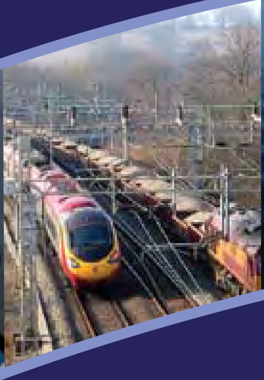
FERRMED

Promotion du Grand Axe Ferroviaire de marchandises Scandinavie-Rhin-Rhône-Méditerranée Occidentale & S.B.I

FERRMED GLOBAL STUDY

- **Supply and Demand**
- **Technical**
- **Socio-economic and Environmental**
- **Legal and Administrative Studies**



FERRMED Great Axis Rail Freight Network and its area of influence

Scandinavia - Rhein - Rhone - Western Mediterranean

FEASIBILITY, CONCLUSIONS AND RECOMMENDATIONS

ACKNOWLEDGEMENTS

FERRMED would like to thank the European Commission, the Member State national and regional governments and the TEN-T Agency for their support and valuable advice in the preparation of the Global Study. Also, we would like to acknowledge contribution from the Federal Government of Belgium, particularly that of the "Service Public Federal Mobilité et Transports", which has reviewed the reports.

FERRMED would also like to thank all the members of the Consortium led by WYG International for their professionalism and working capacity in carrying out and bringing forth such an ambitious and demanding Study.

We would like to thank the Advisory Council and Technical Working Group, the members of FERRMED as well as the General Secretariat supporting team for their assistance in the monitoring of the Global Study preparation.

We have to express, as well our gratitude to the governments of all EU countries that have supported the preparation of the Global Study particularly Finland, Sweden, Norway, Denmark, Germany, The Netherlands, Belgium, Luxembourg, France, Switzerland, Italy, Spain and United Kingdom. Finally, FERRMED would like to acknowledge the financial contribution towards the Global Study, provided by the following entities:

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Trans-European Transport Network (TEN-T)

Liberté • Égalité • Fraternité
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Grand-Duché de Luxembourg

Ministere de la Region de Bruxelles-Capitale

Junta de Andalucia

Generalitat de Catalunya

Generalitat Valenciana

Región de Murcia

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FOREWORD

Antonio TAJANI
European Commission Vice-President, Commissioner for Transport

La création d'un réseau ferroviaire compétitif pour le transport de marchandises est clairement une de mes priorités. A l'heure où notre société a plus que jamais besoin d'une offre de transport performante et respectueuse de l'environnement, il est évident que nous devons agir pour améliorer l'offre ferroviaire. Alors que le rail, de par sa nature, devrait bénéficier d'un avantage compétitif sur les longues distances, nous observons que, dans la pratique, il perd des parts de marché. L'Union a supprimé les frontières internes, mais les frontières ferroviaires peinent à disparaître: standards techniques dont l'harmonisation tarde trop, procédures administratives complexes et encore mal adaptées au trafic international, règles opérationnelles disparates, ouverture encore insuffisante du marché sont autant d'éléments qui freinent le ferroviaire.

Pour cette raison, l'Union européenne s'est attaquée depuis plusieurs années à ces questions. L'ouverture du marché semble porter progressivement ses fruits, du moins dans les Etats membres où la concurrence est réelle. Le trafic international ne croît cependant pas autant qu'il le devrait, en raison des obstacles techniques et des lourdeurs administratives que j'ai rappelées.

Au niveau technique, les standards d'interopérabilité sont définis par l'Agence Ferroviaire Européenne qui veille également à ce que le rail offre un niveau de sécurité le plus élevé possible. La mise en œuvre de ces standards d'interopérabilité est cependant souvent longue en raison de l'étendue du réseau ferroviaire européen. C'est une des raisons pour lesquelles il est indispensable de concentrer nos efforts sur des corridors et c'est aussi en partant d'un corridor qu'il est plus facile d'améliorer la coopération entre les administrations nationales.

Je suis heureux de constater que globalement les propositions de standards techniques de ce rapport rejoignent les conclusions des groupes de travail des six corridors ERTMS (du nom du système commun de signalisation en cours de déploiement) et sont ainsi cohérentes avec notre proposition de règlement pour un fret ferroviaire compétitif.

La Commission propose de développer un réseau ferroviaire européen "pour un fret compétitif". Il s'agit de renforcer la coopération entre gestionnaires de l'infrastructure dans la programmation et la gestion du trafic de fret sur les corridors transfrontaliers où ce type de trafic a un potentiel réel de développement. La question des axes à inclure dans ce réseau, destiné à dynamiser le fret ferroviaire européen, est naturellement une question délicate qui doit être discutée franchement. Néanmoins, ce nécessaire débat ne doit pas occulter la difficulté de la tâche réelle, qui consiste d'une part à harmoniser, voire supprimer, des règles nationales disparates et coûteuses et d'autre part à réaliser des montages financiers permettant l'adoption de standards techniques communs et de procédures harmonisées le long des corridors.

En ce sens, le rapport présenté par FERRMED représente une contribution précieuse pour les organisations des corridors, qui travaillent aujourd'hui à la mise en œuvre concrète de mesures qui sont souvent proches de celles préconisées par FERRMED.

Antonio TAJANI

ETIENNE SCHOUPPE
Secrétaire d'Etat à la Mobilité
Gouvernement Fédéral Belge

Le développement d'un grand axe ferroviaire de marchandises Scandinavie –Rhin – Rhône – Méditerranée occidentale a, dès son ébauche en 2004, recueilli l'intérêt et le soutien du Service public fédéral Mobilité et Transports par l'originalité d'une démarche qui vise à développer l'outil ferroviaire, car cette initiative de FERRMED de recourir au rail pour favoriser le développement économique a été prise par le monde industriel, et vise tous les acteurs tant publics que privés.

L'enregistrement de l'ASBL FERRMED à Bruxelles, le 5 août 2004, a consolidé les liens avec le SPF Mobilité et Transports ainsi que la DG TREN de la Commission européenne.

Ce partenariat étroit s'est développé tout au long des années 2005 et 2006. Il a débouché sur la décision de l'octroi, le 16 avril 2007, d'un subside de 1.300.000€ par la Commission européenne au titre de cofinancement de l'étude de faisabilité de FERRMED. Pour arriver à ce résultat, la Belgique s'est engagée auprès de la Commission comme pays accompagnant FERRMED, notamment en attestant les documents présentés relatifs à l'exécution de cette étude venant aujourd'hui à son terme.

Par ce bref rappel historique, je tiens à souligner le sérieux et la pertinence des démarches et des travaux entrepris par les promoteurs et dûment conduits par Monsieur Amoros, Secrétaire général de FERRMED et son équipe.

La conférence du 18 juin 2008, à laquelle j'ai été associé, relative aux standards ferroviaires, clés de la compétitivité du fret ferroviaire en Europe, a démontré l'efficacité de FERRMED dans son souci de déterminer aussi les moyens opérationnels adéquats. La précision des propositions de normes et paramètres en matériel roulant et en infrastructure atteste de la qualité de tous les travaux initiés et de leur orientation résolue vers le définition du premier réseau européen de transports ferroviaire de marchandises « business – oriented ».

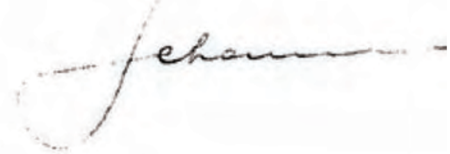
De la sorte, FERRMED contribue à la mise en place du réseau qualité fret attendu par le monde économique et constitue, à sa manière, une opération PPP (partenariat - public - privé).

Ce dossier complexe du fait du nombre d'acteurs impliqués et du vaste territoire concerné constitue un défi que FERRMED a relevé à la fois du point de vue des méthodologies à appliquer et des volumes à traiter.

Il appartient maintenant à chacun de prendre pleinement connaissance des présents résultats, et j'invite tous les lecteurs à devenir partenaires de FERRMED.

Je formule aussi les vœux que cette étude constitue le prototype de démarche à multiplier pour mieux impliquer le rail dans les Etats de l'UE, et contribuer de la sorte à établir demain d'autres grands axes qui participeront à l'organisation de la mobilité durable des marchandises en Europe.

Etienne SCHOUPPE



Gordon LAMOND
Managing Director – International Technical Services
WYG International Ltd

The FERRMED Association's vision is to see rail taking a far more significant share of the overall freight transportation market, in the area of influence of its Great Axis, than is currently the case. This vision, set against a background of increasing awareness of the sustainability agenda and issues regarding competitiveness of the European Union in the global economy, poses significant challenges to those responsible for transport policy and investments in transport infrastructure within the EU.

The Consortium, led by WYG International and comprising companies from thirteen countries across Europe, with extensive experience in transport planning, railway engineering and intermodal transport matters was appointed in 2007 to undertake the FERRRMED Global Study. A number of component analyses have been completed and strategic proposals made for the development of rail infrastructure, and operational systems, within the FERRMED Great Axis Network. These, if implemented, will increase rail's share of the long distance inland freight market through improved capacity, regulations, intermodality and interoperability. The conclusions and recommendations of this extensive and complex study are presented here today, along with detail of the major analytical components, namely;

- Supply/Demand Analysis
- Technical Analysis
- Socio-Economic Analysis
- Policy, Legal and Administrative Assessment

On behalf of WYG International, I would like to express our sincere appreciation of the support and efforts of the management and individual consultants of our consortium partners who have participated in these studies.

I would also like to thank the members of the FERRMED organisation for their invaluable advice and guidance during the course of our work. Our final thanks are reserved for Mr Joan Amorós, General Secretary of the FERRMED Association, whose enthusiasm and commitment to this project have been exemplary.

Gordon LAMOND

JACINTO SEGUI
FERRMED President

Once reached the end of the first stage of our Association FERRMED, I would like to express my gratitude to all persons and entities who have contributed to this milestone.

FERRMED Association was established in August 2004 and since then; we have come a long way to carry out the Global Study of the FERRMED Great Axis Rail Network that is presented on 27.10.09 in Brussels. This has been possible thanks to the Members of our Association who believed in the idea, to the European Commission (Directorate-General Energy and Transport) that positively valued our project and given the subsidy. Also to France and Luxembourg the member states that jointly with the regions of Brussels, Andalucia, Catalunya, Murcia and Valencia have institutionally supported the subsidy application.

We have to express, as well our gratitude to the governments of all involved countries that have facilitated, all kind of information required in order to make this Global Study particularly: Finland, Sweden, Norway, Denmark, Germany, The Netherlands, Belgium, Luxembourg, France, Switzerland, Italy, Spain and United Kingdom.

Also, it is important to remark the monitoring support of Belgium Federal government in the Global Study development.

Likewise I would like to thank their collaboration to the members of the Consortium made up of significant European consultant companies that has done the Global Study and everyone in the FERRMED organization who have devoted their time far beyond what is usual in a disinterested way.

To conclude, I would like to thank the support of all the people and institutions that, without being conscious in FERRMED, have collaborated with the diffusion and formation of favorable opinion in general.

This support encourages us continue our task in favor of the multimodal and rail transportation systems improvement all over the European Union.

Jacinto SEGUÍ DOLZ DE CASTELLAR

JUAN CAMARA
Vicepresidente de FERRMED para España

FERRMED asociación privada sin ánimo de lucro, ha concluido uno de los estudios que en buena parte ha sido su razón inicial de ser: el análisis de la red ferroviaria inherente del Gran Eje cuya área de influencia que engloba la mayor parte de la Europa occidental y es su columna vertebral.

Basta decir que esta área de influencia abarca el 54% de la población y el 66% de producto interior bruto de la Unión Europea. En la misma se hallan ubicados los puertos marítimos y fluviales más importantes dado que, conjuntamente, representan más del 80 % del tráfico de contenedores de la Europa de los 27.

En España este Gran Eje se desarrolla a través del Continente del Eje Mediterráneo peninsular que, siguiendo toda la costa desde Portbou a Algeciras, une los puertos de mayor tráfico (el 65% del conjunto de los puertos españoles, sin contar Canarias) con sus arcas logísticas y su radio de acción se extiende por una zona que representa el 50 % de la población, el 50 % de producto interior bruto, el 50% del valor de la producción agrícola e industrial (en este último caso más del 50% si solo consideramos la industria transformadora) y más del 60% de las explotaciones al resto de Europa, con la característica única de la creación de una línea ferroviaria en la Andalucía Oriental.

Con estas cifras queda bien patente la importancia estratégica de este Gran Eje para el conjunto de la Unión Europea y para España en particular.

Probablemente es el primer estudio de alcance europeo desarrollado con criterios estrictamente socioeconómicos ("Business Oriented"), por lo que el valor de sus resultados resulta altamente significativo y determinante para la mejora de la competitividad de la Unión Europea y la de España en especial.

Así mismo hay que agradecer al gobierno Español y a las Comunidades y aportaciones autónomas de Andalucía, Catalunya, Murcia y Valencia por su colaboración en el desarrollo del mismo.

Es de esperar que Las Conclusiones del Estudio sirvan como punto de partida de un plan de inversiones urgentes en Europa y en España concretamente en el Eje Mediterráneo en toda su extensión, de conformidad con las propuestas de FERRMED y que ello conlleve la declaración de Proyecto prioritario por parte de la Comisión Europea, para que en nuestra vieja Europa podamos realizar en el S. XXI una infraestructura norte-sur vertebradora que sea realmente productiva.

Juan CÁMARA

NOEL COMTE
Vice-président de FERRMED pour la France

L'axe ferroviaire de marchandises Rhin - Rhône - Méditerranée occidentale, - l'axe FERRMED - est essentiel pour la France.

Dès la création de l'Association européenne pour promouvoir sa modernisation, un grand nombre d'acteurs économiques et institutionnels, des opérateurs portuaires, transporteurs, chargeurs etc. ... ont adhéré à cette démarche.

L'enjeu pour cet espace économique majeur est de disposer d'un axe ferroviaire massifié, de haute capacité, afin de satisfaire les attentes des entreprises et de leurs clients en matière de qualité, de fiabilité, de traçabilité, de sécurité, et ceci dans une nouvelle approche privilégiant le respect de l'environnement et donc le report modal.

Pour l'Europe, l'enjeu de cet axe requalifié est aussi structurant, car il viendra renforcer les deux entrées maritimes principales pour les trafics Asie - Europe et Amérique - Europe à travers les ports de ses deux façades maritimes Méditerranée et mer du Nord en offrant de plus, au niveau des Alpes, une connexion Ouest Est vers l'Italie et au-delà.

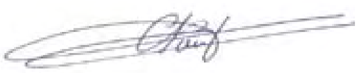
Pour la France, la dynamisation de ce grand axe ferroviaire Nord Sud est un argument supplémentaire pour améliorer de manière substantielle l'infrastructure : possibilité de recevoir les futurs standards de trains fret, traitement du nœud ferroviaire lyonnais, véritable verrou sur l'axe, résorption des goulets d'étranglements Dijon, Nîmes, Montpellier, desserte de Marseille/Fos, extension et création de terminaux intermodaux..Etc. Autant de recommandations qui figurent dans l'étude.

Pour les professionnels de la logistique que je représente, la démarche FERRMED est l'occasion de montrer que cet axe modernisé et opéré dans des conditions compétitives offre une réelle alternative au mode routier pour le trafic de longue distance. La montée en puissance de l'autoroute ferroviaire Bettembourg Perpignan est là pour le démontrer.

Moderniser cet axe européen, c'est aussi donner de nouveaux atouts à la filière logistique, déjà très développée dans cet espace économique. C'est vouloir créer de la valeur ajoutée, donc de la richesse pour les territoires, dans une logique de développement durable.

Je suis particulièrement satisfait de constater que la réflexion FERRMED s'inscrit dans le cadre de la volonté du Gouvernement français de développer la part du fret ferroviaire annoncée dans le Grenelle de l'environnement et confirmée par les investissements prévus dans le plan de relance du Fret ferroviaire ainsi que dans le plan de la SNCF.

Noël COMTE



Victor SCHOENMAKERS
FERRMED Vice-president for the Netherlands

Working together on Europe.

Ports are essential hubs in the European Union. With a throughput of 4.32 billion tons the European ports provide the gateways to the European market with more than 500 million consumers. European ports play a vital role in strengthening the competitive position of the EU.

European ports are focussing on three main themes to maintain and strengthen their position as industrial and logistic hubs. In the first place they need space for their future development so they can accommodate the growth of trade to and from Europe. Secondly each port has to assure that it is easily accessible. Both targets have to be realised in a sustainable way

In regards to the accessibility theme the FERRMED initiative is of high importance to the European ports and their connections to the European markets. High quality hinterland networks are important for the European ports since the quality of the hinterland network is crucial for the overall efficiency of the supply chain to the clients in the hinterland.

The development of priority corridors contributes to Europe's competitive strength. The Trans European Networks (TEN's) contribute towards transports within Europe since 1993. The TEN's will also continue to fulfil an important role in the future with regard to the competitive strength of the Union. The basic principle of this policy should be a market-oriented network with consideration for promising connections and links including seaports.

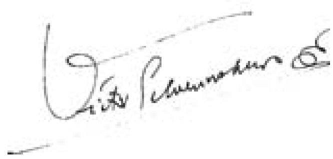
Interoperability must be the basic principle of rail movement between the countries. A shared vision on the development of priority corridors, the improvement of coordination in the construction, management and use of infrastructure is necessary for the rail sector to grow. European coordinators for the priority corridors provide an important contribution in this perspective.

The European Union has an important role to play in stimulating the growth potential of European rail traffic by accelerating the liberalisation of the European rail sector, by passing relevant legislation and by imposing standardized rules and regulations where required.

The FERRMED initiative is important for the future of European rail freight sector, since the FERRMED standards help to improve conditions of capacity, intermodality and interoperability of the rail in the Great Axis Network.

This study and its recommendations give valuable input for policy and measurements to strengthen and increase transportation by rail in the European Union!

Victor SCHOENMAKERS



Erich STAAKE
FERRMED Vice-President for Germany

Sehr geehrte Damen und Herren,

ohne Zweifel gewinnt der Güterverkehr auf der Schiene in Europa weiter an Bedeutung. Im Containerbereich ist trotz der aktuellen Verwerfungen bis 2015 mit einem deutlichen Anstieg des Volumens zu rechnen. Nach aktuellen Berechnungen werden sich die Leistungsanforderungen an die Schiene damit nahezu verdoppeln.

Insbesondere im Kontext dieser zu erwartenden Zunahme der Gütermengen gilt es, die noch vorhandenen Leistungsdefizite des Verkehrsträgers Bahn auszugleichen und das bestehende Angebot möglichst optimal an die Nachfragebedingungen anzupassen. Nur über ein langfristig angelegtes Konzept, das alle Stakeholder grenzüberschreitend vereint, wird es gelingen, das System Bahn nachhaltig als leistungsfähigen und zukunftsfähigen Verkehrsträger in Europa zu positionieren.

Vor diesem Hintergrund begrüße ich die Fertigstellung der "Supply and Demand, Technical, Socio-economic and Environmental Global Study of the FERRMED Great Axis Rail Freight Network and its area of influence" und danke allen Beteiligten für die konzentrierte Erstellung. Methodisch sorgfältig und auf breiter Datenbasis erarbeitet, setzt diese Analyse Maßstäbe.

Als FERRMED-Vizepräsident für Deutschland und Vorstandsvorsitzender der Duisburger Hafen AG weiß ich, dass eine engpassorientierte Analyse richtig ist, um effiziente Lösungen zu finden. Wir vom Duisburger Hafen haben uns daher schon früh auf den Verkehrsträger Bahn als integralen Bestandteil von Logistikketten konzentriert und investieren seit mehr als 10 Jahren überproportional in dessen Infra- und Suprastruktur.

Wie die Erfahrung zeigt, stellen insbesondere die Hinterlandanbindungen der Seehäfen häufig das Nadelöhr Nr. 1 dar. Die Tatsache, dass schon heute rund zwei Drittel aller nach Zentraleuropa laufenden Container über die ZARA-Häfen und das entsprechende Hinterland in Duisburg abgewickelt werden, unterstreicht dies eindrucksvoll. Hier stellt auch die Studie unmittelbaren Handlungsbedarf fest.

Praktiker wussten von Anfang an, dass die Einhaltung der Ferrmed-Standards eine entscheidende Grundlage für den Erfolg des Verkehrsträgers Bahn in Europa ist. Die vorliegende Studie stellt jetzt diese Forderungen auf eine breite Basis und gibt der Entwicklung eine wichtige wissenschaftliche Grundlage.

Jetzt geht es darum, die erarbeiteten Handlungsempfehlungen in die Tat umzusetzen. Hierbei wünsche ich uns allen viel Erfolg.

Erich STAAKE

Joan AMORÓS
FERRMED Secretary General

The "Supply and Demand, Technical, Socio-economic and Environmental Global Study of the FERRMED Great Axis Rail Freight Network and its area of influence" is now completed. This is the crowning achievement of more than two years of hard work for the Consortium which was selected by FERRMED to carry it out but also for the FERRMED Technical Working Group which has closely followed the Study development.

Within my former duties as Director General of Programming and Supply and Executive Director of Purchases of NISSAN MOTOR IBERICA, I have experienced the numerous difficulties raised by the rail freight transport in Europe: lack of reliability and flexibility, high costs and long lead time. If Europe wants to succeed in tackling the challenge posed by strong competition from abroad it must be competitive and cohesive, improving the Added Value Global Chain through the R+D+4i philosophy in a sustainable way. Due to its high impact on the global logistic system, rail freight transport must be a key component in the European agenda.

These are the reasons why with the help of other business, logistics and shipping professionals, we decided to create the FERRMED Association in 2004 and to launch the FERRMED Global Study in 2007.

The overall objectives of that Study are to match freight transport Supply and Demand during the period 2005-2025 in the FERRMED Great Axis Network area of influence and to formulate recommendations aiming at optimising traffic between the different modes of transportation, with a view at taking up 30% to 35% of the inland traffic onto rail and improving management systems and railway infrastructures for freight transport.

Regarding the Demand, the economic development and opportunities of all activity sectors and the impact of different transport modes for the period 2005-2025 has been analyzed. Concerning the Supply, different scenarios have been considered, particularly: Reference Scenario (all improvement plans duly committed by Member States); Full FERRMED Scenario (full implementation of FERRMED Standards by 2025); Intermediate FERRMED Scenario (partial implementation of FERRMED Standards by 2025).

On the basis of this data, the traffic in the different modes of transport has been analyzed and, in the case of rail transport, examined, line by line in the FERRMED Great Axis Network area of influence. Railway bottlenecks have been detected and corresponding countermeasures presented. Besides, on the basis of the forecasted traffic, the FERRMED Great Axis Core Network and main feeders have been identified as a high priority rail freight network, as well as the main intermodal terminals and large-cities by-passes.

Finally a Cost Benefit Analysis was undertaken, estimating the economic benefits for the society as a whole. A Financial Analysis was developed including general criteria for Public Private Projects. The results of the Global Study clearly determine significant economic profitability for the development of the FERRMED Great Axis Rail Network particularly, in the Core Network and Main Feeders.

In the present report, we duly express the FERRMED PROPOSALS derived of the Global Study, which could be summarized as follows:

- Socio-economic criteria (business-oriented) should be the key factor in defining the rail freight network in the European Union;

- The gradual implementation of FERRMED Standards all over Europe, in order to make rail transportation more competitive;

- Railway coordination management should be implemented in core network and main corridors all over the EU;

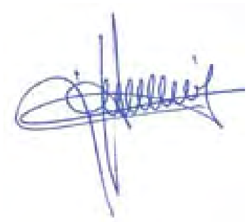
- The urgent implementation of the corresponding improvement actions in the FERRMED Great Axis Core Network and Main Feeders, due to its positive impact on the EU competitiveness and environmental targets.

- The declaration of EU Priority Project for those lines of FERRMED Great Axis Core Network that still do not have this acknowledgement.

The Global Study has been developed thanks to the economic and technical support of the European Commission and several national and regional governments. On behalf of FERRMED Association, I would like to express my warm gratitude for their contribution and their trust in FERRMED philosophy and actions.

Finally, I shall particularly thanks the FERRMED Advisory Council highly qualified transport professionals, who reviewed the Studies; the Federal Government of Belgium for monitoring the study and for their encouragement; the international Consortium that has elaborated the Study, all FERRMED members for their continous support and hundreds of professionals in the whole of Europe who helped us to reach this date.

Joan AMORÓS



INTRODUCTION

What is FERRMED?

At the dawn of the 21st century, the European Union faces extraordinary challenges. The urgent need to increase the efficiency and competitiveness of our economy -- in view of fierce competition from abroad -- coupled with the need to bring cohesiveness to an enlarged Union of twenty seven member-states, with almost 500 million inhabitants, and to ensure the sustainability of our environment, society and values, call for decisive measures.

Central to these challenges is freight transport. We need a freight transport system that is more efficient, effective, competitive, environmentally friendly, reliable, encompassing and safer than the system we have today.

Until the first half of the 20th century, rail freight transport was one of the main pillars of the European transport system. This changed in the second half of the 20th century, due to the growth in road transport. The strategic importance of rail freight transport has resurfaced due to its relatively larger freight carrying potential capacity and its efficiency in terms of energy use, low greenhouse emissions and generally low environmental impact, as recognized by the public and the private sector.

Recognizing the necessity to shift freight transport from road to railways as well as to achieve system interoperability, the European Union has issued a significant amount of legislation and regulations since the 1990s on rail transport policies and standards that is still in the process of being adopted by Member States.

The private sector has an important role to play in the process of reconstructing a rail freight transport system that responds more efficiently to the needs of trade, industry and services, as well as instrumental in the adoption and implementation of harmonized rail freight policies and standards in the European Union.

Having these challenges and alternatives in mind, FERRMED was founded in Brussels on 5 August 2004 as a non-profit association which seeks to enhance European competitiveness and sustainable development by improving rail freight transport. Today FERRMED is supported by 143 members, including key business institutions and private companies from all over Europe and North Africa.

FERRMED Objectives

Consistently with the objectives pursued by the European Union, FERRMED advocates, supports and promotes the following main objectives:

- to promote the creation of the Great Axis Rail Freight Network Scandinavia – Rhine – Rhone – Western Mediterranean;
- to promote the implementation of the FERRMED Standards (see box 1) in the EU and neighbouring countries rail networks;
- to improve intermodal freight transportation – railway being one of the modes – all over the EU and its neighbouring countries;
- to improve ports and airports rail connections with their respective hinterlands;
- to contribute to a more sustainable overall development through the reduction of pollution and green house gas emissions
- to stimulate European competitiveness through the continuous improvement of the global/multimodal chain of added value in the European Union and its neighbouring countries;

Box 1 - The FERRMED Standards

Interoperability is key to improve the competiveness of rail freight in the EU. To this end, FERRMED proposes a set of standards which, albeit ambitious, could be gradually implemented:

1. **A EU reticular and polycentric network** with a great socio-economic and intermodal impact (comprising of three great North-South and three great East-West Trans-European axes, jointly with their corresponding subsidiary main feeding lines).
2. The main branches of the axes should have:
    a. **Electrified** (preferably 25.000 volts) **conventional lines with double track, giving priority or exclusiveness to common freight traffic** suitable for trains with per **axle load of 22,5 ÷ 25 tons**.
    b. **High performance parallel lines available for exclusive or preferential use of passenger and light fast moving freight transportation** properly connected with the main airports network.
3. **Width of the tracks**: UIC;
4. **UIC C loading gauge**;
5. **Freight trains length reaching 1,500 meters with loading capacity from 3,600 to 5,000 tons**;
6. **A maximum slope of 0, 012** and limited ramps length;
7. **Availability of a network of intermodal polyvalent and flexible terminals** with a high level of performance and competitiveness, based in the harbors and main logistic nodes of the great axes;
8. Usable length of sidings and terminals for 1500 m. trains;
9. **Unified management and monitoring systems** by main branches of every great axis;
10. **ERTMS system** with "two ways working" along the tracks;
11. Availability of capacity and **traffic schedules for freight transportation "24 hours a day and 7 days a week"**;
12. **Harmonization of the administrative formalities and the social legislation**;
13. Transport system management shared with several rail operators (**free competition**);
14. **Favourable and homogeneous fees for the use of infrastructures**, bearing in mind the socioeconomic and environmental advantages of the railway;
15. **Rail freight management philosophy based on the principles of the "R+D+4i"** (Research, Development, innovation, identity, impact, infrastructures) in the rail freight network, as an integral part of the global chain of added value;
16. **Reduction of the environmental impact of the freight transporting system** (particularly noise, vibration, and CO2 emissions) as a result of the retrofitting old railway rolling stock, infrastructural solutions where needed, and an increase in the share of the rail in long distance land transport up to 30÷35%;
17. **Locomotive and wagon concepts adapted to infrastructure FERRMED Standards**

What is the FERRMED Great Axis Rail Freight Network?

