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Energy efficiency and security of supply of primary energy in the transport sector

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1. Introduction

This Deliverable follows deliverable 5.8.1 and 5.8. 2, with which it shares the same approach and methodology. For economy of space all general background information concerning energy use in the EU, the methodology applied in the empirical analyses and the database used, are provided in Deliverable 5.8.1; therefore, the interested Reader is referred to that deliverable for an overview of energy consumption and carbon emissions in Europe.

This Deliverable deals strictly with transport energy use. Due to the peculiarities of the sector considered, some care must be used when selecting the energy efficiency indicators for this sector.

In fact, when we talk about the transport sector in terms of energy consumption, we are implicitly merging two different human activities that have in common the fact that they have to do with displacing goods and passengers. The first activity is commercial transport, which produces measurable value added. The second is private transportation, that includes every transportation activity carried out using private means, (anything from a stroll around the block to a car trip across Europe during the summer holidays), which , *per se,* do not generate directly any value added. Thus for the first kind of transport it is possible to derive a meaningful value of energy intensity. However this would be a biased indicator, in that it leaves out the private transport. On the other hand computing energy intensity using the ratio of overall consumption of energy in transport over commercial transport's value added introduces an opposite bias. To overcome this difficulty we couple the biased energy intensity indicator (the latter) with a energy efficiency indicator based upon physical measures, analogously to what presented in Deliverable 5.8.2.

The rest of the report is organized as follows. Sections 2 to 4 reviews the main indicators for the transport sector: Section 2 deals with energy consumption, Section 2 deals with carbon emissions, and Section 4 with energy intensity.

Section 5 illustrates the policy activity of the EU and European member states in the field of energy efficiency in the transport sector.

Section 5 discusses the results of the econometric analysis. Section 6 concludes. In the annexes, Annex I lists and explains the variables used in the econometric analyses; Annex II gives a more detailed breakup for some selected EU countries and Annex III lists national transport policies in EU-15 and Norway.

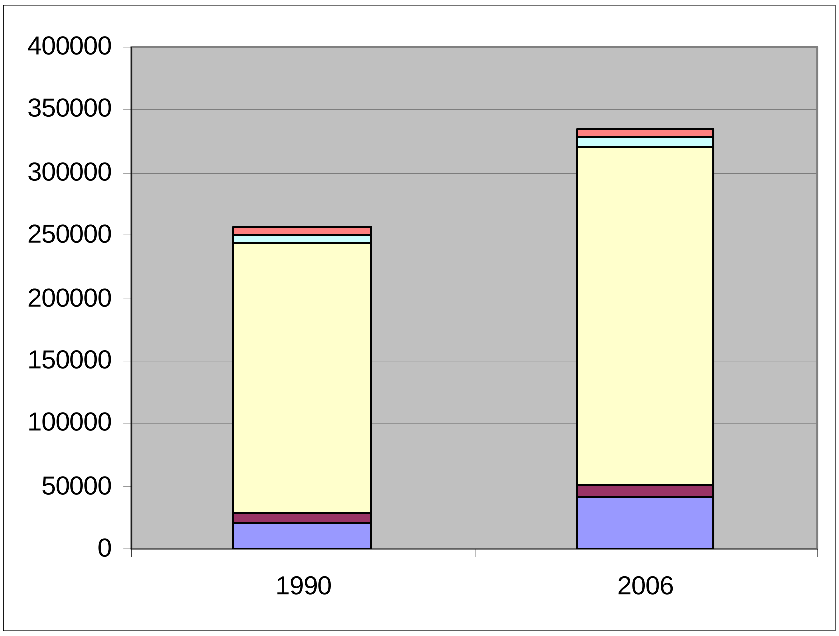
2. Energy Consumption in the Transport Sector

2.1 Overview of Transport Energy Consumption

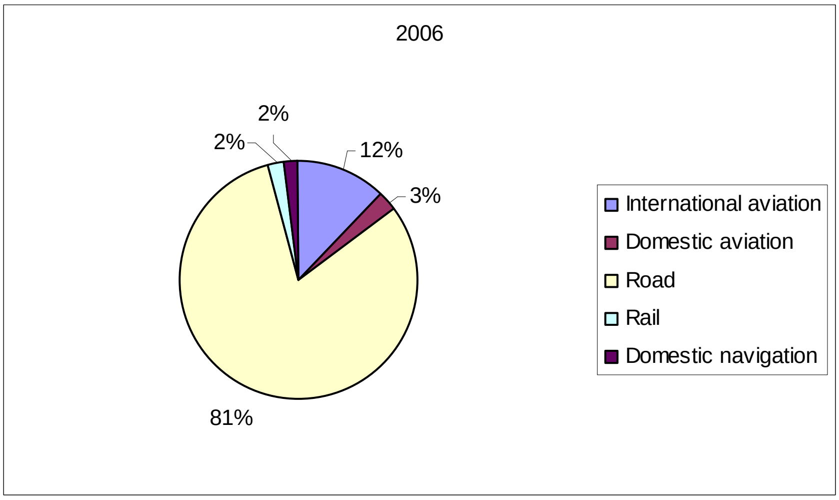
In 2006 the final energy consumption of the EU-15 and Norway's transport sector amounted to 336.4 million toe (Figure 1), representing one third of total final energy consumption, a share which rose from 27 % in 1990 to 30% in 2006. Energy use in transport sector have displayed a rapid growth over the period 1990-2004 (around 2%/year), while a slow down is registered since 2000 (1.3 %/year).

Road transport is by far the largest energy user, accounting for 80.5% of total transport energy use in 2006[1]. A moderate growth is registered for passenger cars (1.5%/year in 1990-2006) with a slow down since 2000, while a more rapid progression is displayed by road freight transport (2.6%/year in 1990-2006).
Rail exhibits a share of 2.05 % of final transport energy consumption in 2006 compared to 2.5 % in 1990. Inland navigation is the transport mode that consumed least energy in 2006 (6.7 million toe), accounting for 2% of total transport energy consumption.
The final energy consumption of international air transport increased throughout the period from 21.1 million toe in 1990 to 41 million toe in 2006, at an average annual rate of 3.7 %, the highest rate among the five transport modes covered. The share of international air transport in final energy consumption rose from 8.2 % in 1990 to 12.2 % in 2006, while the relative shares of the other transport sub-sectors remained rather stable, with the only exception of road transport, that declined from 83.6% to 80.5%.

Figure 1: Final Energy Consumption, Transport Sector: EU-15 + Norway. Comparison between 1990 and 2006 levels, ktoe.



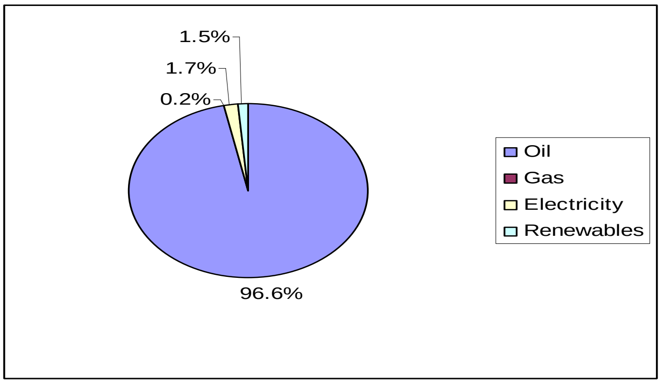
[1] Pipeline and non-specified transport are non included in the analysis.



Source: Authors' computation on IEA data.

Disaggregating the final energy consumption by energy sources, the transport sector remains almost exclusively dependent on oil products, which account for 96.6% of total fuels used in transport in the EU-27 (Figure 2). Transport accounts for 72 % of EU-27 total final consumption of oil products in 2006 compared to 62 % in 1990. The high reliance on oil products is among the main cause of issues about energy security and GHG emissions in the transport sector. There is a clear need for important improvements in energy efficiency, especially for passenger cars, trucks and planes, and for switching possibilities in the fuel mix. In this context, although there has been little switching away from oil in passenger transport, the fuel mix has undergone some important changes in recent years. Most significant has been the increased use of diesel in cars in Europe, whereas in the rail transport a shift between electricity and fuel-oil or diesel appeared in the late 80s, because of the electrification of this transport mode.

Figure 2: Energy consumption by fuels in the transport sector, EU-27, 2006.



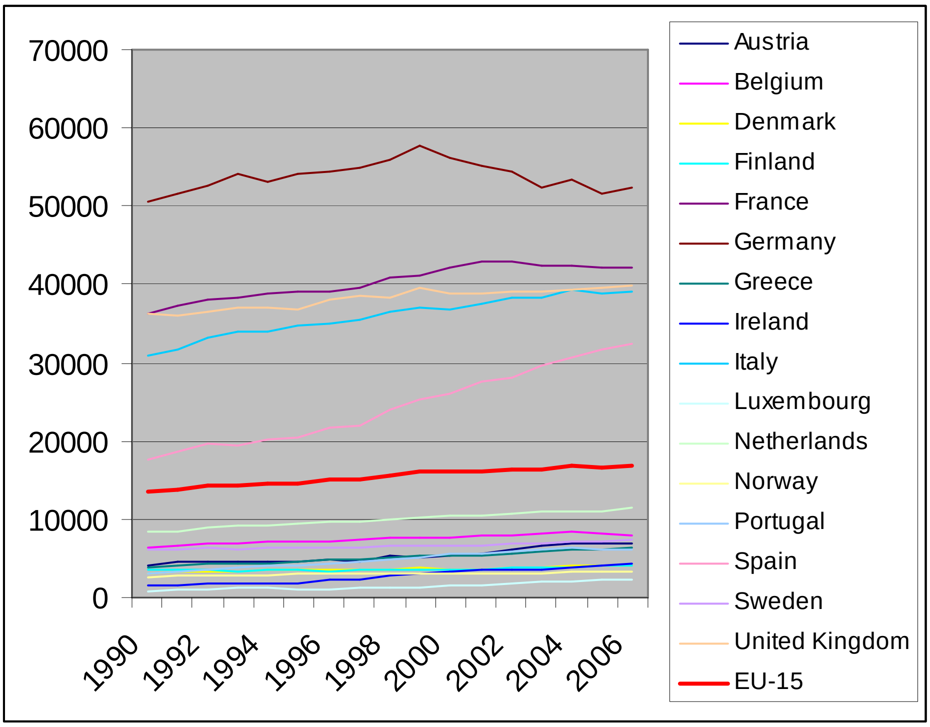
Source: Authors' computation on EUROSTAT (ENERGY) data.

Turning to the country-level analysis (see Appendix), In France and Germany (Figure A.1-A.2) oil is undoubtedly the major energy source. Transport on road is responsible for the largest share in energy consumption, followed by aviation, while rail and internal navigation contribute only to a modest share of total consumption. Road, navigation and aviation consume mainly oil, whereas in the rail transport a shift between electricity and fuel-oil or diesel appeared in the late 80s, most probably because of the electrification of this type of transport.
In United Kingdom a complete different picture can be drawn for the transport sector (Figure A.3): oil, in particular motor gasoline and diesel, is undoubtedly the major energy source. The

rising trend in oil consumption is mainly driven by the explosive growth of the road transport, but it is also true that in UK aviation is responsible for an important share of total consumption, consequently to the isolation of the country and to the presence of the largest air transport hub in Europe (Heathrow). Compared to road and aviation, the rail sector owns only a marginal role: in this sector, the electrification of the line is a recent step, as suggested by the late substitution of fuel-oil and diesel in favour of electricity.
In the Spanish transport sector the striking feature is the absolute absence of substituting fuels for oil: in fact, not only in all sub-sectors oil is the leading fuel, but also the electrification of the rail line is almost absent (Figure A.4).

Since road transport is the main responsible for energy consumption in the transport sector, looking at more detailed indicators for this mode can be interesting. Figure 3 shows the road transport energy consumption, disaggregated for the EU-15 countries plus Norway. It can be observed that the road energy use increased constantly during the period for all of the Countries considered. The only exception is Germany, which displays un upward trend until 1999, followed by a considerable fall. Germany is main road transport energy consumer, followed by France, United Kingdom and Italy, while Spain exhibits the largest increase in energy consumption since 1997.

Figure 3: Final Energy Consumption, Road Transport: EU-15 + Norway, 1990-2006, ktoe.



Source: Authors' computation on IEA data.

The final energy intensity in transport sector is mainly affected by three factors: 1) diffusion of energy-efficient technologies; 2) energy substitution towards energy vectors with high end-use efficiency; 3) behavioural changes regarding the mix between transport modes (substitution between cars and public urban transport modes in passenger traffic, or between road and rail goods transportation) and the living standards (increasing car ownership, changes in the size of cars).

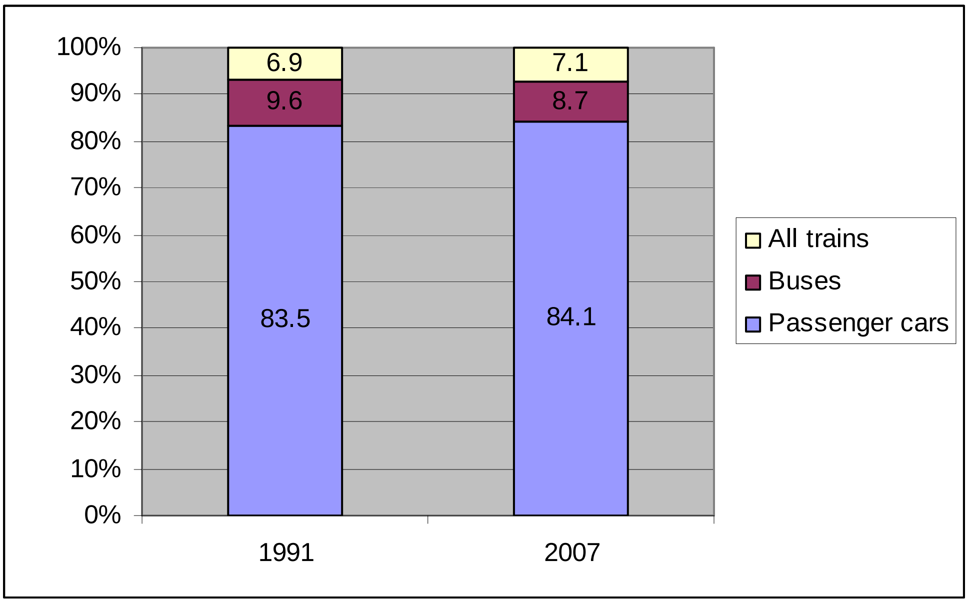
The transport sector includes two main sub-sectors, passenger and freight, impacted by different underlying factors. In order to properly analyze trends in overall transport energy use and efficiency, separate sets of indicators are needed for each sub-sector.

2.2 Passenger Transport Energy Consumption

In the passenger transport sector, high potential energy savings come from transport modal shift. Most policies aimed at increasing the share of less energy-extensive transport modes, focus on shifting from individual motorized transport to public transport.

Trends in the share of passenger transport by mode are shown in Figure 4. The indicator is aimed at monitoring the dependence of passenger transport on each individual mode. It is expressed as the percentage of passenger transport by car, buses and coaches, and trains in total inland passenger transport (in passenger-kilometers).

Figure 4: Modal Split of Passenger Transport: EU-15, 1991-2007, percentages.



Source: Authors' computation on EUROSTAT data.

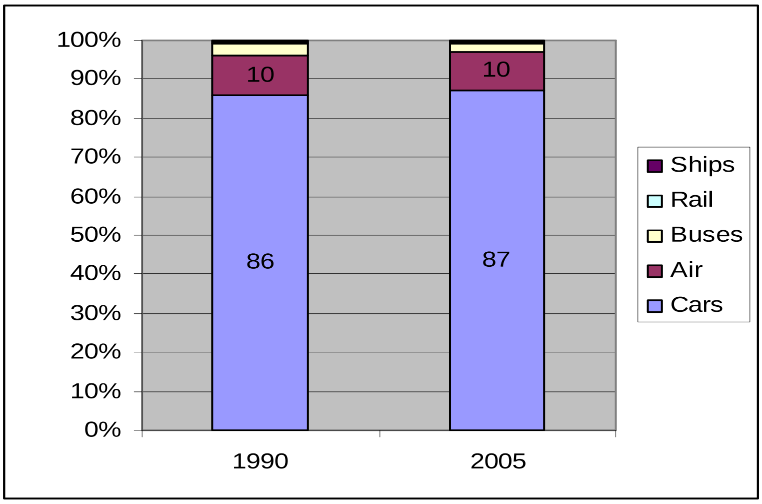
The shares of the different modes of passenger transport in final use have changed little since 1991. Cars clearly dominate the overall modal split in all EU-15 countries. Nevertheless, recent data from IEA[2] on passenger-kilometres (pkm) traveled suggest that travel patterns may be changing; since 2004, buses and train pkm have increased more rapidly than cars pkm. This might indicate that the population is slowly modifying its transport habits and increasingly opting to use more efficient modes of transportation.
However, the share of car travel differs from country to country, reflecting diverse demographic and geographic characteristics, as well as different levels of provision for urban and intercity transport.
At a country-level it can be observed that Norway has the highly dependence on cars (88%), followed by United Kingdom, Netherlands and Germany. Ireland is characterized by a

[2] OECD/IEA (2009), Towards a More Energy Efficient Future, *applying indicators to enhance energy policy*, Paris, France.

significant share of public passenger transport (only 76.3% cars in 2007), followed by Greece and Spain. In all these countries the lower share of cars use is explained by a modal shift from cars to buses. Also Austria displays a low reliance on cars for passenger transport (79.2% in 2007), substituted, with the same weight, by buses e trains. Austria, within the EU-15 Countries, exhibits the highest share of use of trains as a passenger transport mode (10%).

Looking at the passenger energy use by mode, in a group of 18 IEA countries[3] for which information is available, passenger transport energy use increased by 24% between 1990 and 2005. The shares of the different modes of passenger transport in final energy use have changed little since 1990.
Cars are by far the largest energy users in all the countries analyzed, accounting on average for 87% of total passenger transport energy use. In terms of energy mix, oil products as a whole totaled 99% of this consumption. Buses, passenger rail and passenger ships were together responsible for a further 3% of final energy use. Approximately 10% of passenger transport energy consumption is in domestic airplanes.

