
Portugal	10	11	12	12	13	13	14	15	17	18	19	20	20	20	20	99.4%
Spain	58	60	64	63	66	67	72	72	79	84	87	91	93	98	102	77.3%
Sweden	18	18	19	18	19	19	19	19	19	19	19	19	20	20	20	9.0%
United Kingdom	119	119	120	121	122	121	126	128	128	129	129	128	131	133	134	12.5%
Iceland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	19.8%
Norway	11	11	11	12	12	12	13	13	14	14	13	14	13	14	14	27.5%
Liechtenstein	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12.6%
Switzerland	15	15	15	14	14	14	14	15	15	16	16	15	15	16	16	6.9%
Czech Republic	7	7	8	8	8	10	10	12	11	13	12	13	13	14	16	113.6%
Cyprus	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	79.9%
Estonia	3	3	2	2	2	1	1	1	1	1	1	2	2	2	2	-20.3%
Hungary	8	7	7	7	7	7	7	8	9	9	9	9	10	10	11	26.4%
Latvia	3	2	2	2	2	2	2	2	2	2	2	3	3	3	3	12.1%
Lithuania	6	6	5	5	5	5	4	4	4	4	4	4	4	4	4	-32.5%
Poland	30	28	31	28	30	26	29	27	29	32	29	31	30	31	34	16.1%
Slovakia	5	4	4	4	4	5	5	5	5	5	5	5	5	5	6	8.6%
Slovenia	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	57.3%
Malta	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	68.9%
Bulgaria	11	7	7	8	7	7	7	5	7	6	6	6	6	7	7	-32.1%
Romania	9	8	9	8	9	9	12	12	12	9	10	11	12	12	17	95.2%
Turkey	26	25	26	31	30	33	35	34	32	34	36	36	37	38	41	56.8%
Croatia	4	3	3	3	3	3	4	4	4	5	5	5	5	5	5	34.9%
EU15	702	717	743	751	755	766	784	794	819	840	842	853	864	870	884	26.0%
EEA-EFTA	27	27	27	27	27	27	28	29	29	30	30	30	29	30	31	16.0%
EU10	66	61	63	61	63	61	65	65	67	72	67	72	73	76	82	24.7%
AC4	50	42	44	50	48	52	57	55	54	54	56	58	60	63	71	42.2%
EEA32	840	845	875	886	890	902	930	939	966	991	990	1008	1022	1034	1063	26.5%
Index	100	101	104	105	106	107	111	112	115	118	118	120	122	123	127	26.5%

Source: EEA 2006b; UNFCCC, 2006.

Table 2: GHG emissions from national transport split by gas, 2004

Unit: Million tonnes of CO_2 equivalents and %

Pollutant	EU15 Mt CO2 equiv.	Share %	EU10 Mt CO2 equiv.	Share %	AC4 Mt CO2 equiv.	Share %	EFTA4 Mt CO2 equiv.	Share %	EEA-32 Mt CO2 equiv.	Share %
CO2	860	97%	80	97%	70	98%	30	98%	1040	97,3%
CH4	2	0%	0	0%	0	0%	0	0%	3	0,3%
N2O	22	3%	2	3%	1	1%	0	1%	26	2,4%
Total	884	100%	82	100%	71	100%	31	100%	1069	100%

Source: EEA 2006b; UNFCCC, 2006.

Table 3: CO2 emissions from national transport split by mode, 2004

Unit: Million tonnes CO_2 equivalents and %

Mode	EU15		EU10		AC4		EFTA4	
	Mt CO2	Share %	Mt CO2	Share %	Mt CO2	Share %	Mt CO2	Share %
Road transport	801	93%	74	96%	57	88%	25	85%
Rail transport	6	1%	2	2%	1	2%	0	0%
Domestic navigation	21	2%	0	0%	1	2%	3	9%
Domestic aviation	23	3%	0	0,2%	5	8%	1	4%
Other transport	8	1%	1	2%	1	1%	1	3%
Total	860	100%	77	100%	65	100%	30	100%

Note: Emissions from international aviation and maritime bunkers are excluded.

Source: EEA 2006b; UNFCCC, 2006.

Table 4: Contribution to change by pollutant in total GHG emission from national transport between 1990–2004

Unit: Mt CO_2 equivalents and % change

Pollutant Mt CO2 equiv.	EU15			EU10			AC4			EEA-EFTA			EEA32		
	1990	2004	Change %	1990	2004	Change %	1990	2004	Change %	1990	2004	Change %	1990	2004	Change %
CO2	689	860	25%	64	80	24%	50	70	42%	26	30	16%	825	1035	25%
CH4	4	2	-48%	0	0	-13%	0	0	32%	0	0	-49%	5	3	-43%
N2O	8	22	178%	1	2	88%	0	1	137%	0	0	94%	10	26	163%

Source: EEA 2006b; UNFCCC, 2006.

