Industry as a partner for sustainable development

Railways

International Union of Railways (UIC)

Developed through a multi-stakeholder process facilitated by:

UNEP
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Industry as a partner for sustainable development

Railways

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Disclaimer
In a multi-stakeholder consultation facilitated by the United Nations Environment Programme, a number of groups (including representatives from non-governmental organisations, labour unions, research institutes and national governments) provided comments on a preliminary draft of this report prepared by the International Union of Railways (UIC). The report was then revised, benefiting from stakeholder perspectives and input. The views expressed in the report remain those of the authors, and do not necessarily reflect the views of the United Nations Environment Programme or the individuals and organisations that participated in the consultation. Exceptionally, the consultation process for this report was carried out via e-mail due to time constraints.
Guide to the reader

This review should be seen as an introduction to the major trends that have taken place in the railway sector during the past ten years, which means have been applied, and how the rail sector sees the future - all with regards to sustainable development. The review in general includes several examples that are intended to illustrate the substantial actions behind the words.

In part 2, the reader will find a comprehensive introduction to the system characteristics of rail transport. This introduction is made to give an overall insight to rail and the concept of sustainable mobility seen from a more scientific perspective. In addition, the concept of external costs as a way to visualise external effects from different transport modes is presented. This introduction constitutes the platform for the three following sub parts: the environmental, social, and economic dimensions of sustainability in the rail sector.

The findings in part 3 ‘means of implementation’ are based on information gathered especially for this report by the report working group. Based on a questionnaire, several – mainly European – railways and regional groupings have given valuable input and examples of concrete cases, since activities are difficult to refer to in general, but easy when it comes to exact examples.

Part 4 takes a step towards outlining the future and the work needed to support a sustainable development in the rail sector for the next ten years. Firstly the railways’ strategy for sustainable mobility is presented. Secondly, the outlook for public transport companies and the supply industry is presented. The joint plan for railway research is a vital part of future initiatives towards sustainable mobility.

The annexes are meant as a guide for further investigation of the rail sector in general and with regards to sustainable mobility in particular. The content is focused around UIC statistics, the international environmental activities at UIC, CER, UITP, and UNIFE, as well as a bibliography and a reference list.
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The railway sector is proud to present this ten year review covering the main trends toward sustainable development, which have occurred in the last decade since the UNCED Conference in Rio in 1992. This review will serve as the railway contribution to the world society when it gathers at the World Summit on Sustainable Development in Johannesburg, South Africa, in September 2002.

The review has been carried out by the International Railway Union (UIC) in close co-operation with the Community of European Railways (CER), the International Union of Public Transport (UITP), and the Union of European Railway Supply Industries (UNIFE). Western Norway Research Institute has been a consultant in the production of this report.

The railway sector all over the world has changed dramatically in the last decade, in terms of economic restructuring as well as environmental and social issues. This review shows that, even though rail is in most respects the transport mode with the best environmental performance, the railways are by no means resting on their laurels.

A common feature of the last decade’s most successful initiatives in the rail sector, is the co-operation between stakeholders both inside and outside the sector. In the process the railways have built on their advantages in energy efficiency, low emissions, safety, and the use of space, making mobility easier and more sustainable.

For society to make full use of these advantages, appropriate policies must be put in place by public authorities at national and international level. From the railway sector’s point of view, there is no doubt that rail is well placed to respond to both the demands of their immediate customers and those of the public at large.

Rail is an essential ingredient in any programme to address the transport problems of sustainable development. We offer our best wishes for a successful conference in Johannesburg and a revitalised effort towards a sustainable global development in the decades to come.

Philippe Roumeguère, Chief Executive Director, UIC

Hans Rat, Secretary General, UITP

Drewin Nieuwenhuis, General Manager, UNIFE

Carl Henrik Lundstrøm, Acting Secretary General, CER
Globally, the transport sector in general has developed at an increasing and dramatically high rate in the last decade. The Rio Conference in 1992 did not help to reduce the severe effects of the steep growth curve of transport despite the many good intentions of sustainable mobility. Thus, here at the very first beginning of the new Millennium one could argue the global society is even further away than ever from ‘sustainable mobility’. But looking at the major trends in the railways there is more to it than meets the eye. Rail is on a sustainable track.

Rail is an essential part of sustainable mobility. This is acknowledged not only in the rail sector, but it has widespread support in public and at political level. For instance, a report by SOFRES\(^1\) shows that 79% of European citizens see a modal shift from road to rail freight as necessary in the future due to congestion, air and noise pollution. 66% of them see it as urgent. This realisation on behalf of the public is not yet, however, evident in policy-makers’ infrastructure choices around the world. However, there is a growing back-up in the political system.

It is evident that rail systems have some characteristics that clearly give the rail mode natural advantages. Firstly, the rail system has a high efficiency – whether we are talking about capacity, energy, space or time – and these apply both to passenger as well as freight rail transport. No other transport system has a similar volume capacity of transportation attained through such low levels of energy use and land consumption.

Another notable positive characteristic of rail transport systems is its combination with other transport modes – its intermodality. This applies both for freight, as well as passenger traffic. ‘Combined transport’ is by far the most successful way of intermodal freight transport whereas on the passenger side, rail has a long historical tradition in functioning as the main mode in combination with public transport (such as buses and trams), private car use as well as the environmentally benign modes walking and bicycling.

Among the negative effects, transport use in general gives rise to external effects such as air pollution, accidents, noise, climate change, and congestion. These effects cause real costs to society in terms of health, premature deaths, reductions in food production, spread of diseases and loss of time. In this context rail is by far the transport mode that gives rise to the lowest external costs, thus the more passenger and freight transport is produced by rail the better for society and environment.

To sum up the rail sector’s contribution to the three dimensions of sustainable development, the 1990s brought first and foremost a significant ‘greening’ of organisations, as well as a growing understanding of the benefits of encompassing the social dimension as a value-adding strategic cornerstone. The rail sector globally has slightly declined its production, however with important regional differences.

Most railways have been working intensively with the environmental dimension of sustainability since the beginning of the 1990s. The main themes have been reduction in energy use with focus on reduction of greenhouse gases, reduction of local emissions like exhaust gas emissions and noise, and improved land-use planning with regards to barrier effects and biological diversity. The activities are covering economic, regulative, physical, technical, organisational and informative measures. This effort in the environmental area has led to a new agenda in the sector as a whole, lifting the issue up from ad hoc to a main strategic focus.

\(^{1}\) SOFRES Report ‘L’Opinion Publique en France et dans les Grands Pays Européens face à L’Enjeu du Fret’ octobre 2000
Socially, railways also contribute positively to a sustainable development in several ways. Firstly, the high standards of rail safety spare life and many accidents compared with other modes of transport. Health is another factor where rail does not harm the surroundings as much as other modes. Railways acknowledge that some problems still remain with regards to local nuisances such as noise and diesel exhaust gas emissions. However, the technical solutions have been developed to a large extent, only application and implementation is yet not completed.

Another important rail contribution to the social dimension is the provision of public spaces where people can freely meet, thus fulfilling wider social functions within their communities. Public transport, both the transport means and their stations are important in this context.

It is difficult to argue that the railways have not been active in the field of sustainable development in the last decade. As a response to the need for environmental, social and economic changes, as stated in the Rio declaration, many initiatives have been started covering the local level (at workshops, stations, and administrative buildings) to the level of international organisations. For several reasons, however, at present it is difficult to determine to what extend the railway sector in general has improved environmentally over the last ten years.

Firstly, the discussion on which environmental performance level railways have actually reached in the last ten years is difficult to answer given the lack of environmental data on a global level. Thus the sector needs to strengthen its work related to data gathering, processing, and presenting.

Secondly, the ‘greening’ of the railway companies and organisations in a broad sense shows that railways are committed to changing their actions, although improvements are still achievable. This calls for better education and training, visible management, and focused campaigns both internal and external. It also requires more incentives for the sector. These can be provided through sensible and coherent policy frameworks or economic rewards.

Thirdly, railways should reach the breaking point where the change in rolling stock, infrastructure, and procedures will give significant improvements. The low general investment level in railways for the last 20 to 30 years and the high-cost of re-investment for operators and infrastructure managers have to some extent limited the penetration of new technological solutions into the market. This has led to a situation whereby the new technologies have contributed less to sustainable solutions of the transport problems than expected.

The perspectives for the developing world should not be forgotten since the importance of a robust rail system here is even more crucial. The dramatic growth of population and urban areas in developing countries gives rise to mobility problems that will exceed all known problems in the developed countries today. To handle this in an appropriate way requires sustainable urban planning with rail as a backbone for the infrastructure.

What is needed from the rail sector is to build on its social and environmental advantages. The challenge to railways and governments is to accommodate the influx of transport if and when measures are taken from the political level to switch the modal shift in favour of rail. This requires a readiness to conquer both technical and organisational obstacles. This implies a major increase in traffic intensity, as well as extension and upgrading of lines.
At company level, the main challenge towards sustainable mobility is to make use of all the existent research and experience in order to utilise developed tools and implement technical and organisational solutions that support sustainable mobility in the railway sector. This is a challenge of establishing the basic organisational conditions for full-scale implementation of appropriate solutions that are cost efficient, or even better, constitute positive contribution to railways, long-term investment plans.

What is needed from society is action behind the political consensus to support rail and public transportation. This calls for a level playing field among the transport modes concerning infrastructure charges, internalisation of external costs, and appropriate conditions for deregulation of the rail sector worldwide.

Some roles have significantly changed during the last decade. In the beginning of the 1990s, the railway companies were more or less part of the state, thus defining their own performance levels. With deregulation and the rise of private independent rail enterprises (operators, leasing companies etc.), the shared responsibilities of the public transport service level is now back in the hands of politicians.

A railway as a part of a public transportation system is a service to the community, the local government, the national or even international regions. One way for the political level to enhance good public transport is to consider not only the economic, but also the environmental and social aspects of an invitation to tender. The end consumer will get what authorities are asking for and what market-driven railways can provide. This is part of the adjustment to a market situation that was not evident in the 1990s.

Rail is an essential part of the movement towards sustainable mobility. Railways, public transport companies and the rail equipment manufacturing industry are ready to shoulder their responsibilities in full co-operation with their stakeholders.
Part 2: Implementation of the three dimensions of sustainable development

2.1 Introduction – rail system characteristics and externalities

Characteristics of rail transport

Railway systems around the world might seem too different to incorporate and describe in one report like this. But apart from the fact that all railways are guided transport systems, they have much more in common which make them advantageous in a context of ‘sustainable mobility’. This introduction will present some generic characteristics of rail systems covering physical and system-inherent properties.

This report covers all types of rail transport systems. The system characteristics can be grouped in three categories as shown in box 1. Firstly, the transport type should be defined - freight or passenger transport. Secondly, the spatial reach of the systems. In this regard, one important difference is between urban and extra-urban transport. The urban includes both intra-urban and suburban systems. They are mostly for passenger transport. The extra-urban systems may be international, national, regional or intercity. They are both for freight and passenger transport, even though line separation between the two may be found at each spatial level. During the last decades, in particular, there has even been a development of passenger transport linking two cities in different countries – international intercity transport.

The third category is speed. In urban transport there is a difference between light rail and rapid rail. The traditional tramways are light rail, while metros are urban rapid rails. When the speed is between 200km/h to 350 km/h the extra-urban systems are usually termed high speed rails. Above 350 km/h they may be termed transrapid (‘maglev’). They are mostly found in Europe and Japan, but extensive projects are also underway in other parts of the world, such as India and China. These systems have proved able to compete on long journeys with the highly polluting and energy-consuming air traffic.

Various system combinations can be found, for example during the last decade several combined tram-train rail systems for passenger transport have been developed, where the rolling stock is able to operate on both intra-urban light and some extra-urban heavy rail lines (box 2).

<table>
<thead>
<tr>
<th>Transport type:</th>
<th>Spatial reach:</th>
<th>Speed:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freight</td>
<td>Intra-urban</td>
<td>Light rail</td>
</tr>
<tr>
<td>Passenger</td>
<td>Suburban</td>
<td>Rapid rail</td>
</tr>
<tr>
<td></td>
<td>Regional</td>
<td>Conventional rail</td>
</tr>
<tr>
<td></td>
<td>Intercity</td>
<td>High speed</td>
</tr>
<tr>
<td></td>
<td>National</td>
<td>Transrapid</td>
</tr>
<tr>
<td></td>
<td>International</td>
<td></td>
</tr>
</tbody>
</table>
A notable characteristic of all rail transport systems is its combination with other transport mode – its intermodality. This applies both for freight as well as passenger traffic. The intermodal freight transport is usually termed ‘combined transport’ and is a transport type where the major part of the journey is by rail, inland waterways or sea and any initial and/or final legs carried out by road are as short as possible. The railway companies offer two types of intermodal transport – accompanied transport, also known as ‘rolling road’, and unaccompanied transport, changing from one mode of transport to another using a purpose-built terminal (road, maritime, waterway, rail, air).

Combined transport helps safeguard the quality of life and, at the same time, preserves the economic interests of users by integrating and making optimum use of the resources and assets offered by each transport mode. It is also considered as important means to the reduction of environmental pollution, congestion and traffic accidents linked to road transport. Indeed, a seamless transition of goods in their loading unit from one mode of transport to another is instrumental in improving productivity throughout the entire transport chain.

On the passenger side, rail has a long historical tradition in functioning as the main mode in combination with public transport (like buses and trams), private car use as well as the environmentally benign modes walking and cycling. Passenger intermodality solutions by the rail sector have taken the form of special ‘park and ride’ carparks at suburban stations, bicycle trains, and rail stations designed for easy access and transfer from one mode to another.

In summarising the international research on integrated land-use and transport development during the 1990s, such combinations between walking, cycling and bus transport on the one side and rail transport as the backbone mode on the other are emphasised as fundamental preconditions for a sustainable urban development (box 3).

As a response to environmental issues other forms of inter-modality have been developed during the last decade. Within passenger transport high-speed rail may not only compete with air transport, they may also be combined. All over the world there has been a development of such rail systems for passenger transport between airports and the adjacent cities. Furthermore rail systems have been developed dedicated to the transportation of both passenger cars and their passengers over longer distances.

Rail systems are characterised by their high efficiency. No other transport system has a similar volume capacity of transportation attained through such low levels of energy consumption use and land use. Both the

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**Box 2: Combined rail (IRJ, May 2001)**

**Tram-train development in Germany**

Tram-train development was pioneered in Karlsruhe. The first studies into the development of a vehicle that could run on both the local tram and national rail networks began in 1984, leading to the opening of the first track-sharing route between Karlsruhe and Bretten in 1992. This was followed in 1994 by the introduction of tram-train services from Saarbrücken to Forbach. Both schemes enjoyed considerable success, stimulating passenger growth and encouraging quite substantial modal switch. As a result, other German cities and regions began to look at tram-train running, with the most developed projects now in Kassel, Braunschweig, and Bremen.
energy efficiency and the spatial efficiency are high. We shall later return to the issue of energy efficiency. In intra-urban contexts the three characteristics are only shared with pedestrian systems. However, they do not share the high speed or the time efficiency of rail systems. The four basic types of efficiency—capacity, energy, space and time—apply both to passenger and freight rail transport, and both to urban and extra-urban systems. This is known from several theoretical analyses, but is also well documented through empirical data (boxes 4 and 5).

Theoretical studies, also supported by empirical material, show that an urban rapid rail system may transport 60,000 passengers per hour in one direction. To achieve the same capacity with passenger cars one would need a road width of 200 metres (about 57 lanes).

