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INLAND TRANSPORT COMMITTEE

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agenda item 10))

GLOBAL WARMING AND TRANSPORT

Note by the secretariat

The present document on global warming and transport is being circulated in order to facilitate the Committee's debate on the subject and its contribution to the sixty-third session of the Commission, to be held on 30 March – 1 April 2009.

The document has two parts. The first part addresses the subject from UNECE perspective and puts forward some first ideas for consideration by the members of the Committee, while the second part (annex) reflects the views of Professor Werner Rothengatter, Head of the Institute of Economic Policy Research and the Unit of Transport and Communication at the University of Karlsruhe, in a broader perspective.

I. **Economics of Global Warming and Transport – the UNECE work**

1. Taking into account that transport is a significant and growing contributor to global climate change (according to some estimates, it is responsible for 13 per cent of all anthropogenic emissions of GHGs and for almost one quarter of the world's total CO_2 emissions from fossil fuel combustion) the different working parties of United Nations Economic Commission for Europe (UNECE) are discussing their role in promoting the sustainable development of transport.

2. The most relevant working party in this respect is the UNECE World Forum for Harmonization of Vehicle Regulations (WP.29). However, other working parties have also included transport policy considerations related to global warming and transport, particularly those on railways, inland water transport, inter-modal transport and logistics and road transport, as well as working transport trends and economics. In addition, The Transport Health and Environment Pan-European Programme (THE PEP) dedicated to promote sustainable development, has also undertaken specific programs to promote urban public transport and a more environmentally friendly modal split.

The UNECE World Forum for Harmonization of Vehicle Regulations (WP.29)

3. The UNECE World Forum for Harmonization of Vehicle Regulations (WP.29) is the unique global forum where vehicle regulations are developed. Its responsibility for "greening the transport sector" is therefore huge. 53 Countries (including the European Union) are Contracting Parties to at least one of the two United Nations (UN) Agreements on vehicle regulations (1958 and 1998 Agreements) [1] and apply the vehicle regulations adopted by the World Forum (WP.29). These countries, representing the 5 Continents (almost all the European countries, USA, Canada, Japan, China, India, Korea, Thailand, Malaysia, Australia, New Zealand, South Africa, etc.), manufacture more than 80% of vehicles worldwide. Other countries (Vietnam, Philippines, Cambodia, Argentina, Brazil, Mexico, the Community of the Arab Gulf Countries, the Southern African Developing Community (SADC), etc.) are either in the process of acceding to the UN 1958 and 1998 Agreements or have shown interest in acceding to them. Some of them participate, as observers, in the World Forum.

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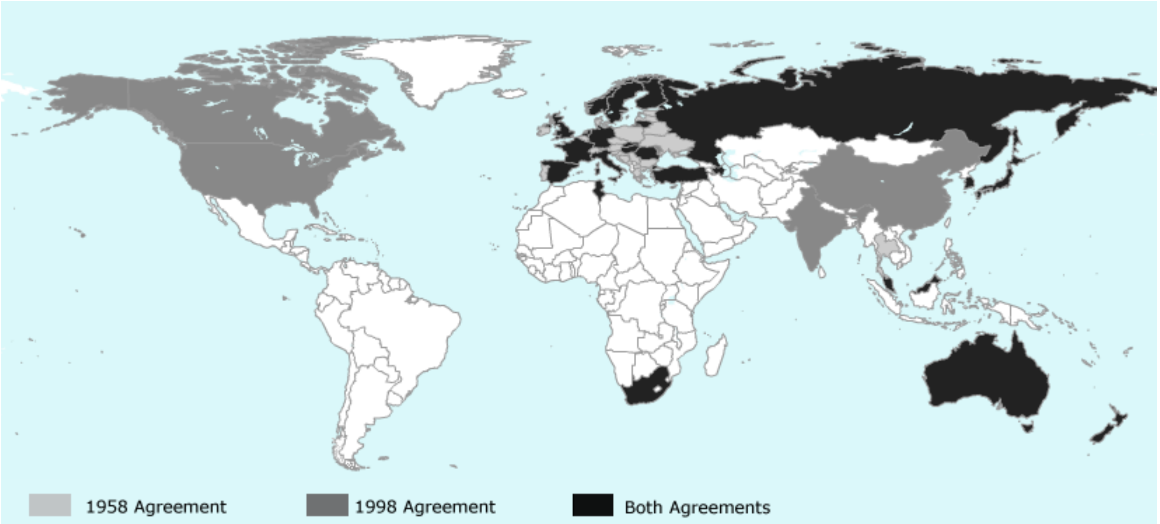
[1]

Agreement concerning the Adoption of Uniform Technical Prescriptions for Wheeled Vehicles, Equipment and Parts which can be fitted and / or be used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these Prescriptions (1958)

Agreement Concerning the Adoption of Uniform Conditions for Periodical Technical Inspections of Wheeled Vehicles and the Reciprocal Recognition of Such Inspections, 1997

Agreement concerning the Establishing of Global Technical Regulations for Wheedled Vehicles, Equipment and Parts which can be fitted and / or be used on Wheeled Vehicles, 1998



Map: Geographical extension of the UN 1958 and 1998 Agreements on construction of vehicles, administered by WP.29

4. The impact of the World Forum (WP.29) is demonstrated by :

   a. The EU decision to replace its vehicle directives (type approval directives) by reference to the UNECE regulations developed and adopted by the World Forum (WP.29);

   b. Endorsement by Transport Ministers: the OECD International Transport Forum (ITF) Ministerial Session (May 2008) on "The Challenge of Climate Change", was the first global meeting of transport ministers that focused on energy and climate change challenges relevant to the transport sector. In their key messages, transport ministers urged the UNECE World Forum for Harmonization of Vehicle Regulations (WP.29) to "accelerate the work to develop common methodologies, test cycles and measurement methods for vehicles", including CO_2 emissions;

   c. The Ministerial Conference on Global Environment and Energy in Transport (MEET), held in Tokyo (Japan) on 15 and 16 January 2009, in which the Ministers [2] responsible for environment and energy in the transport sector reiterated the ITF key messages and welcomed the ongoing efforts of the UNECE's World Forum to realize low carbon and low pollution transport systems. MEET encouraged countries to strengthen international cooperation to develop and harmonize procedures for testing exhaust emissions and to promote the production and use of environmentally friendly vehicles (EFV), as well as clean fuels, and to promote public transport through the UNECE World Forum.

[2] Ministers and Relevant Representatives from: Australia, Brunei Darussalam, Cambodia, Canada, France; Germany, India, Indonesia, Italy, Japan, Republic of Korea, Lao People's Democratic Republic, Myanmar, Philippines, Russian Federation, Singapore, Thailand, United Kingdom, United States, Vietnam and the European Commission

5. As a result, the World Forum set up new working groups for the development of worldwide harmonized light vehicle emission test procedures (WLTP) and for environmentally friendly vehicles (EFV). The World Forum has also established a large number of measures for climate change mitigation within the framework of the 1958 and 1998 Agreements, and continues to work on new requirements to improve fuel efficiency through new engine and vehicle technologies. In November 2008, the World Forum noted that a possible strategy for the automotive sector to contribute to the abatement of emissions was to pursue: (a) improved energy efficiency and the use of sustainable biofuels as a short-term objective (2015); (b) the development and introduction into the market of plug-in hybrid vehicles as a mid-term objective (2015–2025); and (c) the development and introduction into the market of electric vehicles as a long-term objective (2025–2040). This strategy would shift the automotive sector from the use of fossil fuels to the use of hydrogen and electric energy. However, the transport sector will have limited results in this area, unless the energy sector ensures sustainable and cost-effective generation of electricity and production of hydrogen.

6. The World Forum previously adopted amendments to UNECE regulations to limit the maximum admissible level of vehicle emissions for various gaseous pollutants (e.g. carbon monoxide, hydrocarbons, NOx) and particulate matter. These amendments have resulted in substantially lower emissions limits for new private cars and commercial vehicles. Moreover, UNECE Regulations were amended to include electric and hybrid vehicles as well as vehicles with engines fuelled with liquefied petroleum gas or compressed natural gas. At present, the World Forum is developing a common methodology and measurement technique to evaluate environmentally friendly vehicles, hydrogen and fuel cell vehicles. It is considering a number of energy efficiency measures, such as the use of other alternative energy sources like bio-fuels, including biogas, the installation of engine management systems in vehicles (e.g. the stop-and-go function), intelligent transport systems, tyre-pressure monitoring systems and the development of tyres with low rolling resistance. Once a consensus is reached, many of these innovative technologies are likely to be added to the UNECE Regulations and will help increase vehicles' energy efficiency.

7. Concerning fuel-quality standards, in 2007, the World Forum demonstrated the close inverse link between the market fuel quality and the emissions of pollutants from motor vehicles. It recognized that further reduction of emissions required cleaner fuel to be available to consumers. The lack of harmonized fuel quality standards was seen as hampering the development of new vehicle technologies. Supported by the United Nations Environment Programme (UNEP) and the International Petroleum Industry Environmental Conservation Association, the World Forum is committed to developing the necessary standard on market fuel quality, thus enabling vehicles to use fuels that minimize vehicle emission levels.

8. In order to further facilitate climate change adaptation in the transport sector the World Forum is pursuing the following:

a. For the assessment of CO_2 emissions, UNECE, in cooperation with the other Regional Commissions, has submitted a funding request to the United Nations Development Account (UNDA) for a technical assistance project. This project aims to develop a standard methodology for evaluating the CO_2 footprint of land transport with a view to raising awareness among Governments and other stakeholders and providing a scientific basis for sustainable transport policies. Member states are invited to support the UNECE funding request to UNDA and consider the potential further co-funding of the project.

b. A half day roundtable will be organised in the framework of the World Forum for Harmonization of Vehicle Regulations (WP.29).

The related work of other subsidiary bodies of ITC, of THE PEP and of the UNECE secretariat

9. With regard to the reduction of CO_2 emissions by transport, including and beyond vehicle construction, an integrated approach is warranted by taking into account measures for modal split, as well as for the existing fleet of vehicles, driving habits, such as eco-driving, better transport infrastructure, including traffic management systems, etc. UNECE shall continue to play a proactive role in the coordination of this work together with Governments and other stakeholders to foster the development of intelligent transport systems and its implementation in all transport modes and infrastructure. In this context, the working parties on railways, inland waterways, inter-modal transport and logistics, and the one on transport trends and economics, as well as The Transport Health and Environment Pan-European Programme (THE PEP) have included sustainable development concerns in their work programs.

10. The Working Party on Transport Trends and Economics (WP.5) discussed at its 21st session in September 2009 some key issues related to the socially optimal internalization of external costs in transport on the basis of two invited expert presentations that were posted on its website[3]

11. The Expert Group on Hinterland Connections of Seaports, a subsidiary body of WP.5, aims *inter alia* to identify best practices in achieving efficient and sustainable hinterland goods transport. The report of the Expert Group will be submitted to WP.5 at its 22nd session in September 2009. Aware of the overall importance of the topic, the Working Party asked the secretariat to arrange for other expert presentations on this topic for its 22nd session. The Working Party on Rail Transport (SC.2) considered at its 62nd session in November 2008 the report of the European Commission on freight-oriented networks[4]. Subsequently, the Working Party asked the European Commission to provide information about the progress of this initiative at its 63rd session in November 2009. At that time, the Working Party may wish to evaluate the effectiveness of the approach chosen by the EU to increase the modal share of rail transport.