Table 5: Contribution to change by mode in total GHG emission from national transport between 1990–2004

Unit: Mt CO_2 equivalents and % change

Mode Mt CO2 equiv.	EU15			EU10			AC4			EEA-EFTA		
	1990	2004	Change %	1990	2004	Change %	1990	2004	Change %	1990	2004	Change %
Road transport	649	825	27%	61	79	29%	42	63	49%	22	26	17%
Rail transport	9	7	-22%	3	2	-38%	2	1	-40%	0	0	-24%
Domestic navigation	20	21	9%	0	0	-11%	2	1	-21%	2	3	23%
Domestic aviation	18	24	33%	0	0	-21%	2	5	199%	1	1	17%
Other transport	7	8	21%	1	1	-7%	3	1	-73%	1	1	9%
Total	702	884	26%	66	82	25%	50	71	42%	27	31	17%

Note: Emissions from international aviation and maritime bunkers are excluded.

Source: EEA 2006b; UNFCCC, 2006.

Table 6: GHG emissions from international transport

Unit: Mt CO_2 equivalents and % change

Mode Mt CO2	EU15			EU10			AC4			EFTA4		
	1990	2004	Change %	1990	2004	Change %	1990	2004	Change %	1990	2004	Change %
Aviation	62	115	87%	2	4	62%	1	0	-57%	4	5	21%
Maritime shipping	105	150	43%	2	5	127%	1	0	-55%	2	2	33%
Total	166.69	265.17	59%	5	9	93%	2	1	-56%	6	7	24%

Note: AC4 - no data available for Turkey, Romania included its emissions elsewhere

EFTA: without Liechtenstein

Source: EEA 2006b; UNFCCC, 2006.

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Table 7: Total CO_2 emissions from national transport, 1990–2004

Unit: Million tonnes of CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	% change 1990-2004
Austria	12	14	14	14	14	14	16	15	17	17	18	19	21	23	23	89%
Belgium	20	21	22	22	22	22	22	22	23	23	24	25	25	25	26	33%
Denmark	10	11	11	11	11	12	12	12	12	12	12	12	12	13	13	24%
Finland	13	12	12	12	12	12	12	12	13	13	13	13	13	13	13	7%
France	119	122	126	126	127	129	131	133	135	138	138	141	142	141	142	19%
Germany	162	166	172	177	173	177	177	177	181	186	182	178	176	170	171	5%
Greece	15	16	17	17	17	17	17	18	20	20	19	20	20	21	22	41%
Ireland	5	5	6	6	6	6	7	8	9	10	10	11	11	11	12	140%
Italy	101	104	109	110	110	112	113	115	119	120	120	123	125	126	128	26%
Luxembourg	3	3	4	4	4	3	4	4	4	4	5	5	5	6	7	156%
Netherlands	26	26	28	28	29	29	30	30	31	32	32	33	34	34	35	34%
Portugal	10	10	11	12	12	13	14	14	16	17	19	19	20	19	19	97%
Spain	57	59	63	62	65	66	70	71	78	82	85	89	91	95	99	76%
Sweden	18	18	19	18	19	19	18	19	19	19	19	19	19	20	20	9%
United Kingdom	117	117	118	119	119	118	123	125	124	125	124	123	126	127	128	10%
Iceland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	16%
Norway	11	11	11	12	12	12	13	13	13	14	13	13	13	14	14	27%
Liechtenstein	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13%
Switzerland	14	15	15	14	14	14	14	15	15	15	16	15	15	15	15	7%
Czech Republic	7	7	7	7	8	10	10	11	11	12	11	12	12	13	15	107%
Cyprus	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	80%
Estonia	3	3	1	2	2	1	1	1	1	1	1	2	2	2	2	-20%
Hungary	8	7	7	7	7	7	7	7	8	9	9	9	9	10	10	27%
Latvia	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	12%
Lithuania	6	6	5	5	5	5	4	4	4	4	4	3	4	4	4	-33%
Poland	29	28	30	28	30	25	28	27	28	31	28	30	30	30	34	16%
Slovakia	5	4	4	4	4	4	4	5	5	5	4	5	5	5	5	7%
Slovenia	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	54%
Malta	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	68%
Bulgaria	11	7	6	7	7	7	7	5	6	6	6	6	6	7	7	-32%
Croatia	4	3	3	3	3	3	4	4	4	4	4	5	5	5	5	31%
Romania	9	8	9	8	9	9	12	12	12	9	10	11	12	12	17	95%
Turkey	26	25	25	31	29	33	35	33	31	33	35	35	36	38	40	56%
EU15	689	704	730	737	739	749	766	775	799	818	820	830	840	846	860	25%
EFTA4	26	26	27	27	27	27	27	28	29	30	29	29	29	30	30	16%
EU10	64	60	61	59	61	59	63	63	65	70	65	70	71	73	80	24%
AC4	50	42	44	50	48	52	57	54	54	53	55	57	59	62	70	42%
EEA32	825	830	859	869	872	883	909	917	942	966	965	981	994	1006	1035	25%
Index	100	101	104	105	106	107	110	111	114	117	117	119	120	122	125	25%