Figure 5: Passenger Transport Energy Use by Mode, IEA-18, 1990-2005.

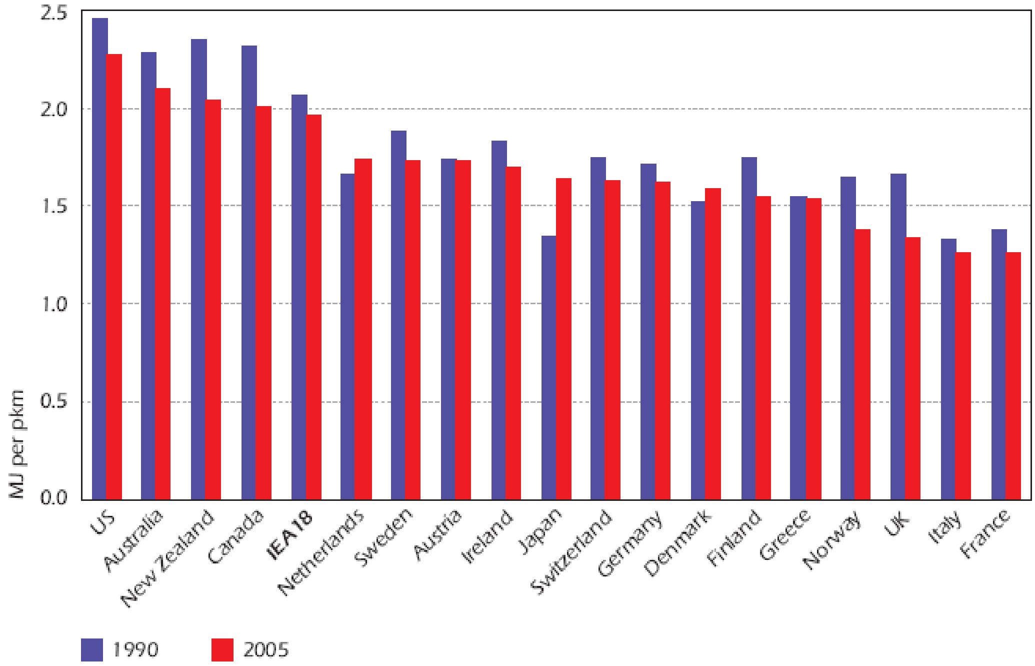


Source: Authors' computation on IEA data.

Combining information on passenger energy use and activity, Figure 5 shows the trends in energy use per passenger-kilometre by country, aggregated across all modes.
These trends are influenced by both the energy intensity of each mode and by the share of that mode in a particular country. For most countries, energy use per passenger-kilometre is declining. Reductions in the energy intensity of individual modes have been more than enough to offset the impact of increasing shares of car and air travel, which are more energy intensive. In the group of EU-15 countries, the only exceptions are Denmark and the Netherlands, where energy use per passenger-kilometre has increased. For the Netherlands, the reasons are higher levels of car ownership, coupled with virtually no change in their energy intensity.

[3] The IEA country coverage for the transport sector is the following: Australia, Austria, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Sweden, Switzerland, United Kingdom, United States.

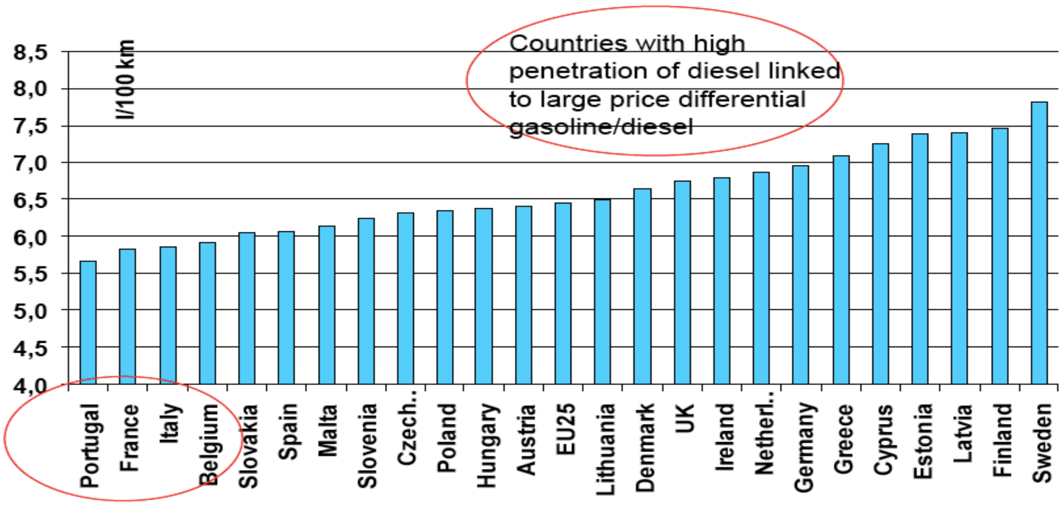
Figure 6: Energy Use per Passenger-Kilometre Aggregated for All Modes, IEA-18, 1990-2005.



Source: IEA.

Since cars are the most important energy user in passenger transport, it is interesting to look at more detailed indicators for this mode. Figure 7 shows the specific consumption of new cars for selected European countries, highlighting a large discrepancy among countries. The lowest fuel consumption of new car is registered by Portugal, France, Italy and Belgium, due to the combination of high penetration of diesel in the fuel market and a large price differential between gasoline and diesel, which drives to a more efficient fuel switching.

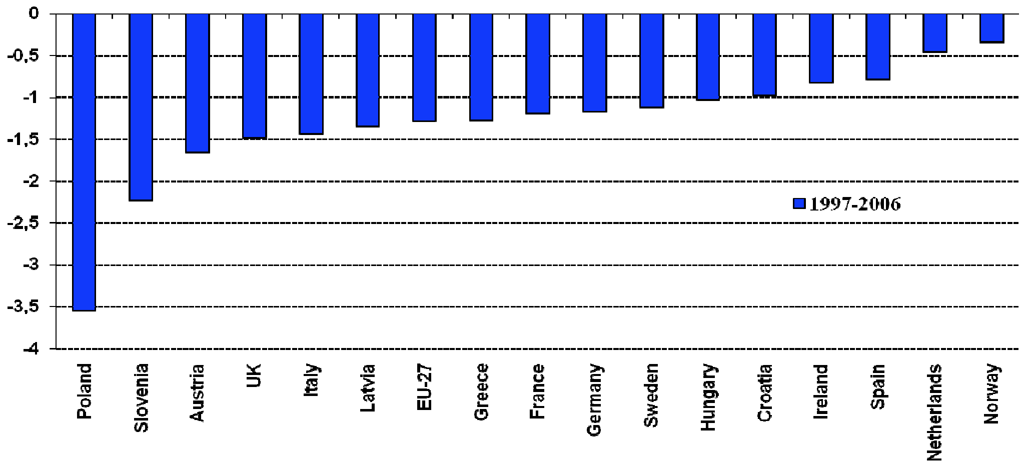
Figure 7: Specific consumption of new cars by country (2006).



Source: ODYSSEE.

In terms of trends, between 1997-2006 a clear decrease in the average specific consumption of the entire car stock in all EU-27 countries takes place (Figure 8). However there are differences among countries, with a rate that ranges between –0.3 and –3.5 %/ year. Within the EU-15 countries, the best improvements in fuels consumption is achieved by Austria, while in Norway consumption of cars hardly changed.

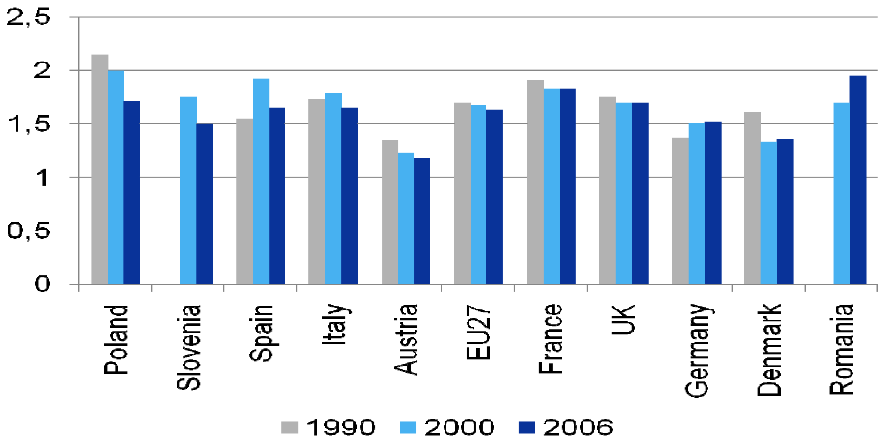
Figure 8: Trends in the specific consumption of cars by country (%/year).



Source: ODYSSEE.

Passenger-kilometres and the efficiency of vehicles are the two main determinants of cars energy consumption. Both are affected by a wide range of interacting factors, among them the occupancy rate, the price of fuel, the distance traveled and the vehicle ownership play a crucial role. Figure 9 shows the occupancy rate of cars in selected European countries. It can be observed a decrease in almost all countries, meaning an increase in cars use and hence negative energy savings. Among the EU-15, Germany exhibits a continuous improvement in the occupancy rate during the period considered.

Figure 9: Occupancy rate of cars (person/car).



Source: ODYSSEE.

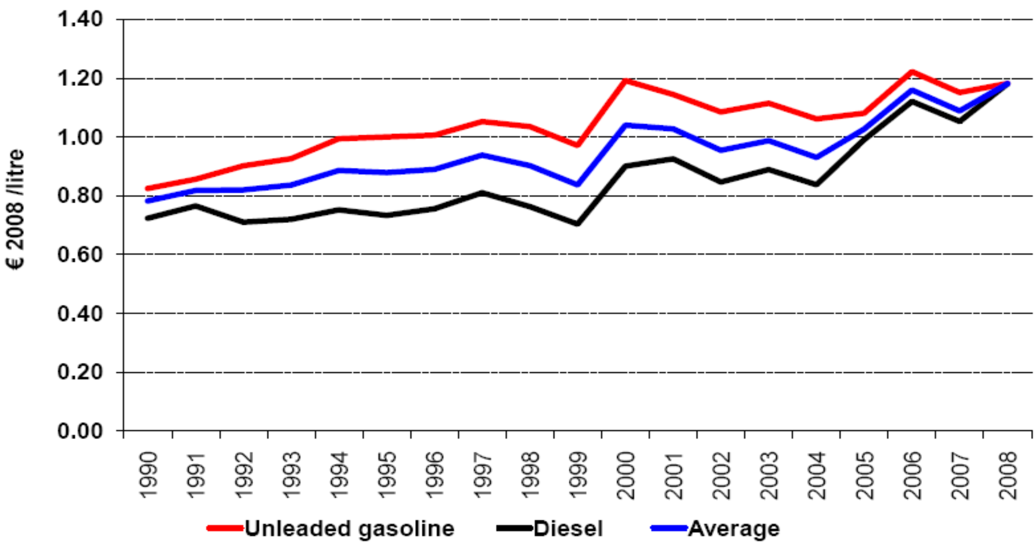
Also for buses and coaches, occupancy rate generally tends to decline over time, while it remains rather stable for rail transport. This picture shows that there is an high potential to further improve energy intensity in the transport sector, by means of policies aimed at promoting behavioural changes. An increase in the occupancy rate of cars and public transport could have a significant effect in reducing fuel consumptions.

In contrast, a steady increase in the occupancy rate can be observed in air transport. This could be explained by the increased demand in air travel, the further development of hub-and-spoke systems and the market penetration of low-cost carriers. In 2007 the occupancy rate (ratio of the number of passengers on board to the number of seats available) on all EU-27 national and international flights was 75 % for EU licensed airlines and 86 % for non-EU-licensed airlines.

According to IEA[4] projections, the transportation sector will remain the main driver of world oil demand growth in the medium term. These projections would suggest that oil demand will continue to increase relentlessly in the longer term. There are, however, several offsetting factors at play that could contribute to slow down transportation fuels demand: the development of alternative technologies, more stringent government policies on fuel economy standards and vehicle performance, and behavioural changes as a result of high oil prices.

Figure 10 shows the trends of transport fuels prices between the period 1990-2008. On average real prices are 50% higher in 2008 than in 1990 (+40% for gasoline and +60% for diesel), although a slight reduction between 2006 and 2007 is observed. The peak in real price levels is reached during the 3rd quarter of 2008.

Figure 10: Trends in motor fuel prices, EU-27, 1990-2008.



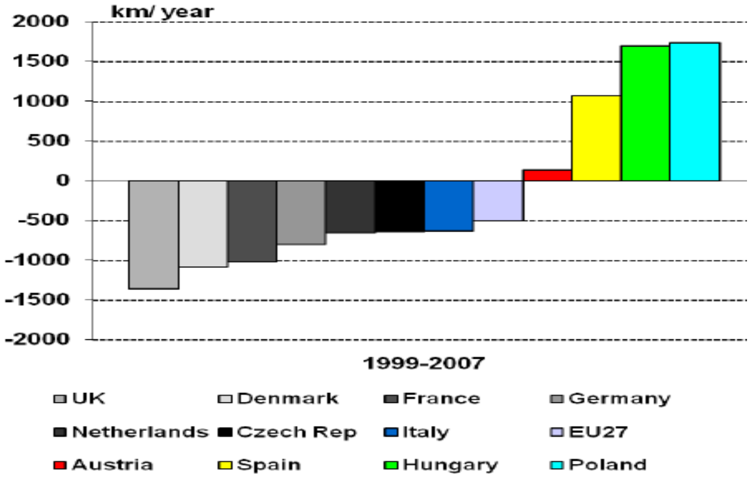
Source: ODYSSEE.

Sustained high prices will probably have a more immediate impact upon oil demand, by prompting consumers to change their driving behaviour and to switch to cheaper modes of transport, such as public transport or bicycle. Anecdotal evidence suggests that this change is already happening, most notably in the US, where motorists are driving less and opting for smaller, more efficient cars.

Looking at the distance traveled by car (Figure 11), a large discrepancy between countries is observed. It can be noticed a decrease in almost all EU-15 countries after 1999, due to the sharp increase in motor fuels prices, resulting in a reduction of 500 km for the EU-27 level. However, Spain, Austria and almost all new member countries display a worsening in this indicator.

4 OECD/IEA (2008), Medium-term Oil Market Report, Paris, France.

Figure 11: Change in distance traveled by car km/ year, Selected European Countries, 1999-2007.



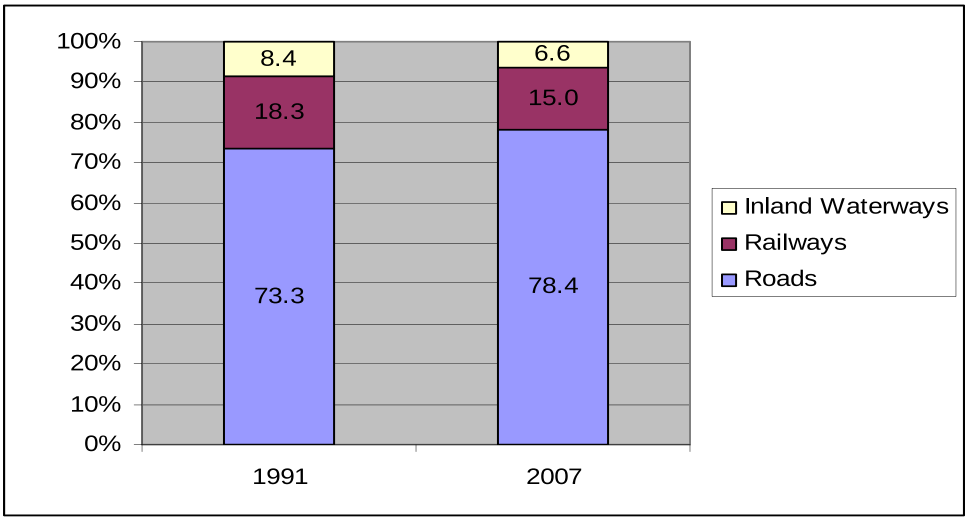
Source: ODYSSEE.

2.3 Freight Transport Energy Consumption

As for the passenger transport, in freight transport high potential energy savings come from transport modal shift. Most of policies aimed at increasing the share of less energy-extensive transport modes, focus on shifting from individual motorized transport to public transport.

Trends in the share of freight transport by mode are shown in Figure 11. The indicator is aimed at monitoring the dependence of freight transport from each individual mode. It is expressed as the percentage of road, rail and inland waterways transport in total inland freight transport (in tonne-kilometres).

Figure 12: Modal Split of Freight Transport: EU-15, 1991-2007, percentages.



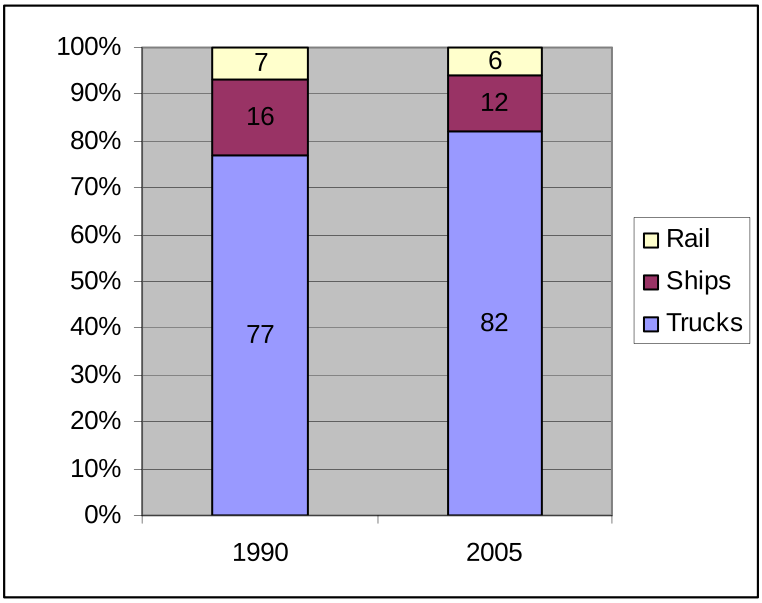
Source: Author s' computation on data from EUROSTAT.

