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Partnership on Sustainable, Low Carbon Transport
United Nations Economic and Social Commission for Asia and the Pacific, and
United Nations Office for Sustainable Development**

**INTERGOVERNMENTAL TENTH REGIONAL ENVIRONMENTALLY
SUSTAINABLE TRANSPORT (EST) FORUM IN ASIA,
14-16 MARCH 2017, VIENTIANE, LAO PEOPLE'S DEMOCRATIC
REPUBLIC**

**Railways as the Backbone of Environmentally Sustainable Transport
and their Contribution to the Sustainable Development Goals (SDGs)**

(Background Paper for EST Plenary Session-11)

Final Draft

This background paper has been prepared by Nick Craven and Marie-Luz Philippe, for the Tenth Regional EST Forum in Asia. The views expressed herein are those of the authors only and do not necessarily reflect the views of the United Nations.



INTERNATIONAL UNION
OF RAILWAYS

International Union of Railway (UIC)

**Intergovernmental Tenth Regional Environmentally
Sustainable Transport (EST) Forum in Asia**

**Regional Seminar on Inclusive and Sustainable Transport
& Vientiane International Mayors Forum**

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Don Chan Palace Hotel & Convention, Vientiane, Lao PDR

**“Railways as the Backbone of Environmentally Sustainable Transport
and their Contribution to the Sustainable Development Goals (SDGs)”**

Background Paper for Plenary Session 11 of the Programme

Final Draft

Nick Craven

Marie-Luz Philippe

1. Introduction

Whilst transport is an accepted enabler of economic growth, the role of sustainable transport is gaining recognition as an enabler of sustainable development. The UN Secretary-General's Five Year Action Agenda (2011 to 2016) specifically included transport as one of the six building blocks for the post-2015 sustainable development agenda. As we move into 2017 the sustainable transport community must forge new links and maintain this momentum, to promote the rapid transformation of transport and ensure that the wide reaching benefits of sustainable transport are fully recognized and delivered.

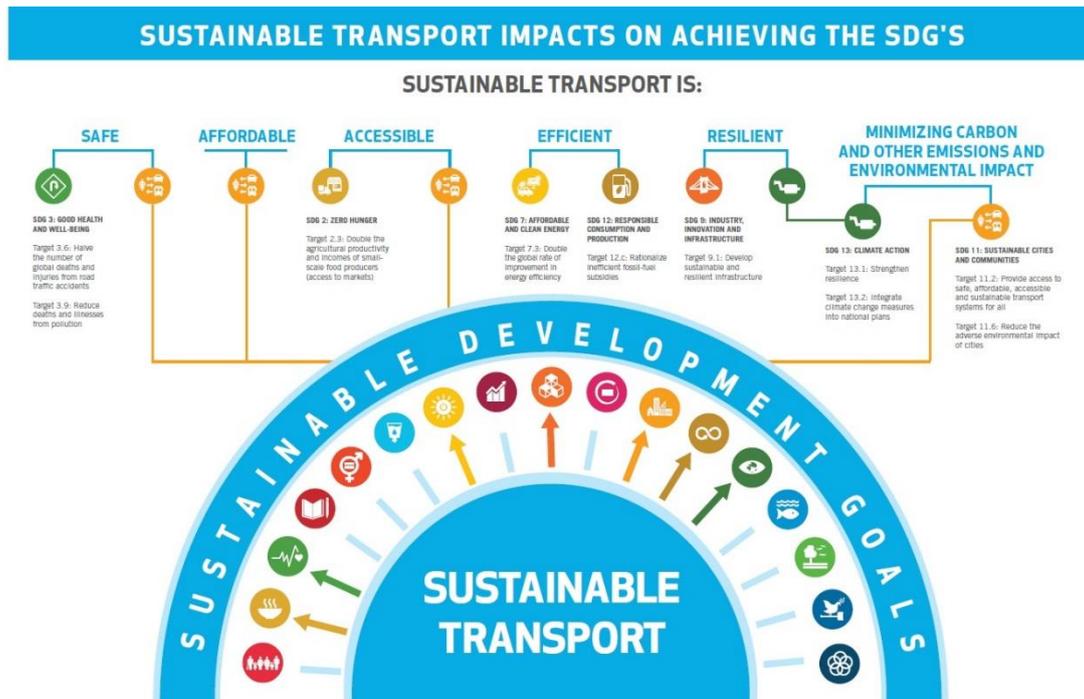
Extract from Mobilizing sustainable transport for Development by the High Level Advisory Group for Sustainable Transport

There is an urgent need for action to address the staggering social, environmental, and economic costs associated with 'business as usual': every year 1.24 million people die in road accidents and a further 3.5 million people die prematurely due to outdoor pollution, including from transport sources; 23% of energy-related greenhouse gas emissions come from transport; and road congestion is a tremendous burden on the economy, currently accounting for 0.7% of the GDP in the United States, 2% of GDP in Europe, 2–5% of GDP in Asia, and as high as 10% of GDP in some cities of emerging economies, including Beijing, Sao Paulo and Lima.

There are also enormous opportunities presented by sustainable transport: saving hundreds of thousands of lives every year through improved road safety and reduced air pollution, and reducing carbon emissions by 7 gigatonnes. The transformation to sustainable transport requires a redirection, rather than any substantial increase, in infrastructure expenditure and can be realised through an annual investment of around US\$2 trillion, similar to the current 'business as usual' spending of US\$1.4 to US\$2.1 trillion. When considering full transport costs, including fuel, operational expenses, losses due to congestion, and vehicles, sustainable transport can deliver savings of US\$70 trillion by 2050. In addition, improvements in border administration, transport and communication infrastructure could increase global GDP by US\$2.6 trillion, or 4.7%.

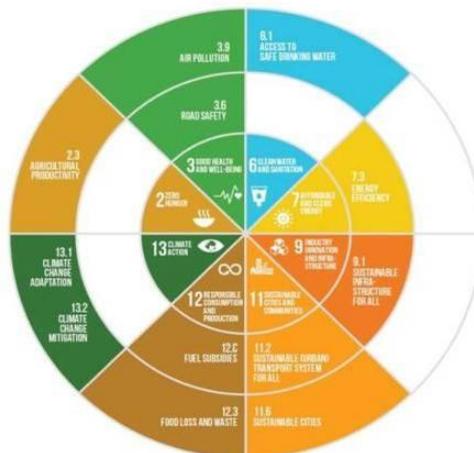
1.1 2030 development agenda

The 2030 Agenda for Sustainable Development, comprising the 17 Sustainable Development Goals (SDGs) sets out the framework for development policy and investments agreed by all member States of the United Nations. Consideration by the High Level Advisory Group for sustainable transport in their report *Mobilizing Sustainable Transport for Development* indicates that sustainable transport is an enabler for all 17 of the SDGs, as summarized below:



Mobilizing Sustainable Transport for Development

Further analysis by the Partnership for Sustainable Low Carbon Transport (SLoCaT) highlights that Sustainable Transport has been specifically included in 7 of the 17 goals and is covered directly by 5 targets as illustrated by the diagram below:



Transport coverage by SDGs as analyzed by SLoCaT

Railways as the backbone of sustainable transport make strong connections to a number of the goals and supporting targets, notably; energy efficiency (Goal 7), resilient infrastructure (Goal 9) and access to sustainable transport (Goal 11), resilience to climate-related hazards (Goal 13), promote environmentally sound technologies & multi-stakeholder partnerships (Goal 17). More detailed consideration of this is present later in this paper. For the purpose of this analysis the contribution transport is considered in 2 parts, firstly energy & climate change and then considering the benefits of modal shift.

1.2 Paris Agreement on Climate Change

A landmark worldwide legally binding agreement on climate change was reached at the 21st annual conference, known as COP21, held in Paris from 30 Nov to 11 Dec 2015. This imposes limits on greenhouse gas emissions with a significant impact on the transport sector. On 4 November 2016 the Paris Agreement entered into force. The Paris Agreement requires all Parties to put forward their best efforts through “nationally determined contributions” (NDCs), to strengthen these efforts in the years ahead and regularly report on emissions and implementation.