Box 3: Sustainable cities principles (Newman and Kenworthy 1999)

1. Traffic calming – to slow auto traffic and create more urban, human environments better suited to other transportation modes.
2. Quality transit, bicycling and walking – to provide genuine options to the car. The sustainability agenda demands transit, especially the development of rail systems that are competitive with the car in passenger appeal and speed.
3. Urban villages – to create multi-nodal centres with mixed, dense land use that reduce the need to travel and that are linked to good transit. Key characteristics of urban villages are among others: high-density land uses, especially at the centre, mixed land use, with offices, shops, businesses, and community facilities integrated into residential development, and a heavy rail or light rail station near the core.
4. Growth management – to prevent urban sprawl and redirect development into urban villages.
5. Taxing transportation better – to cover external costs and to use the revenues to help build a sustainable city based on the previous principles.

Box 4: Capacity in different transport modes (Laconte & al.1995)

<table>
<thead>
<tr>
<th>Transport Mode</th>
<th>Capacity per hour per metre width of infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger car</td>
<td>200</td>
</tr>
<tr>
<td>Bicycle</td>
<td>750</td>
</tr>
<tr>
<td>Bus</td>
<td>1,500</td>
</tr>
<tr>
<td>Pedestrian</td>
<td>3,600</td>
</tr>
<tr>
<td>Busway</td>
<td>5,200</td>
</tr>
<tr>
<td>Rail</td>
<td>9,000</td>
</tr>
</tbody>
</table>
Box 5: Transport capacity in selected urban street (Haatveit 1987)

<table>
<thead>
<tr>
<th>Mode</th>
<th>Area (m²) per person travel</th>
<th>Capacity (person/hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrian</td>
<td>0.8</td>
<td>17,000</td>
</tr>
<tr>
<td>Tram</td>
<td>1.2</td>
<td>17,000</td>
</tr>
<tr>
<td>Bus</td>
<td>2.1</td>
<td>8,000</td>
</tr>
<tr>
<td>Bicycle</td>
<td>9.7</td>
<td>3,000</td>
</tr>
<tr>
<td>Passenger car</td>
<td>22.1</td>
<td>1,800 Freeway 900 Urban street</td>
</tr>
</tbody>
</table>

Box 6: Example of political railway support

Development of EU policies on rail transport and sustainability

The European Commission issued in 1992 the White Paper on a Common Transport Policy (CTP) (EC, 1992). The aim of the CTP was to ensure sustainable mobility by encouraging the development of efficient and environment-friendly transport systems that are safe, socially acceptable, and make less demand on non-renewable resources. The promotion of rail transport is an important part of the CTP and it is focused through the integration in the intermodal and combined transport promotion strategies, and the ‘revitalisation of rail and other environmentally friendly modes’. The 1996 EC White Paper A Strategy for Revitalising the Community’s Railways states that rail transport can make a real contribution to sustainable mobility.

In September 2001 the EC issued a White Paper European transport policy for 2010: time to decide (EC, 2001). This white paper signals a new departure for European transport policy. It shows a new commitment to sustainable development through the focus on rail as a solution to Europe’s transport problems. The paper refers to the conclusions of the Gothenburg European Council, which placed at the heart of the strategy for sustainable transport a shifting of the balance between modes of transport. Revitalising of the railways is one of the strategies for ‘regulated competition’ set out in the 2001 White Paper. However, because of subsidiarity, the White Paper does not adequately tackle the problem of transport in cities and urban areas. This is despite the fact that the majority of congestion, pollution and accidents occur in urban areas, which also provide the best opportunity for public transport to provide a viable alternative to the private car.
in one direction for traffic on streets, and 80 metres (about 23 lanes) for freeways. A similar capacity with a regular bus system in urban streets would need about seven lanes in one direction in order to take the peak traffic.

Flexibility is another measure of efficiency. Other transport systems have generally much larger flexibility than rail. In passenger transport this is not only the case for pedestrian, bicycle and private car systems, but also for bus transport. In freight transport road vehicles represent a much more flexible system than rail. Inter-modality with rail transport as the backbone system is a means to achieve greater flexibility without corresponding losses in the other types of efficiency.

Both in urban and rural development this is achieved through densification around rail stations and the development of these stations as nodal points for other transport modes. As emphasised above these principles have during the 1990s been highlighted as fundamentals of sustainable transport as well as in relation to the broader societal concept of sustainable mobility.

The common global understanding is that rail transport is a crucial part of sustainable transport. On the political level policy-makers are increasingly seeing the benefits of exploring the potential of railways and incorporating them in an efficient inter-modal transport system.

For instance, a report by SOFRES\(^1\) shows that 79% of European citizens see a modal shift from road to rail freight as necessary in the future due to congestion, air and noise pollution; and 66% of them see it as urgent. This realisation on behalf of the public is not yet evident in policy-makers’ infrastructure choices. It is articulated in policy documents from the Commission (box 6). In these ways rail transport is deemed necessary to satisfy basic mobility needs, both regarding persons and freight, and still be within acceptable limits as required by local and global environmental sustainability. It applies just as much to developed as developing countries and to urban and rural areas.

**External costs of transport**

This section will introduce external effects of transport and their valuation as a platform for the following sections on environmental, social, and economic sustainability of railways. An essential concept for understanding and influencing the three dimensions of sustainability is the way to interpret external costs carried by society and nature in general. External costs are the price of actions that affect individuals that do not participate in the actual actions. These effects are called external effects. The price of external effects covers the three dimensions, environmental, social, and economic. It is difficult to give all these impacts – the total external costs – a defined monetary value.

Market-based solutions to the problem only deliver efficient results where prices accurately reflect opportunity costs. In transport, this is far from being the case. This is why the issue of external costs and how to reflect them in the market has assumed current prominence. Several attempts have been developed to give monetary value to external costs (for example ‘polluter-pays’ principle, ‘willingness-to-pay’ principle), and this process is often referred to as ‘the concept of fair and efficient pricing’.

In the transport sector, external costs are particularly large, and have therefore given rise to proposals either to introduce subsidisation schemes based on the value of costs saved, or to impose comprehensive charging schemes for the use of transport infrastructure (internalisation of external costs) which would be based on the marginal social costs (including external costs) of transport activity.

External costs in the transport sector are generally held to include the cost of accidents, noise, air pollution (damage to health, the fabric of buildings and the biosphere), climate

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\(^1\) SOFRES Report à L’Opinion Publique en France et dans les Grands Pays Européens face à L’Enjeu du Fret octobre 2000
A study carried out by INFRAS/IWW (March 2000), based on European conditions, estimated these costs, excluding congestion, at some 530 billion per year or 7.8% of GDP for the 15 EU countries, Norway and Switzerland, in 1995. Of these costs, the largest categories were accidents (29%), followed by air pollution (25%) and climate change due to CO2 and other greenhouse gas emissions (23%). Congestion, if valued on the basis of time lost as compared with an uncongested transport network, is estimated at a further 2% of GDP.

It is important to note that not only are these costs very large, but they are growing, driven by increased road traffic and rising real levels of income, which cause people to value nuisances more highly. In the 17 countries covered by the IWW/INFRAS study, road traffic volumes (vehicle-km) were estimated to rise by some 27% between 1995 and 2010, with freight growing slightly faster than passenger traffic, while incomes were forecast to rise by nearly 39% in real terms. The outcome is a forecast rise of 42% in total external costs, with the highest growth rates in the aviation and road sectors. By that time, climate change will have moved firmly into second place behind accidents as the largest cost categories.

A systematic comparison of the costs of the external effects connected to accidents, noise, air pollution, climate change, damages to nature and landscape, urban effects, and upstream processes are shown in boxes 7 and 8. Urban effects consist of two issues: 1) time losses due to separation effects by pedestrians and 2) scarcity problems (expressed as the loss of space availability for bicycles). Upstream processes consist of energy production and distribution, and vehicle and infrastructure production and maintenance.

The four parameters noise, air pollution, climate change and damages to nature and landscape are described in detail separately in the subsequent sections. This comparison of the four main modes of both passenger and
freight transport covers EU 15 + Switzerland and Norway. The comparison shows that both passenger- and freight-rail transport has lower total environmental impacts than the other main modes, except for water-based freight transport, in which the total costs are similar to rail.

Extrapolating these figures to a worldwide scale presents some problems, because some effects are localised while others (notably climate change) are global. While the values are generally driven by income or population density, others such as accidents, may be in part dependent on other factors such as safety standards and law enforcement.

However, figures for the total value of external costs, while important for an appreciation of the dimension of the problem, are not the most relevant for assessing the impact of transport policy changes. Marginal or average values give a better indication of this. The INFRAS/IWW study estimated average costs of passenger transport in Europe in 1995, excluding congestion, as 85/1,000 tonnes km for road and 20/1,000 tonnes km for rail (88 and 19 in the case of freight). Marginal external costs per passenger-km (excluding congestion) for road are around three to five times those for rail, while for freight (per tonne-km) they are around three to four times as great, depending on the circumstances and type of vehicle. The substantial economies of scale which operate in favour of rail as far as internal costs are concerned clearly do so also for external costs, as much greater flows can be accommodated on rail with little increase in cost.

As far as congestion is concerned, only road suffers from this effect as classically-defined centralised planning of the use of infrastructure allows reduction of speed with increases in traffic to be avoided on rail (the semi-planned characteristics of allocation of airspace make it possible to argue that aviation, too, suffers from congestion in densely-trafficked regions).

Based on an awareness of the size, trends, and implications of external costs for sustainability not only of the transport system, but of the whole economy, and backed by international commitments such as the Kyoto Protocol, a

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**Box 8: External effects of freight transport (INFRAS/IWW 2000)**

<table>
<thead>
<tr>
<th>Mode</th>
<th>Accidents</th>
<th>Air pollution</th>
<th>Climate change</th>
<th>Nature and landscape</th>
<th>Upstream process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rail</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td></td>
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</table>

Euro/1000 tonne-km
number of countries have adopted programmes to achieve substantial transfers of traffic to less environmentally-damaging modes, notably from road to rail.

The most far-reaching of these in terms of scope (with the intention of addressing all modes) and scale (the greater part of the continent) is probably that of the EU, where a directive (framework law) on infrastructure charging is expected to be proposed during 2002.

Internalisation of external costs implies the use of new measures for charging users of the transport network according to the costs they cause. This hits the road sector particularly hard, not only in terms of the net financial impact on users (which could vary quite considerably between the different categories) but also in requiring payment for the use of roads—‘free’ use being often seen as a public right—where none was needed before, and the installation of measuring or counting devices on vehicles, regarded as intrusive.

It must be stressed that traditional road tolling does not fulfil the role of marginal-social-cost charging, as it is normally not related to the totality of costs caused, and the use of revenues is restricted to the maintenance of the road or the development of other roads, which is likely to exacerbate the problem. Fuel taxation also has limitations as a substitute for use-related charging.

2.2 The environmental dimension

This part of the report examines relevant railway aspects of the environmental dimension of sustainable development. The environmental dimension is, in fact, the external effects of transport that affect nature, and comprises four main themes: energy, climate changes, local emissions, and biological diversity according to the reporting categories of the UNCED Rio Summit 1992. Noise is also included here, though it is indeed an effect on the social dimension as well—especially in urban areas.

The environmental dimension of sustainable development covers two levels of rail transport: the modal level and the company level. The environmental dimension of the rail transport mode is described and compared with other transport modes. It also describes what the railway companies are doing (company level) to improve the environmental performance of rail transport.

The environmental strategies of the last few decades can be characterised as having a history of a focus on ‘end-of-pipe solutions’ in the 1970s via a period of regulatory interventions through stricter legislation in the 1980s and to the pollution-preventive approach in the 1990s. For the railway sector this has resulted in efforts on cleaning up and reducing the environmental impacts of previous activities, and strategies for planning and procurement of future sustainable railway operations.

Energy and climate change

Rail transport contributes to climate change mainly through emissions from energy use in general, and emission of CO2 from the combustion of fossil fuels, especially. In other words, there are two aspects of the main theme, energy, connected to rail transport: the energy use and the energy form.

The energy use in rail transport depends on the energy efficiency. The high energy efficiency, as mentioned in the introduction, is a main environmental characteristic of rail transport systems. On a modal level, the typical direct energy use per person-kilometre for rail transport is in the range of three to five times less than for air transport. Freight transport by rail uses four to six times less direct energy per tonne-kilometre than lorry transport (INFRAS/IWW). Only transport at sea is
comparable in energy efficiency to rail freight transport. Even though rail is more energy efficient than most other transport modes, significant efforts are made on the company level in the last decade to reduce the energy use further. Measures, such as energy-saving programmes are established for reducing the energy consumption in a variety of different ways.

The energy efficiency of rail transport can also be improved by increasing the capacity of the systems. Double deck trains are not new, and are used to a large extent in both freight and passenger rail transport particularly in the United States. However rail companies in other parts of the world are making efforts in developing this concept further to increase the rail capacities (box 9).

The energy form, whether in the form of electricity or combustible fuels, is the second main aspect of energy use connected to rail transport. The electricity can also be produced by different energy sources, either in the form of renewable hydro- and wind-power; combustion of renewable biomass; combustion of non-renewable fossil coal, oil and gas, or from nuclear fission. Worldwide, approximately 60% of the person transport and approximately 80% of the freight transport use non-renewable diesel fuel.

Alternatives to diesel fuel produced from renewable raw material are utilised to reduce the fossil fuel dependence of rail transport. Some railway companies, for example in the United States, are conducting studies into using fuels derived from biological raw material, such as bio-diesel. In this case oils from rape, soybean, or sunflower seeds are esterified to bio-diesel, which in addition to being based on renewable energy sources, also have environmental benefits such as reduced emissions.

As an effort to reduce the environmental impacts of electricity use, some rail companies have started to define criteria for the type of electricity being purchased (box 10).

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**Box 9: Energy efficiency (Green Globe 21 2001)**

**Improving the energy efficiency of rail transport by increasing the capacity**

The double deck high speed train (Series E-1) of Japan Rail East increased passenger seats by 40% without any corresponding weight increase. SNCF has also introduced double deck high speed trains (TGV Duplex), which increased passenger seats by 40% without any additional energy required. In Germany, the space requirements of ICE 2 locomotive engines are dramatically reduced, thus increasing space for transporting passengers.

**Box 10: Procurement of electricity (SJ 2000)**

**Green electricity used by Swedish rail**

In February 1999 Swedish Rail (SJ) signed an agreement on the delivery of environmentally labelled electricity according to the label ‘Bra miljöval’ (‘Good environmental choice’) to all SJ’s electrical trains. This eco-label, established by the Swedish Society for Nature Conservation, guarantees that electricity delivered is produced only from renewable energy sources such as wind, bio-fuels, or existing hydropower plants.
The reduction in energy use through energy-saving programmes and actions is an important means of reducing the railway sector’s contribution to climate change, since the combustion of fossil fuels is the main source of CO2-emissions in rail transport. The transition to alternative energy forms based on renewable biological raw material also contributes to reducing the climate change. The transfer of freight from road to rail has a large potential for reducing the emissions of CO2 from freight transport. The concrete efforts carried out in the transport through the Alps clearly demonstrate the important role of rail in lowering the climate change contributions from transport (box 11).

Also person transport by rail plays an important role in reducing the overall transport sector’s contribution to climate change. Instead of closing down railway lines, and letting road-based transport take over; revitalisation of railways can result in reduced emissions of CO2. The example from Germany on maintaining rail as a prime transport mean on the Baltic Sea resort island Usedom illustrates this (box 12).

In general, the railway supply industry is continuously improving the energy efficiency of rail vehicles through various technological developments. There is room for further improvement, including the training of train drivers so as to ‘drive efficiently’ and the possibilities of using alternative sources for electricity such as hydrogen or other renewable resources.

