

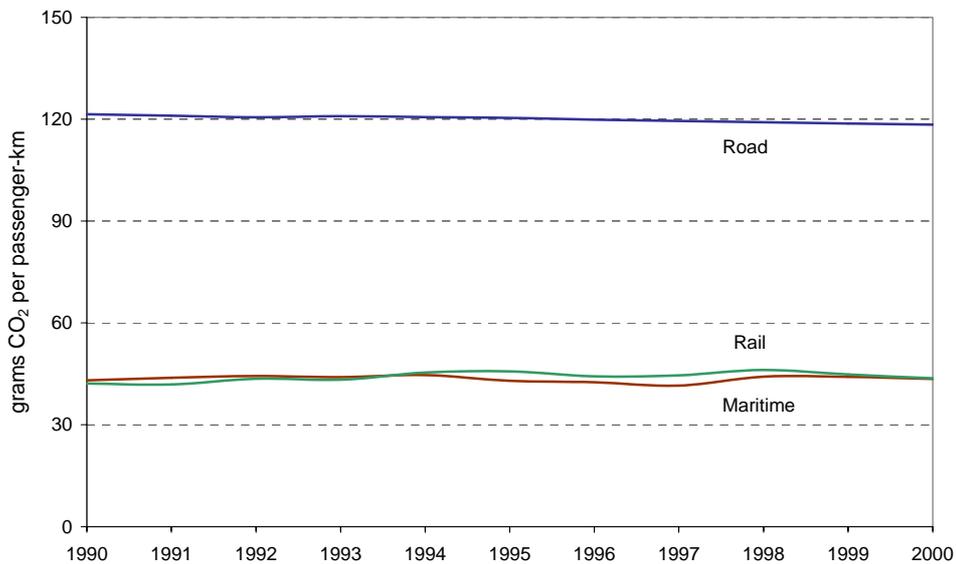
Indicator factsheet

TERM 2003 27 EEA 31 — Overall energy efficiency and specific CO₂ emissions for passenger and freight transport

☺ **The energy efficiency of passenger car transport has improved during the past decade. The voluntary agreement with the car industry to reduce CO₂ emissions from new cars, increasing thus the energy efficiency, is making progress towards its target, although continued efforts are still needed. However, rail and maritime shipping remain the most energy-efficient modes of passenger transport.**

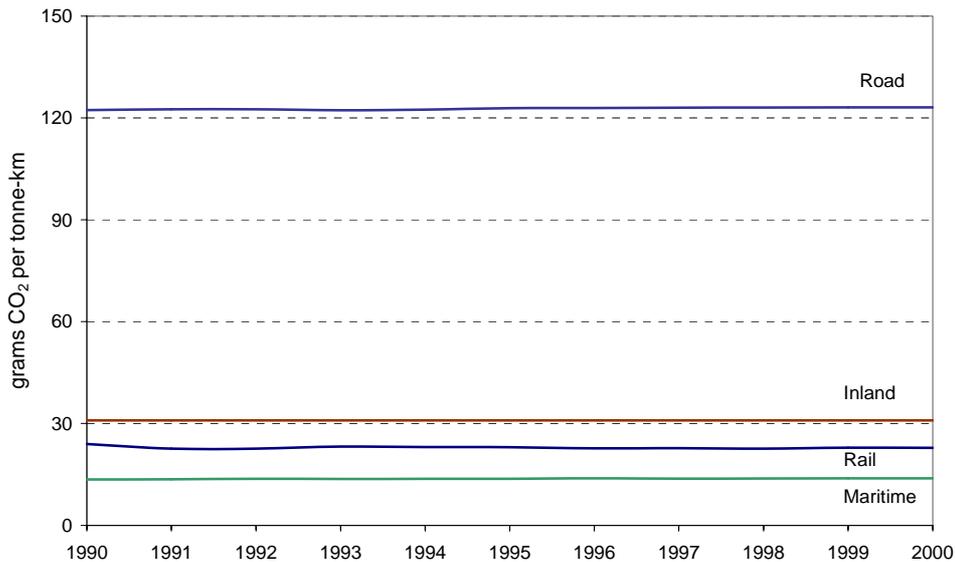
While the energy efficiency of trucks has remained stable, improvement in efficiency can be observed for rail freight transport. Trucks consume significantly more energy per tonne-km than rail or ship transport.

