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THE ROLE OF THE TRANSPORT SECTOR IN ENVIRONMENTAL PROTECTION

BACKGROUND PAPER NO. 15

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The Role of the Transport Sector in Environmental Protection

UNEP

The transport sector has fundamental environmental impacts while greatly contributing to the socio-economic development worldwide. Therefore, all players in the transport sector have an important role to play in making sure that the transport services necessary to economy and quality of life are provided in the most sustainable manner.

Socio-economic development

Transportation means personal mobility as well as access to goods, services and information. It is an essential human activity that makes a critical input to social development, and national and global economies.

The transport sector, comprising the automotive industry, aircraft construction and operation industry, train construction and railway operation and the ship building and operation industry and their suppliers, is probably the largest sector in the world, in terms of financial turnover, workforce, and resource use. The direct value added by the transport sector to the global GDP is at 3 – 5%, and transport directly provides 5 – 8 % of a "typical" country's total paid employment. Indirect value added and employment in related sectors is much higher. The turnover of the largest three automotive manufacturers alone exceeds the GNP of the whole African continent.

Historically, the development of a country's transport sector has been an indicator for its economic welfare and success, and ownership of a car and leisure travel are even status symbols.

Over the past 50 years, the transport sector was the most growing one in industrialised countries. Freight transport, especially, has been growing rapidly; overall freight transport has increased by an average of 2-3% annually in OECD countries since the 1970s, and road freight has even increased by 3.7% annually. Although complete figures for developing countries are not available, the World Energy Council estimates that growth in truck transport between 1995 and 2020 will be 3-4% in Asia and almost 5% in Sub-Saharan Africa.

This growth, which is still increasing, is due to:

- population growth;
- rising living standards, which tend to bring about an increase in the frequency and length of personal travel and in the volume of goods transported;
- increased urbanisation - for the first time, a majority of people will live in urban areas – and particular the expansion of big cities creates new needs for urban transport;
- increased access to transport, also in countries with economies in transition and developing countries; and
- evolutions in industrial practices increase the demand for goods transport (flexible stocks, express deliveries, etc.).

At the same time, increased access to goods, services and information greatly furthers social development.

A third layer of the contribution of the transport sector to the socio-economic development, is through mainly multi-national companies. They are often aiming at improving quality of

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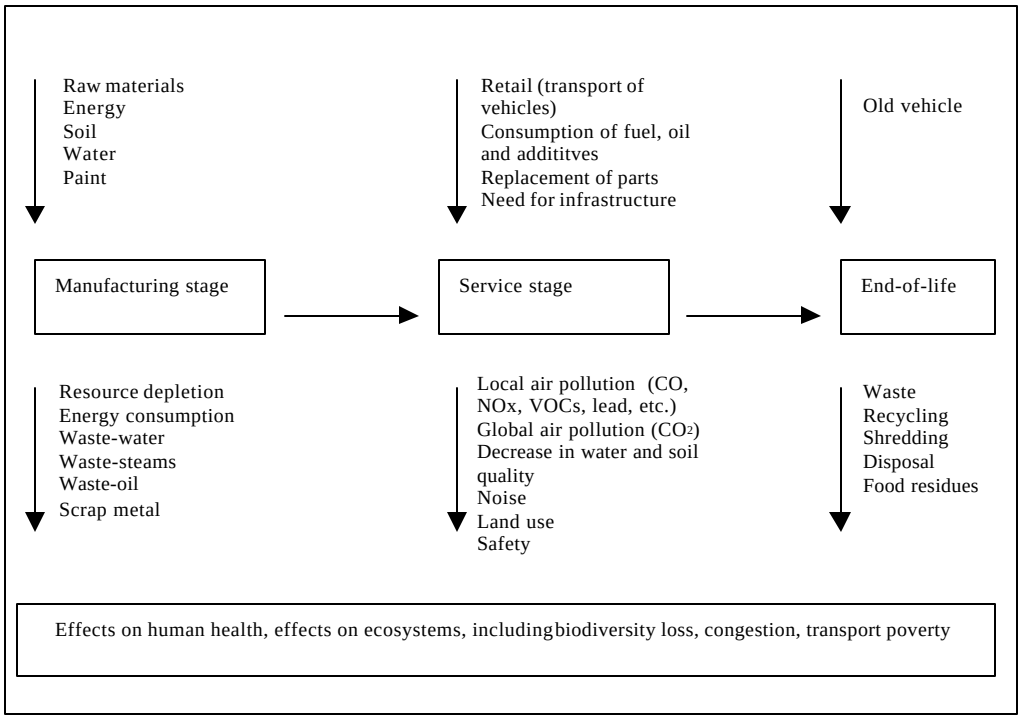
life of those who live in communities where these companies operate through sponsoring of education systems, cultural events, labour practices, etc.