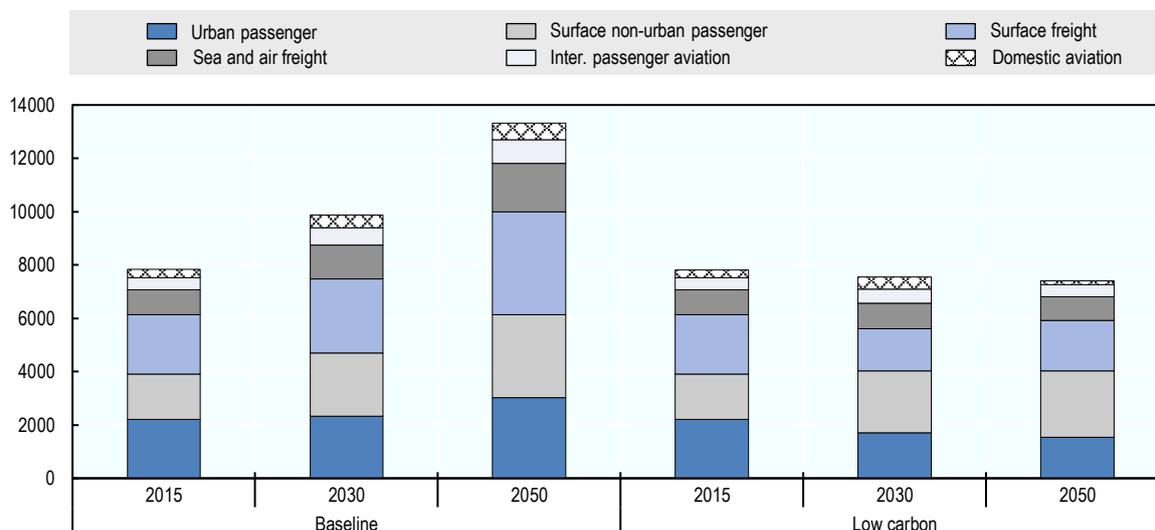
Analysis by the International Transport Forum (Transport Outlook 2017) indicates that contrary to other sectors, CO₂ emissions from transport are still growing and have only recently started to decrease in developed countries. In 2015, total transport emissions were around 9 Gt, of which 4 Gt comes from OECD countries (excluding international traffic) with freight contributing slightly less than passenger.

In the ITF baseline scenario total transport CO₂ emissions are projected to grow 60% to 13.3 Gt by 2050 due to increased demand. This is in spite of significant improvements in average CO₂ intensities, which decrease from 100g to 60 g of CO₂ per passenger-kilometer and similarly for freight.

The ITF low-carbon scenario combines optimistic views on improved efficiency, fuel taxes, vehicle optimization, land use and public transport planning. This predicts that by 2050 transport emissions will be around 7.3 Gt in total, or 5.9 Gt for surface transport only - just above the 2DS target proposed by the IEA and far from the 2 Gt proposed as a target for the 1.5 degree scenario (Gota, forthcoming).

CO₂ emissions by sector and scenario (ITF 2017)

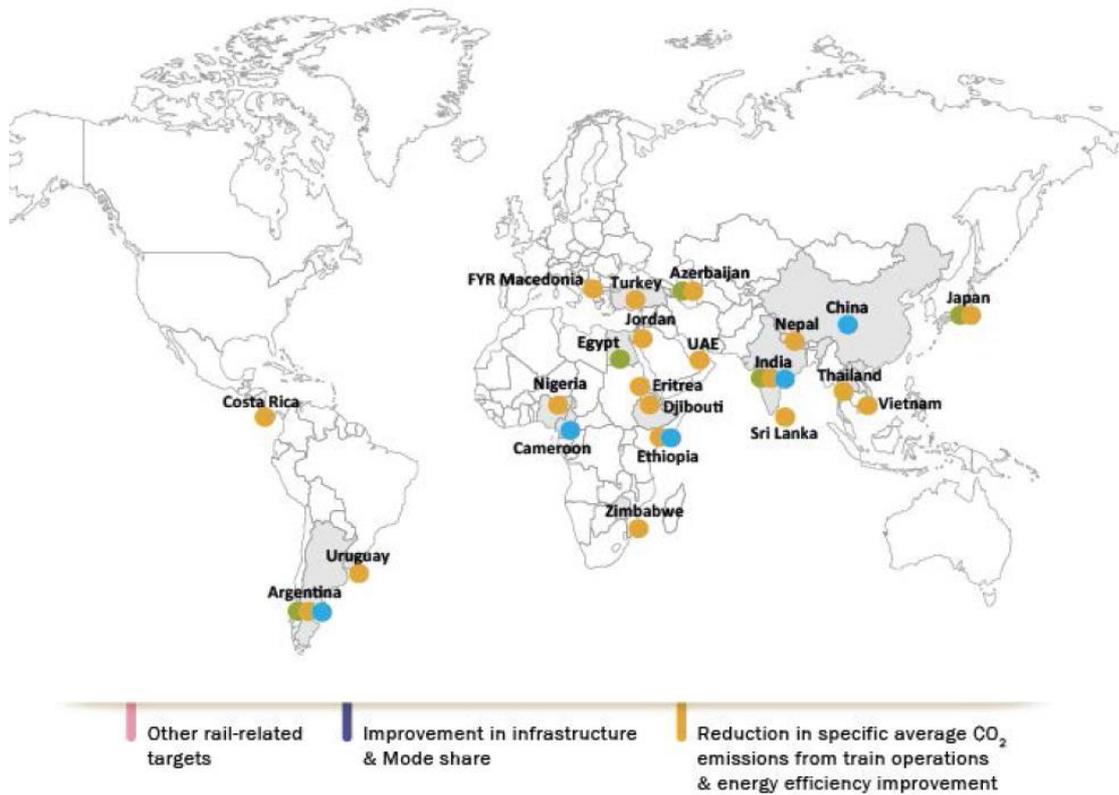
Million tonnes



There is a wide variety in approaches to the climate change policies set out in NDCs. Around 75% of NDCs reference transport as an area for mitigation, but only 19% specifically reference improvements to the rail sector. Statements by developed countries typically provide high level targets for emission reduction with little or no detail on the relative allocation between different sectors or indication of what measures will be deployed. More detailed commitments are presented in NDCs from certain developing countries, although in many cases the specific interventions are contingent on external funding.

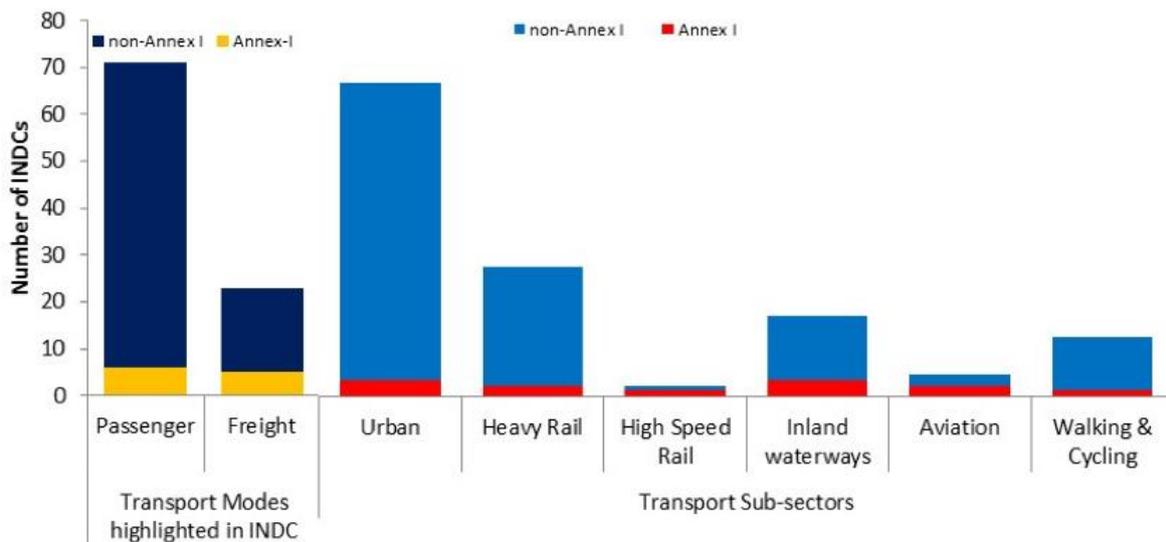
Some of the more detailed commitments include:

- India: 'endeavor is to increase the share of railways in total land transportation from 36% to 45 %, thereby decreasing the load on less efficient diesel operated road traffic' and direct reference to the Dedicated Freight Corridors
- Ethiopia: Investment in improved transportation systems (e.g. railway) that utilize clean and renewable energy



Map of countries that include rail projects in their (I)NDCs and targets related (UIC-IEA 2016)

Share of mitigation measures by mode in NDCs (SLoCaT 2015)



Selected Medium- to Long-Term National Emission Reduction Strategies (SLoCaT 2016)

Country	Economy-Wide Target	Transport Target
Canada	30% below 2005 by 2030	No transport target
People's Republic of China	Reduce GHG/GDP by 60-65% below 2005 level	No transport target
European Union	80% below 1990 levels by 2050	60% below 1990 by 2050
Germany	85-90% below 1990 by 2050	40-42% below 1990 by 2030
Marshall Islands	45% below 2010 by 2030	27% below 2010 by 2030
Mexico	50% below 2000 by 2050	No direct transport target
Norway	30% below 1990 by 2030, carbon-neutral by 2050	No direct transport target
USA	80% or more below 2005 by 2050	76-86 % reduction between 2015 and 2050

The NDC revision process presents an important opportunity to improve the coverage of railway development as a part of climate policy.

Actions also have to be prioritized towards adaptation or enhancing the resilience of transport infrastructure and services. Resilient infrastructure and services can combat the impacts of climate change, including preparedness, protection, response, and recovery. There are also adverse impacts of climate change on transport infrastructure, e.g. extreme heat cracking roads and twisting train rails, or roads being washed away by extreme weather events. Against these new experiences, road engineering, road materials, and train rails have to be adapted to address these issues.