Source: EEA 2006b; UNFCCC, 2006.

Table 8: CO_2 emissions from national transport split by mode, 2004

Unit: Million tonnes CO_2 and %

Mode	EU15		EU10		AC4		EFTA4	
	Mt CO2	Share %	Mt CO2	Share %	Mt CO2	Share %	Mt CO2	Share %
Road transport	801	93%	74	96%	57	88%	25	85%
Rail transport	6	1%	2	2%	1	2%	0	0%
Domestic navigation	21	2%	0	0%	1	2%	3	9%
Domestic aviation	23	3%	0	0.2%	5	8%	1	4%
Other transport	8	1%	1	2%	1	1%	1	3%
Total	860	100%	77	100%	65	100%	30	100%

Note: Emissions from international aviation and maritime bunkers are excluded.

Source: EEA 2006b; UNFCCC, 2006.

Table 9: Contribution to change by mode in total CO_2 emission from national transport between 1990–2004

Mode	EU15			EU10			AC4			EFTA4		
Mt CO2	1990	2004	Change %	1990	2004	Change %	1990	2004	Change %	1990	2004	Change %
Road transport	637	801	26%	60	76	28%	42	62	49%	22	25	13%
Rail transport	8	6	-23%	3	2	-38%	2	1	-40%	0	0	-23%
Domestic navigation	19	21	9%	0	0	-14%	2	1	-21%	2	3	19%
Domestic aviation	18	23	33%	0	0	-37%	2	5	198%	1	1	13%
Other transport	7	8	21%	1	1	-7%	3	1	-73%	1	1	8%

Unit: Mt CO_2 and % change

Note: Emissions from international aviation and maritime bunkers are excluded.

Source: EEA 2006b; UNFCCC, 2006.

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Table 10: EU15 emissions from N_2O from transport, 1990-2004

Unit: Gg

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Index	100	108	118	130	145	161	177	191	209	225	235	248	260	268	278
Emissions	26	28	30	34	38	42	46	49	54	58	61	64	67	69	72

Source: EEA, 2006b.

Table 11: EU10 emissions from N_2O from transport, 1990-2004

Unit: Gg

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Index	102	94	94	92	97	109	126	137	151	166	166	180	188	195	191
Emissions	3.9	3.6	3.6	3.5	3.7	4.2	4.8	5.3	5.8	6.4	6.4	6.9	7.2	7.5	7.4

Source: EEA, 2006a.

Table 12: AC4 emissions from N_2O from transport, 1990-2004

Unit: Gg

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Index	95	83	85	102	103	113	126	122	120	135	146	155	170	192	226
Emissions	1.2	1.1	1.1	1.3	1.3	1.4	1.6	1.5	1.5	1.7	1.9	2.0	2.2	2.4	2.9

Source: EEA, 2006a.

Table 13: EFTA4 emissions from N_2O from transport, 1990-2004

Unit: Gg

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Index	100	112	124	132	145	159	172	184	189	200	197	197	192	191	192
Emissions	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.4	1.5	1.5	1.4	1.4	1.4	1.4

Source: EEA, 2006a.

File: TERM 2006 02 EEA32 – Transport emissions of greenhouse gases.xls

Meta data

EEA32 = EU15, EU10, AC4-HR, EFTA4.

EU15 = Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and UK.

EU10 = Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia.

EU25 = EU15 + EU10

AC4 = Bulgaria, Croatia, Romania and Turkey.

