ENERGY AND ENVIRONMENTAL ASPECTS OF THE TRANSPORT POLICY

SIET

Sassari – June 2008

Abstract:

The aim of this paper is to identify economic and politically feasible measures able to significantly enhance energy efficiency and to reduce negative impacts of transport activities.

The paper is based on an in depth literature review on recent statistics, studies, notes etc. focusing on the analysis of the different impacts as well as the consequences of the emissions caused by different modes of transport and the suggested recommendations on how tackle the related problems. The literature review allowed to identify the most promising and cost efficient short, medium and long term measures with particular attention to the energy and new technology developments.

This paper is based on a study requested by the European Parliament's Committee on Transport and Tourism. Directorate General Internal Policies of the Union - Policy Department Structural and Cohesion Policies - TRANSPORT AND TOURISM

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The complete study is available at Intranet:
http://www.ipolnet.ep.parl.union.eu/ipolnet/cms/lang/en/pid/456

Brussels, European Parliament, 2007.

The text is arranged in the following steps:

- outline of the development of freight and passenger demand in the recent years. Trends are derived EUROSTAT, UITP and by the latest policy document of DG TREN, “Keep Europe Moving”, based on the mid-term assessment of the 2001 White Paper;

- provision of the energy consumption figures by sector and fuel and makes reference to the EUROSTAT database (while energy consumption projections are the output of the PRIMES model in the “European Energy and transport – trends to 2030” report). In the same section, greenhouse gas emissions are derived from the national GHG inventories sent by EU countries to the United Nations Framework Convention on Climate Change (UNFCCC) Secretariat. Historic transport emissions of air pollutants, such as acidifying substances, ozone precursor and particulate matters, made reference to the EEA TERM reports and factsheets and to the EMEP emission database implemented under the UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP);

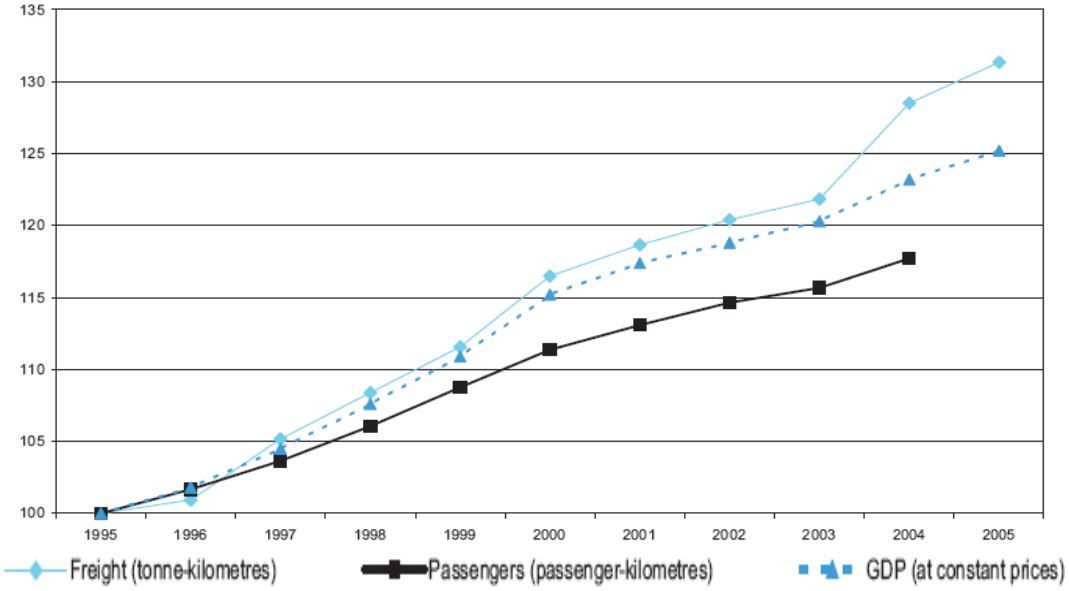
- overview of the different measures grouped into policy. Key reference documents for this chapter are: Banister et al, 2006, IPCC, 2007, OECD 2007, The Bartlett School of Planning and Halcrow Group 2006, JEGTE 2006; COM (2007) 19 final, (2007), ASSESS Final Report 2005, Litman 2007. Policy cluster and measure are analysed from different perspectives: the expected type and the relevance of the impacts on GHG reduction and air quality improvement; the time horizon for the policy implementation; the reference area where the policy applies and the concerned institutional level (either local, national or European);

- policy recommendations at the end of the paper, put the emphasis on the need to implement consistent mix of measures, where synergies might be gained and side effects might be dampened.

Development of passenger and freight transport demand

The transport sector plays a central role in the European economy and accounts a continuous growth in terms of tonne and passenger kilometres. While goods transport grew on average by 2.8% per year between 1995 and 2005 in the EU-25, - thereby surpassing average growth in GDP (at constant prices) of 2.3% - passenger transport increased by a slower rate of 1.8% (based on data covering the 1995-2004 period)[1]. Overall, against a 25% increase in GDP between 1995 and 2005, goods transport grew by 31%. Passenger transport went up by 18% between 1995 and 2004, against an increase in GDP of 23% over the same period (Figure 1).

Figure 1 Evolution of freight and passenger transport compared with growth in GDP, 1995-2004/5 (1995=100)



Source: DG Energy and Transport, reported in Eurostat, *Panorama of transport* (2007).

The share of road transport accounts for about 84% of passenger transport performed in 2004 where passenger cars, powered two-wheelers (P2W), buses and coaches are taken together. In freight although road transport accounts for the single largest share (44%) in 2005, sea transport is not far behind with a share of 39%. The shares carried by rail are 6% for passenger transport and 10% for freight transport, the results of around 9% growth on 1995 figures. With reference to rail freight, the largest increases are generally recorded in those Member States that opened up their rail market early.

Air transport is clearly more important for passenger transport (with an 8% share), in which it also recorded the fastest growth of all transport modes (49%). By contrast, sea transport is clearly more important for freight, registering the second fastest growth (35%) after road and the only decline in passenger transport (-11%), a trend reflecting the shift from ferry transport to other transport modes. Although freight performance over inland waterways only increased by 10% in the EU-25, growths are much larger in certain Member States (50% in Belgium and 30% in France).

[1] Rates refer to tonnes km and passengers km

It is interesting to notice the relevance of urban and short distance transport in general: European citizens makes 1,000 trips (per year and per capita) on average and half of these are less than 5 km long. About 75% of kilometres travelled in EU conurbations are made using cars and, on a daily basis, 60% of all kilometres travelled by car are made for trips within 30 km and 37% are made for covering distances within 10 km (CEI-CIVES based on RWE Energie).

In the meantime, passengers on regional and commuter railway trips represent by far the biggest share of all rail trips in Europe: they account for about 90% out of the total number of rail passengers (including long distance trips) and 50% of the total number of passenger kilometres per year, with an aggregated average distance travelled of about 27.9km, as shown by the study on the "European Suburban and Regional Railway Landscape", (ERRAC, 2006), carried out by UITP (the International Association of Public Transport).

Table 1 Passenger transport performance in EU-25, by mode of transport, 1995-2004 (in billion passenger kilometres)

	Passenger cars	**P2W**	**Bus & Coach**	**Railways**	**Tram & Metro**	**Air***	**Sea***	**Total**
2004	4458	143	502	352	75	482	49	**6061**
2000	4196	132	492	353	71	440	49	**5734**
1995	3787	120	474	324	65	324	55	**5149**
% change 95/2004	*17.7%*	*19.7%*	*5.8%*	*8.6%*	*16.4%*	*48.8%*	*-11.1%*	***17.7%***
% annual change	*1.8%*	*2.0%*	*0.6%*	*0.9%*	*1.7%*	*4.5%*	*-1.3%*	***1.8%***

Source: DG Energy and Transport, reported in Eurostat, *Panorama of transport* (2007).
* Air and Sea: only domestic and intra-EU traffic, data under revision.

Table 2 Freight transport performance in EU-25, by mode of transport, 1995-2005 (in billion tonne-kilometres)

	Road*	**Rail**	**Inland waterways**	**Oil pipelines**	**Sea***	**Air***	**Total**
2005	1724	392	129	131	1525	2	**3903**
2000	1487	374	130	124	1345	2	**3462**
1995	1250	358	117	112	1133	2	**2972**
% change 95/2005	*37.9%*	*9.2%*	*10.2%*	*17.5%*	*34.6%*	*31.1%*	***31.3%***
% annual change	*3.3%*	*0.9%*	*1.0%*	*1.6%*	*3.0%*	*2.7%*	***2.8%***

Source: DG Energy and Transport, reported in Eurostat, *Panorama of transport* (2007).
* Road: national and international haulage by vehicles registered in EU-25. Air and Sea: data only include intra-EU traffic and are estimates by the Commission services based on port-to-port data collected under Council Directive 95/64/EC and on airport-to-airport data collected under Regulation (EC) 437/2003.