The Paris agreement directly supports:

SDG 13. Take urgent action to combat climate change and its impacts

13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries

13.2 Integrate climate change measures into national policies, strategies and planning

13.3 Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning

In addition the focus on adaption supports:

SDG 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation and in particular target

9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all

1.3 The New Urban agenda

The 21st century is the century of cities: as an average, nearly 70% of passenger transport emissions are generated by journeys of less than 50 km. More than half the world's population (54%) resides in urban areas, and 7 of every 10 people will live in cities by 2050, with about 90% of the growth happening in developing countries. Congestion, air pollution, greenhouse gas emissions, lengthy commutes, and social inequality in accessibility have been

increasing rapidly, especially in developing countries, as a result of car-dependent urban development.

The high capacity offered by rail systems can serve the high transport generated within and between cities. The World Bank (2013) concluded that compact, mixed-use, pedestrian-friendly development organized around a mass transit station is one of the most effective strategic initiatives to address the negative effects of motorization and identifies rail transit systems as the backbone of urban development.

The New Urban Agenda (NUA) was officially adopted by the United Nations at the Habitat III conference in Quito, Ecuador 2016. The NUA sets out a 20 year roadmap to guide sustainable urban development. This issue is of rising importance as by 2050 the world urban population is expected to nearly double, making urbanization one of the 21st century's most transformative trends. Mobility and the associated issues of air quality, equitable access, congestion, noise & climate change are critical for urban environments.

Through the NUA Heads of State and Government, Ministers and High Representatives make a range of commitments to further develop sustainable transport and mobility, including rail services.

The NUA directly supports:

SDG 11 Make cities and human settlements inclusive, safe, resilient and sustainable and in particular target

11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.

2. Energy & climate

The rail system offers unparalleled energy efficiency and very low carbon emissions when coupled with modern clean energy sources. These characteristics are based on very high levels of resource efficiency, immediate compatibility with modern renewable and clean energy mean that rail transport can play an important role in delivering a wide range of SDGs and their supporting targets. The rail sector is also investing heavily in climate change adaptation to ensure resilience services for the years to come. Resilience, resource efficiency and renewable energy are recurring themes in the SDGs;



Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all

7.1 By 2030, ensure universal access to affordable, reliable and modern energy services

7.2 By 2030, increase substantially the share of renewable energy in the global energy mix

7.3 By 2030, double the global rate of improvement in energy efficiency

7.a By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology

7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support

Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead

Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable

11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015–2030, holistic disaster risk management at all levels

Goal 12. Ensure sustainable consumption and production patterns

12.2 By 2030, achieve the sustainable management and efficient use of natural resources

Goal 13. Take urgent action to combat climate change and its impacts

13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries

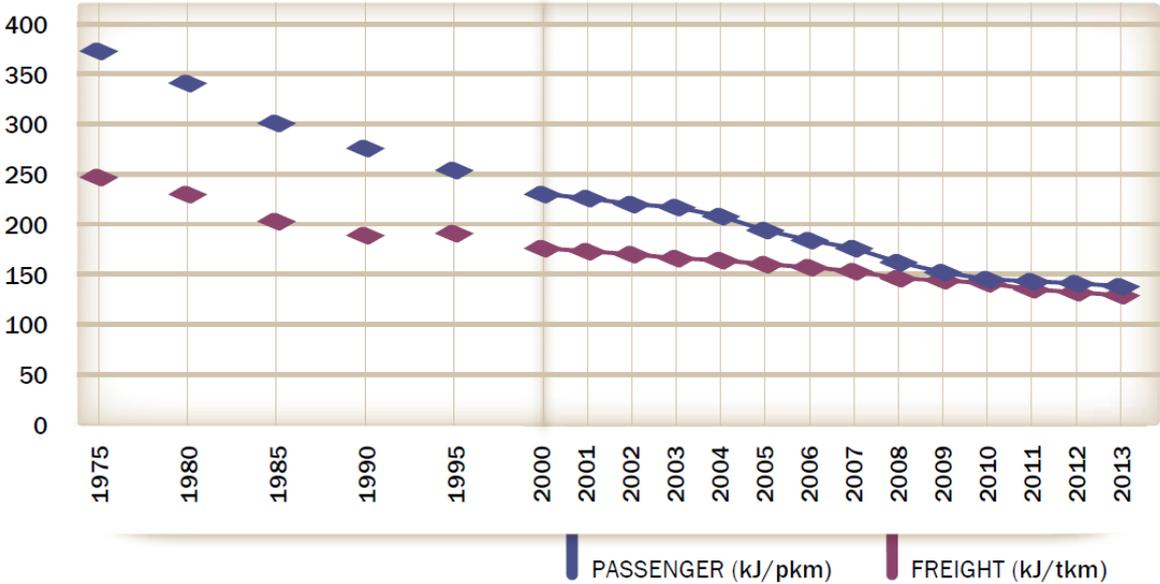
13.2 Integrate climate change measures into national policies, strategies and planning

13.3 Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning

Higher energy efficiency

Railways are arguably much more energy efficient than other modes of transport, and they are constantly improving their own energy efficiency: as can be seen in the graph below, the specific energy consumption decreased by 63% for passenger and by 48% for freight transport.

Fig. 15: Railway specific energy consumption, 1975-2013



Note: See Methodology Notes p. 109

Source: Elaboration by IEA and Susdef based on IEA (2016b) and UIC (2015a)

Source: IEA/UIC (2016)

In 2014 transport sector consumed 27.6% of the global energy use, at the same time railways energy consumption is only 0.6%. In 2011, the level of occupancy of rail infrastructure was over 10 times greater than road. Referred to energy intensity, it means that road activity is 11 times higher than rail one.

Since 1975 rail passenger activity has grown by 130% and freight by 76%. Over the same period we have seen an improvement in energy efficiency. Specific energy consumption has decreased by around 50% from 1975 to 2011 for both passenger (51% improvement) and freight (47% improvement). This trend indicates a decoupling between energy consumption and transport activity, with the volumes on rail constantly growing and the energy

consumption remaining basically stable. The inclusion of rail in the transport chain shows how decoupling in transport sector is possible, rail is the backbone of intermodal chains in terms of sustainability and energy efficiency. The energy-efficiency policies of rail companies have also led to significant improvements. Human factors management such as Eco-driving has been shown to save of up to 19% of energy consumption. The Dutch Railways for example has reduced the energy consumption per passenger kilometer by almost 30% since 2005 and aims for a total reduction of 50% by 2020. Japan Railways East has replaced over than 88% of its fleet by new railcars energy-efficient. TCCD (Turkish Railways) provides thermal power sources for heating and light in its stations. Rail has achieved a high level of energy efficiency – underpinning low carbon intensity.

Rail is resource efficient, especially in terms of energy consumption our main sustainability driver. In 2011, the level of occupancy of rail infrastructure was over 10 times greater than road. Referred to energy intensity, it means that road activity is 11 times higher than rail one. But the trend of energy consumption in rail indicates a decoupling between energy consumption and transport activity. The energy-efficiency policies of rail companies have also led to significant improvements, underpinning low carbon intensity.

The electrification of railway transport has a double benefit for reducing carbon intensity: it increases energy efficiency and also provides access to low emission factors associated with electric power. With the development of renewable electricity sources the electric emission factor has the potential to be reduced to zero.

More than one-third of energy use in railways comes from electricity and a quarter of the world's railway lines are electrified; In India 30% of the network is electrified and in People's Republic of China 50%. While in Europe rail electric traction powers 86% of train-km for freight and 81% for passenger service.

Electric trains powered by renewable energy can offer carbon-free journeys. There are no technical obstacles to a fully-electrified rail system which could achieve zero CO₂ emissions where the electricity is from carbon-free sources. According to the IEA 2 Degrees Scenario, in 2050 the world electricity supply will be significantly decarbonised, reaching an average emission factor of 37 gCO₂/kWh. This would be a reduction of more than 90% compared to the emission factor of 529 gCO₂/kWh estimated for 2013.

There is a strong case for integrating climate change mitigation in a policy framework that can deliver economic growth, social development and climate and environmental protection. Energy efficiency has multiple social, economic and environmental benefits. Improving energy efficiency has a high potential for reducing global emissions, and in a very cost effective way.

Table 2: World railway energy fuel mix, 1990-2013

ENERGY MIX BY SOURCE		1990	2013
OIL PRODUCTS		58.0%	57.3%
COAL PRODUCTS		24.8%	5.6%
BIOFUELS		0.0%	0.7%
ELECTRICITY		17.2%	36.4%
of which Fossil		10.9%	24.5%
of which Nuclear		2.9%	3.9%
of which Renewable		3.4%	8.0%

SUMMARY BY SOURCE TYPE		1990	2013
FOSSIL SOURCE		93.7%	87.4%
NUCLEAR		2.9%	3.9%
RENEWABLE		3.4%	8.7%

Note: See Methodology Notes p. 109

Source: Elaboration by Susdef based on IEA (2015b)

UIC-IEA Handbook 2016

The European rail sector has doubled its use of renewable electricity between 2005 and 2010, now accounting for 28% of all electric traction. Decarbonization of electricity mix is the main driver of reducing GHG emissions: the higher the percentage of electricity from renewable sources used for traction, the lower the CO₂ emissions produced.