Figure 1: Specific emissions of CO₂ per passenger-kilometre and per mode of transport in EU-15, 1990–2000



Source: Trends, 2003.

Figure 2: Specific emissions of CO₂ per tonne-kilometre and per mode of transport in EU-15, 1990–00



Source: Trends, 2003.

Results and assessment

Policy relevance

The European climate change programme (European Commission, 2000a), the sustainable development strategy (European Commission, 2001a) and the sixth environmental action programme (European Commission, 2001b) all point out climate change as a priority area for action. Since transport is one of the biggest energy consumers, it is therefore a priority area for energy-efficiency improvement and thus CO₂ emission reductions (European Commission, 2002a).

Energy efficiency improvements can be achieved by reducing fuel consumption per passenger-kilometre and per tonne-kilometre (improving energy efficiency), increasing occupancy rates and load factors (reducing emissions per passenger-kilometre or tonne-kilometre), shifting transport to the most fuel-efficient means (modal shift), avoiding unnecessary transport, or by using high quality (or alternative) fuels (limiting CO₂ emissions per unit of fuel uptake). Specific targets for transport energy efficiency (or specific CO₂ emission reductions) are, however, not set.

Policy context

Along the lines of the European climate change programme, the sustainable development strategy and the sixth environmental action programme (6EAP), the basic pillars to improve energy efficiency of transport are:

- shifting to less energy consuming modes (like rail and water);
- environmental agreement with industry on energy efficiency;
- reduction of congestion; and
- promotion of alternative fuels.

Only the 6EAP includes the strategy to research and exploit engine technologies offering higher (energy and emission) efficiency. It also states the need for special attention in this respect to the aviation sector.

The Commission's action plan to improve energy efficiency in the European Union (European Commission, 2000b) addresses improving energy efficiency. The action plan proposes, among other measures, enhancing the integration of energy-efficiency considerations into other non-

energy policy and programme areas (like the transport sector) and measures for refocusing and reinforcing existing successful Community energy-efficiency measures. Measures to enhance the integration of energy efficiency into non-energy policy programme areas include incentives for optimal occupancy of vehicles, promotion of new and alternative infrastructure and, subsequently, modal shifting and modal integration, management alternatives to air transport, completion of the internal market in rail transport and changing behaviour regarding mobility. With respect to refocusing and reinforcing successful current energy-efficiency policies and measures, the action plan emphasises the need to fully implement and monitor the voluntary agreements with the car manufacturing industry, and to provide additional incentives to accelerate the rate of compliance, through further action on vehicle fuel economy and improved pricing.

Against the background of the Kyoto Protocol, the EU has adopted a strategy to cut the average CO₂ emissions of new cars sold in the EU by around one third. This strategy consists of three elements.

1. Commitments of the car manufacturers to reduce new car CO₂ emissions mainly by technological innovation. The three commitments with the European (ACEA), Japanese (JAMA) and Korean (KAMA) car manufacturers associations contain the same quantified CO₂ emission objective for the average new passenger car sold in the European Union, i.e. 140 g CO₂/km (to be achieved by 2009 by the JAMA and the KAMA and by 2008 by the ACEA).
2. A fiscal framework for measures to reduce CO₂ emissions from new cars, see COM(2002) 431.
3. Improving consumer information on the energy efficiency of new cars (car labelling directive — 1999/44/EC ⁽¹⁾).

This strategy is monitored annually (see

Box 1). The overall final objective is to achieve an average specific CO₂ emission figure for new passenger cars of 120 g CO₂/km by 2005, and 2010 at the latest.

'Intelligent energy for Europe' ⁽²⁾ is the Community's support programme for non-technological actions in the field of energy, precisely in the field of energy efficiency and renewable energy sources. The duration of the programme is from 2003 to 2006.

Intelligent energy for Europe is intended to support the European Union's policies in the field of energy as laid down in the Green Paper on security of energy supply, the White Paper on transport and other related Community legislation (including the directives on renewable electricity, energy performance of buildings and biofuels). Its aim is to support sustainable development in the energy context, making a balanced contribution to achieving the general objectives of security of energy supply, competitiveness, and environmental protection.