Quantification of energy consumption and pollutant emissions

Energy consumption

About one third of the final energy consumption in the EU-25 is related to transport (excluding maritime transport and pipelines) reaching 352 million tonnes of oil equivalent (Mtoe) in 2004. Road transport is by far the dominating sector, consuming nearly 83% of the energy used for transport purposes.

As indicated by Eurostat data, the transport sector exhibited the highest energy demand growth between 1990 and 2004 (2.0% annually). Improvements in fuel efficiency were offset by increases in passenger and freight transport demand. Following the strong decline of energy needs in industry in the same decade, partly due to the migration of many manufacturing activities in non-EU countries, the transport sector (excluding marine bunkers) became by 2004 the largest demand side sector accounting for 30.7% of final energy demand compared to 26.7% in 1990.

Table 3 Evolution of final energy consumptions in transport, by transport mode, various years, EU-25, in Mtoe and %

	1990	**1995**	**2000**	**2004**	**1990-2004 % change**
Transport	**272**	**295**	**334**	**352**	**29**
Rail	9.1	8.8	9.2	9.3	
% share	*3.4%*	*3.0%*	*2.8%*	*2.6%*	1
Road	228.0	245.5	274.0	290.0	
% share	*83.8%*	*83.3%*	*82.1%*	*82.5%*	27
Air	28.4	33.7	45.3	47.4	
% share	*10.4%*	*11.4%*	*13.6%*	*13.5%*	67
Inland and Coastal Shipping	6.6	6.7	5.4	5.0	
% share	*2.4%*	*2.3%*	*1.6%*	*1.4%*	-23

Source: Eurostat, *Panorama of Transport*, 2007.

Since many years the final energy consumption by transport is growing and current forecasts do not show a break in this trend. The transport market today is almost entirely dependent upon oil-based fuels and is responsible for about 70% of the final demand for oil and oil products in the EU-25 (Eurostat database). The fuel mix is slightly changed in terms of importance of renewable energy sources (RES): looking at 2005 figures, almost 1% of the final energy consumption in transport is shifted from oil-based fuels (97%) to biofuels, with electricity energy having a stable 2%.

Comparing the 1990 and 2005 shares of final energy consumption of oil-based fuels, it can be observed the rapid growth of air transport, which accounted respectively for 11% and 14%, the dominant role of road transport, which absorbed 85% in 1990 and 83% in 2005 of the total consumption and marginal demand of rail transport and inland navigation which accounted respectively 1% and 2% in both periods.

Table 4 Evolution of final energy consumptions in transport, by type of fuel, various years, EU-25, in Mtoe

	1990	1995	2000	2004	2005*
Crude Oil and Petroleum Products	267.3	288.8	327.0	343.1	345.0
Gas (road)	0.2	0.3	0.4	0.5	0.5
Electricity (rail)	5.1	5.5	5.9	6.1	6.2
Renewables – Biofuels (road)	*0.002*	0.2	0.6	2.0	3.2
Solid fuels (rail)	0.1	*0.01*	*0.01*	*0.004*	*0.005*
Total	**272.7**	**294.8**	**333.9**	**351.7**	**354.9**

Source: Eurostat database (* Provisional values).

According to DG TREN estimates (European Energy and Transport, trends to 2030, update 2005), the predominant role of the transport sector in final energy demand growth for the EU-25 is projected to continue under baseline assumptions in the horizon to 2010 (1.4% annually). However, beyond that period the combined effect of decoupling of transport activity from economic growth (especially in passenger transport in EU-15) and technological progress will lead to a deceleration of transport demand growth in 2010-2020 (0.6% pa) and even a decline of transport demand energy needs in 2020-2030 (-0.1% pa). Thanks to these two factors transport in the EU is expected to account for 30% of final energy demand in 2030, still remaining the largest demand side sector.

In its UE Action Plan for energy efficiency (COM 2006.545 final), the Commission estimated the energy saving potential in transport sector to be up to 26% by 2020. The target of the Action Plan is set to achieve at least 20% of cost-effective energy saving potential by 2020.

Table 5 Forecast of energy demand in transport in EU-25 in Mtoe

	2005	2010	2015	2020	2025	2030
Public road transport	7.0	7.0	6.7	6.3	5.8	5.3
Private cars and motorcycles	169.3	170.2	164.5	168.9	166.5	159.9
Trucks	119.8	135.6	148.4	156.8	162.4	164.4
Rail Transport	8.9	8.3	7.2	6.5	6.2	6.0
Aviation	50.0	54.2	57.5	60.8	58.9	60.3
Inland Waterways	5.6	5.8	6.0	6.2	6.3	6.4
Transport sector	**360.6**	**381.1**	**390.3**	**405.5**	**406.1**	**402.3**

Source: European Energy and transport: trends to 2030 - update 2005 - PRIMES baseline scenario

Greenhouse Gas (GHG) Emissions

The most comprehensive public source for assessing greenhouse gas emission trends and reduction commitments in Europe is the EC GHG inventory (years 1990-2005), compiled on the basis of the national inventories by the EEA and the European Topic Centre on Air and Climate Change (ETC/ACC). Greenhouse gas emissions (see annex to chapter 2) within the territory of the EU, also referred to *domestic* emissions, are submitted annually to the UNFCCC Secretariat and used to track progress within the Kyoto Protocol[2] but also to implement the mechanism for

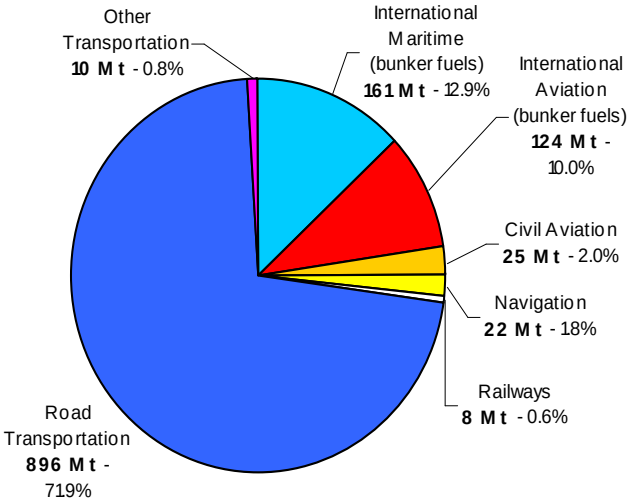
2 Only the old EU-15 countries share a common target under the Kyoto Protocol and only 10 of the 12 new Member States have an individual Kyoto target (Cyprus and Malta do not).

monitoring Community greenhouse gas emissions[3]. Emissions from international aviation and maritime transport, so called *bunker fuels*, are not included in the national totals but are reported as memo items and available since 1990.

In 2005, total *domestic* GHG emissions (CO_2, CH_4, N_2O) in the EU-27, excluding LULUCF[4], were 5,180 million tonnes (Mt) or teragrams (Tg) of CO_2-equivalents. Part of the largest emitting source Energy (80% of total *domestic* GHG emissions), the category "transport" accounted in the same year for 961 Mt of CO_2-equivalents (18,6% of the *domestic* total). This category includes road transportation, railways, domestic navigation, domestic civil aviation and other transportation. The memo items international aviation and maritime transport accounted for additional 285 Mt of CO_2-equivalents in 2005.

The contribution of each single transport-related category to the sector's grand total (emissions from *domestic* transport and *bunker fuels)* is showed in Figure 2.

Figure 2 Transport categories contribution (in Mt of CO_2-equivalents and %) to total GHG emissions from transport in 2005.



Source: based on data from EC GHG inventory 1990-2005.