Deployment of electric rail allows adopting renewable and own energy sources technologies, fostering the economic growth, including developing countries, eg Ethiopia has nine railways projects with trains to run with electricity generated from renewable energy.

The electrified rail system is immediately compatible with renewable energy. Nowadays, Rail is the unique mode consuming renewable energies in a relevant share. Decarbonization of electricity mix is the main driver of reducing GHG emissions. With the aim of increasing the share of renewable electricity, some railways are innovating in the procurement of "green electricity" certificates.

GHG and Rail, decreasing carbon intensity on the transport sector

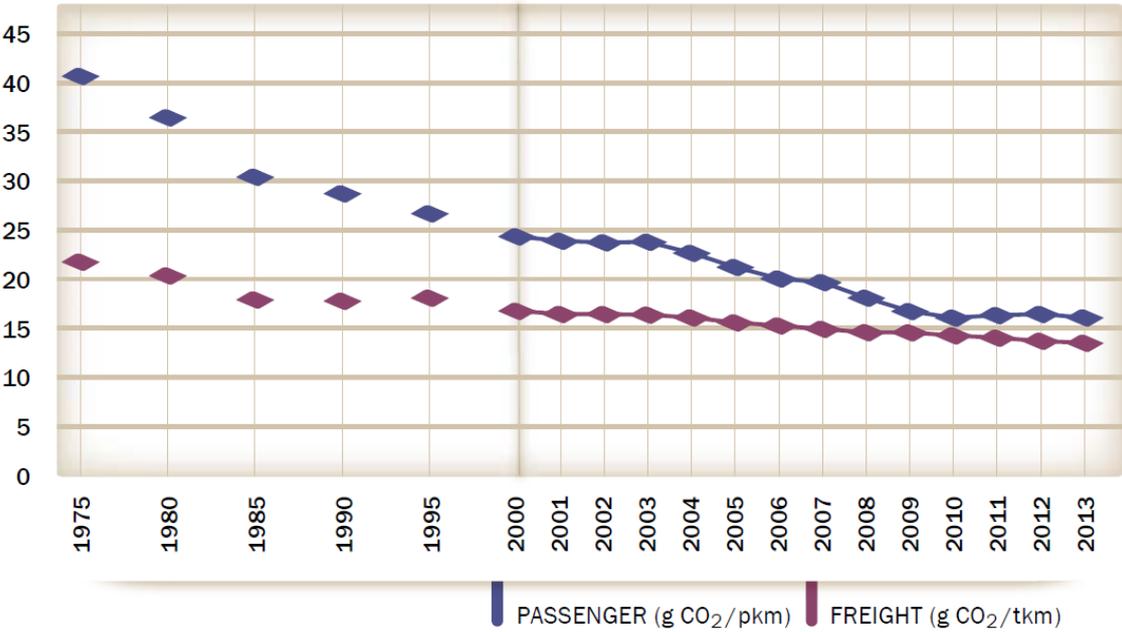
While transport GHG emissions increased by 53% between 1990 and 2011, the share of rail emissions in transport decreased from 4.25 to 3.3%, accounting over than 9% of worldwide passenger and freight transport. This means a 29% reduction in specific emissions from 1990 to 2010.

The contribution of freight railways to sustainability is to provide efficient services, transferring traffic from roads and airplanes. GHG Emissions from a freight train carrying 190 cars are 80% lower than the emissions generated by 19 trucks required as alternative.

Rail is a sustainable key transport for intermodal logistic chains; an increased use of railways in the Gothenburg Port saves 60,000 GHG Tones in the hinterland transport system.

In addition, some good examples can be found in the high Speed Rail in long distance corridors as Paris-Brussels, Tokyo-Osaka or Madrid-Barcelona, showing the high potential of modal shift to low carbon transports.

Fig. 16: Railway specific CO₂ emissions, 1975-2013

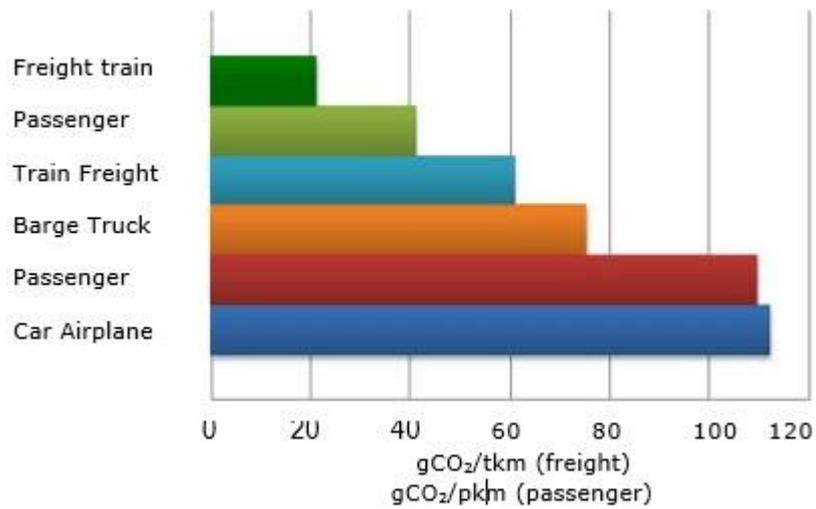


Note: See Methodology Notes p. 109

Source: Elaboration by IEA and Susdef based on IEA (2016b) and UIC (2015a)

UIC-IEA Handbook 2017

The contribution of railways to sustainability is to provide efficient services, transferring traffic from roads and airplanes offering a real alternative to less sustainable transport modes. Rail is a vital part of the solution to the global challenge of climate change.



EEA 2013b

Emission comparison by mode of transport EEA 2013

On average, Green House Gas emissions from freight rail are 8 times less than by road and almost 7 times less than inland shipping. For passenger transport, emissions from rail are nearly 5 times less than travelling by road, and 6.7 times less than flying. For these reasons rail is one of the most climate friendly modes of transport. Increasing rail market share is an important part of the solution to climate change.

3. Modal Shift



According to IEA and ITF reports over the next four decades, global passenger and freight travel is expected to double over 2010 levels, International freight transport volumes will grow more than fourfold (factor 4.3) by 2050. As a result, GHG emissions from freight transport will grow by 290% by 2050. Freight will replace passenger traffic as main source of GHG emissions from surface transport.

It is essential that the rail sector grows its market share so that the increased transport demand can be met whilst avoiding and minimising negative impacts and at the same time achieving the broad range of sustainable development goals. Where transport is an enabler of economic growth, sustainable transport, with rail as its backbone, is an enabler of sustainable development.

The important role of railways as an environmentally sound, safe, efficient, reliable and affordable transport is required to be recognized as one of the most relevant sectors for the global economy.

When considering the total cost of infrastructure, vehicles and fuel consumption, low carbon sustainable transport systems with higher rail market share, cost less than the current unsustainable system.

Additional benefits arising from an increased rail market share include greater and more equitable access to transport as rail forms the backbone of sustainable mobility. As an environmentally friendly high capacity transport mode, the rail system can reduce land take and pollution thereby improving resource efficiency, air quality and biodiversity.

Modern rail projects are characterised by a strong component of international and public, public-private and civil society partnerships investing in the rail system as an inherently environmental friendly technology.

For these reasons, expanding the rail sector market share aligns well with a range of the sustainable development goals identified below:

Goal 3. Ensure healthy lives and promote well-being for all at all ages

3.9 By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination

Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

8.9 By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products

Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

9.4 By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities

9.a Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing States

Goal 10. Reduce inequality within and among countries

10.7 Facilitate orderly, safe, regular and responsible migration and mobility of people, including through the implementation of planned and well-managed migration policies

Goal 12. Ensure sustainable consumption and production patterns

12.4 By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment

Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable

11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons

11.3 By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries

11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management

11.a Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning

11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015–2030, holistic disaster risk management at all levels

Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

15.9 By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts

Goal 17. Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development

17.6 Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge sharing on mutually agreed terms, including through improved coordination among existing mechanisms, in particular at the United Nations level, and through a global technology facilitation mechanism

17.7 Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries on favourable terms, including on concessional and preferential terms, as mutually agreed