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**Box 11: Road to rail (UIC & CER 2001)**

**Transfer of freight from road to rail through the Alps**

Intermodal transport and ‘the rolling highway’ (rail transport of whole trucks), operated by the companies Hupac and Ralpin show how Swiss railways can contribute to a reduction of the quantity of CO2 emitted by the transport of freight through the Alps. Ralpin is a company jointly owned by BLS Cargo, the freight arm of BLS (The Lötschberg Railway), SBB-CFF (The Swiss Federal Railways) and Hupac (a combined transport operator). These services divert nearly 370,000 consignments from road to rail each year. As of September 2001 these services avoid the emission of 91,000 tonnes of CO2 per year. By the year 2007, this quantity will be increased to 230,000 tonnes of CO2 per year, thanks to the opening of the Lötschberg tunnel, and the continual improvement of Hupac and Ralpin’s services.

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**Box 12: Sustainable tourism (UIC & CER 2001)**

**From closure to model project: The Usedomer Bäderbahn**

With its famous seaside resorts, the Baltic Sea island Usedom has a long tradition as a holiday destination. The island’s recreational value for the numerous visitors, and its ecological balance, depend to a great extent on whether the problems associated with increases in road traffic can be solved. In this respect, the Usedomer Bäderbahn is playing an important role by providing environmentally-friendly mobility for commuters, schoolchildren and tourists. This railway was on the brink of closure in the early-1990s. Since then a variety of measures have made the transport more attractive. Tracks and stations have been modernised, trains timetabled more frequently and journey times are reduced. The air-conditioned light railcar sets offer plenty of space for baggage and passengers’ bicycles. In 1992 only 260,000 passengers chose to travel on the railway, while in 2000 it carried more than 1.9 million. If the railway had been closed, the island would now have to cope with an extra 1.3 million automobiles each year, resulting in emissions of 2,000 tonnes more CO2 per year.
Still, at present, air transport has approximately seven times, automobiles more than three times, and bus approximately 70% higher climate change external costs than rail transport per person-km. Compared with road transport, rail freight transport has only one-third of the climate change external costs per tonne-km. Rail transport has only 3% of air transport’s climate change external costs per tonne-km (box 8).

Local emissions
Other emissions from rail transport, with local impacts, consist of noise and vibrations, and air pollution from gaseous and particulate material. The external costs of noise as shown in boxes 7 and 8 consist of reduced value of land, and health risks from the exposure to noise. Rail transport has 30% lower noise external costs per person-km than automobiles, but four times higher than bus and slightly higher than air transport. Rail has noise external costs per tonne-km corresponding to about 50% of road transport. Rail transport has however higher noise external costs per tonne-km than water-based transport.

Noise and vibrations constitute some of the most important and widely recognised environmental aspects of the rail sector. The main contribution from noise reduction in the 1990s was the results of intensive studies of railway noise. Two major findings led to a much more focused effort in this field:

• the railway freight business was found to be the major noise source;
• in more detail, the problems were found to be closely related to the type of brake shoes calling for a simple solution to exchange to more silent brake shoes.

These research findings resulted in the establishment of several activities to reduce noise at the source, such as through the UIC and CER action programme for reducing noise emissions on goods trains (box 13).

Air pollution in the form of emission of gaseous and particulate matter is causing damage to human health, agricultural crops, forests and buildings. The costs of external effects shown in boxes 7 and 8 for air pollution include the emission components NOx, PM10, VOC, NH3 and SO2. The external

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**Box 13: UIC Noise action plan with updated comments (UIC 1998)**

**The action programme of UIC and CER ‘Abatement of Railway Noise Emissions on Goods Trains’**

On the 16 June 1998 the UIC board of management approved the action-programme for noise reduction on goods trains consisting of the following elements (updated with latest development).

- New vehicles are to be equipped with well-tried, authorised synthetic brake shoes inserts. To be able to do this, the relevant, still unresolved, technical questions must be settled in a short time. The framework to guarantee free circulation of these wagons on all UIC railways was established end of 2000.
- Investigation of possible retro-fitting of the existing wagon fleet with synthetic or compound brake shoe inserts of compatible formats, especially with sufficient low friction coefficients. In this field, development work is to be accelerated. The acceptance test was carried out in a short time, so that an international authorisation was achieved by the end of 2000.
- It is feasible that a retro-fitting programme could start and largely be completed within seven years, when a financing scheme is found. The preparation work is in progress but due to technical problems, no deadline has yet been applied to the programme.
costs in the form of air pollution caused by rail person transport are less than one third of the corresponding costs for automobile and about one quarter compared with bus, but three times higher than air transport. Freight rail transport has only one-ninth of the external costs of air pollution from road transport. Water-based freight transport has 2.4 times higher air pollution external costs than rail transport. Air transport has, however, 35% lower air pollution costs than the corresponding figure for rail transport.

Switching to alternative fuels and fuel qualities with improved emission characteristics can reduce emission of polluting gaseous and particulate material from rail transport. Two fuels are of particular interest, although they still have not been utilised on a large scale: bio-diesel and natural gas have both been evaluated for use in rail transport. The use of bio-diesel instead of diesel fuel generally leads to an improvement in the state of emissions from diesel engines. Particulate emissions are reduced by up to 50%. However, with the present world-wide demand for diesel, it is not feasible to change to bio-diesel on a large scale. This is one of the reasons for the interest in this fuel for use in rail tunnels, particularly for maintenance equipment. Natural gas also emits fewer pollutants. In North America strict rules requiring diesel engines to meet clean air targets are forcing railways and their suppliers to seek fresh ways of cutting pollutants from diesel exhausts. In this context, SCRRA and Union Pacific (UP) have initiated natural gas test programmes to achieve significant NOx reductions.

In an effort to reduce sulphur-containing emissions from rail transport, some countries have started to require that only low-sulphur quality diesel are used in the diesel-powered trains (box 14).

Biological diversity
The expansion of transport infrastructure networks and the continuous growth in transport pose threats to biological diversity. Noise and light, air emissions, and run-offs to water and land disturb habitats and species. Some animal species are particularly susceptible to collision with transport means. Linear infrastructure (roads, railways, and

### Box 14: Clean diesel (DSB, 2000; Green Globe 21 2001)

Some rail companies require that only low-sulphur quality diesel be used
In its 1992 Environmental Action Plan, Danish Rail (DSB) set targets to reduce SO2 emissions by 30% compared with 1990 levels, by switching to low sulphur fuel. Since January 2000, DSB has used low-sulphuric diesel with a content of 50 PPM or 0.1 g SO2/kg diesel. This satisfies DSB’s environmental demand for the diesel quality. Before the shift to light diesel, the content of sulphur were approx. 0.73 g SO2/kg diesel. Southern California Regional Rail Authority (SCRRA) is also operating its locomotives on a low sulphur ‘California diesel’ fuel containing 0.05 ppm of sulphur or less. Rail companies in the Netherlands are also implementing this measure.

### Box 15: Land use per transport work by railway in Egypt (WB, 2000)

<table>
<thead>
<tr>
<th>Year</th>
<th>1990</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total rail track kilometre</td>
<td>4,751</td>
<td>5,026</td>
</tr>
<tr>
<td>Person-kilometre</td>
<td>34,876</td>
<td>67,981</td>
</tr>
<tr>
<td>Tonne-kilometre</td>
<td>2,828</td>
<td>3,464</td>
</tr>
<tr>
<td>Total rail track kilometre/person-kilometre</td>
<td>0.14</td>
<td>0.07</td>
</tr>
<tr>
<td>Total rail track kilometre/tonne-kilometre</td>
<td>1.68</td>
<td>1.45</td>
</tr>
</tbody>
</table>
canals) may fragment habitats, thereby reducing the living space for endemic species, and can provide new pathways for the influx of other species. They may also act as barriers to movement and genetic interchange between populations, especially for vertebrates.

A transport mode’s land use is one indicator of the impact on biological diversity. Compared with road transport, railways require the lowest land-take both per passenger-km and tonne-km. Land take per passenger-km by rail is about 3.5 times lower than for passenger cars. The external costs in the form of damages to nature and landscape, shown in boxes 7 and 8, is one way of comparing land use of different modes.

Rail transport has external costs from damages to nature and landscape per person-km corresponding to about 30% of those generated by automobiles, 40% of the air transport’s costs, and only slightly less than bus costs. Per tonne-km these costs for rail are 17% of the costs for road transport, and only 6% of air transport’s costs. Water-based transport is similar to rail transport in terms of external costs from damages to nature and landscape per tonne-km.

More efficient utilisation of the existing land already designated for transport purposes, instead of the expanding land use further, is a crucial factor for avoiding further damage to biological diversity. One example of such improvement in the efficiency of land use is found in Egypt (box 15). Between 1990 and 1999 the total rail track kilometre increased only slightly, from 4,751 km to 5,026 km, while the transport work almost doubled from 34,876 to 67,981 person-kilometres. The freight transport also increased over the same period.

Protecting the natural environment is essential for preserving biological diversity. Reforestation programmes, such as operated by East Japan Railway Company, can contribute in the right direction (box 16).

Efforts in reducing the number of accidental deaths and injury to animals on the rail tracks are being carried out by installing fences along the lines, accompanied by designated crossing points in the form of tunnels or over-passes where animal movements across the railway lines can occur safely. Railway companies are also engaged in securing biological diversity by supporting work in protecting endangered species (box 17).

### Box 16: Reforestation (JR East 1998)

**Employees of East Japan Railway Company plant 30,000 new trees annually**

Since 1992 JR East Group’s employees have supported the ‘Afforestation Alongside Railway Tracks’ programme to plant 30,000 trees annually along JR East-operated railway tracks. Each year between 70,000 and 80,000 employees donate both money to buy the seedlings and the time and labour to plant them. Their families, as well as local residents, also participate in the planting. This is in collaboration with the Nissay Green Foundation’s ‘Million Trees’ campaign.

### Box 17: Safeguarding species (SJ 2000)

**Swedish Rail helps protecting endangered species**

The excess cost that SJ (Swedish Rail) pays for purchasing environmentally labelled electricity is placed in an environmental fund in collaboration with the electricity supplier Birka Energi. This fund supports environmental and energy-saving projects. One project that receives support through this fund is protection of the endangered salmon ‘Gullspånglax’. This is one of the few species of fresh-water-only salmon with its original genetic properties remaining.
Summarising these four themes above, the environmental performance of rail companies has improved during the last decade. Concrete environmental strategies have been developed, and the measures applied will be examined in Part 3.

2.3 The social dimension

The social dimension of sustainability is not defined officially by the international society, but one approach is certainly the Agenda 21 Declaration from Rio, 1992. However, in the present report at hand the social dimension of railways encompasses both classic terms such as health, safety and employment, as well as newly introduced terms like corporate social responsibility. Furthermore, the terms of human rights, worker rights and public space are also fundamental pillars of the social dimension. The social dimension can be seen both from a governmental point of view and from a company point of view, each of them having different responsibilities. Both views will be investigated in the following.

Safety

Traffic accidents have serious social consequences and are very expensive for society as already described in the previous section. People die or become seriously injured and disabled, with wider and lasting social impacts on their families whether it happens in developed or developing countries. However the long-term social effects may be more fundamental in developing countries without satisfactory public social security systems.

The accident risk is low in rail transport in comparison with other transport modes especially road (passenger cars and lorries). This applies to the absolute numbers as well as to the numbers relative to the transport work being carried out (box 18).

All over the world road traffic and, in particular, passenger cars, are causes of the large majority of traffic accidents. In North America the annual number of deaths and injuries in road accidents is close to six million. In the whole European region the annual number is more than 2.5 million. The global figures are very large. In a country like Israel the total yearly number of deaths and injuries is close to 1% of the total population.

Despite the low risk, rail transport accidents are often spectacular, affecting rail passengers as well as passengers in other transport means, in addition to rail personnel. Thus, the rail sector is continuously putting strong efforts into the work for further reductions in the accident risk (boxes 19 and 20). In EU15 the total number of persons killed in accidents involving railways has been reduced from 1,107 in 1990 to 764 in 1995. The number of railway passenger fatalities was reduced from 165 in 1990 to 98 in 1995 and 90 in 1996.

Health

Accident and health hazards from transport are unevenly distributed among the population, both in developed and developing countries. The large majority of hazards are caused by road transport.

<table>
<thead>
<tr>
<th>Box 18: Number of fatalities, passenger transport work and fatality risk for EU transport 1990-1999 (Eurostat 1997 &amp; 2001)</th>
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</thead>
<tbody>
<tr>
<td><strong>Fatalities road and rail</strong></td>
</tr>
<tr>
<td>EU 1990 - 1999</td>
</tr>
<tr>
<td>Fatalities per billion pkm</td>
</tr>
</tbody>
</table>
The external cost analysis of transport in EU15 + 2 (Norway and Switzerland) shows that the total air pollution health costs of rail passenger transport are 50 times as low as for road, while the difference in relative costs per passenger-km is about one to four. For freight transport differences are even larger, 70 times in absolute and ten times in relative terms (per tonne-km). Regarding health costs from noise pollution differences between road and rail are smaller, ten to 20 in absolute and 40% to 100% in relative terms.

Poor people take a relatively large share of the health burden. In Europe this has been most closely studied in relation to accident risks, where casualties are disproportionately drawn from the poorer socio-economic groups. But

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Box 19: Rail fatality development (UIC 2001)

Fatalities in rail accidents in EU15 + Switzerland and Norway in the period 1970 to 1999 (passengers only)

Fatalities per billion person km

Box 20: Example of railway safety work (IR 2001)

Safety work in Indian Railways

Indian Railways operates 11,000 trains, including 7,500 passenger trains, and carries 11 million passengers and 1.2 million tonnes of freight every day. India’s Commission of Railway Safety recently issued a priority list to improve the safety of the nation’s massive railway system. The commission is calling for the installation of better train driver vigilance control devices and auxiliary warning systems. It is also pushing for better psychological testing of drivers, rail-wheel interaction studies that are vitally important to high-speed train safety, and artificial ventilation in two long tunnels on India’s West Coast. Additional measures taken by the commission are:

- proper operation of audio-visual devices in diesel/electric locomotives,
- policy circular on the introduction of new and modified rolling stock,
- revision of rules for opening railways for passenger traffic,
- development of a suitable design for flasher lights that will automatically be switched on if there is a sudden change in pressure/vacuum in cab due to abnormal functioning,
- evolution of a suitable index to determine track fitness and health,
- unified brake power rules and uniformity of guard’s brake van equipment,
- track renewal and development of wheel flat detection,
- checks to control overloading of wagons.
this is also the case regarding air and noise pollution. The health impacts are concentrated in inner-city districts and along busy roads and railways, areas where traffic density is particularly high and many people live and work. Pollutants from transport are emitted near nose height and in close proximity to people. The poor often live in these inner-city areas.

Children and elderly people are the most vulnerable age groups. Children living in deprived areas have higher casualty rates and also dose-response relationships with the degree of deprivation. In many European countries for instance, traffic-related injuries are the most common single cause of hospital admissions among those aged five to 15 years. Elderly people comprise a large group in society with multiple sensitivity to the negative health and social effects of road transport. In addition to being most at risk of pollution-related premature death they are subject to severe losses in opportunities for regular physical activity and to the social consequences of the community severance-effect caused by road traffic.

Worldwide more than 1,000 million urban residents, or one third of the total urban population, are exposed to health-threatening levels of air pollution. Road transport is a major and increasing cause in all world regions, whereas the railway sector in general is insignificant apart from a few hot spot problems. In Asia for instance the road contributes to the largest share of air pollutants to the urban environment. Ten of Asia’s 11 mega-cities exceed the WHO guidelines for particulate matter by a factor of at least three. In South America Santiago, with five million people, is now one of the most polluted urban areas in the world. A main source is road transport. Cities such as Mexico City, São Paulo and Bogota are also suffering from severe air pollution. Rail transport is the only alternative to remedy these problems.

Rail has encountered increasing noise problems in the last decade due to this densification and urban sprawl of the population. However, this does not mean that noise levels necessarily has increased, rather it is a sign of the people getting closer to the source (the track) due to the limitations of the domestic areas. This trend is expected to continue as long as the regional planning is not implemented successfully. On the other hand, increased traffic has also led to focus on the railway contribution. Regional and company-specific solutions to oppose the noise problems are being implemented at different pace around the world.