Environmental impacts

However, transportation does have fundamental environmental impacts on air, land, water, ecosystems and human health. These impacts occur at all levels of the life-cycle, i.e., production of passenger cars, busses, trucks, airplanes, ships and trains, the operation of these products and their end-of life. Different modes of transport do have different environmental impacts. Figure 1 illustrates environmental impacts of the life-cycle of automobiles.

Figure 1 – Life-cycle of vehicle production and use



Major environmental impacts of transport arise from use of energy, and transport is responsible for about a quarter of the world's current energy use. Heavily dependent on fossil fuels, it accounts for about half of world oil demand. Since 1970, transportation energy demand has grown by 110% or 18 million barrels of oil per day, and according to projections by the US Department of Energy, it will grow another 77%, or 27 million barrels oil per day, by 2020.

Through burning fossil fuels in combustion engines, cars, buses, trucks, motorcycles, ships, trains (of course, the issue is different for electric-powered systems, whose impacts depend

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on the power source) and planes (environmental impacts of aviation are even more complex than those of other modes of transport, therefore, they will be further explained in Box 1 at the end of this chapter) emit significant quantities of carbon dioxide, carbon monoxide, hydrocarbons, nitrogen oxides and fine particles. These emissions are responsible for air, soil and water pollution at the local, regional and global levels, and cause serious health problems:

Local air pollution

Carbon monoxide (CO) causes short-term toxicity, blocking the uptake of oxigen by haemoglobin. It aggravates and causes – depending on the level of exposure - cardiovascular diseases, especially angina and peripheral vascular diseases. Expos ure to elevated levels is even associated with impairment of visual perception, work capacity, manual dexterity, learning ability and performance of complex tasks.

Nitrogen dioxides ($N0_2$) can irritate the lungs and lower resistance to respiratory infection

Nitrogen oxides (NO_x) are an important precursor to acid rain and may affect both terrestrial and acquatic ecosystems.

SO2 causes cell destruction.

Volatile organic compound (VOC) emissions contribute to ambient ozone, and some fractions of VOCs emitted from motor vehicles are toxic compounds as well. At elevated concentrations and exposures, human health effects can range from respiratory effects to cancer, as well as neurological, developmental and reproductive effects.

Particulate matter mechanically overloads the lungs.

Aldehydes irritate the bronchi and other mucous membranes, and are acute toxics.

Benzene, a haematotoxic, is suspected carcinogen.

Each of the Policyclic Aromatic / hydrocarbons in exhaust gases has some mutagenic and carcinogenic activity.

Lead in gasoline can cause major health effects. Low level lead exposure in children, for instance, has adverse effects on the development and function of the central nervous system, leading to various behavioral disorders, including distraction, inability to follow simple directions, and lower scores on IQ tests. On adults, increases in both systolic and diastolic blood pressure and cardiovascular effects have been noted.

Regional air pollution

Ground-level ozone, formed by volatile organic compounds (VOC) and NOx in the presence of heat and sunlight, is the prime ingredient of smog. Short-term exposure to high ambient ozone concentrations causes increased respiratory problems and can lead to decreases in lung function. Long-term exposure may cause irreversible changes in the lungs which can lead to chronic respiratory diseases.

Sulfur oxides contribute to acid rain, responsible for fauna degradation and in combination with nitrogen compounds and photochemical oxidants, generates material damage.

