Rail Route 2050:

the sustainable backbone of the Single European Transport Area

An initial update of the ERRAC Vision for Railway Research and Innovation for the future of rail

Towards a Competitive, Resource Efficient and Intelligent Rail Transport System for 2050

ERRAC
The European Rail Research Advisory Council

SEVENTH FRAMEWORK PROGRAMME

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The Sustainable Backbone of the Single European Transport Area

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Foreword

Foreword

Dear reader,

The rail system already provides solutions for the transport of goods and people all over the world, in terms of safety, environment, total journey time, low emissions and low energy. It has the potential to offer attractive urban, regional and long distance mobility throughout Europe and beyond.

In meeting its true potential and contribute fully to the economic and social prosperity of Europe and its citizens, the volume of traffic is expected to radically increase in the future. However critical corridors and sections of the existing European network is already working to its maximum capacity. At the same time, the expectations for green, efficient, smart and integrated whole journey solutions from transport users (passengers and freight forwarders) are increasing.

Therefore there is an urgent need for action to increase the capacity of railway network that can then help enable effective modal shift towards rail which has such potential to support a low carbon economy. Railway transportation will also need to develop its attractiveness and competitiveness to meet that potential.

In this context, we are very pleased that the recent EC 2011 Transport White paper "Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system" echoes this ambition, in particular with the objective of encouraging a modal shift towards rail freight and passenger transport.

It's now time to move up several gears in order to make this common ambition happen.

An initial update of the ERRAC vision for the future of rail, projecting it to 2050, is provided here, addressing the European effort required for research and innovation to achieve this common ambition. This will require streamlined investment from frontier, applied/focused research, development and demonstration to real market uptake, supported by both investment as well as by aligned complementary legislation. Further work in the coming months will refine this work, through challenge and cooperative development.

The European vision for railway research and innovation outlined here illustrates the research pillars that need to be supplemented by the corresponding investment pillar. Complementing these is the legislation pillar necessary to provide fair market conditions. The combination has the potency to transform rail into the low carbon natural transport mode of choice in the middle of the 21st Century.

Prof Andrew McNaughton
ERRAC Chairman

INTRODUCTION: Rail is the Sustainable Backbone of the Single European Transport Area

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Rail Transport is the most Environmentally Friendly Means of Transport

Transport is responsible for about a quarter of the EU's greenhouse gas emissions. 12.7% of overall emissions are generated by civil aviation, 13.5% by maritime transport, 0.6% by rail, 1.7% by inland navigation and 70.8% by road transport (2008 figures[1]).

The advantage that rail has, of being able to source low-carbon electricity, means that journeys such as London to Brussels by train produce only around 10% of the emissions per passenger of a plane journey on the same route. In the European Commission's 2011 Transport White Paper ("Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system"), the European Commission set a target of reducing GHG emissions from transport by at least 60% by 2050 compared to 1990 levels. As a mode with average specific emissions at least 3-4 times lower than road or air transport, the important role that rail transport can play in reaching the 2050 target is obvious, especially through a significant modal shift of the transportation of goods from road to rail.

Rail is also a vital part of the public transport which consumes 3.7 times less energy per passenger transported in Europe than private car (compared with 3 times less in Canada and in Oceania, and 10 times less in Japan, whose exceptional performance is explained by the intensive use of the world's two most powerful regional rail networks, in Tokyo and Osaka).[2]

Compared to air travel and automobiles in Europe, trains are the most friendly passenger transport mode in terms of energy consumption, CO_2 and exhaust atmospheric emission. On the website; http://www.ecopassenger.org, the carbon footprint of a specific trip in Europe can be calculated and compared. In Sweden for example, the energy consumption of rail passenger transport (1.27 Terra Watt hour) is well under the figure of road transport (51 TWh). Regarding freight transport, rail uses 1.1 TWh, while road takes up 16.4 TWh. The performance is 109 billion pkm (passenger km) and 35 billion tkm (ton kilometre) for road, and 11 billion pkm and 19.4 billion tkm for rail. Thus, the energy efficiency of road is 0.47 kWh/pkm and exactly the same for freight (0,47 tkm), while rail is just 0.11 kWh/pkm and 0.06 kWh/tkm.[3] This makes rail the most energy efficient mode compared to road, especially in freight transport.

Clearly, better energy efficiency already has environmental benefits, but in a country like Sweden, where only a small portion of electric energy is produced from fossil fuels, the benefits of rail becomes even more tangible. The CO_2 emission of rail is 2.0-3.6 g/tkm, while long distance trucks emit 53 g/tkm.[4]

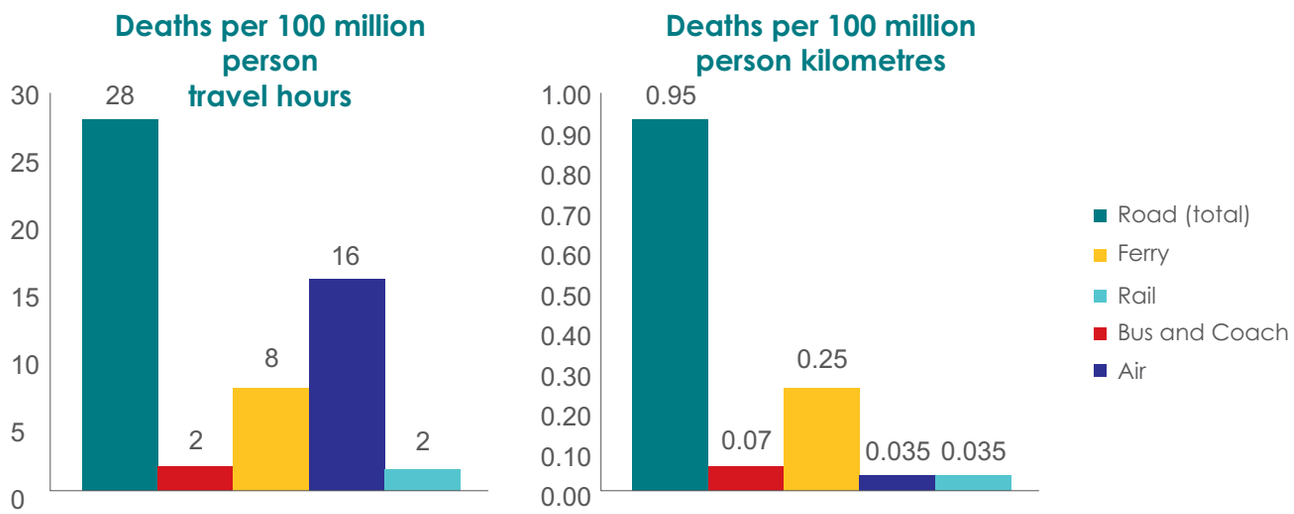
[1] 2011 version of the 'EU Transport in figures' statistical pocketbook, p.119
[2] UITP, Millenium Cities Database
[3] Trafikverket annual report, 2010
[4] VTI, Swedish National Road and Transport Research Institute report 718, 1999

