

### 3. Energy efficiency trends in transport

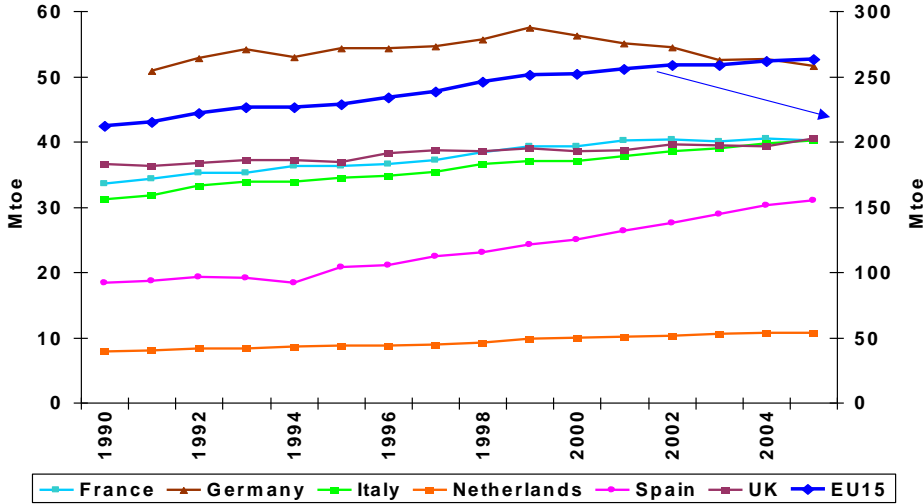
#### 3.1. Energy use patterns

##### Rapid growth until 1999 and a net slowdown afterwards

The energy consumption of the transport sector increased very rapidly between 1990 and 1999 in the EU-15 (at about 1.7 %/year). Since then, there has been a net slowdown (around 0.9 %/year over the period 2000-2005). As a result of this rapid growth, its share in final energy consumption has now reached 32 % in the EU-15 as a whole (322 Mtoe in 2004), up from 29 % in 1990 (252 Mtoe). The weight of transport is even higher in certain countries: 37 % in the UK and Portugal, 39 % in Spain and Ireland, 43 % in Greece and 60 % in Luxembourg.

The slowdown in the growth in energy consumption is significant in some large countries: there has been a decrease of consumption in Germany since 2000, stabilisation in France since 2001 and a slowdown in most other countries (Figure 3-1). This new trend is mainly the result of the sharp increase in oil price in 2000 (+80 % compared to 1999) exacerbated in some countries by national measures (e.g. motor fuel tax increases in Germany and the UK, enforcement of speed limits via speed meters in France). In Spain, in contrast, transport energy demand in recent years has grown even faster than it did in the early 1990s.

Figure 3-1: Trends in the energy consumption of transport in the EU-15



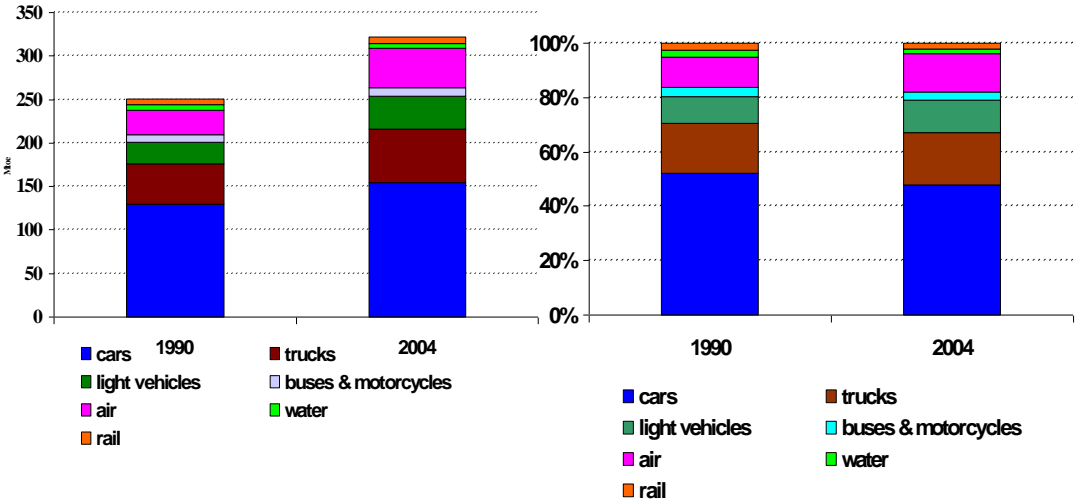
##### Rapid progression of air transport until 2000