The FERRMED Great Axis Network– also known as "Red Banana", due to the shape of its area of influence (see Illustration 2) -- is the focus of the FERRMED standards. This Network interconnects the most important maritime and fluvial ports, the most important economic regions and the main East-West axes of the European Union, spanning over more than 3,500 kilometres from Stockholm and Helsinki to Algeciras and Genoa, crossing 13 countries (Belgium, Denmark, Finland, France, Germany, Italy, Luxembourg, Netherlands, Spain, Sweden, United Kingdom, Norway and Switzerland), encompassing Northern and Baltic Sea basins with Western Mediterranean coasts. The FERRMED Great Axis would have direct influence over an area that concentrates 54% of the EU population and 66% of its GDP. In addition, it would link the EU to Russia, through the connections with the Western end of the Trans-Siberian Railway in St. Petersburg and Finland, and with the North of Africa.

Illustration 2 - Map of FERRMED Great Axis Rail Network

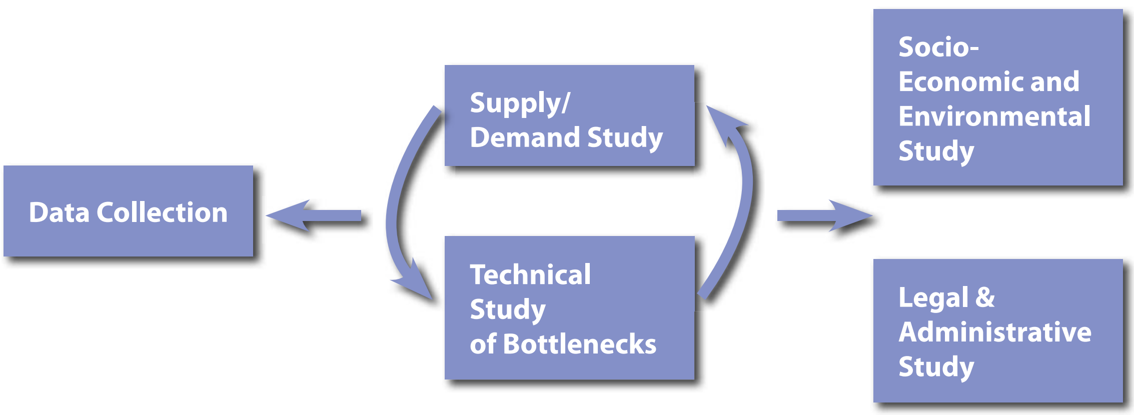
What is the FERRMED Global Study

A comprehensive "Global" Study has been undertaken in order to define a high priority rail freight system and to assess the feasibility of the implementation of FERRMED Standards in the FERRMED Great Axis Network. The Study targets "to match Freight Supply and Demand during the period 2005 – 2025 in the FERRMED Great Axis area of influence and to optimize traffic between the different modes of transportation with a view at taking up to 30% to 35% of long distance inland traffic by rail by implementing FERRMED Standards and improving the conditions of capacity, inter-modality and interoperability of the rail in this Great Axis Network".

The Specific Objectives of the Study are:

- To assess and characterise, in a quantitative and qualitative manner, the demand and supply of different modes of transport along the Great Axis Area of Influence from 2005 until 2025.
- To undertake a detailed analysis of the rail infrastructures in the Great Axis Rail Network, the major interconnection branches and the complementary inter-modal terminals, the operational conditions, the environment, the FERRMED standards and new transport methods in order to match supply with the demand.
- To define precisely the benefits of modernisation of the FERRMED Great Axis Rail Network and to determine the necessary investments and the forecasted cost-efficiency. The study will analyze the socio-economic and environmental impact of carrying on (or not) the modernization of the FERRMED Great Axis Network.

The Global Study activities can be summarized as follows:



Data on the railway network was collected preliminary by country experts. This data serves as a base for the technical analysis and the other studies

Based on the railway data collected, the technical study was performed. It analyses the upgrade to the future FERRMED-network.

In order to address the fact that traffic demand depends on existing railway infrastructure the technical study was performed in parallel with the supply/demand study as an iterative process.

The outcome of the technical study serves as an input for the Socio-Economic and Environmental Study

Illustration 3: Global Study Components

The Global Study has been carried out over a period of 26 months by a Consortium of 12 consultancy firms from 10 European countries, led by WYG International (UK), including SENER (Spain), INEXIA (France), DORSCH GRUPPE (Germany), STRATEC (Belgium), WSP (Sweden), RINA INDUSTRY (Italy), GESTE-Engineering (Switzerland), NTU (Denmark), SIGNIFICANCE (Netherlands), PROGTRANS (Switzerland) and WYG Consulting Group (UK).

Preparation of the Global Study has been closely monitored and supervised by the Secretary General of FERRMED and Technical Working Group[1], with the support of the Brussels based consultancy firm TAS Europrojects. The Federal Government of Belgium and the TEN-T Executive Agency have followed and commented on the study's preparation on behalf of DG TREN at the European Commission -- who has provided a significant part of the funding. Additional funding has been provided by the Governments of France and Luxembourg and the Regional Governments of Brussels, Andalucía, Catalunya, Murcia and Comunitat Valenciana.

This book has been prepared on the occasion of the FERRMED Conference on October 27th 2009, in Brussels. It presents a summary of main findings, conclusions of the Global Study as well as FERRMED´s recommendations based on the Global Study.

[1] Technical Working Group is formed by 36 FERRMED members including main manufacturing companies, ports authorities, chambers of commerce, etc.

1. EXECUTIVE SUMMARY

Overview of the Global Study

The Global Study is an initiative of the FERRMED Association, supported by the EC and several European national and regional Governments with a view to contributing to improve EU railway freight transportation system. It was undertaken by a consortium of European consulting companies over a period of more than 2 years.

The Study is a business-oriented analysis of the social, economic, financial and technical viability of the FERRMED Great Axis Rail Freight Network. This Network, connecting all EU primary economic regions with the main sea and inland ports, comprises 20.562 km (in 2005) of railways, including a core network and main feeders, from Helsinki/Stockholm to Algeciras through 13 Member States. In its present condition, this Network transports an estimated 266 billion of tons km per year.

The Study identifies the infrastructure, technical, institutional, legislative and regulatory actions required, and the financial alternatives initially available, to upgrade the FERRMED Great Axis Rail Freight Network into a harmonized, interoperable, profitable, competitive, efficient, safe and sustainable rail freight network, which would be consistent with EU transportation interoperability policies, legislation and regulations. The resulting increase in the total amount in goods transported would be to 524 billion of tons km per year by 2025.

The Study takes into account four main supply scenarios:

- Reference: includes the infrastructure master plan scheduled for the appraisal period by Member States government.
- Medium FERRMED: FERRMED standards implemented at medium level.
- Full FERRMED: FERRMED standards implemented at high level.
- Full + FERRMED: FERRMED standards implemented at their maximum.

The Global Study includes the following analyses:

- The transport supply and demand for the FERRMED Network from 2005 to 2025, including a section by section analysis of traffic and line capacity, and an origin-destination matrix. To carry out this assessment, the Study relied on Trans Tool, a modelling tool funded by the EC, and additional models, including a specific model for European ports, all fed with information provided by EC publications, including socio-economic variables and transport forecasts, as well as Member States investment plans in the transport sector.

- The rail infrastructure of the FERRMED Great Axis Rail Network in order to determine the feasibility of implementation of the FERRMED standards; to identify the core network, main line and feeders; to identify the infrastructure bottlenecks, to estimate the investments needed for a different speed of implementation of the FERRMED Standards and the resolution of bottlenecks.

- The socio-economic, financial and environmental costs and benefits, in the form of "savings" produced by a shift in modal transport from road to rail and by a lower environmental impact, in the FERRMED Network area from 2016 to 2045;

- EU and Member States rail transport policies, legislation, regulations and technical standards, that have an impact on the harmonization and interoperability of freight transport by railway, including proposals for their improvement.

The Global Study considers the development of the FERRMED Great Rail Axis Network under four main scenarios[1] :	Minimum level of investments	Planned investments until 2025	Investments for bottlenecks solution	FERRMED Standards Implementation	Investments for large cities by-passes
Reference Scenario (RS)	X	X	X		
Medium FERRMED Scenario (MFS)	X	X	X	X	
Full FERRMED Scenario (FFS)	X	X	X	X	X
Full+ FERRMED Scenario (F+FS)	X	X	X	X	X

FERRMED Standards	**Medium FERRMED Scenario**	**Full & Full + FERRMED Scenarios**
1. Signalling	ERTMS 1	ERTMS 2
2. Train length	750 m	1500 m in core lines and main feeders
3. Creation of new terminals and expansion of existing ones	Medium capacity	High capacity
4. Upgrade of the maximum axle load	22.5 tons/axle and new lines 25 tons/axle[2]	
5. Homogenization of the tracks width to UIC standard of 1435 mm	UIC width from France to Almeria	UIC width from France to Algeciras
6. Liberalization of the rail freight market	Included	
7. Reliability and Quality	Consequence of the other standards	
8. UIC C standard loading gauge for new lines and line renovation	Included	
9. Two parallel lines in the core FERRMED Network	Included (when needed)	
10. Increase of freight train priority	Included[3]	
11. Slope limitation to 12 ‰ for new lines	Included[3]	
12. Electrification	Included	
13. Gradual renewal of rolling stock	Included	

[1] Two additional scenarios have been analysed by the Global Study to take into consideration "forced" North South port distribution growth and the achievement of inland long distance freight rail share of 35%.

[2] The Full+FS considers the gradual upgrade of the main lines to 25 tons/axle load, UIC C loading gauge and implementation of automatic couplings in wagons and most of locomotives.

Global Study Main Conclusions

1. All the EC policies, legislation and regulations since 2001, including the TEN-T 30 Priority projects, and all investments in transport scheduled by national and regional authorities of the Member States of the FERRMED Network combined would only freeze the trend at which the rail sector has been losing its transport market share to road transport during the last 50 years (14% of inland freight transport in the FERRMED Great Axis Rail Network countries[4] in 2025 and 20% in the long distance inland transport[5]). More is needed to implement the EU policy of shifting transport from road to railways to improve European socio-economic and environmental conditions.

2. Upgrading the FERRMED Great Axis Rail Network, implementing the FERRMED Standards and eliminating the institutional, legislative, infrastructural and technical bottlenecks should increase the transport share of railways to 17% of all inland freight and 24% (more than 500 km) - 28% (more than 1,000km) of all long distance transport by 2025, reversing the trend of road transport share growth and capturing a broad range of socio-economic and environmental benefits for Europe.

3. The socio-economic benefits of upgrading the FERRMED Great Axis Rail Network and implementing the FERRMED Standards contribute to European industrial competitiveness through lower costs and a better environment. The Study shows that, after the proposed investments and actions, the FERRMED Network is feasible and sustainable from an economic, social and environmental perspective:

- Under the MFS, EUR 130 billion in investments until 2025 should generate EUR **150 billion in savings in vehicle operational costs (VOC), EUR 41 billion in savings in travel and transport time and EUR 12 billion in savings in accident and environmental benefits** from 2016 to 2045. The Economic Internal Rate of Return (EIRR) under the MFS, based on socio-economic and environmental costs and benefits, is estimated at **4.97%**, in line with profitability benchmarks for these types of projects in Western Europe (3 to 5%).

- Under the FFS, EUR 177 billion in investments until 2025 should generate EUR 194 billion in savings in VOC, EUR 284 billion in savings in travel and transport time and EUR 15 billion in savings in accidents and pollutant emissions from 2016 to 2045. The EIRR under the FFS, based on socio-economic and environmental costs and benefits, is **11.09%**.

- The F+FS requires EUR 210 billion in investments until 2025 with an expected EIRR of **8.85%**.

[4] Twln tons.km.

[5] Traffic of trips of more than 500 km.

	2025 Medium (Total in M €)	2025 Full (Total in M €)	2025 Full+ (Total in M €)
1. Bottlenecks solving	21 105	17 131	17 131
2. FERRMED Standards Implementation			
Track gauge	*1 871*	*3 841*	*5 246*
Loading gauge	*8 769*	*8 769*	*8 521*
Rolling motorway	*915*	*915*	*915*
Axle load	*164*	*164*	*19 565*
Train length	*30 606*	*42 425*	*46 457*
Electrification	*596*	*596*	*596*
	42 920	56 709	81 299
3. By-passes in large cities	11 000	11 000	11 000
4. New lines (Spain)	0	16 360	16 360
5. Electric reinforcement (substations)	561	724	1 051
6. ERTMS Implementation	7 518	14 296	18 296
7. Rolling stock automatic coupling	4 210	7 365	10 275
8. Spanish rolling stock to UIC track width	355	630	840
9. Ports and Terminals	42 000	51 700	51 700
10. Noise barriers	1 009	1 848	2 783
TOTAL investments in M €	**130 677**	**177 764**	**210 735**

4. The positive EIIR of the Full FERRMED Scenario indicates that increasing competitiveness of rail freight would cause a sharp shift in modal transport. This implies that economic results will increase significantly provided that investments undertaken goes beyond the threshold marked by investment for the implementation of the FERRMED Standard and resolution of bottlenecks.

5. Most of the investments required to upgrade the FERRMED Great Axis Rail Network will be allocated to achieve rail freight harmonization and interoperability. As a comparison, TEN-T Priority Projects require total investments of about EUR 600 billion until 2020.

6. The Study has identified institutional, legislative and technical bottlenecks at the EU and Member State levels, assessing appropriate alternatives to address and eliminate them. A total of 29 infrastructure bottlenecks were found under the Reference Scenario.

7. The investments in infrastructure in the FERRMED Great Axis Rail Network, without consideration of all social, economic and environmental benefits of the project will require EC and Member States financing support over the period of the financial analysis (2013-2045). The financial structure should be such as to attract also the participation of equity investors, lenders and providers of guarantees from the private sector. PPP financing alternatives should be particularly important to finance infrastructure such as city bypasses and terminals.

8. Transport in the Study area is expected to grow about 61% in ton km until 2025 due to increased economic activity. If no actions to develop and implement alternatives are taken, the increased traffic volume will be translated into increased road traffic, with the additional consequences that the goal of reducing greenhouse emissions by 20% in 2020 would be compromised and road congestions would increase since key highways and large city rings in the FERRMED Great Axis Rail Network area are not ready to absorb this additional road traffic.

9. The rail freight traffic in the FERRMED Great Axis Rail Network would practically double in ton km to achieve a market share of about 24-28 % for long distance freight in 2025. With additional public policy support, the FERRMED Network could reach 30% to 35% of inland long distance freight rail transport market in later years. According to the line capacity assessment undertaken in the study, investments proposed under the Full FERRMED Scenario will be able to respond to this additional rail freight traffic.

Main Recommendations

The FERRMED Great Axis Rail Network project would be a major contribution from the European private sector to implement the EC policy of harmonization and interoperability of the European rail transport system as established in the 2001 White Paper and the 3 Railway Packages of 2001, 2004 and 2007. **The 100-project action plan of this Study proposed by FERRMED Association in Chapter 3 as consequence of this Study, includes 15 essential points:**

1. Upgrading the FERRMED Great Axis Rail Network, implementing the FERRMED Standards and adopting the FERRMED Core Network and main feeders as an EU priority rail network under TEN-T, with a total proposed investment of EUR 178 billion (FFS) until 2025.

2. **Address and eliminate institutional, legislative and technical bottlenecks to the harmonization and interoperability of the FERRMED Great Axis Rail Network** with total investment of EUR 28 to 32 billion until 2025[6] for solving the infrastructure bottlenecks and city bypasses.

3. **Use of mixed conventional lines with parallel high speed lines (HSL)**. In the FERRMED core network, double track (2x2) is required in all its extension. One should be dedicated to fast moving trains (passenger and light freight) and the other to conventional speed trains (mixing freight trains with regional passenger trains). The study shows that if this is accomplished, there is still capacity in existing lines for additional freight traffic. A balanced approach should be used to establish priorities for passenger and freight trains. Dedicated lines could be required in large cities by-passes and HSL main lines in sectors with an existing single line (as is the case in Tarragona-Castelló).

4. **Build rail by-passes in large cities.** Capacity and traffic schedules for freight transport 24 hours a day and 7 days a week requires by-passes for free crossings over nodes and large cities, specifically in the cases of Hamburg, Koblenz, Karlsruhe, Brussels, Paris, Lyon, Lille, Dijon, Barcelona, Valencia, Alacant and Murcia.

5. **Harmonize and reinforce border crossings in the Alps and the Pyrenees**. These crossings are of key importance to upgrade the FERRMED Network. In the Alps new base lines are required between Switzerland and Italy and between France and Italy. The different track width in Mediterranean and Atlantic side crossings of the Pyrenees should be harmonized at international standards sas a first priority action.

6. **Upgrade of Spanish main corridors to UIC width**. The track width should be changed to international standards (UIC, 1435 mm) in the FERRMED Network in Spain.

7. **To build new lines in the FERRMED Core Network** in the corridors which are not interconnection axis as it is the case of Fehmann new fix link and the lines Almeria - Motril, Málaga-Algeciras and Lorca – Granada.

8. **Establish better connections between inland intermodal and industrial terminals, ports and hinterlands and the FERRMED core Network**. These are of key importance to facilitate the flow of freight in the FERRMED Great Axis Rail Network. Special attention should be given to improving these connections as well as to create a network of intermodal public / private terminals in industrial areas of the large cities surroundings

[6] already included in the total investment cited above.

and multimodal communication centres.

One objective of the EC policy is to enhance the capacity of European ports to absorb the intercontinental and shipping traffic growth. The anticipated expansion of EU trade with Asia and North Africa will likely result in increased pressure on Southern ports. The Study recommends a proportional refurbishment of all EU main ports linked to the FERRMED Great Axis Rail Network.

9. **Upgrade of FERRMED Network to UIC GC**. This should be done in 2 steps: before 2025 the network should be upgraded to UIC GB1, less costly in the case of old tunnels. Later, UIC – GC can be introduced gradually during the periodical refurbishment of existing line tracks.

10. **Signalisation**. ERTMS Level 2 should be installed in the rail core network.

11. **Lower gradients:** New lines should be constructed with a maximum gradient of 12‰.

12. **Longer and heavier trains** increase the network capacity and reduce transport costs. Train lengths should be increased to about 750 m in the FERRMED Network and to 1,500 m in the FERRMED core lines and main feeders, allowing the possibility of 3,600 ÷ 5,000 tons of freight capacity by train. New lines should be suitable for 25 tonnes per axle. The 20 tons sections should be upgraded to 22.5 tons/axle in the entire FERRMED Network. The periodical renewal of tracks could be used to gradually convert these lines to 25 tons/axle. New wagon concept with automatic couplings is required.

13. **Electrification**. The railway network should be fully electrified. All new lines must be preferentially at 25Kv.

14. **EC rail transport policies**. The adoption of EC policies, legislation, regulations and technical standards on rail transport by Member States should be accelerated, particularly those related to liberalization **and** openness to competition, operational and management standards, regulations and procedures, especially for traffic priority, operational coordination and infrastructure use fees.

15. FERRMED considers that all railway lines included in FERRMED Great Axis Core Network would have to be considered as EU Priority Projects.

2. FERRMED GLOBAL STUDY

1. INTRODUCTION

The FERRMED Study

The present study (or “Global Study” or “FERRMED Study” hereafter) is a complete pre-feasibility study of the whole Great Axis Rail Freight Network (or “FERRMED Rail Network” hereafter), examining all possible issues concerned with the development of the FERRMED Rail Network. It involved an extensive data collection period, followed by the development of the traffic model and the rail network analysis. It recommends proposals to overcome line capacity bottlenecks and ways for the progressive development of the “FERRMED standards” across the study area. The proposals have been valued and entered a cost-benefit analysis in order to compare the “no-FERRMED” to the “FERRMED” scenarios. Environmental considerations as well as policy and administrative issues have been well analysed to come up with concrete recommendations for the future of the FERRMED Rail Network. A thorough market analysis took place, which led to a considerable market opinion exercise, through face-to-face interviews with key players in the market of freight transport. The duration of the study was 25 months, starting from September 2007 and finishing at October 2009.

Study Consortium

The FERRMED Global Study team consists of top European consulting firms, specialising among others in transportation, engineering, environment and planning issues. The main contractor of the study is WYG International, part of WYG Group (UK) and the main members of the study team have been:

- Inexia (FR)
- Sener (ES)
- Dorsch (DE)
- Stratec (BE)
- WSP (SE)
- NTU (DK)
- Rina (IT)
- WYG Hellas (GR) (project management), subcontractor to WYG International

- Progtrans (CH), subcontractor to Dorsch
- Geste Engineegring (CH), subcontractor to Inexia
- Significance (NL), subcontractor to Stratec

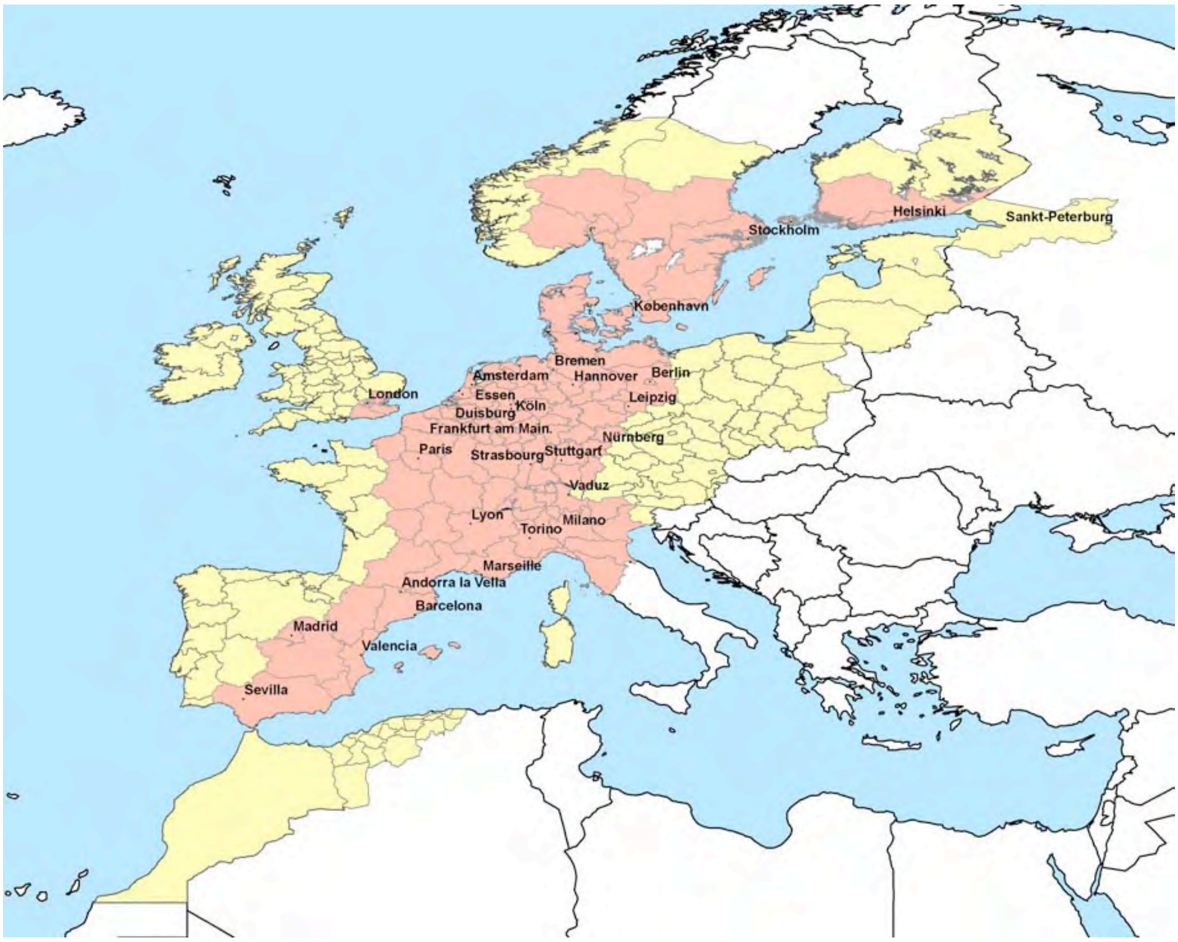
The Study Team has covered geographically the whole of the study area and technically all the possible aspects of railway engineering, planning, transport economics, freight transport and logistics, as well as environmental issues.

FERRMED Great Axis Network catchment area

The areas covered by the FERRMED Great Axis Network, as defined by FERRMED Association, are presented in Figure 1 in red colour. The countries concerned are:

1. Belgium
2. Denmark
3. Finland
4. France
5. Germany
6. Italy
7. Luxembourg
8. Netherlands
9. Spain
10. Sweden
11. United Kingdom
12. Norway
13. Switzerland

Figure 1: FERRMED Study Area



The shape of the catchment area or the FERRMED Rail Network has led to the use of the term "Red Banana', which is used in the Study. The Study area is exactly the whole of the "Red Banana".

<u>FERRMED Great Axis Rail Network definition</u>

The FERRMED Great Axis Rail Network (called FERRMED Rail Network from this point) is the freight rail network included in the "Red Banana" area (Figure 1). It consists of a main trunk from Stockholm (Sweden) to Algeciras (Spain) that includes several branches to Northern Sea ports in Germany, in Netherlands and France. It also includes a branch (considered as main trunk) from Koblenz (Germany) via Switzerland to Genoa (Italy) and from Lyon (France) to Milan (Italy). It also includes further branches to ports of the North Sea, as well as various feeder lines.

In detail, the main trunk's Northern end point is Stockholm (linked with Finland), crosses the straits of Öresund and Fehmarn, and connects all the sea ports of the North Sea and the United Kingdom. It passes through Duisburg then through the Rhine and Rhone valleys and joins up with its two parallel branches that cross the Swiss Alps and Eastern Pyrenees. Thereafter, it continues along the Western Mediterranean coast from Marseille and Genoa until its Southwest end point, which is Algeciras.

Figure 2: FERRMED Great Axis Rail Network (2007)

During the development of the Study, FERRMED Association has decided to expand the FERRMED Great Axis Rail Network to include –among others- parts of the Baltic Sea. The most recent map of the FERRMED Rail Network is presented in Figure 3.

Figure 3: FERRMED Great Axis Rail Network (2009)

All the data, analyses and results of the Study are based on the 2007 FERRMED Rail Network of Figure 2.

Besides the main trunk, all principal lines of the geographical areas concerned are included in the FERRMED Rail Network, with a focus on two parallel branches:

Eastern Branch (Main trunk)

The Northern end of this branch is Duisburg. It continues to Koblenz, then passes through the Rhine-Valley to Mannheim, Ludwigshafen, Karlsruhe, Freiburg, Basel, Bern and Milan, using the Simplon Tunnel, and connects it to its Southern end, Genoa. This branch has also side branches:

- Between Karlsruhe and Basel the route over Strasbourg and Mulhouse.
- Between Bern and Milan the route over Zürich (using the Gotthard Tunnel).
- Between Bern and Genova the route over Torino.
- From Milan and Genoa several routes exist to Central and South Italy.

Western Branch

One end of the Western branch is also Duisburg. It then continues to Rotterdam and thereafter Antwerp, Gent, Lille and Paris, and on to Orleans, Limoges, Montauban and Toulouse, crossing the Pyrenees at Puigcerdà and ending in Barcelona. Side Branches are:

- Between Antwerp and Paris, the route to Brussels.
- From Paris, southwards to Clermont-Ferrand, to the Gulf of Leòn at Nîmes and Béziers.
- From Toulouse to the Mediterranean via Carcassonne and Narbonne.