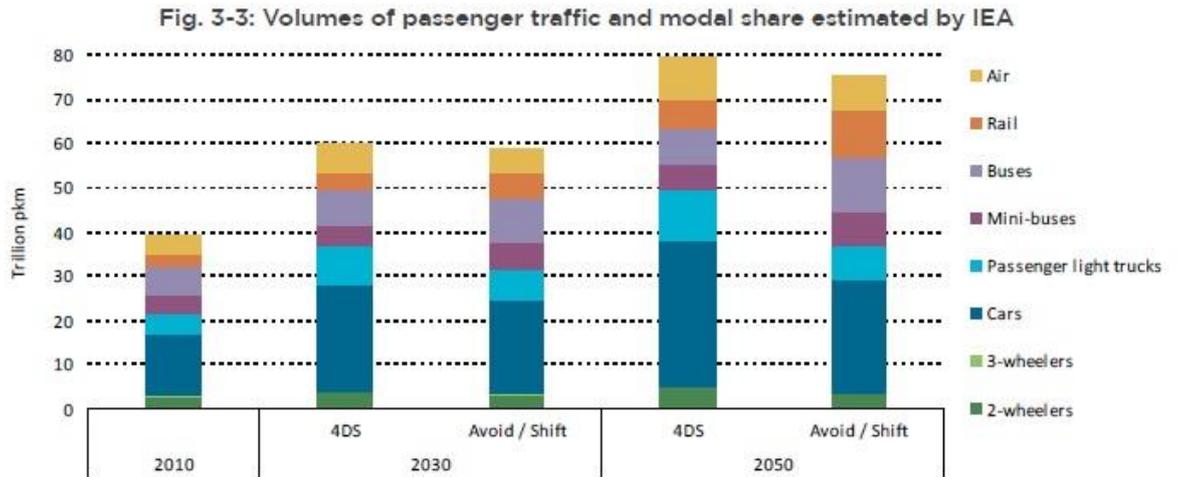
17.17 Encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships

Modelling of modal shift

The IEA Avoid/Shift sub-scenario analyses the potential effects of policies oriented to modal shift and to the reduction of transport demand. The evaluation of policies is based on the ASI (Avoid/Reduce, Shift, Improve) strategy: Avoid/Reduce the movement of passengers and freight wherever possible, Shift transport to more sustainable modes (e.g non-motorised transport, railways, public transport) and Improve the efficiency and emissions of vehicles.

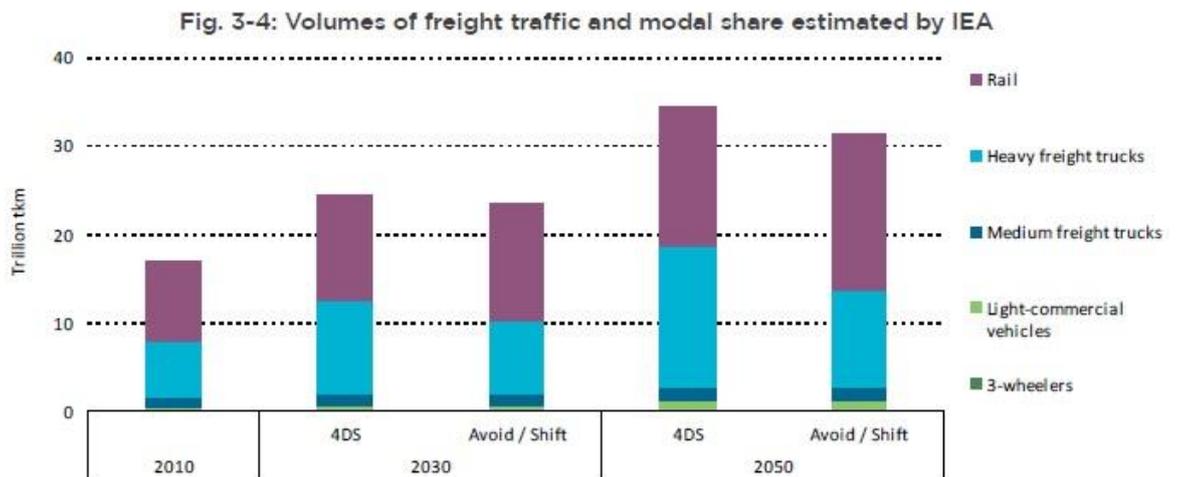
In the passenger sector the Avoid/reduce policies are considered to have more significant effects in the long term, while by 2030 the modal shift is expected to have a greater effect on passenger traffic volumes and modal share to 2030 and 2050.

Passenger railway transport, both on medium- long range and on urban/suburban distances, can increase considerably and reduce the weight of road transport and aviation. In the Land freight transport sector as well, the impact of policies oriented to modal shift on rail is relevant and can be u-and-running in the medium term.



Source: IEA ETP 2012

Passenger railway transport, both on medium-long range and on urban/suburban distances, can increase considerably and reduce the weight of road transport and aviation. In the land freight transport sector as well (see Fig. 3-4), the impact of policies oriented to modal shift on rail is relevant and can be up-and-running in the medium term.



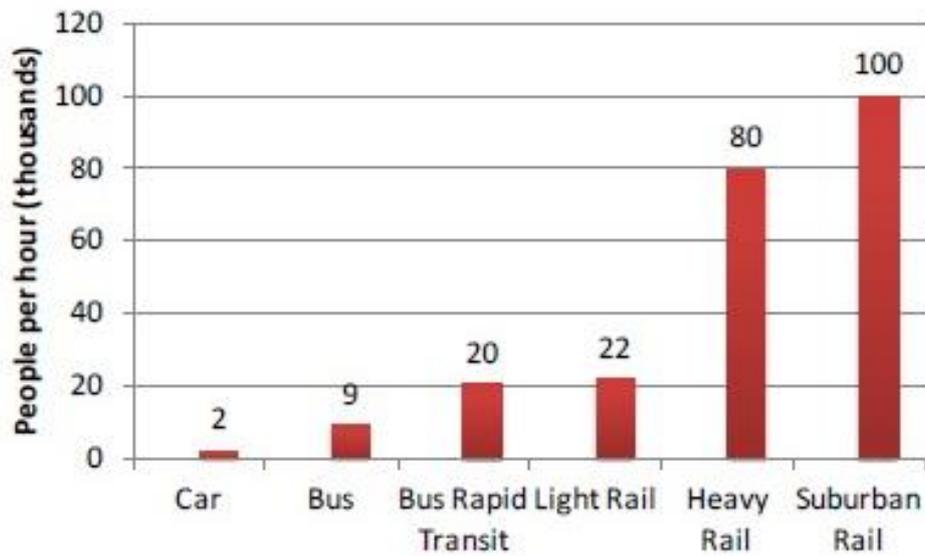
Source: IEA ETP 2012

IEA stresses the important contribution that can come from modal shift particularly in an urban environment where a higher growth and concentration of population is expected in the next decades. An intelligent growth of the cities can reduce the distance and number of movements and promote the use of more sustainable transport modes such as public transport, cycling and pedestrian mobility.

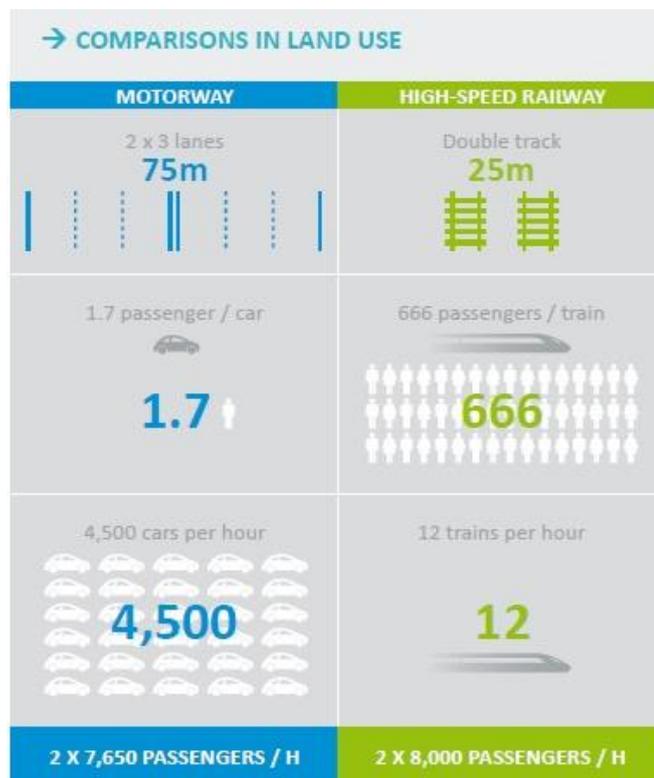
Land use

Rail is a high capacity mode with comparatively low land take. Land use per passenger-km for rail is about 3.5 times lower than for cars. This lower land take helps to reduce biodiversity impacts associated with transport infrastructure.