All major European cities benefit from urban rail networks which are the backbone of their urban transport systems, along with bus services feeding into these. The rail networks are made of a combination of suburban and regional conventional rail lines, and of metro, tram and light rail networks. Generally, public transport services are coordinated with integrated ticketing and passenger information systems. These ensure seamless and optimised use of the urban transport system. The advantage of rail is its very low consumption of urban space and land take:

- Hardly any road lane can offer a capacity of 700 cars per hour on urban street and 2000 cars per hour on expressways, that is a maximum of 1000 to 2500 passengers per lane per hour; and each car needs a parking place at either end of the journey;
- a rail line carries over 5000 passengers per hour at street level in the case of light rail and up to 60,000 passengers per hour on a single track in the case of regional metro (e.g. the RER line A in Paris offering a commercial speed of 48 km/h). Depending on the type of traffic and transport, a rail double track will carry the same capacity as up to 16 road lanes.[5] This is especially important in an urban context.

Rail Transport is the Safest Mean of Transport

Accident levels are approximately 200 times higher in road than in rail transport.



Source: http://www.etsc.eu/oldsite/statoverv.pdf European Transport Safety Council (2003)

The European Railway Agency (ERA) also indicates in its 2011 "Railway safety performance in the European Union" that the total number of passengers killed for the period from 2007 to 2009 is only 196, making railway the safest transport mode for European passengers!

Rail Transport between European Metropolitan Centers Offers Competitive Transport Connections

Rail is very competitive for high-speed lines over distances of up to 800 – 1000 km rail: for example the total journey time from city centre to city centre between London and Paris is 33% shorter by train compared to the plane.

[5] Banverker/Bytspår / Royal Institute of Technology (KTH) (TRITA-TEC-RR 10-002) Kapacitetsanalys av järnvägsnätet i Sverige

A 400 km journey by high-speed train can be up to an hour faster than covering the same distance by plane, or more, depending on the airport location and the capacity of the security control.

Rail Transport for Urban Mobility

In today's Europe, urban mobility consumes yearly 140 million tons of oil equivalent, and emits 470 million tons of CO_2 equivalent (i.e. 8% of total CO_2 emissions). Public transport in urban areas represents 21% of motorised mobility and is responsible for roughly 10% of transport-related GHG emissions. Public transport is already helping cities to better manage their transport energy consumption and pollution.

Today, between 40 and 50% of public transport is already powered by electricity. Public transport has thus already been a major and robust electro-mobility provider for decades and is capable of decreasing further its carbon footprint. The smart use of resources through the efficient management of energy both on-board and throughout the whole system is a key point.

Buses account for 50-60% of total urban transport in Europe, and 95% still use fossil fuels. Long term decarbonisation efforts obviously include electric buses, but also second-generation biofuels.

Electric cars are best deployed in captive car fleets complementary to public transport, such as taxis or car sharing.

Rail transport in urban areas is already running nearly exclusively on electricity. In the last ten years, passenger rail transport decreased its specific energy consumption by 22%. Metro and light rail systems have been recognized as an essential instrument for setting up new urban development and sustainable mobility paradigm– e.g. 25 new light rail networks in 25 years in France.

Technology Adds Value to the Rail Market

Innovation resulting from technology added value is steadily contributing to strengthen all market segments and their seamless connections as well as contributes to environmental efficiency, security and safety, and intelligent mobility. The impact of today's rail technology in high-speed is outpacing the increase in aviation for journeys up to 1000 km; 176 billion pass-km (rail) versus 67 billion pass km (aviation) compared to 2005. High-speed trains are therefore the preferred passenger choice for journeys of this distance.

When Spain's high-speed Madrid-Seville line was launched in 1992, the rail market share rose from 19% to 53%. The Barcelona-Madrid link saw its share rise from 13.7% before the introduction of high-sped to 45.6% in 2010.

High-speed trains have cut travel time by 43% between Brussels and Frankfurt, and by more than 60% (from 4 hours 52 minutes to 1 hour 51 minutes) between Brussels and London excluding the time required to check in.

Today, most national railway networks have their own power supply and signalling system. But modern freight trains with multi-systems locomotives technology are able to cross every border increasing the average speed of freight trains in Europe.

Rail Transport for a Sustainable Future

Rail Transport for a Sustainable Future

In the next decades, the overall transport system will have to answer new needs and expectations from users. Europe will have to deal with a larger volume of freight and greater number of travellers. However, a large part of the European network is already working to its maximum capacity and customer expectations are increasing. At the same time, the EU has called for (and the international community agreed) the need to address a societal challenge "to drastically reduce world greenhouse gas emissions, with the goal of limiting climate change below 2°C".