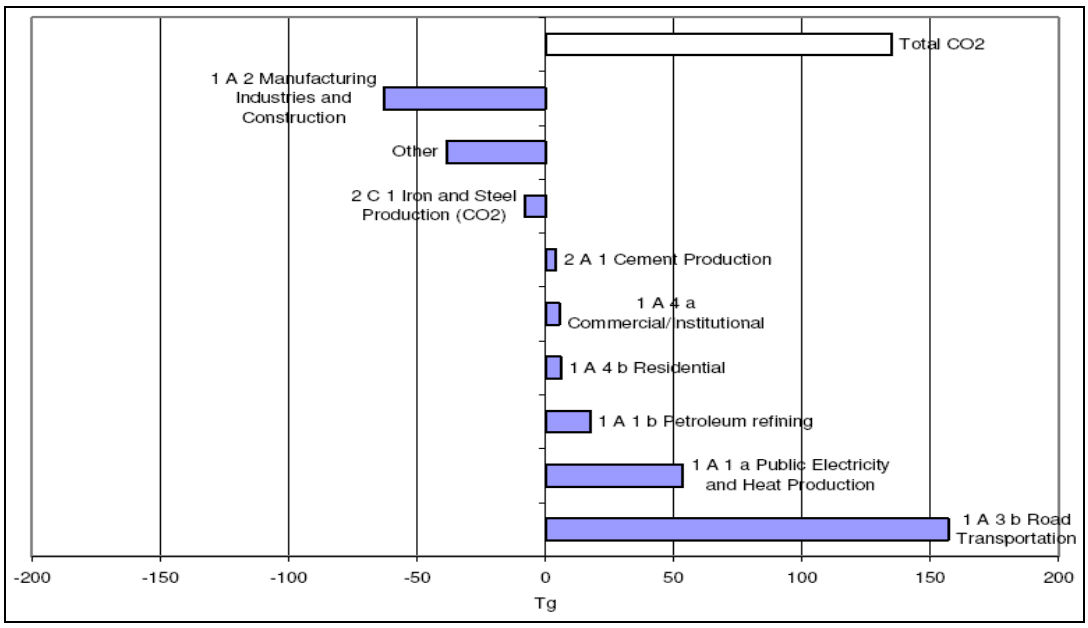
The most important greenhouse gas by far is carbon dioxide, accounting for 83% of total EU-27 emissions in 2005 (including *bunker fuels*). In 2005, *domestic* EU-27 CO_2 emissions (4,269 Mt) were 3.5% below 1990 levels. At EU-15 level, the same aggregate accounted for 3,482 Mt, which was, on the contrary, 3.7% above 1990 levels. The source category of *domestic* transport contributes 20% by CO_2 emissions, 0.1% by CH_4 and 0.5% by N_2O to the EU-15 national totals of GHG emissions. Between 1990 and 2005, emissions from transport increased by 26% in the old 15 Member States reaching 880 Mt.

Analysing the trend of EU-15 key sources (Figure 3), it can be realised that the main reason for increases in CO_2 emissions between 1990 and 2005 was the growing road transport demand (with reflections also on N_2O emissions).

3 Council Decisions No 1999/296/EC and 280/2004/EC.

4 Land Use, Land-Use Change and Forestry activities can remove greenhouse gases from the atmosphere (e.g. by planting trees or managing forests) or reduce emissions (e.g. by curbing deforestation).

Figure 3 Absolute changes of CO_2 emissions by large key source categories 1990 to 2005 in CO_2 equivalents (Tg) for EU-15.



Source: Annual European Community greenhouse gas inventory 1990-2005 and inventory report 2007.

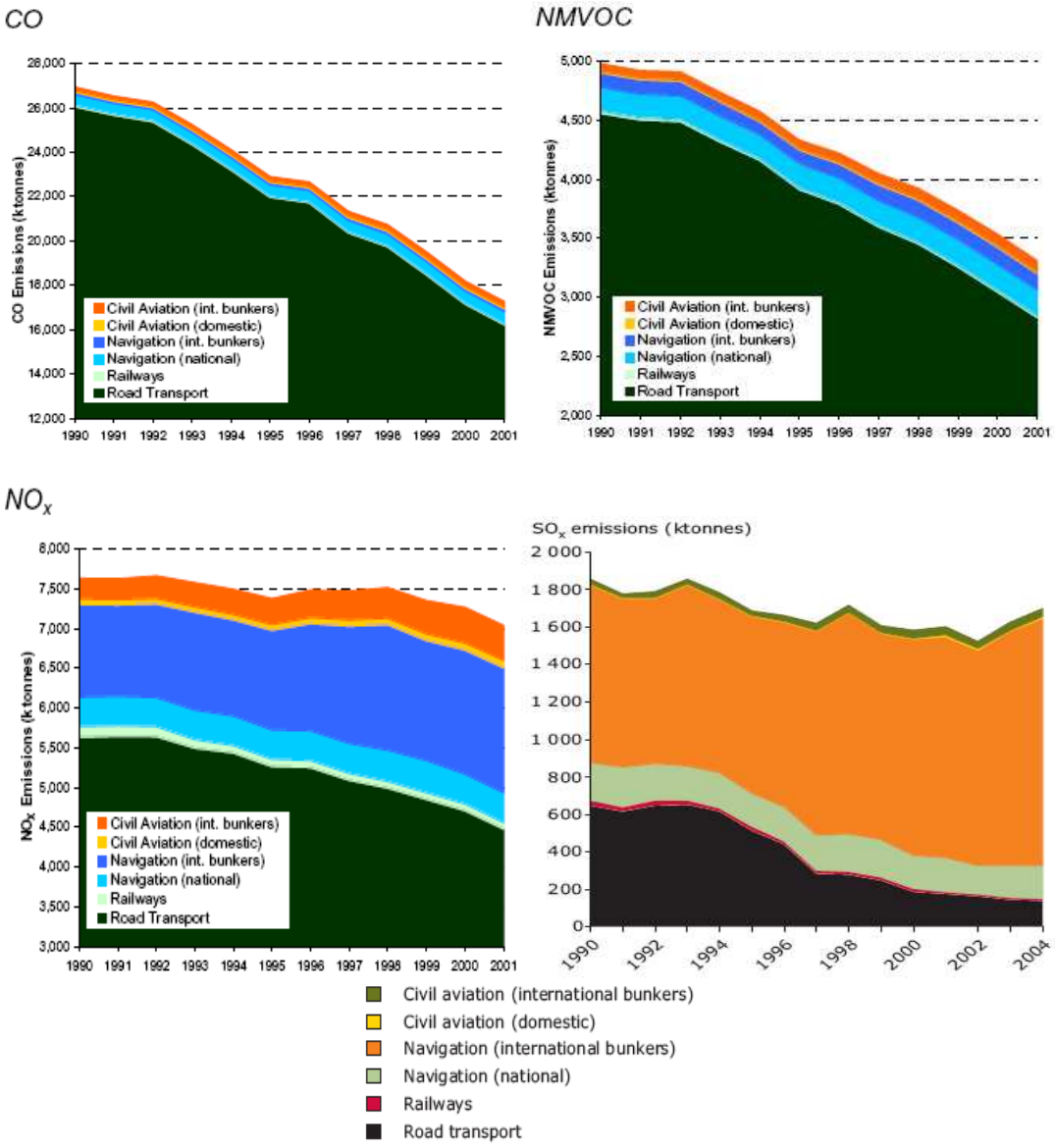
Air Pollutants Emissions

Emissions of harmful substances from land transport have decreased significantly between 1990 and 2004 in EEA[5] member countries: particulate matter (PM_{10}) by 29%, acidifying substances (NO_X and NMVOCs) by 32% and ozone precursors (NO_2, SO_X, and NH_3) by 41%. This is mainly due to innovations in exhaust gas treatment in road vehicles (induced by the introduction of EU standards) and improved fuel quality (especially reduced sulphur concentration).

Carbon monoxide (CO) and non-methane volatile organic compound (NMVOC) emissions are dominated by road vehicles and showed a significant decrease together with rail transport (emission reductions from diesel powered stock and increased electrification of EU railways). Whilst emissions of nitrogen oxides (NO_X) and sulphur dioxides (SO_X) from road transport decreased respectively by 37% and 84% in EU-27 between 1990 and 2004, emissions from maritime and air transport represent now the most important contributors to the sector as a whole. SO_X emissions have shifted from land to sea rather than actually decreased.

[5] The EEA members are the EU-27 plus Turkey, Norway, Iceland and Liechtenstein.