The shares of freight transport modes have changed a little bit more than passenger transport since 1991. Road transport is, also in this case, the dominant mode of goods transport, with an increasing trend over time.

At country level, there is a lower dependency on road transport in Austria, where only 60.9% of total goods are transported by road, while an high percentage of goods (34.8% in 2007) are moved by railways. A low reliance on road transport is also observed in the Netherlands, where there is the highest use of inland waterways (33%) in the EU-15, in Sweden, which has the highest percentage of railways for good transport (36.4%) and Germany. Ireland is instead the highest road transport-dependent country (99.3% in 2007), followed by Greece, Spain and Portugal.

Figure 13 shows the shares of energy use by freight transport modes between 1990-2005. The strong growth in freight energy use was almost entirely due to higher energy demand for trucking, which increased their share of total freight transport energy consumption to 82% in 2005. Total final energy consumption for rail freight increased by 16%, but its share of energy use declined to 6%. In contrast, both the absolute amount and the share of energy use for water freight declined so that in 2005 it accounted for 12% of freight energy use. Oil dominates the freight transport sector, accounting for 99% of the total final energy consumption, most of which is diesel. In 2005, diesel was the dominant fuel for trucks with a share of 87%, whereas ships used mainly diesel (40%) and heavy fuel oil (59%). Rail transport energy use is split between diesel (88%) and electricity (12%).

Figure 13: Freight Transport Energy Use by Mode, IEA-18, 1990-2005.



Source: Author s' computation on data from IEA.

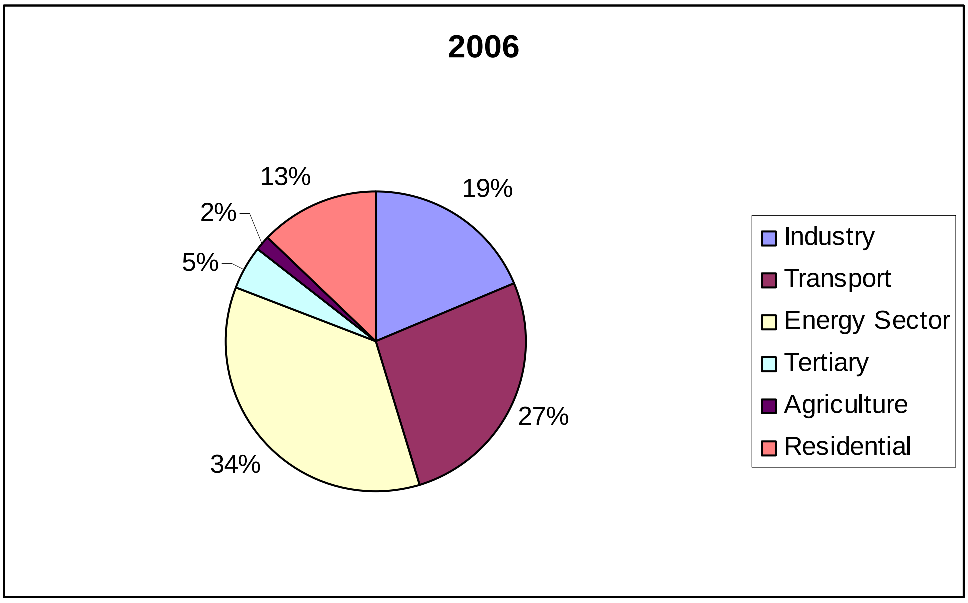
3. CO_2 Emissions in the Transport Sector

3.1. Overview of Transport CO2 Emissions

In 2006, the transport sector contributed 27% of the CO_2 emissions in the EU-15 compared to 23% in 1990 (Figure 14). Shares attributable to different sub-sectors remained rather stable between 1990-2006. Road transport contributed to 93% of total CO_2 emissions in the transport sector, while domestic aviation and domestic navigation are responsible for almost 3.3% and 2.5% respectively of total transport emissions.

The quantities of GHGs and other transport emissions depend on the quantity and quality of the fuels used, on the engine technology implemented for propulsion, and on factors such as speed, loading factor, temperature and engine maintenance. Due in particular to a growing stock of road vehicles and aircraft, the quantities of fuels consumed by transport have increased. Yet the quality of these fuels improved, in particular due to the widespread removal of lead from petrol as well as by the substantial reduction of sulphur levels in diesel. Resulting in energy efficiency gains, notable improvement has been made in vehicle technology from 1990 to 2006. The numerous improvements ensuring much cleaner emissions from road vehicles include those made in combustion, in exhaust technologies, and in the materials used.

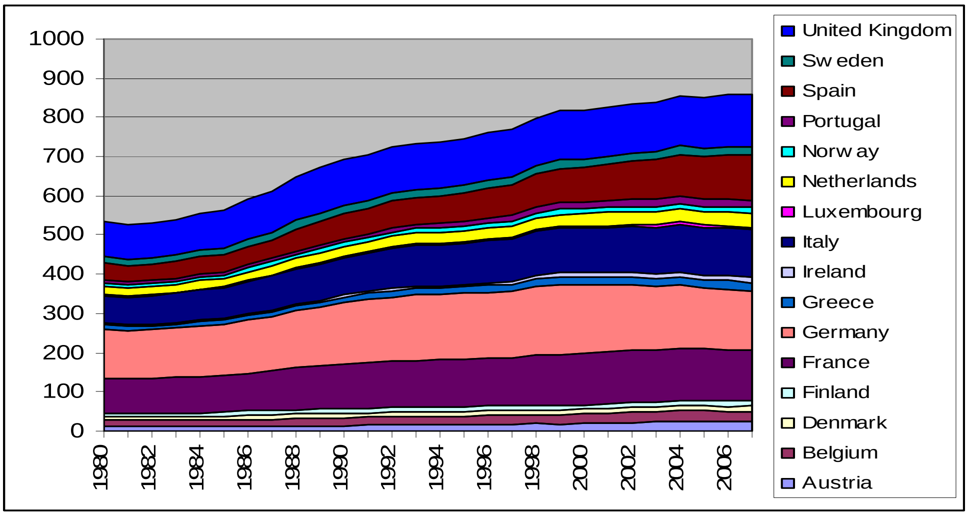
Figure 14: Total CO_2 Emission by Sectors, percentages. EU-15, year 2006.



Source: Author s' computation on data from ENERDATA.

Five member States – Germany, the United Kingdom, France, Italy and Spain – account for over 75% of total CO_2 emissions in the transport sector in 2007 (Figure 15). The highest emissions are attributable to Germany – however with a slight decrease in the volume of emissions from 2000 - followed by the United Kingdom and France. It should be also pointed out that a general slowdown in the emissions growth rate has been observed in almost all of the countries under scrutiny from the late 80's.

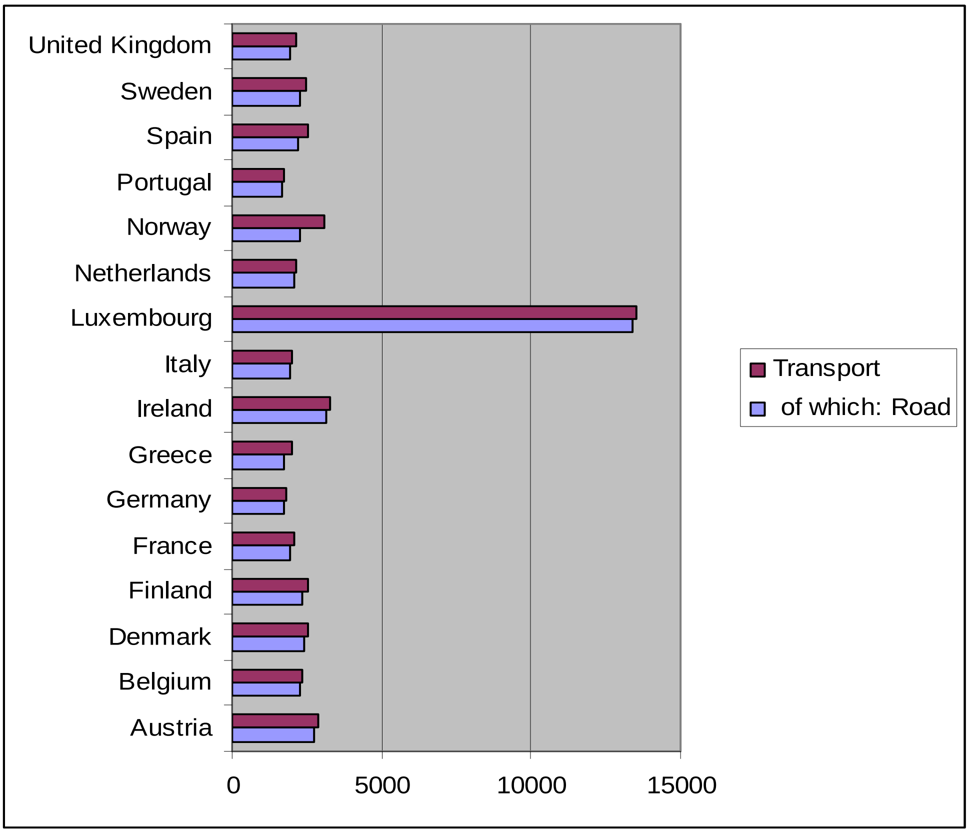
Figure 15: Total CO_2 Emission, Transport Sector. EU-15 + Norway, 1980-2006, Mt of CO2.



Source: Author s' computation on data from IEA.

Turning to per capita CO_2 emissions (Figure 16), Luxembourg has the highest emission intensity with respect to the population volume, exceeding the other countries by almost four times. It should be also mentioned that, although Germany is the main responsible of transport emissions within the EU-15 countries, its per capita emissions are among the lowest in Europe. Moreover, emissions from road transport account for 94% of total transport emissions.

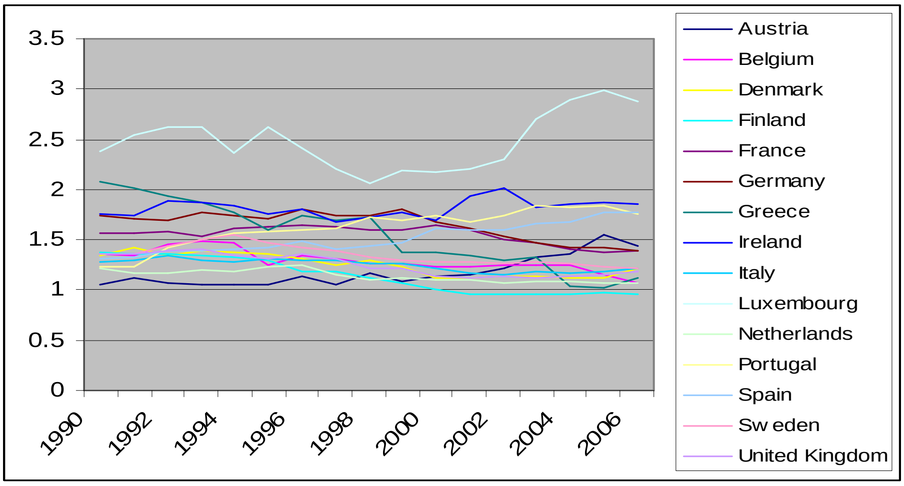
Figure 16: Per capita CO_2 Emission, Transport Sector. EU-15 + Norway, year 2007, kg CO2/cap.



Source: Author s' computation on data from IEA.

Looking at the final Carbon Intensity, the transport sector displays the highest levels, compared to industry and other sectors in the overall EU-15 (see Figure 11 in Deliverable 5.8.1). As regard to the country-level analysis, the transport carbon intensity fluctuates within a stable range during the entire period considered, with the exception of Luxembourg, which displays the highest carbon intensity levels (Figure 17).

Figure 17: Final Carbon Intensity, Transport Sector. EU-15, kt CO_2/00\$ppp, 1990-2006.

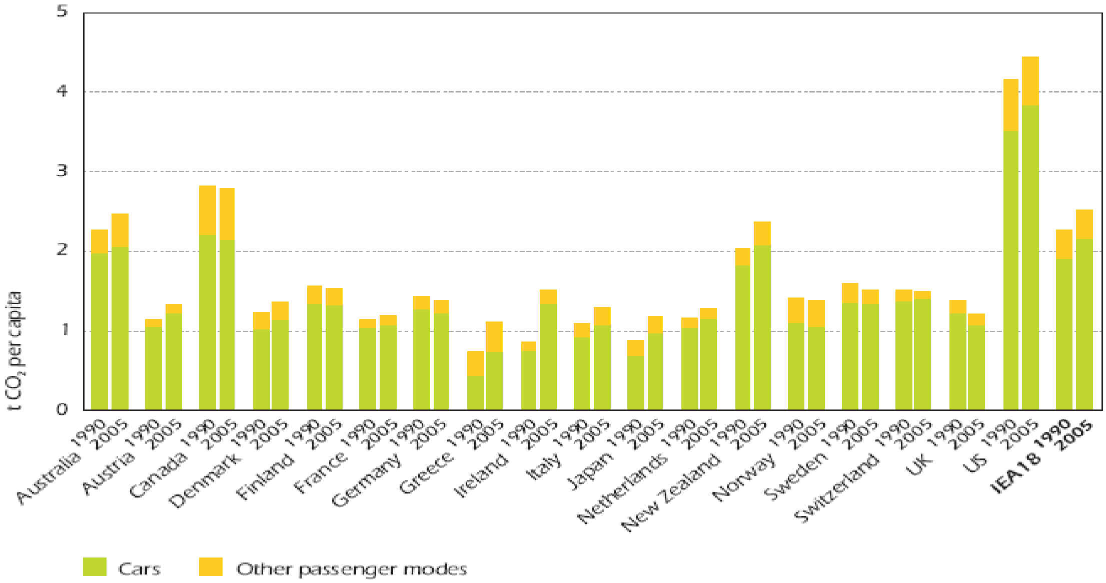


Source: Authors' computation on data from ENERDATA, EUROSTAT, OECD.

3.2. Passenger Transport CO_2 Emissions

Due to the availability of data, the analysis related to passenger transport is constrained to the IEA-18 countries, including also extra-european countries (for the complete list of countries included in the analysis see Note 3). Within this group the higher passenger transport energy use has led to a 23% increase in associated CO_2 emissions since 1990. The strong link between energy use and emissions is due to the almost total reliance on oil-based fuels for cars, buses and airplanes. Examining passenger transport emissions on a per capita basis reveals interesting differences among countries in both the levels and trends (Figure 18). CO_2 emissions per capita in several European countries remained relatively stable or even declined over the period considered. In contrast, Greece and Ireland show sharp increases in their emissions per capita, largely due to a strong growth in car use.

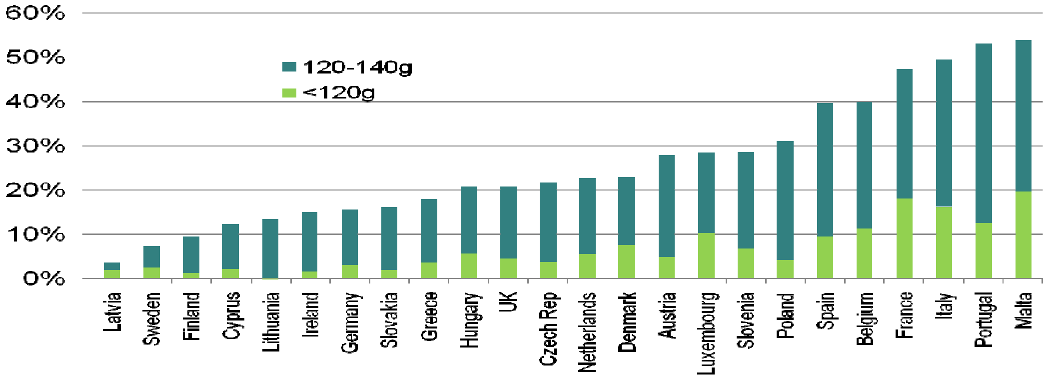
Figure 18: Per capita CO_2 Emission, Passenger Transport. IEA-18, 1990-2005.



Source: IEA.

In terms of future potential of emissions reduction, it can be observed that more than 40% of new cars produce less than 140g CO_2/km in France, Italy, Portugal and Malta and almost 20% produces less than 120g CO_2/km in the same countries (Figure 19).

Figure 19: Emission of new cars: % of cars below 120-140 gCO_2/km (2006).



Source: ODYSSEE.

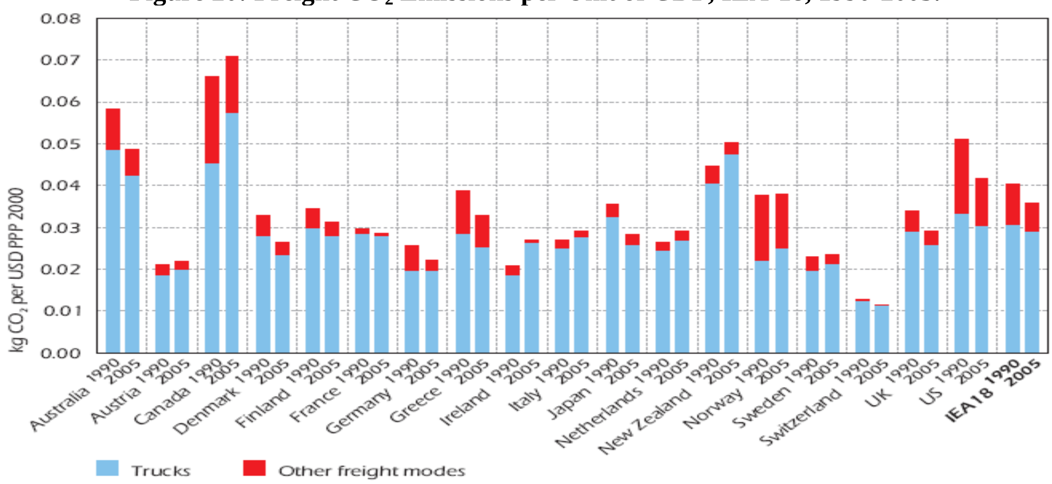
3.3. Freight Transport CO2 Emissions

For the IEA-18, freight transport accounted for 30% of total transportation energy use in 2005. Between 1990 and 2005, energy use in freight transport increased by 27% to 13 EJ and associated direct and indirect CO_2 emissions increased by 26% to 1.0 Gt CO_2.