The programme is structured in four fields: SAVE, Altener, STEER and Coopener. STEER concerns support for initiatives relating to all energy aspects of transport, the diversification of fuels, such as through new developing and renewable energy sources, and the promotion of renewable fuels and energy efficiency in transport, including the preparation of legislative measures and their application.

Additionally, two research programmes need mentioning: Thermie and SAVE.

- The Thermie programme (European Commission, 1994) of the Commission aimed to promote more efficient energy technology. The programme, now closed, had a budget of about EUR 700 million. The Thermie programme now forms part of the specific programme on research, technological development and demonstration on energy, environment and sustainable development for 1998–2002 (European Commission, 1999b). Priorities in this programme are given to an integrated approach to improving energy efficiency in transport, among others.
- The SAVE programme was adopted by the Council in 1996 for a five-year period (European Commission, 1999c). It now forms part of the energy framework programme for 1998–2002

⁽¹⁾ OJ L 171, 7.7.1999, pp. 12–16.

⁽²⁾ OJ L 176, 15.7.2003, pp. 29–36.

(European Commission, 2000c). It has several priorities for the transport sector. These include measures to increase the use of energy-efficient transport in European cities for both passengers and freight, including the optimal occupancy of vehicles (both public and private), promotion of new and alternative infrastructure, management alternatives to air transport and changing behaviour. For 2000–02, emphasis is placed on information dissemination and reducing the use of private cars, encouraging collective transport modes and seriously considering how to reduce the need for transport.

Environmental context

Transport accounts for almost one third of final energy consumption (see TERM 2003 01 EEA — Energy consumption) and around a quarter of total CO₂ emissions (see TERM 2003 02 EEA — Transport emissions of greenhouse gases). Energy efficiency improvements in transport can therefore result in enormous reductions in energy consumption and CO₂ emission.

The average energy efficiency of passenger and freight transport is determined by the fleet composition (number and type of vehicles), vehicle utilisation (occupancy rates and load factors) and driving characteristics (speeds, distances).

NB: For goods transport, energy use per tonne-kilometre also depends on the characteristics of the goods transported by the modes (heavier or less heavy goods). Part of the difference in energy use per tonne-kilometre can therefore also be explained by differences in goods transported.

Assessment

The energy efficiency (in Megajoules per passenger-kilometre) of road passenger transport has slightly improved by 2.6 % between 1990 and 2000, while it has been stable for road freight transport (in Megajoules per tonne-kilometre) over the same period (for a more detailed assessment on the various modes of road transport see also 'Sub-indicator: Energy efficiency and specific CO₂ emissions from road transport', below).

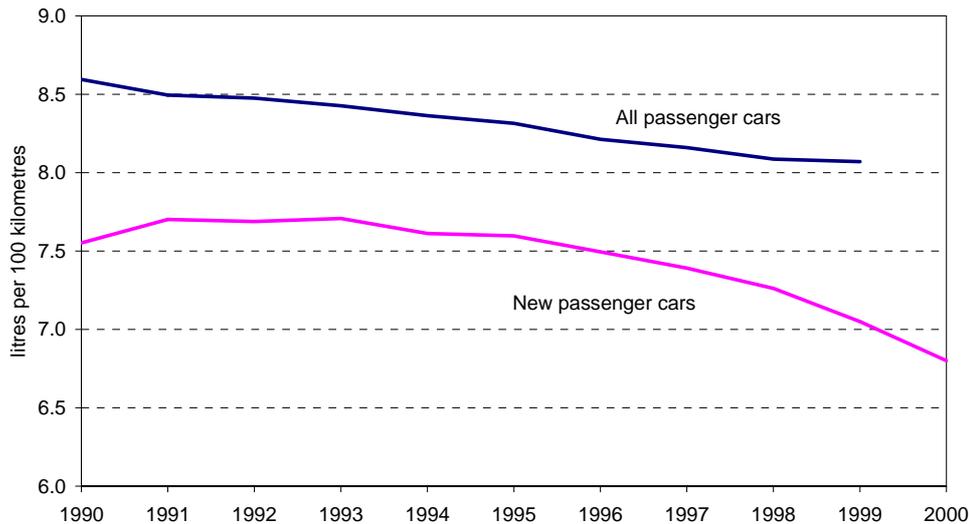
The energy efficiency of rail passenger transport has decreased by 5 % during the last decade, while the energy efficiency of rail freight transport has improved by 5 % over the same period in the EU. This could be related to the combined effect of increased loading factors for rail freight and lower occupancy rates for rail passenger transport.