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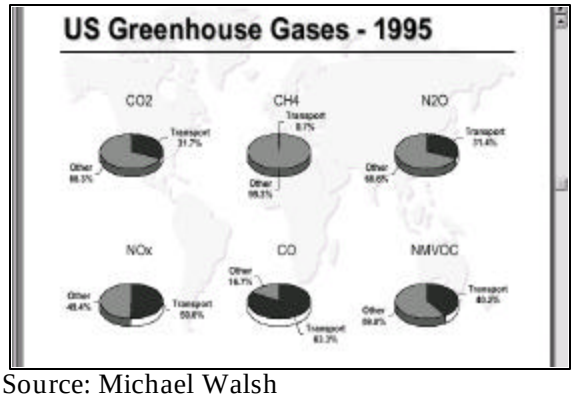
Such local and regional pollution is linked to an estimated 500,000 deaths, 4-5 million new cases of chronic bronchitis as well as millions of cases of other serious illnesses each year. The economic burden of this pollution is estimated at US$150-750 billion a year.

Climate Change

The transport sector is responsible for the emission of more than a quarter of carbon dioxide (CO2) emissions from human activity world-wide, as well as considerable shares of methane (CH_4), and nitrous oxide (N_2O) emissions, and is thereby one of the largest single contributors to global climate change. Figure two illustrates the share of the transport sector of greenhouse gas / gases influencing the greenhouse effect emissions in the US.

Figure 2



Source: Michael Walsh

In its latest report, the UN Intergovernmental Panel on Climate Change, a scientific body established in 1988 by the World Meteorological Organization and the United Nations Environment Programme to assess the scientific, technical and socio-economic information relevant for the understanding of the risk of human-induced climate change, says that climate change due to human influences has almost certainly begun. It predicts that by the year 2100, global mean surface temperatures will rise by 1.4 - 5.8 degrees Celsius and sea-levels will rise by 15 to 95 cm.

Such changes will create unprecedented environmental, economic, and social pressures from:

- sea-level rise,
- more severe droughts, storms and floods;
- increasing desertification,
- changing mountain ecosystems,
- pressure on food production and water resources,
- migration of tropical diseases, and increase of cardio-respiratory, and infectious diseases.

All regions of the world are likely to experience adverse effects of climate change. However, some regions are particularly vulnerable because of their physical exposure to climate change hasards and / or their limited adaptive capacity, such as small island states and low-

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lying coastal areas, which are particularly vulnerable to increases in sea level and storms. Climate change impacts in polar regions are expected to be large and rapid, including reduction in sea-ice extent and thickness and degradation of permafrost. Further, it will be people in the poorest countries who suffer the worst impacts of global climate change. Adverse changes in seasonal river flows, floods and droughts, food security, health effects, etc. will be highest in Africa, Latin America and Asia.

Resource Use and Waste generation

Furthermore, transport has significant impacts on resource use and waste generation.

Box 1 – Environmental impacts of Aviation

Aircraft emit gases and particles directly into the upper troposphere and lower stratosphere where they have an impact on atmospheric composition. These gases and particles alter the concentration of atmospheric greenhouse gases; trigger formation of condensation trails (contrails); and may increase cirrus cloudiness – all of which contribute to climate change.

The principal emissions of aircraft include carbon dioxide (about 10 % of carbon dioxide emissions from all transport sources) and water vapour. Other major emissions are nitric oxide (NO) and nitrogen dioxide (NO_2), sulfur oxides (SOx) and soot. Contrary to CO2, the other gases have shorter atmospheric residence times, and therefore remain concentrated to flight routes. These emissions can lead to radiative forcing that is regionally located near the flight routes for some components (e.g. ozone and contrails). The direct radiative forcing of sulfate and soot aerosols from aircraft is small compared to those of other aircraft emissions. Aircraft emitted NOx, for example, participates in ozone chemistry, and are more effective at producing ozone in the upper troposphere than an equivalent amount of emission at the surface.

Aircraft contrails, which tend to warm the Earth's surface similar to thin high clouds, are estimated to cover about 0,1% of the Earth's surface on an annual averaged basis.

Extensive cirrus clouds, which tend to warm the surface of the Earth, have been observed to develop after the formation of persistent contrails. Increases in cirrus clouds cover beyond those identified as line-shaped contrails are found to be positively correlated with aircraft emissions.