The main East-West connections are also included within the FERRMED catchment area and they are listed below:

Eastern connections

- From Sweden to Finland and North-Russia.
- From the Netherlands, Belgium, Luxemburg and France to Germany.
- From France to Switzerland and Italy.
- From Germany, Switzerland and Italy to the new countries in the east of the EU.
- From Algeciras to Tanger/ Rabat and Algeria.

Western connections

- From Sweden to Norway.
- From France to the United Kingdom.
- From the Western Mediterranean Coast to the French Atlantic coast, to Central Spain and Portugal.

2. STUDY METHODOLOGY

Introduction

The FERRMED Rail Network Study (or "Global" FERRMED Study) is a Strategic Transport Planning pre-feasibility project, which includes all these elements that need to be analysed before the detailed examination of all those aspects that can make this ambitious Railway Corridor operational, such as:

- Railway infrastructure (new or upgrades of existing)
- Necessary investment
- Operational issues
- Legal and administrative framework
- Environmental concerns
- Economic profitability
- Financing options

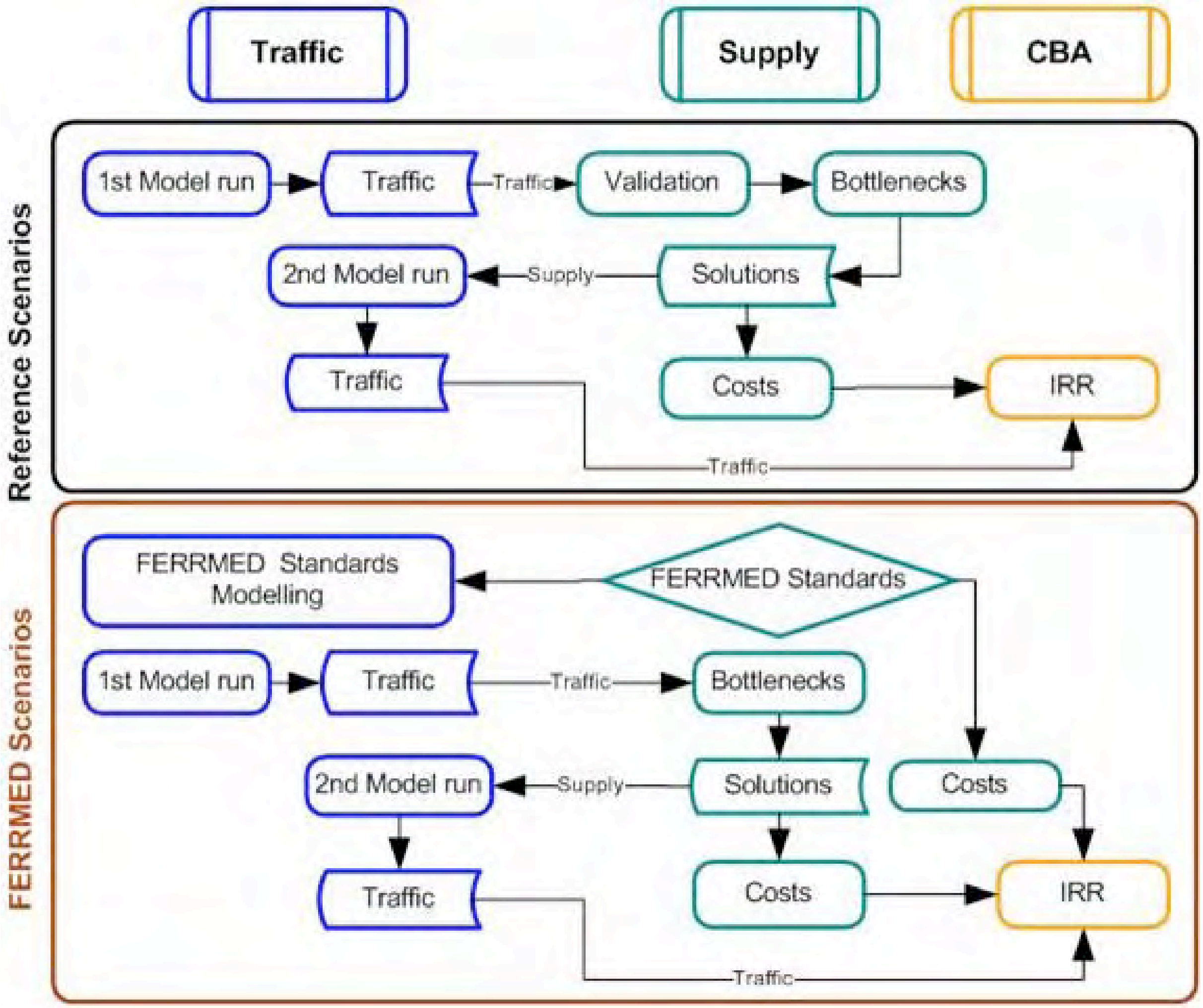
For this reason, the FERRMED "Global" Study was divided by its Terms of Reference in four (4) main modules:

a. Supply/ Demand analysis
b. Technical analysis
c. Cost-Benefit analysis
d. Legal and administrative issue

Other main parts of the Study included in the four modules have been the Financial Analysis / Financing options, the Environmental considerations, the Market Opinion through interviews, the Market Analysis and the Freight Terminals Analysis.

The interaction between the main modules and parts of the "Global" Study is presented below:

Figure 4: Interaction between modules of the FERRMED "Global" Study



The base year has been defined as the year 2005, for which all data have been collected. Horizon (target) years, as requested by the ToR, are 2020 and 2025. Reference scenarios for both the base and the horizon years were created, which have been compared with FERRMED Scenarios.

The study is based on the creation of fourteen (14) scenarios, which are summarised in the table below and analysed later in the report.

Table 1: Summary of Modelling Scenarios Definition

Year	Name	Demand	Transport Costs	Supply	FERRMED Standards
2005	**1. Base year**	2005 Trans-Tools + Calculated	Reference 2005	Existing 2005	-
2020	**2. Reference 1st run**	Freight: 2020 calculated including inland and Maritime. Passengers: 2020 Trans-Tools	Reference 2020	Planned 2020	-
2020	**3. Reference 2nd run Bottlenecks solution**			Planned 2020 + Infrastructural Solutions	-
2020	**4. MEDIUM FERRMED 1st run**		Reference 2020 + MEDIUM	Planned 2020 +MEDIUM	MEDIUM
2020	**5. MEDIUM FERRMED 2nd run Bottlenecks solution**			Planned 2020 +MEDIUM+ Infrastructural Solutions	MEDIUM
2025	**6. Reference 1st run**	Freight: 2025 calculated including inland and Maritime. Passengers: 2025 Trans-Tools	Reference 2025	Planned 2025	-
2025	**7. Reference 2nd run Bottlenecks solution**			Planned 2025 + Infrastructural Solutions	-
2025	**8. MEDIUM FERRMED 1st run**		Reference 2025 + MEDIUM	Planned 2025 + MEDIUM	MEDIUM
2025	**9. MEDIUM FERRMED 2nd run Bottlenecks solution**			Planned 2025 + MEDIUM + Infrastructural Solutions	MEDIUM
2025	**10. FULL FERRMED 1st run**		Reference 2025 + FULL	Planned 2025 + FULL	FULL
2025	**11. FULL FERRMED 2nd run - Bottlenecks solution**			Planned 2025 + FULL + Infrastructural Solutions	FULL
2025	**12. Southern ports enhancement 27% to 35%**	Sea share North-South forced	Reference 2025 + FULL	Planned 2025 + FULL	FULL
2025	**13. FERRMED Objective achieved**	Long Distance (>500Km) Rail share forced 35%	Reference 2025 + FULL	Planned 2025 + FULL	FULL
2025	**14 FERRMED FULL +**	2025 Forecasts	Reference 2025 + FULL	Planned 2025 + FULL+	FULL+

2.1. SUPPLY/ DEMAND ANALYSIS

The main objective of the Supply/ Demand (S&D) analysis is to calculate the current demand in the “Red Banana” and forecast the future demand in order to assess the needs for supply in the future, aiming at:

- Characterising and assessing the potential rail demand in the FERRMED Great Axis Rail Network under different infrastructure and operational scenarios.
- Provide, as a result of the Study, the necessary traffic data to the other parts of the project in order to complete the Technical and Cost-Benefit Analyses.

The required tasks of the Supply/ Demand analysis have been organized in four phases:

- Definition and calibration of a transport model for the base year.
- Prognosis of demand for future years up to horizon years.
- Future supply scenarios definition and iterative process to ensure the inexistence of bottlenecks.
- Results analysis.

<u>Types of traffic considered</u>

The following types of traffic have been considered in the Study:

1. Road passengers traffic:
    a. Regional traffic by personal car and bus.
    b. National traffic by personal car and bus.
    c. International traffic by personal car and bus.
2. Road freight traffic:
    a. Regional traffic by truck and van.
    b. National traffic by truck.
    c. International traffic by truck.
3. Railway passengers traffic:
    a. High speed trains.
    b. Intercity trains.
    c. Regional traffic (commuters).

4. Railway freight traffic:
    a. Container trains.
    b. Single-wagon train.
    c. Block trains.
    d. Rolling motorways.
5. Inland Waterways (IWW) freight traffic:
    a. Standard IWW vessel.
6. Freight sea transport:
    a. Short sea shipping, standard SSS vessel.
    b. International ocean shipping, including intercontinental traffic.
7. Air passenger traffic.

Adopted modelling platform

The use of the **Trans-Tools** modelling software has been selected, mainly due to the following reasons:

- The extent of the Study area.
- The types of traffic to be analyzed.
- The data available.
- The strategic objective of the Study.

Trans-Tools (Tool for Transport Forecasting and Scenario testing) is a transport model developed under European Union funding in order to set the basis for the development of an integrated policy support tool for transport at EU level; therefore Trans-Tools software is the basis for a framework to prioritize and evaluate TEN-T corridors, undertake an impact assessment on socioeconomic and environmental issues, determine the quality of transport service (congestion, accessibility, modal split…) and to identify possible improvements (missing links, new technologies, legislation).

Other reasons that led to the choice of Trans-Tools have been:

- It is the largest and most comprehensive European Transport Model that exists.
- It contains a complete database both of transportation and socioeconomic variables and of networks and services updated to the year 2000, which as updated to 2005.

- It is aimed at being the main tool for transportation modelling in the EU.
- It is a complete four-step model which covers all Europe 27 and is connected to 55 countries.
- It covers all modes, freight and passenger transport.
- It is the largest transport model in the world concerning population and GDP covered.

The technical characteristics of Trans-Tools model, capable of monitoring trends of transport at EU level include the following:

- Zoning scheme that covers the whole EU at a level of detail of at least NUTS II, and preferably NUTS III, and sufficient regional details of neighbouring countries.
- Coverage of the road and rail networks, updated to include any up-to-date network changes.
- Use of a combined passenger/ freight assignment algorithm to estimate transport volume on links.
- Connection of all model zones to the road and rail networks, and definition of road and rail paths to and from these zones.
- Use of updated transport cost and value of time parameters.
- Coverage of transport generated by local traffic activity and served by the links monitored by the model.
- Inclusion of intermodal and logistics chains.

Zoning system

The Trans-Tools model uses a different zoning system to describe the attraction/ generation and the distribution of trips for passengers and freight. This is due basically to the availability and aggregation of datasets. For the passengers model the basic unit of zoning, corresponds to NUTS3 level (province), while for the freight model, the NUTS2 level is employed.

The Trans-Tools model covers all Europe 27 members plus Albania, Belarus, Bosnia, Croatia, Macedonia, Moldavia, Norway, Russia, Switzerland, Turkey, Ukraine and former Yugoslavia. The amount of zones included is 1,269 for the Passengers Model and 278 for the freight model.

Transport networks

The networks for all modes of transport were updated during the data collection phase, both in terms of alignment, as well as topology and link and node characteristics. The following fields have been updated:

- Railway network: Speed, Number of tracks, Length, Class of links, Frequency.
- Road network: Speed, Number of lanes, Capacity, Length, Road class, Toll and Generic cost.
- Inland Waterways network: Speed, Length.

The total number of links and length of the networks contained in the new database for the year 2005 is summarized in the following table.

Table 2: Network characteristics, year 2005

2005 Network	Rail Freight	Rail Passengers	Road (incl. ferries)	Inland waterway
Total links	5.415	5.438	34.615	815
Links in Red Banana	2.660	2.670	17.257	717
Total length of links (km)	161.719	163.326	524.999	22.032
Length of links in Red Banana (km)	60.415	61.741	188.630	16.703
% links in Red Banana	49%	49%	50%	88%
% km in Red Banana	37%	38%	36%	76%

A small amount of mistakes in the 2000 network coding were corrected, caring to respect the homogeneity of the data, and taking into account that the study is focused on main European roads (motorways and dual carriageways), which are used by most of the long distance traffic.

The new distribution per road type is shown in the next table.

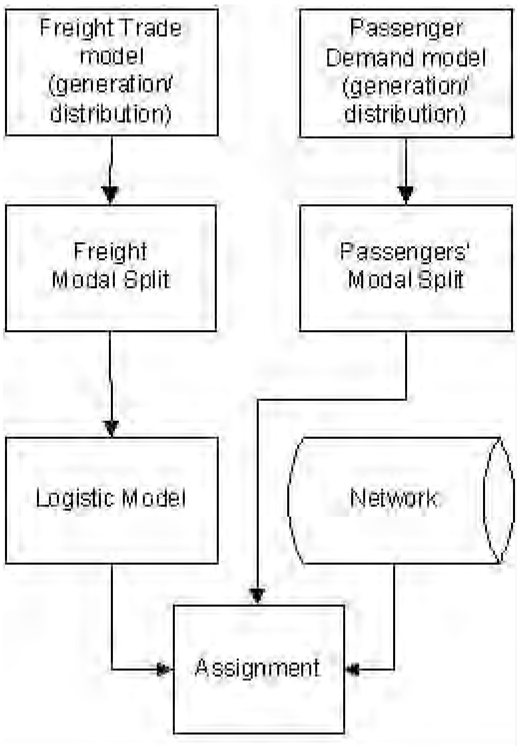
Table 3: Road classification for 2005 road network

Road class	km	%	km (Red Banana)	% (Red Banana)
Motorways and dual carriageways	89.739	17%	47.180	25%
Ordinary roads	353.043	67%	113.191	60%
Urban roads	10.268	2%	5.253	3%
Ferry	71.949	14%	23.005	12%
Total	**524.999**	**100%**	**188.630**	**100%**

Trans-Tools sub-models

Following the four-steps modelling technique, Trans-Tools model contains the first three steps, differentiated for passengers and freight, and finally joined in the last step (assignment to the network), in order to consider the effects due to mutual interaction. Besides freight, there is another model whose task is to introduce the logistic chains effects on modal split. A simplified Trans-Tools flow diagram presenting the structure of Trans-Tools is shown in the following figure.

Figure 5: Trans-Tools structure



The run of the model is an iterative operation that requires high computer performance and long time (more than 48 hours for each simulation). Once the first assignment has been run, the other models must be run in order to consider the network congestion and the changes in costs and level of services, following which the assignment model is to run again.

Trans-Tools weaknesses

Like any model, Trans-Tools software presents certain limitations, and therefore its use is not sufficient to answer all the requirements of the Study. The model has a pre-established catchment area and zoning system, and therefore it has to be run always for all the zones. Moreover, no more zones can be added. This implies various limitations regarding the FERRMED Study requirements:

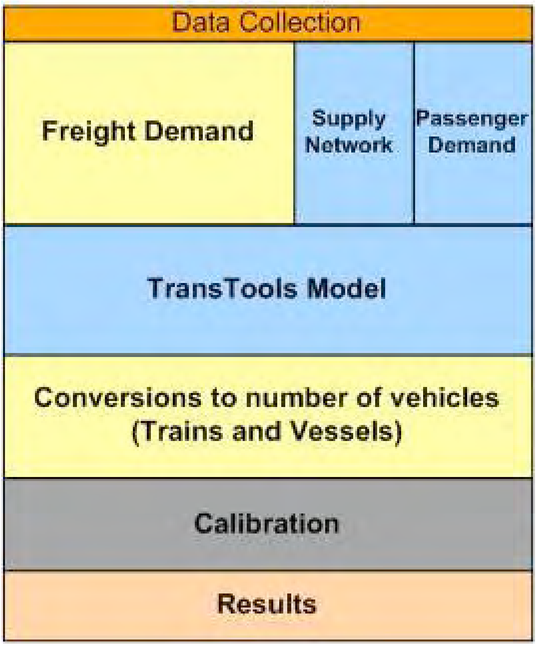
- The FERRMED study area traffic cannot be simulated without running the model for the whole of Europe, resulting in long computing times.
- Ports cannot be modelled as standalone zones in order to separate their behaviour from the zone in which they are already contained.
- The model cannot consider itself the import and export of intercontinental freight flows trough the European sea ports.
- The model is not capacity constrained for railway networks, both passengers' and freight, and the two networks are separated. Furthermore, the output of the assignment model is given only in terms of average tonnes per day for freight traffic and average passengers per day for passenger traffic. Consequently the train traffic must be calculated separately, both for passengers and freight.
- Internal traffic for each zone is not considered by the passenger model, and hence there are no local traffic growth factors and the total amount of commuter traffic is not properly estimated.
- The value of time is common to all Europe although different by trip purpose and NST/R commodity groups.
- The trade model in Trans-Tools provides forecasting of freight flows between production and attraction pairs on NST/R-commodity basis but with unconstrained equations and without consistency between the economic model and the trade flows. Moreover, the resulting matrices are not balanced, which would be necessary to result to equal loaded and unloaded freight by zone for the base year.

Modelling methodology

Due to the limitations listed above, the Trans-Tools model has been complemented with a number of external models.

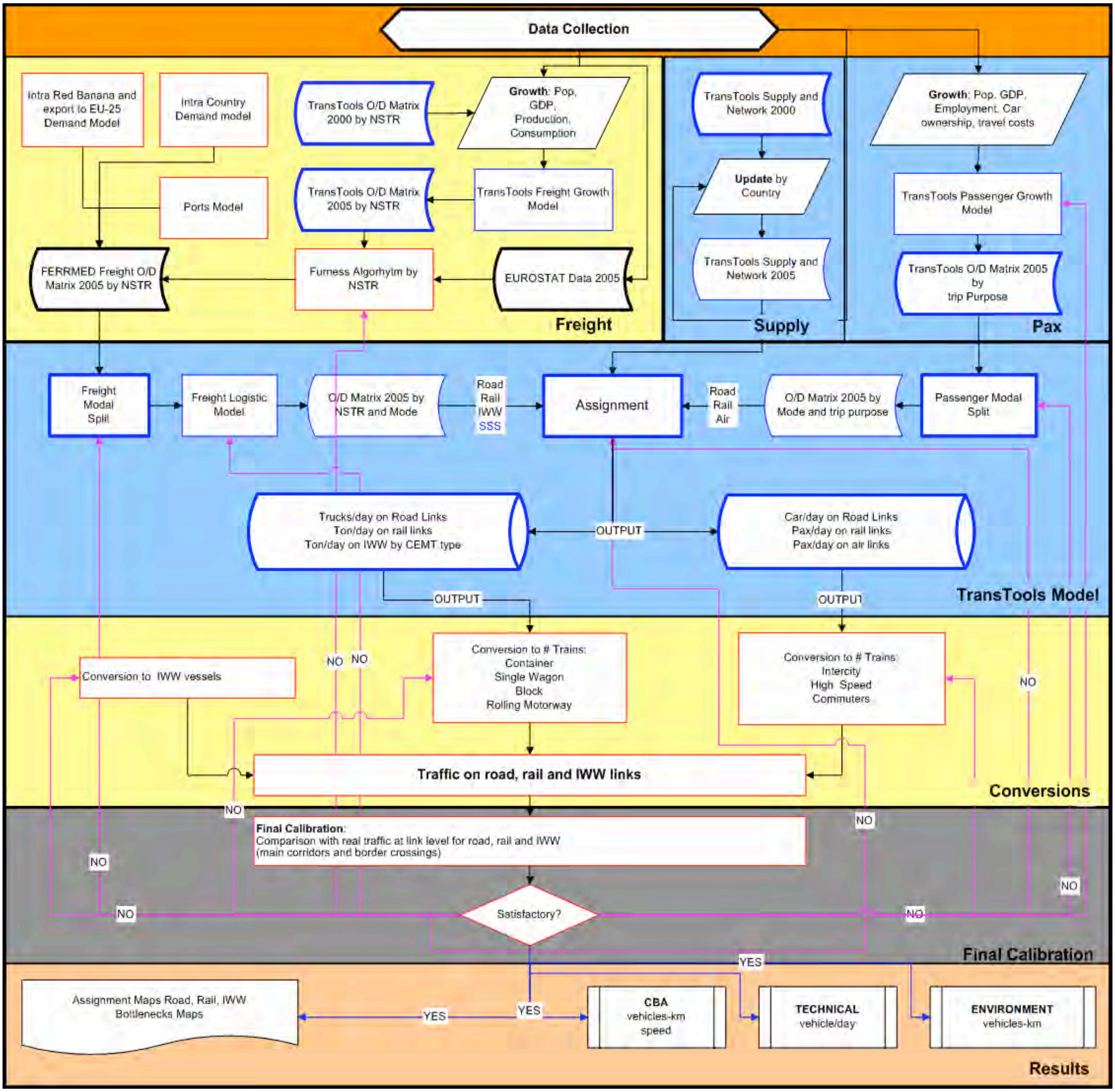
The following figure includes all the models employed. Blue boxes indicate steps executed within the Trans-Tools environment, yellow boxes indicate the use of models external to Trans-Tools, orange boxes constitute data input and grey represent calibration activity.

Figure 6: Modelling structure



The following flow diagram shows the process in more detail, underlining the interchange of data and the sequence of modelling employed. The red outlined shapes indicate actions external to Trans-Tools model, blue represent Trans-Tools sub models, while black are either data input or other actions. Black arrows indicate data flow, violet are feedback loops and blue are data flow when some conditions are satisfied.

Figure 7 : FERRMED base year modelling process (2005)



Demand

The Trans-Tools database was originally updated to year 2000, but the base year for the FEERMED Study is 2005.

Freight demand

The freight demand model of Trans-Tools is complemented with other external models:

1. Intra Red Banana and export to EU 25 for the demand between all the Red Banana countries and export from Red Banana countries to the rest of EU-25. (Figure 8)
2. Intra Country (internal) demand for all the EU-25 countries. (Figure 9)
3. Ports growth and distribution model to consider: the international and intercontinental flows entering the most important EU-25 ports. (Figure 10)

Figure 8: Relations considered by Intra Red Banana and export to EU 25 Freight Demand Model

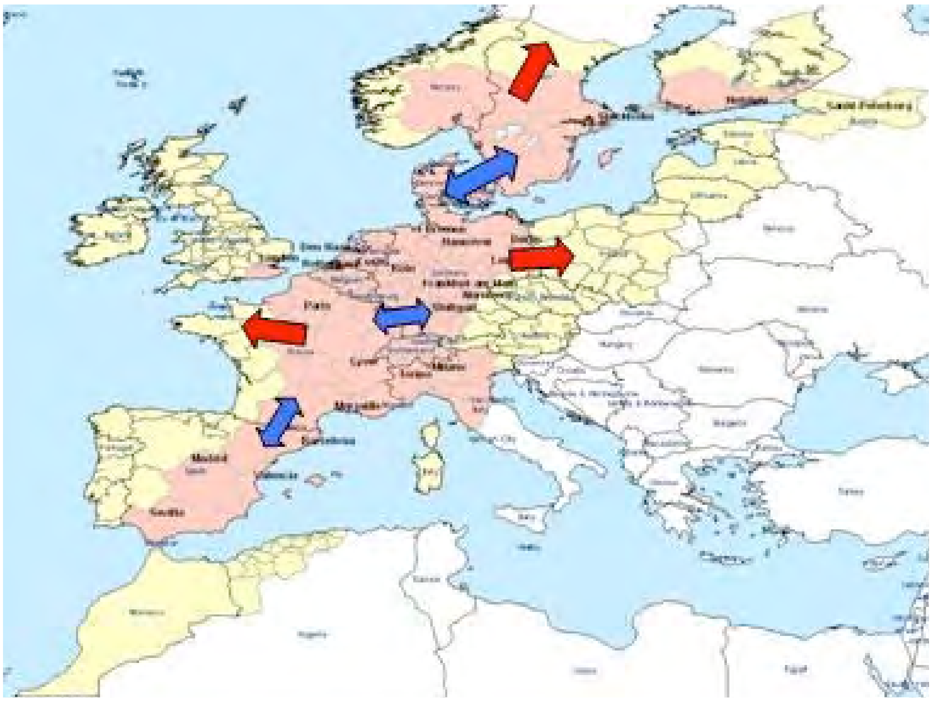


Figure 9: Relations considered by the Intra Country Freight Demand Model

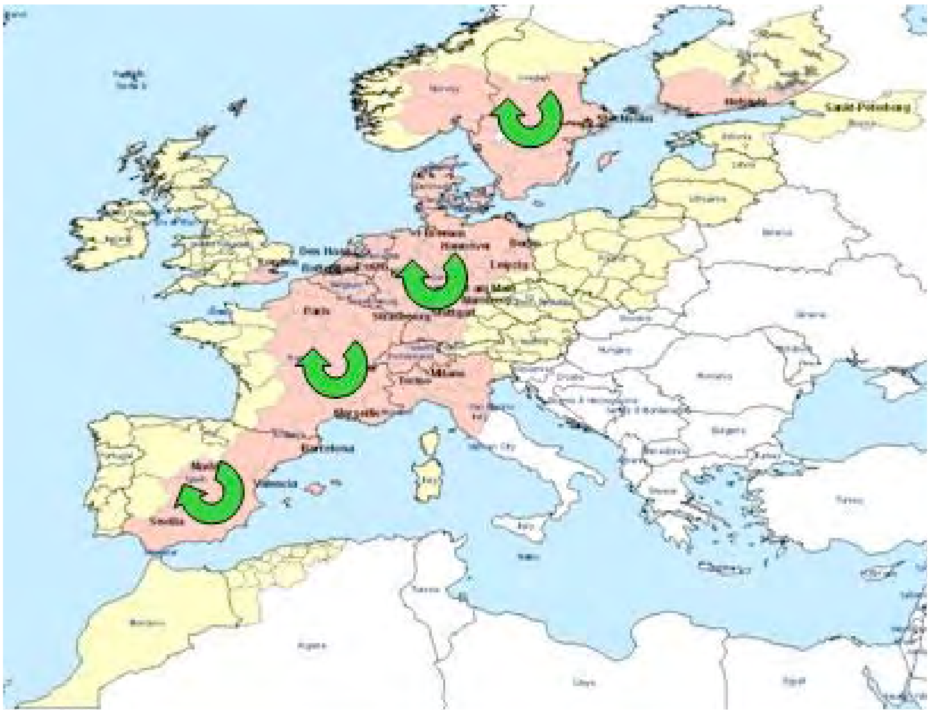


Figure 10: Relations considered by Ports growth and distribution model

The origin-destination matrix for year 2005 was built, based on:

- Loaded and unloaded freight (tonnes) by EU-25 region (NUTS2) per commodity group and mode (EUROSTAT, 2008).
- Total O/D matrix by country (EUROSTAT Statistical books – Panorama of Transport – Edition 2007, European Commission, 2007).

Freight flows have been segmented into eleven (11) commodity groups according to the NST/R classification. Following a series of significance tests to identify the best sets of variables to be employed, the following have been considered:

- Population
- Consumption (€) by country
- National GDP
- Production by economic sector
    - Industry
    - Construction
    - Agriculture
    - Energy
- Distances between countries

Costs

Trans-Tools database contains a complete set of costs and tariffs both for passengers and freight transport, calibrated for its base year 2000.