Road transport represented 80 % of total transport consumption in 2004, down from 84 % in 1990 (Figure 3-2); domestic and international air transport increased from 11 % to 14 % of the energy consumed by the sector over the period. Total transport consumption increased rapidly at around 5 % per annum between 1990 and 2000 until the crisis that struck the sector in 2001. Rail and domestic water transport represented around 4 % of total transport energy demand (with 2.3 % and 1.5 % respectively). Passenger transport represented about two thirds of the total consumption and grew less rapidly than goods' transport.

**Almost half of the consumption was for cars, but this share is in decline; 30 % for trucks**

Cars account for about half of the total consumption of the sector and for about 60 % of road transport consumption. The share of cars is declining (48 % in 2004 compared with 52 % in 1990), whereas the share of road goods transport (trucks and light duty vehicles) is on the increase (31 % in 2004 against 28 % in 1990). The consumption of light duty vehicles has the most rapid progression among road vehicles (3.3 %/year compared to 1.2 %/year for cars). The growth in energy consumption of heavy trucks remained stable over the period (at 2 %/year) and did not slow down after 2000, as was the case for the other vehicles.

**Figure 3-2: Consumption of transport by mode in the EU-15**



**3.2. Cars**

**A rapid drop in the specific consumption of new cars since 1995**

In the EU-15, the specific energy consumption of new cars<sup>40</sup> remained fairly stable between 1990 and 1995<sup>1</sup> (Figure 3-3). Between 1995 and 2004 there was a net reduction from 7.7 to 6.5 l/100 km (from 8 to 7.2 l/100 km for new gasoline cars and from 6.7 to 5.8 l/100 km for new diesel cars). Clearly, the Voluntary Agreements signed with three car manufacturers' associations (ACEA, JAMA and KAMA)<sup>41</sup> on carbon emissions (target of 140g of CO<sub>2</sub>/km for new cars in 2008 at the EU level) was the main driver of the trend observed in the energy performance of new cars.

As about three quarters of the cars on the road in 2004 had been purchased after 1995<sup>42</sup>, the energy efficiency gains achieved in new cars had a direct impact on the average performance

<sup>40</sup>The energy efficiency progress of new cars is usually assessed using an average “test specific consumption” measured by a fuel consumption test for all new cars sold each year.

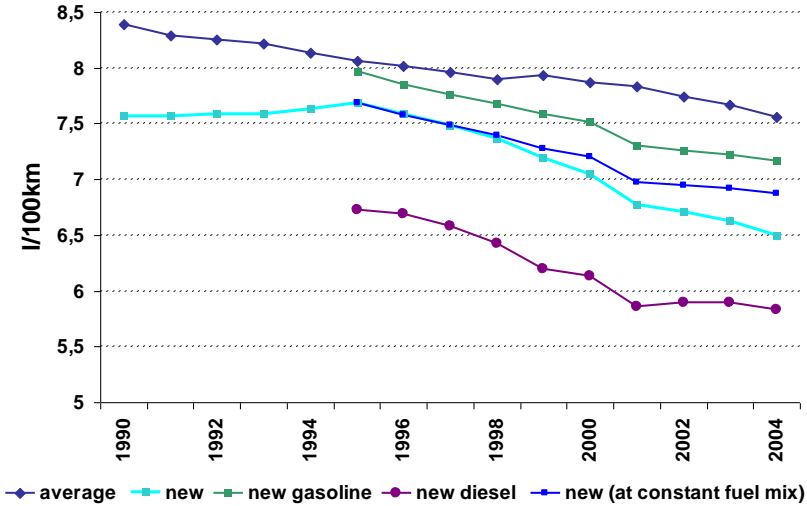
<sup>1</sup> Data are taken from ACEA, JAMA and KAMA since 1995; before 1995, a weighted average was calculated using a sample of 6 countries. Historical data have a break in 1997 due to a modified definition of the test value: the new way of calculating the test value results in values about 9-10 % higher than the previous method according to an assessment made by ADEME for France or ACEA.