12. The UNECE Working Party on Inland Water Transport addresses the environmental aspects of inland water transport in its recommendations on technical prescriptions for inland vessels (Resolution No.61), navigational rules for inland waterways (European Code for Inland Waterways) and pollution prevention. The Working Party also monitors the relevant activities of River Commissions, such as development of guiding principles on the development of inland navigation and environmental protection in the Danube river basin and the 2009 Congress of the Central Commission for the Navigation of the Rhine on “Climate change and the navigation on the Rhine”. The implications of the climate change for inland navigation shall be one of the topics addressed in the second edition of the UNECE White Paper on Inland Navigation “White Paper on Efficient and Sustainable Inland Water Transport in Europe”.

[3] http://www.unece.org/trans/doc/2008/wp5/ECE-TRANS-WP5-2008-21-inf08e.pdf; http://www.unece.org/trans/doc/2008/wp5/ECE-TRANS-WP5-2008-21-inf09e.pdf
[4] http://www.unece.org/trans/doc/2008/sc2/ECE-TRANS-SC2-2008-06e.pdf

13. The Transport Health and Environment Pan-European Programme (THE PEP), a joint project of UNECE and the World Health Organization Regional Office for Europe, was initiated to help achieve more sustainable transport patterns and a better reflection of environmental and health concerns in transport policy. In particular, THE PEP also promotes sustainable urban transport, including alternative modes of transport, in the region.

14. The economics of global warming will be on the agenda of the UNECE biannual session, 30 March - 1 April, 2009. Thus, in light of all the above, the secretariat considered it timely to strengthen its analytical capacity in this respect and has initiated a study on global warming and transport. The study can be found in the annex and will be presented to the ITC with the following objectives:

a. Further awareness raising among transport decision makers;

b. Ensure that the role of ITC and its subsidiary bodies, particularly WP.29, is well known (increase visibility);

c. Develop the ITC position on this substantive issue (new face of ITC); which are the issues that should be addressed by ITC in line with its mandate?

d. Identify new areas of ITC work where we might have a comparative advantage (mandate) - logistics, economic analysis, etc.

e. Involve ITC members in the preparation of the UNECE Commission session.

15. In summary, the ITC is requested to:

a. Support the UNDA project initiative;

b. Support the planned round table in the framework of the World Forum for Harmonization of Vehicle Regulations (WP.29);

c. Support the World Forum’s work-program, in particular;

i. To accelerate the development of test cycles and the agreement on common measurement methodology for emissions by vehicles, including CO_2;

ii. To develop market fuel quality standards.

d. Encourage the other related working parties to act as a forum to exchange best practices in their respective fields related to the topic of global warming and transport.

Annex

Economic Aspects of Transport and Climate Change[5]

Paper for the UNECE

Werner Rothengatter[6]

Version 5.2.2009

1 The Global Challenge

The Intergovernmental Panel of Climate Change (IPCC, 2007) has presented its fourth report on the development of climate change in February 2007. The basic messages are:

- There is little doubt that global warming since the industrial revolution is widely man-made. Other theories that relate global warming on earth to long-term oscillations of temperature or on sun-spot activity have little explanatory power.
- The IPCC scenarios state that the concentration of greenhouse gases might increase under business as usual conditions from 450 to 750 ppm. The associated increase of world temperature might range between 3 and 5^{o} C.

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[5] Disclaimer: The designations employed and the presentation of the material in this publication are the views of the author and do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations.

[6] Werner Rothengatter, born 1943, has been Head of the Institute of Economic Policy Research and the Unit of Transport and Communication at the University of Karlsruhe since 1990. His previous positions included professorships at the Universities of Kiel and Ulm as well as a visiting professorship at Vanderbilt University. Before joining the University of Karlsruhe in his present position, he was Head of the Transport Division at the German Institute for Economic Research (DIW) from 1986 to 1989.

Professor Rothengatter has published widely on transport-related issues, having been involved in collaborative research efforts with leading institutions in Europe (ITS, University of Leeds, UK and INRETS, France) and North America (CRT, Montréal). Past projects have focussed on issues of transport pricing and management, spatial development, the cost evaluation of public transportation schemes and trans-European networks. He has published six books and more than a hundred articles in the field of transport economics and management, covering air, rail and road transport.

Professor Rothengatter serves the academic community in a variety of functions. At the national level, he performs leading functions in the major research associations dedicated to issues of transportation (DVWG, FGSV). Simultaneously, he chairs the Steering Committee of the World Conference on Transport Research Society (WCTRS) and participates as a Member of the Editorial Advisory Board of several leading journals in the field (Transportation Research A, Transport Policy, Journal of Transport Economics and Policy). He is also high in demand as an expert on transportation issues, regularly carrying out research projects for and providing professional testimonies to government agencies and the European institutions.

- To limit the growth of world temperatures (which seems inevitable) to 2° C it will be necessary to start with substantial reduction policies now (a message of the Valencia meeting of the IPCC in September 2007).

The Stern-Review (2006) has taken up the scenarios of the IPCC on the impacts of global warming. Figure 1 summarizes the principle threats.

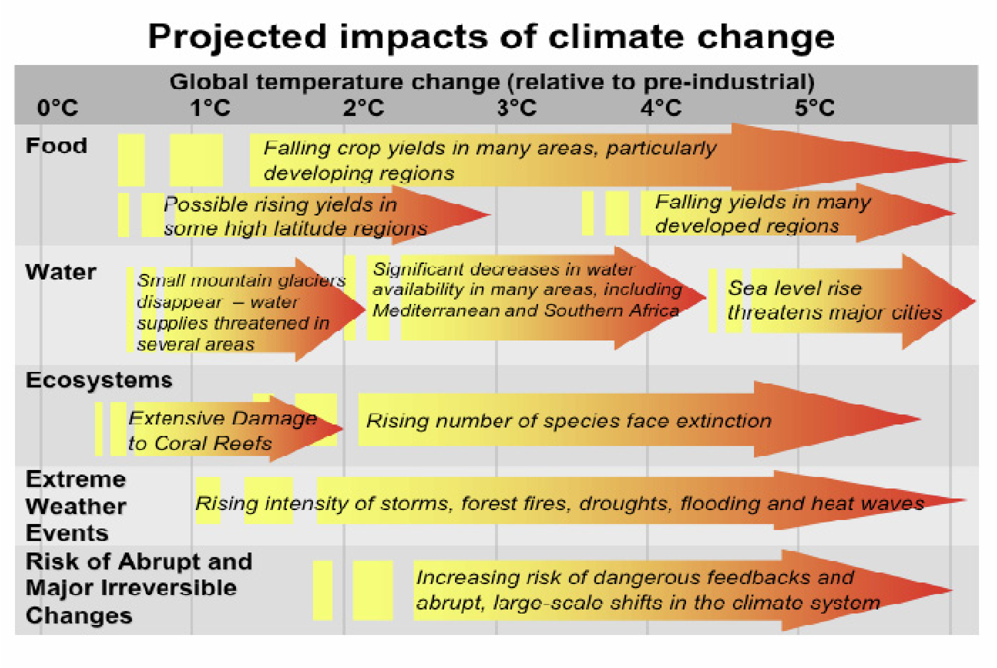

Figure 1: Impacts of Climate Change according to the Stern Review (2006)

According to IPCC and the Stern Review a stabilization policy appears to be most challenging; using the words of Lord Nicholas Stern, it is the biggest challenge for mankind since the industrial revolution. Figure 2 indicates the dimension of necessary reduction of greenhouse gas emissions which sums up to 50% in the year 2100 compared with 1990.

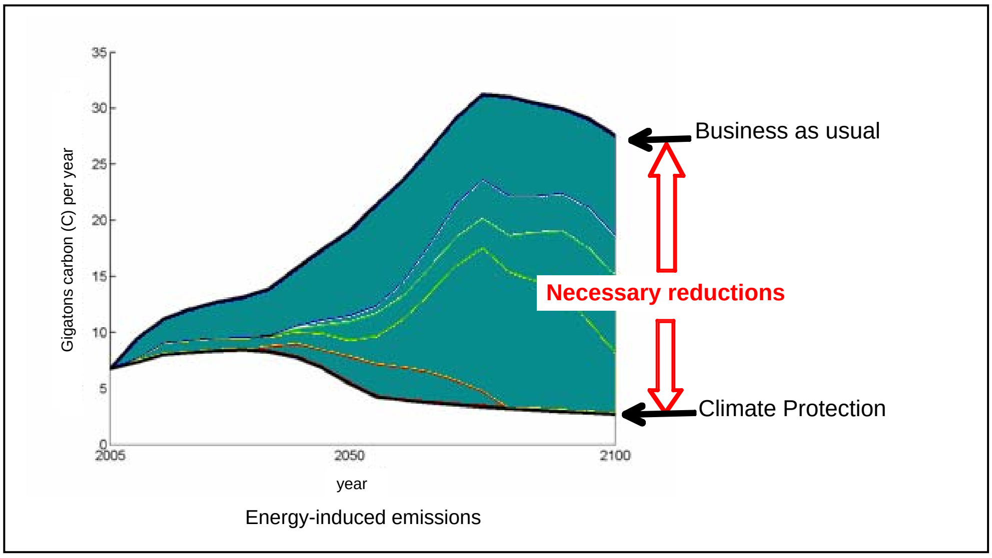

Figure 2: Necessary Reduction of CO_2 for Climate Protection

Source: Edenhofer, 2007

The Stern Review estimates the cost of reducing CO_2-emissions to a target level of 550 ppm to amount to 1% of GDP p.a. The expected future damage costs in a business-as-usual scenario would add up to a magnitude of 5% of GDP p.a., or more, after the year 2050. In the meantime, the IPCC has stated that a level of 550 ppm might not be sustainable. A reduction to the level of 500 or even 450 ppm appears to be necessary to stabilize global warming to not more than 2^{o} C. Nicholas Stern has adjusted his estimations accordingly and has mentioned in his recent speeches that more intense mitigation measures, such as increasing the cost of mitigation to about 2% of GDP, might be necessary. Nevertheless, the basic message remains; big reduction steps now will pay off in the future with high economic benefits in terms of avoided damage costs.

A main critique of the Stern scenario has been brought forward by W. Nordhaus (2007) who in particular attacked the very low social discount rate applied by the Stern team to make all future impacts comparable. Stern's social rate of discount is in an order of magnitude of 0.1 %, which is obviously far from the market interest rate today. The discounting problem underlines that climate policy is a matter of empathy of the present generation for the future generations (who can not vote today). The higher the discount rate, the higher the "rate of rapacity" of the present generation is with respect to future generations. To avoid compromising future generations' chances of living in a sustainable environment, it is necessary to keep the discount rate low. However, this example shows that economists have some problems in dealing with very long-term effects and that a basic trade-off problem of environmental economics has to be solved: is it preferable to lower emissions now to avoid future damages (mitigation), or to prepare future generations for living with the consequences of global warming (adaptation).