Europe will also have to deal with congestion, in particular in cities and intercity traffic. Existing transport infrastructure for a large part of the European network, is already working to its maximum capacity. Short and medium distance mobility might become impeded, and because of the reliance on fossil fuels, despite the development of new technologies, pollution may increase, resulting in an additional burden on the health care system. As a result, mobility is now a major challenge in order to overcome pollution and facilitate sustained economic growth.

In line with this vision the European Commission (EC) adopted in March 2011, a comprehensive strategy (EC White paper "Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system" - 28/03/2011). The objective is to pave the way for a competitive transport system that will increase mobility, remove major barriers in key areas and fuel growth and employment. The EC affirms that "Curbing mobility is not an option." At the same time, the EC proposals will dramatically reduce Europe's dependence on imported oil and cut carbon emissions in transport by 60% by 2050.

To implement this ambition the EC white paper presents 10 Goals for a transformation in Europe's current transport system towards a competitive and resource efficient transport system, and six of these directly concern rail transport, highlighting the importance of this transport mode in Europe for the future:

> (3) **30% of road freight over 300 km should shift** to other modes such as rail or waterborne transport **by 2030, and more than 50% by 2050**, facilitated by efficient and green freight corridors. To meet this goal will also require appropriate infrastructure to be developed.
>
> (4) By 2050, complete a European high-speed rail network. Triple the length of the

existing high-speed rail network by 2030 and maintain a dense railway network in all Member States. **By 2050 the majority of medium-distance passenger transport should go by rail.**

(5) A fully functional and EU-wide multimodal TEN-T 'core network' by 2030, with a **high quality and capacity network by 2050** and a corresponding set of information services.

(6) **By 2050, connect all core network airports to the rail network**, preferably high-speed; ensure that all core seaports are sufficiently connected to the rail freight and, where possible, inland waterway system.

(7) Deployment of the modernised air traffic management infrastructure in Europe by 2020 and completion of the European Common Aviation Area. **Deployment** of equivalent land and waterborne transport management systems (**ERTMS**). **Deployment** of the European Global Navigation Satellite System (**Galileo**)

(8) By 2020, establish the framework for a **European multimodal transport information, management and payment system**

The framework conditions for railway transport will have to be radically improved in order to remove the barriers to the development of a competitive rail offer. The market conditions will have to be improved through increased liberalisation of domestic passenger services, streamlined European single vehicle type authorization, a single railway undertaking safety certification and safety authorisations for infrastructure managers on the interoperable European community rail system. Fair competition between the different modes of transport should also be ensured via of the integration of external environmental costs in the application of the "Polluter pays principle". Indeed, reliable and sufficient infrastructure financing and creation of a level playing field for the internalization of external cost of transport are essential.

The traffic management systems as ERTMS will have to be further enhanced and deployed in order to increase the efficiency of transport and of infrastructure use with information systems and market-based initiatives.

Therefore the European Commission acknowledge in its new Transport White Paper that research and innovation efforts will have to dramatically increase and be coordinated in order to develop innovative solutions to all the above mentioned challenges.

The Rail Sector, a Strong Pillar for European Economic Growth

The railway sector is not only a major contributor to the fulfilment of other economic sectors' needs and society's requirements. It is in itself a major industrial sector.

The global rail market is an important sector of the European industrial dimension since it accounts for an estimated 136 Billion Euros[6], even more than the Aeronautic industrial sector, and is rapidly growing. Europe remains the main market for railway equipment (more than 45 Billion Euros in total). On a global scale, the rail equipment market is particularly promising, with an expected growth of 2.0% to 2.5% annually until 2015-2016.[7]

In terms of employment, the European rail supply industry alone accounts for an estimated 400,000 direct and indirect jobs[8] throughout Europe. This adds to more than 1,350,000 workers employed by European infrastructure managers and railway operating companies[9]. Employment from urban railway operators is at least as important.

In terms of achievements, the European railways run the fastest passenger trains on rail, have the largest high-speed network, are constructing the longest tunnel, offer numerous attractive and efficient metro and light rail systems and have implemented a unique integration of long distance high speed, regional, urban and freight networks on a continental scale. The rail manufacturing industry leadership position is nevertheless challenged by new competition in particular from Asian countries.

The railway sector can play a major role for the success of the EUROPE 2020 strategy as it enables the achievement of several key European objectives underpinning a smart and sustainable growth as well as a more competitive low carbon economy. More specifically, the railway sector intends to realize the social challenge of climate change by enabling an effective modal shift towards rail.

Europe can in return help the railway sector in maintaining and even reinforcing its competitiveness through research and innovation, securing high value jobs and exports and providing Europe with a world-class railway system.

Challenges & Trends

In order to meet the ambitious growth targets described in the EU Transport White Paper, Roadmap to a Single European Transport Area – Towards a competitive and resource

[6] Source UNIFE, 2011
[7] UNIFE rail market study
[8] Source UNIFE, 2011
[9] CER alone estimates that its member companies employ 1,234,000 workers in 2010. CER Annual Report 2011.

efficient transport system, the rail sector needs to meet customer expectations not only of today, but the higher expectations of tomorrow. The rail industry therefore needs not only to reduce the gap between present expectation and customer experience, but also to meet the challenges that will arise from the perception that rail will play an important role to meet the environmental sustainability challenges of the twenty first century, and the exceptional growth in rail transport, both passenger and freight, that this implies. The railways have an unprecedented opportunity, faced with the prospect of sustained growth for many decades, but it should not be assumed that railways in their present form will survive as the preferred transport mode, if they do not rise to this challenge.