The pattern of CO_2 emissions from freight transport reflects the dominance of trucking. Figure 20 presents CO_2 emissions from freight haulage per unit of GDP (converted to USD at PPP) for the IEA18 countries, split into truck and other (rail and shipping).
There is considerable variation among countries, which reflects a combination of three factors: the volume of freight haulage per GDP; the share of the various freight modes; and the energy intensity (energy per tonne-kilometre) of each mode. Norway has the highest emissions per GDP, largely as a result of long haulage distances. In contrast, Switzerland, Austria and Sweden have much lower emission intensities due to a combination of significantly shorter haulage distances and lower than average energy intensities.

In 2005, rail and ships accounted for a significant portion of CO_2 emissions in Norway and Greece. All EU-15 countries, except these two, have experienced an increase in the share of emissions from trucks between 1990 and 2005.

Figure 20: Freight CO_2 Emissions per Unit of GDP, IEA-18, 1990-2005.



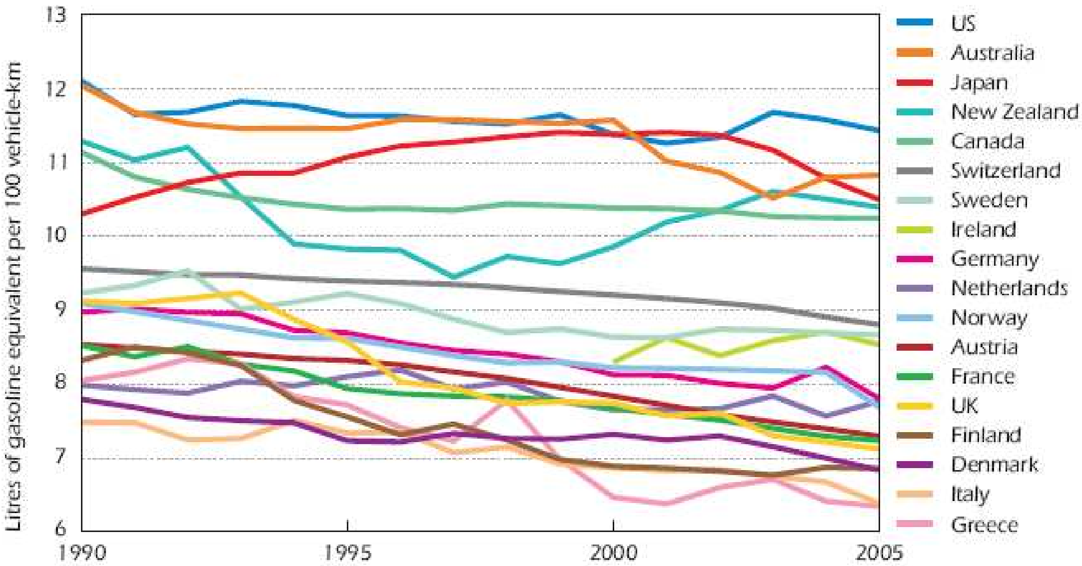
Source: IEA.

4. Energy Intensity and Efficiency in the Transport Sector

4.1. Energy Intensity in the Passenger Transport Sector

In this section we present the analysis of energy intensity focusing on the passenger transport sector (see Table 5 in Deliverable 5.8.1 for the overall transport energy intensity analysis).
As cars are the most important energy user in passenger transport, it is interesting to look at more detailed indicators for this mode. In this case, since that the passenger transport sector is not able to generate value added, the energy intensity of passenger road transport is calculated as liters of gasoline equivalent per 100 vehicle-km. Figure 21 reveals wide variations in the levels and trends amongst countries. The results reflect a number of unrelated factors such as vehicle technologies and the effect of driving conditions.
The average fuel intensities of cars decreased in all of EU-15 countries between 1990 and 2005, due to a combination of several factors. The 1990s were characterized by the widespread diffusion of vehicles equipped with electronic control systems for fuel management and by stronger consumer demand for more efficient cars — a reaction to high fuel prices. Since the early 2000s, intensities declined further in Europe as a result of increased sales of direct-injection diesel cars.

Figure 21: Average Fuel Intensity of the Car Stock, IEA-18, 1990-2005.

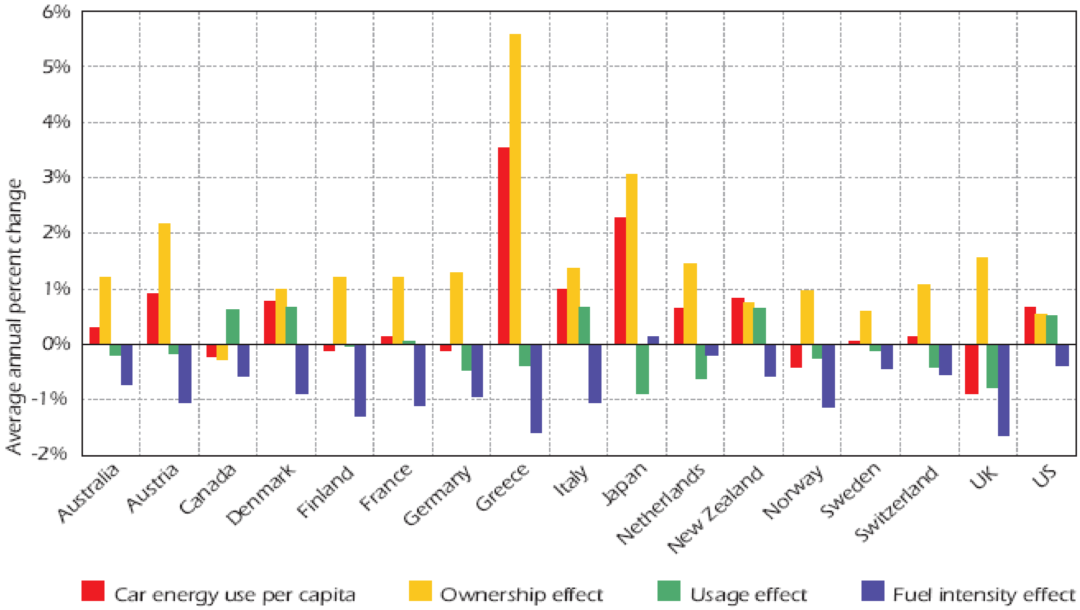


Source: IEA.

The increasing weight of vehicles has been another factor offsetting improvements in the underlying efficiency of new car engine technologies. Over the last 15 years, the average size and weight of the stock of cars increased as larger and heavier vehicles, such as SUVs, became more popular. This trend, combined with additional safety features also increasing weight, has tended to raise the energy consumption of cars.
In European countries, the number of cars with an engine capacity greater than two liters has more than doubled since 1990.

By combining data on fuel intensities with information about car use and ownership it is possible to evaluate how different factors influence car energy use across countries (Figure 22). All EU countries showed increases in car ownership. Greece showed the strongest growth, albeit rising from comparatively low ownership levels in 1990. For most countries, the growth in car ownership tended to increase per capita car energy consumption by about 1% per year. The impact of car usage (*i.e.* the distance traveled by each car) on per capita energy consumption is more varied across countries. For many countries, reductions in the fuel intensity of cars were not sufficient to offset the increases in car ownership and car use. Thus, car energy use per capita increased in many EU countries. The exceptions to this were Finland, Germany, Norway and the United Kingdom. In these countries, the effect of significant reductions in energy intensity were augmented by falling car usage (except in Finland, which showed a small increase), which more than offsets increases in car ownership.

Figure 22: Decomposition of Changes in Car Energy Use per Capita, IEA-18, 1990 – 2005.



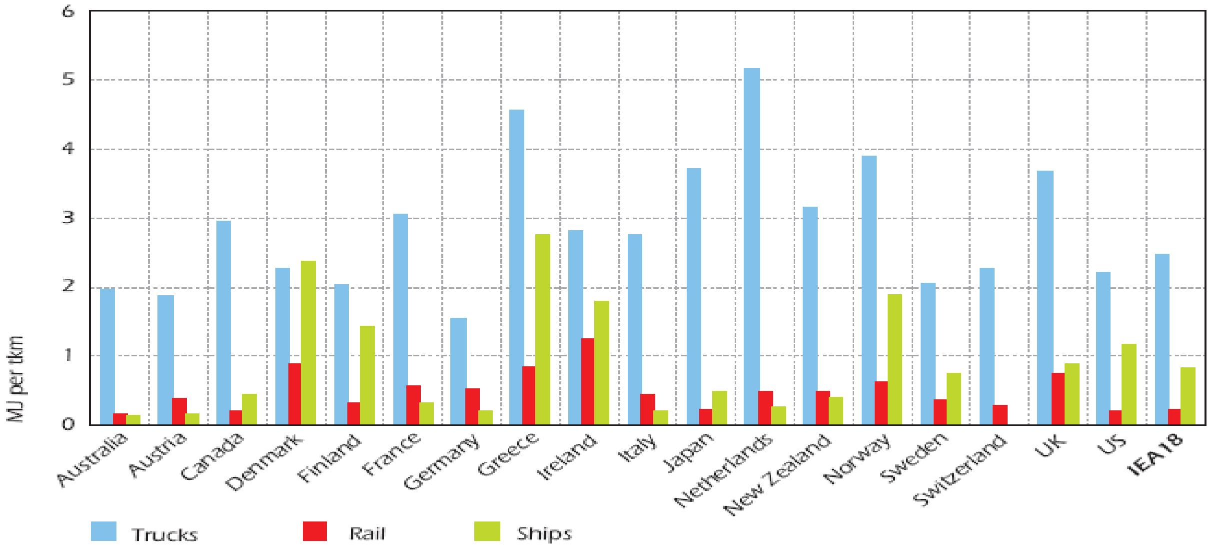
Source: IEA.

4.2. Energy Intensity in the Freight Transport Sector

For the EU-15, the energy intensities of trucks, ships and rail vary significantly, with trucks being the most intensive (Figure 23). In Netherlands trucks use 17 times more energy than rail to move one tonne of goods a distance of one kilometer, while in other countries like Denmark, Finland and Ireland the difference in energy use among transport modes is less wide. The large range for the energy intensity of truck freight can partly be explained by the type of goods moved, the size and geography of the country, the average load factors as well as the split between urban delivery trucks and long-haul trucks, which are much larger and less energy intensive.

Looking at the trends, trucking activity - measured in tonne-kilometres - increased in all EU countries and trucking was the fastest growing freight mode in most of them. The highest increase in trucking was seen in Ireland, driven by the very rapid expansion of the Irish economy. GDP in Ireland increased at an average annual rate of 6.5% between 1990 and 2005. Trucking also increased substantially in large countries with low population densities such as Norway. Rail and shipping activity increased in many countries.

Figure 23: Freight Transport Energy Use per Tonne-Kilometre by Mode, IEA-18, 2005.



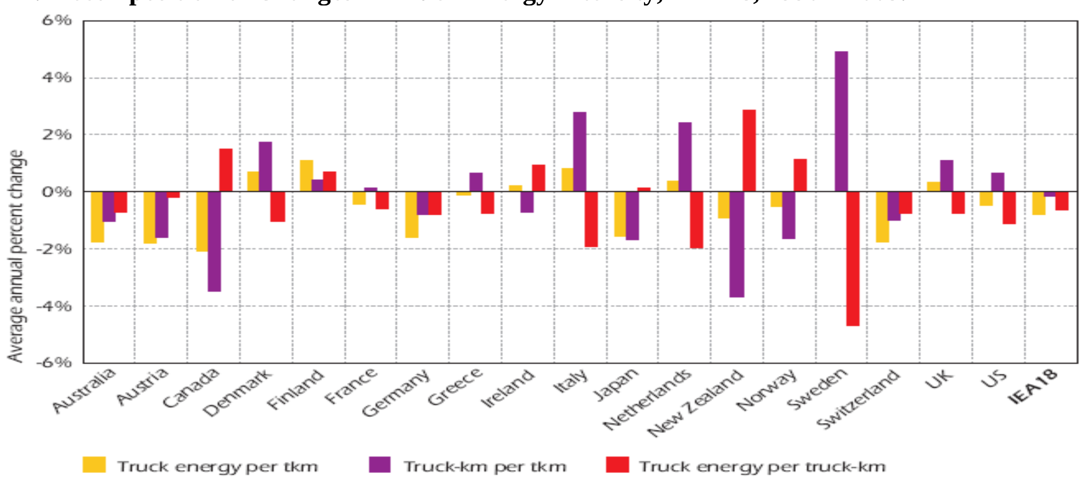
Source: IEA.

The difference in the energy intensity among modes has some important implications for trends in freight energy consumption. First, because of its much higher energy intensity, growth in road freight haulage will have a more significant impact on energy use than growth in freight transport by rail or ships. Second, intensity reductions in trucking will result in higher energy savings than intensity reductions in rail and ships or than modal switching between these two modes.

As trucking dominates freight transport use, it is interesting to look in more detail at the factors affecting the overall energy intensity of truck freight haulage. These include: the load factor (average load per vehicle); the share of short-haul freight; vehicle fuel efficiency; driving behaviour; traffic congestion; maximum allowable truck weight; and the availability and quality of the infrastructure for freight transport.

In order to better assess the impact of such factors, a decomposition analysis of the overall energy intensity has been performed (Figure 24).

Figure 24: Decomposition of Changes in Truck Energy Intensity, IEA-18, 1990 – 2005.



Source: IEA.

The factors for which consistent information are available across countries are the truck-kilometres per tonne-kilometres (which is the inverse of the load factor) and the vehicle energy intensity. This reveals that the overall energy intensity of trucking was most strongly influenced by the evolution of load factors. For many countries analysed, an increase in load factors (*i.e.* a decrease in truck-kilometres per tonne-kilometre) led to a decline in truck energy intensity (measured as truck energy per tonne-kilometre). In Finland and France, changes in vehicle energy intensity had a greater impact on trucking energy intensity than did the evolution of load factors.

4.3. Energy Efficiency in the Transport Sector

As regards to Energy Efficiency, Table 1 shows the percentage change of energy efficiency for the transport sector. Over the whole sample (1980-2004), the countries that reported the best performances have been Ireland and Greece. Across sub-samples the most significant improvements have been achieved by the Belgian transport sector. While during the period 1980-1992, in Belgium, energy efficiency has decreased by 75.4 percent, in the period 1992-2004, energy efficiency has increased by 49.4 percent. Over the whole sample, the improvements in energy efficiency have been equal to 11.2 percent. On a smaller scale, France, Sweden and Norway have reported similar changes. In transport, the progression is modest but regular: 9 % efficiency improvement.

Table 1: Percentage Change of Energy Efficiency in the EU-15 Countries and Norway, 1980-2004. Transport Sector

TRANSPORT (% change in EE Index over period)

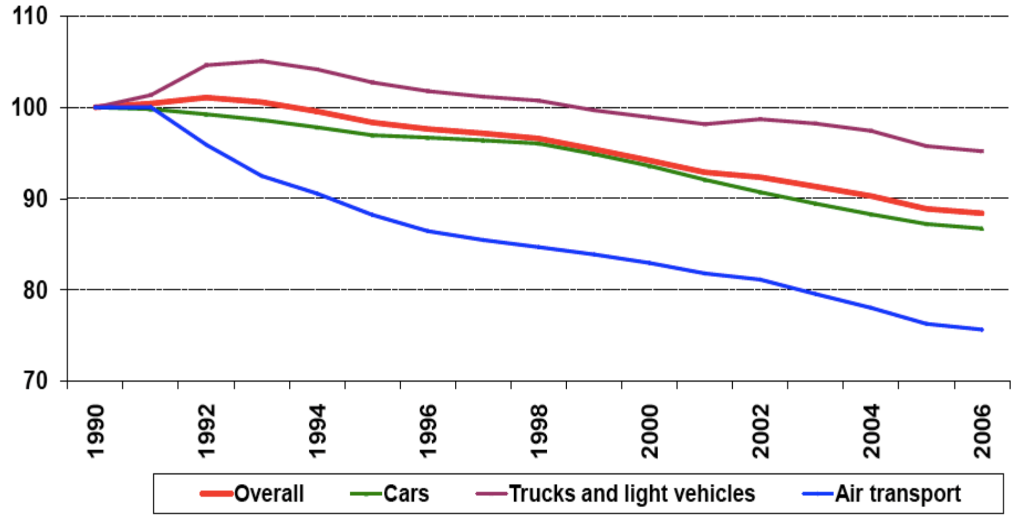
1980 - 2004			1980 - 1992		1992 - 2004	
IE	-45.0%		-35.4%	ES	BE	-49.4%
EL	-43.7%		-25.8%	IE	IE	-26.0%
AT	-33.2%		-24.1%	EL	EL	-25.9%
ES	-31.1%		-21.7%	AT	NO	-21.4%
NO	-27.4%		-13.8%	IT	PT	-14.8%
PT	-24.4%		-12.2%	DE	AT	-14.7%
DE	-23.1%		-11.3%	PT	DE	-12.4%
DK	-16.9%	Median	-10.9%	DK	FR	-12.0%
IT	-13.4%		-7.6%	NO	SE	-11.2%
SE	-12.8%		-3.4%	NL	FI	-7.4%
FR	-12.0%		-2.8%	LU	DK	-6.8%
BE	-11.2%		-1.9%	UK	NL	-4.7%
NL	-7.9%		-1.8%	SE	UK	-3.4%
FI	-7.5%		-0.2%	FI	IT	0.5%
UK	-5.2%		0.0%	FR	ES	6.7%
LU	123.5%		75.4%	BE	LU	129.9%
Average =	-12.0%		-6.1%			-4.6%
Median =	-15.2%		-9.2%			-11.6%
St. Dev =	0.382		0.241			0.381
Minimum =	-45.0%		-35.4%			-49.4%
Maximum =	123.5%		75.4%			129.9%

Notes: Countries are ordered according to their energy intensity. Arrows show significant movements between quartiles over time. Source: Authors' calculations on Odyssee (ENERDATA) data.