<sup>41</sup> ACEA, European Automobile Manufacturers Association; JAMA, Japan Automobile Manufacturers Association; KAMA, Korean Automobile Manufacturers Association

<sup>42</sup> New cars represent about 8 % on average of the total car fleet in the EU-15.

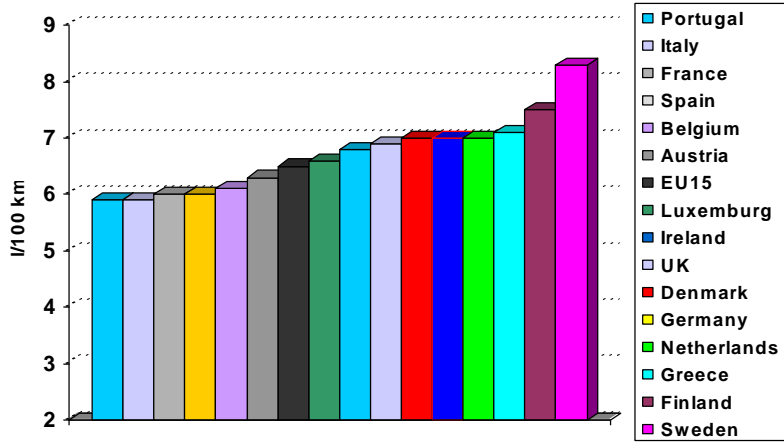
of the car fleet: as a result, the average specific consumption of the car stock decreased from 8.4 to 7.6 l/100 km between 1990 and 2004 (from 8.6 to 7.9 l/100 km for gasoline cars and from 7.1 to 6.6 l/100 km for diesel).

**Figure 3-3: Specific consumption of cars<sup>43</sup> in the EU-15**



The specific consumption of new cars in 2004 ranged from a minimum of 5.9 litres per 100 km in Italy, Portugal, France and Spain, to 8.3 litres per 100 km in Sweden (Figure 3-4).

**Figure 3-4: Specific consumption of new cars<sup>44</sup> in 2004 in the EU -15**



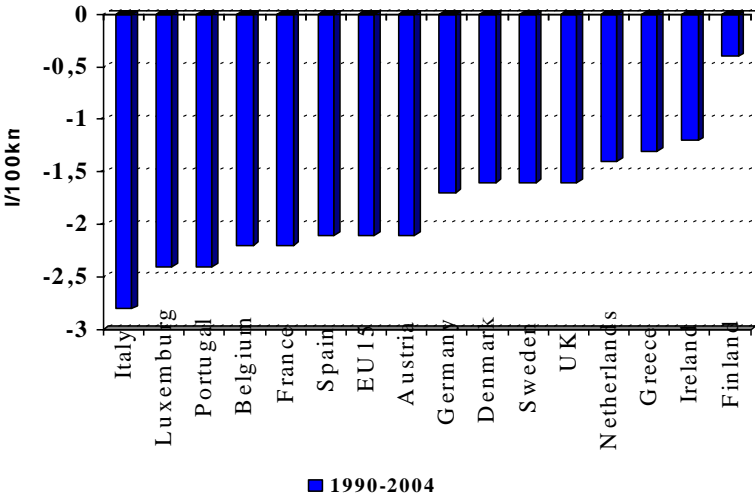
<sup>43</sup> Test values for new cars.

<sup>44</sup> Test values for new cars (Source: estimation ODYSSEE from ACEA, KAMA, JAMA)

**General improvement in the energy efficiency of new cars in all EU-15 countries... but with very different trends**

The specific consumption of new cars has been decreasing in all EU-15 countries since 1995, albeit with different trends. The reduction has been rather rapid in 7 countries, at a rate above 2 %/ year: Italy, Luxembourg, Portugal, Belgium, France, Spain and Austria; the EU-15 average is around 2 %/year (Figure 3-5).