The passenger assignment and modal split models consider the following component in order to calculate the generalised costs:

- Value of Time VoT [€/h]
- Out of pocket perceived cost

The average VoT values considered by the model are different between trip purposes (business travellers have the highest VoT, vacation the lowest) and mode.

Table 4: VoT by trip purpose (Trans-Tools base year 2000)

VoT (€/h)			
Mode	Purpose		
	Business	Private	Holiday
Road	35,84	8,35	5,56
Rail	35,84	8,90	6,54
Air	48,6	13,8	13,8

Source: TRANS-TOOLS Deliverable 4

For freight transport the most important costs employed by the modal split and the assignment models are the costs depending on Time and Length of the journey (operating costs):

- Time cost, expressed in Euros per hour for a reference load.
- Length cost, in Euros per km for a reference load.

Operating costs include energy, personnel, amortization and maintenance of rolling stock and locomotives, and infrastructure charges. These are considered by NST/R commodity group and by transport mode, taking an average load as a reference cargo, representative of the category.

Time and length costs (operational) have been changed assuming the following (STEPs project, 2006, EC) (Polo Sanchez G., 2006):

- Base year prices (2000.)
- Transport operational costs growth, depending on the costs of fuel or propulsion energy and assuming that:
  - o Crude oil price influences road, IWW and SSS.
  - o Energy price (crude oil, natural gas, coal, and electricity) influences rail.
- Fuel prices grow at half the rate of crude oil for road freight transport, while the growth rate for less refined fuels such the ones employed in IWW and SSS is higher (around 80%).
- Price of electric power employed by rail growth 30% of the rate of energy price.
- The component of fuel is 35% for road freight transport, 25% for IWW and 20% for SSS.

Oil and energy price growth are the ones suggested by the World Bank.

<u>**Local traffic**</u>

In Trans-Tools the freight intra-zonal flows are treated at NUTS2 level, whereas the passenger ones at NUTS3 zones.

In order to model congestion in the network, local road traffic has been taken into account, estimated based on traffic counts, land use (urban, non-urban), population and workplaces. Local traffic on the main network has been "pre-loaded" onto the network, influencing the congestion levels together with the inter-zonal traffic that is assigned by Trans-Tools.

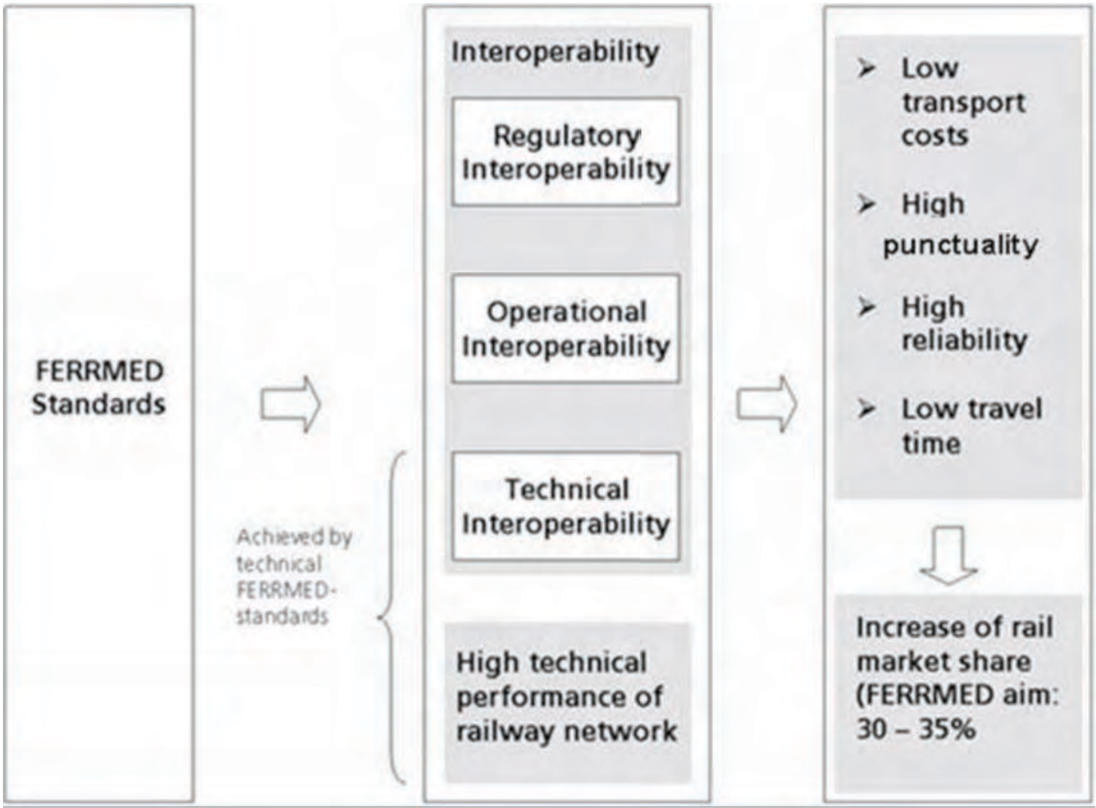
Intra-zonal rail demand (NUTS3) is also not included in the Trans-Tools matrix, thus it is not assigned to the rail passenger network, which in this case is not preloaded with known traffic within the Trans-Tools model.

2.2. TECHNICAL ANALYSIS

FERRMED "technical standards"

The FERRMED Association has proposed the implementation of several standards (referred to as FERRMED "standards") that address interoperability on railway networks and the uninterrupted movement of trains. This is illustrated in the next Table.

Figure 11: FERRMED "standards" and their influence on rail market share



Most of the standards refer to infrastructure limitations. However, rolling stock might impose other restrictions on the standards and interactions between the different standards. Therefore it is not always possible to obtain the maximum limit as defined by the FERRMED Association, even if allowed by infrastructure capability. The FERRMED Study has analysed the feasibility for these "technical standards" to be applied.

Technical FERRMED "standards"

The required by FERRMED Association "technical standards" are the following:

- Width of rail tracks : UIC standard (1,435 mm)
- Loading gauge : UIC C gauge
- Lines suitable for freight trains of 22.5 ÷ 25t per axle.
- ERTMS system with "two way working" along the tracks.
- Electrified lines (preferentially 25.000 volts).
- Train length up to 1,500 meters
- A maximum slope of 12‰ and limited lengths of ramps.
- Conventional lines with double track, giving priority or exclusiveness to freight traffic.
- Train loading capacity from 3,600 to 5,000 tons.
- High performance parallel lines available for exclusive or preferential use of passenger and light fast moving freight transportation connected with the main airport network.
- Sidings and terminals suitable for 1,500 m trains.
- Unified management and monitoring system.
- Availability of capacity and traffic schedules for freight transportation 24 hours a day and 7 days a week.

Technical analysis

The technical analysis aims at proposing ways for upgrading the FERRMED network in order to achieve compliance with the FERRMED "standards" and in order to provide sufficient capacity for additional train traffic. The approach for both cases can be divided into the following steps:

Table 5: Approach of technical analysis

Step	FERRMED standards	Bottleneck analysis
1. Identification of problem	Based on the FERRMED database any non-conformity to the FERRMED "standards" is identified.	Future bottlenecks are identified based on forecasted and the future line capacity.
2. Proposal of upgrade	A proposal for an upgrade is later provided.	A proposal for an upgrade is provided. This can be the construction of an additional track, local investments (e.g. overpass) or signalling solutions.
3. Cost	Cost estimation for the upgrade is given. This cost estimation is based on average cost per km of upgrade and the length of the section to be upgraded.	

The Technical analysis is focusing on investigating the current situation of the infrastructure, its current bottlenecks as well as the investment proposals for improving the transport infrastructure, operational systems, and evaluation of the extent to which these will meet future demand. The investment plans of public and private parties are taken into account, which together with the traffic forecasts form the scenarios for the target years (2020-2025). The Technical Analysis methodology consists in:

1) Collection of technical data:

- Detailed infrastructure data of the rail network located in Red Banana.
- All railway infrastructures officially planned from year 2005 to 2025.

2) Base year rail network (2005) analysis:

- “Line-by-line” analysis of the tracks of the FERRMED Rail network.
- Selection of the best routes for freight trains on the 2005 rail network.
- Capacity calculations.
- Bottleneck identification.

3) Target-years (2020, 2025) rail network analysis:

- Identification of all projects officially planned and committed in all countries concerned.
- Future network coding.
- Best routes selection for freight trains on the 2020 and 2025 rail networks.
- Identification of necessary actions to meet the future FERRMED scenarios.
- Future networks capacity calculations.
- Future networks bottlenecks identification.

4) Proposals on:

- Current network upgrade.
- New railway tracks.
- City by-passes.
- Bottlenecks solutions.
- Implementation of FERRMED technical standards.

5) Calculation of investments costs for applying the proposals above.

FERRMED Rail Network: Suitable Tracks Selection

The outline of the FERRMED Rail Network has been decided originally by the FERRMED Association itself, based basically on important trade flows and the connection of major ports and centres of economic activity within the Red Banana. Within the framework of the Study, the best routes for rail freight traffic have been selected based on certain criteria.

The technical criteria taken into account, suitable for the development of the FERRMED Rail Network, are not of the same level of importance. These criteria (technical characteristics) are divided in three (3) categories:

1. "First priority" technical characteristics:

- Track gauge in UIC standard 1,435 mm in Spain between French Border and Algeciras.
- Bottlenecks solving.
- Loading gauge in UIC B1 or equivalent as PC 410 at least, upgrade some axes for rolling motorway.
- Mission links of a length of 135 km.
- Automatic coupler (traction and compression efforts + wire transmission) for 320,000 (64%) wagons on a total rolling stock of 500,000 wagons and for 13,000 locomotives on a total rolling stock of 19,000 engines of which 4,000 new locomotives already equipped before their use. The total rolling stock equipped with autocoupler will be 17,000 units (89%).
- Environmental measures, such as noise barriers on around a total length of 616 km.

These concern technical constraints and are absolutely necessary to be implemented. They constitute obstacles to freight traffic.

2. "Second priority" technical characteristics:

- Electric reinforcement with additional 103 substations and 23 high booster voltage.
- ERTMS implementation on 8,000 locomotives with retrofit for 4,000 of them. Installation on board for 4,000 of them pre-equipped. It is noted that 3,000 new

locomotives will be equipped in 2025 before use. The total ERTMS equipped locomotive rolling stock will be 11,000 engines on 15,000 units (73%).

- By-passes of large cities.
- Missing links of a length of 554 km.
- Increase the freight train length up to 1,500 m on FERRMED Core Network and on main feeder lines and up to 1,000 m on remaining feeder lines with implementing on the rail network around 1,500 sidings, of which 909 1,000 m sidings and 537 2,000 m sidings,
- Improvements in ports, with a new link between Genoa sea port and new Genoa dry port beyond Apennines, marshalling yards and terminals, construction of new intermodal platforms.

These should be implemented in order to improve rail freight traffic productivity, without being making rail traffic as problematic as the first category ones.

3. <u>“Third priority” technical characteristics:</u>

- Existing lines of 1.5 kV DC should be reinforced.
- Electrification of the remaining lines not still electrified. New lines should be built in 25 kV AC, 50 Hz. However, when choosing the power type it is important to consider the national standards in order to allow an easy access of local trains that are not multi-current.
- Axle load: maintain 22.5 tonnes/ axle in existing lines. New lines: 25 tonnes/ axle.

These are of lower priority compared to the previous ones, but necessary for the promotion of rail freight transport.

A line by line preliminary analysis based on expert judgment has been performed in order to select the most suitable railway lines for freight traffic, which would be easier to upgrade to meet the FERRMED standards and in particular to be able to serve long and heavy trains. The routes selected allow for technically feasible infrastructure upgrades.

High Speed Lines have not been included as suitable to FERRMED Rail Freight Network, mainly because their technical characteristics are not compatible with the traffic of long and heavy freight trains. Also, the circulation of high-speed passenger trains (at 300-320 km/h), combined with lower speed freight trains (100 km/h) would significantly reduce network capacity. In some links, mixed lines able for high speed trains and freight trains might be considered (like Montpellier – Perpignan and Perpignan – Barcelona).

Capacity analysis/ calculation

The methodology to calculate rail track capacity has been based on the following assumptions:

- Block section of 3,000 meters.
- Speed of 100 kilometres/hour.
- Track use of 20 hours over 24 hours, to take into account rail track maintenance and works.
- Track occupation graph of 60% per day (75% in peak hours) as provided by UIC (UIC leaflet n° 406 R “Capacity”).

Based on these assumptions, the following train traffic capacity has been assigned:

Table 6: Train traffic capacity

Double track *Both directions and per day*	**Block**	**Single track** *Per day per direction*
360	Automatic block *4 minutes*	80 to 90
160	Manual block *9 minutes*	40
20	Telephone block *40 minutes*	10 to 12

This methodology takes also into account:

- Heterogeneity or homogeneity of the traffic.
- Competitiveness for blocks, depending on distance from urban areas.
- Block type.

Bottlenecks identification

Bottlenecks are identified by calculating residual capacity and track occupation.

Residual capacity calculation

Residual capacity is defined as the difference between the effective number of trains running on a determined section and the maximum number of trains which one can technically run this section for a determined period. When residual capacity is:

- Between to 20 and 40 trains, it means that 1 or 2 more trains per hour can be added on the lines. Thus, it is not saturated.
- Between 10 and 20 trains: Saturation rate is almost reached.
- Less than 10 trains: The line is very congested.

Track occupation calculation

The track occupation is defined as the line utilisation rate and is calculated as:

Track occupation = number of real trains / theoretical capacity

The following Table provides the classification on tracks occupation, which has been used in the study:

Table 7: Track occupation classification

Track occupation	Interpretation
0 - 60 %	Demand is lower than capacity. No congestion problem exists.
60 - 75%	Demand is nearly as high as capacity. Difficult to add more trains.
> 75 %	Demand of traffic is higher than capacity. The line is congested. A level of saturation higher than 75 – 85 % is not forbidden but corresponds to saturation which does not strictly respect the quality standards recommended.

Bottlenecks have been identified by using the theoretical line capacity and the analysis of traffic. Bottlenecks are identified by calculating a value referred to as track occupation in this study.

$$\text{Track Occupation} = \frac{\text{Traffic (Number of trains)}}{\text{Theoretical Capacity}}$$

In conclusion, a bottleneck appears when Residual Capacity is less than 20 trains and when Track Occupation is higher than 75%.

It should be noted that as traffic data is based on 24-hour traffic (day traffic), the bottlenecks identified have in turn been identified on an average day traffic basis. Any traffic peaks, mainly due to suburban trains around the cities have not been taken into account.

2.3. COST-BENEFIT ANALYSIS

The CBA approach is based on pre-feasibility level. The model for TRansport Infrastructure ASsessment (acronym: TRIAS) was used as the assessment tool. Relevant factors and rates were derived mainly from the following EU sources:

- Handbook on estimation of external costs in the transport sector (2008).
- HEATCO Deliverable 5: Proposal for Harmonised Guidelines (2004).
- TREMOVE 2.5 – Service contract for the further development and application of the transport and environmental TREMOVE model Lot 1 (Improvement of the data set and model structure) (2007).

Inputs and outputs of the CBA model

The basic input components of the CBA model are:

- Economic costs (without taxes but including subsidies where relevant).
- Traffic and transport performance data.
- Cost factors and rates.
- Other basic parameters.

Economic costs are measured in Euro (2005) per year and broken down in the following components:

- Investment costs for "FERRMED standards" implementation.
- Investment costs for bottleneck solutions.
- Operation & maintenance costs for "FERRMED standards" implementation.
- Operation & maintenance costs for bottleneck solutions.

Traffic and transport performance data

These have been considered for all scenarios, in 2005, 2020 and 2025, split by mode, vehicle type and trip purpose and differentiated by unit.

Cost factors and rates

All cost factors and rates taken from the HEATCO study are calculated as weighted averages of the FERRMED Rail Network countries' specific values.

Vehicle operating cost factors are derived by the traffic model. HGV cost is escalated over time assuming an annual growth rate of 1 % between 2005 and 2045; concerning all other means of transport fixed at 2005 prices.

The Value of time factors are derived by the FERRMED traffic model and the HEATCO study. Values increase with GDP growth as recommended by HEATCO study.

The accident cost rates are derived from DG TREN Handbook (DG TREN - Handbook on estimation of external costs in the transport sector Version 1.1; CE Delft; 2008) and formerly undertaken studies. Values increase with GDP growth as recommended in HEATCO study and accidents rates concerning IWW and SSS are assumed to be negligible.

Emission factors of pollutant emissions are derived from TREMOVE transport and emissions simulation model. Pollutant emissions considered are NO_x, NMVOC, SO_2, $PM_{2.5}$, PM_{10}.

Cost factors of pollutant emissions are derived from HEATCO study, they are differentiated by ground-level and high-stack emissions and the values increase with GDP growth as recommended by HEATCO study.

Greenhouse gas (GHG) emissions considered are CO_2, they are derived from the TREMOVE transport and emissions simulation model and international studies on SSS

GHG cost factors are derived from the HEATCO study.

Having computed all costs and benefits, the social value in terms of transport efficiency and safety and environmental impact can finally be calculated. Three standard indicators of socio-economic value are determined. Each of these summary measures compares the benefits of the project with costs:

- The Net Present Value (NPV)
- The Economic Internal Rate of Return (EIRR)
- The Benefit/Cost Ration (BCR)

The CBA is carried out for the investment programme defined for each FERRMED scenario. Only this approach allows taking into consideration all system-related benefits. This would not be possible if each single project was evaluated.

CBA framework

The economic appraisal framework in this study is as follows:

- The base year for prices is 2005.
- An appraisal period of thirty years is used for all scenarios. The appraisal period begins in the year 2016 and ends in 2045. It is assumed that all projects are implemented before 2026 and become all operational in 2026.. By 2045 only part of the created capital stock will be amortised since the lifetime of many of the investments, in particular of rail investments, is much longer, e.g. for tunnels normally 100 years. Therefore, at the end of the appraisal period, the capital stock has a residual value which must be taken into account.
- A social discount rate of 3.5% was used in all cases to calculate the net present value and the benefit-cost ratio. This rate is now recommended by DG REGIO for countries which do not obtain Cohesion Fund funding. It is nevertheless also applied for Spain.
- GDP growth rates are derived from EUROSTAT statistical database for the years 2000 to 2005 and from ProgTrans sources for the period 2005 to 2045 (Table 7).

Table 8: GDP growth assumptions (% per annum)

Period	Average GDP growth rate (%)
2000 – 2005	3.48
2005 – 2010	2.19
2010 – 2015	1.76
2015 – 2020	1.46
2020 – 2025	1.37
2025 – 2030	1.21
2030 – 2035	1.08
2035 – 2040	1.08
2040 – 2045	1.07

Transport and traffic forecasts

All values for intermediate years between the base and forecast years (2005, 2020, and 2025) have been interpolated linearly. Values for the appraisal horizon in the year 2045 have been forecasted, estimating that the transport and traffic figures between 2025 and 2045 increase by 30% of the growth rate observed between 2005 and 2025.

Cost inputs

The main cost components are broken down in following items:

- Investment costs for "FERRMED standards" implementation.
- Investment costs for bottleneck solutions.
- Operation & maintenance costs for "FERRMED standards" implementation.
- Operation & maintenance costs for bottleneck solutions.

The total rail infrastructure costs were transferred into yearly annuities by multiplication of the total investment by annuity rates. In absence of detailed information it was assumed that the "FERRMED standards" investments to spread over a period of ten (10) years, using a constant share of 10% per year.

Concerning costs for operation of FERRMED standards infrastructure (including costs for ports and terminals upgrade) the difference between reference scenario and FERRMED scenarios is expected to be negligible. Until the end of the appraisal period in 2045 regular annual and periodic maintenance costs for FERRMED standards investments amount to 19,825 m EUR (2005 prices) in the MFS and to 21,851 m EUR (2005 prices) both in the FFS and in the F+FS.

Financial Analysis of Investments

The financial analysis of the investment projects proposed for the FERRMED Great Rail Axis Network covers the following tasks:

- Identification of the total eligible investment costs relevant for financing.
- Identification of the possible financing sources and co-financing institutions.
- Assessment of the suitability of PPP for rail projects.
- Identification of critical financial issues, e.g. of financing gaps, etc.

- Overall cash-flow analysis of the rail investments proposed.

The financial analysis is carried out for the alternative investment scenarios the economic feasibility of which proved positive in the Cost-Benefit Analysis.

The financial analysis has been carried out for the entire FERRMED Rail Network so that the methodological consistency with the traffic model and the cost-benefit analysis is maintained. Thus an overall view of the financial viability of the entire FERRMED project is provided.

For the quantification of benefits, the quantities derived from transport and traffic performance data have to be transposed into monetary values. This is accomplished by applying the specific cost factors and rates.

The value structures encompass:

- value of time (economic value of one hour for passengers depending on the trip purpose and for freight),
- vehicle operating costs (total economic costs (EUR) per vehicle-km, net of taxes),
- accident costs (costs of fatalities, injuries as well as material damages) and
- environmental costs (pollutants and GHG emissions).

The benefits of the scenarios are finally calculated by subtracting the monetary values of the reference scenario from those of the MFS respectively the FFS / F+FS.

2.4. LEGAL AND ADMINISTRATIVE ISSUES

The Legal and Administrative issues are considered to be of great importance for the implementation of the FERRMED standards and the development of the Great Axis Rail Network. The main purpose of this part of the Study has been to examine the policy and legal framework concerning the development of the FERRMED Great Axis Rail Network - at both European and national level- in order to review existing legislation and policies and to develop legislation and policy recommendations.

This has allowed for a thorough picture of the existing situation, based on which it can be further assessed whether the implementation of the FERRMED standards is feasible and to what degree. Furthermore, an effort has been made to identify current and future bottlenecks related to legislation and administrative regulations within the EU and particularly within the "Red Banana" region and at the same time propose solutions to these bottlenecks.

3. STUDY SCENARIOS

A transport investment project is normally proposed as part of a planning process to solve a set of specific problems or to achieve certain objectives. As such there is usually a range of solutions or alternatives that require appraising. These alternatives are termed "project" scenarios. In the FERRMED global study, three scenarios are proposed: the Medium FERRMED Scenario (MFS), the Full FERRMED Scenario (FFS) and the Full+ FERRMED Scenario (F+FS). To ensure that the different scenarios can be compared against each other it is important to undertake the appraisal against a single reference case scenario which is termed the "business-as-usual" scenario or in the FERRMED study the "Reference" Scenario (RS).

The **Reference Scenario** is defined as the scenario which involves

- carrying out the investment and maintenance necessary to keep the system working without excessive deterioration (business as usual),
- the implementation and maintenance of basic infrastructure investments which are already supposed to be an inherent part of transport and infrastructure master plans scheduled within the appraisal period by national governments,
- the implementation and maintenance of infrastructure investments in order to solve bottlenecks (determined by the Supply/Demand Analysis and the Technical Analysis) in the reference FERRMED network.

The reference scenario must not be confounded with a do-nothing approach. This is because a do-nothing concept does not even include a maintenance programme and therefore in the long term would not be able to even meet existing demand levels.

The **Medium FERRMED Scenario** is defined as the scenario which involves

- all the basic infrastructural investments as described and implemented in the reference scenario,
- infrastructural and operational measures in order to implement "FERRMED standards" on a medium level,

- the implementation and maintenance of infrastructure investments in order to solve bottlenecks (determined by the Supply/Demand and the Technical Analysis) in the Medium FERRMED network.

The **Full FERRMED Scenario** is defined as the scenario which involves

- all the basic infrastructural investments as described and implemented in the reference scenario,
- infrastructural and operational measures in order to implement “FERRMED standards” on a high level,
- the implementation and maintenance of infrastructure investments in order to solve bottlenecks (determined by the Supply/Demand and the Technical Analysis) in the FULL FERRMED network.

The **Full+ FERRMED Scenario** is defined as the scenario which involves

- all the basic infrastructural investments as described and implemented in the reference scenario,
- infrastructural and operational measures in order to implement “FERRMED standards” to their maximum,
- the implementation and maintenance of infrastructure investments in order to solve bottlenecks (determined by the Supply/Demand and the Technical Analysis) in the Full+ FERRMED network.

Additional scenarios:

2025 Ports Scenario 65%-35%

This scenario was created using the 2025 Full FERRMED network and by modifying the Maritime demand. Maritime demand has been changed in such a way to represent a different share among European ports: the modal share of the Southern ports was increased from 27% to 35%, and the share of the Northern ones was decreased from 73% to 65%. The new demand was used for the simulation of the 2025 Ports Scenario 65%-35%, keeping the same amount of total freight traded as the 2025 Full FERRMED Scenario.

2025 Objective achieved: RAIL 35% (>500Km)

This scenario was created using the 2025 Full FERRMED network and modifying the inland freight transport share between road, rail and IWW. Under this scenario rail freight share reaches 35% of total inland long distance freight (greater than 500 km) transport. The new demand was used in the 2025 Objective achieved: RAIL 35% (>500Km) simulation, keeping the some amount of total freight as in the 2025 Full FERRMED Scenario.

3.1. REFERENCE SCENARIOS

The FERRMED Reference Scenario is a “Business as usual” scenario: it assumes that the evolution of the transport system is an extension of the current trends. Two future reference scenarios have been established for the two target years: one for year 2020 and one for year 2025. The reference scenarios have been defined as follows.

Supply

The Reference Scenarios have been simulated in two phases, which correspond to two different runs of the model for the same scenario. The “first run” considers the changes in Supply, Policies, Transport Services and Costs. More specifically, it considers:

- Transport networks and service (Supply) changes already planned and committed in the different countries concerned.
- Policies which will be applied at medium term to the Transport Sector at European level.
- Changes in transport costs (i.e. due to higher oil price).
- Demand trends in European and intercontinental movement of freight.

The second model run, besides the previous, includes also the specific infrastructural solutions proposed by the Technical Analysis in order to solve bottlenecks identified after the first run in the rail freight network.

For simplicity, the two simulations undertaken for each Reference Scenario year (2020 and 2025) are identified and named respectively as “first run” and “second run”, however all the results presented refer to the second run, including the rail bottlenecks solution.

Networks

The "reference" network is created after taking into account the investments planned by national authorities, already approved and financially committed for each horizon year.

Three territorial levels of transport planning policies and projects have been considered in the Data Collection Phase:

- EU Policies and Planning (TEN-T and White Paper).
- National Planning in the thirteen Red Banana Countries.
- Projects planned/ under construction by the Regional Authorities included in the Red Banana Area.

The list of all the investments and projects considered for Road, Rail and IWW networks is provided in the Annex. The planned projects have been coded into the network in a different way, depending on their nature: new infrastructure, upgrade of existing infrastructure and changes in services.

EU Transport Policies

The EU Policies considered are the following measures included in the White Paper:

1. Measures to improve freight intermodality and logistics:
   a. Motorways of the sea.
   b. Intermodal Loading Units (ILU) and freight integrators (Marco Polo Programme).
2. Road pricing (Eurovignette) for Road passengers and freight transport.
3. Liberalization of transport markets and interoperability:
   a. Adoption of common rules in rail sector to improve interoperability and enhance quality of services.
   b. Liberalisation of the rail sector with reference to the full separation between infrastructure and services.
   c. Gradual deregulation of international passenger services.
   d. Ports service liberalisation.
4. Simplification of Sea and IWW customs formalities.

The implementation of the measures to improve freight intermodality and logistics, the promotion of the motorways of sea and the development of the freight integrators (Marco Polo programme) is implemented into the model in terms of their indirect effects, using the results of the ASSESS project as a reference to quantify them.