The energy efficiency of maritime and inland shipping has recorded slight changes in the order of ± 3 %.

Sub-indicator: Fuel efficiency of passenger cars

- ☺ **Fuel efficiency of new passenger cars has improved, mainly due to the commitments of the car manufacturers' associations, as well as supporting measures (labelling, fiscal measures etc.). Fuel efficiency of the entire passenger car fleet also improved, due to the voluntary agreements, fuel quality improvements and a shift towards diesel cars.**

Figure 3: Specific fuel consumption of (new) passenger cars in EU-15, 1990–2000



NB: Source for test values: national agencies, except Ireland, Luxembourg and Portugal. For these countries, the data are elaborated for Odyssee from data provided by associations of car manufacturers from Europe (ACEA), Japan (JAMA) and Korea (KAMA). Data are based on the new test cycle, in accordance with Directive 93/116/EC. For 1995, data were initially based on the old cycle; they have been adjusted by the ACEA by applying a 9 % adjustment 'across the board'. For previous years, data have been adjusted to be consistent with the new cycle. The latest monitoring report can be found at: http://europa.eu.int/comm/environment/co2/co2_home.htm

Source: Odyssee, 2002.

Assessment of the sub-indicator

Fuel efficiency (litres per 1 000 km) of passenger cars improved. New cars consumed around 6.6 % less fuel in 1999 than they did in 1990. The average new car consumes about 7 litres of fuel per 100 km. In the same period, the entire passenger car fleet also improved its fuel efficiency, though a little bit less: on average 6.1 % less fuel per 100 km was needed in 1999 than in 1990. An average passenger car in the EU consumes about 8 litres of fuel per 100 km.

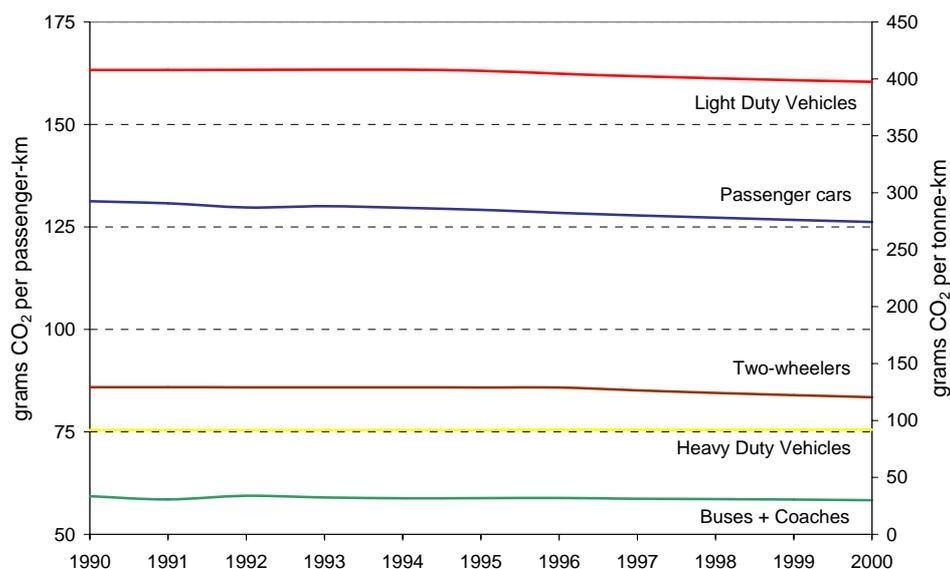
Fuel efficiency of the total passenger car fleet has decreased less in recent years than that of new cars. When looking at a somewhat longer period of time (from 1985 up to 1999), we see that fuel consumption of the entire passenger car fleet fell by 11 % versus 8 % for new passenger cars. Fuel quality improvement in the late 1980s and early 1990s is probably the main cause of this difference. Dieselisation (more and more cars running on diesel, which has a higher energy density) also partly explains the observed trends. Lastly, diesel engines have experienced great technological improvements, which have made them more energy efficient.

Research has shown discrepancies between 'on road' fuel consumption and emission rates (i.e. real driving circumstances) and test emission values, as a result of poor driving behaviour, worsening traffic conditions and other problems that are not generally taken into account in policy-making. This emphasises the need for regular maintenance and inspection programmes, improvement of traffic management and changes in driving behaviour.