2 Dynamics of Mobility, Transport and Logistics

Mobility and transportation are growing worldwide at high growth rates. The drivers are:

- Growth of income
- Growth of motorization
- Cultural change and tourism
- Reduction of transport cost and time
- Industrial trends (world-wide distribution of workflows)

In some industrialized countries in Europe domestic passenger transport is stagnating, but this does not hold for the highly populated parts of the world at the threshold of industrialization, in particular Latin America, China or India. While passenger transport development is influenced predominantly by income, freight transport activity is more linked to trade, which is growing almost at double rates compared with GDP. The worldwide growth rates in passenger transportation are expected to be extremely high for aviation (4-5%). Motorization is still developing rapidly in developing countries whereas it has slown down in industrialized countries. Presently, less than 1 billion road vehicles are registered worldwide. This figure is expected to double by 2030 (see Sperling, 2008). The development of road traffic, therefore, is one of the most challenging problems that must be solved by climate policy. The options are clear: either vehicles become much more energy efficient in the future or road traffic will have to be restrained. Considering the importance of the automotive manufacturing industry in industrialized countries for economic growth and employment, which is also the case for China, it is unlikely that a concerted policy to suppress road traffic will be adopted at one of the forthcoming climate conferences. From this follows that a sustainable path for future transport development cannot be found without a drastic improvement in road vehicle technology.

The development of railways has been modest in the past and will depend, in the future, on the willingness of States to internalize the external costs and to provide fair market conditions for the environmentally more friendly transport modes. The development of High Speed Rail (HSR) connections between major agglomerations can contribute to diverting a part of domestic and short distance international air transport to rail, which would reduce the growth of passenger air transport slightly. In Japan and Western Europe HSR is already well developed, while in China the implementation of an ambitious plan to construct about 8,000 km of HSR has just begun.

Public transit is very successful in cities with a clear centrality and axial structure (in Japan and some cities in Europe), but by and large it could be much more developed if land use and city development would give priority to public transport.

Non-motorized transport needs dedicated paths for bikers and pedestrians and strict regulations like car bans or speed limits (30 km/h). In most countries non-motorized transport is declining, in particular in China where bikers formerly held a big share of local transport.

Freight transport is dominated by trucking and maritime shipping. The growth of trucking was significantly higher than that of GDP in the past decades and container shipping has grown with unprecedented speed, in particular in the past ten year (5-7%). Railway performance differs worldwide. In the United States of America (USA), rail companies have achieved a market share of 41% in domestic transport and are stronger than the road haulage industry (31%). In Europe railways are, on average, stagnating and are only being successfully developped in a few countries (e.g.: Germany, where the growth of rail freight transport was higher than that of road transport in the past 3 years and where railways have gained about 17% of the market). In former socialist countries railways play a most important role in the freight transport market. In Russia the railway modal share even exceeds the US value. However, one has to be careful with conclusions concerning energy and climate efficiency of rail transport in these countries. This is because the transport intensity (tonkm/unit of GDP) is far above the average of Western industrialized countries, and logistics as well as vehicle technology are still lagging behind.

With respect to the climate problem transport development is a matter of growing concern because the transportation modes which cause the biggest specific CO_2 emissions show the highest growth rates.

3 External Costs of Transport

External effects are unplanned interactions among economic agents, which are processed outside the market (not priced) and are detrimental to the dynamic economic efficiency because they generate wrong incentives. According to INFRAS/IWW (2004) external costs of transport consist of the following components:

- Uncovered costs of accidents
- Costs of noise
- Cost of air pollution
- Cost of climate change
- Change of nature and landscape
- Detrimental urban effects
- Upstream and downstream effects (production and disposal)

Furthermore, congestion externalities are mentioned in the literature, but these costs are external for the single user while internal for the transport system (road, rail or air) and therefore a case for improving efficiency within a particular transport sector. This means that congestion externalities signal the need for capacity extension and better infrastructure management.

There are two approaches to quantify external costs of transport. The first one starts with a *top-down* analysis and quantifies the total and average external costs. Internalization can be performed by a host of different instruments, which include, but are not restricted to, km-based charges. Other measures are taxes and regulation or emission trading schemes, and all measures are set to achieve particular reduction targets. The second approach starts from a microscopic (bottom-up) impact path approach and tries to quantify the marginal costs of externalities. Under the assumption of neo-classical welfare economics the transportation system will approach a systems optimum if charges are set at marginal costs. In the following we present both, the top-down and the bottom-up approaches.

The total external costs of transport, stemming from the above listed types of externalities, are estimated to about 7% of GDP in Europe for the year 2000 (INFRAS/IWW, 2004). This indicates that transport consumes a high amount of resources which are not priced, such as human health, damages to biodiversities or impacts of climate change. The road sector is responsible for more than 90% of external costs of transport, while air transport count for 6%. Railways contribute 2%, which is much less than their transport share.

The average external costs of railways are 2.3 cts/pkm versus 7.8 cts/pkm for cars and 5.3 cts/pkm for aviation. In goods transport the respective values are 1.7/8.5/26.4 cts/tkm for rail/road/air transport (INFRAS/IWW, 2004). Corridor studies show that rail traffic is the mode which – organized efficiently - minimizes social costs of traveling medium distances (which are short distances from an aviation viewpoint). Internalization of external costs would increase the competitiveness of railways on short distances compared to individual road traffic, and on medium distances compared to aviation. The position of aviation with respect to external costs is heavily dependent on the evaluation of CO_2 and other GHG.

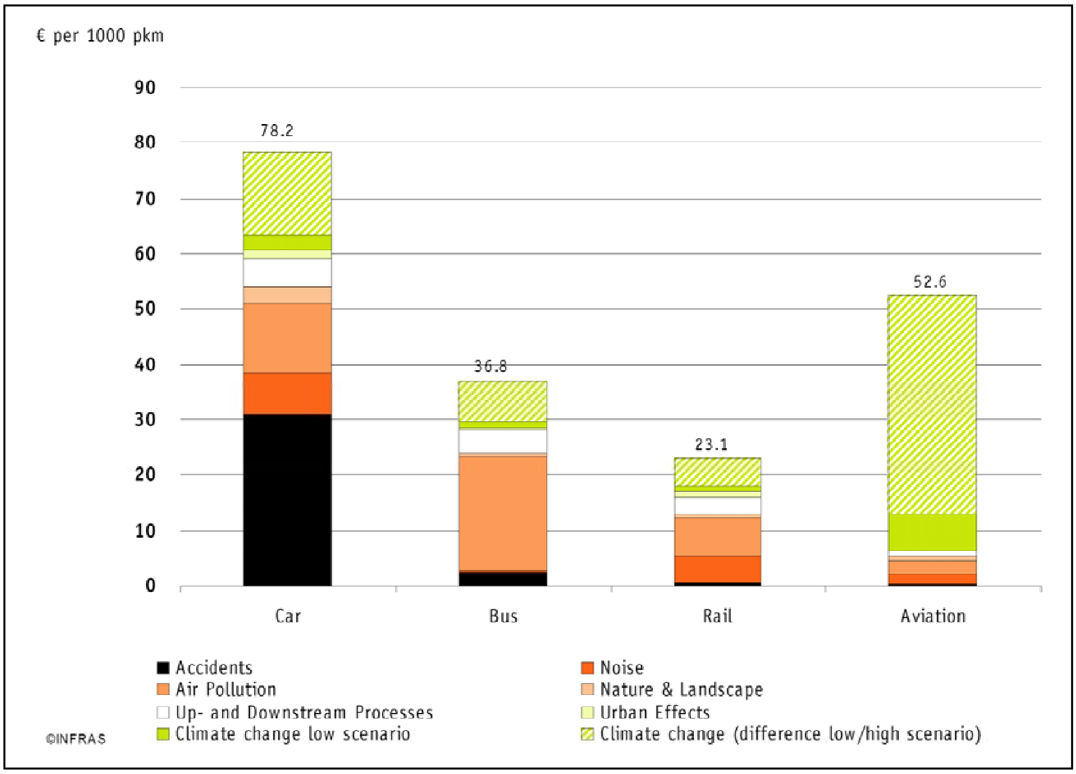

Figure 3: Average External Costs of Passenger Transport

Source: INFRAS/IWW, 2004

Figure 3 shows that the evaluation of impacts of CO_2 emissions is most important to characterize the environmental friendliness of a transportation mode. If the CO_2 value is low (in figure 3: 20 Euro per ton of CO_2) then the advantage of railways will diminish, compared with road and air, which leads to a very positive position for aviation on average. Alternatively, using a high value (in figure 3: 140 Euro per ton of CO_2) will completely change this picture and the favoring of energy efficient transport modes becomes the primary task of climate policy.

The contrasting *bottom-up approach* aims at quantifying the marginal external costs. In this context the congestion costs play an important role because they are social costs and lower the net welfare position of society. As the aim of quantification of social marginal costs - including marginal infrastructure and external costs - is setting charges right, this approach does not generate figures on total or average costs. The EU Commission has favored this scheme since 1998 when the *White Paper on Fair and Efficient Pricing of the Transport Infrastructure* was published. Since that time the Commission has launched a series of research studies to quantify the marginal external costs of transport. The most comprehensive studies were UNITE (2005) and GRACE (2007). As the European Parliament had insisted on including external costs of transport in the motorway charging scheme for heavy goods vehicles (Directive 2006/38), the Commission was obliged to present, no later than 10 June 2008, a generally applicable, transparent and comprehensive model for the assessment of all external costs on all modes to serve as the basis for future calculations of infrastructure charges. This model should be accompanied by a strategy for stepwise implementation of the model for all modes of transport.

In fulfilment of this obligation the Commission has presented a Handbook for calculating the marginal external costs of transport and a first implementation proposal which is still under discussion. Figures 4 and 5 show the type of marginal external costs and their magnitude. Note that the magnitudes are derived from the studies launched by the Commission such as UNITE and GRACE.

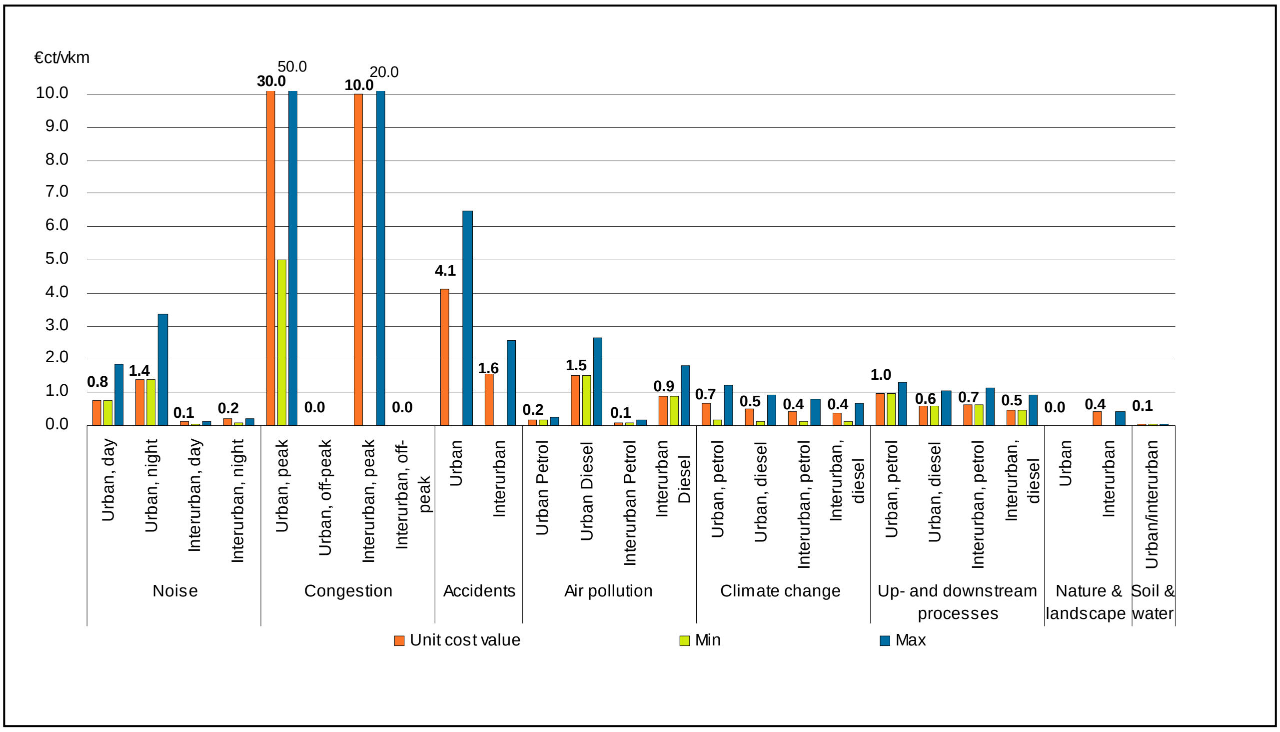

Figure 4: Passenger Car Unit Values of the Handbook; Base Year 2000.