EFTA4 = Iceland, Liechtenstein, Norway and Switzerland

Technical information

1. *Data source*: Official data reported national total and sectoral emissions to UNFCCC and under the EU Monitoring Mechanism and EIONET. For the EU-25, the data are compiled by EEA in the European GHG inventory report (and related database) (EEA, 2006b). Data deadline for the EU-25 Member States was 15 June 2006. Data for other EEA countries are compiled for the EEA report GHG emission trends and projections in Europe 2006 (EEA, 2006a). Data deadline for these countries was July 2006. Emission projections are taken from the official submissions under the EU Monitoring Mechanism and from the fourth national communications and published in EEA 2006a..
2. *Description of data*: Annual emissions of CO_2, CH_4, N_2O, HFCs, PFCs and SF_6 in UNFCCC reporting format (in million tonnes) converted to their global warming potential where necessary (100 year time horizon) for addition and comparison with the Kyoto Protocol targets.
3. *Geographical coverage:* EEA32.
4. *Temporal coverage:* Historical data: 1990-2004. Data gaps exist for a few countries and were filled according the implementing provisions under the EU Monitoring Mechanism. For more details see EEA (2006b). Projected data: 2010.
5. *Methodology and frequency of data collection:* Annual official data submission by EU Member States to UNFCCC and EU Monitoring mechanism (EEA, 2006a). Compilation of emission estimates by Member States is based on combining sectoral activity data, calorific values and carbon emission factors. Recommended methodologies for emission data estimation are compiled in the Intergovernmental Panel on Climate Change (IPCC) Guidelines for National GHG Inventories (IPCC, 1997), supplemented by the 'Good Practice Guidance and Uncertainty Management in National GHG Inventories' (IPCC, 2000) and UNFCCC Guidelines (UNFCCC, 2000).
6. *Methodology of data manipulation':* The data has been weighted according to the following global warming potentials (GWP) for each GHG: CO2 = 1. CH4=21. N2O =310 SF6=23900 to give total GWP emissions in Mt CO2 equivalent. HFCs and PFCs have a wide range of GWPs depending on the gas and emissions have been reported by the Member States as Mt CO2 equivalent. Where data is not available for EU Member States, the data gap filling procedure has been used as agreed under the Monitoring Mechanism (EEA, 2006a).

GHG intensity of energy use calculated using: energy related GHG emissions from / gross inland energy consumption

Average annual rate of growth calculated using: [(last year/base year)(1 / number of years) –1] x 100

Quality information

7. Strength and weakness (at data level). Strength: officially reported data following agreed procedures, e.g. regarding source sector split. The GWP weighting is the agreed UNFCCC and EU Monitoring Mechanism procedure. Weakness: HFC, PFC and SF6 are not reported by all Member States.
8. Reliability, accuracy, robustness, uncertainty (at data level): The IPCC (IPCC, 2000) suggests that the uncertainty in the total GWP-weighted emission estimates, for most European countries, is likely to be less than +/– 20 %. The IPCC believes that the uncertainty in CO2 emission estimates from fuel use in Europe is likely to be less than ± 5%. Total GHG emission trends are likely to be more accurate than the absolute emission

estimates for individual years. The IPCC suggests that the uncertainty in total GHG emission trends is +/– 4 % to 5 %.
The results of the uncertainty estimate suggest that uncertainties at EU-15 level are between +/- 4 % and 11 % for total EU-15 GHG emissions. Transport related GHG emissions are estimated to have an uncertainty of +/– 3 % (see EEA, 2006b). For the new Member States and some other EEA countries, uncertainties are assumed to be higher than for the EU-15 Member States because of data gaps.

9. Overall scoring (give 1 to 3 points: 1=no major problems, 3=major reservations): 2

   Relevancy: 1 (GHG emissions from transport are a relevant overall indicator for the impact of transport on the environment. However, a further modal split of road transport into passenger and freight transport emissions would be helpful for further analysis of trends.)

   Accuracy: 2 (some data gaps exist)

   Comparability over time: 2 (Parties to the UNFCCC are required to recalculate their emission data if methodologies have been changed. Therefore, the time series provided should be consistent. However, not all Parties recalculate the time series every year.)

   Comparability over space: 1 (Methodologies used should be comparable between countries because of the reporting guidelines of the international conventions. However, missing data or existing data gaps affect this comparability.)

Further work required

The EEA32 countries should improve the completeness of the time series of their estimates (filling gaps). Further validation and checking is the responsibility of the country and needs especially to lead to improved detailed sectoral time series of emissions. There is also a need for further validation and checking within the framework of UNFCCC and EU Monitoring Mechanism, as recommended by the IPCC Good Practice Guide.