Figure4 Emission trends of major air pollutants in EEA member states by type of transport

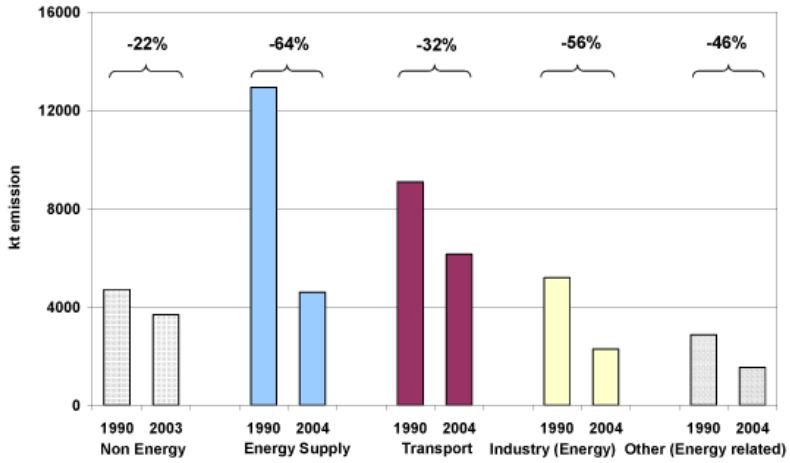


Source: TERM 03 EEA-31 indicator factsheet (2003) and TERM 2006 (2007), European Environment Agency.

Maritime transport is the major emitter of SO_X in transport. Its contribution has increased from 50% in the early nineties to 78% in 2004. Despite a sulphur limit for marine fuel of 1.5% in Sulphur Emission Control Areas (SECA – the Baltic, North Sea and English Channel) and the average sulphur content at 2.7%, the general limit under the IMO Marpol convention Annex VI (entered into force in May 2005) is only 4.5%. The Annex VI also contains a limit for NO_X emissions of marine engines and most manufacturers have been building engines compliant with this standard since 2000. EU strategy seeks to extend the SECA concept also to other European Seas and to press for tighter NO_X standards. 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.

Emissions of particulate matter from the transport sector decreased by 32% between 1990 and 2004 in the EU-25, even though not at the same rates of the other sectors. The reduction was largely a result of the continued penetration of catalytic converters and of the improvements to vehicle technology, reducing the emissions of secondary particulate precursors.

Figure 5 Total and sectorial non-energy and energy-related emissions of primary and secondary PM_{10} particulate matter emissions, EU-25 (weighted using particle formation factors)

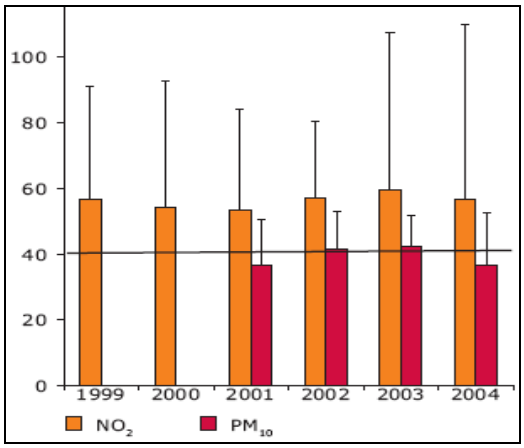


Source: EEA/ETC-ACC 2006.

In the European Union, the most part of the population lives in urban areas. About 60% of the European population lives in cities of over 10,000 inhabitants (EC GREEN PAPER, 2007 – source Eurostat) and over 70% lives in inner cities or inner suburban districts (World Bank, see the annex to chapter 1).

Data from selected measuring stations in urban agglomerations close to major traffic arteries indicate that the concentrations of NO_2 (2010 limit) and PM_{10} (2005 limit) are at or above the European air quality limits at these sites (EEA TERM 2006). Air quality is affected by a combination of emission and meteorological factors. However, two elements may help to explain why the improvement still fails to appear: the increased use of diesel in urban areas and an increase of the fraction of NO_X emitted as NO_2 since 2000. Oxidation catalysts and regenerative traps in modern diesel engine have been found to cause the increase (AQEG, 2006).

Figure 62 Average annual concentrations of NO_2 and PM_{10} in urban areas ($\mu g/m^3$)



Source: EEA TERM 2006.
Note: the error bars represent maximum value. The dotted line represents the yearly limit value set for PM10 (2005) and NO2 (2010).

Impacts, Scale and Timing of the Policy Measures and Packages

Overview of policy cluster

In order to analyse their impacts, suitability and effectiveness the measures suggested by the literature review and promoted by the policy documents have been selected and grouped into homogeneous policy clusters, as illustrated in Table 6.

Table 6 Policy clusters and measures

Policy clusters	Measures	Descriptions
Technological improvement (vehicles and fuels)	Reduction of CO_2 emissions and fuel consumption	Compulsory targets for CO_2 emissions of cars (120g/km) and vans (175 g/km) by 2012, also through Emission Trading Schemes for car manufacturers
	Increase efficiency in automotive sector	Reduction of vehicle weight and resistance factors; efficiency requirements automobile air conditioning system
	Labelling scheme for tyres	Standards to measure tyre rolling resistance 2008
	Labelling scheme of car fuels	New CO_2 labelling scheme for amended car fuels efficiency directive (1999/94EC)
	R&D on efficient vehicles	Support of project to develop more efficient vehicles
	Improved fuels	Development of the second generation of biofuels and alternative fuels able to reduce CO_2 and air pollution emissions
Pricing and taxation	Road vehicles taxation reform	Passenger cars taxes linked to CO_2 emission levels
		Fiscal incentives to encourage the cleanest LDV classes
		Inclusion of land transport in CO_2 emissions trading
	Pricing Interurban Roads	Application of "Eurovignette" Directive (1999/62) and its amended version (Directive 2006/38/EC)
		Attention to congested corridor and sensible areas (i.e. Alpine region)
		Internalisation of external costs of transport
	Road pricing in urban areas	Congestion pricing, value pricing, road tolls and HOV lanes
	Tradable mobility credits	Tradable permit schemes among car drivers in urban areas
Long distance travel (passengers and freight)	Rail interoperability	Improving the seamless movement of trains across Europe, both on High Speed and conventional rail networks
	Harmonised regulation systems	Provide fair competition of rail operators across EU
	Rail efficiency	Increase technical unit efficiency of rail
	Rail passenger services quality	Stimulating rail usage by increasing the quality (rolling stock, ICT, ticketing, etc.)
	Intermodal facility for passengers	Develop service integration by mode (train, air, maritime, road) and trip (long/short distance)
	Intermodal facility for freight	Intermodal loading units and freight integrators. Freight facility incentives to offset the capital costs of providing rail freight handling and operating facilities
	Rail capacity	Improve rail capacity by using advantage technology in key corridors (metropolitan areas) and rail bottlenecks

Policy clusters	Measures	Descriptions
Liveable cities	Improve public transport services	Systems providing high quality PT service and convenient Light Rail Transit on urban corridors
	Regulation incentive effectiveness	Policy changes to encourage transport service competition, innovation and efficiency
	Park&Ride facilities and access to PT	Providing convenient parking at transit and rideshare stations
	Walking and cycle facilities	Strategies for improving bicycle transport and walking conditions
	Trasport Demand Management	Develop car sharing and car pooling services as a substitute for private vehicle ownership and encourage ridesharing
		Commuting and school travel planning that encourage more efficient transport mode (shift from car to public transport and environmental mode)
	Integrated planning	Land use, environmental and transport integration, reduction of urban sprawl, encourage the LEZ (Low Emission Zone)
ICT (Information Communication Technology)	Real time and pre-trip information	Real time road traffic and PT travel information; travel planning systems to optimise use of combined modes of transport
	Teleworking / teleconferencing	Use of telecommunications as a substitute for business and commuter travels
	Telebanking / teleshopping	Use of telecommunications as a substitute for physical travel
	Research and Development	Application and technology including Galileo programme
Eco-friendly behaviour	Eco-driving	Strategies for improving driving behaviour, energy-efficiency and traffic safety among drivers
	De-marketing of car	Campaign to de-market cars to change public attitudes and develop environmental certification (ecolabels)
Logistics	Logistic management (integrated supply chain)	Strategies to improve the efficiency of freight transport and storage
	City logistics (freight distribution centres and regulation)	Strategies to improve the efficiency of freight distribution in urban areas
	Increased load factor	Strategies to optimise the load capacity of freight vehicles
Air and Maritime	Operation rules for ports	Rules on pilotage, cargo handling, stevedoring
	Marco Polo Programme	Modal shift, catalyst and common learning actions
	Vessel traffic monitoring	Monitoring System to prevent illegal discharges at sea and help in recognise ships and their environmental performances
	Single European sky	Management of air traffic and thereby facilitate further cost reductions and demand growth
	Environmentally differentiated charges at terminals	Differentiate terminal fees and charges according to the level of pollutants emitted/discharged and noise produced mainly by ships and aircrafts

Source: TRT, 2007.