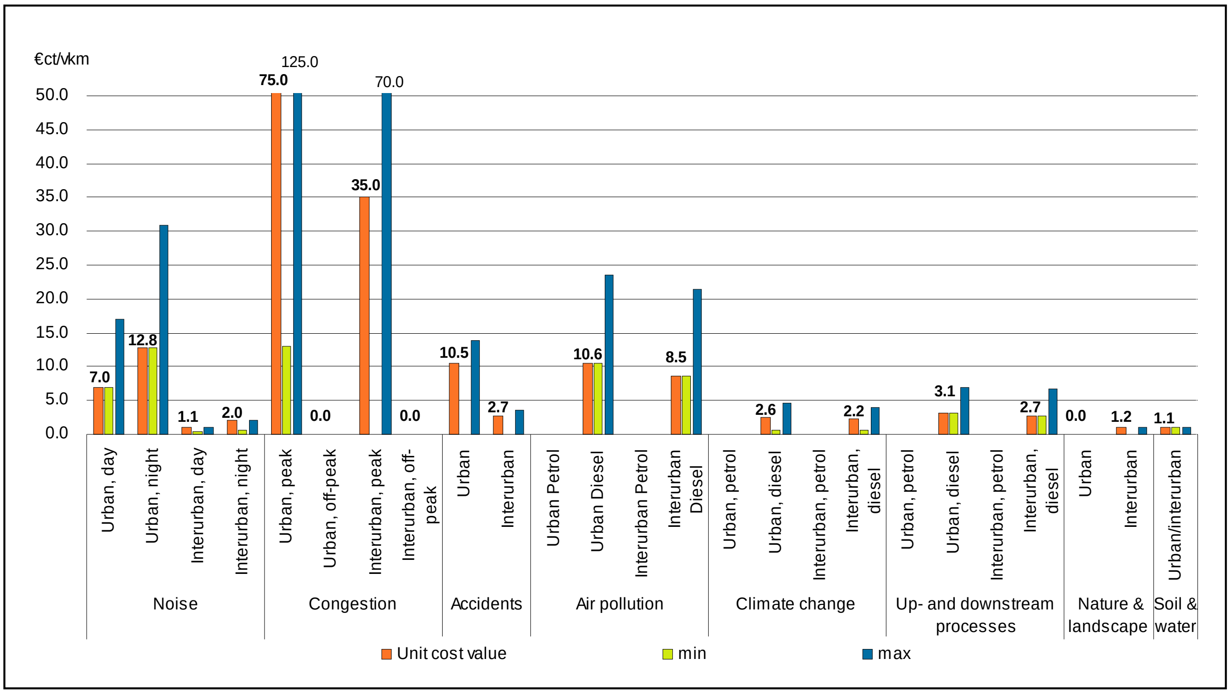

Figure 5: Heavy Goods Vehicles Unit Values of the Handbook; Base Year 2000

The implementation proposal of the Commission suggests that only three externalities should be included in the first phase: congestion, air pollution and noise. As can be easily derived from Figures 4 and 5, the congestion externalities will play a dominant role. Air pollution and noise are almost negligible; in particular if one assumes that the EURO V standard will be widely implemented in about five years. For instance, in Germany, where the HGV charges are differentiated according to EURO standards, PROGTRANS and IWW (2007) have forecasted that more than 70% of HGV operating on motorways in the year 2010 will be EURO V or even better.

The first impact analyses of the EU internalization scheme underline that – except for congestion – there will be little impact on the choices of shippers, forwarders and haulage companies (IWW and NESTEAR, 2009). Only the congestion part of the charge may have some impact, but it is not clear whether this goes in the right direction. For instance, if a truck moves on a long route through a busy corridor it is almost impossible to avoid congestion at day-time. Therefore, the only way to avoid congestion charges is to go by night. But this will cause noise costs at a time when people react most strongly to noise.

Furthermore, the Commission's concept of congestion charging is not consistent insofar as it adds marginal congestion costs to average infrastructure costs and does not take into account the different nature of congestion costs compared with other externalities. This is because congestion externalities in terms of additional time and operating costs at bottlenecks are covered by the road users and therefore internalized in the road system. In the absence of other externalities congestion costs could be internalized by traffic management systems and the revenues from road pricing would have to be used for removing bottlenecks in the road system. At the end of the day, such a scheme of congestion charging and investment activity to remove road bottlenecks would make road transport more efficient.

Imposing charges on road transport users which exceed the allocated infrastructure costs can only be justified if there are very high externalities of air pollution, noise, accidents or climate change. However, air pollution and noise are almost negligible and accidents and climate are missing in the EU internalization scheme. In particular, the missing internalization of climate change makes the scheme incomplete and in no way contribute to the CO_2 reduction targets of the EU.[7] Thus, the proposal of the Commission does not justify a cross-financing of railways or inland waterways by revenues from road pricing as it discussed in the *White Paper on Common Transport Policy*, 2001. This cross-financing model, which is applied in Switzerland to finance the NEAT tunnels crossing the Alps, is only rational if the "real externalities", in particular the external costs of climate change, are evaluated as very high.

4 TRANSPORT AND CLIMATE CHANGE

Transport counted for 24% of the worldwide production of CO_2 in 2003. For the OECD

[7] The Commission argues differently and underlines the influence of congestion charging on transport demand. However, if long distance trucking routes are studied from a logistics perspective the congestion charging, applied only to HGV, has little influence on CO_2 emissions, see IWW and NESTEAR, 2009).

countries this share was 29% (see ECMT, 2007). Road transport was the major emission source with 18%/23% for World/OECD, while aviation was responsible for 2%/3% of CO_2-emissions. In the developed world the share of road traffic, aviation and waterway transport is even higher. In particular, aviation has increased CO_2 emissions dramatically in the past 15 years. In the period between 1991 and 2003 these emissions have grown by 87% in the European Union. Furthermore, it has to be considered, that CO_2 emissions make up only 50% of climate gases produced by the aviation sector. Other components are water vapor, contrails or NO_x.

From this follows that the transport sector is a major source of the climate problem and will increase its relative contribution dramatically in the forthcoming decades. While OECD countries presently count for about 70% of transport induced GHG, this percentage will drop in the next decades and developing countries and countries which are presently at the threshold of industrialization (China, India, Latin America, South Africa), will take the lead.

This indicates a basic dilemma of climate policy: the industrialized countries are responsible for the problem of climate change the world is presently facing. They have neglected climate effects since the industrial revolution and are responsible for the current threats reflected in the statement of IPCC at the Valencia meeting in November 2007 that reduction measures have to be started in the short run to limit the increase of world temperature to 2^o C. In the long-term future the developing and the threshold countries will be the main accelerators for the problem (see Figure 6). It is therefore of crucial importance to integrate them into any form of climate policy from the beginning. There might be a natural interest of these countries to join common policies towards climate change because it can be shown by climate impact analysis that they will be hit substantially by the consequences of climate change.

While other sectors like the production or energy supply industries are starting to bring down CO_2-emissions in the developed world, the transport sector still shows a substantial increase. Road traffic is the major climate problem of the transport sector, followed by air and maritime transport.

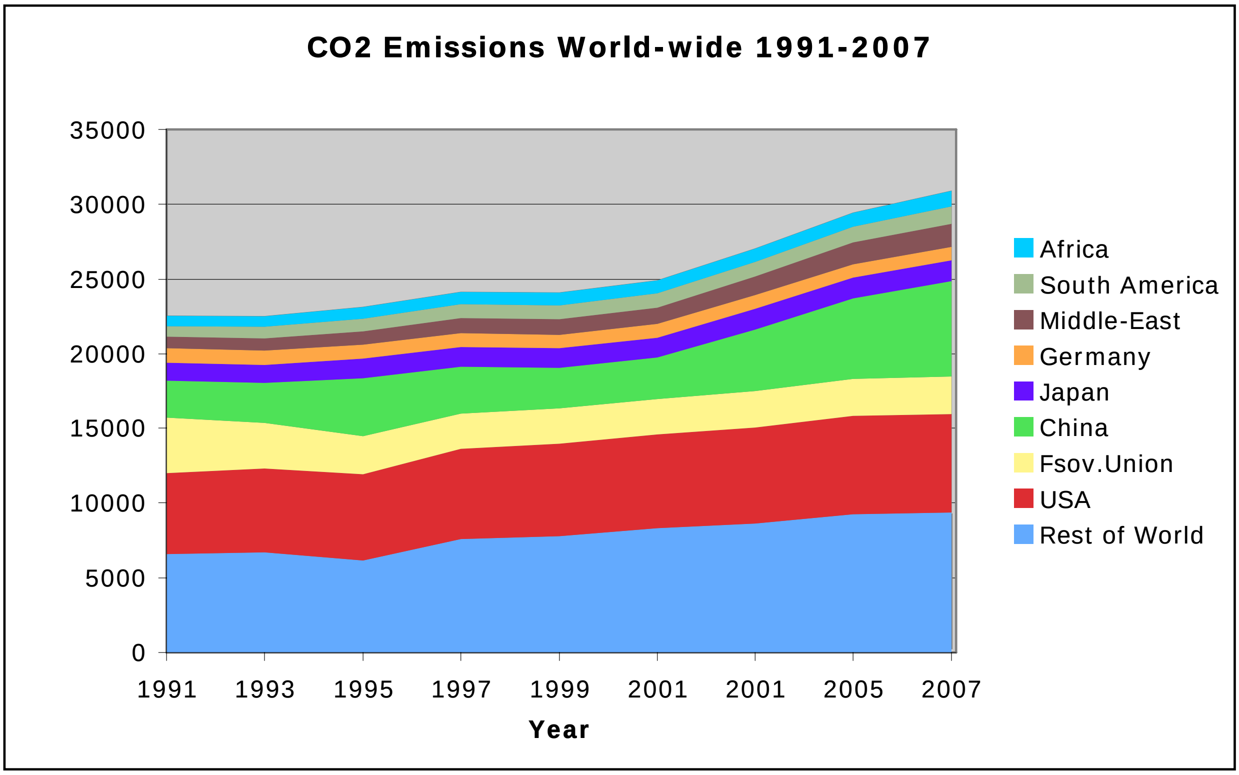

Figure 6: CO_2 Emissions of Selected Countries and Worldwide

Source: IWR, 2007

Figure 6 shows that the economic dynamics are the main drivers of energy consumption and CO_2 production. The rapid growth in China is accompanied by a similar rise in GHG emissions and China reached the total emission level of the US by the end of 2007. Nevertheless, the CO_2 emissions per capita are quite different with 19 tons per year and per capita in the US and almost 5 tons in China. The relative position of the countries of the former Soviet Union seems to have improved, which is mainly a result of the structural economic change after the breakdown of the socialist regimes. Also, the decrease in CO_2 emission in Germany is mainly due to the breakdown of old industrial structures of the socialist GDR regime and the industrial modernization after 1989. Still, one can observe that even after the economic restructuring and revitalization the trend of CO_2 production is increasing again in these countries.