**Figure 3-5: Trends in the specific consumption of new cars in the EU-15**



**Part of the technical progress is offset by a shift to larger and more powerful cars**

The test specific consumption of new cars not only reflects changes in energy efficiency from a technical point of view, but also changes in the structure of new car registrations by size or fuel type (gasoline/diesel). For instance, a shift towards smaller cars (or diesel cars) decreases the test specific consumption, all other things being equal.

Clearly, in the past ten years there has been a shift to heavier and more powerful cars in most countries. From 1995 to 2000, the engine capacity of the new cars registered each year measured in cm<sup>3</sup> increased in every country, except Belgium and Sweden. Since 2000, there has been a reverse trend in four countries (Austria and Denmark and, to a lesser extent, France and Spain)<sup>45</sup>. Austria and Denmark are among the few countries that have introduced a tax based on the energy efficiency of cars. More generally, the evaluation made by ACEA<sup>46</sup> shows that over the period 1995-2004, the average car mass increased by 15 % and the engine power by 29 %. The actual technical progress achieved therefore was even more pronounced than is indicated by the changes in the test specific consumption of new cars.

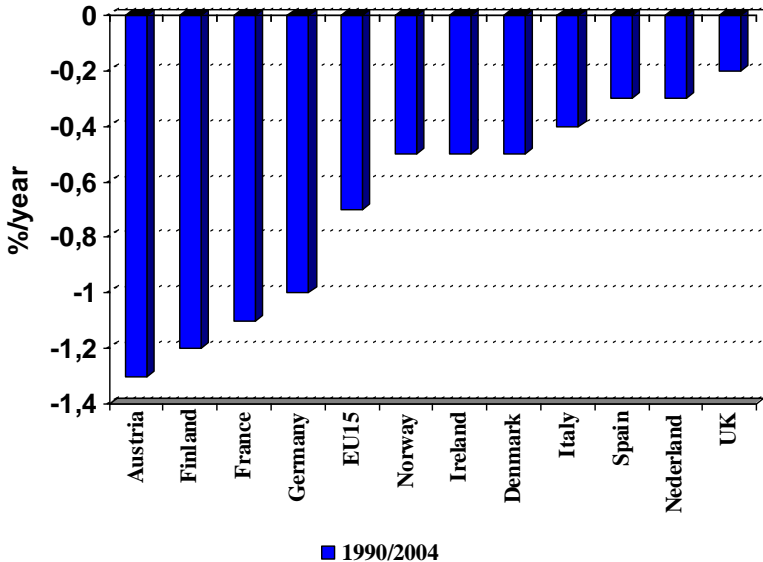
<sup>45</sup> Based on ACEA data, Communication of the Commission “Monitoring ACEA’s commitment to reducing CO<sub>2</sub> emissions from passenger cars”; November 2006.

<sup>46</sup> According to ACEA data, the average car mass increased from 1180 to 1357 kg, the engine power from 63 to 81 kW, and the engine capacity from 1650 cm<sup>3</sup> to 1740 cm<sup>3</sup>.

**Slowdown in the decrease of the car stock's average specific consumption since 1999; trends vary across countries**

As about three quarters of the cars on the road in 2004 had been purchased after 1995<sup>47</sup>, the energy efficiency gains achieved in new cars had a direct impact on the average performance of the car fleet. As a result, the average specific consumption of the car stock decreased from 8.4 to 7.6 l/100 km between 1990 and 2004 and ranged across countries from 6.6 to 8.8 l/100 km in 2004. The average reduction over the period 1990-2004 was 0.7 %/year: in 2004, cars consumed 0.8 litre/100km less than they did in 1990 in the EU-15 (Figure 3-6). This specific consumption decrease occurred in each country to a varying degree, e. g. by more than 1 %/year in Finland, Austria, France and Germany, by between 0.5 and 1 % in Norway, Denmark, Ireland, Spain and Sweden. The decrease was smaller in Italy, Spain, the UK, and the Netherlands (around 0.2-0.4 %/year). This continual improvement stems from the oldest and less efficient cars being replaced by new ones and also, in many countries, from the increasing share of diesel vehicles in the stock of cars.