Capacity of a 3.5 m wide lane in a city



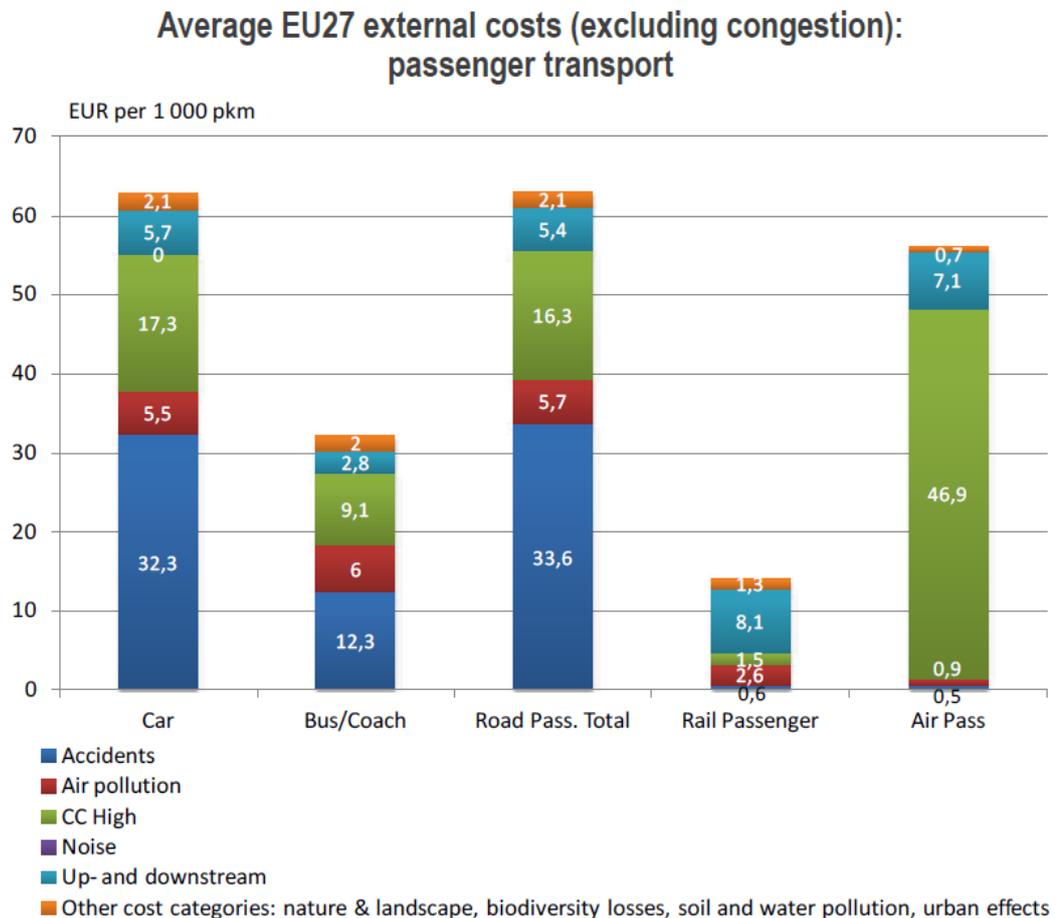
ADB/giz 2011



UIC 2011

External cost

Rail's average external costs (i.e. the costs of the negative effects of transport, such as air pollution, that are not paid by the users themselves but borne by the society at large) are more than four times less than road's for passenger services, and more than six times less for freight services.



CE Delft et al. 2011

Multimodal transport system providing environmental friendly and equitable access

Combined transport for freight services is the ideal solution to get an effective transport services on the basis of cooperation between different modes, carrying the major part of the journey by a sustainable and efficient mode as rail and involving other actors as trucks to complete the door-to-door carriage.

New sustainable urban commodity delivering modes as bike or electric vehicles require logistic hubs located nearby the city as the railway stations to ensure sustainable door-to-door freight services.

In the case of passenger services, the city center location of the station allows intermodality with urban public transport services and with cycling and walking modes. Innovative and

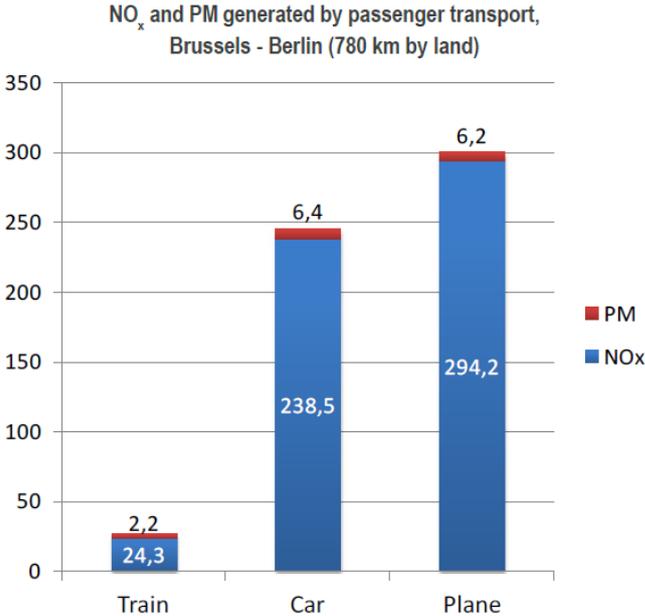
efficient models of car travelling as car sharing or car pooling could be combined with public and centric places as rail stations, profiting the rail electricity connections for the deployment of electric vehicles in a smart grid frame.

This multimodal transport environment interoperability across different rail networks and countries is required to get an effective modal shift in the global logistics transport and for the international passengers market, playing railways a relevant role in global, regional, and local levels.

Health & air quality

Transport is a major contributor to air pollution, particularly in cities and urban areas. key air pollutants emitted from combustion engines from all modes of transport include NOx, PM, CO and volatile non organic compounds (VOCs). Non exhaust emissions of PM are also released due to the mechanical wear of breaks, tyres and road surfaces.

As urban and suburban rail lines are frequently electrified, local emissions of Nox and PM are frequency zero. The graph below compares PM and NOx emissions for a journey from Brussels to Berlin.

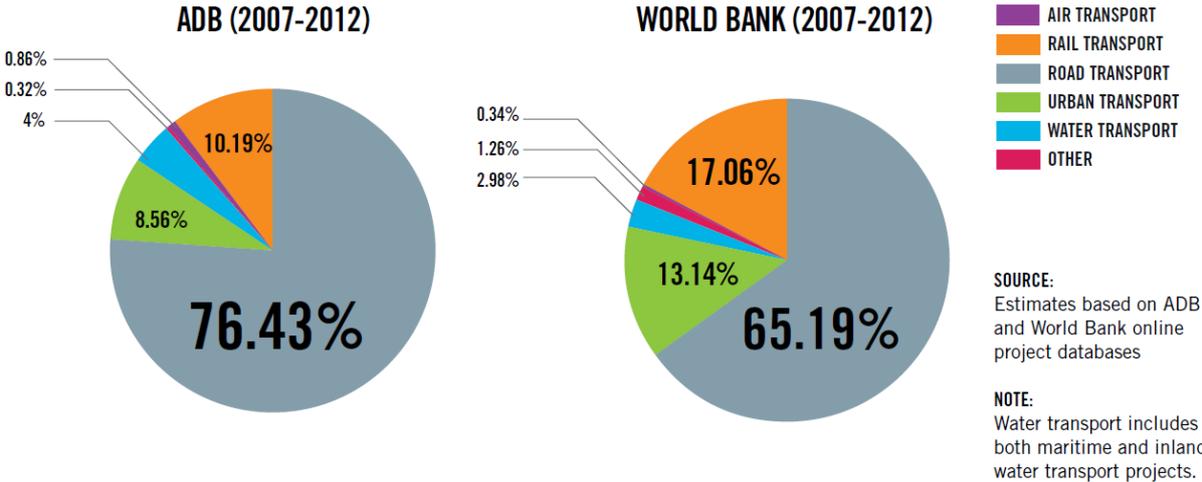


(Train: average loading; Car: medium-size, diesel Euro IV, 1.5 passengers; Aeroplane: typical aircraft type for European flights with average utilisation ratio, effect of emissions at high altitude included, transport to and from airport by car included.)

Policy opportunities

As previously said the investment on rail projects in Asia is still very much unbalanced towards rail transport. As UNESCAP (2013a) shows (see Fig. 0-1), more than 76% of the Asian Development Bank’s investment in transport is spent on road projects, and only 10% on rail. The World Bank is only slightly more focused on rail, with 17% of its spending compared to 65% spent on road.

Fig. 0-1: Modal split of Asian Development Bank (ADB) and World Bank (WB) investment in transport, 2007-2012



Source: UNESCAP (2013a)

As shown in the previous sections, investments in rail are more sustainable – from many points of view – than investments in road. Therefore, a modal shift from road to rail presupposes an investment shift from road to rail projects. This can be done for instance through investments in new rail projects (in particular urban rail services and freight corridors), investments in existing rail infrastructure (e.g. electrification of the infrastructure and removal of bottlenecks), internalisation of external costs (e.g. via road pricing), providing the right environment for private finance, smart land use, planning to support stations as intermodal hubs.

The Asian region also lacks the strong regional research institutional support which exists in other regions (mainly Europe). This has resulted in the lack of qualitative documentation on the basic activities carried out by railways within the region. The railway research sector needs to be incentivised with the goal of obtaining better information and evaluations on the specific issues concerning railways.

Competitiveness of rail versus other modes

There are technical and economic constraints – always in evolution – that determine the market segments in which railways can be competitive with other less sustainable modes such as cars, light and heavy-duty vehicles and aviation. The necessary condition for the train to be preferred to modal alternatives is that railways are able to offer a competitive product/service on a specific mobility segment.