5 MITIGATION AND ADAPTATION STRATEGIES

5.1 Mitigation

There are general and transportation specific instruments to mitigate climate change. Carbon taxation, for instance, is a general instrument which could be applied in a consistent way to all emitting sectors. However, there are already many solutions initiated by countries or sectors (sometimes leading to partial solutions only), such as fuel taxes or vehicle taxes, differentiated by fuel consumption so that the existing taxation systems would have to be changed in many countries before introducing a carbon tax.

A second general alternative is the emission-trading scheme, which in its most general extension would be an open cap and trade system, for which the caps would be periodically adjusted according to the agreed reduction trajectory for CO_2. Such a scheme was introduced in the European Union for the power production and other industrial sectors in the year 2005, albeit with a delayed and restricted auctioning of emission allowances, so that the prices per ton of CO_2 are still rather low. A worldwide system could start with an allocation of emission rights to the countries on a per capita base, which would take into account the different development levels of the countries. This might be an acceptable base for the developing countries that would receive more emission rights than needed and could sell the excess stock of certificates. The countries could allocate the emission rights domestically by auctioning.

Further variants of trading schemes are closed systems, within countries, sectors or even bottleneck capacities within sectors. For example, studies have been conducted on introducing a trading scheme for alp transit by motorway in Switzerland. All trading schemes can start from up-stream (production and distribution of fossil fuel), mid-stream (vehicle purchase) or down-stream (use of vehicles by consumers and transport industries). From the viewpoint of implementation, an up-stream system seems to be preferable because the number of trading agents can be limited. Furthermore, a trading scheme can be open, i.e., include all producers of CO_2, or closed in a way that only emittents of a particular sector are allowed to trade. In the latter case the global reduction target has to be broken down by sectors. While the advantage of closed systems lies in the strict controllability of the scheme, its economic efficiency can be doubted. This is because the market processes will not lead automatically to a least cost mitigation scheme, starting with the sectors for which the marginal costs of mitigation are low. An open system, on the other hand, could guarantee such an automatic process provided it is working with market conforming instruments and all emission allowances are auctioned off. As one can learn from the EU Emission Trading Scheme (ETS), which was introduced in 2005 for the energy production and several industrial sectors, such a scheme can be disturbed and loose efficiency by distributing the allowances through non-market schemes, as for instance by grandfather rights.

The Kyoto Protocol leaves the possibility for industrialized countries to achieve emission reductions by investing in developing countries through the Clean Development Mechanism (CDM) and the Joint Implementation (JI). Using the Global Environmental Facility (GEF) instrument, which has been established by UNDP, UNEP and World Bank, can extend this policy. In general, the CDM and GEF instruments have not been used extensively in the transport sector (see WCTRS and ITPS, 2003). At present, only two transport projects have been launched under the CDM and GEF mechanisms. A main reason for this is the difficulty with which transport projects meet all CDM criteria “long-term”, “measurable”, “verifiable” and “additional”. An exact measurement of CO_2 reduction due to a transport project is very difficult.

Sector specific instruments apply only for segments of the transport sector, as for instance:

- Fuel taxation (special carbon tax)
- Vehicle taxation based on CO_2 production
- User charges for infrastructure use with differentiation or mark-ups for CO_2
- Regulation and standards

First of all, these instruments do not apply to sectors governed by international law, as for instance aviation and maritime shipping. Secondly, the disadvantages of such sector specific instruments are that (1) they cannot be controlled with respect to a global target[8] and (2) it is not possible to determine an optimal design with respect to CO_2 reduction (e.g.: equilibrate the marginal costs of damage and mitigation). The main advantage of these instruments is, on the other hand, that they are easy to implement and widely available already in the short run, without

[8] The EU, for instance, has decided a reduction target of 20% until 2020, which might be increased to 30% if major non-EU countries follow.

waiting for international agreements.

While the above measures aim at directly controlling the CO_2 emissions produced by transport activities, there is a host of state policies which work indirectly but can be most efficient. This includes:

- Investment in the transport infrastructure
- Co-ordinated planning of land-use and transport
- Support for research and technology development for innovative vehicles

Better infrastructure can remove bottlenecks and attract transport activities to the environmentally best alternatives. Co-ordination of land-use and transport infrastructure determines the traffic patterns of the future and is a most important instrument of sustainable transport policy in the big cities of developing countries. Although there is a high potential to reduce CO_2 emissions with existing technologies, the long-term balance between growing demand for mobility and freight transport and a sustainable environment will require innovative technologies in the future. State research programs and pilot field tests with innovative vehicles are therefore necessary to create the conditions to leapfrog on to new technologies.

5.3 Adaptation

While mitigation aims at reducing the probability of risk, the adaptation strategy tries to reduce the damages, which follow if the risk scenario has actually occurred. The recent IPCC studies, meanwhile, assume that an increase in world temperature of 2° C is inevitable until 2100. If concerted worldwide mitigation agreements are not possible then the temperature increase approaches the business-as-usual line. The damages described in Figure 1 can then be understood as having a high probability of occurring, but the intensity is not known today. In this situation, it is rational to consider possibilities of reducing damages induced by potential catastrophic events in the future.

US based literature in particular focuses on this point of departure (see e.g. Dewar and Wachs, 2009) or Lockwood (2008). “Hard” strategies focus on material investment to reduce damages, such as constructing higher dikes to prepare for higher sea levels or providing inundation areas to prepare for high river water. “Soft” strategies for adaptation can be establishing well-prepared command and management structures, providing appropriate information systems or training personnel for managing catastrophes. Also in the case of adaptation policy, least cost combinations can be determined to reduce the consequences of risks.

From the economic point of view the challenge will be to find an optimal combination of mitigation and adaptation policies. But here the problem of discounting future benefits and costs emerges again. If the discount rate is high, the present generation prefers to focus on adaptation in the future. Transferring capital and resources to the future will be the right policy to help future generations. If the discount rate is low, it is rational to invest in mitigation measures now to keep the risk of future damage as low as possible.

6 Case Studies

6.1 Limit Values for Cars

In the EU there has been a heavy debate on the reduction of specific emission values of cars. The vehicle manufacturers had promised by voluntary agreement to reduce CO_2 emissions to 140 g/km by the year 2008. As it turned out, this target could not be achieved by far, because the emission values of 2007 exceeded 160 g/km. The DG Environment of the EU Commission decided, against this background, to set a reduction target of 120 g/km by the year 2012, as an average value for all newly registered vehicles. The intervention of the German Government led to a change insofar as it was decided to allow the adding of bio-fuels in an order of magnitude which leads to a reduction of 10 gCO_2/km.Accordingly, the target for fuel consumption was set to 130 g/km.

The question of how to achieve this target led to the analysis of different strategies:

- Make every vehicle producer achieve the target value with the vehicle mix of its fleet;
- Introduce a closed cap and trade system and trade emission certificates among vehicle manufacturers (mid-stream “standard and credit” system);
- Define a reference curve for producers of vehicles of different sizes (defined in

space or weight) and introduce a penalty (or bonus-malus) system - the favored solution by the Commission, see Figure 7.

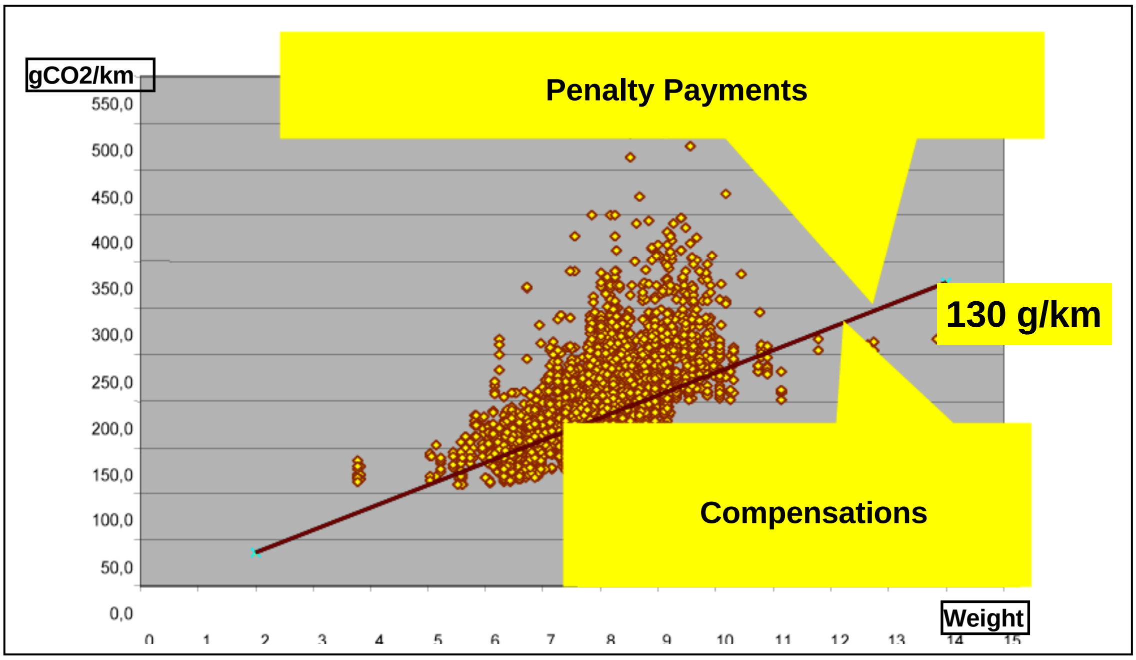

Figure 7: EU Penalty Scheme for CO_2 Emission of Passenger Cars

Source: EU Commission, Zierock, 2007

130 g limit: 120 g to be achieved through reduction of fuel consumption, 10 achieved through adding bio-fuels.

The EU Commission suggests introducing soft regulations on fuel consumption of the vehicle fleet of manufacturers in 2012, which are followed by rigid rules in the year 2015, limiting CO_2 emissions to 120 g/vehkm in 2015 and restricting this limit to 95 g/vehkm in 2020. The penalties foreseen can reach a magnitude of 95 Euros per gram of CO_2 emission exceeding the reference curve. The reference curve allows the producers of bigger cars (e.g. Vans) to deviate from the target, but less than proportional. Very fuel-efficient cars in the fleet can compensate for higher fuel consumption of others. The long transition phase of introduction allows the producers of high powered “premium” passenger cars to adjust their fleet. This is a result of successful lobbying of the German automobile industry trying to avoid disadvantages compared with the French and Italian manufacturers that produce smaller passenger cars with lower fuel consumption, on average. Under status quo conditions the producers of big BMW, Mercedes or Porsche cars would have to pay between 3,500 and 15,000 Euros per car, which might influence purchase decisions substantially, even in the market segments of premium cars.