**Figure 3-6: Variations in the average specific consumption of cars (l/100km)**



The average amount of energy consumed by a car over one year (in toe per car) does not only depend on the technical performance of the car (in litres/100km), but also on the annual distance travelled (km/year).

**The annual distance travelled by cars increased until 1999 and is now decreasing**

In most countries (Austria, Denmark, Italy, Finland, France and Belgium) and in the EU-15 as a whole, the average distance travelled every year by cars increased between 1990 and 1999. In almost all countries except Spain, this trend has been reversed since 1999 because of the large motor fuel price increases in 1999 and 2000. There was a reduction of 300 km at the EU-15 level between 1999 and 2005; this decrease was around 700 km in Germany and Finland and around 1000 km in France and the UK. In most countries, the reduction in recent years has offset the progression at the beginning of the nineties and the average distance travelled has returned to the same level as in 1990.

<sup>47</sup> New cars represent about 8 % on average of the total car fleet in the EU-15.

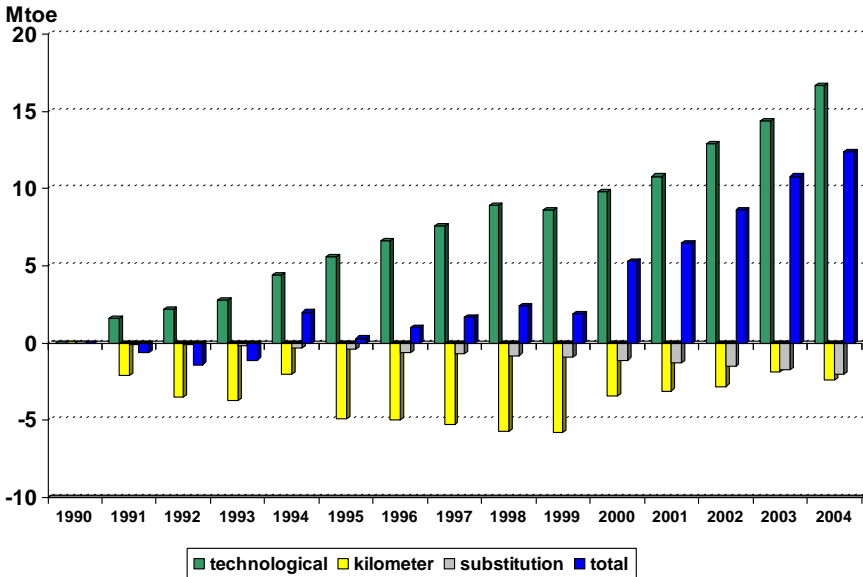
**Technological savings reached 17 Mtoe in 2004 in the EU-15**

Energy savings in cars may stem from improvements in their technical performance (in litres/100km), from a reduction in the annual distance travelled by each car (km/year), from changes in driving behaviour and from substitution to motor fuels with a lower calorific value.

“Technological savings” resulting from the decrease in the average specific consumption per car are estimated at 17 Mtoe in 2004 (compared to 1990), i. e. about 11 % of the total consumption of cars (Figure 3-7). The increase in the average distance travelled by cars between 1990 and 1999 helped to partly offset the impact of technology savings and reduced the overall energy savings for cars. These negative “behavioural savings”<sup>48</sup> were almost 6 Mtoe in 1999, or the equivalent of 1/3 of the technology savings. Since 1999, because the distances travelled by car have decreased, net behavioural savings have been realised each year. However, such behavioural savings can soon disappear and should not be assessed on the same level as technology savings, which are more durable and have a long lasting effect. Fuel switching from diesel to gasoline contributed to increasing energy consumption by about 2 Mtoe in 2004<sup>49</sup>.

In 2004, total savings were still 25 % below technology savings. The overall energy savings due to both technical and non-technical factors totalled 12 Mtoe in 2004: in other words, without these savings, the consumption of cars in 2004 would have been 12 Mtoe above its actual level or 8 % higher.

**Figure 3-7: Energy savings from cars**



<sup>48</sup> Behavioural savings do not include the impact of changes in driving style because of a lack of data.  
<sup>49</sup> The substitution effect measures the impact of changes in the average calorific value of motor fuels which varies according to the mix between diesel and gasoline: 1 litre of diesel has a calorific value of 088 toe/litre, 10 % higher than that of gasoline (0.8).