By contrast, performances in the energy transport sector have worsened in Spain. If, on the one hand, improvements have been very significant in the first sub-samples with an increase in energy efficiency equal to 35.4 percent, in the second sub-sample, efficiency has decreased by 6.7 percent.
In Italy, the performance of the transport sector has been remarkable. From 1980 to 2004, energy efficiency has increased approximately by 13.4 percentage points, or the median change and twenty times higher than the increase in the efficiency of the industrial sector. However, even in this case, a potential for further improvements would be possible if appropriate policy measures and technological changes concerning the transport sector as a whole were implemented.

Disaggregating the E.E. index by transport modes, it can be noticed that a regular improvement of the energy efficiency of transport (12%) takes place in the EU over the period 1990-2006. The lower progress can be blamed on the road transport of goods, while the best performance in the index takes place in the air transport (Figure 25).

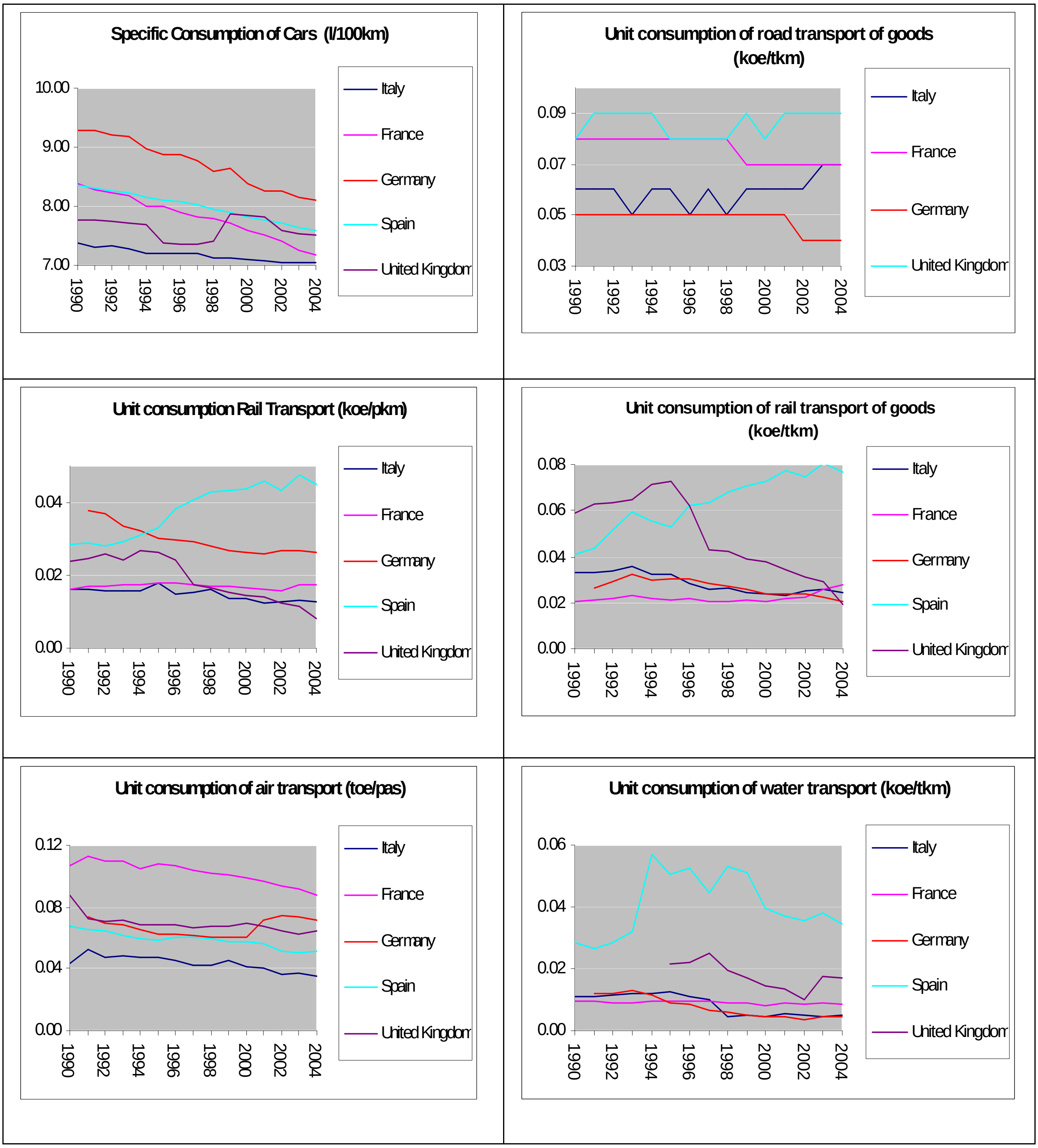
Figure 25: Energy efficiency index for transport EU-27 (ODEX).



Source: ODYSSEE.
Note: Technical ODEX index calculated on 7 modes: cars (litres/km), trucks & light vehicles(toeper tkm), air (toe per passenger); rail ,water (toe/ tkm or pkm); motorcycles, buses (toe/vehicle).

We can evaluate energy efficiency also in terms of unit consumption. Unfortunately, data are not available for all countries and all sectors; it is, however, possible to make significant comparisons as far as the transport is concerned. These comparisons are illustrated in Figure 26. There is an interesting progressive convergence for some means of transport, in terms of unit consumption of fuels, whereas other methods are quite heterogeneous. Emblematic is the comparison among the consumption levels of cars. Figure 26 shows a substantial homologation, with respect to the transport by trucks and light vehicles. Furthermore, for both the rail and water transport a general convergence of consumption levels can be noticed. A noticeable exception is, however, represented by Spain, whose consumption levels are significantly higher than those of other countries. Differences in the relative consumption levels can be explained, not only by considering the different efficiency in implementing the European standards, but also by examining the peculiarities of national transport networks.

Figure 26: Unit Consumption for Different Methods of Transport, 1990- 2004



Source: ENERDATA, World Energy Database.

5. The Energy Policy in the European Transport Sector

5.1. Introduction

In what follows, we describe the common European policies in the area of transport sector, set by European Commission and Parliament during recent years, aimed at promoting more energy efficient transport modes and fuels as well as a substantial reduction of carbon emissions. We also present a brief description of actions taken by several European countries in implementing the European directives, as well as national and regional policy initiatives which could have a positive effect in improving energy efficiency and air pollution in the transport sector. The Appendix includes a complete list of transport policies implemented by European Countries from 1990.

In the Green Paper on energy efficiency[5], the Commission estimates that the EU could reduce energy consumption by 20% by 2020, and it claims that the first sector with a high energy saving potential is transport, representing a third of the EU's total consumption. The dominance of road transport and its high level petrol dependence are accompanied by congestion and pollution problems which add to energy waste. To face these issues, the Commission proposes tax schemes favouring clean and economical vehicles and the use of public transport and car pooling. The Commission also is in favour of financing research and the development of alternative fuels. Finally, it calls for better road and air traffic management on a continental scale to limit congestion and pollution, particularly by using the applications of the GALILEO Programme[6].

In the Action Plan for Energy Efficiency (2007-12)[7], the Commission estimated that the energy saving potential in the transport sector is around 26% reduction in energy consumption. The Commission plans to set a binding target to reduce polluting car emissions to achieve the threshold of 120g of CO_2/km by 2012. It also intends to address the issue of car components, such as air conditioning and tyres, in particular by issuing a European standard for rolling resistance and by promoting tyre pressure monitoring. The Action Plan includes an initiative to extend the greenhouse gas emissions trading scheme to the air transport sector, to improve air traffic control (SESAR), to implement the third rail package, and to connect ships to the electricity network when in harbour.

Since the 2001 White Paper, which was revised in 2006, this policy area has been oriented towards harmoniously and simultaneously developing the different modes of transport, in particular with co-modaility, which is a way of making use of each means of transport (ground, waterborne or airborne) to its best effect.

[5] Commission Green Paper, 22 June 2005, "Energy Efficiency - or Doing More With Less" [COM(2005) 265 final - not published in the Official Journal].

[6] The purpose of the Galileo programme is to establish the first worldwide satellite radionavigation and positioning infrastructure specifically for civil purposes.

[7] Communication from the Commission of 19 October 2006 entitled: Action Plan for Energy Efficiency: Realising the Potential [COM(2006) 545 – Not published in the Official Journal].

5.2. Road Transport

5.2.1 "Euro" Emission Standards

According to a recent study on European transport policies[8], the EU "has developed vehicle emission standards with the aim of lowering the negative environmental and health impacts from motorized transport. The standards are defined in a series of Directives, which date back to the 1970s, staging the progressive introduction of increasingly stringent requirements. The setting of standards has had an impact on the evolution of the vehicle fleet composition over the years. This led to a considerable change in the size and type of emissions of air pollutants from motorized transport, which have substantially decreased over time".
A regulation of 2007[9] introduces new common requirements for emissions from motor vehicles and their specific replacement parts (Euro 5 and Euro 6 standards). The Regulation covers vehicles of categories M1, M2, N1 and N2, with a reference mass not exceeding 2610 kg. The Euro standards set limits on vehicles' emissions of carbon monoxide (CO), hydrocarbons (HC), oxides of nitrogen (NO_x) and particulate matter (PM). As soon as the Euro 5 and Euro 6 standards enter into force, Member States must refuse the approval, registration, sale and introduction of vehicles that do not comply with these emission limits.
The Euro 5 standard came into force on September 2009. Its main effect should be to reduce the emissions of particulate matter from diesel cars from 25 mg/km to 5 mg/km.
Euro 6 is scheduled to come into force on 2014 and will mainly reduce the emissions of NO_x from diesel cars further, from 180 mg/km to 80 mg/km.
The same document cited above states that "this action was to be undertaken by the Commission and there were no specific obligations for the States. However, it must be noted that in Germany and Italy the setting of EU standards has had a significant impact on fleet composition over time. In addition, EU standards have been used as a basis for calculation of vehicle taxation and for the identification of the features of Low Emission Zones. Moreover in Italy EU standards have been used for differentiating charges in the urban road pricing scheme introduced by the city of Milan in 2008. No particular action has been taken by Spain".

5.2.2. Air Quality Directive

The road transport sector is one of the main contributors to air pollution. According to the Review of Common Transport Policy[10], "the contribution to tropospheric ozone formation precursors (TOFP) in 2004 was 30 % in the EU10 and 35 % in the EU15 countries. Regarding the emission of primary PM^{10} and secondary PM^{10} (inorganic pollutants) contributing to the formation of particulates, in 2004 17% was attributed to road transport in EU10 and 26% in EU15".
The Air Quality Framework Directive sets limits for the atmospheric concentrations of pollutants, including SO_2, NO_2, PM^{10} and O_3, at levels that should prevent or reduce effects on health and ecosystems. The NO_2 limit value of 200µg/m^3 hourly average and 40µg/m^3 annual average were set in Council Directive 1999/30/EC. The limit is to be met by 1 January 2010. The same Directive also sets limits for SO_2 and PM^{10}, 125µg/m^3 24-hour average and 50µg/m^3 24-

[8] European Commission, Review of the Common Transport Policy, Final Report, August 2009.

[9] Regulation (EC) No 715/2007 of the European Parliament and of the Council of 20 June 2007 on type approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and Euro 6) and on access to vehicle repair and maintenance information.

[10] See note 8.

hour average respectively, to be met by 1st January 2005. For PM^{10} there is also an annual average limit, which is set at 40µg/m^3.
Despite these emission limits, the European countries has so far failed to achieve significant improvements in air quality. The increase in the number of vehicles, indeed, is offsetting reductions in emissions from technological and fuel quality improvements. According to the Review of Common Transport Policy, “in 2006, 40-50% of the EEA urban population still lived in areas where pollutant concentrations are higher than selected limits/targets”.

In Germany, Italy and Spain, the Framework Directive 96/62/EC and limit values given in the subsequent Directives 1999/30/EC, 2002/3/EC and 2004/107/EC have been transposed into the national legislations. Some improvements have occurred in the air quality of cities in the three Countries, but the limit values are still exceeded.

5.2.3. Pricing and Taxation

A common EU environmental framework for road vehicles registration and annual circulation taxation is still under discussion. At national level there are some examples of transport charges. In Germany, Italy and Spain, light vehicles’ registration tax varies according to their emissions. In Spain, the government has also introduced financial incentives to replace old vehicles with new ones with better CO_2 performances.
It should be also noted that some European cities, namely London, Stockholm and Milan, have introduced urban charging schemes and distance related charging schemes on motorways (e.g. HGVs charging scheme in Germany).
However, few measures have yet been taken to internalize costs of CO_2 emissions, rail and road noise and congestion. With the exception of Milan, urban road charges have focused on congestion, though some exemptions were allowed for electric or hybrid vehicles.
The EU legislation sets minimum annual taxes for heavy goods vehicles (above 12 tonnes) and establishes that taxes have to vary according to the number and composition of axles; yet national authorities can set taxes structure as well as the procedures for levying and collecting them. However, several Member States already apply charges differentiated on proxies for environmental impact (e.g. engine size and type).

5.2.4. Urban Public Transport

In order to achieve a more sustainable transport system, the Commission has funded two projects, namely CUTE (Clean Urban Transport for Europe) and CIVITAS, aimed at improving the urban public transport in terms of emission reduction and efficiency in energy use.
The European Union initiative CUTE funded local hydrogen-powered public transportation, especially by buses, which will contribute to the reduction of overall CO_2 emissions. The project has shown significant result. According to the Review of Common Transport Policy “since mid-2003, 27 public transport buses have covered more than 1 million km and carried more than 4 million people in 9 European cities, producing zero emissions and causing no accidents during their operations”. The project, which concluded in 2006, has then been followed by the “Hydrogen for Transport” initiative.
The CIVITAS initiative is aimed at helping cities to achieve a more sustainable, clean and energy efficient urban transport system. Both CIVITAS I and CIVITAS II have financed several local measures in order to introduce cleaner public transport vehicles. In Graz public transport company now operates all of its 120 busses on 100% biodiesel, while in Toulouse a 100% clean public transport fleet have to be reach by 2009.
According to the Review of Common Transport Policy “both CUTE and CIVITAS showed significant results, but they were limited to a number of cities participating to the initiatives,

mainly supported the usage of forefront not-exploited technologies, and also limited budgets. To get a cleaner urban transport fleet across the different EU cities, a specific policy framework is needed, accompanied by additional financial support".

In 2009 the EU adopted a Directive (Directive 2009/33/EC of 23 April 2009) to promote the introduction of clean and energy efficient vehicles, which requires that energy and environmental impacts linked to the operation of vehicles over their lifetime are taken into account in all purchases of road transport vehicles. In addition, the European Investment Bank (EIB) is currently developing a financing facility to help cities improve their energy efficiency and buy cleaner bus fleets. At a national level, several programmes promote zero emission and biofuel technologies in urban transport (like in Germany and Spain), and some initiatives - both at the national and regional level - promote public fleet renewal and the purchase of cleaner vehicles (like in Italy).

5.2.5. Promotion of Biofuels

In 2001, the Commission set out a strategy to achieve 20% substitution of conventional automotive fuel by 2020, identifying biofuels as one of the possible alternatives. In 2003 the Directive on the promotion of biofuels and other renewable sources in transport (Directive 2003/30/EC) set indicative targets for road transport biofuels of 2% by the end of 2005 and 5.75% by the end of 2010, although Member States were then allowed to set their national indicative targets.
Several Member States have passed the biofuels Directive into national law, but since these targets were indicative and non-binding, some countries have announced indicative targets below that of the Directive. According to the Review of Common Transport Policy "Member States are far from reaching the targets: in 2007 biofuels made up 2.6% of road transport fuel and they are expected to account for 4.8% by 2010".

Nevertheless, the production of biofuels has been growing rapidly in recent years. According to the EEA's TERM 2007 report (EEA ,2008), 5.1 million tonnes of biofuels were produced in the European Union in 2006, 31 % more than in 2005. Biodiesel accounted for 85 % of total biofuels production. Currently biofuels are principally produced as biodiesel and bioethanol. They mainly consist of first-generation fuels, based on vegetable oils and starch from crops that can also be used for food. The feedstocks used for ethanol production are predominantly cereals and sugar beet, while biodiesel is manufactured mainly from rapeseed, estimated to account for over a quarter of the EU rapeseed crop. In 2006, the two main producers of both biodiesel and bioethanol were Germany and France.

More ambitious targets have recently been proposed. In 2008 the Commission proposed to raise the share of biofuels in transport to 10% by 2020 [COM(2008)19 final], but the 10% target has been recently assigned to a mixture of renewable sources, including biofuels and green electricity.

However, there are some concerns about both the environmental effects of biofuel production, and the adverse socio-economic impacts that it may have. Such crops indeed cannot produce enough biofuel without threatening food supplies and biodiversity. Such effects were highlighted during recent strong concomitant increases in the prices of crude oil and staple commodities on world markets. For this reason, in 2008 the EU has also proposed "sustainability criteria" to prevent mass investment in cheaper but environmentally harmful biofuels, though the latest text adopted does not take into account for indirect land displacement as a negative effect to be addressed in the production of biofuels. Second-generation biofuel processes aim to extend the amount of biofuels that can be produced in a sustainable way by using the biomass from residual non-food parts of current crops such as stems, leaves and husks that are left behind once a food crop has been extracted, from other non-food crops as well as from agro-industrial waste such as wood chips, skins and pulp from fruit pressing, etc.

In 2006 the Commission has identified the following seven policy axes listed in the document *The EU Strategy for Biofuel*s: stimulating demand for biofuels, capturing environmental benefits, developing the production and distribution of biofuels, expanding feedstock supplies, enhancing trade opportunities, supporting developing countries and supporting research and development. Regarding the fuel quality, in 2003 the Fuel Quality Directive was amended to include environmental specifications, which apply to biofuels as well as to petrol and diesel. According to the Review of Common Transport Policy, the European Committee for Standardization (CEN) "has set limits on biodiesel blending to no more than a 5 percent share by volume for technical reasons, a strict technical requirement which however represented an obstacle to achieving some targets set by the Biofuels Directive".
In addition, the Energy Products Directive (Directive 2003/96/EC) promotes the use of biofuels by means of exemptions of biofuels from taxation. Several Member States have already introduced exemptions at various levels up to 100%.