Land use

With regard to land-use, automotive transport in particular presents some of the most pressing challenges: The competition for land between cars and crops is a major threat to the food security of countries such as India and China. In the US, the area dedicated to roads and car parking covers an estimated 16 million hectares – just slightly less than the 21 million hectares planted in wheat. If China obtains the same level of car ownership as Japan - in 1995, China had 23 motor vehicles registered per 1000 persons, compared to over 550 in Japan - and creates roads at the same ratio the country would need to pave 13 million hectares. This represents half the amount of land used for crops in a country already struggling to attain food security for its 1.2 billion people.

Mega-cities

Negative environmental impacts of transport are concentrated in mega-cities, and with the growing level of urbanization, pressure on urban areas will increase. The situation is

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particularly dramatic in major developing country cities, where the separation of working, living and moving spaces is inadequate, a highly mixed traffic composition prevails, and where a low proportion of urban space is devoted to roads (e.g. 11% in Bangkok, compared to 30% in Los Angeles). The result is high congestion, causing higher pollution levels and longer exposure of people in the street to pollution.

Developing-countries

In addition, in developing countries, access to both public and private transport is insufficient, but existing transport means are often inefficient and highly polluting. Vehicle stocks, for instance, are by far older than in the developed world – vehicles at their end of life in developed countries are often transferred to developing countries, without ensuring appropriate retrofit and maintenance measures. Furthermore, in many cases fuel quality is poor, and gasoline still contains lead, causing serious health problems.

Safety

Transport accidents cause a significant number of injuries. In the European Union alone, about 44,000 deaths go back to traffic accidents per year.

Improvements in the past

In the past decades, improvements were made with regard to legal frameworks and technical innovation.

Legal Frameworks

Most of the environmental legislation relevant to the transport sector passed so far is based on emission standards related to air pollution and noise.

International legislation addresses visible smoke, carbon monoxide, hydrocarbons and oxides of nitrogen. Phase out of lead in gasoline and reduction of sulfur in diesel fuel received increased attention. In addition, limits on emissions of respirable particulate matter from diesel-fueled vehicles were gradually tightened.

Vehicle emission standards, for example, are in effect in all industrialised countries, and have also been adopted in many developing countries, especially in those where rapid economic growth has led to increased vehicular traffic and air pollution, as in Brazil, Chile, Mexico, the Republic of Korea and Thailand. However, standards differ from country to country. In some countries, such as the US, differentiated emission standards for heavily used vehicles in highly-polluted areas and the clean fuel vehicle programme (requiring vehicles certified to lower emissions standards) have been introduced.

Emission standards can be a very effective means of limiting emissions when the maximum allowed emission standards set are stringent enough, and when compliance with these standards is sufficiently monitored and enforced. In addition to such emission standards, which sometimes lack flexibility and therefore often result in higher costs for industry, a number of other methods have been introduced, such as voluntary agreements, information and labeling schemes as well as fiscal measures. In the US, for example, programs for emissions averaging, trading and banking have been introduced. Some countries, notably

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Germany, have made effective use of tax incentives to encourage buyers to choose vehicles certified to more stringent emissions standards than the minimum requirements.

Box 2 – International Legal Framework Relevant to Transport

- *Geneva Convention, 20 March 1958* (international harmonisation of measures preventing pollution from automotive vehicles)
- *Vienna Convention, 9 November 1968* (prohibition of excessive emissions of harmful gases, smoke, odors and noise)
- *Geneva Convention on the Long-range Transboundary Air Pollution, 13 November 1979*

  This was the first multilateral Convention relating to environmental protection, which involved almost all nations of Eastern and Western Europe, the USA and the USSR. It was also the first to deal specifically with the problem of long-range transboundary air pollution where it is not possible to distinguish the contribution of individual emission sources. The Convention sets out the general obligation to limit, reduce and prevent air pollution. The definition of "air pollution" is wide and therefore brings many substances within the scope of the Convention. The obligations are limited to what is economically feasible and refer to the best available technology. The Convention obliges States to exchange information, consult and undertake research.