### 3.3. Road transport of goods

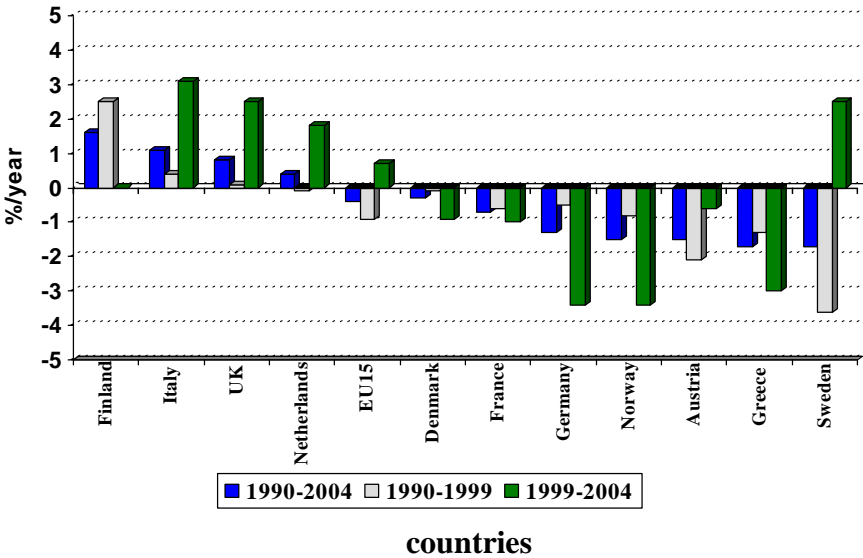
#### Energy efficiency of vehicles versus efficiency of transport services

The energy efficiency of the overall transportation of goods can be assessed by the **unit energy consumption per ton-km**. This indicator helps to capture the fact that a shift towards heavier trucks, while increasing the average specific consumption (l/100 km), certainly decreases the consumption per ton-km. In other words, trucks and light vehicles may consume more fuel per 100km, but at the same time road goods transport may actually become more efficient. Thus in the case of road goods transport, energy efficiency may have two different meanings depending on whether we are interested in the energy efficiency of vehicles (l/100 km) or the energy efficiency of the transport services (toe/ton-km)<sup>50</sup>.

#### Lower efficiency of road goods transport since 2000

In EU-15 countries, the average unit consumption per ton-km decreased in the majority of countries over the period 1990-2004. This can be explained by improvements in the economic situation, which enabled rapid growth in the volume of traffic coupled with a more efficient management of goods transport (higher load factors and reduction of empty running, as captured by the increase in the ratio ton-km/vehicle) and a shift to bigger trucks. However, there has been a reverse trend visible in several countries since 2000, especially in Italy, the UK and the Netherlands, which has an effect on the EU-15 average (Figure 3-8).