Social aspects
In a broader context of transportation, the human rights pillar encompasses a basic access to mobility and a fair distribution of such mobility resources, but also the right to live in human environments without being subjected to accident and health hazards. Worker rights include fair income and a good working environment, the right to take part in worker unions, and health and social security systems connected to the workplace.

Access to public spaces include places where all people freely can meet each other in public, and where they are free to discuss and express their opinions. As public meeting places such spaces do additionally fulfil wider social functions within their communities. Public transport, both the transport means and their stations are important in these contexts. They are in themselves public meeting places, but are also backbones in the creation of conditions for the more extensive presence of these spaces in human societies. This is not the least an important part of the history and development of rail transport, in rural as well as in urban contexts.

Rail transport offers mobility opportunities to the large populations in developing countries. This applies both to passenger and freight mobility, and to urban and rural areas,
particularly evident in the case of the large and fast growing mega-cities of the world. Private cars offer individual mobility opportunities for the few, with unacceptably high environmental and spatial problems when used extensively.

For passenger mobility, bus transport may offer the same opportunities as rail to the large populations in developing countries. While bus systems can be implemented very quickly, they do not provide the best long-term solution for mega-cities. It takes many buses to move the passengers that can be carried on one train. Buses take up considerable road space, and in some cases are major sources of polluting emissions.

There have been considerable advances in clean technology for buses in the developed world, using green fuels, gas power and the promised development of fuel cells, but where bus fleets are old and poorly maintained they can be a major cause of local pollution. In order to meet these challenges, rail systems have expanded extensively in the 1990s in many of the mega-cities of the developing world, and further expansion is underway (box 21).

The importance of these systems in offering mobility opportunities for the large populations may be illustrated by their transport intensities. Average occupancy rates through the whole year for the urban rail systems may be about 1.1 in Asian developing cities, 0.7 to 0.9 in eastern European and African cities, but down to 0.4 in western European cities (all figures for 1995). Rapid rail systems (metros) in mega-cities as Sao Paulo, Beijing, Manila and Mexico City are annually transporting ten to 15 million passengers per km rail line, while the system in Hong Kong may reach 18 million per km line.

Figures are also high – ten to 12 million per km line – in major cities of the eastern European countries in economic transition, as Moscow, Prague and Kiev. Corresponding figures for larger cities in developed countries, as New York, London and Stockholm, may be two to three million per km line annually. These figures are even somewhat lower than the most efficient light rail systems in developing countries, as in Rio de Janeiro and Istanbul.

In developed countries, rail transport offers an alternative to the private car in the urban areas, enabling people fair mobility opportunities without the economic burdens and limitations of car ownership. In addition, rail serves large groups of children, youths, functionally disabled and elderly people without the usual access to cars.

Rail transport has a long historical tradition in serving such ‘weak’ groups in developed countries with the basic mobility opportunities. Public authorities, on city or national levels, have thus in various ways economically supported rail and public transport companies in order for them to take care of such transport functions. It is considered necessary public means to achieve social and spatial, or regional equity in the access to mobility.

<table>
<thead>
<tr>
<th>City</th>
<th>System</th>
<th>Length</th>
<th>Starting year</th>
<th>Completion year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beijing</td>
<td>Metro</td>
<td>13.5 km</td>
<td>1996</td>
<td>1999</td>
</tr>
<tr>
<td>Shanghai</td>
<td>Metro-line2</td>
<td>16.3 km</td>
<td>1998</td>
<td>2000</td>
</tr>
<tr>
<td>Shanghai</td>
<td>Elevated</td>
<td>25 km</td>
<td>1998</td>
<td>2000</td>
</tr>
<tr>
<td>Guangzhou</td>
<td>Metro-line2</td>
<td>21.3 km</td>
<td>1998</td>
<td>2003</td>
</tr>
<tr>
<td>Shenzen</td>
<td>Metro-phase1</td>
<td>14.3 km</td>
<td>1998</td>
<td>2003</td>
</tr>
</tbody>
</table>
opportunities. Strategies and means to strengthen this transport function have been further developed by the rail sector during the 1990s. For instance, many railway companies put substantial efforts into bettering the travel conditions for functionally disabled persons, both at stations and in the passenger wagons.

In this lies the main reason behind the crucial function given to rail transport in a sustainable urban development. The principles of sustainable cities have been emphasised (box 3). Not only rail transport, but also rail stations fulfil crucial functions in the development of such cities. They are important nodal points both in city centres and in the local urban villages. As such they serve wider social functions. The stations are places where people can meet, deliberately and casually, and where they can carry out various tasks. At the same time they are centres for the social functioning of larger city areas and of the urban villages.

Both in developed and developing countries the rail sector has initiated and participated in planning and development of rail stations according to these principles. The sector has during the 1990s put substantial efforts into the participation in such processes (box 22).

Rail transport and infrastructure and their rail-companies have a long industrial history. It is a history with both development and continuity, and the sharing of basic principles all over the world. One of these principles is fundamental worker rights. It encompasses the rights to employment, rights at work, coverage and effectiveness of social protection for all employed, and the promotion of social dialogue. Important are also rules against employment of child labour.

Rail is a large employment sector with a total global employment of above eight million persons at the end of 1997. Through its long history rail company workers and employees have attained diverse forms of social security both for themselves and their families. In these contexts they have been frontrunners for other industries. This is not the least important in several developing countries where public social security systems are lacking or only poorly developed.

The 1990s have been a decade of extensive restructuring of the whole rail sector. This has had severe effects on the level of staffing of the companies involved (see box 52 on page 60). Social costs of these job losses can be significant, but can be lessened if carefully handled. Examples of such care are found in the privatisation of the Brazilian federal railway, the Japanese railways and the privatisation plan for Pakistan railways. Redundancy packages all included voluntary early retirement, severance payments, and retraining and assistance in finding alternative employment.

Corporate social responsibility (CSR) is a new term, but an old concept for many railways managed by the state. It includes all three fundamental pillars of the social dimension: human rights, worker rights and public space.

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**Box 22: Better stations (IRJ December 2000)**

**Construction of the Po Lam station in Hong Kong**

This urban rail station under construction in year 2000 was planned at an urban design level, and forms part of large extensions of the rail networks. It is based on the principles of integration both with other modes of transport, taxis, buses and light buses, and with crucial passenger generators as retail shops and residential areas and developments. It was master-planned by the government in order to be adjacent to several such passenger generators. Many residential towers are positioned with direct lift links both to shopping areas and to the station.
CSR requires companies to behave and act socially responsibly both internally and externally; that is both in relation to own employees and workplaces and to local communities, workers and institutions which are parts of their production and supply-chains in other parts of the world. Several rail companies – for instance Norwegian State Railways (NSB) – have lately developed such systems for CSR reporting and management.

2.4 The economic dimension

This section outlines some aspects of the market development concerning passenger and freight transport, as well as the railway supply industry in the last decade. There is a strong and longstanding, but not well-understood, relationship between the growth in the volume of transport and growth in the economy. Throughout the world this has led to considerable road building in response to economic growth, or in order to ‘kick-start’ regions seeking economic development. This has led in turn to an increase in road traffic, particularly of heavy goods vehicles, bringing additional cost, disruption, pollution, accidents and adverse social effects.

There is now increasing awareness of the need to ‘de-couple’ economic growth from transport growth, so that we may obtain the benefits of economic growth without the adverse effects of the increasing road traffic. The aim is, firstly, to reduce unnecessary routine travel by sensible land use planning and by making greater use of locally produced goods. Secondly, to develop the most environmentally friendly modes where an increase in transport is necessary. Rail has a strong contribution to make in providing greater capacity for both passengers and freight, while reducing the environmental effects.

The railway sector was a first crucial infrastructure element in the industrial revolution at the turn of the 19th century, and has therefore in historic terms made valuable contributions to society and economic prosperity. The last decade has not been an exception from this trend despite the fact that the railways’ relative contribution has declined.

This has taken place in most parts of the world, for example, in Russia (box 23). Even though there has been a substantial increase in passenger rail transport in several countries,


![Dynamics of passenger operations (passenger turnover, billion passengers/km)](chart.png)
particularly in urban areas, it has not been sufficient to keep up with the overall growth in person mobility mostly linked to the use of passenger cars. On the total global level during the 1990s there has been a decline in the absolute figures both for passenger and freight transport, measured in passenger- and tonne-kilometres respectively.

There are however some exceptions, illustrating that these are trends that can be reversed. In China, rail freight transport rose from 811 billion tonne-kilometres in 1985 to 1,300 billion tonne-kilometres in 1996. In India, during the same period, freight transport increased from 173 to 270 billion tonne-kilometres, whereas rail passenger transport went up from 227 to 342 billion passenger-kilometres. Not the least notable is the development in North America, both the United States and Canada (box 24).

After a steady growth during the 1990s, the modal share for freight transport on rails reached about 44% in United States and more than 60% in Canada by the end of the decade (figures for 1998). The corresponding shares for road trucks were 33% and 25% respectively. To put things in perspective the modal split for Russia is 81% for rail freight and 8% for road (year 2000).

Two specific railway products have gradually taken a larger share of the production in the last decade and thus contributed more and more to the economic development, namely combined freight transport and high speed trains. As can be seen from box 25, the development of combined transport in Europe is very positive. Notable on the passenger side during the last decade is the development of fast rail systems on separate lines for passenger transport (box 26).

To put things in perspective, rail freight and passenger together in the EU and EFTA now have more traffic than at any time since the end of World War II, which means at any time in their history. Most forecasts for the next decade show further growth in demand for transport.

The annual investment in transport worldwide is approximately USD300 billion per annum. This is compared with an annual investment in railways worldwide reaching USD70 billion of which USD45 billion is made in infrastructure and USD25 billion in rail vehicles (Source DVB 30 Implementation if the three dimensions of sustainable development).
Group, Deutsche VerkehrsBank). Some regions like eastern Europe have received loans for special infrastructure investments. Since 1990, the European Investment Bank (EIB) has lent over 15 billion to projects in the ten central European EU applicants. For example, 80 million to PKP-Polski Linie Kolejowe (PLK) will help the new infrastructure company of Polish Railways to eliminate bottlenecks on several railway lines, mainly along the pan-European corridors. Since 1990 the EIB has lent some 4.7 billion to projects in Poland, of which more than 1 billion went to trans-European road and rail networks (TENs), with emphasis on upgrading major international road and railway axes.
The railway supply industry worldwide

In 1999 the rail sector purchased on a global level 27.2 billion from the railway supply industry. Of this, the European market accounted for nearly 47% by value also accounting for the CEECs, Asia Pacific with 21%, North and South America for 30%, and Africa and the Middle East for only 2% as can be seen from box 27.

The EU railway supply industry alone represented nearly 60% of world production and it currently employs (directly) about 130,000 EU nationals, not including subcontractors, raw material suppliers, etc. The industry is currently facing a huge reconstruction worldwide. This reconstruction has demanded continuous rationalisation and investment, particularly in research and development. This has led to a general trend of acquisitions and mergers, and increased specialisation, and a depleting number of actors in the supply industry.

The restructuring of the railway sector is closely correlated with the structural changes in the supply industry. Here UNIFE plays a crucial role – and not only on a European level – as the voice of the railway manufacturing and supply industry. Eastern European countries have experienced a decade of complete change in terms of market structure and financing upon the breakdown of communism and the opening of the borders towards the world. Of immediate concern in the eastern European states is the upgrading of existing track and the acquisition of new rolling stock and signal systems. The railways have in general suffered neglect due to a lack of investment in eastern Europe and Russia.

In the United States market, the successful development of the rail freight business with its high market share caused by cost-effective rail freight logistics has already been described on page 30 in box 24. On the passenger side, the presence of old passenger network infrastructure characterises the railway landscape in the United States. This element has not facilitated courageous decisions for expensive investments in new infrastructure (box 28). Americans are therefore increasingly feeling the drawbacks of such political and economic choices, for example, environmental and congestion effects.

The railway supply markets in Austral-Asia are expanding and are increasingly using new technology for developing their systems. This growth has not been stable in the 1990s due to the economic disruption of the Tiger economies. The present growth is due to various different changing factors:

- population growth rate, particularly in metropolitan areas. Therefore a new emphasis on integrated transport solutions e.g. Western Australia;
- gradual increase in the integration of different transport modes in various different areas - network, ticketing, infrastructure and information e.g. Singapore;
- the possibilities for rail freight in general are experiencing a reboot of interest as part of the efforts towards achieving sustainable development.
Box 27: Worldwide railway sector purchase 1998/1999 (DVB group)

- Europe: 47%
- Asia Pacific: 21%
- North and South America: 30%
- Africa/Middle East: 2%

Box 28: Government expenditure for transport systems in the United States (DVB Group)
Part 3: Means of implementation

This part of the report deals with the different means and measures that have been applied within the last ten years to facilitate a sustainable development in the railways. How has the rail sector contributed to sustainable development, and with what success?

To answer this question, the ideal would be to evaluate and compare each measure, each mean, and each activity with regards to effectiveness. However, this is neither possible nor feasible since it is well known to all practitioners in the field of environment that not one single measure can solve all problems alone. They should be combined in a concerted approach case by case.

The following measures constitute both an opportunity and a threat for a sustainable development: regulative, physical, technical, organisational, and informative (box 29) measures have been used both internally and externally by the railway sector as well as by other stakeholders (competitors, society). In addition, economic measures can be applied, but this is not included in this study.

The following part of the report should therefore be seen as a catalogue of activities and experiences that have been deemed useful by the various organisations. They should be used in co-ordination with each other depending on the actual purpose.

3.1 Regulatory measures

Internally, several railways have elaborated internal environmental guidelines since the early – 1990s concerning issues like purchasing, use of chemicals, construction etc. These policies are internal regulative measures aiming at a certain environmental performance level. They are set as a point of direction for all employees thus making it easier to communicate the environmental principles of business.

EIA and SEA

One regulatory demand that evolved and found its shape in the 1990s was the use of Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) as an integrated planning tool. The aim was obvious – to have a better information of

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**Box 29: Drivers towards sustainable development**

- Regulatory
- Technical
- Physical
- Informative
- Organisational

Means/measures

Sustainable development
36 Means of implementation

Noise abatement policy
It is a positive development for the population living next to railways that the regulative measures are now used more actively. In many countries national or regional legislation exist on the maximum noise reception level. These levels vary quite a lot, but the main idea is to reduce the average noise level, especially in the night time. Common for all current legislation is that the legislation is valid for domestic use only, and this includes both emission levels and receptance levels. However, it has not been possible to compile a worldwide overview of legislative noise levels.

The railways have a realistic potential to become more quiet and new rolling stock put in operation for the last ten years is considerably less noisy than old. Technical solutions exist thanks to large-scale investments in research from both industry, the rail sector and governments in the last decade. However, lower noise levels implicate big investments in both rolling stock and infrastructure management. Thus, the issue of noise abatement often ends as a socio-economic trade-off between certain qualified scenarios.

Diesel exhaust gas emissions
The regulation of exhaust emissions from diesel engines has mainly taken place in the road sector; but now also the railway sector is facing upcoming regulations in some parts of the world. UIC has worked with the diesel emission limits for many years as a voluntary activity setting compulsory limits concerning four emission types: Carbon monooxide (CO), Hydrocarbons (HC), Nitrogen oxides (NOx) and Particular Matter (PM). In box 31 a diagram shows the development of UIC emission limits for new locomotives based on cycle F in ISO norm 8178 (applicable for railway locomotives only).

Other regulative areas
Below are listed some regulated environmental areas relevant for railway operation. It should be noted that many railways have already conducted work in the areas mentioned in box 32. It should also be noted that the list is by no means exhaustive.