From an operational perspective (source: UIC-CER 2010 Sustainable Mobility Strategy) the following trends have been identified:

- Globalisation:
  - Transport demand will grow
  - Infrastructure limitation will be notable
  - Need for sustainable co-modal transport concepts
  - Greening the economy becomes an asset
- Demographical change:
  - Aging customers
  - Decreasing total number of inhabitants (in some countries)
- Urbanisation:
  - Increasing numbers of passengers in big cities and conglomerates
  - Decreasing numbers of passengers in rural areas
  - Infrastructure needs will change
- Scarcity of energy resources:
  - Increasing energy prices
  - Need for new energy sources (e.g.: biofuel, biomass, solar, etc.)
  - Need to improve energy efficiency
- Climate change:
  - Share of CO_2-free energy sources will grow (renewable energy sources, nuclear power?)
  - Adaption of the railway system to changing climate and extreme weather conditions (infrastructure and operations)
  - Need for alternative traction concepts
- Limited natural resources:
  - Scarcity of certain materials with increasing prices
  - Ecologic footprint of materials and recycling becomes more important

- Biodiversity:
    - Degradation of bio-systems and loss of biodiversity, need for sustainable land-use
- Individualisation and change of lifestyle:
    - Physical well-being becomes more important this will trigger a stronger regulation
    - Demand for green products
- Limited public funding:
    - Limited investment in railway infrastructure and vehicles
- Stronger regulation:
    - Stronger regulation on impacts with possible health effects (Noise, Emissions, EMF, etc.)
- Intermodal competitors:
    - High innovation in the road and aviation sectors with better performance

Apart from the issues listed above, some further trends also require explanation. The Asian and African economic development will lead to increased market trade demand, and also the world economic centre is foreseen to split between regions, where countries such as India and China will play an important role. Knowledge and information will increase, and knowledge transfer worldwide will be faster.

The mobility of the workforce will increase; fewer people will make their entire career with one company or one sector. The various societal changes require transport to respond to the needs of people with reduced mobility as well (e.g. barrier free door-to-door journeys). A level playing field in the transport modes: right prices (internalisation of external costs) and distortions avoided. Meanwhile, in Europe, the increased competition and liberalisation of the railway market is an important trend.

The strategic vision of research in the railway sector focuses on clearly identified needs for RTD activities reflecting the challenges for 2020 – the competitiveness, attractiveness, and performance of the entire rail transport mode and its interfaces. The research effort embraces rolling stock, infrastructures, operations and services.

The following challenges should be addressed:

Meeting customer's expectations:

- To provide both products and services that attract passengers to choose the rail transport mode and promoting complementarity between different types of rail service and between those services and other modes. To achieve a significant modal shift, the issue of both physical and non-physical interconnectivity must be addressed through technology innovation;

- Even though rail is a safe mode of transport, the perception of personal security is a challenge, as it is the case for any public transportation. Even more so for an ageing society, where perceptions of personal security are often identified as one of the top concerns of the elderly. It is perhaps, even more difficult to reassure rail passengers because of its nature of mass transport and complex networks. Research and innovation can help to ensure a trade-off between actions needed in favour of even greater security and the need to ensure easy access to trains while keeping any additional costs affordable;

- To satisfy the markets needs with seamless door-to-door transport for both passengers and goods and with technologies and systems to ensure effective and efficient co-modality. Delivering this broad scope means identifying and prioritizing knowledge gaps that can be researched in order to integrate the railways in an efficient way with other modes to meet customer demands. The challenge is therefore to support sustainable rail freight development in Europe and build upon and exploit the inherent advantages of rail as the most sustainable transport mode.

Increasing environment performance:

- To enhance the environmental advantages of the rail mode by further optimising its energy consumption and reducing noise emissions. Noise is one of the major environmental issue of the railways; it is necessary to adapt noise attenuation techniques to differing networks ahead of emerging standards. Improved power regeneration and energy supply throughout the railway system are required even though a major share of the rail network is already using electric power solutions. Other environmental challenges also concern electromagnetic emission and recycling of materials used in the construction and refurbishment of rail vehicles and infrastructure.

Improving capacity:

- To provide the technical capability for future increase in traffic on rail with product

innovation in control command and passenger and freight rolling stock solutions. Significant investment on research and development activities will be needed to innovate;

- To improve the performance of railway infrastructure in order to absorb a bigger share of traffic. Innovative solutions should be developed to significantly reduce the life cycle costs of high value infrastructure assets as well as to target new interoperability requirements around improvements in safety and security, reliability, maintainability and interoperability;

- To improve the information management systems with high-quality services and implementation of intelligent mobility concepts involving customer information for freight and passenger services for enhanced accessibility and availability;

Enhancing rail competitiveness:

- To develop innovative and advanced rolling stock, signalling and infrastructure solutions with cost competitive technologies, including retrofitting solutions. To this end, research and innovation will have to improve the performance of products, production processes and reduced life cycle costs (benefiting from economies of scale) with the aim of improving the economic attractiveness of the rail transport mode.

- To reduce cost on product certification and validation, fleet operation and maintenance costs; this being one of the most significant areas of expenditure for the railways. This will potentially release substantial capital for further investment that support greater modal shift.

Achieving interoperability and intermodality:

- For many reasons, rail is, or should be, the leading mode in the multimodal chain of goods and passenger transport. For long and medium distance travel, improving interoperability of the European Community rail system is essential in order to develop new rail services and remove inappropriate barriers to trade. Also, appropriate coordination of long, medium and short distance transport services is the only way to provide attractive transport conditions to European citizens. This coordination has to be achieved between public transport services (public transport intermodality and integration), but also with private modes (co-modality). A modal shift of medium and long distance freight and passenger traffic from road to rail should be a key objective of European, national and local transport policies.

Maximising (sub)urban transport efficiency:

- 80% of Europe's citizens live in urban areas. The development of efficient urban, suburban and regional transport systems are thus critical elements for a sustainable transport system. The challenge is to increase the attractiveness of integrated public transport systems for existing and potentially new passengers and to achieve more attractive rail related transport products and services, with a progressive harmonisation across Europe.

Providing a suitably qualified work force:

- To make the rail sector attractive to young engineers and to provide high quality education opportunities in order to provide a work force to deal with an increasingly technology intensive rail transport system. Training activities will be needed into the use of technology to increase the productivity of staff.