5.2.6. Reduction of CO2 Emissions from Cars

According to the Review of Common Transport Policy, "in 1998 and 1999 the European Commission entered a voluntary agreement with the European, Japanese and Korean car industry to reach average emissions of CO_2 from new cars of 140g/km by 2012. In 2007 the Commission concluded that, although there had been a reduction in average emissions (from 186g/km in 1995 to 161g/km in 2004), the target was unlikely to be met, and made a legislative proposal to ensure that, along with other technological improvements and an increased use of biofuels, the target of 120g/km would be met by 2012.
The legislation was discussed and approved on December 2008. It sets that the fleet average to be achieved by all cars registered in the EU is 130 grams per kilometre (g/km), with an additional 10g/km to be achieved from other sources, including CO_2 restrictions for vans, the use of biofuels, cleaner fuels, more efficient air conditioning systems, and the use of tyres with lower rolling resistance. A so-called limit value curve implies that heavier cars are allowed higher emissions than lighter cars while preserving the overall fleet average. In 2012, 65% of each manufacturer's newly registered cars must comply on average with the limit value curve set by the legislation. This will rise to 75% in 2013, 80% in 2014, and 100% from 2015 onwards. If the average CO_2 emissions of a manufacturer's fleet exceed its limit value in any year from 2012, the manufacturer has to pay an excess emissions premium for each car registered. This premium amounts to €5 for the first excess g/km, €15 for the second g/km, €25 for the third g/km, and €95 for each subsequent g/km. From 2019, even the first excess g/km will cost €95.
A target of 95g/km is specified for the year 2020. The implementation of this target, including the excess emissions premium, will have to be defined in a review to be completed no later than the beginning of 2013".

5.2.7. Vehicle Labelling

In order to reduce carbon dioxide emissions from new cars and vans sold in the European Union, in 1999 the European Commission proposed to label new vehicles according to their fuel economy[11] [Directive 1999/94/EC], with the aim to ensure aware consumption choices. Currently the Directive is under revision [COM(2007) 19] and the adoption of the proposal to revise CO_2/cars labelling Directive is foreseen towards the end of 2009.

In 2009 the Commission has prepared a proposal[12] for a Directive to introduce tyre labelling according to rolling resistance (this is of direct relevance for fuel consumption and hence CO_2 emissions). Following the Review of Common Transport Policy, the Directive aims "to provide end-users of vehicles with clear and relevant information about the quality of the tyre, and to guide them towards choosing a product which is more fuel efficient, has better wet braking and is less noisy. It should allow energy-efficient tyres to be promoted and thus increase the energy efficiency of road transport".

5.2.8. The Marco Polo Programme

Marco Polo is the European Union's funding programme for projects which shift freight transport from the road to sea, rail and inland waterways.
It aims at improving the environmental performance of European freight transport, by freeing the roads of an annual volume of 20 billion tonne-kilometres[1] of freight, the equivalent of more than 700 000 trucks a year travelling between Paris and Berlin. This translates into substantial environmental, societal and economic benefits.
Up till now more than 400 companies have benefited from funding. The projects funded provide high quality services by using innovative technologies such as IT management systems, GPS for cargo track-and-trace, and new-design containers to facilitate intermodal handling. Big European infrastructure projects, such as the Oeresund tunnel and bridge between Denmark and Sweden, are been utilized in some projects in order to offer door-to-door international transport services.
In addition to direct modal-shift projects, Marco Polo also funds projects that provide supporting services, including management systems, integrated cargo control or common IT platforms to facilitate inter-operability between partners and between modes, as well as training projects related to inter-modal transport and logistics. The current second Marco Polo programme runs from 2007-13, with an annual budget for grants of about €60 million, and it has enlarged the eligible Countries for funding to Countries bordering the EU.

5.2.9. Intelligent Transport Systems (ITS)

On 16th December 2008, the European Commission took a major step towards the deployment and use of Intelligent Transport Systems[13] (ITS) in road transport. The Action Plan adopted suggests a number of targeted measures and a proposal for a Directive laying down the framework for their implementation. ITS can significantly contribute to a cleaner, safer and more efficient transport system. The goal is to create the momentum necessary to speed up market penetration of rather mature ITS applications and services in Europe. ITS does this by applying the latest information and communication technologies (telephone, satellite, computer, etc.) to transport. Examples in road transport include travel information, navigation and Electronic Stability Control (ESC). The expected direct benefit is a faster, better coordinated and more harmonised use of intelligent transport systems and services, which in turn should contribute to more efficient, cleaner and safer transport.

[11] The fuel economy is the distance traveled by a vehicle per unit of fuel used.

[12] Proposal for a Directive of the European Parliament and of the Council on labelling of tyres with respect to fuel efficiency and other essential parameters [COM(2008) 779 final – Not published in the Official Journal].

[13] **http://ec.europa.eu/transport/its/road/action_plan_en.htm**

5.3. Maritime Transport

5.3.1. Limits to Maritime Pollution

A severe issue emerged in recent years in the field of maritime transport is sea pollution resulting from accidents and routine ship operations. The European regulation of maritime transport focuses more on energy security and pollution reduction rather than on energy efficiency. The freight transport by ships has in fact a relatively low energy use, while accidents resulting in massive spills cause serious damages to the marine and coastal environment, and threaten the energy security, since temporarily disrupt oil import flows along the affected route.

In addition to accidents, large amounts of oil are pumped deliberately from ships every day, due to three types of routine ship operations, such as ballast water, tank washings and engine room effluent discharges.
To face the problem of maritime pollution the EU has introduced different types of measures : i) the gradual elimination (phasing out) of the fleet of single-hull tankers and replacing these by double hull tankers; ii) establishment of the European Maritime Safety Agency (EMSA) (in particular, since March 2004, EMSA was also given additional tasks related to oil pollution response); iii) penal sanctions for those responsible of causing oil spills or other ship–source type pollution.

An improvement in the security of maritime transport sector has been achieved, with a reduction of the number of maritime accidents registered in the 2000-2007 period with respect to 1990-1999. However certain safety and environmental threats remain. The Commission has recently adopted a new proposal on ship-source pollution and on the introduction of penalties for infringements [COM(2008) 134 final]. The financial support to EMSA has been increased, in order to improve the activity of the Agency with new tools. To this purpose the EMSA is developing a centralized satellite imagery service, which will facilitate the early detection of polluting incidents and the identification of the ships responsible.

These actions were to be undertaken by the Commission and there were no specific obligations for the States. Yet, following the Prestige disaster in 2002, Spain created an institution responsible for the Prevention of maritime accidents and legislation has been introduced in Italy to promote fleet renewal and the introduction of double hull tankers.

Furthermore, the International Maritime Organisation (IMO) adopted in May 2003 the Supplementary Fund Protocol which provided a significant increase (up to about €1 billion) in the fund available to compensate damages caused by oil tanker accidents under a regime of strict liability.

5.3.2. Sulphur Content of Marine Fuel

According to the Review of Common Transport Policy, the maritime transport “has a higher energy-efficiency than other modes of transport and is, in general, less harmful to the environment than other modes of transport per tonne or passenger carried. The good environmental performance of shipping is, however, hampered, in particular, by sulphur dioxide (SO_2) emissions that are significantly higher than in other modes”.
In November 2002, the European Commission adopted a European Union strategy to reduce atmospheric emissions from seagoing ships. The strategy reports on the magnitude and impact of

ship emissions in the EU and sets out a number of actions to reduce the contribution of shipping to acidification, ground-level ozone, eutrophication, health, climate change and ozone depletion. Air pollutant emissions from ships are also covered by Annex VI of the Marine Pollution Convention (MARPOL) 73/78, of the International Maritime Organization. The IMO establish a maximum worldwide level of sulphur in fuel of 4.5% for heavy fuel oil burned by ships and set up SO_x Emission Control Areas (SECAs) where fuel burned by ships must contain less than 1.5% sulphur, or equivalent abatement technologies must be applied. In October 2008 the IMO adopted tighter restrictions on the sulphur content of fuel used both within SECAs and worldwide. In SECAs limits for sulphur levels would be 1% from 1 January 2010 and 0.1% from 1 January 2015. At the same time the global limits will be reduced to 3.5% from 1st January 2012, with a further reduction to 0.5% from 1st January 2020 or 2025 if insufficient fuel is available. The EU has also applied the same 1.5 % limit on fuel sulphur content for passenger vessels on regular services to or from EU ports. While ships spend most of their time at sea, their berthing in ports also adds to pollution. This is why, together with the implementation of the SECAs, the EU strategy aims to limit emissions from both inland vessels and seagoing vessels at berth in EU ports. Directive 2005/33/EC addressed the sulphur content of marine fuels and introduced a 0.1 % (1 000 ppm) maximum sulphur content requirement for ships at berth in EU ports from January 2010.

The Baltic and North Seas are currently designated as SO_x Emission Control Areas (SECAs) where fuel burned by ships must contain less than 1.5% sulphur, which will be 1% from 1st January 2010 and 0.1% from 1st January 2015. Germany is monitoring the contents of SO_x in the Baltic Sea.

5.3.3. Promotion of the Shore-side Electricity

In 2006 the Commission encouraged the use of shore-side electricity by ships (and did not specifically exclude recreational craft) in ports, claiming that the switching to shore-side electricity would reduce CO_2 emissions by over 50%, carbon monoxide by about 99% and nitrous oxide emissions (N_2O) by over 50%, as well as eliminating vibrations and noise from auxiliary engines.

In particular, the Recommendation, which is a soft measure without any binding effect on Member States, called for Member States to install shore-side electricity for use by ships at berth in ports and to offer economic incentives (particularly in the form of electricity tax reductions) to operators to use such electricity. The recommendation was released just as eight states bordering the North Sea agreed to introduce economic incentives for provision of shore-side electricity.

The Commission calls on Member States to work within the IMO to promote the development of harmonised international standards for shore-side electrical connections. At present only a few EU ports (Stockholm, Gothenburg, Lübeck) offer shore side electricity equipments.

Overall, although the adoption of the EU Regulation has been achieved, more actions need to be taken both at international and Member State level.

5.4. Air Transport

5.4.1 Inclusion of aviation in the ETS and other measures

Aviation contributes to climate change through different aircraft emissions (carbon dioxide and water vapour emissions, contrails or 'aviation smog', indirectly nitrogen oxides). The EU is seeking to reduce aviation GHG emissions through a comprehensive approach based on:

- R&D for 'greener' technology, within the 7th Framework Programme for Research & Technical Development,

- modernisation of air traffic management systems through the Single European Sky SESAR initiative, and
- market-based instruments

In the 2000-2005 period several policy options for market based instruments were examined by the EU: in particular the possibility to introduce aviation taxes, such as a fuel tax – as kerosene is currently exempted from taxation – was explored, but this option resulted not to be feasible as it would have required a unanimous decision in the Council and was strongly opposed by the aviation industry. In its 2005 Communication "Reducing the Climate Change Impact of Aviation", the Commission concluded that bringing aviation into the EU's emission trading system (EU-ETS) was the most cost-effective way of reducing the climate change impact of this sector. Aviation has recently been included in the European Emission Trading System (ETS) and as from 2012 planes arriving at or departing from EU airports will be subject to a cap on GHG emissions which will require airlines to buy and sell 'pollution credits' on the EU 'carbon market'.

6. Panel Analysis Results

In this Section we illustrate the results of the panel analyses, whose methodology and dataset has been described in sections 4 and 5 of Deliverable 5.8.1.

As mentioned there, our aim is to check whether the implementation of energy efficiency policies has had an effect in EU (EU15+Norway) countries on indicators of energy efficiency, carbon efficiency and security of supply. In particular we are interested in checking whether some policies had a sort of "double dividend" by having a positive effect on more than one of these indicators. Besides policy dummies, we also look at the effect of the macro drivers (GDP, prices, R&D, etc.)

In this section we analyse such effects for the European transport sector.

6.1. Panel results for energy indicators in the transport sector

The main results are collected in Table 2 below.

			Dependent variables				
			Unit	**Energy intensity**	**Energy efficiency**	**Energy security**	**Carbon intensity**
				Eitra	**eetraody**	**estra**	**Citra**
Coefficients		Energy Price	US$	-0.046			
		GDPppp	US$	0.176		-26.602	-0.346
		R&D	MUS$ (ppps)	-0.063	-7.798		0.271
		Share Industry	%				
		Energy Production	ktoe				-0.282
	Transport Policy Variables	Tr06		-0.054	-9.515		-0.115
		Tr09		-0.052			
		Tr10			-7.008		

		Tr11				-13.407	
	Cross-Cutting Policy Variables	Cc03			-5.390		
		Cc04			-4.709		
		Cc05				-7.243	
		Cc06		-0.041			-0.170
		Cc07		-0.023			
R-square				0.25	0.52	0.63	0.33

Notes
Eitra: energy intensity index transport sectors
Eetraody: energy efficiency index - transport sector (Odyssee), 1980-2004
Estra: energy security index - transport sectors (proxy:Oil consumption/GDP)
Citra: carbon intensity index - transport sectors

Table 2 Econometric Results of the Energy Intensity, Energy Security and Carbon Intensity Indicators

The energy intensity of the transport sector is beneficially influenced both by sector-specific and cross-cutting measures. Sector-specific measures include support fiscal instruments encouraging the adoption of more efficient vehicles such as tax exemptions, tax reductions or accelerated depreciation of obsolete vehicles and the measures to improve transport infrastructures. Cross-cutting policies include those promoting the introduction of marked based instruments.
In terms of macro drivers, increases in the price of diesel improve this indicator, not unexpectedly. R&D seem to have a similar effect. Per capita income, on the other hand, has a detrimental effect.

If we look at **energy efficiency improvements** in pure physical terms, the fit of the regression improves considerably, thus highlighting the bias induced in the case of energy intensity by implicitly comparing the consumption of a whole sector to the value added generated only by a fraction of it. The general picture is not so different however: both sector-specific policies and cross-cutting policies are effective, although not quite the same policies. The exception are the support fiscal instruments noted above, which are effective also in this perspective. Social planning measures (e.g. those aimed at improving the efficiency of transport networks) also work in this direction. As to cross-cutting measures, fiscal and financial measures appear to be effective. In terms of macro variables, only R&D expenditures have an effect akin to the one displayed for energy intensity.

As to **carbon intensity**, the sector appear to be particularly sensitive to include support fiscal instruments encouraging the adoption of more efficient vehicles such as tax exemptions, tax reductions or accelerated depreciation of obsolete vehicles. Among cross cutting policies, market base instruments appear to be effective. In terms of macro variables, increasing incomes improves this indicator, something that at first glance is at odds with what noted for energy intensity. On one hand in fact richer economies consume more energy for their transport needs. On the other hand, they seem to use cleaner means of transport. Thus there appears to be an increasing diversification in transportation options as income per capita increases, while the higher availability of economic means leads nevertheless to a higher demand for energy. R&D, worsens this indicator.

Finally, in terms of the sector's contribution to **energy security,** results are in general quite disappointing; the best fit is obtained in the case of the ratio of oil consumption to GDP[14]. Even in this case however, only-cross cutting measures (those with sector specific characteristics and those aimed at improving general public knowledge about energy efficiency) appear to be effective. In terms of macro variables, only income per capita have a (beneficial) effect on this indicator: the same argument about diversification of transport means in richer economies noted for carbon intensity may hold here as well.

6.2. Discussion

Our analysis has shown that while there are quite a number of cross cutting policies and of policies aimed at the transport sector that improve energy efficiency, energy intensity and carbon efficiency, only cross cutting policies (both with and without sector-specific characteristics) have a significant impact on oil security, the only facet of energy security that, according to our descriptive analysis, is relevant for this sector.

The indication here seems to be that while energy efficiency can be significantly improved in this sector by well designed policies, the sector is still too tightly bound to oil products for any of these policy to result in significant change in its oil security.

This result is underpinned also by the fact that our analysis did not find any significant overlapping between security and other indicators. One significant overlapping among energy efficiency, carbon intensity and energy intensity was singled out, as while carbon intensity and energy intensity overlap twice.

In terms of goodness of fit, the results are mixed, with R-square ranging from 0.25 and 0.63, reaching its highest value in the energy security regression. On average R-square is below the values observed in the general case of Deliverable 5.8.1 and in all other sectors examined so far.

[14] Regressing our dependent variables on alternative energy security indicators (oil import/oil consumption and oil consumption in transport / total energy consumption in transport) have led to way less significant results.

7. Conclusions

In this third Deliverable of SECURE's WP5.8 we have explored the relationships between energy efficiency and energy security for the transport sector in the EU 15 and Norway.

To this purpose we have provided a descriptive analysis of a few energy efficiency indicators and of the energy EU energy policies in this sector. As mentioned in the concluding Section of Deliverable 5.8.1, the distinguishing feature of this WP, is its original econometric approach applied to a dataset of policies and measures in the EU whereby panel analysis methods are used to assess the effect of such policies on energy efficiency, carbon efficiency and energy security.

The descriptive analysis of Sections 2 to 5 have highlighted a substantial effort of the EU both at the community and at the state level in improving energy efficiency and environmental quality in the transport sector.
Varying results in terms of performance and speed across countries are noticeable; however for this sector there is more homogeneity across Europe due to the overwhelming preponderance of road transport, both for passenger and freight traffic, and the fact that road transport is the mode that has improved the least over the period considered in this study.
Differences in physical terms are difficult to assess in terms of pure energy efficiency due to the intrinsic cross-country incomparability of the index, that by construction mainly allows to track energy efficiency progress of a given country across time, but cannot tell us within any given pair of countries, which one has ever been more efficient than the other. In terms of specific technical indicators, comparisons are easier, but then data availability and transport mode specificities can be sometimes problematic.

Surely there has been since the 90's a growing policy activity in this area in the EU. For quite a while, the prevailing concerns have been however preventing pollution than improving efficiency or reducing oil dependency. The Green Paper Energy explicitly recognize the great potential for energy efficiency gains in this sector, and indeed it appears clear that there is still a lot to do, particular in terms of rethinking the pecking order of the transport mode in Europe, still severely unbalanced towards road transport.

The general analysis on the economy as a whole performed in Deliverable 5.8.1 showed that quite a number of policies had a beneficial impacts on energy efficiency and carbon efficiency, but only general cross-cutting policies have proven also useful to improve the performance of aggregate energy security indicators. We noted in that Deliverable that in a more general perspective, it is the policy mix rather this or that policy in insulation that has been all in all, quite effective.