The above mentioned policies are quantified (according to the sources), as presented in the following table:

Table 9: Reference scenarios transport policies

Policy	Action	Scenario year	Result (modelling assumption)
Measures to improve freight intermodality and logistics	Motorways of the Sea	2020	Reduction of sea ports waiting time by 10%.
	Intermodal Loading Units (ILU) and freight integrators (Marco Polo Programme)	2020	Reduction of cost at freight terminals by 30% in all its elements: Fixed inventory costs, Costs for handling commodities at terminals Costs for storing commodities at terminals
			Reduction of waiting time at freight terminals by 10% Reduction of rail freight travel time by 10%
Road pricing for freight and passenger transport	Eurovignette	2020	HGV and car charging changes
Liberalisation of transport markets and interoperability	Adoption of common rules in rail sector to improve interoperability and enhance quality of services	2020	Reduction of rail freight travel time by 10%
	liberalisation of the rail sector with reference to the full separation between infrastructure and services	2020	Reduction of rail freight travel cost by 10%
			Reduction of rail freight travel time by 10%
	gradual opening-up of international passengers services	2020	Reduction of rail passenger travel cost by 5%
	Ports service liberalisation	2020	Reduction of sea shipping costs by 10%
	Liberalisation of airport slots	2020	Reduction of major airports charges by 20%
Simplification of Sea/ IWW customs formalities		2020	Reduction of port (sea and IWW) waiting times by 10%

Transport Costs – Freight transport

The following assumptions regarding transport operational costs have been made while building the reference scenarios:

- Transport operational costs growth depends mainly on the costs of fuel or propulsion energy:
  - o Crude Oil Price for Road, IWW and SSS.
  - o Energy Price (Crude Oil, Natural Gas, Coal, Electricity) for Rail.
- Fuel prices grow at half the rate of crude oil for road freight transport, while the growth rate for less refined fuels such the ones employed in IWW and SSS is higher (around 80%).
- Price of electric power employed by rail grows by 30% of the rate of Energy Price.
- The component of fuel as part of the total operating costs is 35% for road freight transport, 25% for IWW, 20% for SSS and 10% of rail freight.

Transport Costs – Passenger transport

The passenger assignment and modal split models consider the following component in order to calculate the generalised costs:

- Value of Time VoT [€/h]
- Out of pocket perceived cost [€/Passengers-km]

As Trans-Tools model works at 2000 constant price, VoT has been calibrated for the Trans-Tools base year 2000, and it is assumed to grow according to the CPI index.

It has been assumed that the component of fuel respect the total costs which is reflected in the final user tariff is 100% for the road transport and only 25% for Air and Rail because the public transport always receives subsidies.

The cost change between 2000 and 2025 at constant prices has been implemented by applying the following annual rates:

- Road: 2.5% p.a.
- Air: 1% p.a.
- Rail: 0.3 % p.a.

Demand

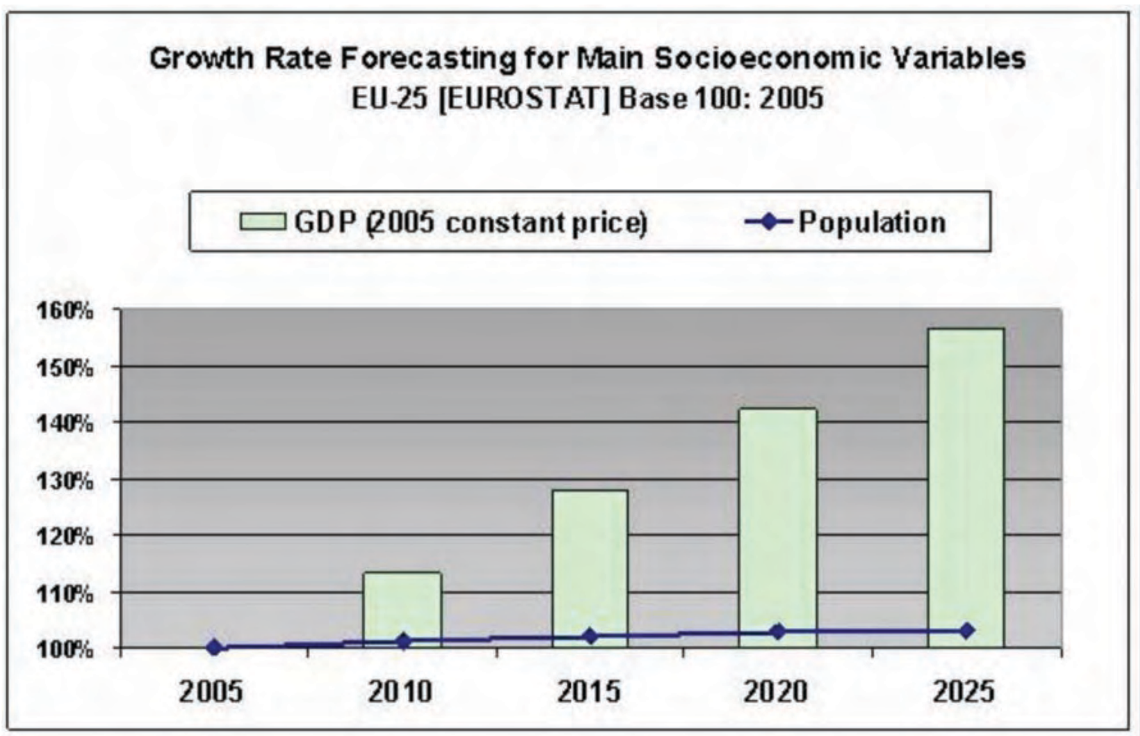
The demand for freight transport for the Reference Scenarios is the "reference" demand, which is forecasted for each horizon year, without any interventions into the network and the services apart from the planned and committed projects.

The demand forecast is undertaken by calculating for each horizon year (2020 and 2025) the future O/D matrices by NST/R commodity group, starting from the base year ones.

Trans-Tools model considers the generated and attracted flows from and to singular points or gates, like ports and logistics centres, and the external trade forecasts (import/export).The ports flows have been treated building a specific model external to Trans-Tools, implemented employing another modelling platform (TransCAD).

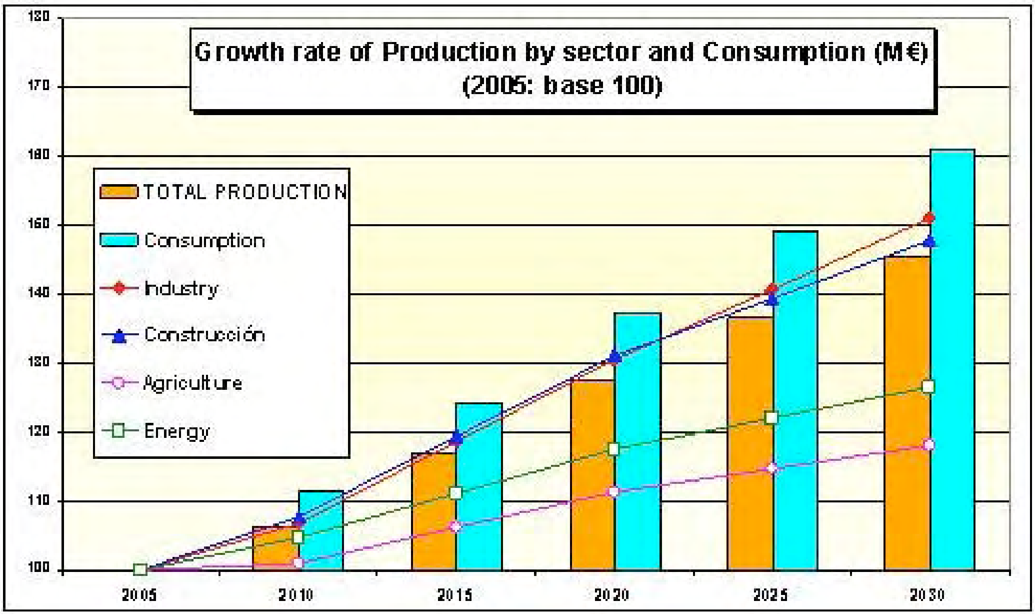
All the projections up to 2025 for the explanatory variables per country, are based on the last updated EUROSTAT data, available in the publication "European Energy and Transport, TRENDS TO 2030, update 2007" (EUROPEAN COMMISSION, 2008a).

Figure 12: Forecasted growth rate for the socioeconomic variables (EU-25)



Source: Elaboration from [EUROPEAN COMMISSION, 2008a]

Figure 13: Forecasted growth rate for Production by sector and Consumption (EU-25)



Source: Elaboration from [EUROPEAN COMMISSION, 2008a]

Inland freight Demand

Next table presents the intra-Red Banana Countries growth of freight by NST/R commodity group and inland transport mode between the Base year scenario and the Reference ones:

Table 10: Freight growth between base and target years (Reference Scenario)

NST/R	Rail		Road		IWW	
	2005/2020	2005/2025	2005/2020	2005/2025	2005/2020	2005/2025
0	39%	53%	29%	37%	34%	42%
1	71%	83%	27%	35%	61%	69%
2	24%	30%	72%	83%	125%	137%
3	10%	13%	15%	18%	11%	13%
4	49%	57%	45%	53%	268%	272%
5	38%	52%	32%	41%	65%	82%
6	28%	36%	26%	34%	29%	35%
7	31%	38%	30%	39%	41%	49%
8	49%	64%	31%	40%	54%	69%
9	59%	81%	32%	41%	108%	139%
10	28%	37%	47%	62%	54%	71%

The Reference FERRMED Rail Network

The 2005 Reference FERRMED Rail Network consists in:

- Core Network: 7,915 km,
- Feeder lines: 12,647 km.

Figure 14: 2005 Reference FERRMED Rail Network

The following table presents the Reference FERRMED Rail Network technical characteristics.

Table 11: Technical standards – 2005 Reference scenario

Technical Standards		Network (km)				Total	
		Core		Feeders		(km)	%
Loading Gauge	GA	461		1,872		2,333	11
	GB	3,152		4,758		7,911	38
	GB 1	3,467		3,999		7,466	36
	GC	834		2,018		2,852	14
Slopes	≤ 12‰	6,034		9,619		15,653	76
	> 12‰ and ≤ 15‰	754		1,051		1,805	9
	> 15‰	1,126		1,978		3,104	15
Number of tracks	Single	995		3,167		4,162	20
	Double	6,406		8,691		15,097	72
	Three	56		155		211	1
	Four	430		634		1,064	5
	More than four	28		0		28	1
Implementation of GSM-R	No GSM-R	4,958		8,119		13,077	62
	GSM-R	2,956		4,807		7,763	38
Signalling	Manual	433		297		730	4
	Automatic	0		1,183		1,183	6
	ETCS	7,329		11,148		18,477	89
ERTMS	No ERTMS	7,761		12,628		20,389	99
	ERTMS	153		19		172	1
Maximum train length	< 500 m	1,601		2,625		4,226	21
	≥ 500 and < 750 m	1,402		3,977		5,379	26
	≥ 750 and< 1000 m	4,819		6,044		10,863	53
	≥ 1000 and< 1500 m	0		0		0	0
	≥ 1500 m	93		0		93	0
Electrification	0 V	627		991		1,618	8
	750 V DC	0		117		117	1
	1,5 kV DC	1,736		1,707		3,443	17
	3 kV DC	1,456		3,736		5,192	25
	15 kV AC	2,295		3,799		6,094	30
	25 kV AC	1,800		2,298		4,098	20
Maximum axle load	20 t	0		434		434	2
	22.5 t	7,764		11,229		18,993	92
	25 t	151		984		1,135	6
Maximum train load	> 3,600 tonnes	318				318	2
	> 2,400 and ≤ 3,600 tonnes	7,318				7,318	35
	> 1,800 and ≤ 2,400 tonnes	7,084				7,084	34
	≤ 1,800 tonnes	5,840				5,840	29
Track Gauge		Spain	Finland	Spain	Finland		
	Standard	6,589		9,797		16,387	80
	Broad	1,325	0	2,364	486	4,175	20

2025 Reference Rail Network

The main rail freight projects completed by 2025 in the study area are the following:

- Fehmarn bridge between Denmark and Germany.
- Betuwe line between Netherlands (Rotterdam) and Germany (German border) and the upgrade between German Border and Duisburg.
- Completion of the High speed line between the Channel Tunnel and London.
- North Lyon by-pass.
- Lyon – Torino axis between France and Italy, including new lines in the "French Sillon Alpin" and new base tunnel.
- New mixed line between Nîmes and Montpellier.
- New mixed line Montpellier - Perpignan
- Upgrade of Montpellier – Narbonne line.
- New mixed line between France (Perpignan) and Spain (Figueras).
- New line between Figueras – Barcelona.
- Alicante by-pass.
- New line between Murcia and Almeria.
- New lines built mainly in Sweden, Denmark, Germany, Netherlands, Belgium, France, Switzerland, Italy and Spain.
- Upgrade of existing lines.

The entire rail freight and passenger projects officially approved by governments are presented in the Annex.

The 2025 Reference Rail network is presented in Figure 15, and its technical characteristics in the next table. It consists of 8,273 km of FERRMED Core Network and 13,843 km of Feeder lines.

Figure 15: 2025 Reference FERRMED Rail Network

Table 12: Technical standards – 2025 Reference scenario

Technical Standards		Network (km)				Total	
		Core		Feeders		(km)	%
Loading Gauge	GA	208		1,571		1,778	8
	GB	2,841		5,124		7,965	36
	GB 1	3,594		4,422		8,017	36
	GC	1,630		2,726		4,356	20
Slopes	≤ 12‰	6,067		11,149		17,216	78
	> 12‰ and ≤ 15‰	1,052		1,167		2,219	10
	> 15‰	1,154		1,528		2,682	12
Number of tracks	Single	339		1,925		2,264	10
	Double	6,834		10,978		17,812	80
	Three	148		138		287	1
	Four	890		803		1,692	8
	More than four	62		0		62	1
Implementation of GSM-R	No GSM-R	1,837		5,870		7,707	35
	GSM-R	6,436		7,973		14,409	65
Signalling	Manual	0		448		448	2
	Automatic	3,372		9,654		13,025	59
	ETCS	4,902		3,742		8,644	39
ERTMS	No ERTMS	3,371		10,101		13,472	61
	ERTMS	4,902		3,742		8,644	39
Maximum train length	< 500 m	318		796		1,114	5
	≥ 500 and < 750 m	958		2,488		3,446	16
	≥ 750 and< 1000 m	6,775		10,355		17,130	77
	≥ 1000 and< 1500 m	0		0		0	0
	≥ 1500 m	222		205		427	2
Electrification	0 V	0		253		253	1
	750 V DC	0		117		117	1
	1,5 kV DC	1,329		1,695		3,025	14
	3 kV DC	2,047		3,850		5,897	27
	15 kV AC	2,187		3,887		6,074	27
	25 kV AC	2,710		4,041		6,752	31
Maximum axle load	20 t	0		384		384	2
	22.5 t	7,411		12,259		19,669	89
	25 t	862		1,201		2,063	9
Maximum train load	> 3,600 tonnes	475				475	2
	> 2,400 and ≤ 3,600 tonnes	8,209				8,209	37
	> 1,800 and ≤ 2,400 tonnes	7,735				7,735	35
	≤ 1,800 tonnes	5,668				5,668	26
Track Gauge		Spain	Finland	Spain	Finland		
	Standard	7,259		11,228		18,487	84
	Broad	1,015		2,056	558	3,629	16

3.2. FERRMED SCENARIOS

The FERRMED FULL and MEDIUM scenarios are obtained starting from the basis of the Reference Scenario related to the corresponding horizon years; on top of this all the FERRMED standards and proposals, as well as the rail bottlenecks solutions and the infrastructural improvements suggested by the Technical Analysis are implemented.

The following table shows a summary of the modelling scenarios which have been simulated in the framework of this Study specifying also their horizon year.

Table 13: Summary of Modelling Scenarios

Year	Reference	Medium FERRMED	Full FERRMED	Southern ports enhancement 27% to 35%	FERRMED Objective achieved
2005	Yes	-	-	-	-
2020	Yes + Bottlenecks solved	Yes + Bottlenecks solved	-	-	-
2025	Yes + Bottlenecks solved	Yes + Bottlenecks solved	Yes + Bottlenecks solved	Yes detecting bottlenecks	Yes detecting bottlenecks

<u>FERRMED Standards modelling</u>

The FERRMED Standards are included in the model in two different scenarios: FULL and MEDIUM FERRMED. Both scenarios are simulated in two runs of the model. The first run considers a group of FERRMED standards which in general terms consist of the first priority infrastructural modifications of the rail network:

- Signalling
- Train length
- Creation of new terminals and expansion of existing ones.
- Upgrade of the maximum axle load allowed.
- Homogenisation of the tracks width to UIC standard of 1435 mm.
- Liberalisation of the rail market.
- Quality and reliability

The “second run” takes into account the standards which imply deep, extensive and expensive infrastructural changes to the rail network. These will include the infrastructural solutions proposed by the Technical Analysis to solve the rail traffic bottlenecks identified after the first run. The second group of FERRMED proposals considered at this second stage includes the following:

- Homogenisation of the loading gauge to the UIC C standard for new lines.
- Two parallel lines in the core FERRMED network when needed.
- Increase of freight train priority.
- Maximum slope limitation to 12‰.

There are some FERRMED standards which are not directly considered by the model, either because they do not have a direct impact on the transport system, or because they are considered as a consequence of the implementation of other proposals (indirect effect). These are the "Homogenisation of power type" and the "Renewal of the rolling stock". The previous considerations are summarized in the following Table.

Table 14: FERRMED standards considered in the FERRMED Scenarios

FERRMED Standard	FERRMED Scenarios	
	1st Run	2nd Run
1. Signalling	Included	Included
2. Train Length	Included	Included
3. Creation of new terminals and expansion of existing ones	Included	Included
4. Upgrade of the maximum axle load allowed	Included	New lines
5. Homogenisation of the tracks width to UIC standard of 1435 mm	Included	Included
6. Liberalisation of the rail freight market	Included Reference scenario	Included Reference scenario
7. Reliability and Quality	Included	Included
8. Homogenisation of the loading gauge to the UIC C standard for new lines	As in Reference scenario	+ Upgrade and New lines (when needed)
9. Two parallel lines in the core FERRMED network	Included when needed	Included when needed
10. Increase of freight train priority	As in Reference scenario	Selected lines
11. Slope limitation to 12 ‰	As in Reference scenario	Included when needed (slope bottlenecks)
12. Homogenisation of Power type	Included	Included
13. Renewal of Rolling stock	Indirect Effect	Indirect Effect

"FERRMED train" definition

Due to the heterogeneous characteristics of the locomotives and the rolling stock today employed all over the FERRMED Great Axis Rail Network, the train hereby described is only a theoretical, reference one, employed by the study Team to allow certain calculations to be undertaken in order to estimate, comparatively with the present situation, the effects of the introduction of some FERRMED standards.

The basic characteristics of the common in use trains are summarized in the following Table, which has been compiled by finding the averaging technical characteristics about the most employed locomotives and rolling stock, found in different sources and mainly through the Infrastructure Statement of all the Red Banana Countries (UIC).

Table 15: Theoretical train characteristics

Characteristic	Value	Unit
Locomotive length	20	m
Locomotive tare weight	90	Tonnes
Wagon length	16	m
Wagon tare weight	20	Tonnes
Number of axles per wagon	4	Axles
Axle load	22.5	Tonnes/axle

Source: Infrastructure statements of Red Banana Countries

A reference speed of 100 km/h has been taken into account in order to allow the common axle load of 22.5 tonnes/ axle, which has to be decreased when trains circulate at higher speeds.

In view of these average characteristics, the 1,500 m long trains can be operated by employing up to 91 wagons pushed and pulled by 2 locomotives for a total theoretical gross weight of 8,370 tonnes.

Nevertheless, the maximum gross weight of a train is limited by wheel friction and coupling resistance.

Among these, the most limiting one on the flat is the couplings resistance at start up; the others can be overcome by modern engines which can stand total gross weight higher than 8370 tonnes, when circulated.

This limiting resistance obviously depends on the type of couplings employed. Calculations have been undertaken with two types of couplings today employed in Europe: conventional (resistance of 30 tonnes) and reinforced couplings (resistance of 36 tonnes), which give a restriction of the maximum gross weight allowed respectively of 4300 and 5180 tonnes. However the results shown in the following tables always consider reinforced couplings.

Consequently it can be stated that, with reinforced conventional (not automatic) couplers, the 1500 m long train can be operated employing two locomotives, and limiting its gross weight to 5180 tonnes; this means that only a part of the total theoretical train capacity is employed, more precisely the loading factor results in 60%.

Actually these conditions are very restrictive only for conventional heavy freight trains (iron, bulk…) while for container and, in general, light trains, for example loaded with cars, a gross weight up to 5100 tonnes is not a limiting factor. For example nowadays a container train loaded with full 40 feet containers units, has a gross weight of about 3600 tonnes, which is under the 5180 tonnes limit. A summary of the characteristics of the 1500 m long train is presented in the following Table.

Table 16: Characteristics of 1500 m long container train with 2 locomotives and reinforced couplings

Length (m)	Number of locomotives	Wagons	Theoretical Gross Weight (tonnes)	Allowed Gross Weight REINFORCED couplings (tonnes)	Loading capacity (Payload)
1500	2	91	8370	5180	3180

These calculations have been undertaken also considering a 1500 m long train pushed and pulled by 3 or 4 locomotives (with automatic couplers) in order to allow fully loaded conventional wagons; in these cases the most restrictive factor becomes the resistance to start up, due to wheel friction, which is limited to 2500 tonnes per locomotive at start up on the flat.

The results are summarized in the following Table, which shows that with 4 locomotives the maximum load is reached (loading factor 100%), because a gross weight of 10000 tonnes can be pulled, while a 3 locomotives train can pull up to 7500 tonnes, achieving a high loading factor of about 90%.

Table 17: Characteristics of 1500 m long train with up to 4 locomotives and automatic couplings

Length (m)	Number of locomotives	Wagons	Theoretical Gross Weight (tonnes)	Allowed Gross Weight Automatic couplings (tonnes)	Loading capacity (Payload)
1500	3	90	8370	7500	5700
1500	4	88	8280	10000	6160

Nevertheless it should be observed that, as explained in the Technical Analysis, the use of more than 2 locomotives requires either a dynamic radio communication system or a wire transmission for electric orders between them in order to synchronize the accelerating and braking powers.

The telecommunication radio system, today commonly employed in the US, Russia and other countries, which makes the operation of long trains possible, is not feasible in Europe, even in a 2025 FULL FERRMED scenario, because of two reasons.

It has not been implemented yet in European railways, and consequently it is not homologated. The starting up would take a considerable time. The frequency under which this system works is not available in Europe because it is locked for military use.

Nevertheless if all the rolling stock is renewed, it is possible to employ auto-coupler for traction effort and longitudinal compression effort with wire transmission for electric orders between locomotives (mainly in acceleration and braking phases) which are dispatched along the train and electronic information as well.

Investigations are underway regarding the possibility to substitute the previously described telecommunication system with GSM-R; if this technical solution succeeds, the use of more than 2 locomotives could be possible in the 2025 Full FERRMED scenario.

Furthermore, it should be observed that the previous calculations are valid on flat terrain; nevertheless the effect of the line slope is to be taken into account as it reduces progressively the gross weight allowed, due to the loss of traction power, both at start up and while trains are running at normal speed. Two locomotives are necessary in order that a 3,600 tonnes train can be put into circulation on the rail track.

Moreover there is a decrease of the circulation speed that depends strictly on the locomotive engine and the length and slope of the ramp. Nevertheless, the present study considers trains with a gross weight of 5,000 tonnes, circulating with a maximum slope of 12 ‰ which can be always overcome but when starting from complete stop. Accordingly the circulation speed on ramps is expected to be lower than 100 km/h and the train cannot be stopped while circulating on these high slope lines. In this case it has to be stopped and in order to start moving again, it is necessary to split it into two trains of 750m with two locomotives each (1,300 tonnes per locomotive are reached with this slope, thus two locomotives can pull 2,600 tonnes of gross weight).

For these reasons the 1,500 m-long train adopted employs only two locomotives in order to reflect the most probable and feasible situation that can be achieved by 2025.

In the FERRMED scenarios, modelling variables have been altered to represent the effect of the changes in comparison to the Reference scenario. These changes are presented in the following table:

Table 18: FERRMED scenario modelling variables

Modelling variable	Full FERRMED Scenario (1st Run)	Medium FERRMED Scenario (1st Run)
Link Speed	15%	0%
Line capacity	15%	0%
“Dummy” at borders	Eliminated	Eliminated
Loading capacity	50%	45%
Operating costs	-25%	-15%
Market prices	-25%	-15%
Costs at freight terminals (handling, storage…)	-20%	-15%
Times at terminals	-35%	-25%

The FERRMED Standards considered in the Study are presented in the following table together with the corresponding variables in the model and their values considered in the “first’ run.

Table 19: Effects of the FERRMED Standards implementation in the rail Transport System and translation into the model

FERRMED Standard	Full FERRMED Scenario (1st run)	Medium FERRMED Scenario (1st run)	Effect on the real transport system	Modelling variable	Value
1. Signalling	ERTMS L2		▪ Interoperability ▪ Increase of line capacity	▪ Link speed ▪ Line capacity	▪ Speed: +15% ▪ Line capacity: +15%
		ERTMS L1	▪ Improve interoperability	▪ “Dummy” variable at border links ▪ Speed at border link level	▪ Elimination of “dummy” variable at border link ▪ Increase of speed at border link to the same of adjacent lines
2. Train Length	▪ **1500 m** in FERRMED network (core lines and main feeders) ▪ **750 m** rest of the Network		▪ More Loading capacity ▪ Lower Operational costs ▪ Market prices	▪ Loading capacity ▪ Operational costs ▪ Market prices ▪ Technical data: Garage Siding, Max load factor and length of train (calculation of capacity)	▪ Loading capacity: +45 % ▪ Operating costs: -25% ▪ Market prices: -25% Note: using only reinforced couplings
		▪ 750 m homogeneous in all FERRMED Network			▪ Loading capacity: +40 % ▪ Operating costs: -15% ▪ Market prices: -15%
3. New terminals and expansion of existing ones	Optimistic capacity		▪ Improve freight intermodality ▪ Reduction of costs and time at terminals	▪ Fixed inventory costs ▪ Freight handling and storage costs ▪ Times at terminals	▪ Cost at freight terminals: -20% ▪ time at freight terminals: -35%
		Medium capacity			▪ Cost at freight terminals: -15% ▪ Time at freight terminals: -25%
4. Maximum Axle Load	Uniform to 22.5 tonnes/axle and 25 in some specific lines Upgrade of 20 tonnes/axle lines to 22.5		▪ More loading capacity	▪ Loading capacity	▪ Loading capacity: +5%
5. Width of the tracks UIC 1435 mm	UIC width from French border to Algeciras (conventional line)	UIC width from French border to Almeria (conventional line)	▪ Improve interoperability at border crossing	▪ Dummy” variable at border links ▪ Speed at border link level	▪ Elimination of “dummy” variable at border link ▪ Increase of speed to the same of adjacent lines

FERRMED Standard	Full FERRMED Scenario (1st run)	Medium FERRMED Scenario (1st run)	Effect on the real transport system	Modelling variable	Value
6. Liberalisation of the rail market	The same as reference scenario		▪ Reduction of rail costs and market prices ▪ Improvement of rail operations and efficiency	▪ Operating costs ▪ Market prices ▪ Costs of logistic activities at distribution centres: inventory, handling and storing costs.	▪ Operating costs: -10% ▪ Market prices : -10% ▪ Costs of logistic activities at distribution centres: -10 % ▪ Freight rail speed: +10%
7. Reliability and quality	Consequence of all the other standards		▪ Reduction of delays ▪ Increases of Competitivenes s ▪ Reduction of Generalized Cost	▪ Costs and Times according to the Standards implemented	▪ Costs and Times according to the Standards implemented
8. Loading Gauge UIC C	The same as reference scenario		▪ Interoperability ▪ Decrease of rail loading times and costs at freight terminals	▪ Rail loading and unloading time ▪ Rail loading and unloading costs	New network characteristics
9. Parallel lines	When needed		▪ Increase the capacity of rail freight lines	▪ Link speed ▪ Line capacity	New network characteristics
10. Freight train priority	The same as reference scenario		▪ Increase of capacity ▪ Increase of reliability	▪ Line capacity	Capacity: increase equal to the passenger trains reduction
11. Slope limitation to 12‰	When needed		▪ Reduction of travel times ▪ Increase of speed and capacity	▪ Link speed ▪ Line capacity	New network characteristics

4. TRAFFIC FORECASTING

Reference Scenario Traffic forecasting

Next tables present the forecasted traffic for all the passenger and freight modes employing the aggregated transport performance in terms of tonnes-km and passenger-km. The resulting traffic maps by mode are presented in Annex.