In order to assess the impacts as well as the feasibility and suitability of the policy measures, these have analysed under different dimensions:

- What are the main effects expected in terms of reduction of carbon intensity and atmospheric emissions (NO_X, SO_2; CO, PM_{10}, $PM_{2,5}$);
- What are the timings for the policy implementation and for the expected impacts (short, medium and long term);
- Which are the areas interested (local/regional, European, global);
- What are the institutional levels involved in the implementation phase (urban/regional, National, European);

Table 7 gives a synthetic score for each policy cluster in relation to the capability of reducing GHG emissions and pollutants emissions. In the same table, the assessment of the implementation timing and territorial area of interest is given for each measure. All policy clusters have positive impacts on GHG and air quality but their performances are extremely variables. According to the IPCC (2007), improved energy efficiency offers an excellent opportunity for transport GHG and air pollution mitigation in the medium term period. Carbon emissions, fuel consumption and air pollution could be reduced (-50% of GHG by 2030 compared to currently produced models) assuming continuous technological advances and strong policies, like pricing measures, tax incentives to encourage the purchase of clean vehicles and tax disincentives to purchase vehicles with high CO2 emissions. These policies might be coupled with soft measures, public facilities in urban areas and regulatory actions, as well as mandatory standards for new engines and fuel emissions.

Table 7 Expected effects of policy packages

Policy packages	Impact on CO_2	Impact on air quality	Measures	Timescale	Territorial area
Technological improvement (vehicles and fuels)	+++/++	+++	Reduction of CO_2 emissions and fuel consumption	Medium	EU
			Increase efficiency in automotive sector	Medium	EU
			Labelling scheme for tyres	Short	EU
			Labelling scheme of car fuels	Short	EU
			R&D on efficient vehicles	Medium	EU
			Improved fuels	Long	EU
Pricing and taxation	++	++	Road vehicles taxation reform	Short/Medium	EU
			Pricing Interurban Roads	Short/Medium	EU
			Road pricing in urban areas	Short	Local
			Tradable mobility credits	Short	Local
Long distance travel (passengers and freight)	+	++	Rail interoperability	Short	EU
			Harmonised regulation systems	Short	EU
			Rail efficiency	Medium	EU
			Rail passenger services quality	Medium	Country
			Intermodal facility for passengers	Medium	Country
			Intermodal facility for freight	Medium/Long	EU
			Rail capacity	Long	EU
Liveable cities	+	++	Improve public transport services	Short/Medium	Local
			Regulation incentive effectiveness	Short	Local
			Park&Ride facilities and access to PT	Short/Medium	Local
			Walking and cycle facilities	Short	Local
			Transport Demand Management	Short	Local
			Integrated planning	Long	Local
ICT (Information Communication Technology)	= / +	= / +	Real time and pre-trip information	Short	Country
			Teleworking / teleconferencing	Medium	Country
			Telebanking / teleshopping	Short	Country
			Research and Development	Medium	EU
Eco-friendly behaviour	= / +	+ / ++	Eco-driving	Short	EU
			De-marketing of car	Medium	EU
Logistics	+	++	Logistic management (integrated supply chain)	Medium	Country
			City logistics (freight distribution centres and regulation)	Medium	Local
			Increased load factor	Medium	Country
Air and Maritime	+	++	Operation rules for ports	Medium	EU
			Marco Polo Programme	Short	EU
			Vessel traffic monitoring	Medium	EU
			Single European sky	Short	EU
			Environmentally differentiated charges at terminals	Medium	EU

Note: positive: low (+), medium (++), high (+++); neutral (=).

Policy Measures and reduction of carbon intensity

The following tables show two different estimates of the policy clusters impacts on carbon intensity, as reported in the scientific literature. Although the two tables derive from diverse studies, they are useful to evidence the ranking of the policy clusters effectiveness in reducing CO2 emissions in different time frames.

An estimate of the policy clusters effectiveness in the short term is illustrated by Table 8, based on the ECMT study (ECMT, 2007), which provides - for more than one hundred countries - a measure of expected potential CO_2 emissions abatement in million tones for the year 2010 in comparison to 2002 (see also annex to chapter 6). With reference to the values reported in the table, the ECMT analysis underlines the following aspects:

- the more effective policy approach in the reduction of the CO_2 emissions is the fiscal one (pricing and taxation), actually activated in numerous countries (51);
- logistics measures, liveable cities policies (public grants and facilities), actions related to the information/education field, including ICT and interventions aimed at changing citizens behaviour show a medium impact, verified by widely diffusion;
- technological improvements that fix mandatory standard and regulatory reform seem to have less influence within the considered time frame.

Table 8 CO_2 emission expected savings of policy clusters at 2010

Policy clusters	CO_2 expected savings at 2010 (%)	Number of Countries with Active Policies*
Technological improvements (Vehicles and fuels)	12%	19
Pricing and taxation	46%	51
Liveable cities (urban policy)	19%	33
ICT (Information Communication Technology)		
Eco-friendly behaviour		
Logistics	23%	37
Total	100%	140

Source: TRT on the basis of ECMT 2007

* The EU is included as if it were a single country where the policy was introduced across Member States through am EU Directive

Table 9 is based on a UK Department for Transport study (VIBAT, 2007) and gives a measure of the policy clusters effectiveness in terms of the contribution to achieve the UK 60% CO_2 reduction target (-25,7 MtC) at the time horizon of 2030. The table offers useful insights to the understanding of the policy impacts in the longer term (more than 20 years). Indeed, the ranking of the policy clusters is now different and, in this case, the more effective policy concerns the technological improvements (where vehicle improvements score better than fuels improvements), while pricing measures and ICT for passengers seem to be much less effective.

Table 9 Contribution to the UK CO_2 emission reduction target at 2030

Policy clusters		Contribution to CO_2 reduction target at 2030 (%) - Passenger	Contribution to CO_2 reduction target at 2030 (%) - Freight
Technological improvements	Vehicles	-46% +	-25%
	Fuels	-14%	
Pricing and taxation		-4%	
Liveable cities (urban policy)		-2%	
ICT (Information Communication Technology)		-4%	-2,5%
Logistics		-2,5%	
Total		100%	

Source: TRT on the basis of high impact scenario of VIBAT 2006

The two estimates confirm that technological advances and pricing measures are the best policies clusters to reduce CO2 emissions, pointing out the importance of soft and logistics measures as supporting actions. However, if the technological improvements show off their high effectiveness in the long period, the pricing and taxation policy cluster seems to be the most operative in the short term.

Policy Measures and implementation timescale

Although all measures might be implemented in the near future, their impacts might appear only in the medium-long term: it is the case for instance of some innovation technology measures, of many modal shift interventions and in general of all the investment policies for building new infrastructures (i.e. increasing capacity). The main factors considered are:

- the maturity of technologies (the availability of commercial products)
- the complexity of the decision making process for the regulatory actions (institutional levels involved, number of stakeholders, public acceptability and barriers);
- the completion time for major transport projects, like for instance the TEN-T network;
- the flexibility of the solutions and their capability to adapt.

Many measures that, from the point of view of the implementation, belong to the short term ones (like for instance pricing measures and information technology actions), have shown in the past be more uncertain in their application. The main problems concerning the pricing measures are:

- the lack of harmonisation that still exists among European countries' fiscal policies, added to the long processes for the adoption of economic regulation, both in European Institutions and in member states (i.e. legislative iter concerning marginal cost road pricing, public services, freight transport pricing, etc.);
- the acceptability of the measures, due to the potential impact on the European economy deriving from the increase of passenger and freight transport costs after the prospective external costs internalisation. This process could be anticipated by the introduction of economic measures, such as tradable mobility credits, valid for passenger and freight transport.

In the case of information and communication technology (ICT), i.e. teleworking, teleconferencing, telebanking, their effectiveness - in terms of significant travel reductions - will depend on the ICT network's capability of reaching a wide range of European citizens in a short time, then the economical convenience of supplying services "in remote" (i.e. see the telebanking development) and the telephone operator's convenience of creating new areas of business, such as links between the network and road freight operators.

Policy Measures and Territorial Areas

The territorial analysis is an important input to be considered for the selection of the most appropriate measures. With the exception of the measures concerning technological innovations on vehicles and fuels, ICT and fiscal policies, which have a EU and global relevance, many of the policies analysed are designed for urban and metropolitan areas and heavily used part of the network. Two fundamental considerations support this focus on the local dimension:

- the concentration of transport activities, the majority of the passengers trips are concentrated in the European conurbation and catchments areas, freight logistics is located mainly along corridors near or within the urban and metropolitan areas, and consequently,

- the concentration of emissions sources in urban areas, as well as congestion and other environmental effects (i.e. $PM_{2.5}$ concentration). Examples of the most suffering urban areas in Europe are the cities of Northern Italy, Germany and Eastern Europe, such as Poland and Hungary[6].