Figure 3-8: Change in the unit consumption of road goods transport in EU-15



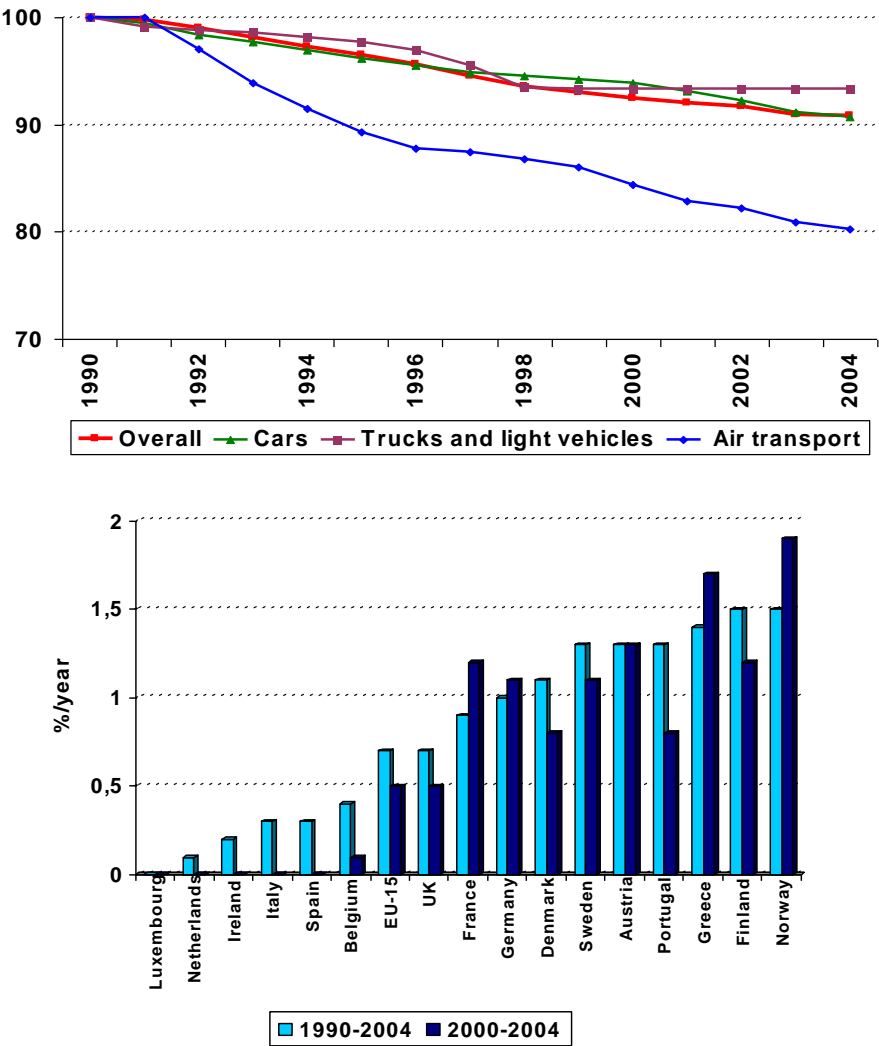
<sup>50</sup> It is becoming less and less accurate to measure the traffic of goods in ton-km because of changing packaging techniques: the density of the load is decreasing and there is an increasing discrepancy between the actual ton-km at full volume capacity and the theoretical one corresponding to the truck's loading capacity.

### 3.4. Energy efficiency trends

#### Regular improvement of the energy efficiency of transport in the EU-15 (9 %)

As shown by ODEX, the energy efficiency of transport in the EU-15 improved by about 9 % between 1990 and 2004 (0.7 %/year) (Figure 3-9)<sup>51</sup>. Greater progress was achieved in the energy efficiency of both cars and airplanes than was the case for the rest of the sector. In seven EU-15 countries and in Norway, the rate of progress was between 1 and 1.5 %/year. For the road transport of goods no further progress has been registered since 1998. As in the other sectors there has been a slowdown since 2000 to 0.5 %/ year, which is only half the target of the Energy Service Directive. In France, Germany and Greece, there has been an acceleration of energy efficiency improvements in transport since 2000.

Figure 3-9: Energy efficiency progress in transport in the EU-15



<sup>51</sup> For cars, motorcycles and buses, energy efficiency is captured by specific consumption measured in litres/100km. For freight transport (trucks and light vehicles), energy efficiency is measured by the unit consumption per ton-km as, ultimately, the main activity involved here is the transportation of goods (at least for trucks). For other modes, the most relevant indicators of unit consumption were taken depending on the statistics available: toe/passenger for air transport, goe (gram oil equivalent) /passenger-km for passenger rail, goe/ton-km for transport of goods by rail and water.

### 3.5. CO<sub>2</sub> emission trends in transport

#### CO<sub>2</sub> emissions in the transport sector have increased by 22 % since 1990

The emissions of the transport sector have increased by 25 % since 1990, compared to a reduction of about 9 % in industry and 2 % in households, services and agriculture.