Currently, with reference to the experiences collected in different geographic areas and railway systems, the greater potentialities of railways can be seen mainly in some market segments where the train has the technical means to compete for significant market shares with other modes of transport:

- In passenger service:
 - Commuter rail vs. private car;
 - High-speed train vs. plane;
 - Medium-long range rail (high-speed included) vs. private car;
- In freight service:
 - Freight rail vs. trucks;
 - Freight rail vs. cargo ships.

The outcome of this competition, in case the railway prevails, determines a potential reduction of the environmental impacts of transport.

Local/urban mobility: commuter rail vs. private car

Rail can potentially serve very well the great volumes of traffic centred in the metropolitan cities, coming and going from the suburbs and the outskirts of the city. The car congestion of the roadways entering the city is a competitive advantage for rail: many successful examples of commuter train can be chosen from European, North American and Asian cities. An urban development tightly connected to the railway system is a great opportunity for railways and for the liveability of large cities.

Medium-long range mobility: high-speed train vs. plane

In countries which were early adopters of High-Speed Rail (HSR), e.g. in France, several studies have shown how its introduction has triggered a direct competition with airlines. HSR is definitely faster and cheaper than a plane when travel time is lower than 2 hours. When the train travel time is more than 4 hours, the plane is faster than the train and has the majority of market shares. When train travel time is between 2 and 4 hours, the competition between rail and aviation is very strong.

Medium-long range mobility: intercity train (including HSR) vs. private car

Both High-Speed Rail and Intercity¹ can compete with the car in the movements above a certain distance. This also depends on certain factors, e.g. the geographic characteristics of a country, the travel time difference between rail and car, the train schedules and the density of train stations. There are countries such as Switzerland, Germany or Japan², where well-performing Intercity services on some routes engender modal shares for rail well above the modal shares for road.

There is a very strong correlation between the modal split between rail and road and the travel time needed for each mode: thus, only fast railway networks with frequent connections can compete with road transport. All this is possible on some conditions, e.g. a high population density with an equally high density of railway offer and demand.

Medium-long range mobility: freight train vs. truck

Railway freight traffic is a strategic transport system and plans to keep such a position. In EU27, since the year 2000 rail freight is gaining ground in all railway companies, especially Deutsche

¹ Generally speaking, Intercity trains connect stations of different cities with a high demand. They differ from local/regional trains on price, commercial speed and fleet used. Depending on railway systems, the distance between terminal stations can vary, as well as the distance between stops (which is usually larger than for local/regional trains).

² All the countries mentioned are characterised by a high per-capita income, extremely developed networks of roads and highways, and rates of penetration for private cars much higher than the world average.

Bahn. In Switzerland and Austria, railway transports more than 50% of freight, in a context where railways have been assigned specific environmental objectives. In the USA as well, freight rail has gained market shares since the mid-Eighties.

Railway transport is extremely efficient to transport raw materials for industrial activity (e.g. steel, chemicals, automotive) and for container traffic, tightly integrated with naval and road freight. The main feature of freight rail is to operate on long distance: the challenge for the whole railway sector is to constantly reduce the distance in which rail transport is effective, and gain market shares in commercial sectors which are not using railway transport, or very little. All this is possible, and demonstrated by several success stories, through technological and organizational improvements that increase efficiency, security and reliability of transport.

Medium-long range mobility: freight rail vs. cargo ships

Given a specific distance, freight transport through ships is more efficient than rail. Freight rail – where geographically feasible – can be competitive with navigation when it can significantly reduce the distance travelled by the goods. This is the case of the Trans-Asian rail network that connects the markets of People's Republic of China, India and Europe, or the North-South Europe railway corridors which can guarantee access to Central Europe for the merchandise crossing the Suez strait, using the Mediterranean ports and avoiding Gibraltar.

The opportunity of inter-modality

Inter-modal integration for freight is one of the opportunities that would increase the importance of the role that railways have in Asia. As mentioned above, railway can be competitive with road transport over mid-range distances to transport freight that has arrived by ship. Obviously, for distributing the goods over shorter distances road freight is more viable.

For the ship-rail inter-modality, it makes sense to spend some efforts on specific infrastructures and layouts for ports that facilitate the loading and unloading of container trains from ships: currently, most Asian ports do not have ideal infrastructure. For rail-road inter-modality, “dry ports” are an on-going trend, offering all the services of a port and facilitating the transfer of goods between rail and road. Companies can open logistic centres in dry ports, thereby taking advantage of the availability of cheap and fast long-range railway transport and limiting road transport to local distribution. Several dry ports are being developed in the Asian region, from the Republic of Korea to Uzbekistan.

4. Case studies

The UIC Low Carbon Rail Transport Challenge and the UIC Climate Responsibility Pledge

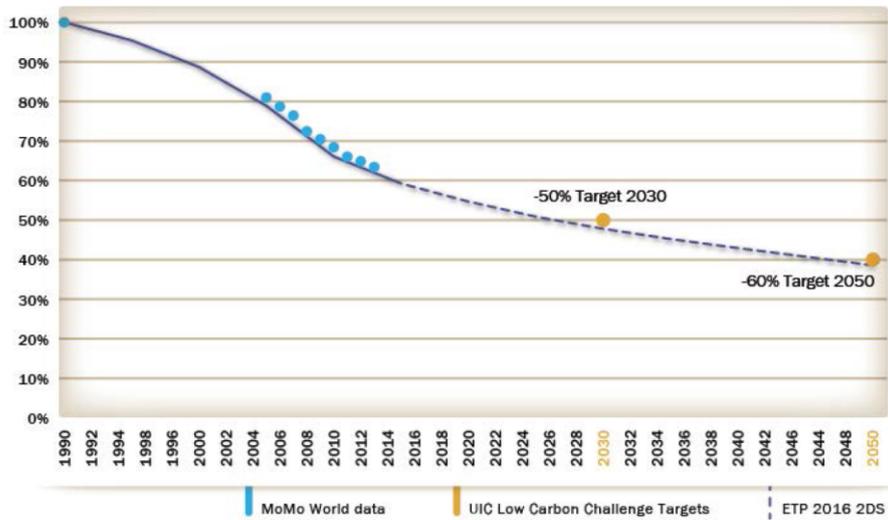
At the UN Climate Summit in September 2014, UIC presented the Low Carbon Rail Transport Challenge. This initiative sets out a vision for development of the rail sector at the global level as a sustainable alternative to other modes of transportation with a higher carbon intensity such as road transport and aviation. The challenge includes three sets of voluntary targets: to improve rail efficiency, to decarbonise electricity supply and to achieve a more sustainable balance of transport modes.

UIC is committed to reducing specific final energy consumption per traffic unit (50% by 2030 and 60% by 2050) and specific average CO₂ emissions per traffic units from train operations (50% by 2030 and 75% by 2050), all relative to a 1990 baseline. In order to reach these goals, railway operators are investing in electrifying trains, in improving load factors, in procuring more efficient rolling stock, in developing more efficient energy and traffic management systems and in promoting efficient driving.

In 2015, UIC has also launched the Modal Shift Challenge calling for investments that encourage a move to rail transport away from more carbon intensive transport options. The target is to achieve a 50% increase of the share of rail in passenger transport (in passenger-km) by 2030 compared to 2010, and a 100% increase by 2050. For the rail share of freight land transport to achieve the same activity level (in tonne-km) of road transport sector by 2030 and also to reach a level 50% larger by 2050.

One key component of the Modal Shift Challenge is the Railway Climate Responsibility Pledge, which sets out industry actions to complement the targets set for railways world-wide. During the Train to Paris high level event on the 28th of November 2015, this pledge was presented to high level representatives of the United Nations. The Climate Responsibility pledge has been signed by more than 60 UIC members, representing the majority of global rail activity.

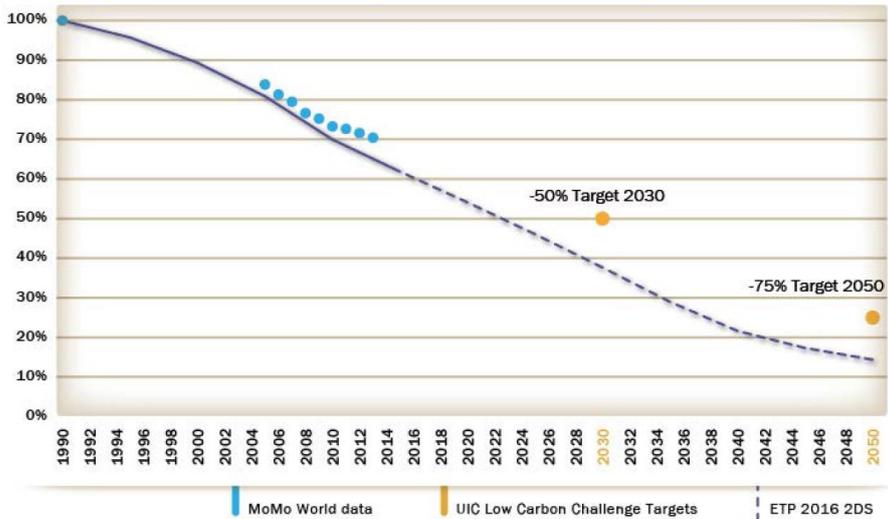
Fig. 90: World specific rail energy consumption evolution per traffic unit (TU) between 1990-2013 compared to 2030 and 2050 targets (1990=100)



Source: Elaboration by SUSDEF based on IEA (2016b), UIC (2015a) and UIC (2015d)

Note: See Methodology Notes p. 109; the IEA 2 Degree Scenario, or 2DS, describes an energy system consistent with an emissions trajectory with a 50% chance of limiting average global temperature increase to 2°C.