Policy Measures and Institutional Level

A policy action with global impacts may involve also national and local partners, in order to generate the requested consensus, and overlaps of decision making levels is inevitable. Whereas policies require a shared definition at higher institutional levels (i.e. the harmonization of regulatory frameworks or funding activities), practical action measures frequently require the involvement of local bodies for their correct implementation. At the same time, the normative apparatus and the financial resources available for the policy implementation often require the support of higher institutional levels. Furthermore for many policies the research and development component is relevant. On this regards, two different sets of policies can be identified:

- ***Technologies, regulative and market based policies***; these are characterised by the presence of normative EU or Member States provisions. At this regard, the improvements recently experienced seem to be modest and slow. The ten-year time lag taken for building the European framework seems not to be coherent with the objectives and targets set by the EU and implemented then at national level. This is also due to a feeble use of sanction measure.

- ***Transport Demand Management policies***; in this case, and especially in the implementation stage, the action at local level is predominant. Nevertheless, these measure demand financial resources for the process/product development that involves a higher spatial detail. From this point of view, the largest problem experienced in the last ten years can be found in the small

6 EEA estimates that in 2004 European people exposed to the daily values exceeding the PM_{10} were 117 millions (Excedance of air quality limit values in urban areas, EEA, 2006).

amount of the financial resources used, in their temporal discontinuity and in the demonstrative perspective rather than being structural measures. The integrated and strategic planning (land-use-transport-and environmental) would play a crucial role to overcome these weaknesses; at this regard, not only the local government levels but also at national and international level would be very important to support the innovation (guidelines for planning), to address the resources and destination of use and to promote the spreading of best practises with the aim to build a sustainability mobility model.

Conclusions

The Need of a Consistent Mix of Policy Measures

The problems due to the current levels of transport emissions are serious and, without a coordinated intervention, will in some respects get worse. Only a sophisticated policy mix can respond to such a demanding challenge.

The literature review and the analysis of a number of practical actions strongly support the point of view that ***to achieve substantial reductions in transport emission it is necessary to combine mutually supporting policies***, involving a variety of stakeholders.

There seems to be a general agreement that individual policies will not significantly contribute to reduce CO_2 emissions and improve air quality, and that only combined polices or policy mix including soft measures designed to raise awareness can. Policy mix can help mitigating the negative effects of a single measure, and therefore increase acceptability, can help control for rebound effects, i.e. problems of reversing the initial benefit by readjustments of individual behaviours. But the important aspects is that the combination of *push and pull* policies are able to simultaneously improve different dimensions of the transport emissions problems, The synergies of combining different measures are such that the effect of their combination is better then the sum of the effects of individual policies.

Up to now, modal shift induced by increasing the supply of competitive modes (rail, short sea shipping, inland waterways, public transport, etc.) have shown to be weak in terms of CO_2 and emissions abatements, in particular for long distance travel and non-urban areas. The reasons for this are manifolds: investments in new infrastructure take a long time to be completed and therefore results become apparent after years, but the main one is that in general the shift of demand has shown to be much lower then expected. Indeed, people and goods are reluctant to abandon the road and air mode also when new or upgraded infrastructures of competing modes are in place, unless they are pushed by demand management and pulled by integrated policies.

To be effective the integrated policies should cover all modes of transport and should include ambitious fuel-efficiency targets, improved standards for vehicles and fuels, reduction in road and air transport activity through pricing, logistics and behavioural changes. The three main of the mix of mutually supporting policies are:

- Technological improvement (use of new vehicles technologies and alternative fuels),
- Pricing and taxation (reform of road vehicle taxation, road pricing, Eurovignette),
- Soft and eco-friendly measures (ICT, transport demand management, logistics measures) able to optimise the use of private vehicles, improve the use of public transport as well as to promote behavioural changes.

The Relevance to focus on Selected Policy Actions

There is little strategic case for action in all places and therefore the EU policy should focus on those parts of the system that are more critical:

(i) congested urban and metropolitan area, where the majority of passenger trips take place;

(ii) key interurban corridors where domestic intra-EU and international trades are concentrated;

(iii) environmental sensible areas (Alpine region, Baltic Sea, etc.).

The ways to approach the CO_2 emissions and air quality impacts of the transport sector are in many cases overlapping and this implies that there are significant synergies in tackling the two problems in a coordinated way. Air pollution policies should concentrate in urban and metropolitan areas as well as in environmental sensible areas, where the impacts are particularly high. CO_2 and in general GHG emissions are function of total transport demand and therefore urban areas and key interurban corridors are priority areas of intervention.

(a) ***Increase fuel efficiency for all modes of transport***. There is a general agreement that technology is the most promising and effective tool to reduce transport's pollution and GHG emissions. Nevertheless, technology progress per se is not sufficient, while the severity of the problem requires implementing also policies that produce results in the short term, including incremental improvements of the current technologies, use of electric and hybrid vehicles, train, vessels. The focus should be on increasing fuel efficiency for all modes of transport, especially air and road transport including vehicles in the Eco-design Directive and the planned Energy End-use Efficiency Directive and reducing the emission target for passenger car fleet to 120 g CO_2 per vehicle kilometre by 2012 and to 100 by 2020 and extend such an approach to cover trucks, aircraft, vessel. COM (2007) 19 underlines that in a long-term vision the Commission will support research of "*improvements in vehicle efficiency that will deliver as much a 40% reduction in CO_2 emission passenger cars for the new vehicle fleet in 2020. This would correspond to a new car fleet average of 95g CO_2/km*". To reach this target, a system of emission credits has been proposed, see also Carbon Allowance Reduction System (CARS) recently proposed in the European Parliament Report (see also point c).

(b) ***Get the prices right so that passengers and freight face the full cost of travel and feel the consequence of their decision***. A general reform of taxation in the transport sector, clearly based on CO_2 emission and other environmental emissions, appears to be a fundamental instrument to maximise abatement of emissions. The policy should be designed in order to provide strong incentives to shift toward better performing vehicles in all transport modes: tax levels linked to energy and emission efficiency of the vehicles (lower for the most energy-efficiency, higher for the less energy efficiency), to congestion pricing on roads and to environmental pricing across modes.

(c) ***Introduce innovative measures based on the "emission trading" approach***. One argument often raised against road pricing is that imposing an additional cost to car users affect unfairly different population groups, e.g. low-income individuals that have no alternatives to using car. Technologies now allow for introducing more sophisticated *push and pull* approaches toward a more sustainable urban mobility based on a mix of "pay as you go" and rationing policies based on the possibility of trading the external costs of transport. A first step in this direction is to couple road pricing with a mechanism based on ***tradable mobility credits***. Mobility credits would guarantee to everyone the freedom to move and will be differentiated according to

several dimensions like the vehicle type (size, emission class), but also the supply of alternative modes. The same closed market mechanism applied on the car manufacturing side, the Carbon Allowance Reduction System (CARS), might help in obtaining substantial reduction in CO_2 emission levels (see point a): manufactures and importers will be required to pay financial penalties in proportion to any exceedance per car sold of the emissions limits. These penalties may be offset by redeemable credits awarded to newly registered passenger cars of the same manufacturer with emission below the limit value curve.

(d) ***Support modal shift from individual car to public transport, pedestrian and cycling, in urban areas and from road to rail freight transport through pricing policies and soft measures***. As stated before, urban and metropolitan areas suffer of high levels of pollution and at the same time alternatives modes to private transport are already available. A combination of pricing policies (congestion charging) and improvements in the public transport supply can significantly reduce emissions, particularly if public transport service enhancements are achieved through short-term measures, fleet renewal, bus priority, information technologies etc.

(e) ***Induce a more efficient organisation of road freight transport***. For long distance freight transport, truck-km charges have shown to be able to induce a process of rationalisation of distribution systems and logistics organisation, and thus to reduce distances optimise routing, load factors and occupancy rates. There is a general agreement that the freight distribution sector as well as logistics have still margins for optimisation and this might be exploited by taxation and charging policies strongly differentiated in order to encourage a more efficient use of the existing fleets.

(f) ***Promote more responsible behaviour of road users***. Develop eco-drive procedure in the road transport sector (freight and passenger) to reduce emission and fuel consumption. De marketing of cars, support to car sharing and car pooling initiatives, support to green logistics, promoting eco drive ITS are all soft measures that might play a highly positive role in strengthening the positive impacts of other hard measures and in some cases in mitigating the negative ones.