Table 20: Freight traffic growth (tonne-km) in Red Banana Countries between 2005 and 2020/2025 (Reference Scenarios 2nd run)

Growth	Road	Rail	IWW	Sea	Total All	Total Inland
2005-2020	50,6%	54,2%	66,1%	49,7%	52,4%	51,5%
2005-2025	56,6%	70,5%	78,8%	64,5%	60,3%	61,7%

Table 21: Passenger traffic growth (Pass-km) in Red Banana Countries between 2005 and 2020/2025 (Reference Scenarios 2nd run)

Growth	Road	Rail	Air	Total All
2005-2020	6,6%	48,9%	25,8%	10,3%
2005-2025	9,7%	68,3%	43,1%	15,6%

Modal split

The next Tables present the modal split for freight modes in Red Banana, as well as modal split for long distance traffic (more than 500, 750 and 1,000 km).

Table 22: Freight modal split in Red Banana for all modes

Mode	2005 Base Year	2020 Reference 2nd run incl. Bottlenecks Solutions	2025 Reference 2nd run incl. Bottlenecks Solutions
Sea	32.6%	32.2%	33.2%
IWW	5.3%	5.8%	5.8%
Rail	9.4%	9.6%	10.0%
Road	52.7%	52.4%	51.0%

Table 23: Inland freight modal split in Red Banana Countries

Mode	2005 Base Year	2020 Reference 2nd run incl. Bottlenecks Solutions	2025 Reference 2nd run incl. Bottlenecks Solutions
for Trips > 500 km			
IWW	19.6%	20.2%	20.2%
Rail	20.5%	20.7%	21.4%
Road	59.9%	59.1%	58.4%
for Trips > 750 km			
IWW	19.8%	19.8%	19.5%
Rail	22.6%	22.9%	23.1%
Road	57.6%	57.3%	57.4%
for Trips > 1,000 km			
IWW	14.4%	15.1%	15.5%
Rail	24.1%	24.7%	25.2%
Road	61.5%	60.2%	59.3%

The next table shows the modal split resulting from the forecasted traffic (pass-km) for the Reference Scenarios, compared with the Base Year situation:

Table 24: Passenger modal split in Red Banana Countries

Mode	2005 Base Year	2020 Reference 2nd run incl. Bottlenecks Solutions	2025 Reference 2nd run incl. Bottlenecks Solutions
Air	9.6%	11.0%	11.9%
Rail	4.5%	6.1%	6.6%
Road	85.9%	82.9%	81.5%

Freight transport performance

The following tables road and rail freight transport performance in the Red Banana Countries is presented, resulting from the simulation of the reference scenarios (2020 and 2025) compared with the 2005 base year data.

Table 25: Road Freight Transport Performance (bn tonne-km)

Country	2005 Base Year	2020 Reference incl. Bottlenecks Solutions	2025 Reference incl. Bottlenecks Solutions	Growth 2005 - 2020	Growth 2005 - 2025
Belgium	49,1	79,4	82,7	62%	69%
Denmark	21,0	35,0	35,9	67%	71%
Finland	26,6	42,3	43,6	59%	64%
France	239,7	367,9	383,4	54%	60%
Germany	349,9	520,8	539,7	49%	54%
Italy	196,5	289,4	302,6	47%	54%
Luxembourg	7,0	8,2	8,5	18%	22%

Country	2005 Base Year	2020 Reference incl. Bottlenecks Solutions	2025 Reference incl. Bottlenecks Solutions	Growth 2005 - 2020	Growth 2005 - 2025
Netherlands	78,5	121,7	125,9	55%	60%
Spain	235,8	387,6	403,5	64%	71%
Sweden	34,4	54,8	57,1	59%	66%
United Kingdom	206,4	267,1	275,8	29%	34%
Norway	20,9	32,4	34,7	55%	66%
Switzerland	15,2	24,3	25,6	60%	68%

Table 26: Rail Freight Transport Performance (bn tonne-km)

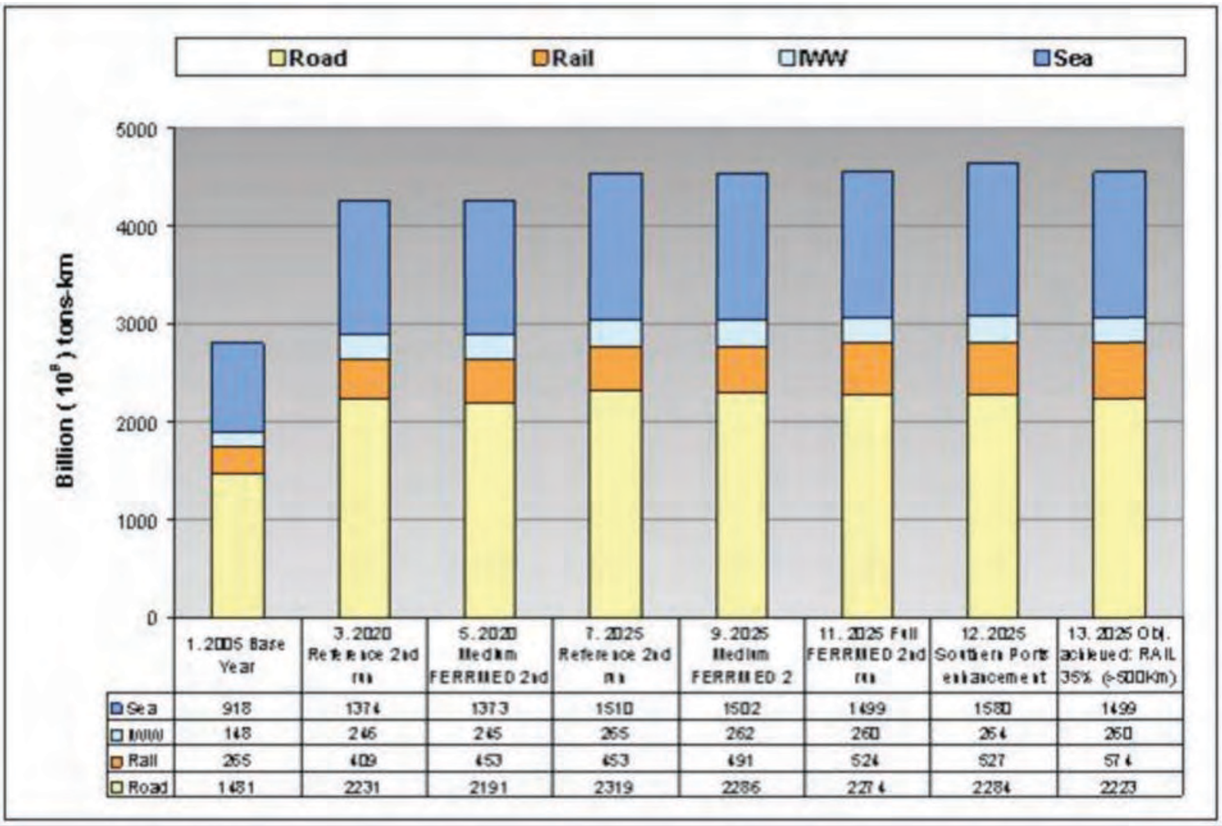
Country	2005 Base Year	2020 Reference incl. Bottlenecks Solutions	2025 Reference incl. Bottlenecks Solutions	Growth 2005 - 2020	Growth 2005 - 2025
Belgium	9,6	14,7	16,3	53%	70%
Denmark	2,4	4,8	5,4	102%	124%
Finland	11,3	15,7	17,8	40%	58%
France	49,9	83,8	90,9	68%	82%
Germany	89,8	133,4	147,9	49%	65%
Italy	26,3	42,2	47,0	61%	79%
Luxembourg	0,5	0,5	0,5	1%	11%
Netherlands	5,9	13,3	14,8	126%	151%
Spain	12,9	24,8	27,6	92%	114%
Sweden	18,1	26,3	29,1	46%	61%
United Kingdom	26,1	35,4	38,7	36%	48%
Norway	2,5	4,0	4,5	60%	81%
Switzerland	10,3	10,5	12,1	2%	17%

By applying only the planned/ committed projects, road sector will continue to have the lion's share in the future freight transport market (76% between freight inland modes and 82% between passenger modes or 2025).

For long distance traffic, rail transport can be competitive with road. For more than 500 km, the rail share within the inland modes in the Red Banana Countries in 2025 would be 21%, and for more than 1,000 km this value would increase to 25%.

The following figure shows the freight traffic, by mode, in the Red Banana Countries for all FERRMED Scenarios:

Figure 16: Freight transport performance per mode for all FERRMED scenarios



The next table shows the growth of traffic in freight modes between scenarios in Red Banana Countries:

Table 27: Growth of freight transport performance between the Reference and FERRMED Scenarios

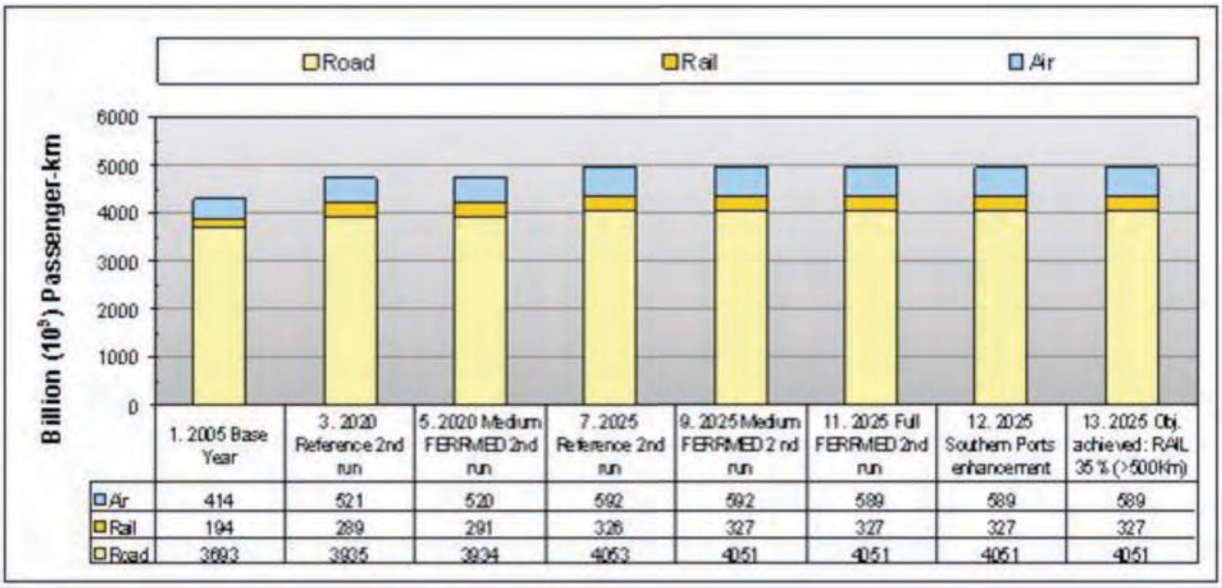
Growth (tonnes-km)	Road	Rail	IWW	Sea	Total All	Total Inland
2020 Reference/ 2020 Medium	-1,8%	10,7%	-0,5%	-0,1%	0,1%	0,0%
2025 Reference/ 2025 Medium	-1,4%	8,4%	-1,0%	-0,5%	0,1%	-0,1%
2025 Reference/ 2025 Full	-2,0%	15,6%	-1,8%	-0,8%	0,7%	0,2%
2025 Full/ 2025 Ports	0,4%	0,6%	1,5%	5,4%	0,6%	2,2%
2025 Full/ 2025 Objective Achieved	-2,2%	9,7%	0,0%	0,0%	0,0%	0,0%

The figure and table above show, as expected, that Rail is the transport mode which present a higher increase of transport performance in Red Banana, due to the FERRMED standards implementation.

Passenger transport performance

The following figure shows the passenger traffic, by mode, in the Red Banana Countries for the all FERRMED Scenarios.

Figure 17: Passenger transport performance per mode for all FERRMED scenarios



The next table shows the growth of traffic in passenger modes between the base and the reference years:

Table 28: Growth of passenger transport performance between the Reference and FERRMED Scenarios

Growth (ton-km)	Road	Rail	Air	Total
2020 Reference/ 2020 Medium	0,0%	0,6%	-0,1%	0,0%
2025 Reference/ 2025 Medium	0,0%	0,1%	0,0%	0,0%
2025 Reference/ 2025 Full	-0,1%	0,3%	-0,5%	-0,1%
2025 Full/ 2025 Ports	0,0%	0,0%	0,0%	0,0%
2025 Full/ 2025 Objective Achieved	0,0%	0,0%	0,0%	0,0%

In line with what was explained before, the passenger traffic performance has no significant changes between the reference and FERRMED scenarios, because the FERRMED scenarios are drawn mainly in order to improve rail freight transport. Regarding 2025 “Ports” scenario and 2025 “Objective achieved” the amount of pass-km is the same as in the 2025 Full FERRMED.

Trip Distance

In order to establish the definition of long distance trip, in the case of the Study area, an analysis has been undertaken in order to calculate the base year average trip distance for road and rail transport. The results are presented in the following graphs.

Figure 18: Average weighted trip distance for Red Banana - Rail

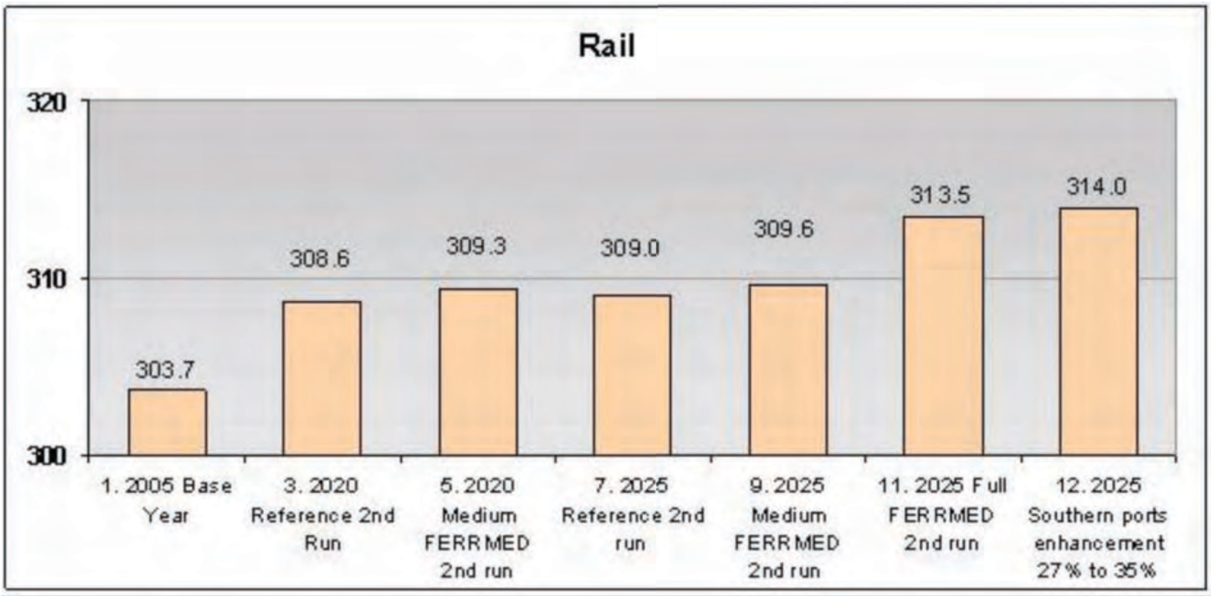
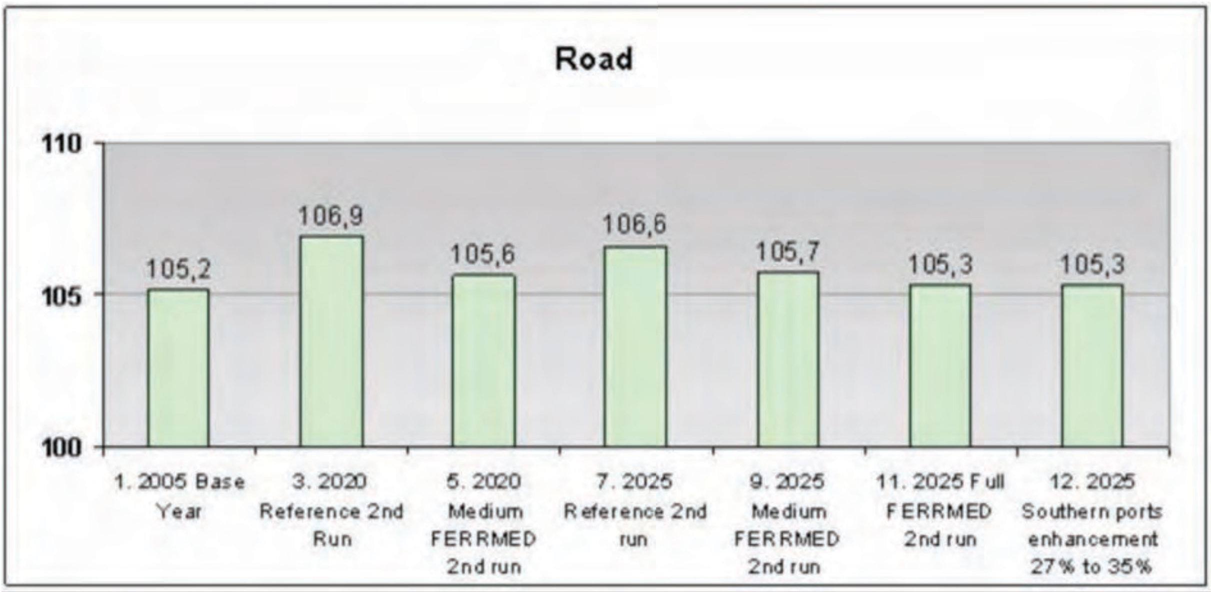


Figure 19: Average weighted trip distance for Red Banana - Road



The average trip distance for Rail is around 300 km, while for road is around 100 km.

Table 29: Trip length distribution in Tonnes-km - Rail

Tonnes-km in Red Banana	Trips < 500 km	Trips 500-750 km	Trips 750-1000 km	Trips >1000 km
1. 2005 Base Year	51%	16%	10%	23%
3. 2020 Reference 2nd run	51%	17%	11%	21%
5. 2020 Medium FERRMED 2nd run	51%	17%	11%	21%
7. 2025 Reference 2nd run	50%	17%	12%	21%
9. 2025 Medium FERRMED 2nd run	50%	18%	11%	21%
11. 2025 Full FERRMED 2nd run	50%	18%	11%	21%
12. 2025 Ports Scenario 35%-65%	50%	18%	11%	21%

Table 30: Trip length distribution in Tonnes-km– Road

Tonnes-km in Red Banana	Trips < 500 km	Trips 500-750 km	Trips 750-1000 km	Trips >1000 km
1. 2005 Base Year	75%	11%	5%	9%
3. 2020 Reference 2nd run	74%	11%	5%	10%
5. 2020 Medium FERRMED 2nd run	74%	11%	6%	9%
7. 2025 Reference 2nd run	74%	11%	5%	10%
9. 2025 Medium FERRMED 2nd run	74%	10%	6%	10%
11. 2025 Full FERRMED 2nd run	74%	10%	6%	10%
12. 2025 Ports Scenario 35%-65%	74%	10%	6%	10%

Modal Split - Freight

The next tables and graphs present the modal split for freight modes in all FERRMED scenarios:

Figure 20: Freight modal split for all modes

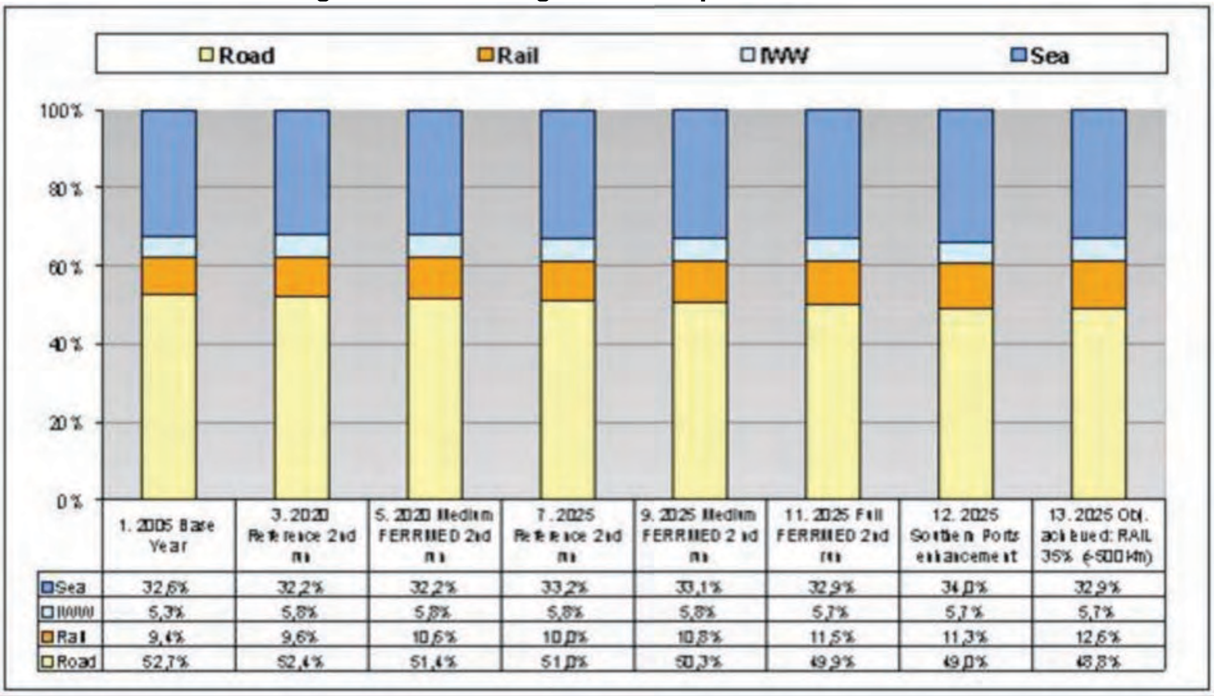
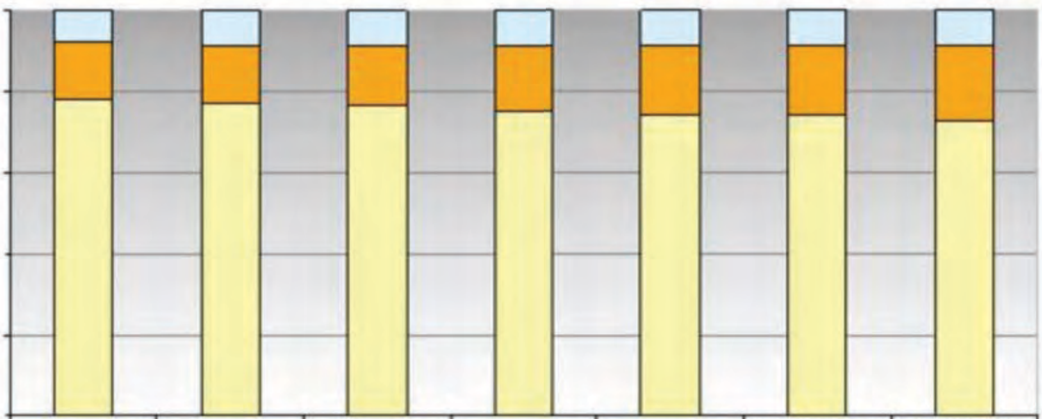


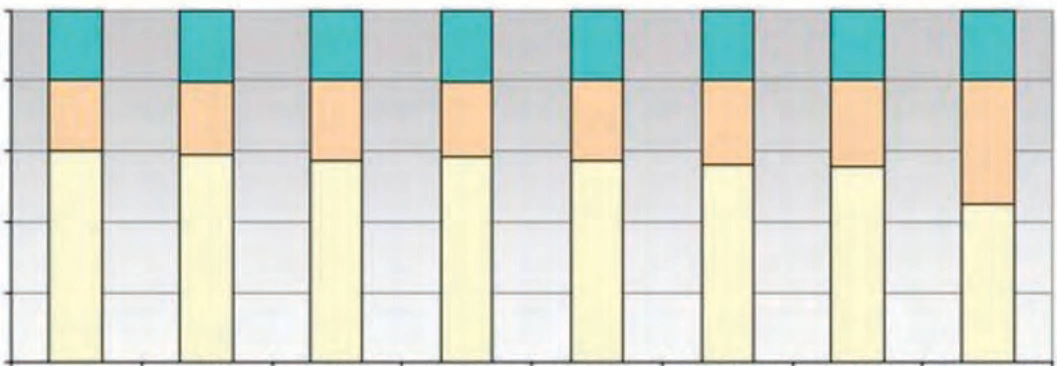
Figure 21: Freight modal split for inland modes



	1. 2005 Base Year	3. 2020 Reference 2nd run	7. 2025 Reference 2nd run	9. 2025 Medium FERRMED 2nd run	11. 2025 Full FERRMED 2nd run	12. 2025 Southern Ports enhancement 27 % to 35 %	13. 2025 Obj. achieved: RAIL 35% (>500 Km)
IWW	7,8%	8,5%	8,7%	8,7%	8,5%	8,6%	8,5%
Rail	14,0%	14,2%	14,9%	16,1%	17,1%	17,1%	18,8%
Road	78,2%	77,3%	76,4%	75,2%	74,4%	74,3%	72,7%

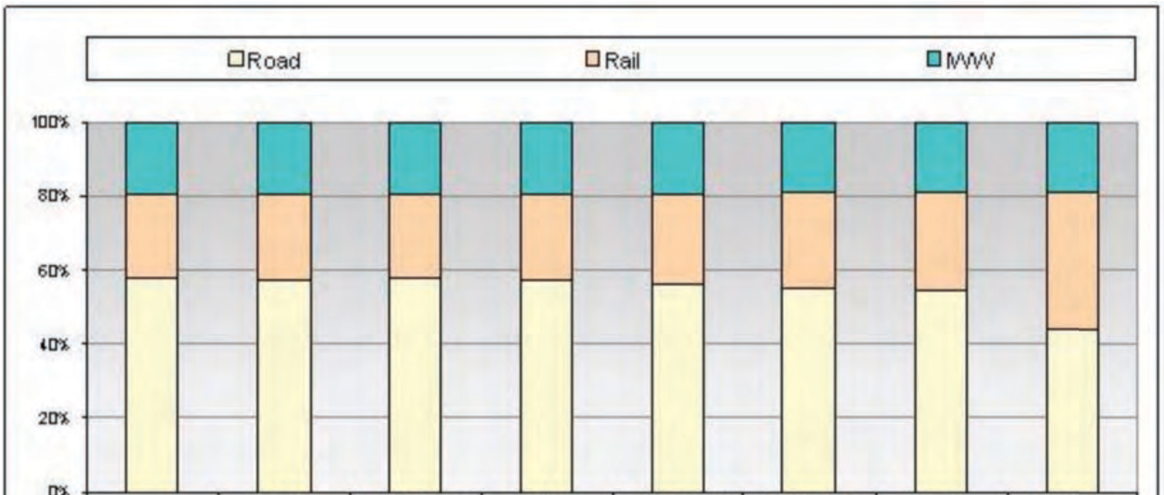
Rail share increases proportionally to the FERRMED Standards' implementation, for all distance trips. With respect to the Reference Scenarios, the increase of rail share is very little. The following three figures show the modal split of inland freight transport modes in Red Banana Countries for long distance traffic (more than 500 Km, 750 km and 1000 km).