Fig. 91: World specific rail CO₂ emissions evolution per traffic unit (TU) between 1990 and 2013 compared to 2030 and 2050 targets (1990=100)



Source: Elaboration by SUSDEF based on IEA (2016b), UIC (2015a) and UIC (2015d)

Note: See Methodology Notes p. 109; the IEA 2 Degree Scenario, or 2DS, describes an energy system consistent with an emissions trajectory with a 50% chance of limiting average global temperature increase to 2°C.



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Railway Climate Responsibility Pledge

On the low carbon track

The worldwide railway community is aware that a shift towards sustainable transport is essential to achieve the internationally agreed goal of limiting climate change to a rise in average global temperature of no more than 2 degrees Celsius.

The rail sector is the most emissions efficient transport mode, but as a major transport mode we acknowledge our responsibility and that further improvement is needed. This pledge sets out ambitious but achievable goals for the sectors contribution towards the solution to climate change

As a member of the worldwide community of railway operators and infrastructure managers, I commit to take a leading role in the actions to prevent climate change, by reducing my company's carbon footprint and supporting a shift towards a more sustainable balance of transport modes.

In order to achieve this I pledge to:

1. *reduce my company's specific energy consumption and CO2 emission*, and through this contribute to the UIC "Low Carbon Rail Transport Challenge" and its global 2030/2050 targets, presented in 2014 at the UN Climate Summit;
2. *Stimulate modal shift to rail in national and international markets*, by working in partnership with key stakeholders;
3. *actively communicate climate friendly initiatives undertaken by my company during the years 2016 and beyond*, in order to raise awareness, acceptance and recognition of the role of sustainable transport as a part of the solution to climate change;
4. *Report data on my company's specific energy consumption and CO2 emissions to UIC on a regular basis*, In order to promote and demonstrate the continuous improvement of railway sector at international level.

.....
Place, date

.....
Signature

.....
Name, title of signee



Examples of targets set by individual rail companies

Companies	CO₂ targets	Energy Targets
<p>ATOC NETWORK RAIL Country: United-Kingdom</p> <p><i>Source: ATOC (2015)</i></p>	<p>Reduction of carbon emissions by 34% by 2020 and by 80% by 2050, both from 1990 levels (in line with the UK Government targets).</p>	
<p>DEUTSCHE BAHN Country: Germany <i>Source: DB (2014)</i></p>	<p>By 2020, reduction of specific CO₂ emissions from rail, road, air and ocean transportation by 20% compared to 2006 levels. By 2050, rail transport completely CO₂-free.</p>	<p>Increase of renewable energy sources (increase to 35% until 2020).</p>
<p>INDIAN RAILWAYS Country: India <i>Source: UNDP (2011)</i></p>	<p>Saving of 3.33 million tonnes of CO₂ by 2020 (80% over the period 2011/12-2020/21).</p>	<p>Saving of 4.05 billion kWh by 2020.</p>
<p>JR-EAST Country: Japan <i>Source: JR-East (2014)</i></p>	<p>Halving of CO₂ emissions from its railway business by FY 2030 compared to FY 1990. CO₂ emissions: -30% by 2021 relative to 1991.</p>	<p>Energy Consumption: -8% by 2021 relative to 2011.</p>
<p>JR-WEST Country: Japan <i>Source: JR-West (2016)</i></p>		<p>Energy consumption rate (MJ/Rolling-stock km) -3% compared to FY 2011. 83% Energy-saving railcars as a percentage of total railcars in FY 2018.</p>
<p>KORAIL Country: the Republic of Korea <i>Source: KORAIL (2015)</i></p>	<p>GHG mid-term reduction goals: -8% by 2019 from 2015 levels.</p>	
<p>NS Group Country: Netherlands <i>Source: NS (2015)</i></p>		<p>Rail network powered entirely by renewable wind energy by 2018. By 2020, 50% more efficient in running trains than in 2005.</p>
<p>NSB Country: Norway <i>Source: NSB (2015)</i></p>		<p>Reduction of power consumption by 15% from 2013 to 2017.</p>
<p>RENFE Country: Spain <i>Source: RENFE (2015)</i></p>	<p>Less than 20 g of CO₂ per UT.</p>	
<p>RZD Country: the Russian Federation <i>Source: RZD (2014)</i></p>	<p>Reduction of the negative environmental impact (CO₂ emissions) by 7% in 2017 and by 15% in 2030 compared to 2012 (optimistic scenario).</p>	

SNCB Country: Belgium <i>Source: SNCB (2012)</i>		Use 1% less traction-energy per passenger-km annually between 2010 and 2020.
SNCF Country: France <i>Source: SNCF (2016)</i>	Cutting GHG emissions by 20% between 2014 and 2025.	Traction: reduce electricity and diesel fuel consumption by 20% between 2012 and 2022. Buildings: reduce electricity, home heating oil and natural gas consumption by 20% between 2012 and 2020.
THALYS Country: International HS <i>Source: THALYS (2015)</i>	Reduction of CO ₂ emissions by 40% by 2020 compared to 2008 levels.	
VIA RAIL CANADA Country: Canada Source VIA RAIL CANADA (2015)	Reduce our GHG emissions by 20% by 2020 and 30% by 2030 when compared to 2005	

Kazakhstan railways medical train

It is normal to think of transport moving people to access essential services. However, in an innovative programme, the Kazakhstan railway transports the series to the people.

Within corporate social liability of business structures before society, since 2010 the joint-stock company "National company "Kazakhstan Railways" realizes the charitable project on the organization of running is advisory - diagnostic medical.

The project is implemented for the purpose of providing country people of the remote regions of the Republic of Kazakhstan with the mobile versatile specialized consulting and diagnostic and medical help. Annually three trains drive out to the remote stations and departures: «Densaulyk», «Zhardem» and «Salamatty Kazakhstan».

All Trains are equipped with a modern diagnostic and curative equipment, and also highly skilled medical personnel

Medical trains give the next types of services:

- primary health care;
- consulting and diagnostic help;
- inspection of patients with use of laboratory, functional, instrumental methods and the modern diagnostic equipment;
- performing obligatory periodic medical examinations of the decreed contingent of railroad workers;
- implementation of medical and expert work;
- recommendations on planned hospitalization on medical indications of the revealed patients;
- sanitary and educational work in the form of seminars, conferences, lecturing.

As a part of medical crews there are qualified doctors of the main specialties: therapist, pediatrician, neuropathologist, oculist, ENT, gynecologist, surgeon, urologist, mammologist, dentist. By results of survey the doctor refers the patient on further treatment

Trains are equipped a modern diagnostic equipment, including.:

- computer spirometric system;
- echoencephalograph;
- videofibergastroscope;
- the cardiologic monitor system for carrying out diagnostic loading tests having a veloergometer, a cardiograph and computer system of data processing in a set;
- roentgen equipment;
- dentinal, otolaryngology and ophthalmology equipment.

The listed equipment allows to carry out patients in quick mode to take general and biochemical blood tests and urine samples, X-rays, an US research of internals and vessels, an electrocardiogram, a cycleergometry, a gastrofibroskopiya, the computer spirometry, echoencephalography and other types of diagnostic testings, and also to perform to patients small surgeries and high-quality stomatological treatment.



Patients being treated on the KTZ medical train

From the beginning of realization of project the trains «Densauilyk», «Zhardem» and «Salamatty Kazakhstan» visited the 1 051 station. About 299 thousand habitants are inspected, including 71 209 children.

1 210 thousand diagnostic procedures are conducted:

275 171 ultrasonic researches of internals;

6 865 spirometries;

57 154 echoencephalographies and ultrasonic dopplerographies of cerebrum;

91 195 electrocardiographies;

98 208 measuring of ophthalmotonus;

68 976 roentgenologic researches;

17 050 esophagogastroduodenoscopies;

651 930 clinical biochemical analysis;
4 313 small ambulatory operations;
19 video medical consultations;
44 000 women are examined by mammologist;
a stomatological help is rendered to 72 000 habitants.

The idea of creation medical trains is supported by the Head of state of the Republic of Kazakhstan who emphasized relevance and need of further development of transport medicine.

The charitable project on the organization of medical trains repeatedly became the winner of the republican and international contests on corporate social liability held among employers. The set of letters with expression of gratitude arrives in the Company and from inhabitants of the Republic.



INTERNATIONAL UNION
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