(g) ***Encourage integrated land use and transport planning***. Spatial planning at urban and regional level might play an important role in the medium long term both in slowing down the increase in distance travelled both for goods and passengers and in increasing the attractiveness of alternative modes by concentrating new developments along rail, or metro or near ports or intermodal nodes.

The actions will, inevitably, have to be adapted for specific countries, regions, and urban areas whose needs and problems vary widely. As a consequence, the “weight” of each package or measure in the policy mix has to be carefully chosen in order to better exploit their potential positive impacts.

The importance of the accompanying measures to support new technologies development

It might be counter-productive to call for action on all measures; priorities should be given to measures that can produce benefits also in the short term, and this include the option to make the best use of the existing transport networks, to sustain the effectiveness of the long term ones.

There is a general agreement that innovation technology (both on vehicles and on fuels) is the most promising and effective tool to reduce transport’s pollution and GHG emissions in the ***long***

term. Nevertheless, technology progress per se is not sufficient. In order to reach the ambitious target of the EU, it is necessary to ***support new technologies with a consistent package of accompanying measures***:

- Amendment of the Eurovignette directive charge related to type of vehicle (emissions and consumption) and distance travelled;
- Promotion of congestion charge in cities and selected (congested) corridors;
- Introduction of tradable mobility credits schemes in urban and metropolitan areas;
- Incentives to increase occupancy and load factors to offset the costs of road pricing to user;
- Support captive fleets renewal (particularly for public transport, car sharing fleet, taxi), through a system of incentives.

In order to be effective in the ***short time***, the use of alternative fuels (such as natural gas, bio-fuels, electricity and hydrogen) needs to be supported by:

- Tax reform aims at the promotion of fuel-efficient cars and proposes to reduce taxes for road vehicles that emit less CO_2 and increase them for those that emit more;
- Extend emission targets also to trucks, aircraft, vessel;
- Training campaign (eco-driving) for professional and common drivers;
- De-marketing campaign of the car transport mode (shifting demand to the most eco-efficiency cars available).

The following table reports the main recommendations, showing how and in which way the EU can contribute to the implementation of the measures.

Table 106 Recommended measures

Measures	Best level to act	How can EU contribute	Goals/actions/instruments
Technological improvement			
Compulsory targets for CO_2 emissions of cars and vans	EU	Reviewing the Community strategy to reduce CO_2 emissions from passengers cars and light-commercial vehicles. Supporting improvements in vehicle efficiency that will deliver a 40% reduction in CO_2 emission passenger cars for the new vehicle fleet in 2020.	Cars: 120g/km by 2012 and 95g CO_2/km by 2015 Van: 175 g/km by 2012 and 160 g/km
Improve alternative fuels and energy efficiency	EU Member States	Promoting energy efficiency in all transport modes and reach energy saving by promoting the increase of alternative fuels (such as second generation biofuels).	9% reduction energy consumption by 2016 New EU Directive by the end of 2007 to reach 10% use of renewable energies by 2020
Pricing and taxation			
Reform of road taxation	EU Member States	Re-structuring road registration tax and annual circulation tax by linking taxation to CO_2 emissions and energy consumption	New Directive by 2012
Pricing for long distance freight	EU Member States	Introducing in the new Directive a toll differentiation according to vehicle weight and environmental performance and extend it to the entire interurban road network.	Emended Eurovignette Directive by 2008 Harmonising EU charges by 2010 Appling the Eurovignette to all vehicles over 3.5 tonn by 2012
Pricing for interurban raod and sensible areas	EU Member States Regional	Promoting the introduction of congestion charging on interurban roads Promoting emission charging in sensible areas	New directive based on the Model for the internalisation of marginal cost pricing by 2010
Pricng for urban and metropolitan areas	EU Local/regional Level	Promoting congestion pricing Introducing innovative measures based on “tradable mobility credits”	Action plan of Green paper for urban mobility by 2008
Other supporting measures			
Information Communication Technology	EU Member States	Promoting research and development applications on passenger and freghth transport services and infrastructure management in order to further develop ITC	New roadmap for Information Transport System by 2008
Improve public transport services	EU Member States Local	Harmonising regulation of public transport services on rail and road	New Directive on regulation on public transport services by rail and road by 2008

Transport demand management	EU Local	Developing car sharing and car pooling system to integrated public transport services Developing walking and cycling facilities	Action plan of Green paper for urban mobility by 2008
Improve efficiency in city logistics	EU Local	Supporting city logistics schemes (delivery regulation in the city centre)	Freight Transpor Logistics Action plan by 2008
Eco-driving	EU Member states	Promoting European strategy for improving driving behaviour for energy efficiency and traffic safety	Eco Drive Campaign
Integrated land use and transport planning	EU Local	Promoting the follow-up of sustainable urban transport plans (SUTPs)	Action plan of Green paper for urban mobility by 2008
De-marketing of cars	EU member states	Promoting eco-friendly behaviour among cars trade/brand and customers	New Directive on environmental certification of vehicles based CO_2 emissions and consumption.by 2008-2010

Source: TRT, 2007.

BIBLIOGRAPHY

An F. e Sauer A., *Comparison of passenger vehicle fuel economy and greenhouse gas emission standards around the world*, 2004.

APAT, *Qualità dell'Ambiente Urbano* - II Rapporto APAT, 2005.

CE Delft Netherlands for ECMT, *Cost Effectiveness of CO2 Mitigation in Transport* – An outlook and comparison with measures in other sectors, April 2006.

CE Delft, *Greenhouse Gas Emissions for Shipping and Implementation Guidance for the Marine Fuel Sulphur Directive*, Delf, 2006.

CE Delft-KNMI-RIVM-MMU, *Climate impacts from international aviation and shipping*, 2004.

Commission of the European Communities Commission Expert on transport and Environment, *Measures that simultaneously address climate change and other environmental or other aspect of sustainability Working Group II*, 2000.

Commission of the European Communities, Communication from the Commission "*Freight Transport logistics Action Plan*", Brussels, 18.10.2007

Commission of the European Communities, *Green Paper –Towards a new culture for urban mobility*- COM (2007) 551 Draft, Brussels, 25.9.2007.

Commission of the European Communities, Communication to the Council and the European Parliament, *A Competitive Automotive Regulatory Framework for the 21st Century Commission's position on the CARS 21*. High Level Group Final Report. A contribution to the EU's Growth and Jobs Strategy, COM(2007) 22 final, Brussels, 7.2.2007.

Commission of the European Communities, Communication to the Council and the European Parliament, Results of the review of the Community Strategy to reduce CO2 emissions from passenger cars and light-commercial vehicles, COM(2007) 19 final, Brussels, 7.2.2007.

Commission of the European Communities, Communication to the Council, the European Parliament**,** the European economic and social committee and the committee of the regions, *Limiting Global Climate Change to 2 degrees Celsius*. The way ahead for 2020 and beyond, COM(2007) 2 final, Brussels, 10.1.2007.

Commission of the European Communities, Communication to the Council and the European Parliament, *An energy policy for Europe*, COM(2007) 1 final, Brussels, 10.1.2007.

Commission of the European Communities, Communication to the Council and the European Parliament, Renewable Energy Road Map. *Renewable energies in the 21st century: building a more sustainable future*, COM(2006) 848 final, Brussels, 10.1.2007.

Commission of the European Communities, Communication to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Region, *Towards a European Strategic Energy Technology Plan*, COM(2006) 847 final, Brussels, 10.1.2007.

Commission of the European Communities, Communication to the Council, the European Parliament, Biofuels Progress Report on *the progress made in the use of biofuels and other renewable fuels in the Member States of the European Union*, COM(2006) 845 final, Brussels, 10.01.2007.

Commission of the European Communities, Communication to the Council and the European Parliament, Cohesion Policy and cities: *the urban contribution to growth and jobs in the regions,* COM(2006) 385 final, Brussels, 13.07.2006.

Commission of the European Communities, Communication to the Council and the European Parliament, *Keep Europe moving* - Sustainable mobility for our continent Mid-term review of the European Commission's 2001 Transport White Paper, COM(2006) 314 final, Brussels, 22.06.2006.

Commission of the European Communities, Communication to the Council and the European Parliament, *Thematic Strategy on air pollution*, COM(2005) 446 final, Brussels, 21.9.2005.

Commission of the European Communities, Communication, *Action Plan for Energy Efficiency: Realising the Potential*, COM(2006)545 final, Brussels, 19.10.2006.

Commission of the European Communities, *EU Energy Policy Data*, SEC(2007) 12, Brussels, 10.10.2007.