For occupational health the main regulatory focus in the last decade has been to improve conditions regarding:

- working hours, breaks and holidays;
- primary safety aspects at tracks, workshops and in the trains;
- secondary safety aspects like use of chemicals etc;
- training and knowledge transfer;
- risk assessment.

Environmental Impact Assessment in European legislation
Directive (85/337/EEC as amended by 97/11/EEC) This directive sets out the requirements for undertaking environmental impact assessments before development consent is granted for public and private projects which are likely to have a significant impact on the environment. Projects are classified either as compulsory or as discretionary. The assessment covers direct and indirect effects of the project on humans, fauna and flora, soil, water; air; climate and the landscape, material assets and cultural heritage, as well as the interactions between these factors. It is important that authorities with environmental responsibilities and the public, including those in other member states in case of projects with trans-boundary effects, are properly and timely informed and have the possibility to give their opinion.

Box 30: Sustainable planning instruments (EC 2001)

Environmental Impact Assessment in European legislation
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The diagram shows the progress made in the standards, indicating that railways have been active for a long period in this field and that the work to promote cleaner diesel technology is ongoing.

Box 31: UIC emission limits for new locomotives based on ISO 8178, cycle F (UIC 2001)

<table>
<thead>
<tr>
<th>Year</th>
<th>CO (g/kWh)</th>
<th>NOx (g/kWh)</th>
<th>HC (g/kWh)</th>
<th>PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre 1982</td>
<td>&gt;560 kW</td>
<td>&lt;560 kW</td>
<td>&gt;560 kW</td>
<td></td>
</tr>
<tr>
<td>1982</td>
<td></td>
<td></td>
<td>&gt;560 kW</td>
<td></td>
</tr>
<tr>
<td>1993</td>
<td></td>
<td></td>
<td>&gt;560 kW</td>
<td></td>
</tr>
<tr>
<td>1997</td>
<td></td>
<td></td>
<td>&gt;560 kW</td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td></td>
<td></td>
<td>&gt;560 kW</td>
<td></td>
</tr>
</tbody>
</table>

Box 32: Some environmental regulative areas

<table>
<thead>
<tr>
<th>Regulated environmental area</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil contamination</td>
<td>For railways and especially infrastructure managers, the cleaning of polluted sites is a major task that follows from the lack of environmentally sound actions in the past. In many countries these cases of contamination are being regulated, so those railways will have to register, monitor and remediate polluted sites after an agreed scheme. The main environmental problems for remediation of polluted sites are hydrocarbons in the soil (diesel and lubricants at workshop and marshalling areas); and hazardous chemicals in the soil (for example old pollution of creosote for treatment of wooden sleepers).</td>
</tr>
<tr>
<td>Resource consumption</td>
<td>In some countries the railways are controlled in workshops and stationary areas concerning water and energy consumption in some buildings. This regulation is often a part of legislative measures concerning public buildings. Such regulation is often a driver towards having an environmental management system.</td>
</tr>
<tr>
<td>Waste treatment and separation</td>
<td>Regulation on waste treatment is very different around the world. In some countries no legislation exists, whereas in others waste must be separated and handled very carefully.</td>
</tr>
</tbody>
</table>
3.2 Physical measures

By physical measures is meant actual (re-)construction of buildings, infrastructure pathways as well as more technical solutions like applying noise abatement and emission filters on rolling stock.

Major infrastructure works have taken part in many parts of the world during the 1990s linking regions with bridges and high standard railway lines. What has been new in this decade is the active use of more holistic planning tools like the requirement of EIA in the EU. One aspect of that is the consideration of the barrier effect of new railway lines. This includes especially the considerations when lines are crossing vulnerable areas like natural parks and habitat areas. Such crossings require either some tunnelled area or very wide bridges, which allows both flora and fauna to cross the railway line. See also boxes 34 and 35.

In the last ten years there has been a rapid development of intramodal nodal points where railway ‘station centres’ are connecting different modes of traffic with different commercial and community purposes (such as shops, public authorities, libraries) providing a meeting place for local people. ‘Park and ride’ constructions have been established to take off the top load of highways providing the customers a direct and easy switch to the rail mode. These constructions have been implemented with different success in different countries, but mainly the outcome has improved public transportation. The key word is accessibility.

In the construction phase a number of measures can be applied. An example is given in box 33. Infrastructure corridors have been developed and high speed networks have been established in the developed regions of the world. However, the rail investments in the developing countries are very sparse and often not sufficient to establish a rail transport alternative. In South America the development of international freight corridors have not taken the rail mode into account.
Box 34: Regaining biodiversity (Railtrack 2001)

**Railtrack Biodiversity Plan (United Kingdom)**

The United Kingdom Railtrack network passes through many important wildlife habitats that have suffered the greatest losses either to their extent or quality. Such habitats are categorised as priority habitats in the United Kingdom Biodiversity Action Plan (UK BAP) - the process endorsed by the Government which sets out a detailed approach to conserving biodiversity in the United Kingdom. Lowland heathland, floodplain and coastal grazing marshes, reedbeds, fens and lowland meadows are some of the priority habitats found in East Anglia Zone.

**Extracts from Railtrack’s East Anglia zone’s biodiversity action plan:**

- enhance the trackside environment where possible to increase local biodiversity and provide ecological links with more distant habitats;
- integrate environmental management with the safe and efficient operation of the railway, treating all legal obligations as the minimum standard;
- set objectives and targets annually, measure performance against these and make them more challenging each year;
- share their experience of good practice in environmental management, and promote examples from others;
- work with other organisations at a local, regional and national level to seek advice and ensure co-ordinated work at trackside.

Box 35: Environmental Impact Assessment in practice (QR 2001)

**The Gold Coast railway line - Queensland Rail (QR), Australia**

The development of a new rail corridor from Brisbane to the Gold Coast (approximately 80km) was a major undertaking for QR. The majority of the proposed route was through undeveloped land, which in some cases was directly next to residential properties. In other areas it passed through environmentally sensitive ecosystems (wetlands, creeks, open forests).

Utilising world’s best practice assessment methods, QR was able to determine the types and level of impacts expected, then develop mitigation programmes to minimise those impacts. Monitoring programmes for all wetland, and creek/river system crossings were developed to give both QR and the State regulatory agency data before, during and after construction to continually assess potential impacts.

Potential habitat areas were identified prior to construction and biologists were employed to re-survey the route virtually in front of construction crews to identify and remove any wildlife found within the corridor.

As a result of the assessment, and the mitigation programmes, QR was able to plan for, and address all environmental issues for every sensitive location within its proposed corridor. Community consultation was continuous.
3.3 Technical measures

Technical measures can be applied in many sub areas such as rolling stock, workshops, infrastructure, and administrative buildings. The technical measures applied in the railway sector aim at reducing energy and/or resource consumption in general based on (see also box 36):

- improvements within the same technology (e.g. energy saving devices),
- new technology (e.g. shifting from chemical to non-chemical methods),
- new business processes (e.g. old work flows become unnecessary).

The necessary continuous improvement of the environmental performance of rolling stock is mainly concerned with the environmentally orientated design for:

- energy efficiency;
- noise emissions;
- the use of ecologically sound materials for example renewable materials;
- avoidance of hazardous materials;
- environmentally sound manufacturing processes, maintenance, repair and refurbishment;
- optimised recyclability at the end-of-life of the vehicles and products.

### Box 36: Examples of technical measures taken in the railways in the last ten years

<table>
<thead>
<tr>
<th>Energy and emissions</th>
<th>Noise</th>
<th>Resources (and others)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrification of lines</td>
<td>Wheel monitoring reducing noise and vibration</td>
<td>Cleaner technology reducing water and energy consumption (new pumps, insulation, etc.)</td>
</tr>
<tr>
<td>Shift to low-sulphur diesel</td>
<td>Source reduction of noise (e.g. new brake blocks, damping of wheels)</td>
<td>Securing oil delivery systems against spillage</td>
</tr>
<tr>
<td>New low-weight single axled trainsets with approximately half the energy consumption per seat</td>
<td>Noise-reducing barrier constructions</td>
<td>Closed toilets in trains</td>
</tr>
<tr>
<td>New diesel engines in existing fleet</td>
<td></td>
<td>Weed control management along track sides on a non-chemical basis</td>
</tr>
<tr>
<td>Test of diesel particulate filters</td>
<td></td>
<td>Substitution projects for chemicals (reduction and substitution of existing chemicals)</td>
</tr>
<tr>
<td>Stationary energy supply to train on hold to reduce air pollution and noise</td>
<td></td>
<td>Environmental requirements in invitation to tenders</td>
</tr>
<tr>
<td>Procurement of eco-labelled electricity</td>
<td></td>
<td>Shift from wooden to concrete sleepers (avoiding the use of creosote for wood protection)</td>
</tr>
<tr>
<td>Optimisation of heating of switches during winter</td>
<td></td>
<td>Securing oil tanks onboard rolling stock</td>
</tr>
<tr>
<td>Optimisation of heating, ventilation and air-conditioning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Driving advise systems</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Energy
Reducing energy consumption is relevant not only due to the associated environmental impact, but also for cost reasons. Sometimes, energy cost is almost of the same order as vehicle capital cost or maintenance cost. Several technical projects are driven by economic incentives like those presented in the case story from Dutch Railway, NS (box 37).

When aiming at reducing energy consumption, there may be trade-offs between energy consumption on one hand and other properties, like comfort (insulation increasing vehicle mass, air-conditioning) on the other: it has to be considered that most of these influencing factors will play more or less important roles for intercity/high speed trains as compared with regional/urban trains.

Aerodynamic drag is of course most relevant for high speed applications, where it amounts to 50% to 70% of the total running resistance. In contrast, for local trains the acceleration/retardation losses account for most of the energy consumption.

Concerning improvement strategies, this leads to focusing on weight for local applications versus air resistance for high speed trains. A universal influencing factor would be increasing seating capacity – by introducing double-decker cars, and wider bodies. A calculation shows the potential of such strategies (box 38).

Sub-suppliers also play an important role in providing technological solutions to shared, possible environmentally damaging, problems such as CO2 emissions and high-energy use (box 39).

The main result of an energy saving policy in Dutch railway NS based on experiences from 1998 to 2000 is that energy efficiency went up by 8.7%. Without any energy saving policies, the use of energy would have been 125 million KWh higher.

This result is based on the following main actions and initiatives:

- some 50 new traction units designed for double deck coaches, were put to operational service, while at the same time old locomotives were phased out;
- pilot project with the use of chopper installations on two trainsets;
- improvements of the train timetable (first introduced during 1998/1999) with longer trains and more flexibility for coasting (driving technique to save energy);
- improvements of climate control onboard double-deck trains by means of a reduction of fresh air ventilation and cabin temperature.

Climate control onboard double deck trains, a closer look at this project
Early investigations had indicated that the initial settings to control the climate onboard double-deck trains, resulted in a too high amount of fresh air; much more than was needed to achieve the desired level of comfort. So NS had to make a trade-off between the need to offer a certain level of comfort and the need to save energy.

The level of comfort regarding temperature and fresh air onboard trains was based on the demand that at least 90% of the passengers should be satisfied with the climate onboard. The installation of the new software for climate control onboard resulted into 21 million KWh saved energy, which accounts for 16% of the overall package of energy saving measures.

Box 37: Energy saving project in the Netherlands (NS 2001)

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Electromagnetic fields have been discussed within the railways as a potential problem area especially about the health aspects of staff and passengers from catenary lines, consequently investigations are now carried out in several situations as the example of box 40.

Noise
There are generally moderate or high levels of noise around large freight transport terminals – therefore location and planning is important. So too are the noise levels produced by the products and tracks themselves. It is possible to reduce noise levels through various technical measures, such as development of new infrastructure and rolling stock products. With regard to infrastructure – for example smoother hard-wearing track surfaces, resilient track mountings (reducing noise at the source) etc. – much can be done to improve noise levels. This requires the development of new technologies and they often require the relaying of old infrastructure. For rolling stock, there are many options, first off safeguarding smoother wheel surfaces, further on rubber noise absorbers, anti-noise skirts, and new types of braking systems that have been able to reduce noise levels by several decibels. A combined approach to solving noise problems is the most sensible one, as overall costs can be minimised with benefits to all stakeholders.
Materials
New, more environmentally-friendly materials are constantly being developed — many being used across the various transport sectors. Recycled materials are now being encouraged and the ability of the industry to recycle an even larger proportion of material inputs, including liquids and consumable parts has led to many cost-saving and environmental benefits. In addition to recycling, innovative design, manufacture and servicing techniques, the industry could realise many important commercial advantages for rail and huge advantages for the environment. It is estimated that over 90% of the average rail vehicle is recyclable. This figure is rising fast.

3.4 Organisational measures
Networking is a vital part of the organisational work towards a more sustainable rail sector. The increased environmental awareness raised in railway companies worldwide would not have existed at such a high level without the establishment and use of networks. Three main factors are crucial for the performance of today’s environmental network in the railway sector; namely the existence of ‘fiery souls’, informal networking internally at company level, and formal networking (mainly company and sector level activities).

The role of fiery souls in the railways was very important in the beginning of the 1990s, and still today they play a crucial role all over the world. Today fiery souls exist both inside and outside the formal environmental organisation. They work in informal networks making it possible to consider environmental aspects even where no formal body could take responsibility, installation of low-energy such as the consuming devices at workshops.

The establishment of environmental management systems (ISO 14000) is one way of creating a formal network for the environmental work. So far no railway operator has been certified as a whole company, since this is often too complicated and yields too few benefits compared with the costs. However, in many railways co-operation on local level is very beneficial and thus ISO 14000 and other certifications have been implemented.

British Railways (BR) released its environmental policy statement in 1991. This included the following programme areas — the reduction of noise, vibration and emissions, the reduction and management of waste, and the assessment of environmental performance. Danish State Railways (DSB) released its environmental action plan in 1992. It included the plan to introduce new organisational structure, staff training and tools, making it possible to assess the environmental performance such as environmental impact assessments.

Swedish State Railways (SJ) adopted its first environmental policy in 1989. French National Railways (SNCF) emphasised the intrinsic advantages of rail transport as less energy, less pollution and less space. It has also striven to further improve its performance in the protection of ecosystems, the reduction of noise nuisance, the treatment of industrial waste, and the safe transport of hazardous materials (SNCF 1994). German Railways (DB) has introduced a specific EMS, called the ‘environmental protection system’, to integrate environmental protection into the planning, preparation and practice of operating a railway. (Kettner, J, 1995). East Japan Railway (JR East) has organised its company-wide environmental activities and set its environmental targets in 1996 under the Committee of Ecology, established in 1992 (JR East 1996).

The supply industry too is now looking to the environment and sustainable development in general, as a winning business strategy. This has led to increased communication of environmental performance and the setting up of large environmental in-house departments.
Their role is to personify the main issues of sustainability and integrate them into the core of the company as a horizontal issue and an underlying priority.

The experience so far with formal networks and organisation of the environmental work is very positive. If the formal networks had not been established in the early-1990s, the level of activities as well as the environmental performance in general would probably have been lower here at the beginning of the millennium.

**International activities**

Associations and unions play a crucial role in encouraging and facilitating its member companies in their moves towards sustainable development. They represent an important driving force towards corporate responsibility and environmental consciousness. These associations provide networks where common experiences are shared and common problems are solved (box 41).

In 1991 a small working group (Danish, Dutch and Swedish railways) was formed at UIC to work out proposals for joint activities on the environment. It was this ‘forerunner’ group that made the report entitled *Towards sustainable mobility*. In 1992, an official UIC Environment Working Group was created. The working group acts to promote international co-operation and information exchange as well as common response to initiatives developed by the EU institutions.

In October 1994 the working group hosted the first environment co-ordinators’ conference to promote exchange of experience between member railways. The UIC Environmental Co-ordinators Conference is now organised every other year with additional conferences in between on more specific topics. A list of major international network events within the environmental area can be found in the annexes.