Opportunity

As Vice-President Siim Kallas, responsible for transport said, "*The widely held belief that you need to cut mobility to fight climate change is simply not true. Competitive transport systems are vital for Europe's ability to compete in the world, for economic growth, job creation and for peoples' everyday quality of life. Curbing mobility is not an option; neither is business as usual. We can break the transport system's dependence on oil without sacrificing its efficiency and compromising mobility. It can be win–win*."

Rail offers an alternative solution to road congestion in the logistic chain, in particular for medium and long distance journeys and the transportation of goods and services. The railway sector can strongly contribute to the absorption of this increasing traffic, supporting economic growth while dramatically reducing CO_2 emissions.

The greening of current CO_2 intensive modes of transport (car, aviation, etc.) and a greater use of greener or sustainable modes of transport (rail, waterborne) have therefore to be strongly promoted by both public authorities and industry if Europe wants to attain both its environmental and transport objectives. In particular, strong support to enable a smooth modal shift from CO_2 intensive modes of transport to other already more sustainable modes will significantly and rapidly contribute to the implementation of the EU Transport White Paper objectives.

Ambitious targets have still to be set up for urban public transport at the European level, e.g. as proposed by UITP in its "PT X 2" initiative, aiming at doubling the market share of public transport worldwide by 2025.

From the ERRAC SRRA to the Implementation of Research

From the ERRAC SRRA to the Implementation of Research

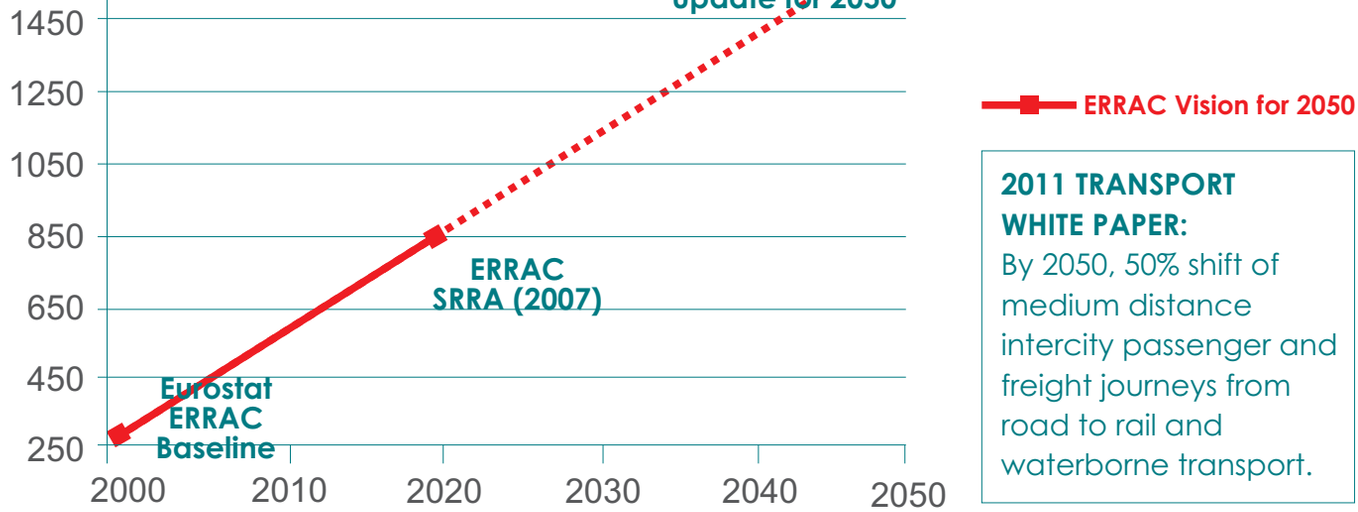
The European rail sector will have to respond to the important challenges expressed in the previous section and they will have to be addressed within the next 40 years. ERRAC delivered a first response with its Vision for rail in 2001 and then with the Strategic Research Agenda (SRRA) in 2002 - updated in 2007.

The recent EC transport White Paper, Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system, has, with its vision of transport for 2030 and 2050, updated the priorities of the SRRA and puts sustainability at the heart of transport. This cannot be done without a massive modal shift from road to rail or waterborne transport: rail therefore faces an unprecedented challenge to provide the capacity for affordable and attractive services required to enable this modal shift. The 2011 EU Transport White Paper foresees a global freight transport activity to increase, with respect to 2005, by around 40% in 2030 and by little over 80% by 2050. Passenger traffic would grow slightly less than freight transport: 34% by 2030 and 51% by 2050.

Taking into account this general transport trend, the ERRAC initial updated vision for 2050 is fully matching the 2011 Transport White Paper objectives as showed in the table and graphics below: **the rail share of both the freight and passenger markets will double by 2050, at the same time the rail freight and passenger market volumes will more than triple by 2050 as compared with 2000.**