Looking at the topic of this Deliverable, unfortunately, what said above about general indicators is still as good as it gets, as it was the case for all other sub-sectors of energy consumption: restricting our focus to the transport does not lead to sharper or more encouraging conclusions in terms of co-benefits on energy security of energy efficiency policies.

In fact it turns out that energy efficiency policies aimed at the transport sector have very little effectiveness in improving energy security.

While there are quite a number of policies aimed at the transport sector that improve energy efficiency, energy intensity and carbon efficiency, only cross cutting policies (both with and without sector-specific characteristics) have a significant impact on oil security.
The indication here seems to be that while energy efficiency can be significantly improved in this sector by well designed policies, the sector is still too tightly bound to oil products for any of these policy to result in significant change in its oil security.
This result is underpinned also by the fact that our analysis did not find any significant overlapping between security and other indicators.

This study is based on the most up-to-date data we were able to recover, and employs state of the art techniques. However, the analysis performed here could in principle be extended and refined. In particular it would have been interesting to look to more countries, and to use continuous, instead of binary, policy variables.
The main limitation has been data availability. In particular, policy indicators and energy efficiency indicators for new accession countries were not available or available for a decade or less of observations. For policy variables, the MURE database is mostly qualitative, and reports the presence and the category of the policies and measures implemented in a given country, but it does not provide systematically quantitative information about these policies (such as the funds earmarked for a given policy or the financial impact of a given tax). Future analyses can be pursued by investigating the country-specific P&Ms that contributed to energy efficiency improvements. We have looked at such P&Ms at the regional level (EU-15 plus Norway), but analyses of single countries can help to understand if selected policies are more effective in different countries than others.

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Annex I – Data Dictionary

Variable	Description
Country	EU15 countries + NO
year	1980 – 2006
EIfin	Energy intensity index; Final (all sectors)
EIind	Energy intensity index; Industry
EIoth	Energy intensity index; Other sectors
EItra	Energy intensity index; Transport sectors;
ESfin	Energy security index; Final (all sectors)
ESind	Energy security index; Industry
ESoth	Energy security index; Other sectors
EStra	Energy security index; Transport sectors;
CIfin	Carbon intensity index; Final (all sectors)
PReleHH	Price in US$ of electricity residential (incl. taxes); Total Price (US$/unit)
PReleIND	Price in US$ of electricity industry (incl. taxes); Total Price (US$/unit)
PRdiesel	Price in US$ of diesel (incl. taxes); Total Price (US$/unit), Household
ShINDwdi	Industry, value added (% of GDP) (NV.IND.TOTL.ZS) WDI
R&Dpps	Total intramural R&D expenditure (GERD). Millions of PPS (Purchasing Power Standard). All sectors. EUROSTAT
GDPppsCur	GDP per capita, PPP (current international $) (NY.GDP.PCAP.PP.CD), WDI
EnProdWdi	Energy production (kt of oil equivalent) (EG.EGY.PROD.KT.OE), WDI
PMhhT1	P&Ms Household sector - Mandatory Standards for Buildings
PMhhT2	P&Ms Househod sector - Regulation for Heating Systems and hot water systems
PMhhT3	P&Ms Household sector - Other Regulation in the Field of Buildings
PMhhT4	P&Ms Household sector - Mandatory Standards for Electrical Appliances
PMhhT5	P&Ms Household sector - Legislative/Informative
PMhhT6	P&Ms Household sector - Grants / Subsidies
PMhhT7	P&Ms Household sector - Loans/Others
PMhhT8	P&Ms Household sector - Tax Exemption / Reduction
PMhhT9	P&Ms Household sector – Tariffs
PMhhT10	P&Ms Household sector - Information/Education
PMhhT11	P&Ms Household sector - Co-operative Measures
PMhhT12	P&Ms Household sector - Cross-cutting with sector-specific characteristics
PMtrT1	P&Ms Transport sector - Mandatory Standards for Vehicles
PMtrT2	P&Ms Transport sector - Legislative/Informative
PMtrT3	P&Ms Transport sector - Grants / Subsidies
PMtrT4	P&Ms Transport sector – Tolls
PMtrT5	P&Ms Transport sector - Taxation (other than eco-tax)
PMtrT6	P&Ms Transport sector - Tax Exemption / Reduction / Accelerated Depreciation

PMtrT7	P&Ms Transport sector - Information/Education/Training
PMtrT8	P&Ms Transport sector - Co-operative Measures
PMtrT9	P&Ms Transport sector – Infrastructure
PMtrT10	P&Ms Transport sector – Social Planning/Organisational
PMtrT11	P&Ms Transport sector - Cross-cutting with sector-specific characteristics
PMinT1	P&Ms Industry sector - Mandatory Demand Side Management
PMinT2	P&Ms Industry sector - Other Mandatory Standards
PMinT3	P&Ms Industry sector - Legislative/Informative
PMinT4	P&Ms Industry sector - Grants / Subsidies
PMinT5	P&Ms Industry sector - Soft Loans for Energy Efficiency, Renewable and CHP
PMinT6	P&Ms Industry sector - Fiscal/Tariffs
PMinT7	P&Ms Industry sector - New Market-based Instruments
PMinT8	P&Ms Industry sector - Information/Education/Training
PMinT9	P&Ms Industry sector - Co-operative Measures
PMinT10	P&Ms Industry sector - Cross-cutting with sector-specific characteristics
PMteT1	P&Ms Tertiary sector - Mandatory Standards for Buildings
PMteT2	P&Ms Tertiary sector - Regulation for Building Equipment
PMteT3	P&Ms Tertiary sector - Other Regulation in the Field of Buildings
PMteT4	P&Ms Tertiary sector - Legislative/Informative
PMteT5	P&Ms Tertiary sector - Grants / Subsidies
PMteT6	P&Ms Tertiary sector - Soft Loans for Energy Efficiency, Renewable and CHP
PMteT7	P&Ms Tertiary sector - Tax Exemption / Reduction
PMteT8	P&Ms Tertiary sector - Information/Education/Training
PMteT9	P&Ms Tertiary sector - Co-operative Measures
PMteT10	P&Ms Tertiary sector - Cross-cutting with sector-specific characteristics
PMccT1	P&Ms Cross-cutting - General Energy Efficiency / Climate Change / Renewable Programmes
PMccT2	P&Ms Cross-cutting - Legislative/Normative Measures
PMccT3	P&Ms Cross-cutting - Fiscal Measures/Tariffs
PMccT4	P&Ms Cross-cutting - Financial Measures
PMccT5	P&Ms Cross-cutting - Co-operative Measures
PMccT6	P&Ms Cross-cutting - Market-based Instruments
PMccT7	P&Ms Cross-cutting - Non-classified Measure Types

Annex II. Final Energy Consumption: Selected EU Countries. [15]

Please note that for the graphs that follows:

ROAD includes fuels used in road vehicles, excludes military consumption as well as motor gasoline used in stationary engines and diesel oil for use in tractors
RAIL includes fuels used in rail traffic, including industrial railways. In the graphs related to rail transport, oil refers to fuel-oil
AVIATION includes international and domestic aviation fuels
INTERNAL NAVIGATION: includes domestic navigation includes fuels delivered to vessels of all flags not engaged in international navigation

[15] ROAD: Fuels used in road vehicles, excludes military consumption as well as motor gasoline used in stationary engines and diesel oil for use in tractors

RAIL: Quantities used in rail traffic, including industrial railways

AVIATION: International and domestic aviation fuels

INTERNAL NAVIGATION: Domestic navigation includes fuels delivered to vessels of all flags not engaged in international navigation

Figure A.1: France

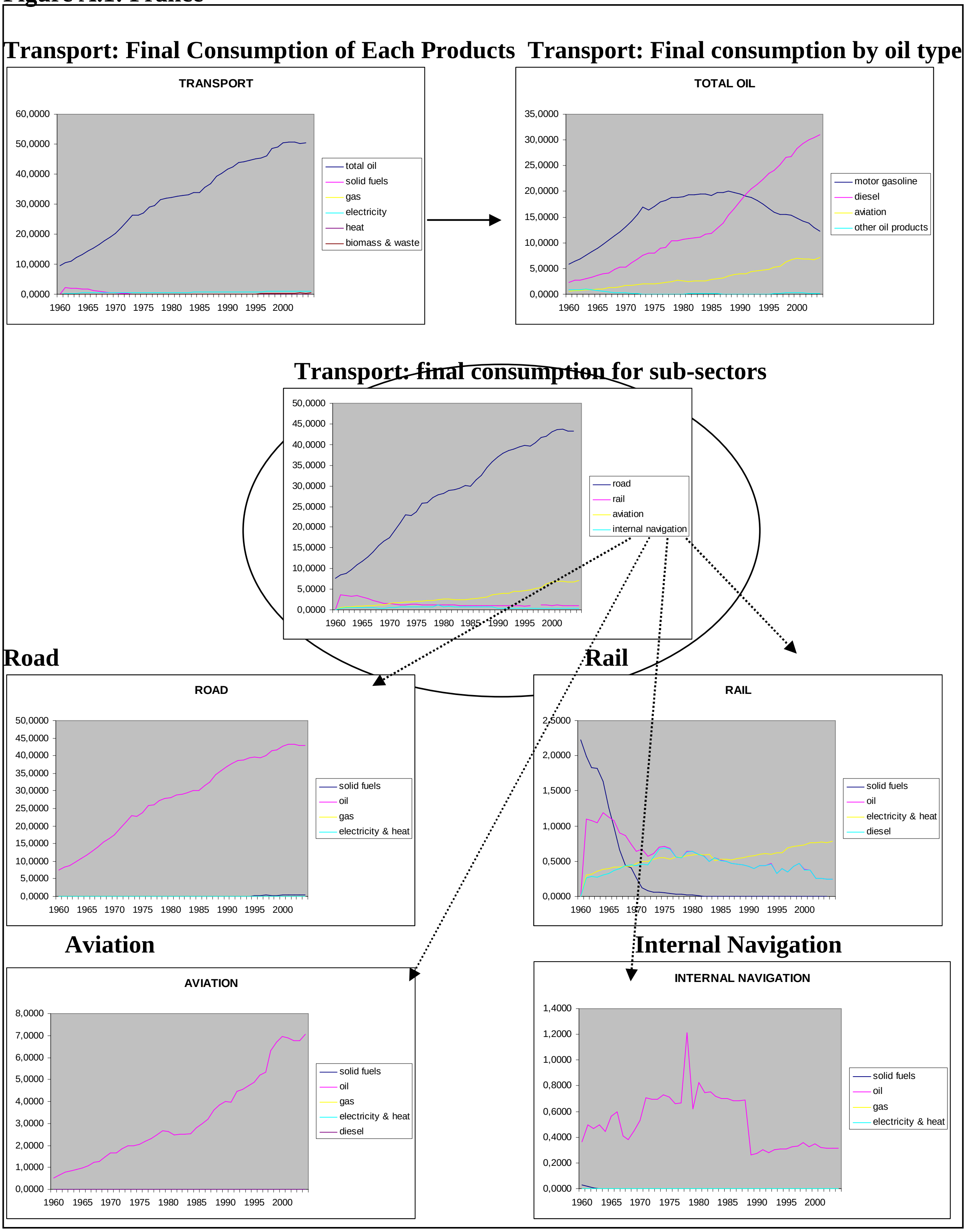


Figure A.2: Germany.

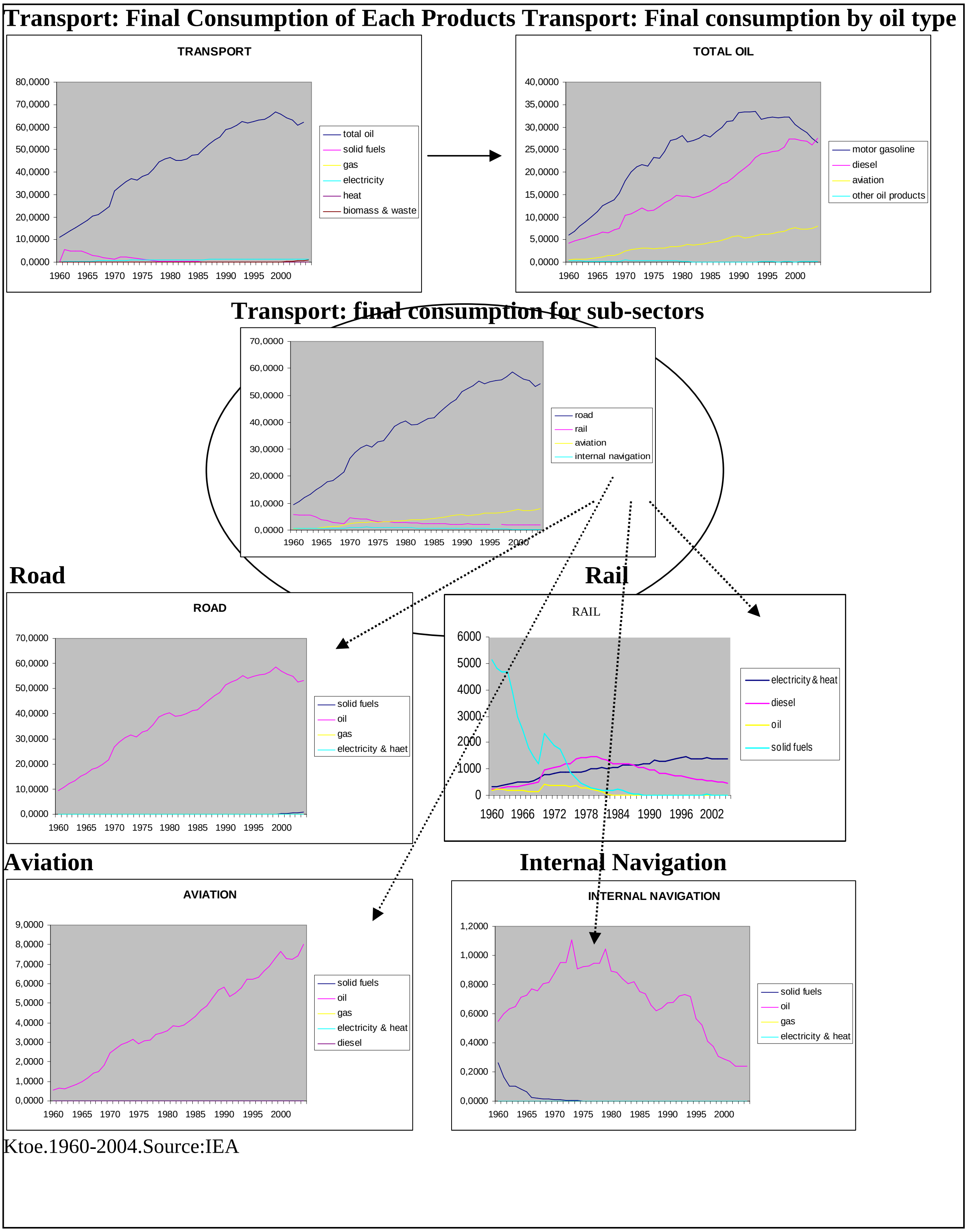
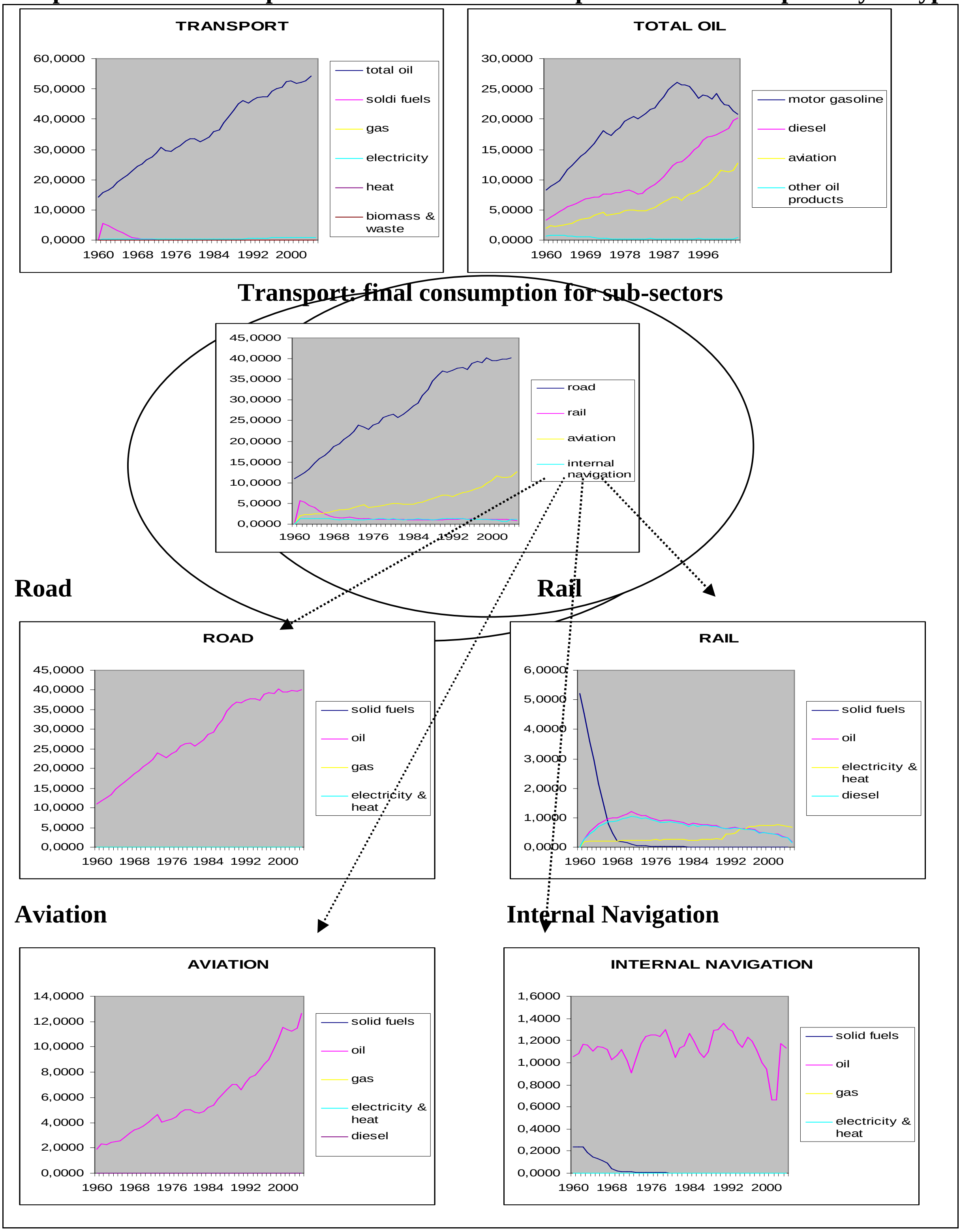


Figure A.3: United Kingdom.