**Negotiation**

More and more railways are using negotiations as a measure to reach a good relation to competitors, authorities, and customers regarding environmental performance. Negotiations of certain environmental requirements can result in agreements that substitute regulation. Areas where negotiations have lead to improved environmental conditions:

- voluntary agreement with government cleaning of polluted soil, (in the future possible noise on existing fleet and diesel emissions at European level);
- round table discussions with consumers organisations;

**Box 41: International activities**

UIC, CER, UNIFE and UITP environmental working group activities:

- promote sustainable development in public and railway sector, as well as industry;
- provide a forum where experiences and problems are shared. From this, common issues can be isolated and solutions searched for. This allows for burden-sharing of the work;
- pass relevant information on to all members through the Web site, newsletters, reports and seminars;
- inform internal working groups of relevant legislation, and provide input;
- filter relevant information on technical development back to the members of the working group. This allows for early input of the rail industry;
- are working together with co-operates sustainable mobility, only in this way can the industry ensure consistency.
• environmental requirements in tenders for rolling stock based on LCA;
• contracts between infrastructure managers and railway undertakings;
• voluntary membership of organisation which forces environmental considerations to be taken when purchasing certain energy consuming goods.

3.5 Informative measures
Policy measures are characterised by the company’s or organisation’s free will to follow some predefined ‘guidelines’. As already mentioned in the previous section, many railways have established overall environmental policies at company level. Just as the concept ‘sustainability’ is not always interpreted in the same way, environmental policies focus on a variety of issues, see box 42.

The major problems for some environmental policies in the railways have been their approval or their practical use at top management level. It is difficult to give one clear reason for the lack of management backup, but the problem is not only with the management. Often the environmental department has not communicated the policies very well, making them difficult to handle in practice. Another possible reason is lack of ownership or practical commitment in an organisation towards centrally-decided policies.

Box 42: Selected policies concerning environment and social issues

Examples of basic sustainable policy statements in the railways:
• occupational health policy,
• monitoring of train water supply, food, and sanitary conditions;
• nuisance control (noise, exhaust gases),
• soil pollution policy,
• environmental policy,
• meets or exceeds environmental applicable requirements of government,
• safety strategy.

Examples of more ‘advanced’ sustainable policy statements in the railways:
• guidelines for ‘green’ purchasing,
• environmental code of conducts,
• CO2 policy,
• keep employees and the public informed about its environmental plans through communications programmes (stakeholder involvement),
• policy to avoid discrimination among employees (with regards to gender; race, etc.),
• senior policy.
Corporate social responsibility

Corporations are now functioning in a new environment. This environment encourages corporations to increasingly take responsibility for their actions on a global level. This not only implies the rights of their workers, but also the manner in which they trade, with whom they trade and the promoting of good practice in terms of integration in the local environment, in-depth social dialogue, attempts to achieve equality and equal treatment, integration of minorities, and financing micro-enterprises. This the rail sector strives to do through different measures. These include the protection of workers’ rights through unions and internal ‘opportunity’ programmes, support for organisations supporting labour rights, setting up of production facilities for the supply industry in developing countries, and membership of organisations such as the World Business Council for Sustainable Development (boxes 43 and 44).

Campaigns

Campaigns provide the visibility for policies, procedures, and projects. The 1990s became the decade for environmental campaigns in the railways. But railways have had other campaigns for example related to occupational health, safety, accessibility, etc. A list of campaigns is given in box 45.

The campaigns have increased in strength and belief in the benefits of the railways during the last decade. When the railways in the beginning of the 1990s feared to discuss environmental performance of other modes, and still hesitated to promote their own qualities in their external communication, this is no longer the case. Railways used to be public state-owned departments with no incentive to promote their advantages, but today their external environmental communications are much more aggressive in style.
Communicating clear, concise and understandable information on the products and processes is another essential part of environmental communication. Customers need to be aware of the possible negative effects of any products they purchase and the public needs to be made aware of the positive environmental benefits of using rail as a form of transport. An example of this is ‘product declarations’ as described in box 46. Such declarations are increasingly requested by the railway operators aimed at guiding the manufacturer in building products with minimum negative effects.
Knowledge and education
A natural part of sharing information is via knowledge dissemination and education of different employee groups. This measure has been used right from the beginning of the environmental work. It is not enough for the top-level management of a company to place economic, social and environmental concerns at the top of the agenda. These philosophies must permeate throughout a company from the design of products to practices on the factory floor. Therefore, the training of all the staff working within a company is essential to the success of these policies (box 47).

3.6 Incentives for the railway sector
It is difficult to argue that the railways have not been active in the field of sustainable development in the last decade. As a response to the need for environmental, social and economic changes as stated in the Rio declaration, innumerable initiatives have been started covering the local level (at workshops, stations, and administrational buildings) to the level of international organisations. For several reasons, however, at present it is difficult to determine to what extent the railway sector in general has improved over the last ten years.

<table>
<thead>
<tr>
<th>Box 47: Green initiatives in the rail supply industry (UNIFE 2001)</th>
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<tbody>
<tr>
<td><strong>EHS management at Bombardier Transportation India, Baroda</strong></td>
</tr>
<tr>
<td>The site in Baroda was built in January 1996. At an early stage, it was decided to work according to best practice in environmental and health and safety affairs. Therefore, a well-respected senior manager, who was already responsible for quality management, was put in charge of establishing the environmental management at the new site. The overall philosophy is to ‘walk the talk’. The environmental management system is partly integrated with quality management and health and safety management. One of the programmes concerns the environmental awareness of all employees, contractors and suppliers. Due to the general lack of environmental knowledge and safety awareness among job beginners in India, Bombardier Transportation trains their employees on how to handle environmental and safety issues properly. This training programme is ongoing. The site in Baroda was one of the first foreign subsidiaries to attain ISO 14001 certification in 1998.</td>
</tr>
<tr>
<td><strong>Alstom Transport Intranet</strong></td>
</tr>
<tr>
<td>Alstom Transport has taken many measures to improve the knowledge of employees about environmental issues concerning both the products they produce, the services they supply and the way in which they conduct their work. One method Alstom Transport has found particularly successful is the use of a specially designed Intranet to inform their members of staff about the practices and policies encouraging sustainable development. The Intranet, which is run in-house, furthermore provides a forum for the members of Alstom Transport to ask questions and put forward possible ideas for the future development of the company with regards to its sustainability.</td>
</tr>
</tbody>
</table>
Firstly, the discussion on which environmental performance level the railways have actually reached in the last ten years is difficult to answer given the lack of environmental data on a global level. Thus the sector needs to strengthen its work related to data-gathering, processing, and presenting.

Secondly, the ‘greening’ of the railway companies and organisations in a broad sense shows that railways are committed to change their actions, however improvements are still achievable. This calls for better education and training, visible management, and focused campaigns both internal and external. It also requires more incentives for the sector. These can be provided through sensible and coherent policy frameworks or economic rewards.

Thirdly, the railways should reach the breaking point where the change in rolling stock, infrastructure, and procedures will give significant improvements. The low general investment level in railways for the last 20 to 30 years and the high-cost of re-investment for operators and infrastructure managers have to some extent limited the penetration of new technological solutions into the market. This has led to a situation whereby the new technologies have contributed less to sustainable solutions of the transport problems than expected.
The main challenge to be met by the rail sector in the coming ten or 20 years can roughly be divided into two categories: internal factors (the sector and the railway level) and external factors (the market and the political level). This is shown in box 48. This part of the report will try to take a closer look at the future of the rail sector. What will the rail sector do to contribute to sustainable development?

On a sector level, the challenge of the rail sector is to host the influx of transport if and when measures are taken from the political level to switch the modal shift in favour of rail. This requires a readiness to conquer both technical and organisational obstacles. This implies a major increase in traffic intensity as well as extension and upgrading of lines.

On a company level, the main challenge towards sustainable mobility is to make use of all the existing research and experience in order to utilise developed tools and implement technical and organisational solutions that support sustainable mobility in the railway sector. This is a challenge of establishing the basic organisational conditions for full scale implementation of appropriate solutions that are cost efficient or even better constitute positive contribution to railways, long-term investment plans.

Furthermore, a railway as a part of a public transportation system is a service to the community, the local government, the national or even international regions. Thus, these different levels of transportation authorities and political levels of decision-making have also a serious responsibility for the above-mentioned modal shift. In this sense, railways can only provide the service that the public wants to pay for.

One way for the political level to enhance good public transport is to consider not only the economic, but also the environmental and social aspects of an invitation to tender. The consumer will get what authorities are asking for and what market-driven railways can provide. This is part of the adjustment to a market situation that was not evident in the 1990s.

These initiatives within the rail sector are resulting in important changes in the regulation of, and national and international competition between, former national railways. The railways and their associations appreciate and welcome the new challenges related to sustainability. Within a framework of increasing competition in the transport market, railways will focus on the economic, social, and environmental benefits of their transport product.
A policy for a level playing field between market actors has already been developed and successfully represented in the EU by CER. Simultaneously with these growing sustainability trends, the transport sector in general and the railway world particularly are facing increasing competition. Private, public and supranational initiatives have been taken and implemented in order to improve efficiency and increase competition. This has led to a new customer-focused attitude on behalf of the railways and a more profitable rail supply industry.

4.1 Railways’ strategy for sustainable mobility

At UIC and CER level, railways will continue to co-operate on issues that will improve sustainable mobility. Railways, having the obligation and clear will – but also the possibilities to contribute with valuable solutions – welcome the growing demand for sustainable mobility in society. However, to implement these solutions with success is complicated and it needs the full involvement of politicians as well as all actors within the transport sector, including actors in industry and infrastructure planning.

In this multi-stakeholder process, railways want to address and stress relevant aspects of sustainable mobility, and contribute, participate and co-operate with other stakeholders and actors in order to achieve the overall goal of sustainable mobility. In this way UIC will also further develop its position as the international technical co-ordination body for the railway sector.

The railway vision on sustainable mobility

Railways will provide society with thoroughly considered railway transport solutions, based on economic, social and environmentally sound conditions adapted to the needs of society for sustainable transport and mobility.

The railway strategy towards sustainable mobility

This strategy addresses four key levels for further actions. The railways’ future sustainable mobility activities will concentrate internally on the railways themselves, and externally on the political and legislative level, as well as the market level. Internally, the railways want to initiate measures such as specific target settings and actions to assure railways keep proactive and capable of contributing to society’s sustainable transport solutions.

Externally, the railways want to assure that the political, market and legislative conditions support the overall movement towards sustainable mobility structures. To contribute to this vision, UIC and CER want to:

• co-operate with all relevant stakeholders such as UNIFE and UITP,
• communicate openly about the impacts of railways,
• organise and co-ordinate international activities to promote and implement sustainable railway transport solutions,
• establish management and monitoring systems suitable to support the overall goal of sustainability and to provide stakeholders with relevant information about impacts and progress,
• contribute with research and technological solutions based on the principles of sustainability.

The railway level

Railways have a key role to play in order to develop, tender and deliver sustainable railway transport solutions. A focus on the environmental, social and economic advantages of today’s railway product will be combined with a strong commitment to the further development of these possibilities.

To develop and implement such solutions, railways need UIC to provide the necessary technical co-ordination on sector level. Thus in order to realise this, UIC and CER will focus on:
- improving interoperability,
- implementing management tools to assure and monitor the necessary step towards sustainability,
- improving the efficiency in the use of the existent railway infrastructure,
- supporting the development of new infrastructure and transport products that contribute to the goals of sustainability,
- investigating possibilities to develop standards concerning acceptance levels for environmental impacts.

The political level
The political level is one key factor concerning the future decisions on sustainable mobility. Politicians on a national and international level, in parliaments, councils, organisations and NGOs decide the transport policy of tomorrow. Sustainable mobility demands the linking of different political areas such as land use planning, environmental, energy, and transport policies.

It is of vital interest for the railways to be able to deliver relevant and reliable documentation, information and viewpoints on this level. This will contribute to political decisions meeting the demands of mobility, not exceeding the limitations given by the environment. In order to realise this; CER and UIC will focus on:

- collaborating with all relevant stakeholders on the necessary structural changes and adjustments in the railway world in order to promote sustainable mobility,
- achieving fair prices (‘getting the prices right’) reflecting the true costs of the different transport modes,
- active co-operation with all relevant stakeholders to define and concretise the concept of de-coupling economic growth and resource use for transport,
- contributing relevant, purposeful and reliable information, for example indicators for the railway products.

The market level
The market and the market conditions constitute future possibilities and incitements for the railways, as other modes, to move towards sustainable mobility. Fair and equal competitive conditions in both the railway and the overall transport market, forms (in respect to this) the crucial preconditions for success. In order to realise this; UIC and CER will focus on:

- establishing and assuring equal economic and environmental competitive conditions and treatment of all transport modes,
- establishing and assuring access to the railway infrastructure based on defined environmental conditions,
- delivering relevant and reliable information about the environmental impacts of the railway products to customers,
- continuing a close co-operation with suppliers to fit the needs for further sustainable progress (such as railway products with higher eco-efficiency),
- co-ordinating information of transport products adapted to improved sustainable mobility together with other transport actors,
- collaborating with customers and other transport modes to improve sustainable transport solutions,
- increasing the market share of sustainable transport solutions.

The legislative level
The legislative level turns political initiatives and decisions on sustainable mobility into legally binding decisions. It is of vital interest for the railways to assure qualified and weighted solutions in the ongoing legislative decision-making processes, which for the EU are closely monitored and actively accompanied by CER. In order to assist this process, the railways will focus on:

- contributing technical and economical analyses in legislative decision-making processes,
• insisting on fair economic and environmental conditions and treatment of all transport modes.

Active contribution to legislative bodies on national, EU, and international level, providing them with the railways’ knowledge, competence, and research.

The strategy mentioned above sets a framework for the future work with specific environmental issues like energy, noise and materials explained in the following.

Energy efficiency
One main area for improvements in the railway sector is the source and use of energy. The railways have, on several occasions, put focus on the energy issue at special conferences, last time at a UIC Conference in Paris, 2000.

Some examples of high saving potentials:

• energy efficient driving,
• fine tuning diesel engines,
• braking with energy recovery – electricity only,
• weight optimised trainsets or wagons,
• optimised heating, ventilation and air-conditioning systems.

All relevant railway energy-saving technologies are currently being analysed and categorised in an ongoing UIC funded project. This will end up with a public accessible database of possible improvements on existent rolling stock or when procuring new material. This database will enable the user to have an overview of the energy-efficiency potential as a percentage, given a fleet of wagons, locomotives and trainsets and the improvements decided.

Noise abatement
Noise is probably the area where railways in the future will have the biggest problems to comply with increasing demands from neighbours, customers, and authorities. This is due to several factors:

• population growth is mainly focused in urban areas giving problems around the existent tracks with more dense residential areas;
• acceptance levels towards noise are decreasing as people get wealthier and more independent of public services like transportation;
• the rail traffic is planned to rise by a factor of two to three, making it impossible to contain the overall noise level without applying appropriate measures.

The noise abatement will in the future develop regionally but not totally independent around the world. Two main trends will determine this development:

• maintenance of existent rolling stock and infrastructure,
• procurement of new rolling stock and infrastructure.

The first trend is the need, for example, of retro-fitting of brakes on existing freight and passenger wagons. This area is well defined and investigated at European level, the total effort has been calculated based on the fleet’s size. This trend also includes the appropriate maintenance of wheels and rail to reduce noise caused by roughness. The second trend is the investment in new rolling stock and new infrastructure with low noise technology.

Integrated procurement policies
For the railway sector to improve as a whole, co-operation is needed in the supply chain. Environmental and social requirements to both the product and production are crucial means to obtain a market-based improvement scheme for the future railway sector. Such a scheme relies on management back-up.
4.2 Railway supply industry strategies for sustainable mobility

UNIFE recently published a document entitled Vision 2010 which outlines the main challenges facing the rail supply industry and the main trends which have concerned the industry over the last few years. The supply industry has many opportunities to provide solutions to the problems of the future sustainability of the transport system worldwide.