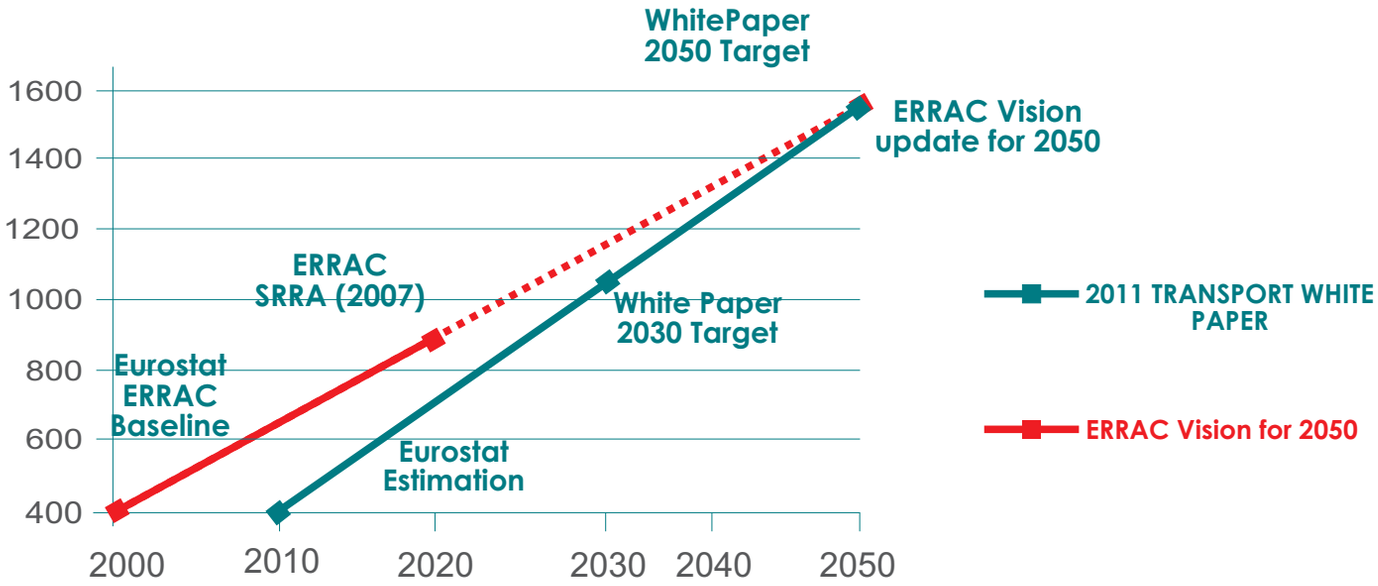
	Rail Market Share (%)	
Year	Freight	Passenger
2000	11,5	7,6
2020 - ERRAC SRRA	14	11
2050	**22,2**	**15,3**

Passenger vision for 2050 (pkm*10^9)



The ERRAC vision is compatible with the 2011 Transport White Paper's goal, namely: "By 2050, 50% shift of medium distance intercity passenger and freight journeys from road to rail and waterborne transport."

Freight vision for 2050 (tkm*10^9)



ERRAC identified seven priority areas (SRRA2007) that have to be addressed in order to turn the vision into reality and during the past two years has populate them with research topics identified through a comprehensive roadmapping activity (ERRAC-Roadmaps). ERRAC has always recognized the importance of the market uptake of research results, but today considers the implementation of research activity into innovation as a key issue for the rail sector in order to achieve its ambitious objectives.

ERRAC provides today an answer to the complexity of the rail transport system with an initial research investigation for 2050 based on the ERRAC-roadmaps work that, starting from the SRRA priority areas, identify the needs for EU funded research.

		Strategic Rail Research Agenda Priority Areas						
		Intelligent Mobility	Energy & Evironment	Personal Security	Safety & Homologation	Competitiveness & Enabling Technologies	Strategy & Economics	Infrastructure
Roadmaps	WP01 The Greening of Surface Transport		✓					
	WP02 Encouraging Modal Shift and Decongesting Transport Corridors	✓					✓	✓
	WP03 Ensuring Sustainable (Sub)Uran Transport	✓					✓	✓
	WP04 Safety and Security			✓	✓			
	WP05 Strengthening Competitiveness					✓	✓	✓

Intelligent Mobility 2050

Intelligent Mobility 2050:

In 2050, Railway will be the most attractive transport mode. The European high speed Rail network will be tripled by 2030. Passengers will be able to cross Europe in only a few hours thanks to seamless end-to-end journeys, all airports will be linked to rail, and co modality will be easier. This will be performed by improved ticketing services, interoperability as well as better journey planning information. Crossing Europe means crossing borders, and interoperability will have to be developed with new communication systems between trains and track.

In 2050, the major part of medium distance passenger transport should be on rail. Railway needs to improve its punctuality as well as reliability. By punctuality and reliability, we mean at least 19 trains out of 20 arrive on time (95%). Passengers want to have prices matching the services offered be informed if the train is delayed and travel in comfort and security.

In addition to the establishment of a dedicated freight network serving the economy with longer, heavier and faster trains, freight transport will increasingly be undertaken by containerised trains that look like a passenger train in terms of loads, average speed, reliability and performance. This results in better traffic management opportunities, lower infrastructure maintenance costs and higher capacity of the rail network.

In 2050, 50% of road freight over 300km will be transfered to rail freight. It will be achieved by improving management techniques and the reliability of trains. Every customer will received accurate information of the train position throughout Europe. Connecting railway networks to seaports will also allow direct use of trains from the docks to the final destination.

Targets

(1) European citizen receives real time traffic and journey information thanks to improved communication/information systems, allowing better services, including easy re-routing. Passengers will enjoy seamless journeys in a safe and secure environment (travels from A to B fully independent of mode);

(2) Practically all customers or their freight will arrive at the destination on time because 95% of all trains are punctual, arriving within 5 minutes of the planned time of arrival. Improved system performance and advanced on board and waysides technology together with full interoperability deliver reliabile, available, maintainable and safe trains;

** New command control technology will contribute to increase the reliability of connections and network capacity*

(3) Freight forwarders prefer to ship their goods though rail. Improved management techniques and train reliability together with full traceability across Europe makes freight transport by rail the most punctual and reliable transport mode. Train is the strongest link in intermodal transport chains.

** Through technology innovation the capacity of TEN-T and rail freight corridors will be increased to allow the shift from road to rail freight.*

** Innovation through technology examples*

Energy and Environment 2050

Energy and Environment 2050:

In 2050 rail will still be the most energy efficient and environmentally friendly transport mode. Trains will be quiet and no vibration will be perceived around the railway infrastructure. This allows trains to run 24h services in urban areas and near settlements without causing noise and vibration annoyance.

In 2050, railways won't be dependent on fossil fuels due to electric traction and, where not feasible, general use of sustainable bio-fuels. The European railway network is mostly electrified allowing the use of clean, carbon free electric energy. Energy saving potentials will have been highly exploited and new hybrid engines are in operation.