Case Study 2: Differentiation of Road User Charges

The so-called Euro-Vignette charging scheme for HGV on motorways in Europe gives an example of how a differentiation of user charges according to environmental performance can create incentives for buying and employing the most environmentally advanced technology. With this in mind, the scheme comes close to the Japanese “Top Runner” charging system which gives advantages to the “innovators” who start early with buying the environmentally best vehicles available. The charging system, which is presently implemented in Austria and Germany and in an even more effective way in Switzerland, starts from the allocated average infrastructure costs and allows for a differentiation of charges by maximally 100% for congestion and 100% for environmental performance. Only by looking at the latter one can see that EURO I vehicles pay double charge compared with EURO V. In Germany, where the system was introduced in 2005,when the range for differentiation was only 50%, one can observe significant market reactions. Figure 8 has been prepared in the context of the Germany motorway charging study (PROGTRANS and IWW, 2007) to give an impression of the possible market reaction to the differentiation scheme.

The most remarkable reaction is that the EURO IV category, which is presently the minimum requirement for newly licensed HGV, will play a small role in the future because better categories are already on the market (EURO V) and get charge reduction. Table 1 shows that this reduction is more effective than the marginal cost difference according to the Handbook calculation of the Commission.

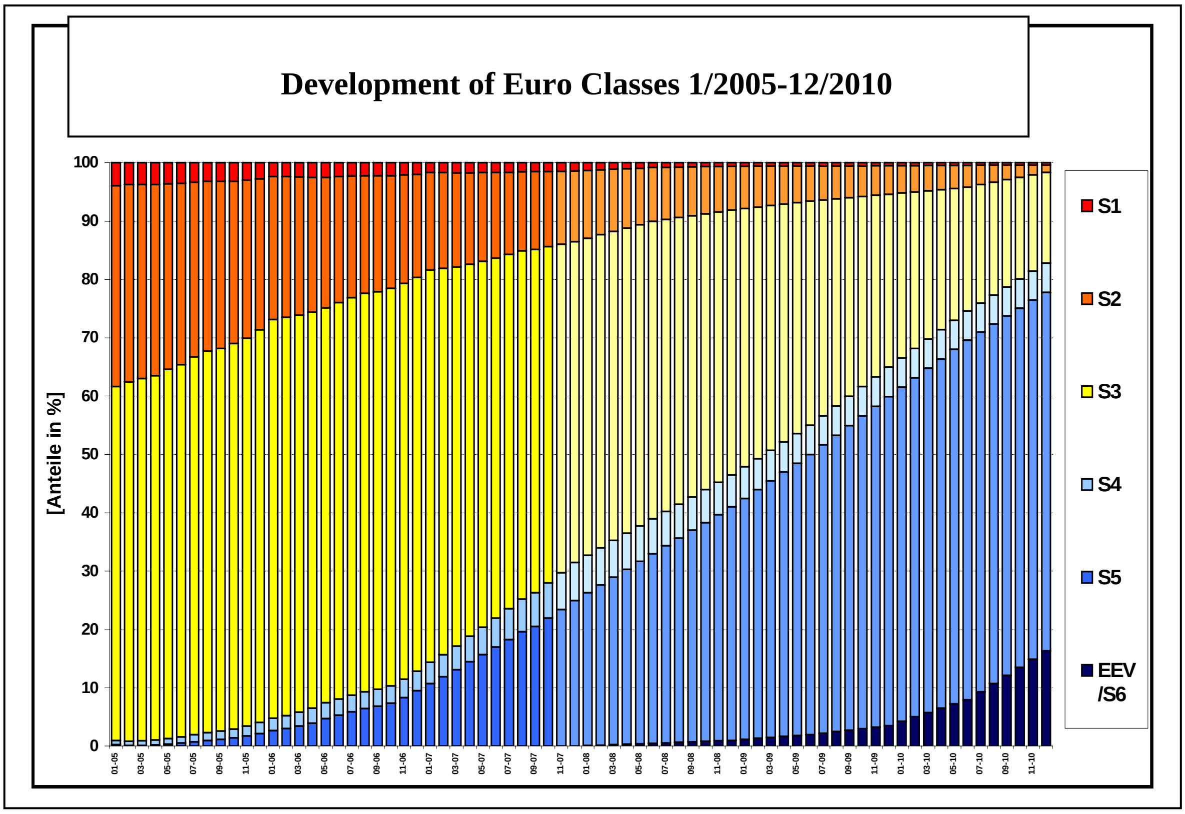

Figure 8: Development of Euro Classes on German Motorways after Introducing a Differentiated HGV Charge

Source: PROGTRANS and IWW (2007)

SI corresponds to Euro Class I; EEV means environmentally enhanced vehicles.

If we compare the incentives generated from this cost internalization scheme with the EU marginal cost scheme summarized in the Handbook it is easy to notice that the latter is much less effective. It will take much longer before the market accomodates the most advanced environmental technology, if the Handbook values are internalized. This leads to a further conclusion: until now the EURO VI standard has not been finally decided on. Agreements are widely achieved on NO_x and Particulate Matter. It might be useful to also include, as a new element, CO_2 in the EURO standard, beginning with EURO VI.[9] In this case it would be easy to integrate incentives in road user charging schemes for HGV, and also for other vehicle categories.

Differential Charge cts/km; >32 t	E5/E4	E5/E3	E5/E2
Handbook	**1.7**	**4.8**	**6.8**
Progtrans/IWW	**2.6**	**6.5**	**12.3**

Break-even E3 -> E5	**Handbook**	**80,000 km**
Break-even E3 –> E5	**Progtr/IWW**	**60,000 km**
Break-even E4 -> E5	**Progtr/IWW**	**50,000 km**

Table 1: Comparison of Incentives of the German Motorway Charging Scheme Compared with the Internalization Proposal of the EU
Sources: Handbook (2008), Progtrans and IWW, 2007

Case Study 3: Up-stream Emission Trading Scheme

The EU has ratified the Kyoto Protocol and promised to reduce its CO_2 emissions by 8% until 2010 compared to 1990. Facing the future challenges the EU has taken a big step further and promised to reduce CO_2 emissions by 20% until 2020, based on the 1990 level. If other countries follow, for instance the US after the change of president-ship, the EU would be willing to raise the figure up to 30%. One of the policies which has been implemented to do so is the European Emission Trading Scheme for CO_2 certificates. So far, the transport sector, which contributes

[9] This would be a major new element and presupposes that appropriate test cycles are agreed on.

around 28% of European CO_2 emissions, has been exempted from ETS[10], although a further increase in CO_2 emissions from the transport sector is expected in the coming years. Furthermore, this is the only sector in which emissions have increased (by about 32% since 1990). For post 2012 an inclusion of road transport into ETS could be feasible.

For trading schemes the following remains to be defined (beyond a long list of technical requirements):

- What the reduction amounts should be and how they are measured
- Whether a down –, mid- or upstream system should be established
- Which parties are allowed to trade
- Whether the trading scheme should be open or closed

The European Emission Trading Scheme (ETS) was introduced in 2005 and includes so far the energy sector and parts of the industrial sector. Jochem (2009) has analyzed the impacts of different types of trading on the effectiveness and prices of CO_2.

First of all, it makes little sense to introduce a downstream system because this would imply that millions of costumers would become traders. At the end of the day, this would mean that a second currency is introduced because the vehicle operators would need money for fuel and allowances for CO_2. It is obvious that transaction costs would be much lower if the climate target could be achieved through a carbon tax. In the case of upstream trading, the fuel suppliers would be the trading parties. They would be allocated CO_2 allowances through a distribution mechanism (e.g. auctioning) and they would forward the costs to the customers through the fuel price.

In an open system the fuel suppliers would trade with each other and also with other agents, which are already included in ETS. In this case all parties, which are confronted with high costs of mitigation, would prefer to buy allowances, while the parties with low mitigation costs could sell a part of their stock of emission certificates. This means that the market would decide which sectors to buy and which sectors to sell certificates and the global mitigation target could be

[10] Only the railway companies are included as producers (directly) and consumers (indirectly) of electrical power.

achieved at minimal costs.

In a closed system the global reduction target has to be broken down to the single sectors. If all sectors are confronted with the same reduction target then most studies forecast that the transport sector will be substantially hit because of high costs of mitigation and high growth rates in some segments. As a consequence, a closed trading system would lead to higher costs in reducing one ton of CO_2 compared with an open system. Jochem (2009) has tested this hypothesis with German data and a multi-agent model. The results are summarized by the two Figures 9 and 10.