Box 1: Aviation and the global atmosphere

Aircraft emit gases and particles directly into the upper troposphere and lower stratosphere where they have an impact on atmospheric composition. These gases and particles alter the concentration of atmospheric GHGs, including carbon dioxide, ozone, and methane. They trigger formation of condensation trails (contrails) and may increase cirrus cloudiness. All these contribute to climate change.

Global passenger air travel, as measured in passenger-km, is projected to grow by about 5 % per year between 1990 and 2015 (although this estimate is expected to be influenced by the events of 9-11, SARS and the Iraq war), whereas total aviation fuel use is projected to increase by 3 % per year, over the same period, the difference being due mainly to improved aircraft efficiency. All scenarios assume that technological improvements leading to reduced emissions per revenue passenger-km will continue and that optimal use of airspace availability is achieved by 2050. Emissions of carbon dioxide by aircraft were 0.14 Gt C/year in 1992. This is about 2 % of total anthropogenic carbon dioxide emissions in 1992 or about 13 % of carbon dioxide emissions from all transportation sources. The range of scenarios considered by IPCC projects that aircraft emissions of carbon dioxide will continue to grow and by 2050 will be 0.23 to 1.45 Gt C/year.

The climate impacts of emissions can be compared using the concept of radiative forcing. The radiative forcing in 1992 by aircraft was 0.05 Wm^{-2} or about 3.5 % of the total radiative forcing by all anthropogenic activities. For the reference scenario, the radiative forcing by aircraft in 2050 is 0.19 Wm^{-2} or 5 % of the total radiative forcing in the mid-range IPCC scenario. This equates to aircraft contributing about 0.05 ^{0}C to global warming in 2050, compared to a total of 1.5 to 6 ^{0}C projected by 2100 due to all sources of GHG emissions (IPCC, 2001).

There is a range of options to reduce the impact of aviation emissions, including changes in aircraft and engine technology, fuel, operational practices, and regulatory and economic measures. Substantial aircraft and engine technology advances and the air traffic management improvements are already incorporated in the aircraft emissions scenarios used for IPCC climate change calculations. Other operational measures, which have the potential to reduce emissions, and alternative fuels, were not assumed in the scenarios. Further technology advances have the potential to provide additional fuel and emissions reductions. In practice,

some of the improvements are expected to take place for commercial reasons. The timing and scope of regulatory, economic, and other options may affect the introduction of improvements and may affect demand for air transport.

CO_2 emissions from international aviation (not included in the Member States' emission totals), represented 4 % of the total CO_2 EU15 emissions in 2004, which is an increase compared to the share of 2 % in 1990.

Source: IPCC, 1999.

Box 2: EU15 GHG emissions from international transport

GHG emissions from EU15 Member States reported as emissions from international transport (so-called 'international bunkers') represented 4 % of the total EU GHG emissions in 1990 and 6 % in 2004. Therefore, a 60 % increase in EU emissions was reported as originating from this source between 1990 and 2004. (The shares on total GHG emissions were 2 % and 4 % for marine transport and 1 % and 3 % for aviation in 1990 and 2004 respectively.)

According to the UNFCCC reporting guidelines, 'inventories should include GHG emissions and removals taking place within national (including administered) territories and offshore areas over which the country has jurisdiction'.

One of the qualifications of the national territory principle in the guidelines is: 'Emissions based upon fuel sold to ships or aircraft engaged in international transport should not be included in national totals but reported separately.'

International marine and aviation bunkers are reported separately. However, it is not known whether all EU15 Member States apply the guidelines correctly. In addition, it is not clear from the guidelines whether for the EU15, as the sole instance of a regional economic integration organisation, maritime and air traffic between EU15 Member States, EU15 Member States and the overseas countries and territories, and the overseas countries and territories themselves should be considered as 'belonging' to the EU15. It is assumed that at least each Member State applies its own definitions consistently.

Emissions from international flights and shipping are excluded from the emission reduction targets of the Kyoto Protocol, although emissions from domestic transport are not. The UNFCCC Subsidiary Body on Scientific and Technical Advice is currently considering the issue of emissions from international flights. Annex 1 Parties to the UNFCCC are required by the Kyoto Protocol to act to limit or reduce emissions from international flights, working through the International Civil Aviation Organisation (ICAO). The ICAO has asked its Committee on Aviation Environmental Protection (CAEP), to study policy options to limit or reduce GHG emissions from civil aviation, but ICAO has so far only been able to agree on a template for voluntary agreements and to publish a catalogue of operational opportunities to minimize fuel use and reduce emissions. For international shipping, the Kyoto Protocol requires developed countries to pursue action through the International Maritime Organisation.