Sub-indicator: Energy efficiency and specific CO₂ emissions from road transport

☺ **With increasing energy efficiency of new passenger cars, specific CO₂ emissions decreased significantly.**

Figure 4: Development of specific CO₂ emissions from road passenger and freight transport in EU-15, 1990–2000



Source: Trends, 2003.

Assessment of the sub-indicator

Passenger cars remain the most polluting and least energy efficient passenger transport mode in terms of specific CO₂ emissions and energy consumption respectively. On the other hand, buses and coaches are the cleanest and most energy efficient mode of passenger transport, emitting only half the CO₂ and consuming half the energy per passenger-kilometre as compared with passenger cars. With respect to freight transport, light duty vehicles emit more than four times more CO₂ and consume more than four times more energy per tonne-kilometre than heavy duty vehicles. The energy efficiency of passenger car transport improved by 4 % between 1990 and 2000. As a result, on average, the European passenger car emitted 4 % CO₂ per passenger-kilometre less in 2000 than it did in 1990. The improvement in passenger cars' energy-efficiency results partly from the commitments of the car manufacturing industries, as pointed out in the fourth annual report on the effectiveness of the Community's strategy to reduce CO₂ emissions from passenger cars (European Commission, 2004). Additional efforts are, however, still needed to reach the Community goal of 120 g per vehicle-kilometre (note the difference between per passenger-kilometre and per vehicle-kilometre) — see Box 1. In addition, the Commission started work on mobile air conditioning, focusing on possible options to (i) measure and, if possible, reduce the additional fuel consumption and related CO₂ emissions, and (ii) to reduce emissions of the coolant HFC-134a.

Specific CO₂ emissions from buses, coaches and two-wheelers were also reduced by 1.5 and 3 % respectively over the same period. The energy efficiency of light duty vehicles has improved by 2.5 %, with the increased penetration of diesel and with general technical improvements in diesel or petrol trucks while the energy efficiency of heavy duty vehicles remained stable over the same period.

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Data

Table 1: Estimated CO₂ emissions per passenger-kilometre and per tonne-kilometre in EU-15

Unit: grams per passenger-km (for passenger transport) or grams per tonne-km (for freight transport)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Passenger transport											
Air	185.1	181.1	177.2	173.4	169.7	166.1	146.6	146.3	144.6	143.5	141.6
Maritime	43.1	43.9	44.4	44.1	44.7	42.9	42.5	41.5	44.2	44.2	43.5
Rail	42.1	41.9	43.6	43.3	45.4	45.7	44.3	44.6	46.1	44.8	43.7
Road	121.5	121.0	120.6	120.9	120.6	120.4	119.9	119.4	119.1	118.7	118.4
Passenger cars	131.3	130.8	129.7	130.1	129.7	129.2	128.4	127.8	127.3	126.7	126.2
Two-wheelers	85.9	85.9	85.9	85.9	85.9	85.8	85.8	85.1	84.5	83.9	83.5
Buses	67.1	66.2	67.3	66.8	66.6	66.7	66.7	66.5	66.4	66.2	66.1
Coaches	34.9	34.5	34.9	34.6	34.5	34.5	34.6	34.5	34.4	34.4	34.3
Freight transport											
Inland	30.9	30.9	30.9	30.9	30.9	30.9	30.9	30.9	30.9	0.0	30.9
Maritime	13.5	13.5	13.7	13.7	13.7	13.7	13.8	13.8	7.9	5.9	13.9
Rail	24.0	22.6	22.6	23.2	23.1	23.0	22.7	22.7	0.0	22.9	22.8
Road	122.3	122.6	122.5	122.3	122.5	122.9	122.9	123.0	123.1	123.1	123.1
LDV	407.7	407.7	407.8	408.0	408.1	407.1	404.5	402.4	400.5	398.9	397.4
HDV	91.7	91.7	91.7	91.7	91.7	91.8	91.8	91.8	91.9	91.9	92.0

Source: Trends, 2003.