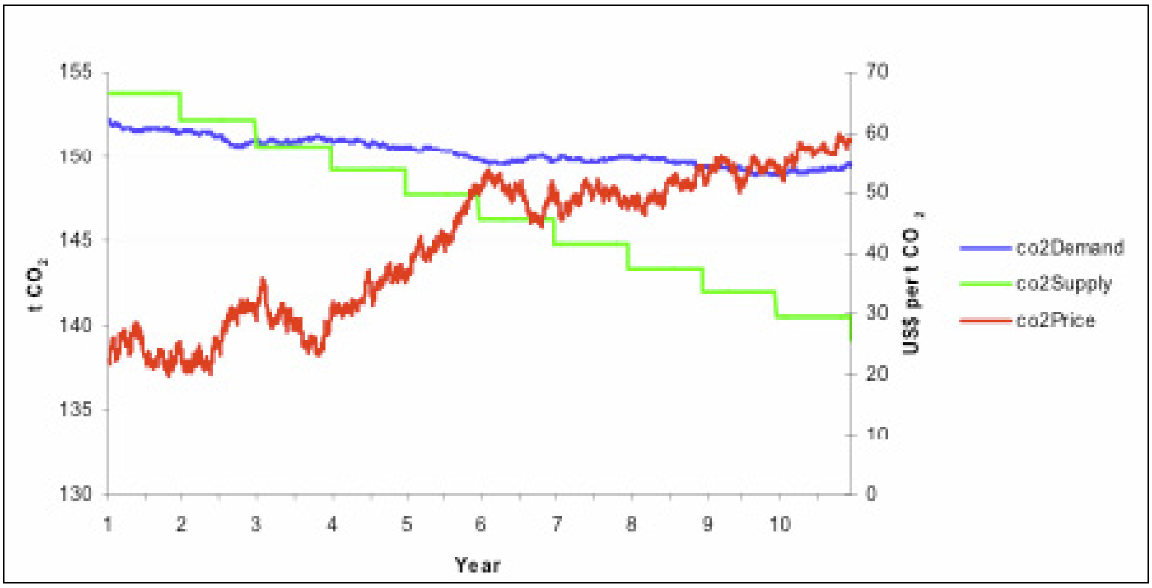

Figure 9: CO_2 Price in an Open Trading System

Source: Jochem, 2009

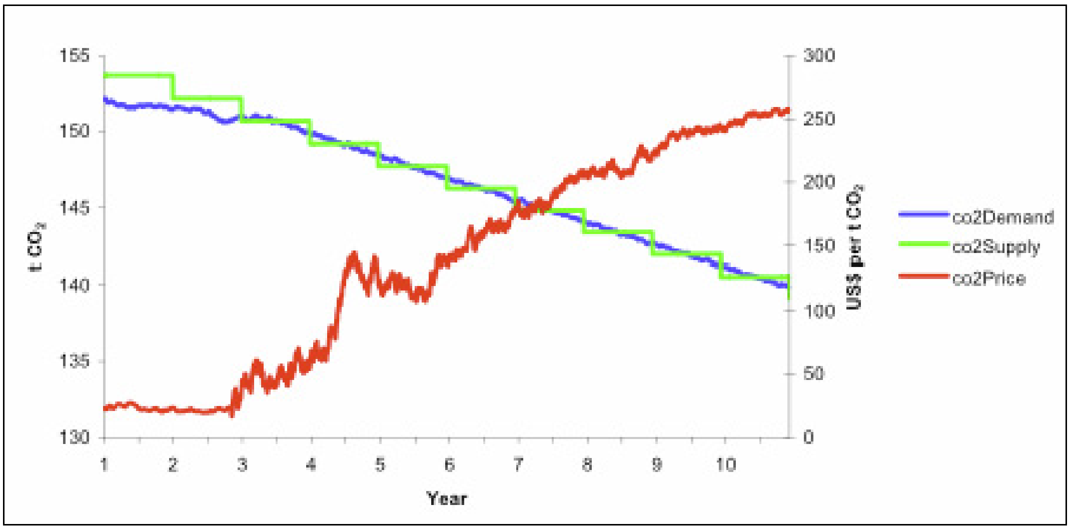

Figure 10: CO_2 Price in a Closed Trading System

Source: Jochem, 2009

The above results reflect the “standard” outcome of an economic evaluation of mitigation strategies including different sectors. Taking into consideration the reactions of consumers to price changes in the past, one can derive that the demand elasticities to price are very low in the transport sector. Considering the figures on production costs in the past one can conclude that it is very expensive to produce low fuel consumption technology. For example the automobile manufacturers of Germany – who are specialized in high powered premium cars – have argued that the 120 g target would imply a cost of some hundreds of Euros for a ton of CO_2. Against the background of these historical findings the results of Jochem seem reasonable.

But analyzing these arguments more deeply one cannot agree with dramatically higher mitigation costs in the transport sector and low price elasticities of demand. Low price elasticities have been observed in time periods of low fuel prices (in real terms fuel prices have been decreasing for a long time). When the low price era ended in 2005 one could observe an increasing response of demand to higher fuel prices. In some EU countries this has led to constant and partly decreasing overall vehkms on roads.

When it comes to mitigation costs one has to keep in mind that many households have bought overpowered cars, and that a great share of high powered premium cars has been sold to companies and given to their management staff as salary compensations to save taxes. This means that the share of high powered and high fuel consuming cars will diminish as soon as counterproductive incentives from taxation rules disappear. In the following section we will show that not only passenger car travel but also freight and logistics demonstrate a high potential for CO_2 reduction.

7 Changing Behavior and Organizational Structures

In many climate scenarios only the technological potential for reduction of CO_2 is analyzed. This leads to rather naive results; for instance it leads to the expectation that restructuring the car fleet in a way that 120 g CO_2/km is consumed instead of 160 g on the average, would bring a net saving of 25% of CO_2 for car traffic. However, in reality this level only can be achieved if customers buy the new technology and adjust their driving behavior. In freight transport the potential for more efficient propulsion technology seems much lower, in the medium term, compared with passenger cars. Nevertheless there are many possibilities to reduce energy consumption by changing behavior and logistical organization.

7.1 Passenger Transport

The instruments beyond fuel prices that stimulate people to save energy in passenger transport are:

- Taxes and charges
- Regulation
- Acceptance campaigns and badges
- Promotion of voluntary change of driving behavior

The reactions can be:

- Driving more smoothly with the existing car
- Buying a more fuel-efficient car
- Changing destinations (reduce km distance), or routes
- Changing mode, prefer rail or non-motorized transport
- Reducing motorized trips

The willingness of people to change behavior is often underestimated. In particular, observing the reactions in the past to rising fuel prices one could derive that demand does not react sensitively to higher prices, induced by taxes and charges. But this is not true. Eco-driving can bring about significant reductions in fuel consumption and may become more popular through campaigns in an environment of rising fuel prices. A number of examples show (e.g. London, Stockholm and Singapore) that there will be significant reactions of demand, if the price level is high enough and good, environmentally friendlier, alternatives exist. In the case of partial road pricing schemes, which are only related to part of an agglomeration (city center), a part of users (cars or trucks) or a part of the network (only motorways or urban freeways), counter-productive reactions from the demand side can occur. This is because every incomplete pricing scheme will motivate the users to divert to cheaper alternatives. Switzerland, therefore, gives the best example insofar as all roads are included in the road charging system for trucks and all vehicles pay (vignette for passenger cars on motorways, km-based charge for trucks on all roads).

The question of whether or not customers will buy more fuel efficient cars depends on the situation and preferences of households and the price differential for cleaner technology. In the past ,clean cars had little chance to expand their market share because they were much more expensive than standard cars. For instance, the first European 3l/100 km car, the VW Lupo, was 25% more expensive than the standard model, or the other way round; for the same price the customer could buy a much higher powered and more comfortable model with higher prestige. Dudenhöffer (2007) has shown that this problem could be overcome by a closed trading system. In such a system the producer of high powered cars, such as Porsche, would have to pay about 8,000 Euro while the producer of a small fuel efficient car would receive about 1,000 Euro per unit.

Figure 11 shows the range of technologies on the left hand and the average emissions by countries on the right hand. It can be seen that Italian and French car manufacturers produce a higher share of fuel efficient cars compared with German producers who have concentrated on the market for high powered “premium cars” for a long time.

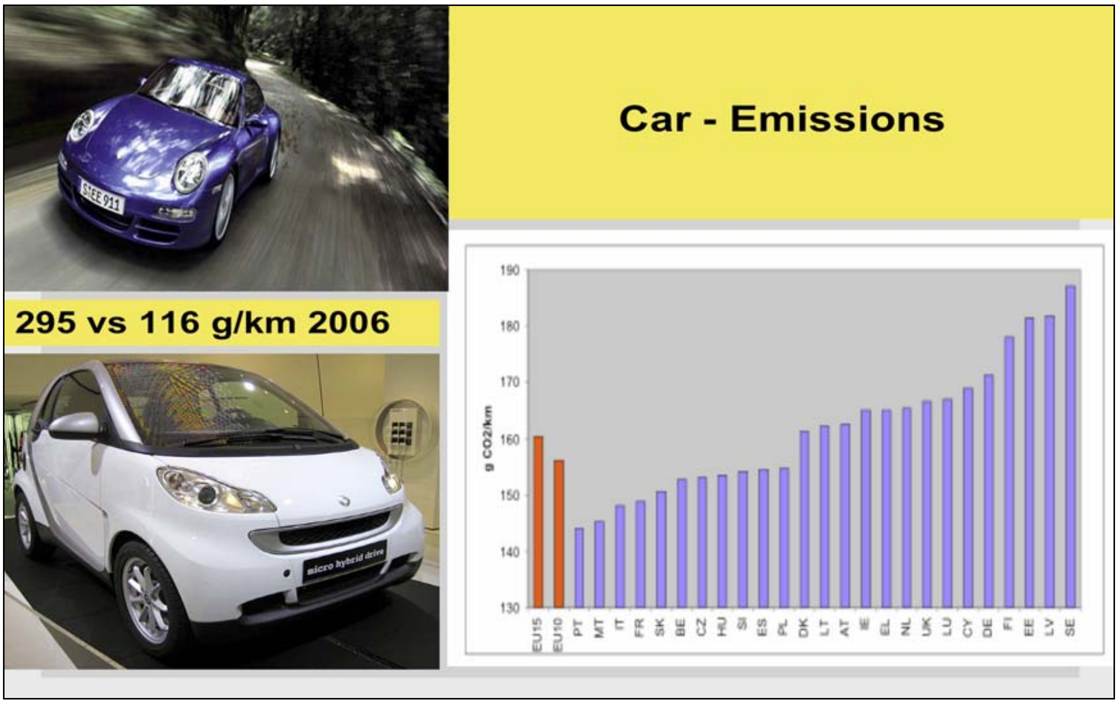

Figure 11: Fuel Efficiency by Type of Products and By Countries

Average CO_2 Emissions in g/km

7.2 Freight Transport

While passenger transport is more or less stagnating in several European countries, freight transport is much more dynamic. Freight transport grows at rates higher than GDP (see Figure 12) because it is closely related to trade development, which was increasing due to globalization until the economic crisis in 2008.

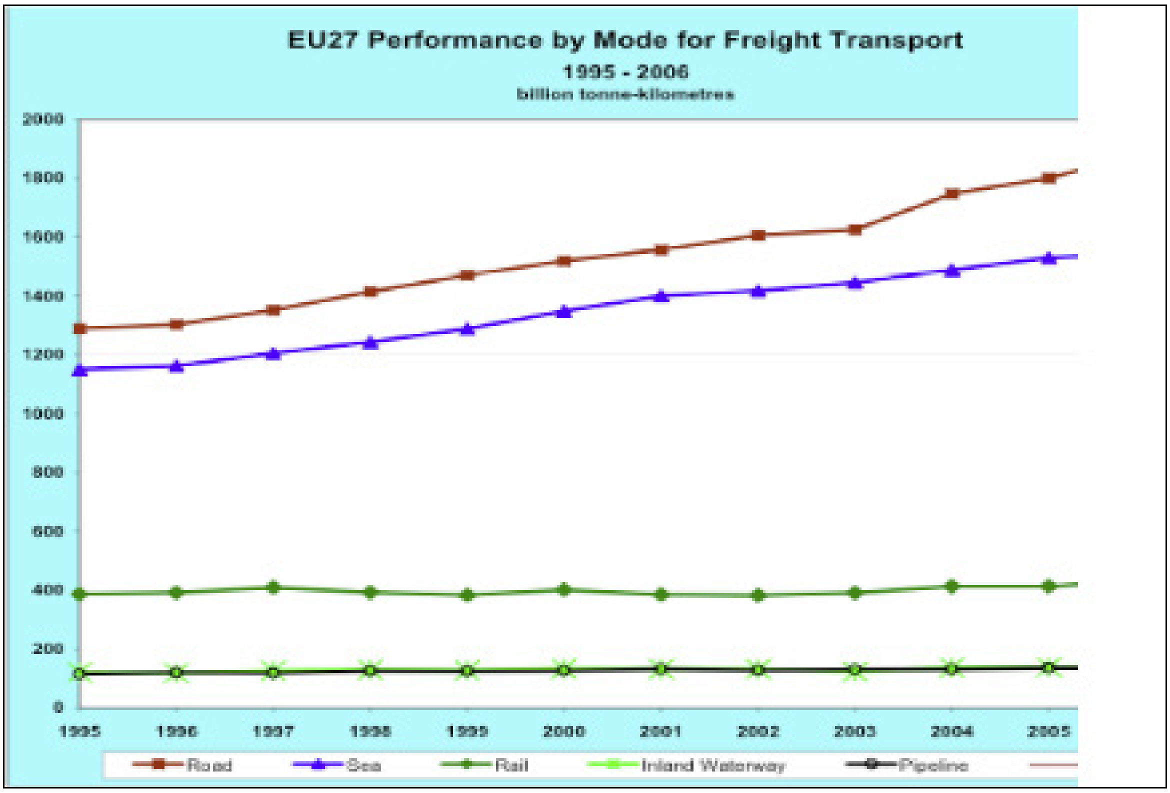

Figure 12: Development of Freight transport in Europe 1995 – 2005 (ton-km)

Source: EU Pocket Book Transport Facts and Figures, 2008

From this development it follows that it is almost impossible to reduce emissions from freight transport for two reasons: first of all, the rapid growth and secondly the intrinsic tendency in this sector to minimize transport costs. As fuel consumption is a part of transport costs it is also the focus of minimization. This differs from the passenger transport sector in which non-rational driving or purchase behavior leads to large deviations from minimization of cost and fuel consumption.