In 2050 railway energy networks are managed as smart grids. The consumption of energy is optimised on global and local level.
In 2050, smart energy on-board distribution, use and storage is fully implemented. The temperature in the metro is reduced; cooling systems consume considerably less energy and are clearly more environmentally friendly. Furthermore, smart and low impact rolling stock is developed, reducing infrastructure maintenance needs.

In 2050, the performance of the vehicles is improved. Engines consume less energy, traction components are lighter, regenerative braking is standard, and the use of the regenerated kinetic energy in the grid is significantly improved. Rail traction is improved and energy supply is optimised. New vehicles are built to be recyclable and innovative lighter materials are used in the new trains generation.

Targets

(1) The European railways will strive towards carbon-free train operation by 2050 and provide society with a climate neutral transport alternative

**The environmental performance of rolling stock and installed equipment is significantly improve*

(2) The European railways will strive towards noise and vibration no longer being considered a problem for the railways and its neighbours – meaning that noise levels are socially and economically acceptable and allow for 24-hour passenger and goods operations by 2050;

**The environmental performance of rolling stock is significantly increased*

(3) The European railways will strive towards halving the specific final energy consumption from train operations by 2050 compared to the base year 1990; measured per passenger-km (passenger service) and gross tonne-km (freight service).

**The energy efficiency of rolling stock and installed equipment is significantly increased*

** Innovation through technology examples*

Security 2050

Security 2050:

In 2050, rail has security even more sophisticated fine-tuned strategies and security concepts that can adapt flexibly to changing circumstances. Staffing and technology go hand in hand with risk prevention and co-operation on an international level. The integration of security across Europe has been achieved through various technologies and security strategies. Railway staff is appropriately trained. Automatic control of rolling stock is widely used in Europe, raising the security level with advanced station design.

In 2050, signalling systems and communication systems are fully secured. Research has been performed on supervision systems for the management of degraded modes. Vision systems connected to a public security system are tracking activity, which permits fast response in cases of acts of aggression, terrorism or vandalism.

In 2050, freight is well managed. Vehicle cargos and loading details are known from the operators thanks to scanning systems, and advanced tracking and well advanced surveillance technologies. This enables the tracking of dangerous materials throughout Europe.

In 2050, detection systems are installed on-board to detect explosives and toxic substances along the track. Scenarios have been put in place by all Member states in Europe, enabling the fastest possible reaction in the event of an emergency.

Targets

(1) By 2050 rail transport will be the most secure public transport mode without perceiving intrusion to privacy.

**Intelligent technology solutions which allows for quick decisions and preventive actions to be taken under high risk conditions guarantees a secure environment.*

(2) Stations have a new design with low or very low perceived, and actual risk. and older stations are upgraded;

(3) All transported goods are handled, managed and tracked in a secure way; accidents due to a security failure do not occur;

**innovative technology widely available and used by 2050 allows increased security of the entire containers transport chain*

** Innovation through technology examples*

Safety and Certification 2050

Safety and Certification 2050:

In 2050 railway is still the safest transport mode. A significant majority of level crossings have been further improved or removed; tracks as well as bridges and junctions are even more secured. In the event of an incident, the systems are quicker to restart, and degraded modes performance is close to normal operational mode. The reliability, availability, maintainability and safety of the railway system have increased.

In 2050, maintenance performed on infrastructure will be safer. New operational and possession management techniques will be enabled. Intelligent infrastructure and rolling stock will be in place that is autonomously monitoring itself and other system components. The interaction between drivers, signallers and other railway staff will be enhanced, and human will work in parallel with computers.

In 2050, authorisation and certification will be performed at a European level for the interoperable European community rail system. All aspects of verification and authorization are covered by a single set of harmonized European or equivalent national rules in a single process and virtual certification systems will be common practice for new rolling stock. This will lower the costs, and deliver the test results more quickly.

Targets

(1) Rail transport is the safest transport mode in Europe enhanced further by the incorporation of human factors based safety features and adaptation to climate change or natural hazards in safety research and policy making. Passenger and freight customers benefit from new methods of degraded mode management that will significantly minimise disruption and maintain risk at an acceptable level;

**railway applications will be fully covered by new advanced and secure signalling, information and communication technologies in fully interoperable communication networks.*

(2) New automated methods of inspection, maintenance and construction of infrastructure reduces the need for work on the live railway;

(3) The authorisation process is easy and cost competitive for all railway applications.

**rolling stock and installed equipment test costs will be reduced together with a significant move towards virtual assessment that will lead also to a time reduction*

** Innovation through technology examples*

Competitiveness and Enabling Technologies 2050

Competitiveness and Enabling Technologies 2050:

In 2050, European manufacturers are at the forefront of new technologies. Europe will deliver the most advanced rolling stock and infrastructure technology for railway systems. Innovation from research activities allows the European manufacturers to maintain an industrial leadership role in the world and to secure European jobs and know-how.

In 2050, all barriers for interoperability will be removed. It will be easier and seamless to cross Europe thanks to the removal of bottlenecks. Ticket services will be easier to use for passengers, and new commercial models will allow the introduction of innovative efficient services to passengers and freight forwarders.

In 2050, new maintenance technologies will be found, and the capacity of the system will be maximised. Rolling stock will be less aggressive to the track, which means lower maintenance costs. Innovative maintenance technologies will be put in place.

In 2050 technology innovation will play a predominant role in enabling rail to become the most popular transport mode in Europe.

Rail should tackle any freight booming market, including the last mile challenge and develop research on new concepts, new business models and new marketing for this segment in order to reduce the required investment and find the best way to make attractive proposals on selected corridors.

Spatial planning for logistics freight villages and mega hubs, taking into account the last mile into urban centres issue, in a borderless union, is necessary for traffic bundling and deployment of longer trains. It is also necessary to develop collaborative business approaches to fill the longer and heavier trains in order to realise the potential efficiencies and synergies of advanced transport systems.