Spreadsheet file: TERM 2003 27 EEA — Energy efficiency.xls

Metadata

Technical information

- Data sources:
energy-efficiency data, 1990–2000 from Trends, 2003;
fuel-efficiency of passenger cars, 1990–2000 from the Odyssee database.
- Description of data: Energy efficiency of passenger transport (in Megajoules per passenger-kilometre), energy efficiency of freight transport (in Megajoules per tonne-kilometre) and specific fuel consumption of entire car fleet and new passenger cars (in litres per 100 km).
- Geographical coverage: EU-15 (Belgium, Denmark, Germany, Greece, Spain, France, Ireland, Italy, Luxembourg, the Netherlands, Austria, Portugal, Finland, Sweden and the United Kingdom).
- Temporal coverage:
Energy efficiency and specific CO₂ emissions: 1990–2000
Fuel efficiency of new passenger cars: 1990–2000
Fuel efficiency of all passenger cars: 1990–99
- Methodology and frequency of data collection: New runs of the model are performed as soon as new data are available (e.g. data on the composition of the vehicle fleet).
- Methodology of data manipulation, including making 'early estimates': Total energy consumption and tonnes of CO₂ are divided by total passenger-kilometres or tonne-kilometres for the corresponding mode.

Quality information

- Strength and weakness (at data level): There are full data-series for the EU countries but no data for the acceding and candidate countries. The specific emissions and energy

consumption are modelled rather than measured, based on estimates of the vehicle fleet composition and on emissions from different modes of transport.

8. Reliability, accuracy, robustness, uncertainty (at data level): Data can be considered as fairly reliable.
9. Overall scoring (give 1 to 3 points: 1 = no major problems, 3 = major reservations): 2
Relevancy: 1.
Accuracy: 2 (specific emissions and energy consumption are modelled rather than measured).
Comparability over time: 1.
Comparability over space: 1.

Further work required

More work is needed to further improve the quality of data. Trends has been jointly developed by Eurostat and the Transport DG and is a system for calculating a range of environmental pressures due to transport. These environmental pressures include air emissions and energy consumption from the four main transport modes, road, rail, water and air. An important aim is to produce a consistent set of estimates to be used for EU policy purposes including TERM. Trends enables the effects of specific policy measures on emissions and other environmental pressures to be monitored (EEA, 2000). This project and a number of research projects under the Commission's transport RTD programme (in particular the Artemis project) are expected to develop an improved emission model for road transport based on a harmonised methodology for national and regional inventories and forecasts. Artemis will also include emission estimates for aircraft, motorcycles and probably even ships. Most resources are however still allocated to road.

Results on aviation were not included as there is a lower confidence in their reliability compared with other modes of transport.

Box 1: Effectiveness of the agreement with the car industry

In its fourth annual report on the effectiveness of the Community's strategy to reduce CO₂ emissions from passenger cars (European Commission, 2004), results from the voluntary agreements with the car manufacturing industries are evaluated. The main findings for the reporting period (1995–2002) are the following.

- Compared with 2001 all three associations reduced the average specific CO₂ emissions of their cars registered for the first time on the EU market (the ACEA by about 1.2 %, the JAMA by about 2.5 % and the KAMA by about 1.8 %). Since 1995, the fuel efficiency improvements for diesel passenger cars are clearly better compared with gasoline vehicles.
- The JAMA and the ACEA show good progress, although the ACEA's 2002 performance is lower than in the previous years. However, the ACEA reached, already in 2000, the intermediate target range envisaged for 2003, and is now at the very low end of this range. The JAMA achieved, in 2002, the upper end of the intermediate target range. Both associations can be considered to be on track.
- The KAMA's progress is still unsatisfactory, although it has been catching up slightly in the last two years. There is a real risk that the KAMA will not meet its 2004 intermediate target range of 165 to 170 g/km, seeing that only two years are left to close the gap of 13 g/km. This could affect the whole approach on CO₂. However, the KAMA has reconfirmed its commitment to meet its targets.
- In order to meet the final target of 140 g/km, additional efforts are necessary, as the average annual reduction rate of all three associations needs to be increased. On average the reduction rate must be around 2 %, or about 3.5 g/km per year from 1995 to 2008–09. In the years remaining until 2008–09 the reduction rates must be on average 2.5 % for the ACEA, 2.8 % for the JAMA and 3.4 % for the KAMA. However, it was anticipated from the

beginning that the average reduction rate would be higher in the later years.