- *Protocol to the 1979 Convention on Long-range Transboundary Air Pollution Concerning on the Reduction of Sulfur Emissions or their Transboundary Fluxes by at least 30%, 08. July 1985, Helsinki .*

  The Protocol sets specific emission targets and timetables. It requires that by 1993 at latest, Parties reduce their annual sulfur emissions on their transboundary fluxes by at least 30%, using 1980 levels as a basis. The Protocol requires Parties to report annually on both their emission levels and the basis of their calculations.

- *Protocol to the 1979 Convention on Long-range Transboundary Air Pollution Concerning the Control of Emissions of Nitrogen Oxides or their Transboundary Fluxes, 31. October 1988, Sofia*

  The Protocol sets out targets and timetables for the annual emissions of nitrogen oxide or their tansboundary fluxes. It requires that by 31 December 1994 at latest, Parties limit their emissions to the levels emitted during any previous year before 1987. The Protocol also requires Parties to implement national emission standards to major new stationary and mobile sources based on best available technologies, which are economically feasible. In addition, the Protocol requires Parties to commence negotiations within 6 months of entry into force on further ways to reduce nitrogen oxide emissions.

- *Protocol to the 1979 Convention on Long-range Transboundary Air Pollution Concerning the Control of Emissions of Emissions of Volatile Organic Compounds or their Transboundary Fluxes, 18 November 1991, Geneva*

  The Protocol applies to all anthropogenic compounds that are capable of producing photochemical oxidants by reactions with nitrogen oxides in the presence of sunlight with the exception of methane. The Protocol sets an emissions or transboundary flux reduction target for VOCs of at least 30 % by 1999, based on 1988 levels or the levels of any year between 1984 and 1990. Furthermore, this Protocol takes a more sophisticated approach than the other Protocols (details available, if needed). The Protocol requires Parties to monitor compliance. A Party that suspects another Party of non-compliance with the Protocol may notify the Executive Body and have the matter discussed. Parties are also required to conduct future negotiations on further reductions and to regularly review the adequacy of the Protocol in the light of scientific and technological developments.

- *UN Framework Convention on Climate Change, 9 May 1992, New York*

  The ultimate objective of the UNFCCC is the stablilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Developed country parties and countries of Central and Eastern Europe are required to take measures to limit their greenhouse gas emissions with the aim of returning individually or jointly to their 1990 levels by the end of 2000. Parties are required to cooperate in developing, applying and transferring technology that reduces or prevents emissions of

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Technological Innovation

Over the past two decades, environmental impacts of production processes have been steadily reduced through the introduction of cleaner production methods. This comprises the drastic reduction of energy consumption, use of more efficient use of raw materials, use of filters, closed water-cycles, water-solvable paint, etc., and use of renewable and recycled materials. Moreover, many auto manufacturers, for example, have introduced environmental guidelines for their production plants and developed environmental management systems, often with third-party certification.

Furthermore, the products themselves have been improved. Through new designs and new engines, cars, buses, trucks, trains, ships and airplanes operate more fuel-efficiently. Filters decrease particulate emissions, and the introduction of catalytic converters in vehicles have successfully reduced emissions of local air pollutants. Fuels used in conventional combustion engines are more environmentally friendly (unleaded gasoline, fuel additives, low sulfur fuel, natural gas, etc.), and new engine systems running on alternative fuels are under development (fuel cell, biomass, etc.).

Finally, already in the conception stage, recyclability of end of life vehicles is more and more being taken into consideration. This comprises reuse of parts and components, use of more easily recyclable materials, use of recycled materials, the and the marking of different parts in the construction phase allowing for easy dismantling and recycling.

UNEP's experience with the transport sector

… *Reporting…*
Reporting is an important tool to both increase awareness of consumers and ensure accountability and transparency of industry operations.

Together with SustainAbility, UNEP has published a series of sectoral reports (Oil Sector Report, Life-sciences Report), examining how industry sectors address the expanding environmental and social reporting agenda. A report on the automotive sector is underway.

Some automotive manufacturers are actively involved in the Global Reporting Initiative (GRI), aiming to design globally applicable guidelines for enterprise-level sustainability reports, and to elevate corporate sustainability reporting practices to a level equivalent to financial reporting.