Most of these opportunities are of a technical nature and pertain to issues of immediate concern such as emission levels, energy efficiency, noise pollution and the increased recyclability of the products themselves. The technological solutions to these problems require increased levels of spending on research and development, an action which the rail supply industry has vowed to undertake, also in co-operation with the other stakeholders in the industry.

Some of these opportunities also lie in the organisation of the companies themselves, such as Environment Management Systems (EMS), increased product knowledge (IPP and environmental indicators) and internal and external information programmes (health and safety training, EHM, product declarations and environment reporting).

Lastly, many future opportunities will arise from increased international co-operation through organisations such as UNIFE. UNIFE’s working group on Environment and Transport provides a forum for its supply industry members to discuss common problems and to search for common solutions. UNIFE facilitates this process and works closely with the operators and other relevant stakeholders to ensure a sustainable future for the rail industry.

4.3 Public transport strategies for sustainable mobility

UITP is developing an environmental strategy based on the need to enhance and develop public transport systems as an integral part of meeting the Kyoto targets for CO2 emissions, while improving the urban environment in term of air quality, public health, social inclusion and safety. Improved public transport is essential in meeting society’s demands for increasing mobility, while avoiding the detrimental social and environmental side effects of increasing traffic.

The particular focus will be on government and international government organisations, including in particular the EU, the UN and their institutions, to stress the role of public transport in meeting these objectives. The principal messages will be:

- the strong and positive role of public transport in meeting environmental and community objectives;
- that public transport is sustainable, and is an integral part of sustainable development;
- that the public transport industry is doing its part.

UITP’s work will initially be to co-ordinate its members in the public transport industry to devise and implement a plan of campaign. This group will include operators, industry and government representatives throughout Europe (including eastern Europe), together with Asia, Africa, North and South America, and both public and private sector representation. The plan will include development of an ‘Environmental Charter’ stressing the commitment to environmental standards for UITP members, and possibly certification of performance standards.
A particular focus will be on helping members to approach their own regional and national governments; building up effective communication with authorities at all levels.

### 4.4 Railway research

To obtain the goals of a significant increase in railway services such as planned within the EU, the railways have co-ordinated their efforts in the so-called ‘European Railway Research Strategy 2020’ made in a co-operation between UIC, CER, UITP, and UNIFE.

The principal objectives of the proposed interoperable railway system in Europe by the year 2020 are:

- for rail to achieve a 10% market share of passenger traffic in the EU with no detrimental environmental impact. This represents a doubling of passenger kilometres within less than 20 years (based on Eurostat/UIC Statistics);
- for rail to achieve a 15% market share of freight traffic in the EU with no detrimental environmental impact. This represents a tripling of tonne kilometres within less than 20 years (based on Eurostat/UIC Statistics);
- a three fold increase in productivity (UIC Strategy);
- elimination of avoidable fatal accidents within proposed interoperable European railway system;
- a 50% gain in energy efficiency over vehicle or product life cycles;
- a 50% reduction in the generation of pollutants over the life cycle of rail industry products and services;
- an increase in network capacity to accommodate the traffic projections given above.

The research priorities are focused around the following main topics:
1. conditions for interoperability,
2. development of telematic solutions,
3. a holistic approach to safety. New product assessment and approval is becoming more and more expensive and time consuming. For interoperability to generate real benefits by accelerating conformity acceptance, new approval techniques and facilities need to be introduced capable of maintaining existing high levels of safety. Harmonised validation systems for safety assessment:
   - define the mechanical and operational aspects of rail systems analysis;
   - construct a database to validate the expert choices, comparing them with service feedback;
   - guarantee exhaustive levels of assessment while protecting the railway community from over-specification.

4 Retaining the environmental advantages of rail. Rail traffic must be able to double without damage to the environment. Europe's citizens want heavier freight and faster passenger trains but without the resulting noise, air and EMC pollution impacts.
   - developing noise-attenuation techniques appropriate for different networks,
   - noise and vibration footprints in comparison with other modes,
   - reduction of CO2 and toxic emissions,
   - analysis of electromagnetic emission solutions,
   - recycling of materials used in the manufacture and refurbishment of rail vehicles,
   - energy efficiency and alternative energy sources.

Support fields. Rail will be included in programmes initiated by other transport modes.
5 innovative materials,
6 production methods.

As can be seen from the list above, all research topics support a more sustainable railway, especially with regards to interoperability, safety, and environment.
4.5 Transport policy

Transport policy should from the rail sector’s point of view contribute to sustainable development by encouraging sound economic, social and environmental transport solutions globally for both present and future. A new modal split should be reached in the transport system to better match collective demand, minimise costs arising to society and improve economic efficiency. Railways are crucial in re-balancing transport trends. The following are some areas of concern of the railways.

All transport modes should be subject to comparable environmental and safety standards. The different transport modes cause greatly differing levels of external effects on the environment. It is desirable to harmonise environmental standards and specifications for all modes, in order to focus required improvements on the transport modes, which cause the greatest external effects.

Such an approach would complement the continuing progress made by the railway sector in reducing various external effects, in particular relating to noise and energy consumption, through the use of innovative technology. In the area of safety, the railways’ excellent record is due to highly-detailed regulation, making rail at least 20 times safer than road. Here too, safety policies for other transport modes should be strengthened, by combining regulation and effective enforcement of its implementation by the various actors concerned, backed by effective penalties related to the severity of the damage.

Non-commercial services provided in the public interest should be paid for through public service contracts. In order to reduce the external effects of transport, notably congestion, atmospheric pollution, and noise, in particular in large conurbations and in sensitive areas, the local and national authorities should favour rail transport and conclude public service contracts with the operators concerned. A clear division of tasks between the public authorities and the railways should ensure that any provision of transport services in the public interest is backed by contractual arrangements covering – along with the definition of these services – all the costs borne by the railway undertakings.

Distortions of competition between the different transport modes should be eliminated. Regulations in the road sector are notoriously less restrictive than those applying to railways and, moreover, their enforcement is far from being systematic. This is contrary to the general interest as well as that of the customers and puts railways in an unfavourable position in the transport market. Hence enforcement of road transport regulations should be strengthened and new measures should be introduced. In particular, conditions on working time in road transport should be significantly harmonised, and stricter rules should be applied.

Similarly, checks backed by penalties should be applied to ensure that limits on loading, speed limits, and driving hours are enforced. Restrictions, quotas and bans on certain types of road traffic (for instance covering weekends and environmentally sensitive areas) should be introduced or maintained.

There should be an integrated approach to planning and funding transport infrastructure. Planning and funding of transport infrastructure should in future be the result of methods of analysis taking account on the one hand all transport modes, and on the other all the needs of the regional area. The choice of investment projects should be based on cost-benefit analysis taking account systematically of all external effects. In order to respond to transport needs in a coherent way throughout the world, a greater involvement of governmental funding is necessary.

Interoperability of rail systems should receive greater support. Although initially developed
primarily within national frameworks, the railways soon sought to improve the efficiency of international transport, in particular through agreements on exchange of rolling-stock. However, within an integrated economic area, where customs controls between, for example, European member states have disappeared, these efforts on the part of the railway companies should be accelerated and supported by the transport policy of the region. They should first of all prevent increasing divergence between systems and equipment at an international level and ensure through appropriate measures that the investments planned by the different companies do not introduce further disparities.

Due to the significant financial sums involved, incentives should be made available for a transitional period to compensate for the extra costs of the initial investment. This is necessary in order for the railways rapidly to achieve a high degree of interoperability in high trade economic regions and thereby confirm the relevance of the rail mode on a worldwide basis.

Improving the performance of the railway system in consultation with the social partners. The railways have already achieved significant improvements in terms of productivity and performance thanks notably to changes in operating methods, often linked to new technology. However, substantial disparities still exist between railway undertakings themselves and in comparison with other transport modes. These concern particularly working and rest-time, training costs, staffing levels and social charges. Fundamental changes are essential, and a social dialogue is necessary both at national and international level.

The principles for charging for the use of transport infrastructure should be the same for all transport modes. A harmonised infrastructure-charging regime is required for all modes, which should internalise environmental costs, costs of accidents and costs of congestion. This would recognise the environmental advantages of railways and increase their competitiveness.

Such a charging system should be based on the principle of marginal social cost, which would improve efficiency in the use of infrastructure. In the road sector variable taxation should replace fixed charges at international level, and a system of kilometre charges should be introduced for heavy goods vehicles according to the tonnage transported.

Charging should start with particularly environmentally-sensitive areas to achieve a significant transfer of traffic from road to rail. Until comparable charging regimes are introduced across modes, a second-best solution would be to provide financial compensation to the more environmentally friendly modes for the use of their infrastructure.

Energy taxation should be harmonised and a carbon tax should be introduced. Fiscal measures for energy should reduce the current price distortions and at the same time minimise the economic costs of reducing the level of greenhouse gases, mainly CO₂. For all transport modes, energy taxes should reflect in particular the external costs due to climate change, in order to promote efficiency and meet the target set by the Kyoto Protocol.

Therefore ecological tax measures should involve a gradual increase in taxes and prices relating to energy, depending on CO₂ emissions and on mileage covered. The revenues from this could be redirected to industry (for example by reducing employers’ social contributions) or to households. In the aviation sector, a tax on fuel should be introduced.
Annexe 1: Railway statistics

The following data is based on UIC Statistics (2001). For further statistical information please go to: http://www.uic.asso.fr/d_stats/stats_en.html.

Box 49: Global share of railway lines

Box 50: Length of global railway lines with details about electrification
Box 51: Railway traction energy sources 1999

- Diesel/other
  - Asia
  - Africa and Middle East
  - America
  - Europe

Box 52: Employment in the railways (the railway supply industry not included)

- India, United States, Japan and others
- Eastern Europe
- EU 15
- Magreb and Middle East
Box 53: Mobility audit (Green Cargo 2001)

<table>
<thead>
<tr>
<th>Emissions (kg)</th>
<th>Road</th>
<th>Rail</th>
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<tbody>
<tr>
<td>HC</td>
<td>1,782</td>
<td>0.52</td>
</tr>
<tr>
<td>NOx</td>
<td>17,409</td>
<td>0.52</td>
</tr>
<tr>
<td>CO2</td>
<td>1,989,600</td>
<td>207</td>
</tr>
<tr>
<td>SO2</td>
<td>414</td>
<td>0.31</td>
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<tr>
<td>Social costs</td>
<td>431,200</td>
<td>37</td>
</tr>
</tbody>
</table>

Example of mobility audit (environmental declaration of a specific transport)

Environmental analysis by Green Cargo (Sweden) Miljödata

Transport of 50,000 tonnes of steel from Luleå to Borlänge (Sweden):

- Distances, road: 829km, rail: 1,035km.
- Comparison between heavy lorries (60 tonnes, Euro II) and electric train.
- Best available diesel fuel was used for road transport, environmentally labelled electricity for train transport.
- Swedish official socio-economical evaluations are used for cost comparison.

Box 54: World revenue-earning rail freight transport (million tonnes km)

Europe, Maghreb, Middle East, India, China, United States and Russia
Box 55: World rail passenger transport (passenger-kilometres)

Europe, Maghreb, Middle East, India, China, United States and Russia

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<tr>
<td>Value</td>
<td>1,000,000</td>
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Annexe 2: Ongoing activities at international level

UIC
UIC working group Environment is the core group under UIC to take action within the environmental field. The group was established in 1991 and has several purposes:

- co-ordinate work between the different sub working groups,
- forum for launching and discussion of new ideas and projects,
- policy support for UIC board of management in the field of environment.

Sub Commission Energy Efficiency:
The commission created to guide UIC R&D projects in relation to energy use, energy technologies, energy sources etc. A number of projects has run under this Commission including currently ‘EVENT’ (Evaluation of Energy Efficient Technologies), ‘Driving Advise Systems’, and ‘Environmental Criteria for Procurement of Rolling Stock’.

Sub Commission Noise and Vibrations:
Noise and the associated phenomenon of vibration have been the subject of railway sponsored research for over 30 years, this group was revived in 1995. This Commission is a forum for UIC noise R&D projects and provides a focus for UIC work concerning environmental noise and has the objectives to prepare the position of the UIC and its member railways towards policy initiatives of governmental bodies, which result in environmental legislation/regulation. Current research activities include ‘STAIRRS’ - developing policy tools for the implementation of EU Policy (http://www.stairrs.org), ‘RENVIB’ – investigations into the phenomenon of vibration, and ‘Harmonoise’ – creating a harmonised noise-prediction model.

Working group Environmental Indicators:
This group has elaborated a draft manual called Guide to produce environmental indicators for the railways which formed the basis for a very successful conference held in June 2001 in Paris. The conference was co-organised with the EU funded RAVEL project (http://www.ravel-project.de). The group has proposed a core set of five environmental indicators:

1. energy consumption,
2. energy source (mix),
3. energy emissions (CO2),
4. noise,
5. land take.

The main objective of the future work is to make and propose a UIC technical leaflet of indicators. Read more in the official UIC press release from the Indicator conference http://www.uic.asso.fr/uk/news/index.html

Working group External Effects:
This has the objective to work with studies on external effects of the railway. The main outcome from this group has been the INFRAS/IWW report on ‘External Cost of Transport’ from March 2000. This report is widely recognised as a reference report for external effects. See also under references.

Working group Environmental Communication Strategy:
It is the aim of newly launched ‘Working Group Environmental Communication Strategy’ to develop a co-ordinated UIC communication strategy in the field of environment. This is based on the fact that the railway sector has an urgent need to become more professional in its environmental communication. By providing assistance to members in the environmental communication concerning facts and methods, it is possible to improve communication with stakeholders like customers, neighbours, politicians, and public.
Project Weed Control:
A UIC project on ‘Weed Control’ along track sides finished in 2001 and was divided into four sub-projects:

- ‘Need of weed control measures’ with the main objective to figure out the consequences and the effects of neglected weed control;
- ‘Optimising and improving the effectiveness of alternative/supplementary vegetation control methods’ with the main task to gain an overview on all weed control measures (especially non-chemical) inclusive a description of their operating conditions;
- ‘Vegetation management system’ is based and linked directly to sub-project 2. The main goal of this subproject is to evaluate synergies between different methods, which can be used by the railway companies to develop their own weed control management systems hitting their specific conditions;
- ‘Communication and PR’ will be used to publish the results of the other three subprojects within different print media and to present the projects results on a seminar for the UIC railways (held November 2001). A list of environmental activities is found in box 56.

UNIFE
UNIFE has established an ‘Environment and Transport Working Group’. This group assists the industry to answer the calls of policy makers and provide an environmental form of transport to move Europe’s citizens and goods.

Selected tasks for the Environment and Transport WG:

- prepare an environmental strategy for the rail supply industry in conjunction with UIC and CER;
- improve general communications of environmental issues by the industry, and co-operate with UIC on a common environmental communications strategy;
- gathering relevant statistics and making comparative analyses;
- integrate the issue of interoperability into environmental issues and vice versa;
- set priorities for R&D projects (6th Framework Programme and the Joint Strategy on Rail Research) and managing these projects;
- setting a UNIFE standard for product declaration (including the setting of environmental indicators and the tools with which to calculate environmental costs);
- work with specialists on Energy and Noise in the Environment Group to address these issues also with regards to legislation.
UITP

UITP is involved in environmental activity in the following areas:

• lobbying to promote public transport in order to achieve the Kyoto global warming objectives. The UITP has participated in UNFCCC meetings (Kyoto follow-up), plus working with e5 (The European Business Council for Sustainable Energy), with Climate Network Europe, the WWF etc;
• working with the World Health Organisation (WHO) and others on the health impacts of transport. Participated in creation of WHO Charter on Transport, Environment and Health (London 1998) and in the current follow-up;
• working with industry, the EU etc to research and develop new environmentally friendly technologies. EU research programmes on fuel-cell buses. EU Report on clean vehicles and fuels etc;
• working with members to develop best practice in all public transport activities, and in creating a strategy for reducing emissions from transport fleets;
• providing members with materials to argue their case at a national and local level.
**Annexe 3: Bibliography of important railway related publications**

This section consists of some relevant railway related documents and Web sites in relation to environment and sustainable mobility in a broader context. However, the lists are by no means exhaustive.