Figure 22: Inland freight modal split in Red Banana Countries for Trips >500km



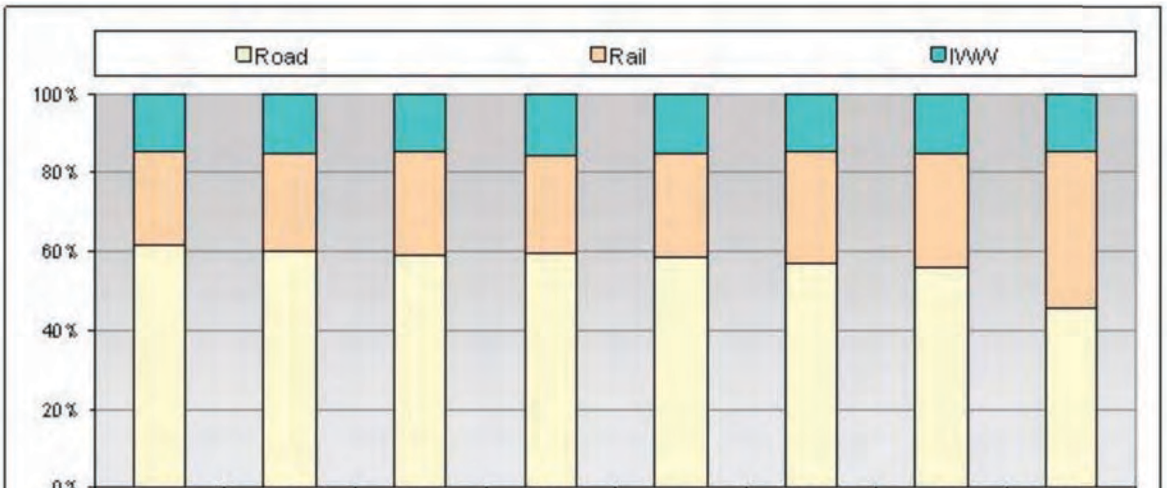
	1. 2005 Base Year	3. 2020 Reference 2nd Run	5. 2020 Medium FERRMED	7. 2025 Reference 2nd run	9. 2025 Medium FERRMED 2	11. 2025 Full FERRMED 2nd run	12. 2025 Southern ports enhancement	13. 2025 Obj. achieved: RAIL 35 % (>500 Km)
IWW	19,6 %	20,2 %	19,8 %	20,2%	19,9 %	19,6 %	19,9 %	19,8 %
Rail	20,5 %	20,7 %	22,6 %	21,4%	23,0 %	24,3 %	24,6 %	35,0 %
Road	59,9 %	59,1 %	57,7 %	58,4%	57,1 %	56,1 %	55,6 %	45,1 %

Figure 23: Inland freight modal split in Red Banana Countries for Trips >750km



	1. 2005 Base Year	3. 2020 Reference 2nd Run	5. 2020 Medium FERRMED 2nd run	7. 2025 Reference 2nd run	9. 2025 Medium FERRMED 2nd run	11. 2025 Full FERRMED 2nd run	12. 2025 Southern ports enhancement	13. 2025 Obj. achieved: RAIL 35% (>500 Km)
IWW	19,8%	19,8%	19,8%	19,5%	19,2%	18,8%	19,0%	18,8%
Rail	22,6%	22,9%	22,6%	23,1%	24,6%	26,1%	26,4%	37,3%
Road	57,6%	57,3%	57,7%	57,4%	56,2%	55,1%	54,6%	43,9%

Figure 24: Inland freight modal split in Red Banana Countries for Trips >1000km



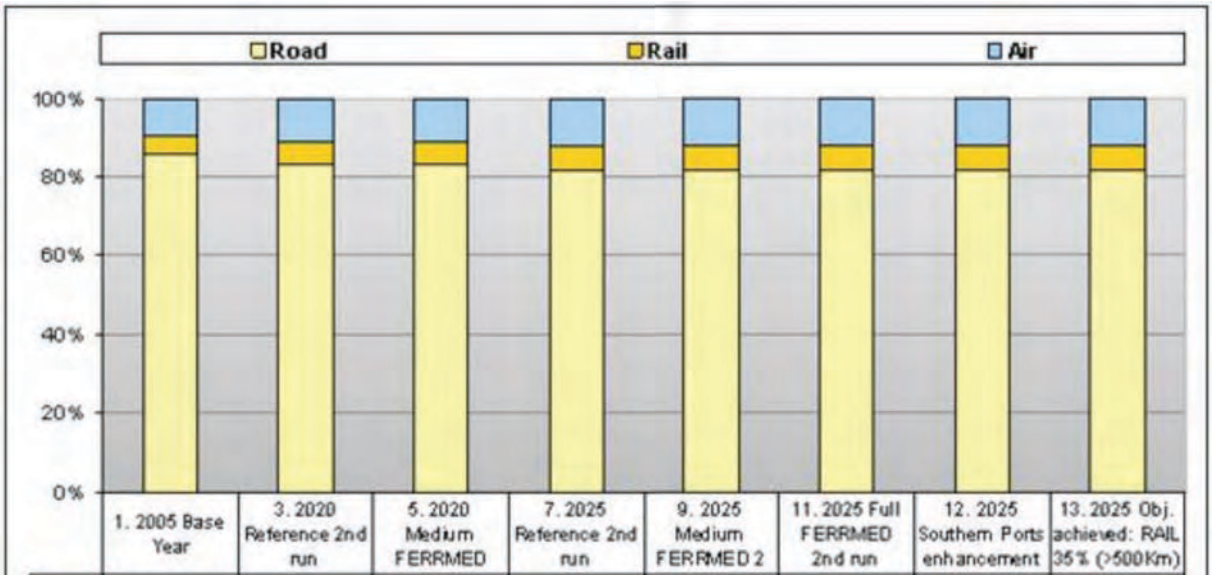
	1. 2005 Base Year	3. 2020 Reference 2nd Run	5. 2020 Medium FERRMED 2nd	7. 2025 Reference 2nd run	9. 2025 Medium FERRMED 2	11. 2025 Full FERRMED 2nd run	12. 2025 Southern ports enhancement	13. 2025 Obj. achieved: RAIL 35 % (>500 Km)
IWW	14,4 %	15,1 %	14,7 %	15,5 %	15,1 %	14,7 %	15,1 %	14,7 %
Rail	24,1 %	24,7 %	26,4 %	25,2 %	26,4 %	28,2 %	28,9 %	39,8 %
Road	61,5 %	60,2 %	58,9 %	59,3 %	58,5 %	57,1 %	56,0 %	45,4 %

For trips longer than 500 km, the rail freight share increases with the implementation of the FERRMED scenarios, starting from the 20.5% in the 2005 Base Year to 23.0% in the 2025 Medium FERRMED and 24.3% in the 2025 FULL FERRMED. For trips longer than 1,000 km, in the FULL FERRMED Scenario, rail share increases to 28.2%.

Modal Split - Passengers

The passenger modal split, it is presented in the next table for all FERRMED Scenarios.

Figure 25: Passenger modal split in Red Banana



	1. 2005 Base Year	3. 2020 Reference 2nd run	5. 2020 Medium FERRMED	7. 2025 Reference 2nd run	9. 2025 Medium FERRMED 2	11. 2025 Full FERRMED 2nd run	12. 2025 Southern Ports enhancement	13. 2025 Obj. achieved: RAIL 35% (>500Km)
Air	9,6%	11,0%	11,0%	11,9%	11,9%	11,9%	11,9%	11,9%
Rail	4,5%	6,1%	6,1%	6,6%	6,6%	6,6%	6,6%	6,6%
Road	85,9%	82,9%	82,9%	81,5%	81,5%	81,5%	81,5%	81,5%

As expected, passenger modal split for the FERRMED Scenarios maintains the same share as the correspondent reference year, because the introduction of the FERRMED standards does not produce any major impacts in the passenger transport system.

5. FREIGHT TERMINALS

Freight terminals in FERRMED area: present situation

Comparing the share within the freight transport market of the European countries, the following conclusions are drawn: Germany has the highest market share in Europe (above 3 million m^2) followed by France and the UK (both on average about 2.5 million m^2). The Netherlands and Belgium follow with a market share of 10%-15%. Spain and Italy come next but their market share is comparatively low.

The leading container ports in Europe are Rotterdam, Antwerp and Hamburg, with more than 5 million TEUs per year. The ports of London, Felixstowe and Algeciras follow with 2.5-5 million TEU per year. More than 90% of European inland container shipping is connected with the ports of Rotterdam and Antwerp (container traffic is densest on the Rhine and its tributaries). The largest hinterland rail container flows are between the seaports of Hamburg, Bremen, Rotterdam and Antwerp and hinterland regions in central and southern Germany, Alpine countries and Northern Italy. Domestic container traffic in France is also heavy, with Le Havre being the most important container port.

Air cargo terminals

The main air cargo terminals on the FERRMED study area are presented in terms of current and future capacity (potential expansions), covered area, freight traffic and several other general data, which are considered of interest to the FERRMED Study. All information on the major air cargo terminals of the FERRMED area is summarized in the following Table.

Table 31: Air cargo terminal main characteristics

Terminal	Country	Cargo Dedicated Area (m^2)	Capacity ('000 tonnes)**	2007 Freight Traffic* (tonnes)	Plans for Future Expansion (m^2)
Brussels National Airport	Belgium	120,000	2,000	767,523	NA
Copenhagen Airport	Denmark	63,000	550	395,506 (airport's statistics)	Cargo terminal: 2,370

Terminal	Country	Cargo Dedicated Area (m^2)	Capacity ('000 tonnes)**	2007 Freight Traffic* (tonnes)	Plans for Future Expansion (m^2)
Paris Charles de Gaulle Airport	France	NA	2,000	1,434,619	No
Cologne Bonn Airport	Germany	NA	NA	738,281	Cargo hall and cargo centre: 42,000
Frankfurt Airport	Germany	510,000	4,500	2,210,743	Distribution hub: 840,000
Malpensa Milan Airport	Italy	NA	600	496,670	NA
Luxembourg Airport	Luxembourg	293,000	750	702,760	Train connection
Amsterdam Schiphol	Netherlands	375,000	1,800	1,498,514	Warehouses: 155,000
Aeroport Internacional El Prat de Barcelona	Spain	NA	300	97,881	New terminal, new runway
London Heathrow Airport	UK	340,200	NA	1,393,243	New runway

** Source: Eurostat*

***Source: a-z world airports (http://www.azworldairports.com/)*

Sea Ports

All information on the major seaports of the FERRMED study area is summarized in the following Table.

Table 32: Seaports main characteristics

Seaport	Country	Area (ha)	Capacity	2007 Container Traffic (TEU)	2007 Freight Traffic* ('000 tonnes)	Plans for Future Expansion (ha)
Port of Antwerp	Belgium	14,055	NA	7,878,920	165,512	Yes
Port of Zeebrugge	Belgium	NA	NA	1,190,971	34,843	Yes
Copenhagen-Malmö Port	Denmark and Sweden	200	NA	192,000	18,300	300
Port of Helsinki	Finland	NA	NA	431,000	11,885	225
Port of Turku	Finland	225	NA	21,982	3,956	6
Port Autonome de Marseille	France	NA	NA	1,058,472	92,552	Yes
Port Autonome du Havre	France	10,000	NA	2,684,698	78,856	53
Port of Dunkerque	France	NA	NA	194,777	50,244	Yes
Port of Hamburg	Germany	NA	NA	9,913,531	118,190	Yes
Port of Bremen	Germany	NA	NA	4,916,114	59,262	Yes
Port of Genova	Italy	500	NA	1,855,026	58,650	new railway junction
Port of Rotterdam	Netherlands	10,000	NA	10,773,401	374,152	1,000

Seaport	Country	Area (ha)	Capacity	2007 Container Traffic (TEU)	2007 Freight Traffic* ('000 tonnes)	Plans for Future Expansion (ha)
Port of Amsterdam	Netherlands	NA	NA	408,742	62,516	Yes
Groningen Seaports	Netherlands	1,658	NA	NA	7,805**	NA
Puerto de la Bahía de Algeciras	Spain	NA	NA	3,419,850	62,128	490
Port de Barcelona	Spain	829	NA	2,605,593	41,040	Yes
Puerto de Valencia	Spain	600	NA	3,048,903	45,935	Yes
Puerto de Cartagena	Spain	172	NA	46,880	23,843	Yes
Port de Tarragona	Spain	328	NA	47,138	35,802	NA
Port of Goteborg	Sweden	360	NA	840,868	40,353	Yes
Ports of Stockholm	Sweden	NA	NA	NA	8,900	65
Port of London	UK	NA	NA	857,751	52,739	607 Capacity: 3.5 million TEUs per year.
Port of Felixstowe	UK	324	NA	3,342,271	25,685	Yes
London Thamesport	UK	87	660,000 TEU	NA	NA	Yes
Harwich International Port	UK	97	NA	NA	NA	Yes

**Source: Eurostat*

*** Source: Groningen Seaports*

<u>Inland Ports</u>

Information on the major inland ports of the FERRMED Rail Network is summarized in the following Table.

Table 33: Inland ports main characteristics

Inland port	Country	Area (ha)	Capacity	2007 Container Traffic (TEU)	2007 Freight Traffic* ('000 tonnes)	Plans for Future Expansion (ha)
Port Autonome de Liège	Belgium	366	NA	NA	287	100 Capacity: 200,000 TEUs per year
Port de Rouen	France	NA	NA	NA	22,026	60
Port of Paris	France	1,100	NA	NA	NA	NA
Lyon Terminal	France	Not known	NA	137,000	1,317	Capacity to 200,000 TEUs per year

Inland port	Country	Area (ha)	Capacity	2007 Container Traffic (TEU)	2007 Freight Traffic* ('000 tonnes)	Plans for Future Expansion (ha)
Port de Strasbourg	France	1,370	NA	259,059	8,797 **	50
Port of Lille	France	300	NA	NA	NA	NA
Duisburger Hafen AG	Germany	1,356	NA	901,000	55,100	NA

**Source: Eurostat*

***Source: Port Authority of Strasbourg*

Inland terminals

The main inland terminals on the FERRMED study area are presented in the following Table.

Table 34: Inland terminals main characteristics

Inland terminal	Country	Area (ha)*	Capacity	Traffic	Plans for Future Expansion (ha)
Athus - Pôle Européen de Développement (PED)	Belgium	107	N/A	N/A	N/A
La Martinoire / Dry Port Mouscron-Lille International	Belgium	117	N/A	N/A	N/A
Tournai Ouest II	Belgium	127	N/A	N/A	N/A
Charleroi Dry Port	Belgium	40	N/A	N/A	N/A
Garocentre - La Louvière	Belgium	155	N/A	N/A	N/A
Villers-le-Bouillet	Belgium	142.26	N/A	N/A	N/A
Liege Logistics / Grâce-Hollogne		205	N/A	N/A	N/A
Hauts-Sarts / Milmort	Belgium	450	N/A	N/A	N/A
Eupen / Welkenraedt	Belgium	92	N/A	N/A	N/A
Ardenne Logistics	Belgium	80	N/A	N/A	N/A
Bastogne II	Belgium	33	N/A	N/A	N/A
TCT Belgium	Belgium	10	N/A	260,000 TEU (2007)	N/A
TTC – Taulov Transport Center	Denmark	210	N/A	N/A	N/A
Scandinavian Transport Center	Denmark	130	N/A	N/A	50
HTT – Hoeje Taastrup Transport Centre	Denmark	100	N/A	N/A	50
NTC- The Nordic Transport Centre	Denmark	80	N/A	N/A	N/A
DTC - Denmark's Transport Center	Denmark	32	N/A	N/A	N/A
Clesud	France	283.28	N/A	N/A	60 Capacity:9

Inland terminal	Country	Area (ha)*	Capacity	Traffic	Plans for Future Expansion (ha)
					million tons of freight
GARONOR	France	73	N/A	N/A	N/A
DIJON Bourgogne Logistics Pole	France	35	N/A	N/A	15
SOGARIS – Logistics Platform of Rungis, Paris	France	22	N/A	N/A	N/A
GVZ Berlin	Germany	616	N/A	N/A	N/A
GVZ Leipzig	Germany	600	N/A	N/A	Yes
GVZ Emsland	Germany	400	N/A	N/A	N/A
GVZ Erfurt	Germany	350	N/A	N/A	N/A
GVZ Regensburg	Germany	340	N/A	N/A	N/A
GVZ Nürnberg	Germany	337	N/A	14 million tons (2008), 255856 TEU	New terminal
GVZ Magdeburg	Germany	307	N/A	N/A	N/A
GVZ Lübeck	Germany	300	N/A	N/A	New terminal
GVZ Kiel	Germany	270	N/A	N/A	N/A
GVZ Frankfurt/ Oder	Germany	237	N/A	N/A	N/A
GVZ Koblenz	Germany	210	N/A	N/A	N/A
GVZ Köln	Germany	167	N/A	N/A	N/A
GVZ Augsburg	Germany	115	N/A	N/A	N/A
GVZ Rheine	Germany	114	N/A	N/A	N/A
GVZ Salzgitter	Germany	110	N/A	N/A	N/A
GVZ Kornwestheim/Stuttgart	Germany	96	N/A	N/A	N/A
GVZ Kassel	Germany	75	N/A	N/A	N/A
GVZ Rostock	Germany	68	N/A	N/A	N/A
GVZ Trier	Germany	66	N/A	N/A	N/A
GVZ Ulm	Germany	60	N/A	N/A	N/A
GVZ Ingolstadt	Germany	52	N/A	N/A	N/A
GVZ Hannover-Lehrte	Germany	35	N/A	N/A	N/A
GVZ Emscher	Germany	23	N/A	N/A	N/A
GVZ Hamburg	Germany	20	N/A	N/A	N/A
Germersheim	Germany	11	220,000 TEUs	N/A	N/A
Interporto di Torino	Italy	300	NA	3,000,000 tons of cargo per year	50
Interporto di Verona	Italy	250	NA	6,661,433 tons (2008)	60
Interporto di Bologna	Italy	200	8,000 TEUs handling volume: 127,000 loading units	N/A	270 Capacity: 300,000 loading units
Interporto di Rivalta Scrivia	Italy	125	N/A	N/A	N/A

Inland terminal	Country	Area (ha)*	Capacity	Traffic	Plans for Future Expansion (ha)
Interporto di Novara	Italy	84	N/A	110 trains loaded per week	158
Eurohub South	Luxembourg	50	N/A	N/A	N/A
Eurohub Centre	Luxembourg	18	N/A	N/A	N/A
Tilburg	Netherlands	809	N/A	N/A	N/A
Oosterhout	Netherlands	696	N/A	N/A	N/A
Eindhoven	Netherlands	596	N/A	N/A	N/A
Venlo	Netherlands	584	N/A	N/A	N/A
Almere	Netherlands	553	N/A	N/A	N/A
Tiel	Netherlands	470	N/A	N/A	N/A
Roosendaal	Netherlands	428	N/A	N/A	N/A
Breda	Netherlands	422	N/A	N/A	N/A
Utrecht	Netherlands	356	N/A	N/A	N/A
Veghel	Netherlands	336	N/A	N/A	N/A
Alphen-Waddinxveen	Netherlands	309	N/A	N/A	N/A
Schiphol	Netherlands	267	N/A	N/A	N/A
Nijmegen	Netherlands	242	N/A	N/A	N/A
Venray	Netherlands	170	N/A	N/A	N/A
Groningen Railport (Veendam)	Netherlands	44	N/A	60,000 TEU annually	N/A
Logistic Centres in the Madrid Region	Spain	324**	N/A	N/A	3,800
Logistic Centres in Aragon	Spain	1,530**	N/A	N/A	56.36
CITMUSA Murcia	Spain	85	N/A	N/A	N/A
Logistic Centres in Catalonia Region	Spain	730**	N/A	N/A	9
CTM Malaga	Spain	23	N/A	N/A	63

**Source: Different sources*

***Source: Institute Cerdà (from Transmarket Report – 2005)*

In fact, in addition to these multi-customers terminals it is important to take into account, as well, the industrial private terminals, in the case of important companies, not included in this table.

Recommendations on future needs for freight terminals in the study area

In order to estimate the future needs in terminal space, the data used is the freight volumes for the year 2005 (base year) as they are inserted in the traffic model and the model estimation for the freight volumes for the target year 2025 (full scenario). This data is estimated for NUTS regions.

The freight traffic volumes (imports, exports, internal) in tonnes for the years 2005 and 2025 (full scenario) are presented in the following Table for the corresponding NUTS region.

Table 35: Freight traffic volumes in tonnes for the years 2005 and 2025

NUTS	2005 TRAFFIC			2025 TRAFFIC		
	IMPORTS	EXPORTS	INTERNAL	IMPORTS	EXPORTS	INTERNAL
BE	**586,255,603**	**608,821,290**	**229,029,048**	**1,087,328,882**	**1,013,101,118**	**332,018,990**
BE1	30,233,505	24,733,229	4,172,792	49.178,019	39,623,668	5,227,168
BE2	429,312,460	442,225,063	167,124,564	836,152,796	774,122,394	254,188,729
BE3	126,709,638	141,862,998	57,731,692	201,998,067	199,355,056	72,603,093
CH	**123,148,031**	**103,342,076**	**238,706,793**	**188,964,224**	**157,083,218**	**355,362,195**
DE	**1,695,996,708**	**1,648,042,112**	**1,687,068,337**	**2,499,091,689**	**2,312,743,396**	**2,159,717,957**
DE1	185,906,047	176,246,147	232,566,032	257,321,988	236,627,412	294,691,891
DE2	111,461,809	102,378,703	152,665,692	158,162,843	135,142,278	193,225,895
DE3	38,712,581	22,685,878	26,373,362	56,259,094	30,357,639	33,442,989
DE4	57,342,261	55,133,406	84,263,023	85,432,127	76,007,040	106,586,845
DE5	49,908,397	46,479,677	16,442,944	97,550,089	85,382,989	26,099,516
DE6	109,733,292	104,145,827	49,824,902	215,188,079	191,079,374	78,350,604
DE7	111,638,039	95,390,891	91,275,406	146,440,392	124,210,393	115,603,866
DE8	28,616,783	23,525,162	67,291,573	43,113,126	32,807,922	85,338,098
DE9	238,150,939	222,020,447	197,128,603	358,764,990	331,711,316	253,560,244
DEA	479,049,272	498,470,906	377,111,763	675,825,678	662,132,329	477,146,445
DEB	90,809,050	94,964,421	96,200,747	121,790,881	126,372,088	121,683,848
DEC	20,320,178	20,033,985	30,114,355	33,074,360	27,779,037	37,940,444
DED3	18,016,950	16,784,523	29,646,535	27,133,974	22,235,080	37,450,010
DEE	53,899,957	63,666,156	85,165,932	73,578,791	82,474,647	107,569,591
DEF	59,174,839	57,087,745	60,750,180	90,385,883	84,037,471	76,883,402
DEG	43,256,315	49,028,236	90,247,290	59,069,396	64,386,380	114,144,269
DK	**73,437,811**	**72,732,590**	**176,440,949**	**147,145,574**	**120,871,041**	**222,091,960**
ES	**426,915,347**	**414,138,833**	**1,097,634,470**	**663,516,534**	**639,251,565**	**1,703,927,638**
ES24	50,832,978	51,625,795	47,089,978	77,932,978	77,006,562	69,737,695
ES3	91,228,766	65,626,188	99,367,461	146,063,556	95,791,433	147,074,699
ES42	58,519,581	74,396,034	75,602,458	88,461,298	111,848,410	112,134,575
ES5	151,248,583	149,230,264	582,889,582	238,800,503	243,617,255	912,165,634
ES6	75,085,439	73,260,552	292,684,990	112,258,199	110,987,906	462,815,034
FL	**65,513,631**	**56,577,458**	**232,276,912**	**93,278,523**	**78,498,660**	**344,162,410**
FR	**834,711,263**	**813,586,942**	**1,235,954,622**	**1,302,067,774**	**1,185,941,398**	**1,761,931,626**
FR1	109,915,624	85,038,909	155,450,450	165,873,694	121,379,463	213,197,664
FR2	270,889,697	284,343,949	311,027,088	415,288,177	415,216,289	446,038,064

NUTS	2005 TRAFFIC			2025 TRAFFIC		
	IMPORTS	EXPORTS	INTERNAL	IMPORTS	EXPORTS	INTERNAL
FR3	114,505,742	114,878,666	102,316,953	200,343,223	161,462,310	176,557,789
FR4	111,507,267	125,053,213	192,771,488	167,047,122	175,619,239	264,575,199
FR6	38,148,244	33,992,459	92,506,983	55,036,556	47,124,197	126,853,249
FR7	84,320,212	81,215,993	199,181,226	123,231,969	116,131,585	273,093,978
FR8	105,424,476	89063,753	182,700,434	175,247,032	149,008,315	261,615,684
LI	**816,509**	**813,125**	**0**	**982,106**	**963,065**	**0**
LU	**55,750,562**	**17,169,553**	**28,250,024**	**36,533,498**	**24,872,750**	**44,323,611**
NL	**816,182,386**	**834,046,579**	**438,941,445**	**1,636,870,621**	**1,523,848,306**	**550,698,336**
NL1	62,633,626	55,816,821	36,536,145	113,712,101	84,026,304	48,253,014
NL2	119,495,565	111,976,297	65,883,785	203,913,009	148,881,056	80,062,486
NL3	485,773,110	492,948,131	246,026,680	1,058,777,186	1,048,092,049	311,598,088
NL4	148,280,085	173,305,330	90,494,835	260,468,325	242,848,898	110,784,747
NO	**46,147,240**	**46,178,046**	**90,275,240**	**65,838,869**	**68,247,022**	**134,641,720**
SE	**109,900,057**	**113,941,243**	**277,625,301**	**167,827,265**	**176,085,525**	**441,352,440**
UK	**229,189,200**	**207,244,574**	**148,388,378**	**344,076,059**	**298,931,017**	**214,288,266**
IT	**554,483,121**	**514,715,846**	**700,021,091**	**783,667,469**	**698,787,108**	**928,537,521**
Total	**5,618,447,469**	**5,451,350,268**	**6,580,612,610**	**9,017,189,085**	**8,299,225,190**	**9,193,054,670**

The freight traffic volumes in tonnes for the years 2005 and 2025 mainly served through terminals are imports and exports and are presented in the following Table. Moreover, for the purpose of this study the level of the analysis is the state level (per country). As a result, the last column demonstrates the increase (or decrease) of freight traffic for the correspondent state region according to the outcome of the traffic model.