…*Sharing Information…*
UNEP has issued different publications on transport issues, such as a joint OECD/UNEP/Austrian Federal Ministry for Environment, Youth and Family publication *Towards Sustainable Transport in the CEI Countries*, two joint UNEP/OECD publications *Phasing Lead out of Gasoline* and *Older Gasoline Vehicles,* showing best practice

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Challenges for the future

The issue of sustainable mobility is more pressing than ever: Environmental impacts of the transport sector continue to rise! The improvements in reducing environmental impacts of production processes and products have been outweighed by an enormous growth of transport demand in developed and lately also in developing countries. Vehicle and aircraft fleets as well as kilometers driven and flown have been increasing. Use of railways remained stable, which means with regard to the enormous increase in other transport modes, considerable decrease of the share of rail transport.

Figure 3

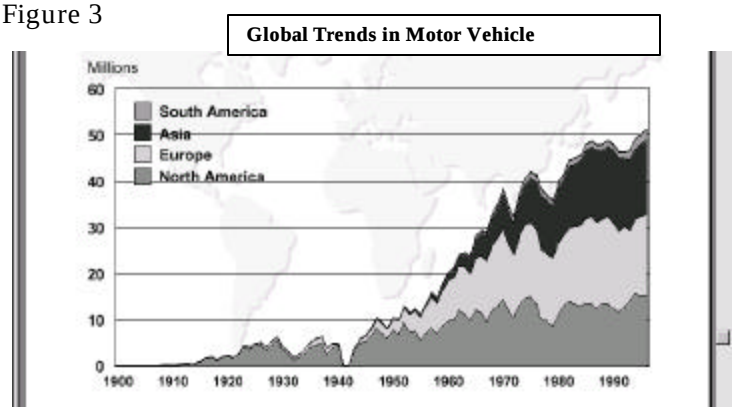
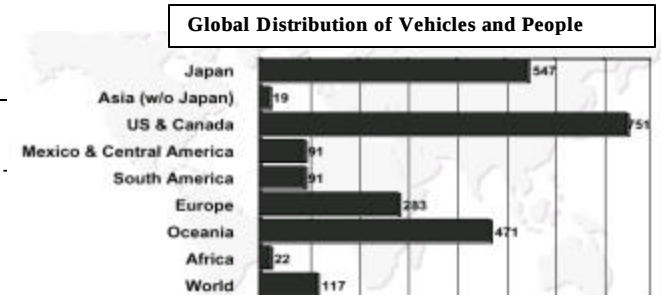


Figure 4



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Source: Michel Walsh

Against this background, it is evident that technological solutions alone are nor sufficient. They need to be complemented by a whole rethinking and restructuring of current transport patterns. The focus of attention must be switched from particular modes of transport to the wider question of how to organise access to personal mobility, goods, services and information most efficiently. This involves change of land use and infrastructure planning, change of consumption patterns, including intermodal transport, avoidance of unnecessary travel, and support for non-motorised forms of transport, and switch to alternative fuels.

Making sustainable mobility happen is a highly complex task and therefore requires a coordinated approach by all players: governments on the national and local level, industry, NGOs, consumers and international organisations. Dialogue of the various players is a first step. Also the Global Compact, by which the UN Secretary-General, Kofi Annan, invited business leaders to "embrace and enact" Human Rights, International Labour Standards and the Rio Principles both in their corporate practices and by supporting appropriate public policies, will play an important role.

Measures that could be taken…

… by governments…

The role of governments in the challenge of sustainable mobility is to create an enabling environment. This comprises the setting up of an appropriate regulatory framework coupled with sustainable transport planning and the use of economic instruments. In the following, several possible measures will be mentioned, the list is not exhaustive.

© Short-term measures that could be taken comprise policies to accelerate the rate of capital stock turnover in automobile and aircraft fleets to reduce the rate of emissions growth. This is particularly relevant for developing countries, where large fleets with many older vehicles are in place, and where air travel will experience a major uptake. Furthermore, measures for retrofitting and maintenance of vehicles, trains and aircraft could be particularly helpful. A third pillar would be the promotion of cleaner, lead and sulfur free fuel.