Targets

(1) Improved competitiveness with new rolling stock, operational systems and infrastructure that breaks the dependency on oil, and delivers the maximum economic, quality and capacity benefits for the least environmental impact

**Innovative use of new materials will allow for lighter structures and increased payloads contributing to increased line capacity*

(2) Going beyond interoperability : by 2050 technological solutions will enable the establishment of a seamless European transport system

**Standard system architectures will ease the integration of innovative solutions into products, ensuring full interoperability between new individual commercial solutions.*

(3) An 50% increase of capacity from existing infrastructure

** Innovation through technology examples*

Strategy and Economics 2050

Strategy and Economics 2050:

In 2050, rail will still be the safest mode of transport and it will also be economical and ecological. Models of Life Cycle costs will be developed for infrastructure with the objective of reducing maintenance costs and for rolling stock to optimise all tendering processes.

The European Commission recognised the importance of the market uptake of research results and promoted the use of instruments at EU level encouraging industry to innovate; research demonstration activities are performed on a cooperation basis between European manufacturers.

In 2050 railway will contribute heavily to the economic stability of Europe. Freight and passenger transport will continue to grow. Interoperability will be developed, so that it becomes easier to cross borders inside Europe. Rail will be the benchmarking case used by other sectors to identify the factors that contibute to success.

In 2050, the strategy of railway will be to fully understand how train operators respond to track access charges. At peak hours, improvements will be performed to reduce overcrowding. This will drive the improvement in train operations, scheduling and signalling.

Traffic management is essential for optimizing existing network capacity, especially on mixed traffic lines which constitute the majority of the European trunk network. This requires the development of mixed traffic management methods.

Targets

(1) By 2050, the capacity of a given railway will be doubled compared with today, through improved train operation and management, together with more intelligent and automated train operation..

**Innovative solutions for rolling stock and equipment will reduce the maintenance costs and increase their RAMS.*

(2) Analyses on long term projections for passenger and freight travel have allowed an optimisation of the service provided for an increased demand. Track access charges are optimised following a transport system LCC and environmental approach. The modernisation and take up of new technology of rail equipment is at least as fast as in other modes;

(3) By 2050 the European rail network is fully interoperable and regulated in the most viable conditions. Rail significantly contributes to local, regional and national economic development.

**The costs and time for the production of new rolling stock and equipment are significantly reduced thanks to new manufacturing processes.*

** Innovation through technology examples*

Infrastructure 2050:

In 2050, infrastructure maintenance costs will be significantly decreased. New methods of maintenance will have to be put in place. With the growth of freight and passenger traffic, less time is available for maintenance. The installation of automatic inspection and maintenance techniques, will deliver enhanced capacity while increasing safety and security.

In 2050, in order to improve capacity, new lines (e.g. corridor concepts, high speed networks) will have to be built according to consistent corridor performance standards and new stations will be designed to provide safety and security. This, together with improved processes and methodologies will boost passenger and freight attractiveness.

In 2050, level crossings on 150-200 kph and higher speed lines will be removed. This will permit an increase of the average speed on certain lines. Procedures will be created to give greater flexibility in track access. In addition, the removal of bottlenecks, particularly near borders on TEN, and further harmonisation will smooth traffic flows.

Targets

(1) Maintenance cost of infrastructure is reduced by at least 50%. This will have been achieved by the development of cost efficient maintenance and maintenance-free infrastructure systems together with strategies for fewer maintenance interventions, the use of more reliable track systems and the automation of maintenance activities;

(2) The improvement of station design attracts passengers and interchange is organised not only between the various rail market segments, but also between rail and other modes of transport;

(3) The infrastructure conditions are improved with lines equipped with innovative technologies and through research into the correct revitalisation of older infrastructure.

**New advanced monitoring and diagnostic systems together with the use of innovative solutions guarantee the optimum infrastructure quality.*

** Innovation through technology examples*

ERRAC Commitment to Innovation

ERRAC Commitment to Innovation:

The message provided by ERRAC with this paper is clear: action on rail research, development and innovation cannot be delayed.

As the EC White Paper "Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system" outlines, rail transport has an unparalleled opportunity, but one that cannot be missed.

ERRAC was set up ten years ago with the ambitious goal of creating a single European body with both the competence and capability to help revitalise the European rail sector and make it more competitive, by fostering increased innovation and guiding research efforts at the European level. ERRAC gathers representatives from each of the major European rail research stakeholders: manufacturers, operators, infrastructure managers, academics and users' groups, providing strategic advices on RD&I to the European Commission and the EU Member States.

The European rail stakeholders are prepared to move up a gear and will present to the European Union RD&I projects in line with this ambitious and commonly shared initial work on the ERRAC 2050 vision and goals. It is therefore necessary to establish the right framework at the European level in order to support the European rail stakeholders and the European Union in meeting their goals:

- ERRAC will continue to bring a medium and long term functional and operational platform framework for discussion and coordination of the different frontier and applied focused research activities needed;

- The Innovation chain from blue sky research, applied engineering up to demonstration and market uptake (roll-out / deployment) shall be addressed at European level in coordination with the European Commission and Member States;

- The European Union has to provide appropriate budgetary resources – at least tripling the current very low (by far the smallest funding among all transport modes!) EU RD&I support for the rail sector – for the necessary RD&I investment to promote the most environmentally friendly means of transport and the strongest possible global rail market for European products;

- The upcoming Horizon 2020 - the Framework Programme for Research and Innovation- shall provide to the European rail stakeholders a full set of instruments, from small collaborative projects to large structured technical demonstration initiatives, to allow different stakeholders to perform the specific research required to achieve the Rail Route 2050 targets.

Rail Route 2050:

the sustainable backbone of the **Single European** Transport Area

An initial update of the ERRAC Vision for Railway Research and Innovation for the future of rail

Towards a Competitive, Resource Efficient and Intelligent Rail Transport System for 2050