Commission of the European Communities, *Green paper on market-based instruments for environment and related policy purposes*, COM(2007) 140 final, Brussels, 28.3.2007.

Commission of the European Communities, Green Paper to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the regions, Adapting to climate change in Europe – options for EU action, COM(2007) 354 final, Brussels, 29.6.2007.

Commission of the European Communities, Green Paper: A European Strategy for Sustainable, Competitive and Secure Energy, COM(2006) 105 final, Brussels, 08.03.2006.

Commission of the European Communities, Proposal for a Directive of the European Parliament and of the Council On ambient air quality and cleaner air for Europe, COM(2005) 447, Brussels, 21.9.2005.

Commission Staff Working Document. Annex to the Communication from the Commission to the Council and the European Parliament on Thematic Strategy on the Urban Environment - Impact Assessment, SEC(2006) 16, Brussels, 1/01/2006.

Commissione Nazionale Emergenza Inquinamento Atmosferico, *Relazione conclusiva della Commissione Nazionale Emergenza Inquinamento Atmosferico,* Marzo 2006.

Committee of the Regions, *Programme of the forum: EU Urban Policies for Dynamic Cities*, April 25/27/2006.

Communication from the Commission to the Council and the European Parliament on Thematic Strategy on the Urban Environment - Impact Assessment, COM(2005) 718 final, Brussels, 11/01/2006.

Communication from Commission to Council and the European Parliament, *Results of the review of the community strategy to reduce CO2 emissions from passenger cars and light-commercial vehicles*, COM(2007) 19 final, 2007.

Communication from the Commission to the Council and the European Parliament, *the European Economic and Social Committee and the Committee of the Region Towards a thematic Strategy on the Urban Environment* - Impact Assessment, COM(2004)60 final, Brussels, 11/02/2004.

Council of the European Municipalities and Region - CEMR Position Paper – *Public consultation on the preparation of the Green Paper on Urban Transport*, Brussels, 30/04/2007.

Directive 2003/30/EC of The European Parliament and of The Council of 8 May 2003 *On the promotion of the use of biofuels or other renewable fuels for transpor*t, Bruxelles, 2003.

ECMT, *Cutting Transport CO_2 Emissions, What Progress?*, France, 2007.

ECMT, *National Transport Sector CO_2 Abatement Policies and Measures Database*, Paris, 2006.

ECMT, *Transport and environment NOx emissions: ensuring future exhaust emissions regulations deliver air quality standards*, ECMT/CM(2006)5/FINAL, Paris, 2006.

ECMT, Transport and Environment review of CO_2 abatement policies for the transport sector, CEMT/CM(2006)4/FINAL, Paris, 2006.

European Commission, *Communication on alternative fuels for road transportation and on a set of measures to promote the use of bio-fuels*, COM (2001) 547 final, Brussels, 2001.

European Commission, White Paper - *European Transport Policy for 2010: time to decide*, COM(2001)370 final, Luxembourg: Office for Official Publications of the European Communities, 2001.

European Commission – DG TREN, Assessment of the contribution of the TEN and other transport policy measures to the midterm implementation of the White Paper on the European Transport Policy for 2010, Brussels, 2005.

European Commission – DG TREN, *Doing more with less – Green Paper on Energy Efficiency*, Belgium, 2005.

European Commission – DG TREN, *Energy & Transport: Figure and Main Facts* – Statistical, Pocket Book, 2006.

European Commission -DG Environment, Review of the EU strategy to reduce CO_2 emissions and improve fuel efficiency from cars, Report on the public consultation, June-August 2006 Brussels, 2006.

European Commission – DG TREN, Fourth Technical Workshop "*Integrated urban transport approaches for successful and attractive cities*", Brussels, 2007.

European Commission – DG TREN, Launch-Conference "*Urban transport: problems, solutions and responsibilities*", Brussels, 2007.

European Commission – DG TREN, Preparation of the Green Paper on Urban Transport Stakeholder Conference "*Towards a European policy for urban transport*", Brussels, 2007.

European Commission – DG TREN, Technical Workshop, *Urban transport and green propulsion Background paper on the Promotion of Clean and Energy Efficient Vehicles*, Brussels, 2007.

European Commission JRC/IES–EUCAR–RENAULT–CONCAWE, *Well-to-Wheels analysis of future automotive fuels and powertrains in the European context*, 2006.

European Commission JRC-IPTS, *Hybrids for road transport*, 2005.

European Commission JRC-IPTS, *The introduction of alternative fuels in the European transport secto*r, 2004.

European Commission JRC-IPTS, *Trends in vehicle and fuel technologies: review of past trends*, 2003.

European Environment Agency, *Air pollution at street level in European Cities*, No 1/2006, Copenhagen, 2006.

European Environment Agency, Annual European Community greenhouse gas inventory 1990–2005 and inventory report 2007-Technical report No 7/2007, 27/05/2007.

European Environment Agency, EEA Report No 1/2007, *Transport and environment: on the way to a new common transport policy*, Copenhagen, 2007.

European Environment Agency, EEA Report No 7/2006, *How much bioenergy can Europe produce without harming the environment?*, Copenhagen, 2006.

European Environment Agency, ETC/ACC Technical Paper 2006/3, *Greenhouse Gas Emissions from Aviation*, Copenhagen, 2006.

European Environment Agency, *Excedance of air quality limit values in urban areas* (CSI 004) - Assessment published, Nov. 2006.

European Environment Agency, *Excedance of air quality limit values in urban areas* (CSI 004).

European Environment Agency, *Ten key transport and environment issues for policy-makers*, No 3/2004, Copenhagen, 2004.

European Environment Agency, *Transport and environment: on the way to a new common transport policy* TERM 2006: indicators tracking transport and environment in the European Union, No 1/2007, Copenhagen, 2007.

European Parliament – DG Internal Policies of the Union – Policy Department: *Economic and Scientific Policy*, *Reducing the Impact of Aviation on Climate Change*. Economic aspects of inclusion of the aviation sector in the EU Emissions Trading Scheme, IP/A/ENVI/NT/2006-08, March 2006.

European Parliament resolution on *Winning the battle against global climate change*, 2005/2049 (INI).

European Parliament and Council, Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport, 2003.

European Parliament – *Report on the Community strategy to reduce CO_2 emissions for passenger cars and light-duty vehicles* (2007/2119 (INI)).

EUROSTAT, *Panorama of Transport*, Luxemburg, 2007.

EUROSTAT, *Panorama of Energy*, Luxemburg, 2007.

Eyers, C J., Quineti, Q. for European Commission, AERO2K *Global Aviation Emissions Inventories for 2002 and 2025*, 2004.

ICCT, *Air Pollution and Greenhouse Gas Emissions from Ocean-going Ships: impacts, mitigation and opportunities for managing growth*, Washington, 2007.

Intergovernmental Panel on Climate Change (IPCC), Climate change 2007: *The physical Science Basis*, Geneva, 2007.

International Energy Agency (IEA), *Energy Technology perspectives*, Paris, 2006.

International Energy Agency (IEA), *Prospects for Hydrogen and Fuel Cells*, Paris, 2005.

International Energy Agency (IEA), *World Energy Outlook*, Paris, 2004.

International Energy Agency (IEA), *World Energy Outlook*, Paris, 2006.

T&E European Federation for Transport and Environment, *A price worth paying, a guide to the new EU rules for road tolls for lorries*, second edition, June 2007.

T&E European Federation for Transport and Environment, *Regulating CO_2 emissions of new cars*, Brussels, 2007.

T&E European Federation for Transport and Environment–CAN Europe, Climate Action Network Europe, *Clearing the Air The Myth and Reality of Aviation and Climate Change*, Brussels, 2006.

The Bartlett School of Planning and Halcrow Group ltd, Visioning and Backcasting for UK Transportation Policy (VIBAT), *Policy Packaging and Pathways*, Stage 3 Report, 2006.

TRT Trasporti e Territorio Srl, *Using mobility vouchers for implementing urban road pricing: a modelling simulation*, December 2006

VIBAT, *Visioning and beck casting for UK Transport Policy*, The Bartlett School of Planning and Halcrow Group Ltd, Stage 3 Report Policy Packaging and Pathways, Department for transport Dft Horizons Research Programme, 2006.

VIBAT, *Visioning and beck casting for UK Transport Policy*, The Bartlett School of Planning and Halcrow Group Ltd, Draft Stage 1 Baseline Report, Department for Transport New Horizons Research Programme, 2005.

Vtpi.org, *Transport Demand Management Encyclopedia*, 2007.