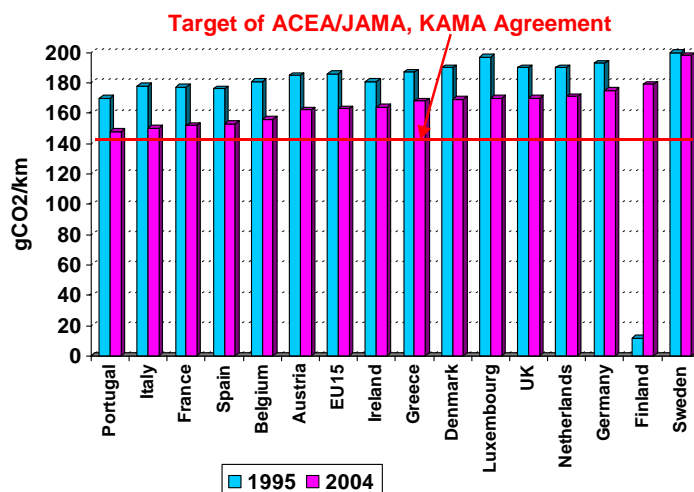
#### Road transport of goods is driving CO<sub>2</sub> emissions from transport

The emissions from road goods transport increased by almost 42 % and made up 36 % of the emissions of the sector (compared with 31 % in 1990). This is the main source for the rapid growth in emissions from this sector. The emissions from cars increased by 20 %. The emissions from domestic air transport<sup>52</sup> have grown by 50 % since 1990, but represent only 3 % of the total.

#### CO<sub>2</sub> emissions from new cars have fallen by 12 % since 1995

The average specific CO<sub>2</sub> emissions decreased from 186 g/km in 1995 to 163 g/km in 2004: this corresponds to an average reduction of 0.9 %/year (and even 1.3 % /year since 2000) (**Figure 3-10**). The average level achieved in 2004 was 16 % above the 2008 target of 140 g CO<sub>2</sub>/km set in the agreement between the European Commission and the associations of car manufacturers. 27 % of new ACEA cars sold in 2004 were below the target of 140 gCO<sub>2</sub>/km and 8 % below 120 g/km. Four countries were less than 10 % above the target of 140g CO<sub>2</sub>/km (Portugal, Italy, France and Spain), while Sweden was 40 % above this target.

**Figure 3-10: Variation of the specific CO<sub>2</sub> emissions of new cars (EU-15)<sup>53</sup>**



#### CO<sub>2</sub> savings have offset 20 % of the increase in CO<sub>2</sub> emissions since 1990

More vehicles on the road and the increase in traffic should have increased CO<sub>2</sub> emissions by 212 Mt CO<sub>2</sub> between 1990 and 2004. However, savings in CO<sub>2</sub>, which were almost exclusively due to the reductions in the emissions from cars, limited this progression to 170 Mt.

<sup>52</sup> Emissions of international air transport are not included in countries emissions according to the UNFCC methodology.

<sup>53</sup> Data from various sources: Commission report for recent years (“Monitoring ACEA’s commitment to reducing CO<sub>2</sub> emissions from passenger cars; November 2006”), data from ACEA monitoring of the agreement and estimates made within ODYSSEE.

### 3.6. Conclusions

- Since 2000, with the sharp increase in oil price, the rate of growth of consumption has slowed down with even a stabilisation reached in France and a decrease of consumption in Germany.
- The transport sector was 9 % more energy efficient in 2004 than in 1990. Most of the gains come from cars. There has been no efficiency improvement for road freight transport since 1998, a mode with a very rapid growth in energy consumption.
- The energy efficiency of cars has been improving regularly (by 0.7 %/ year since 1990), albeit with a slowdown in recent years: on average in the EU-15, cars consumed 0.8 litre/100km less in 2004 than in 1990.
- As a consequence of the agreement signed between the Commission and the association of car manufacturers (ACEA, JAMA and KAMA), new cars sold in 2004 were 15 % more efficient than new cars in 1995. The increased market share of diesel in new car registrations explains 40 % of the reduction in the average specific consumption of new cars since 1995. Part of the improvements in the performance of new cars is offset by a general shift to larger cars.
- The annual distance travelled by cars increased until 1999 and is now decreasing.
- The transport sector is the only sector where CO<sub>2</sub> emissions continue to increase: emissions in 2004 were 25 % above their 1990 level in this sector.
- CO<sub>2</sub> emissions of new cars have decreased by 12 % since 1995. However, the average specific emissions in 2004 were 16 % above the 2008 target of 140 g CO<sub>2</sub>/km stipulated in the agreement between the European Commission and the associations of car manufacturers.