**Documents**

*White paper, European transport policy for 2010: time to decide*
Commission of the European Communities, Brussels, September 2001

*TERM 2001 Indicators tracking transport and environment integration in the EU*
European Environment Agency, September 2001

*Towards a Single European Rail System*
UNIFE, January 2001

*External costs of Transport, accident, environmental and congestion costs of Transport in Western Europe*
IWW/Infras, Zürich/Karlsruhe, March 2000

*UIC Railplan, scenario – strategy – action*
UIC, October 1997 updated 2000

*Safety plan 2000/2001*
UIC, February 2001

*Internalisation of the external costs, instruments – policy paper*
Infras, Zürich, January 1999

*Land transport services part II – rail transport services*
World Trade Organisation, October 1998

*An Urban and congestion free 21st Century (Opening of the 53rd UITP Congress, Toronto, 1999), H. Allen, ‘Public Transport International’ (PTI)*

*Comparison of the external costs of public transport and cars in urban areas. The case of greater Paris*
J Vivier, PTI, 1999

*Hong Kong, 1998 – challenges for the city, challenges for mass transit*
JP Bailly, UITP/APC Congress Report, 1998

*Millennium Cities Database for sustainable mobility – overview of the database*
J Kenworthy, F Laube and J Vivier, UITP – ISTP, 2001

*Urban Mobility: Observations and perspectives (demographics, economics, urban sprawl and car dependency, congestion)*
D Bayliss, UITP Conference Report, Mexico, 2000

*Air quality and urban traffic*

*European Energy Saving Experiences in urban public transport operations*
Rubens project, R Macario, UITP Conference Report, Maastricht, 2001

*Full cost pricing and sustainable urban transportation*
EJ Miller et al, UITP Congress Report, Toronto, 1999

*Focus – pricing and urban mobility*
An Official Position of UITP, 2001

*Matters at stake within sustainable development of transport*
R Torode, UITP Conference Report - Mexico, 2000

*Environment*
Rail International, 05/95, Special edition

*Diesel Engines*
ERRI, 07/98, Report
Directions of railway reform
Louis S Thompson, Railways Adviser; The World Bank, Rail International June 2001

When will sustainable mobility be achieved?
Jean Hourcade, international expert, Rail International May 2000

Brochures

A joint strategy for European Rail research, 2020, towards a single European Railway system
UNIFE, UIC, CER, UITP, September 2001

Vision 2010
UNIFE, Brussels, 2001

OECD, EST: Environmental Sustainable Transport, futures strategies and best practices
October 2000

The way to sustainable mobility, cutting the external costs of transport
CER/UIC, April 2000

Constructing the railways of the 21st century
UIC, October 1998

List of major environmental publications – from CER and UIC (1992 to 2001)

Railways & Environment – contributions to sustainable mobility
UIC & CER, 09/01, Brochure

Railways and Climatic Change
CER/UIC, 10/00

Ten Measures for fair competition and sustainable mobility in the transport market
CER/UIC, 10/00

Market research on innovative traction
UIC, 07/00, Report

External costs of transport
UIC, 03/00, Report

Fuel Cell Technology for railway vehicles
UIC, 06/99, Report

Reducing the external cost of transport
UIC, 1995, Report

External Effects of Transport
UIC, 11/94, Report

External Effects
UIC, 10/92, Brochure

Towards sustainable mobility
UIC, 09/92, Brochure

External Effects
CER & UIC, 10/91, Report
The UIC Web site has a global updated collection of relevant railway links. Among the most relevant in relation to environment, social issues and sustainable mobility in general are (English or local language):

http://www.bahn.de/konzern/uebersicht/holding/dbag_umweltschutz.shtml DB (Germany)
http://www.b-rail.be/about/F/projects/index.html SNCB (Belgium)
http://www.cff.ch/gs/umwelt_f.htm SBB (Switzerland)
http://www.railtrack.co.uk/our_business/safety_env/index.cfm Railtrack (United Kingdom)
http://www.renfe.es/ingles/medio_ambiente/index.html Renfe (Spain)
http://www.sncf.com/co/environnement2000/fr/index.html SNCF (France)
http://www.cpr.ca/English/About+CPR/Environment/default.htm CPR (Canada)
http://www.sj.se/node/0.4452.3405_1.FF.html SJ (Sweden)
http://www.dsb.dk DSB (Denmark)
http://www.nsb.no/no/nyheter/miljo/index.jhtml?language=no NSB (Norway)
http://www.metrorail.co.za/corporate/corp_index.htm Metrorail (South Africa)
http://www.spoornet.co.za/Spoornet/CDA/Articles/SPN_Article_Index/1,11065,1-23,00.html Spoornet (South Africa)
http://www.ara.net.au/sections/enviro/enviro.html ARA (Australia)
http://www.kcrc.com/eng/company/cikd.html KCRC (Hong Kong)
http://www.railway.gov.tw/taiwan/ta12-7e.html TRA (Taiwan)
http://www.eng.mps.ru Russian Railways (Russia)
http://www.jreast.co.jp/e/index.html Japan Railways (Japan)
http://www.aar.org Association of American Railways
### Other railway or environmental related Web sites:

<table>
<thead>
<tr>
<th>Website Address</th>
<th>Description</th>
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<tbody>
<tr>
<td><a href="http://www.ravel-project.de">http://www.ravel-project.de</a></td>
<td>Supply chain Project: Eco-efficient rail vehicles design</td>
</tr>
<tr>
<td><a href="http://www.starrrs.org">http://www.starrrs.org</a></td>
<td>Noise Project: STAIRRS</td>
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<tr>
<td><a href="http://www.globalreporting.org">http://www.globalreporting.org</a></td>
<td>Global Reporting Initiative</td>
</tr>
<tr>
<td><a href="http://www.ecoplan.org/wtpp/wt_index.htm">http://www.ecoplan.org/wtpp/wt_index.htm</a></td>
<td>World Transport Policy &amp; Practice, transport journal</td>
</tr>
<tr>
<td><a href="http://www.global-sustainability.org/">http://www.global-sustainability.org/</a></td>
<td>Alliance for global sustainability (University site)</td>
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<tr>
<td><a href="http://www.geocities.com/sustranet/">http://www.geocities.com/sustranet/</a></td>
<td>SUSTRAN</td>
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<tr>
<td><a href="http://www.dieselnet.com/">http://www.dieselnet.com/</a></td>
<td>Diesel emission norms (road)</td>
</tr>
<tr>
<td><a href="http://www.ceroi.net">http://www.ceroi.net</a></td>
<td>Cities Environmental Reports</td>
</tr>
<tr>
<td><a href="http://www.ilo.org">http://www.ilo.org</a></td>
<td>ILO</td>
</tr>
<tr>
<td><a href="http://www.un.org/esa/agenda21/natinfo">http://www.un.org/esa/agenda21/natinfo</a></td>
<td>UN, Sustainable development</td>
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<tr>
<td><a href="http://www.wbcsd.org">http://www.wbcsd.org</a></td>
<td>World Business Council on Sustainable Development</td>
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<td><a href="http://www.wbcsdmobility.org/">http://www.wbcsdmobility.org/</a></td>
<td>WBCSD Mobility</td>
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<td><a href="http://www.eea.eu.int/">http://www.eea.eu.int/</a></td>
<td>European Environmental Agency</td>
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<td><a href="http://www.epa.gov">http://www.epa.gov</a></td>
<td>American Environmental Protection Agency</td>
</tr>
<tr>
<td><a href="http://www.worldbank.org">http://www.worldbank.org</a></td>
<td>World Bank</td>
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<tr>
<td><a href="http://www.oecd.org/oecd/pages/home/displaygeneral/0,3380,EN-home-518-nodirectorate-no-no-no-25,0,0.html">http://www.oecd.org/oecd/pages/home/displaygeneral/0,3380,EN-home-518-nodirectorate-no-no-no-25,0,0.html</a></td>
<td>OECD Environmental Sustainable Transport</td>
</tr>
</tbody>
</table>
Annexe 4: References

A. Perl, 2001 University of Calgary, Alberta, Canada

DSB (2001): Personal communication from Danish Rail, Margrethe Sagevik, Rikke Næraa

Green Globe 21 (2001): Rail Transport and the Environment: Energy Consumption, Green Globe 21, 7 St Stephens Court, St Stephens Road, Bournemouth BH2 6LA, United Kingdom


IRJ, International Railway Journal


NS 2001 Nederlandse Spoorweege H. Resida


UIC (2001): Rail traffic statistics of the UIC European railways (http://www.uic.asso.fr/d_stats/online/docs/4tri_m2000.xls), The international railway association


SNCF (1994), La SNCF et l’Environnement, Paris


JR East (1996), JR East’s approach to environmental problems: Issues and current state of affairs, JR East, Tokyo


Annexe 5: Organisations behind the report

UITP

Founded in 1885, UITP is the worldwide association of urban and regional passenger transport operators, their authorities and suppliers. It is located in Brussels and has over 2,000 members from nearly 80 countries. The UITP seeks to promote a better understanding of the potential of public transport. It provides information, research and analysis on all aspects of public transport including infrastructure, rolling stock, organisation and management. It also lobbies on behalf of its membership with international institutions such as the EU, UN and OECD. The current president is Dr Wolfgang Meyer; Board of the Cologne Transport Company (KVB). The General Secretariat in Brussels is managed by Hans Rat, the secretary general (since 1998).

UNIFE

Union of European Railway Industries (UNIFE) is an industrial organisation representing its member’s interest towards the European institutions, rail operator associations and other business relations. Its members come from trend-setting industries such as the major system integrators, rolling stock manufacturers, infrastructure builders, suppliers of information technology and manufacturers of basic materials, parts and services.

UNIFE is located in Brussels and is the European network for manufacturers in the railway industry. It represents the interests of the 80 largest and medium-sized companies of the railway supply industry. A further 800 suppliers of railway equipment are associated members through their national associations. The European railway industry has a total annual turnover of 27 billion and accounts for over 60% of the world market.

UNIFE is an international organisation directed by the Presiding Board and the General Assembly. The general manager Drewin Nieuwenhuis and his staff of experts manage the day to day running of the association.

CER

The Community of European Railways (CER) created in its current form in 1988 and based in Brussels, brings together the 29 main railway undertakings and rail infrastructure managing bodies of the member states of the EU plus Norway, Switzerland and eight central and eastern candidate countries for accession to the EU.

CER promotes the development of rail as essential to the creation of a transport system, which is both efficient and environmentally sound. In this respect CER acts as a collective voice for the railways vis-à-vis the decision makers at EU level. CER works in close cooperation with UIC. Whereas CER is responsible for the political environment of the EU, technical information is often provided by UIC. The president of CER is Giancarlo Cimoli, the chief executive of Italian Railways (FS), and the acting Secretary-General is Carl Henrik Lundstrøm.

UIC

UIC was founded in 1922 with the aim of creating uniform conditions for the establishment and operation of railways. Today it is based in Paris and is the worldwide organisation for co-operation among its 151 member railway companies from all over the world.

The role of UIC is to promote co-operation between railway enterprises at world level and to carry out activities to develop international transport by rail. UIC maintains and develops the overall coherence of the railway system and enhances interoperability in order to improve railway competitiveness. To achieve this goal, it strives to encourage state-of-the-art technology and modern management...
methods among its members. It also prepares statements and common position papers to promote the role of rail transport.

The current president of UIC is Etienne Schouppe, chief executive of Belgium Railways (SNCB). The UIC headquarters in Paris is managed by Philippe Roumeuguère, the chief executive (since 1997).
UNEP contribution to the World Summit on Sustainable Development

The mission of the United Nations Environment Programme (UNEP) is to provide leadership and encourage partnerships in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations. The UNEP Division of Technology, Industry and Economics (DTIE) contributes to the UNEP mission by encouraging decision-makers in government, business, and industry develop and adopt policies, strategies and practices that are cleaner and safer; make efficient use of natural resources; ensure adequate management of chemicals; incorporate environmental costs; and reduce pollution and risks for humans and the environment.

This report is part of a series facilitated by UNEP DTIE as a contribution to the World Summit on Sustainable Development. UNEP DTIE provided a report outline based on Agenda 21 to interested industrial sectors and coordinated a consultation process with relevant stakeholders. In turn, participating industry sectors committed themselves to producing an honest account of performance against sustainability goals.

The full set of reports is available from UNEP DTIE’s web site (http://www.uneptie.org/wssd/), which gives further details on the process and the organisations that made it possible. The following is a list of related outputs from this process, all of which are available from UNEP both in electronic version and hardcopy:

- industry sectoral reports, including
  - accounting
  - advertising
  - aluminium
  - automotive
  - aviation
  - chemicals
  - coal
  - construction
  - consulting engineering
  - electricity
  - fertilizer
  - finance and insurance
  - food and drink
  - information and communications technology
  - iron and steel
  - oil and gas
  - railways
  - refrigeration
  - road transport
  - tourism
  - waste management
  - water management

- a compilation of executive summaries of the industry sectoral reports above;
- an overview report by UNEP DTIE;
- a CD-ROM including all of the above documents.

UNEP DTIE is also contributing the following additional products:
- a joint WBCSD/WRI/UNEP publication entitled Tomorrow’s Markets: Global Trends and Their Implications for Business, presenting the imperative for sustainable business practices;
- a joint WB/UNEP report on innovative finance for sustainability, which highlights new and effective financial mechanisms to address pressing environmental, social and developmental issues;
- two extraordinary issues of UNEP DTIE’s quarterly Industry and Environment review, addressing key regional industry issues and the broader sustainable development agenda.

More generally, UNEP will be contributing to the World Summit on Sustainable Development with various other products, including:
- the Global Environmental Outlook 3 (GEO 3), UNEP’s third state of the environment assessment report;
- a special issue of UNEP’s Our Planet magazine for World Environment Day, with a focus on the International Year of Mountains;
- the UNEP photobook Focus on Your World, with the best images from the Third International Photographic Competition on the Environment.
Sustainability profile of the Railways industry

• Achievements
  - Rail systems – whether passenger or freight – contribute to sustainable development by having a high efficiency concerning capacity, energy, space, and time.
  - The railway sector worldwide has undergone a significant ‘greening’ during the last decade showing commitment and actions towards the needs of sustainable development.
  - The high standard of rail safety sparing life and many accidents is still improving, while the railway sector’s contribution to public health problems is declining.

• Unfinished business
  - Collection of appropriate environmental data on a global level is lacking. Thus the sector needs to strengthen its work related to data gathering, processing, and communication.
  - The railway sector should reach the breaking point where new technical solutions in rolling stock, infrastructure, and procedures will give significant environmental improvements.
  - This calls for better education and training, visible management, and focused campaigns. It also requires more incentives for the sector; for example, through sensible and coherent policy frameworks or economic rewards.

• Future challenges and possible commitments
  - The challenge of the railway sector is to accommodate the influx of transport due to the future modal shift in favour of rail. This implies conquering technical and organisational obstacles as well as a level playing field among the transport modes.
  - The railway sector will maintain and develop its environmental and social advantages by continued research and proper exploitation of the results in the sector.
  - Robust rail systems for the developing countries will be crucial due to the current dramatic growth of their populations and urban areas. This requires sustainable urban planning with rail as a backbone for the infrastructure.