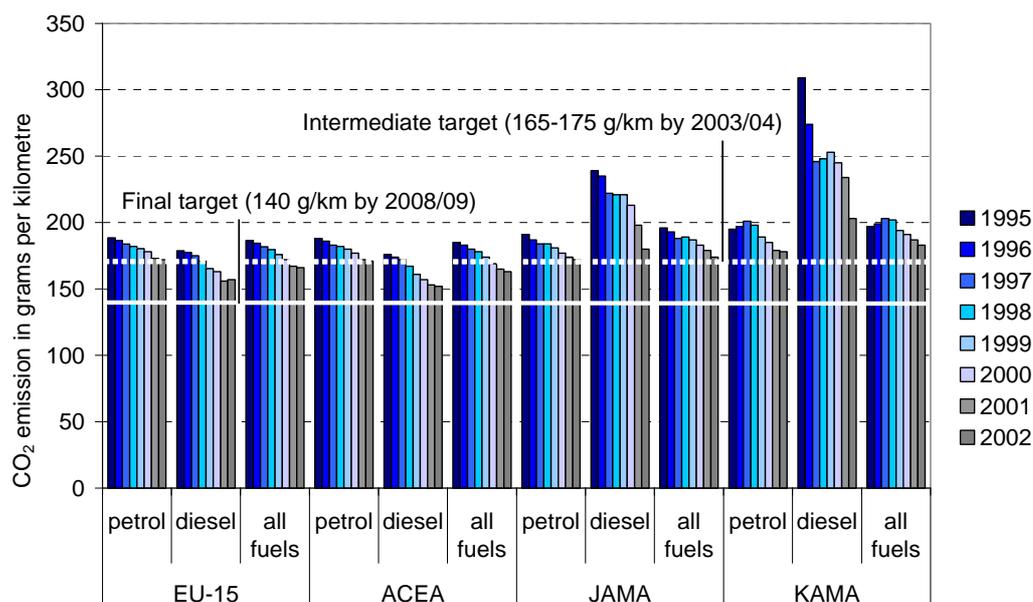
All associations increased further the share of diesel cars in their respective sales within the reporting period. This was predicted for the short-term. For the 2008–09 target it was understood that the associations would not meet it by simple increases in the diesel share only but by technological developments and market changes linked to these developments. In this respect it is important to note that the Council invited the Commission ‘...to make continued efforts to significantly reduce nano-particulate emissions, and in particular devise a new measuring procedure for private cars, light duty vehicles and heavy duty vehicles taking into account the results of recent studies into the health effects of nano-particulate emissions...’ and that the ACEA recently raised uncertainties associated with the introduction of gasoline direct injection technology. This technology was supposed to break the strong trend towards diesel powered passenger cars.

All associations declared in their respective commitment that they would meet the final target by mainly technological developments and market changes linked to these developments. Such developments have indeed contributed to the reductions achieved so far (mainly the introduction of high-speed direct injection diesel (HDI) engines, and to a lesser extent by the introduction of gasoline direct injection (GDI) engines, continuously variable transmission (CVT), variable valve lift (VVL), as well as other technical improvements, and alternative fuelled vehicles (AFVs) as well as dual-fuelled vehicles (DFV)). In 2000, the ACEA and — to a lesser extent — the JAMA introduced passenger cars emitting 120 g CO₂/km or less (meeting one of the commitments); the KAMA is still to introduce such models on the market.

Based on the evaluation reports, the Commission has reason to believe that all associations will meet their commitments. However, to meet the final objective (on average 140 g CO₂/km for the entire passenger car fleet), the Community should continue its work in developing and implementing the two other pillars of its strategy to reduce CO₂ emissions from passenger cars, i.e. the car labelling directive and fiscal measures.

The car industry attributes great importance to the availability of low sulphur fuel to meet dual targets of reduced CO₂ and NO_x emissions. The associations made their commitments on the basis of the fuel quality requirements laid down in Directive 98/70/EC, although they expect that better fuel qualities might be available in the market in the future. The amended Directive 98/70/EC will provide 10 ppm sulphur fuels, as requested by the car industry (see Directive 2003/17/EC).

Figure 5: Achievements of the car manufacturing industries regarding CO₂ emissions from new passenger cars, 1995–2002



NB: the 'Final target' is 120 g/km to be achieved in 2010 at the latest; the target of the commitments is 140 g/km to be achieved by 2008–09.

Source: European Commission, 2004.