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UNEP, together with the OECD, has recently released two publications to support governmental measures regarding such measures. Replication of measures included in both publications can help address environmental impacts from transportation:

- *Phasing Lead out of Gasoline*: An Examination of Policy Approaches in Different Countries. This publication includes successful programmes to phase-out lead completely in some countries as well as co-ordinated action of the lead industry.
- *Older Gasoline Vehicles*: Information included in this publication comprises inspection maintenance programmes, retrofit programmes, accelerated retirement of older vehicles, switching to cleaner fuels, and other measures that have been undertaken by governments.

© In many countries, external costs of transport are not reflected in the costs of the different modes of transport. Putting in place environmental taxes, abolishing fossil fuel subsidies and creating incentives for promoting environmentally friendly transport systems are measures that can help internalise environmental externalities in the cost of transport. This could also include the facilitation of setting up alternative fuel infrastructures.

To support governments in finding ways to reduce GHG emissions from transport and particularly to internalise externatlities, the UNEP Collaborating Center on Energy and Environment has prepared for the World Bank Climate Change Global Overlays for the transport sector. The Global Overlays Guideline document, which will be released later this year, includes a number of conceptual issues relating to GHG externalities including baseline definitions and cost-effective GHG abatement policy options. Specific policy options under consideration include new technologies, economic instruments and infrastructure planning.

© Transport planning is particularly important in congested and heavily polluted urban areas, especially since in the coming years, more than half of the world's population will live in cities. As a general motto, sensible land use should be emphasised over physical mobility.

Intelligent city planning, provision of safe and efficient public transport systems, the use of IT ("virtual city" programmes), road and parking pricing, traffic calming and other similar measures have already successfully been used by some governments to reduce congestion and thereby save emissions and costs. As a general statement, non-motorised transport, such as walking and cycling, needs to be strengthened. This is particularly true for developing countries, where in many cases the poorest cannot afford public transportation and where many different modes of transport co-exist on the roads, causing injuries and congestion. Governments could be a facilitator of introducing non-motorised options.

Policies and measures, of course, will vary from city to city as they need to be adapted to the city's specific needs.

UNEP is preparing a project that will gather case studies on sound practices in urban transport management and on energy efficient urban transport systems. Furthermore, together with Habitat's Sustainable Cities Programme, IETC is preparing an Air Quality Management Toolkit for Cities.

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© Furthermore, the individual user of transport systems needs to be addressed. In the US, for example, there are more licensed drivers than voters. Education and awareness raising are steps that co uld be taken by governments to promote the necessary change in consumption patterns.

Together with automotive manufacturers, UNEP is planning an awareness raising campaign on more environmentally friendly driving behaviour. Governments could possibly help to disseminate the lessons learned by for example translating them into official programmes of driving schools.

… by industry…

Along the lines of responsibility, accountability, and transparency, industry should integrate environmental and social concer ns into core-decision making. In the production stage, ideally a cradle–to–cradle approach needs to be taken, and as to the products, efforts to develop innovative technology rendering operations more efficient and cleaner need to be enhanced. This new technology should also to be transferred to less developed countries.

Furthermore, through voluntary initiatives and a partnership approach, industry should work with national and local governments and exchange information with consumer groups, environmental NGOs and consumers. Transportation issues have received increased attention in recent years because of the heightened concern at all levels of society about global climate change and local air pollution, as well as greater recognition of the critical role that transport plays in sustainable economic and social development. This means that consumers will be more receptive to sustainable transport solutions. To use this awareness to change consumer behaviour, consumers need to better informed to be able to make the right transport choice Reporting on environmental policies and measures will be an important tool to share information, but also to ensure compliance with regulation and voluntary initiatives.

Moreover, the challenge of sustainable mobility presents an opportunity for this industry sector to restructure and develop into proactive mobility service providers.

© The rail transport sector could use a three-pillar approach:

The first pillar could be technological innovation, comprising:

- Development of retrofit systems to render the existing locomotive fleet more efficient, more efficient new diesel engines and new locomotive engines, such as liquid gas and fuel cell;
- Use of renewable raw materials and recycled materials (“cradle-to-cradle approach”), and increase of recyclability of old material; and
- Reduction of noise and vibration levels.