With rising energy prices in the past three years more companies have become interested in reducing their energy costs. As reduction through more fuel efficient vehicles is limited in freight transport (in the short and medium run), companies analyzed their logistics patterns and tried improvements through better organization of transport flows. For instance, DHL announced at last year's ITF conference in Leipzig, to reduce CO_2 emissions from their service operations by 30 % until 2020, based on 2007.

Another instrument for improvement is co-operative logistics, i.e. logistic patterns are not optimized for one individual firm, but rather for families of firms. This can be done by forming alliances or employing contract logistic service providers who try to bundle the transport flows of a number of companies. Big companies are starting to coordinate logistics together with their suppliers. A further possibility is to construct a platform for open logistic networks. This is studied in a project by the German Ministry of Economic Affairs, LOGOTAKT (2008).

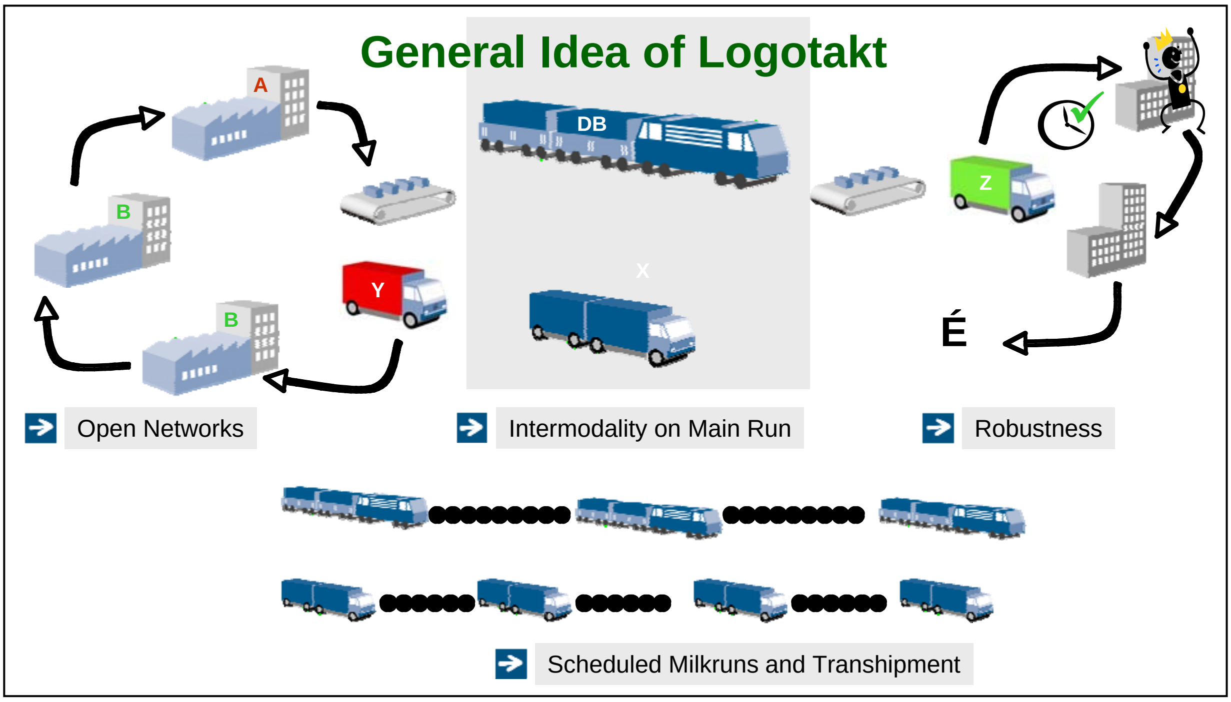

Figure 13: The General Idea of the Open Logistic Network LOGOTAKT

Source: LOGOTAKT, 2008

The general idea is to offer scheduled services for a number of network partners so that milk runs can be better coordinated and so that the most efficient transport means can be chosen for main runs. For long distances and high volumes (after consolidation of consignments) railways may be preferred because of less energy consumption (factor 4, depending on loading factor). Figure 14 shows the so-called railport network which European railway companies are considering to establish. Most of the railports are former marshalling yards, which are transformed into logistic centers. The precondition is that goods can be containerized through consolidation from pallet units, which holds for the major part of non-bulk cargo.

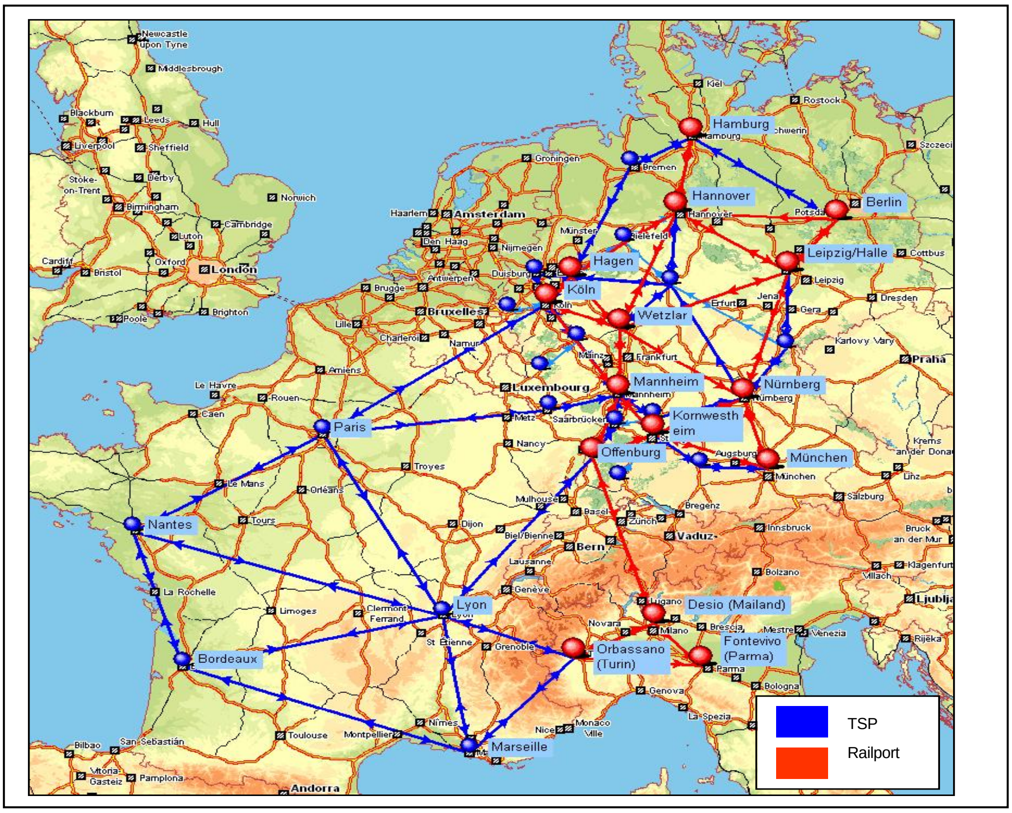

Figure 15: Railport Network in Europe

Source: LOGOTAKT, 2009

IWW/NESTEAR (2009) have shown in a study for the Community of European Railway and Infrastructure Companies (CER) that this tendency can be substantially accelerated by a consequent internalization of external costs on roads and removing bottlenecks/improving productivity for rail. With respect to CO_2 reduction, they come to the conclusion that shifting freight transport from road to rail in segments in which railways can compete on can reduce emissions in the EU by 12 million tons per year, or 12.5 %. It follows that a modal shift would bring a substantial contribution to the “Bali Roadmap” and the EU target to cut CO_2 emissions of transport. According to the European Environment Agency (EEA) (2008) the projected emissions of transport in the EU will be 949 mill. tons in 2010. The minimum EU target for 2020 is to achieve a level of 767 mill. tons/year in 2020 which makes a difference of 182 mill. tons/year. The modal shift from road to rail estimated in the CER study would contribute about 7% to this global goal.

8 Conclusions

The COP 14 UN Climate Conference, held in Poznan in December 2008, began and ended with critical comments from environmentalists. A most critical assessment was given with respect to the Kyoto Protocol achievements. The EU has achieved only 2,2% reduction instead of 8% compared with 1990, and the US (which has not signed the Kyoto Protocol) has even shown an increase of 14%. Political pressure for more effective reduction policies will grow, and there is some hope that the US will be integrated in the global initiative. This would be the precondition to get the developing countries on board. One of the major achievements of COP 14 is the establishment of an Adaption Fund for the developing countries. However, no agreement was possible with respect to financing this fund by contributions from industrialized countries. The conference was heavily influenced by the present economic and financial crisis, making it difficult for the parties to agree on long-term financial obligations.

Some positive signals came from countries at the threshold of industrialization. China plans to reduce energy consumption per Yuan of GDP by 20% until 2010, compared with 2005. The Republic of South Africa has announced they will stop the increase of greenhouse gases within 10 years. And the Brazilian Government promised to reduce CO_2 emissions by about five bill. tons, until the year 2017, by ending the cutting and burning of rain forests.

It seems that advanced developing countries are ready to increase their efforts in CO_2 reduction policy because they realize that they will benefit from such policy in the long run; through better environmental quality/less environmental risk for their citizens as well as by becoming competitive on the future product markets on which innovative CO_2 saving products and services might gain much higher shares compared with today.

While the road maps for the reduction policy and the intensity of instruments are still uncertain, it is highly probable that more ambitious reduction targets will be decided at the next climate conferences, beginning with Copenhagen in December 2009 where the follow-up agreements to the Kyoto Protocol are on the agenda. This will have consequences for the transport sector. This sector cannot be excluded from reduction policy with the arguments that mitigation measures might be more expensive compared with other sectors, or that the growth rates are so high, as observed in the road freight sector in the past. There are good reasons to postulate that in the industrialized countries, the transport sector can achieve similar percentages of reduction as the energy and industrial production sectors. In the developing world the rapid increase of CO_2 emissions from the transport sector can be stopped within a limited range of time.

The present economic crisis following the turmoil in the financial sector has forced governments to increase their activities and the central banks to keep interest rates low. This offers a chance to increase investments in new environmental technologies and lower entry barriers for clean products. In this sense the recovery phase can be used for "creative disruption" (Schumpeter, 1952)[11], which overcomes old structures and prepares the economy for the challenges of the future.

[11] The Austrian economist Joseph A. Schumpeter established the theory that crises can accelerate the market dynamics because old structures are removed and innovations are fostered.

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