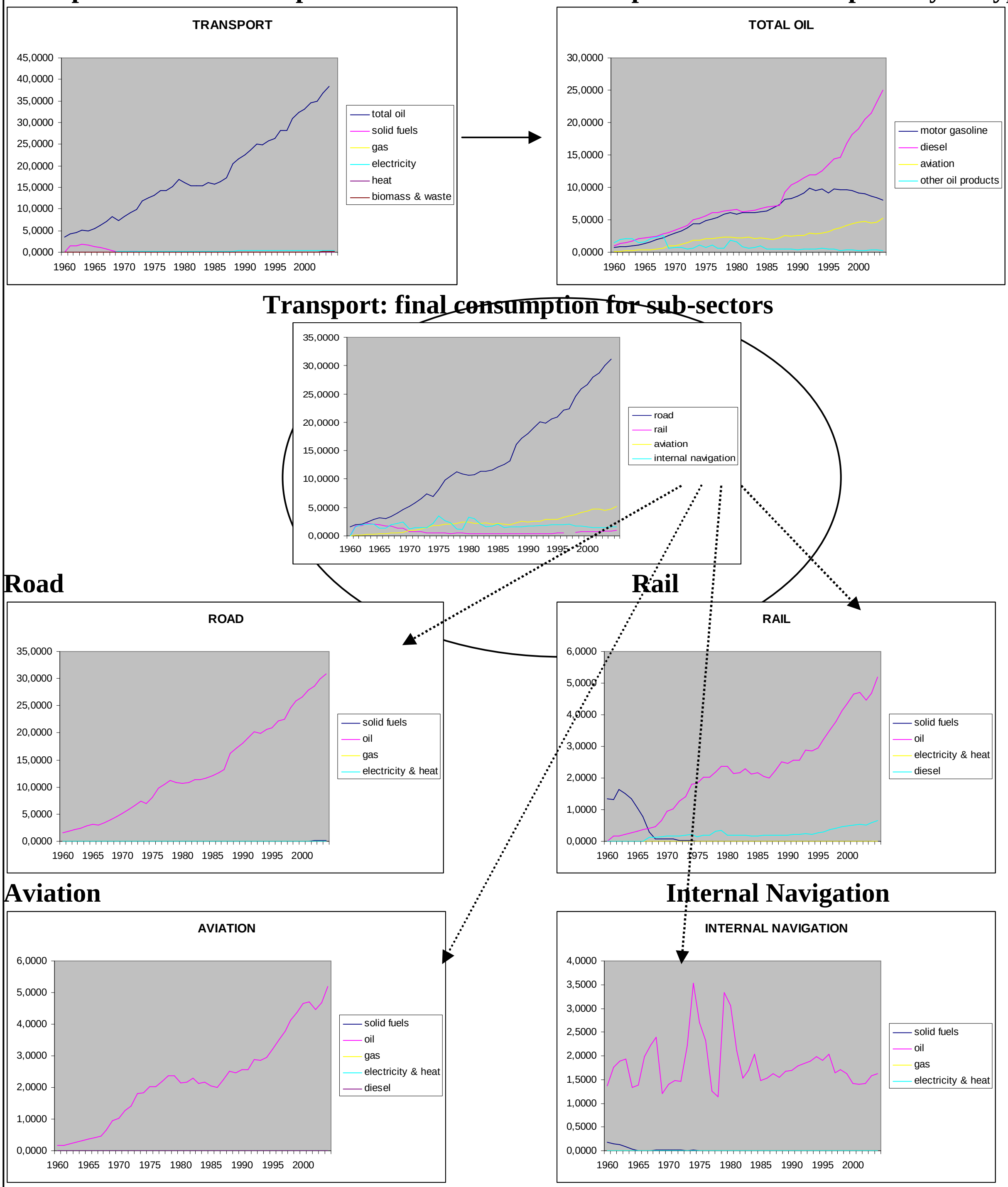
Transport: Final Consumption of Each Product Transport: Final consumption by oil type



Ktoe. 1960-2004. Source: IEA.

Figure A.4: Spain

Transport: Final Consumption of Each Products Transport: Final consumption by oil type



Ktoe. 1960-2004. Source: IEA.

Annex III – National Transport Policies in EU-15 + Norway[16]

Country	Name	Type	Target	Status	Year
Austria	Strategic Plan to Reduce Transport's CO_2 Emissions	•Policy Processes	•Transport	In force	1991
Belgium	Carpooling & Car Sharing - Wallonia, Flanders & Brussels-Capital	•Incentives/Subsidies •Voluntary Agreement	•Transport	In force	
Belgium	Incentives for the purchase of low emission vehicles	•Financial •Incentives/Subsidies	•Transport	In force	2007
Belgium	Supporting alternative mobility - the Bruxell'Air bonus	•Incentives/Subsidies	•Transport	In force	2006
Belgium	Tax reduction for purchase of low emission vehicles	•Financial	•Transport	Superseded	2005
Belgium	Vehicle consumption and CO_2 label	•Education and Outreach •Regulatory Instruments	•Transport	In force	2001
Belgium	"Entreprise Ecodynamique" (Ecodynamic Company) seal of approval	•Education and Outreach •Voluntary Agreement	•Buildings •Industry •Multi-sectoral Policy •Transport	In force	1999
Denmark	Agreement on Danish Energy Policy 2008-2011	•Financial •Incentives/Subsidies •Policy Processes •Public Investment •RD & D	•Multi-sectoral Policy •Transport	In force	2008
Denmark	Action Plan for Transport	•Policy Processes	•Transport	Superseded	2001
Denmark	Energy Labelling of New Cars	•Education and Outreach	•Transport	In force	2000
Denmark	Lower Purchase Tax on Very Energy Efficient Cars	•Financial	•Transport	Ended	2000
European-Union	EU Climate and Energy Package: CO_2 emission limits for cars	•Regulatory Instruments	•Transport	In force	2009

[16] Policies extracted from the "World Energy Outlook" – WEO Policy Database (International Energy Agency) http://www.iea.org/textbase/pm/?mode=weo

Country	Name	Type	Target	Status	Year
European-Union	Clean Sky Joint Technology Initiative	•RD & D	•Transport	In force	2008
European-Union	Marco Polo Programme - Intermodal Freight Transport	•Incentives/Subsidies	•Transport	In force	2003
European-Union	European Reference Centre for Intermodal Freight Transport (EURIFT)	•Policy Processes	•Transport	In force	2001
European-Union	White paper: European transport policy for 2010: time to decide	•Policy Processes	•Transport	In force	2001
Finland	Amendment of Car Tax and Annual Vehicle Tax Regimes	•Financial •Regulatory Instruments	•Transport	In force	2007
Finland	Sustainable community technology programme	•RD & D	•Buildings •Multi-sectoral Policy •Transport	In force	2007
Finland	Environmental Guidelines for the Transport Sector until 2010	•Policy Processes	•Transport	In force	2005
Finland	Energy Tax Overhaul	•Financial •Incentives/Subsidies	•Appliances •Buildings •Industry •Transport	Ended	2002
Finland	Travel Virtually! Multimedia Game to Promote Public Transport	•Education and Outreach	•Transport	In force	2002
Finland	Implementation of EU Directive on Fuel Economy and CO_2 Labels for Cars	•Education and Outreach •Regulatory Instruments	•Transport	In force	2001
Finland	Environmental Guidelines and Strategies for Transport Sector	•Education and Outreach •Policy Processes	•Transport	Superseded	1999
Finland	Voluntary Agreements in the Transport Sector	•Voluntary Agreement	•Transport	Superseded	1999
France	Plan for the energy performance of agricultural exploitations	•Education and Outreach •Incentives/Subsidies	•Buildings •Industry •Transport	In force	2009

Country	Name	Type	Target	Status	Year
France	PREDIT 4: Sustainable transport	•Policy Processes •Public Investment •RD & D	•Transport	In force	2009
France	New Energy Technologies Demonstration Fund	•RD & D	•Transport	In force	2008
France	Super bonus: Vehicle scrappage scheme	•Incentives/Subsidies	•Transport	In force	2008
France	Bonus-Malus: vehicle CO_2 bonus and penalty system	•Incentives/Subsidies	•Transport	In force	2007
France	Livret de Developpement Durable: Preferential loans for energy saving measures	•Incentives/Subsidies	•Appliances •Buildings •Transport	In force	2007
France	National Strategy for Research and Development in the field of Energy	•RD & D	•Buildings •Transport	In force	2007
France	Maritime Transport Initiative	•Policy Processes •Public Investment	•Transport	In force	2006
France	White Certificate Trading	•Tradable Permits	•Appliances •Buildings •Industry •Transport	In force	2006
Germany	Old vehicle scrappage scheme	•Incentives/Subsidies	•Transport	In force	2009
Germany	Climate Legislation Package Enacted under the Integrated Climate Change and Energy Programme	•Policy Processes	•Buildings •Multi-sectoral Policy •Transport	In force	2008
Germany	Clean Truck Procurement Subsidies	•Incentives/Subsidies	•Transport	In force	2007
Germany	Mandatory Fuel Efficiency Labelling for Passenger Cars	•Education and Outreach •Regulatory Instruments	•Transport	In force	2004
Germany	Urban and Regional Planning	•Regulatory Instruments	•Transport	In force	2004
Germany	Investing in the Future Programme (Zukunfts - Investitions-Programm, ZIP)	•Incentives/Subsidies •RD & D	•Buildings •Transport	Ended	2001

Country	Name	Type	Target	Status	Year
Germany	Transport Initiatives	•Policy Processes	•Transport	In force	2001
Germany	Vehicle Taxation	•Financial	•Transport	Ended	1997
Greece	New Subway System	•Public Investment	•Transport	Superseded	1999
Ireland	Use of Motor Taxation to encourage more efficient vehicles	•Financial •Tradable Permits	•Transport	In force	2008
Ireland	One Small Step	•Education and Outreach	•Transport	In force	2007
Ireland	Energy Awareness Week	•Education and Outreach	•Appliances •Buildings •Transport	Ended	2000
Ireland	A Platform for Change	•Policy Processes	•Transport	In force	2000
Italy	Cleaner vehicle purchase incentives	•Financial •Incentives/Subsidies	•Transport	In force	2009
Italy	Industry 2015: Industrial Innovation Projects	•RD & D	•Industry •Transport	In force	2008
Italy	Regional Measures for Energy Efficiency: Lombardia	•Education and Outreach •Regulatory Instruments	•Buildings •Multi-sectoral Policy •Transport	In force	2006 (amended 2007, 2008)
Italy	Development of Transport Infrastructure	•Public Investment •Policy Processes	•Transport	In force	2002
Italy	Car Sharing	•Education and Outreach •Financial •Incentives/Subsidies •Policy Processes	•Transport	In force	2001
Italy	National Transportation Plan	•Policy Processes	•Transport	In force	2000
Italy	Sustainable Mobility	•Incentives/Subsidies	•Transport	In force	2000
Italy	Energy Efficiency Co-financing	•Incentives/Subsidies	•Transport •Industry •Appliances	In force	1999
Italy	Experimental Car Sharing	•Public Investment •RD & D	•Transport	Superseded	1999

Country	Name	Type	Target	Status	Year
Italy	New Buses	•Public Investment •Financial	•Transport	Planned	1999
Italy	Voluntary Climate Pact	•Voluntary Agreement	•Transport •Industry	In force	1999
Italy	Vehicle Certification	•Regulatory Instruments	•Transport	In force	1998
Italy	Incentives for Renewal of Car Fleet	•Incentives/Subsidies	•Transport	Ended	1996
Luxembourg	CO_2 Reduction Action Plan	•Policy Processes	•Buildings •Transport	In force	2006
Luxembourg	Energy Tax	•Financial	•Buildings •Multi-sectoral Policy •Transport	In force	1999
Netherlands	Environmental Tax on Flights from Netherlands	•Financial	•Transport	In force	2008
Netherlands	Kilometre Pricing System for Road Usage	•Financial	•Transport	Planned	2007
Netherlands	EcoDriving (Het Nieuwe Rijden)	•Education and Outreach •Financial •Incentives/Subsidies •RD & D •Regulatory Instruments	•Appliances •Buildings •Industry •Transport	In force	2006
Netherlands	Implementation of EU Energy Performance of Buildings Directive (EPBD): Energy Performance Certificate and Energy Labeling	•Education and Outreach •Regulatory Instruments	•Appliances •Buildings •Framework Policy •Industry •Transport	In force	2006
Netherlands	Labelling of Vehicle Efficiency (Energielable voor autos)	•Education and Outreach	•Appliances •Buildings •Industry •Transport	In force	2006
Netherlands	Market Penetration Strategy for Energy Efficient Appliances	•Education and Outreach •Financial •Incentives/Subsidies	•Appliances •Buildings •Industry •Transport	Superseded	2006
Netherlands	Tax Benefits for Energy-Efficient Cars (Belasting van personenauto's en	•Education and Outreach •Financial	•Appliances •Buildings •Industry	In force	2006

Country	Name	Type	Target	Status	Year
	motorrijwielen - BPM)		•Transport		
Netherlands	Tax Reduction for Investments in Energy Saving Equipment and Sustainable Energy (Energie-investeringsaftrek)	•Financial •Incentives/Subsidies	•Industry •Transport	In force	2006
Netherlands	Energy Labels on Passenger Cars	•Education and Outreach •Regulatory Instruments	•Appliances •Buildings •Industry •Transport	In force	2001
Netherlands	Energy Savings in Greenhouse Horticulture (GLAMI)	•Regulatory Instruments •Voluntary Agreement	•Appliances •Buildings •Industry •Transport	In force	2001
Netherlands	Tax for Commuters	•Financial	•Transport	In force	2001
Netherlands	Technical Vehicle Upgrades for Fuel Efficiency	•Education and Outreach •Voluntary Agreement	•Transport	In force	2000
Netherlands	Transport Avoidance Project	•Education and Outreach •Financial •Incentives/Subsidies	•Appliances •Buildings •Industry •Transport	In force	2000
Norway	Automobile Fuel Economy Information	•Education and Outreach •Policy Processes	•Transport	In force	
Norway	Commission on Low Emissions - Final Strategic Report Published	•Education and Outreach •Incentives/Subsidies •Policy Processes •Public Investment •Regulatory Instruments	•Buildings •Industry •Transport	In force	2006
Norway	Fossil Fuel Tax Increases	•Financial	•Appliances •Buildings •Industry •Transport	In force	2000
Norway	Passenger Vehicle Purchase Tax	•Regulatory Instruments •Financial	•Transport	In force	1996
Portugal	State vehicle park procurement rules: Fleet renewal and CO_2 emission limits	•Public Investment	•Transport	In force	2009
Portugal	National Energy Efficiency	•Education and Outreach	•Appliances	In force	2008

Country	Name	Type	Target	Status	Year
	Action Plan: Portugal Efficiency 2015	•Financial •Incentives/Subsidies •Policy Processes •Public Investment •Voluntary Agreement	•Buildings •Industry •Transport		
Portugal	Management Regulation of Energy Consumption in Transport (RGCEST)	•Regulatory Instruments	•Transport	In force	1991
Spain	Automotive Sector Competitiveness Plan	•Incentives/Subsidies	•Industry •Transport	In force	2009
Spain	Energy Saving and Efficiency Plan 2008-11	•Education and Outreach •Incentives/Subsidies •Policy Processes •Public Investment •RD & D •Regulatory Instruments	•Appliances •Buildings •Transport	In force	2008
Spain	Supplementary Measures Energy Efficiency Action Plan E4+ 2008-2012	•Policy Processes	•Multi-sectoral Policy •Transport	Planned	2008
Spain	VIVE Plan (Innovative Vehicle - Ecological Vehicle)	•Incentives/Subsidies	•Transport	In force	2008
Spain	Maritime Transport Initiative	•Policy Processes •Public Investment	•Transport	In force	2006
Sweden	Eco Car Subsidy	•Incentives/Subsidies	•Transport	In force	2007
Sweden	Funding to Develop Sustainable Cars	•Public Investment •RD & D •Voluntary Agreement	•Transport	Ended	2000
United-Kingdom	Vehicle Excise Duty (VED): fuel type and CO_2 emission vehicle bands	•Financial •Regulatory Instruments	•Transport	In force	2009
United-Kingdom	Low Carbon Transport Innovation Strategy	•Public Investment •RD & D •Tradable Permits	•Framework Policy •Transport	In force	2007
United-Kingdom	Technology Strategy Board	•RD & D	•Buildings •Transport	In force	2007
United-Kingdom	Energy Review	•Policy Processes	•Appliances •Buildings •Industry	Superseded	2006

Country	Name	Type	Target	Status	Year
			•Transport		
United-Kingdom	National Action Plan on Sustainable Procurement: "Procuring the Future"	•Public Investment •Policy Processes	•Buildings •Transport	In force	2006
United-Kingdom	Research Councils Energy Programme (RCEP)	•RD & D	•Industry •Multi-sectoral Policy •Transport	In force	2004
United-Kingdom	Company Car Tax Reform	•Financial	•Transport	In force	2002
United-Kingdom	Vehicle Excise Duty (VED)	•Financial	•Transport	Superseded	2001 (updated 2002, 2006, 2008)
United-Kingdom	10 Year Transport Plan	•Policy Processes	•Transport	Superseded	2000
United-Kingdom	White Paper: A New Deal for Transport	•Education and Outreach •Financial •Policy Processes	•Transport	Superseded	1998