The second pillar could be management measures to:

- Make international rails fungible to allow for easier and quicker freight transport;
- Allow for intermodal shift. The railway sector could work with other industry using rail transport, with air carriers (“fly and ride”, bringing country-internal traffic on rail), car rental companies (“ride and drive”), with local governments (“ park and ride”) and taxi operators (“ride and be driven”);

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- Purchase green electricity.

A third pillar could be relationship with other stakeholders, especially consumers. Rail is often the most environmentally friendly means of transport. The sector should use the increased public awareness for environmental issues to promote this more environmentally friendly means of transport. An example for such an approach is the interactive internet tool developed by Deutsche Bahn, which indicates to the interested traveler the most environmentally friendly and the most efficient means of transport to a given destination.

© The automotive sector could also use a three-pillar approach:

Similarly, the first pillar could draw on technological improvement:

- Production process: environmental management best practice / ISO14001 and / or EMAS third-party certification; savings of natural resources, energy, air and water pollution; enforcement of EM and industrial best practice on suppliers;
- Product: reduction of fuel consumption and thereby reduction of GHG and pollutants emissions; development of new fuel technologies / engines (biofuel, fuel cell, etc.); use of and efficiency in renewable materials, take back and recycling of old vehicles.

The second pillar could be so called non-product or non-technical measures, covering the promotion of use of unleaded gasoline in old cars, the promotion of education and training on environmentally friendly driving, the promotion of regular and systematic maintenance of vehicles, car-pooling or short-term rental; multi-modal / regional transport schemes, integrated freight schemes, cooperation with the IT sector.

The third pillar could also consist in relationship with other stakeholders, especially consumers. Most auto manufacturers complain that consumers would like to have a more environmentally friendly car, but that they are not willing to pay more for it, and that therefore, there is no market for "green cars". Automotive manufacturers have always found ways to market their new invention that made cars more expensive, therefore, advertising could concentrate on creating a demand for environmentally friendly vehicles. Reporting would, of course, be a means of communicating efforts undertaken.

© Also, the aviation sector could use a three-pillar approach:

Again, the first pillar could draw on technological improvement:

- Due to engine improvements and airframe design improvement, subsonic aircraft being produced today are 70% more fuel efficient per passenger-km than 40 years ago. Further increase of fuel efficiency is needed. Thereby, a balance of considerations among many factors (CO2, NOx, water vapour, etc.) will have to be made;
- Reduction of sulfur content of kerosene to reduce SOx emissions and sulfate particle formation;
- Research on new fuels, such as hydrogen;
- Reduction of noise emission, especially in areas surrounding airports.

The second pillar could draw on operational measures:

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- Air traffic management systems for guidance, separation, coordination and control of aircraft movements need to be improved to avoid aircraft flying in a fixed pattern waiting for permission to land; and to avoid inefficient routings, sub-optimal flight profiles and taxiing;
- Increase of load factors (carrying more passengers or freight on a given aircraft), elimination of non-essential weight, optimisation of aircraft speed and limitation of the use of auxiliary power (e.g. for heating and ventilation).

The third pillar could consist in policy options:

- Conclude voluntary agreements with national governments and international organisations to reduce environmental impacts;
- Work with the rail sector to set up intermodal travel; especially for short-distance travel, high-speed trains are the most efficient option;
- Increase transparency with stakeholders through environmental reporting.

As to maritime transport, it appears that the most pressing environmental issues are safety of vessels, dumping at sea and other issues related to compliance. With regard to a changed mix of transport modes, in certain areas short distance travel by ships make ecological sense – if the technical equipment, especially engines, is up to modern standards.

…by the international community…

- Raise awareness of decision-makers within governments and industry;
- Promote the integration of sustainability considerations into transport provision and planning;
- Promote a coherent and coordinated approach among environmental instruments and regions;
- Disseminate best practice examples;
- Strengthen capacity-building;
- Support and empower civil society;
- Encourage private-private and public-private partnerships.

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