Table 36: Imports and exports volumes in tonnes for the years 2005 and 2025

Country	Imports and Exports for 2005	Imports and Exports for 2025	Increase
BE	1,195,076,893	2,100,430,000	1,76
CH	226,490,107	346,047,442	1,53
DE	3,344,038,820	4,811,835,085	1,44
DK	146,170,401	268,016,615	1,83
ES	841,054,180	1,302,768,099	1,55
FL	122,091,089	171,777,183	1,41
FR	1,648,298,205	2,488,009,172	1,51
LI	1,629,635	1,945,171	1,19
LU	72,920,115	61,406,248	0,84
NL	1,650,228,966	3,160,718,927	1,92
NO	92,325,286	134,085,891	1,45

Country	Imports and Exports for 2005	Imports and Exports for 2025	Increase
SE	223,841,300	343,912,790	1,54
UK	436,433,774	643,007,076	1,47
IT	1,069,198,967	1,482,454,577	1,39
Total	**11,069,797,737**	**17,316.414,275**	**1,56**

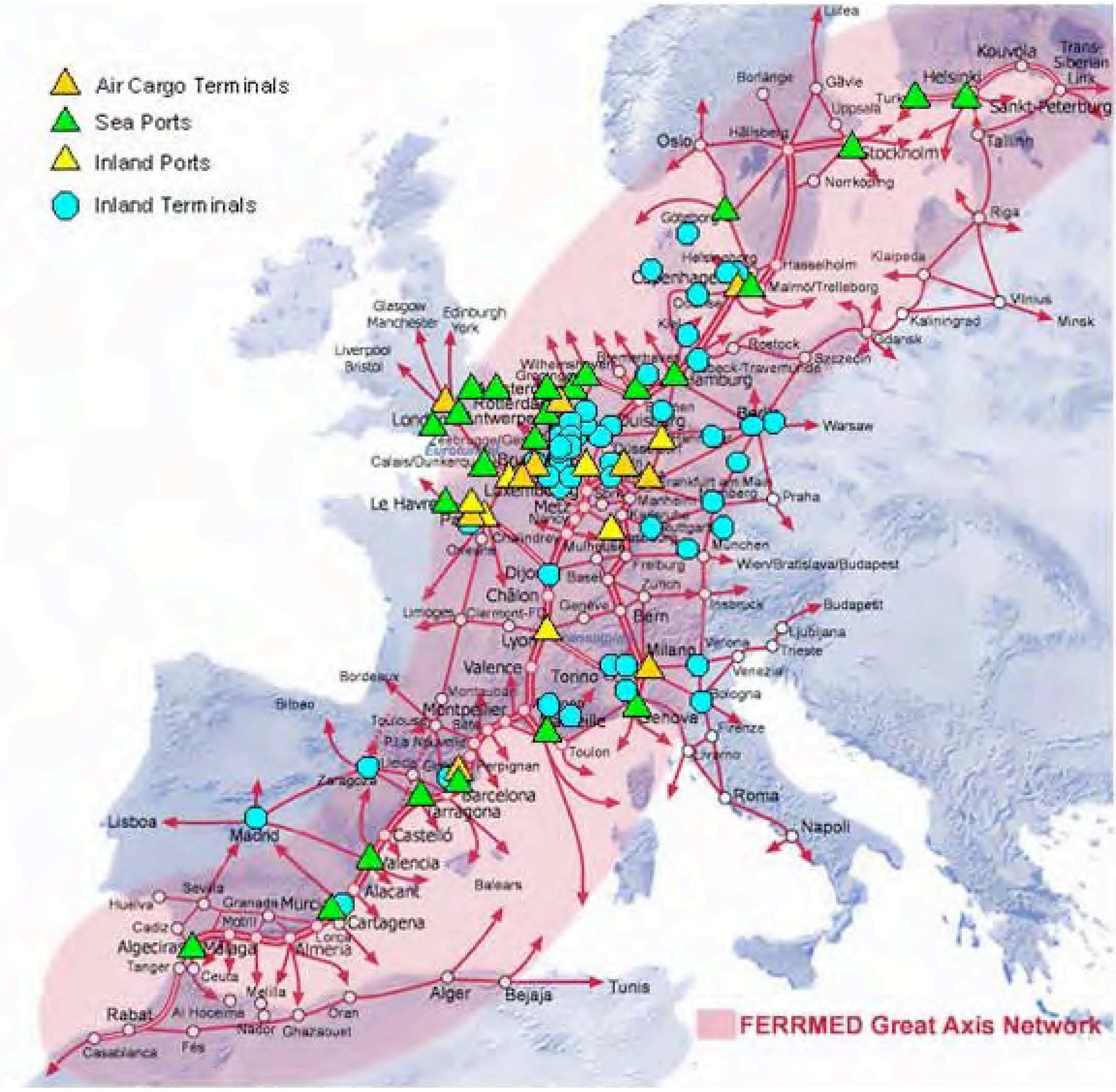
Based on the assumption that all the main terminals in the influence area of FERRMED Rail Network were detected, the assumption that the freight traffic volumes presented are served through those terminals is made.

After taking the aforementioned into consideration, the assumption made is that the increase of freight traffic volumes can be transposed into an increase of area dedicated to freight, such as terminals. The most important outcome is that the area of terminals must be increased by 1.56 in total, although this increase is not equally distributed in every country, since the freight traffic volumes' increase is not estimated to be equal for every country.

Moreover, the future need for terminals' area may be increased by the same factor for two countries, but the initial freight traffic volumes play a very important role in the calculation of the area required. An additional parameter that must be taken into consideration is the expansion planned to be completed until the year 2025 from the owners of the existing terminals and the present offered area not in use, as listed in the previous chapter, which is not included in the needs (in terms of space) suggested.

For the base year situation, the main terminals are demonstrated in the following Figure.

Figure 26: Summary of Main terminals on the study area



By observing the above figure, it can be detected that some areas seem to be lacking significant main terminals. These areas consist of regions mostly in France, Spain, Germany and Italy. Also, some smaller needs are detected in Sweden, Netherlands, Switzerland and Belgium. Finally, it is noted that there are some more areas which seem to have minor needs in all countries influenced by FERRMED Rail Network, which will be increased through the years due to the increase of freight traffic volumes and the promotion of the Axis. The areas with lack of terminals are presented in the following Table.

Table 37: Areas with lack of terminals

Country	Areas/ cities
BE	Antwerp, Zeebrugge, Gent, Liege, Brussels
CH	Basel, Bern, Zurich, Geneva, Innsbruck
DE	Lubeck, Bremen/ Bremenhaven, Rurh, Koblenz, Mainz/ Frankfurt, Ludwigshaven. Mannheim, Karlsruhe, Hannover, Berlin, Frankfurt, Nurnberg, Stuttgart, Ulm, Munchen
DK	Copenhagen, Jutland
ES	Figueras/Girona, Barcelona, Tarragona/Reus, Castello, Valencia, Alacant, Cartagena, Lorca/Totana, Almeria, Motril, Malaga, Algeciras, Granada, Antequera, Sevilla, Lleida, Zaragoza, Pamplona, Bilbao, Madrid, Cordoba, Linares, Sagunt, Albacete
FL	Turku, Helsinki
FR	Dunkerque, Calais, Lille, Metz, Dijon, Le Havre, Rouen, Amiens, Reims, Langres, Paris, Nancy, Lyon, Valence, Nimes, Montpelier, Marseille, Perpignan, Toulouse, Strasbourg, Clermont, Mulhouse, Grenoble, Nice
LU	Luxembourg
NL	Amsterdam, The Hague, Rotterdam, Utrecht
SE	Stockholm, Hallsberg, Jokoping, Helsingborg/ Malmo
UK	London
IT	Torino, Milano, Rivalta Scrivia, Verona, Padova, Mestre, Trieste, Genoa, Savona, Livorno, Firenze, Roma, Bologna

The implementation cost of all these dedicated to freight traffic areas can be determined after having calculated the building cost per hectare (unit cost). This is done by analysing the various investment costs for the creation of a terminal, which result from the required area and the infrastructure, storage spaces and other building facilities and equipment, which are necessary in order to accommodate the attracted freight transport flows.

Regarding the cost of implementation, through rough calculations for terminal expansion costs (or creation of new ones), based on previous studies and on actual terminal infrastructure costs, it is calculated to be approximately 48 billion Euros in the 2025 full scenario. Consequently, the cost of implementation for the 2025 medium scenario is 42 billion Euros and for the 2020 medium scenario is 30 billion Euros.

It is mentioned that the above are investment costs. Maintenance costs are around 1.5% annually and the investment life period is 25 years for buildings (around 85% of total cost) and 15 years for terminal facilities (cranes etc), which account for 15% of total cost. Also, it is noted that all the above figures are based on general calculations and cannot be applied to each individual terminal.

6. TECHNICAL ANALYSIS

Analysis of technical FERRMED "standards"

Track width

In Europe and worldwide, the standard track gauge (1,435 mm) is mostly used. It accounts to 66% of the world-network, to 80 % in the FERRMED-network (base year).

Broad gauge refers to any gauge wider than standard gauge. Russian (1,520 mm), Finish (1,524 mm) and Iberian gauges (1,668 mm) are all broad gauge networks.

It is necessary to apply standard track width all over the Study area, apart from the case of Finland. The Finish rail network is linked with the Russian network and the other East countries which have similar track width characteristics (1,524 mm).

Except if the whole network is changed, there will be always a lack of interoperability with the remaining part of the network. Moreover it will be necessary to change the powered axles of the engines and the wheelset of coaches and wagons for all rolling stock running on the network changed from broad to standard gauge.

The implementation of a dual gauge may be a solution. The lines have 3 rails, one set of two forming a standard gauge line, with the third rail either inside or outside the standard set forming rails at either narrow or broad gauge. Thus trains built to either gauge can use the line.

However its implementation is a complex and costly operation. All the sleepers and switches have to be changed. Moreover this system requires more space, especially in the stations where switches are numerous.

Furthermore some security cases are not solved like speed control. Balises and loops concerning speed control are read by the under engine antenna only by UIC gauge trains and not by Iberic gauge trains because the median axle is not the same.

Therefore, dual gauge can be implemented only on some short feeders to complete the UIC network, but not on main lines with many trains.

Loading gauge

Loading gauges are often defined differently by each country making their direct comparison difficult. However, UIC has defined a general set of gauges that has been used for this study, namely UIC GA, UIC GB, UIC GB1, UIC GB2 and UIC GC. These gauges have all the same width, 3.29 m and they differ only in their high parts, 4.35 m for GA and GB with a different upper circular section, 4.70 m for the GC with almost a square section.

The UIC GA is the basic gauge and the smallest one. Nevertheless, it is possible to transport traditional containers (8 ft and 8 ft, 6'' = 2 600 m in height) on standard wagons. The High-cube containers (9' 6''- 2.9 m in height) fit in gauge GB when they are loaded on wagons "C" (UTI standard carrier).

Subclasses UIC GB1 and GB2 permit as well the transport of large containers such as seaborne containers. The UIC GC is the largest gauge and is required for all the new lines in Europe. This gauge permits the loading of road trailers or heavy goods vehicles on standards wagons.

In Europe, all the countries of the Central Europe railway Union and the Scandinavian networks have a rather generous gauge which foreshadowed GC gauge, whereas the networks of the south, which dealt with a more mountainous terrain, originally adopted more restricted gauges. Great Britain constitutes a particular case because it preserved a reduced gauge in height and in width.

FERRMED Association proposes the upgrade of the whole network to UIC C gauge (GC). However in order to reduce initial investment costs, the Study Team has proposed to primarily upgrade the network towards UIC GB1 until 2025. Indeed, the upgrade from gauge UIC GA or UIC GB toward UIC GB1 is less costly than the upgrade to UIC GC because in many cases it is technically not possible to upgrade the loading gauge from GB to GC in particular in the case of old tunnels.

On the other hand, it should be along term vision to obtain a network complying with the UIC GC standard. Therefore new projects should comply with this larger gauge. This is already the case with the European rules: all the new lines must be built with C gauge.

Axle load

FERRMED association proposes to upgrade the network to a maximum axle load of 25 t per axle in order to carry a higher load per wagon to a given length of train, and also to reduce the operational costs by load value unit (less staff, less hauling resources, less train-path use) and finally to improve the socio-economic evaluation by load value unit.

This upgrade implies the modification of the rolling stock and of some components of the infrastructure and as a consequence requires a very costly update of 19 453 km, or 94% of the network. On the other hand, the operational gain by this upgrade remains limited.

In order to reduce investment costs, it is proposed to upgrade the network to 22.5 t axle load. In this case only 434 km (2% of the network) needs to be upgraded. However, in order to allow a long term upgrade to 25 t axle load, it is proposed to build all new lines in the FERRMED network according to this standard and should also be considered when existing lines are significantly modified in their superstructure.

Signalling

Control-Command and Signalling systems (CCS) usually varies from country to country and are rarely compatible. In the 13 FERRMED countries under consideration this results in 19 different automatic train warning / stop systems.

Since an international train has to be compatible to the CCS of the countries it travels in, the locomotive needs to be equipped with several technical systems. This requires large investments on rolling stock. Alternatively it is possible to exchange the locomotive at border crossings resulting in shunting costs and an increase in the overall travel time.

Due to these reasons, the current control-command and signalling systems are a major barrier for interoperability. Therefore the European Union, the railway industry and railway operators have supported the development of a new common and interoperable system. The European Rail Traffic Management System (ERTMS) shall facilitate cross-border traffic in the future. It consists mainly of two subsystems, the communication system GSM-R and the signalling and train control system ETCS (European Train Control System) in one of its levels. The third component of complete ERTMS is traffic management system as Europtirail.

It is proposed to upgrade all lines of the FERRMED-network without ETCS installation to ETCS Level 2. If a national plan proposes to upgrade a line to a lower level (Level 1 or Level 1 Limited Supervision) no upgrade to Level 2 shall be performed unless deemed necessary due to capacity reasons.

Electrification

Infrastructure investments aiming at the supply of electric energy are high. A rough estimate made is 2.4 M€ per km of double-track line, including substations and their connection with the electric high voltage network, however, once these investments have been undertaken, electric traction is cost-efficient. Electrified locomotives have very good performance (e.g. good degree of efficiency, good power-weight ratio, possibility of regenerating brake energy – especially for passenger trains, less important for freight train, etc).

Due to these savings on operating costs, FERRMED-association proposes the electrification of the whole FERRMED-network. This electrification does not only benefit “FERRMED-trains”, but other trains on the respective line as well.

FERRMED Association wants as well to have the maximum interoperability level in Red Banana Network. In that sense, modern and efficient diesel locomotives are good complement to electric ones.

Due to technical constraints in the past and different time periods of the electrification, four major types of electrification are implemented within the European railway network. Other electrification types exist, but are of secondary importance. The electrification type often differs according to the country, but sometimes even one country can have more than one electrification type. The major electrification types are as following:

- 1.5 kV DC
- 3.0 kV DC
- 15 kV, 16.2/3 Hz AC
- 25 kV, 50 Hz AC
- 750 V third rail (this system is present in the south of England)

Traditionally electric locomotives have been designed for a particular electrification type and until recently, most of them were not interoperable between the different electric networks. Nowadays, multi-system locomotives exist. They can comply with two or even more different electrical systems. Therefore the interoperability problems resulting from different electricity systems are reduced by today's technology. Nevertheless, each electrification type has its advantages and disadvantages.

The 1.5 kV and 3.0 kV direct current, mainly 1.5 kV DC electricity system, are characterised by low voltages and high amperage, resulting in high energy losses on the line. The 15 kV, 16 2/3 Hz system applies a frequency not used in the national electricity networks and therefore requires either transformation of the 50 Hz national system to the 16.2/3 Hz railway system or needs an independent railway power supply. Both solutions bring extra costs to the infrastructure operator.

Nowadays, despite some minor disadvantages, the most modern electrification system is based on 25 kV, 50 Hz. However, when choosing the power type it is important to consider the national standards in order to allow an easy access of local trains that are not multi-current. The proposals for the new electrification of railway lines will consider these aspects when choosing power type.

Maximum train length

The average length of freight train running on the 13 countries concerned by FERRMED is around 400 m – 450 m. Running longer trains increases the railway network's capacity (in terms of freight volume) and reduces transportation costs. The FERRMED Association proposes to upgrade the network to a maximum train length of 1,500 m. However, this requires the modification of nearly the entire network. Marshalling yards, ports and terminals must be equipped with long tracks up to 1,500 m. Along the route used by very long freight train, it is necessary to implement longer garage sidings in case of mechanical failure (e.g. heating of the wagon axle box) or to allow faster trains (regional or intercity passenger train).to overtake slower trains (freight trains).

In addition, the feasibility of such long trains cannot be guaranteed at this moment. In order to reduce investment costs considerably and in order to guarantee the technical feasibility, a gradual implementation of maximum train length of 1,500 m is proposed for the FERRMED core network and main feeders, keeping 750 m for the all remaining Red Banana network. Beyond and up to 1,500 m for heavy trains, it is necessary to change the coupling and the braking system of the wagons.

Maximum line gradient

Any upgrade of a line towards a lower gradient requires the rerouting and reconstruction of major parts of the line. However, any rerouting and reconstruction of a line will be very costly, since lines with a high gradient are usually in a topographically very difficult area (mountains, etc.). In many cases, an upgrade towards a lower gradient will technically not be feasible for a reasonable price (e.g. it could require the construction of helical tunnels or base tunnels which are longer than summit tunnels).

Due to these reasons no realistic upgrade strategy exists for most of the gradient-critical line sections. In case of the construction of new lines, however, it is recommended to construct them with no more than 12‰ whenever feasible, with some exceptions up to 15‰ on short distances (few hundred metres). Short sections with a large gradient do not have the same impact on a long train as the same gradient on a section of a few kilometres. The “determining gradient” takes this aspect into account and therefore is the base of the analysis in this study.

Maximum train load

Since the maximum force supported by the current European coupling system is fairly low. It is not advisable to load trains more than 2,500 tons with the screw coupler whereas with an automatic coupler it is possible to reach 10,000 tons. With the screw coupler, even UIC reinforced coupler, the train load needs to be limited. Hence, the main limiting factor to an increase in train load is the rolling stock and its coupling system.

It would be technically possible to equip freight cars with a new, modern coupling system and hence increase maximum train load. This is already done outside of Western Europe and in some special cases within Europe. However, the coupling system currently in use is standardized in Europe which allows compatibility for different freight cars. If the rolling stock is upgraded it is therefore preferable to upgrade it throughout Europe (not only on the FERRMED Great Axis Network) in order to maintain this compatibility.

Alternatively it is possible to place intermediate or rear locomotives in order to reduce the maximum force on the coupling system and hence increase. However, this complicates operation and therefore is not very frequent on European railway lines. In case of intermediate and rear locomotives should be used on a regular basis, it would be preferable to radio-control these locomotives. However, no such radio-control system is currently employed on a regular basis in Europe.

Since maximum train load is mainly limited by rolling stock, an upgrade strategy of the infrastructure is not relevant. An upgrade of the coupling system would be helpful. In that sense, the gradual incorporation of automatic couplings in rolling stocks is considered in the different FERRMED Scenarios. FERRMED Association should also push towards the development of a radio control of locomotives. Such a radio control would also help operating trains of 1500 m length which should remain a 2025 objective of FERRMED association.

7. INFRASTRUCTURE COSTS

Bottlenecks: identification and potential solutions

The number of bottlenecks detected for each scenario is presented in the next Table. As it can be observed, for the “medium” scenarios, the bottlenecks number is higher than for the “full” scenarios, due to the fact that the freight trains’ length is shorter and for the same freight volume, is carried by more trains.

Table 38: Bottlenecks detected per scenario

Country	Scenario				
	2020 Reference	2020 Medium	2025 Reference	2025 Medium	2025 Full
Finland	1	1	1	1	1
Sweden	1	3	3	3	3
Norway	1	1	1	1	0
Denmark	1	0	0	0	0
Germany	2	2	5	6	2
Netherlands	0	0	0	0	0
Belgium	0	0	0	0	0
Luxembourg	0	0	0	0	0
United Kingdom	0	0	0	0	0
France	3	3	6	8	2
Switzerland	4	4	5	5	2
Italy	4	4	5	4	3
Spain	0	0	3	3	1
Total number of bottlenecks	**17**	**18**	**29**	**31**	**14**

Bottleneck decrease
No change
Bottleneck increase

No additional bottlenecks were detected in the other two scenarios (ports and objective achieved).

In the following table, the links where the bottlenecks are detected, the country, the length of the link, the bottleneck justification and the potential solutions are presented for each of the scenarios (2020 reference and medium, 2025 reference, medium and full scenario).

Concerning the 2020 reference scenario, 17 links with bottlenecks have been identified, with a total length of 641.7 kilometres.

Table 39: 2020 reference scenario bottlenecks

No	Link	Country	Length (km)	Reason for bottleneck	Potential Solution(s)
1	Kirkkonummi-Naantali	Finland	166.0	Single track	Favour just one direction of traffic with the Toijala-Humppila line or Double track
2	Laxa-Charlottenberg	Sweden	88.5	Single track	Double track
3	Oslo-Sarpsborg	Norway	103.2		Block system improvement
4	Viersen-Venlo	Germany	1.5		Use alternative route via Emmerich (180 trains/day) or double track in totality
5	Weinheim-Karlsruhe	Germany	12.3	Insufficient number of tracks	Use between Darmstadt and Mannheim parallel North-South routes West of main line.
6	Lenzburg-Othmarsingen	Switzerland	2.0	Insufficient number of tracks	Construction of additional tracks
7	Mühle Horn tunnel / Sargans	Switzerland	15.3	Single track tunnel	Second parallel tunnel; tunnel length only 133 m, rest of the line is already double-tracked
8	Bern-Thörishaus	Switzerland	7.0	Very high traffic	Construction of a third track
9	Lausanne - Geneva	Switzerland	54.3	High traffic	Construction of a third track
10	Milan-Monza	Italy	9.6	Block system	Improve block system into ERTMS at least or two tracks more
11	Savona-Ceva	Italy	24.8	Single track, block system, high slope (30‰)	Block system improvement (ERTMS)
12	Finale Ligure- San Lorenzo al Mare	Italy	51.7	Single track. Block system	Improve block system into Automatic block System or double track.
13	Genova-La Spezia	Italy	20.0	Block system	Block system improvement (ERTMS)
14	Bailleul-Lille	France	28.2	Block system	Block system improvement (ERTMS)
15	Lens-Valenciennes	France	30.8	Block system	Block system and railway nodes improvement
16	Lyon	France	5.3	Too many trains in Lyon's node of Lyon Part-Dieu	ERTMS L1 + use the future complete CFAL by-pass
17	Avignon-Tarascon	France	21.2	Block system	Block system improvement (ERTMS)
		Total	**641.7**		

Regarding the 2020 "medium" scenario, 18 links presenting bottlenecks are listed in the next Table, with a total length of 722.6 kilometres.

Table 40: 2020 medium scenario bottlenecks

No	Link	Country	Length (km)	Reason for bottleneck	Potential Solution(s)
1	Kirkkonummi-Naantali	Finland	166.0	Single track	Favour just one direction of traffic with the Toijala-Humppila line or Double track
2	Stockholm-Hovsta	Sweden	37.3	Single track	Double track
3	Göteborg-Herrljunga	Sweden	78.2		- Block system improvement - Reduce the X2000 speed or increase the freight trains speed
4	Laxa-Charlottenberg	Sweden	88.5	Single track	Double track
5	Oslo-Sarpsborg	Norway	103.2		Block system improvement
6	Viersen-Venlo	Germany	1.5		Use alternative route via Emmerich (180 trains/day) or double track in totality
7	Darmstadt-Karlsruhe	Germany	12.3	Insufficient number of tracks	Use between Darmstadt and Mannheim and between Darmstadt and Wörth parallel North-South routes on West side and East side of the main line.
8	Lenzburg-Othmarsingen	Switzerland	2.0	Insufficient number of tracks	Construction of additional tracks
9	Mühle Horn tunnel / Sargans	Switzerland	15.3	Single track tunnel	Second parallel tunnel; tunnel length only 133 m, rest of the line is already double-tracked
10	Bern-Thörishaus	Switzerland	7.0	Very high traffic	Third track construction
11	Lausanne - Geneva	Switzerland	54.3	high traffic	Third track construction
12	Milan-Monza	Italy	9.6	Signalling	Euroloops implementation at least or two tracks more
13	Bottarone-Tortona	Italy	16.2	Signalling	Third track construction
14	San Giuseppe-Ceva	Italy	24.8	Single track, high slope (30‰)	Euroloops implementation
15	Finale Ligure- San Lorenzo al Mare	Italy	51.7	Single track. Block system	Euroloops implementation + sidings or double track.
16	Bailleul-Lille	France	28.2	Signalling	Euroloops implementation
17	Lyon	France	5.3	Too many trains in Lyon's node of Lyon Part-Dieu	ERTMS L1 with Euroloops + use the future complete CFAL by-pass
18	Avignon-Tarascon	France	21.2	Block system	Block system improvement (ERTMS)
		Total	**722.6**		

Regarding the 2025 reference scenario, 29 links with bottlenecks are identified, with a total length of 1,807.1 kilometres.

Table 41: 2025 reference scenario bottlenecks

No	Link	Country	Length (km)	Reason for bottleneck	Potential Solution(s)
1	Kirkkonummi-Naantali	Finland	166.0	Single track	Favour just one direction of traffic with the Toijala-Humppila line or Double track
2	Stockholm-Hovsta	Sweden	187.0	Lack of line capacity, Single track	Block system improvement, Double track
3	Göteborg-Herrljunga	Sweden	78.2		- Block system improvement - Reduce the X2000 speed or increase the freight trains speed
4	Laxa-Charlottenberg	Sweden	207.4	Single track	Double track
5	Oslo-Sarpsborg	Norway	103.2		Block system improvement
6	Hambourg-Elmshorn	Germany	41.1	Local bottlenecks (stations) and insufficient number of tracks	Use North-Eastern alternative route via Bad Oldesloe to Neumünster (line with 57 to 68 trains/day).
7	Viersen-Venlo	Germany	18.0	Single track	Use alternative route via Emmerich (180 trains/day) or double track in totality
8	Aachen-Herzogenrath	Germany	12.8	Local bottlenecks and tunnel	Rehabilitation of existing tunnel and removal of local bottlenecks
9	Weinheim-Karlsruhe	Germany	67.2	Insufficient number of tracks	Use between Darmstadt and Mannheim parallel North-South routes West of main line.
10	Koblenz-Königsbach	Germany	1.3	Insufficient number of tracks	Use an alternative route
11	Lenzburg-Othmarsingen	Switzerland	2.0	Insufficient number of tracks	Construction of additional tracks
12	Mühle Horn tunnel / Sargans	Switzerland	15.3	Single track tunnel	Second parallel tunnel; tunnel length only 133 m, rest of the line is already double-tracked
13	Bern-Thörishaus	Switzerland	7.0	Very high traffic	Construction of a third track
14	(Basel -) Muttenz - Frick (- Zurich)	Switzerland	48.3	High traffic	Construction of a third track
15	Lausanne - Geneva	Switzerland	54.3	High traffic	Construction of a third track
16	Milan-Monza	Italy	9.6	Block system	Improve block system into ERTMS at least or two tracks more
17	Milan-Tortona	Italy	70.7	Lack of line capacity	Improve ERTMS with euroloops + additional track. It would increase the theoretical capacity to 320/360 trains.
18	Savona-Ceva	Italy	42.2	Single track, block system, high slope (30‰)	Block system improvement (ERTMS)
19	Finale Ligure- San Lorenzo al Mare	Italy	51.7	Single track. Block system	Improve block system into Automatic block System or double track.
20	Genova-La Spezia	Italy	99.0	Block system	Block system improvement (ERTMS)

No	Link	Country	Length (km)	Reason for bottleneck	Potential Solution(s)
21	Tardienta - Lérida	Spain	127.3	Single track	Block system improvement (ERTMS)
22	Cerdanyola-Mollet	Spain	22.0	Single track	Double track implementation
23	El Burgo de Ebro - Falset	Spain	182.0	Single track	Block system improvement (ERTMS)
24	Bailleul-Lille	France	28.2	Block system	Block system improvement (ERTMS)
25	Lens-Valenciennes	France	59.6	Block system	Block system and railway nodes improvement
26	Lyon	France	5.3	Too many trains in Lyon's node of Lyon Part-Dieu	ERTMS L1 + use the future complete CFAL by-pass
27	Moirans-Grenoble	France	21.1	Too many trains + Block system	Block system improvement + possibly a third track
28	Avignon-Tarascon	France	21.2	Block system	Block system improvement (ERTMS)
29	Carcassonne-Narbonne	France	58.1	Block system	Block system improvement (ERTMS)
		Total	**1,807.1**		

With reference to the 2025 medium scenario, 31 links with bottlenecks are listed in the following Table, with a total length of 1,583.5 kilometres.

Table 42: 2025 medium scenario bottlenecks

No	Link	Country	Length (km)	Reason for bottleneck	Potential Solution(s)
1	Kirkkonummi-Naantali	Finland	166.0	Single track	Favour just one direction of traffic with the Toijala-Humppila line or Double track
2	Stockholm-Hovsta	Sweden	187.0	Lack of line load, Single track	Block system improvement, Double track
3	Göteborg-Herrljunga	Sweden	78.2		- Block system improvement - Reduce the X2000 speed or increase the freight trains speed
4	Laxa-Charlottenberg	Sweden	207.4	Single track	Double track
5	Oslo-Sarpsborg	Norway	103.2		Block system improvement
6	Hambourg-Elmshorn	Germany	41.1	Local bottlenecks (stations) and insufficient number of tracks	Use North-Eastern alternative route via Bad Oldesloe to Neumünster (line with 57 to 68 trains/day).
7	Minden-Wunstorf	Germany	40.1	Very high traffic	Double track x 2
8	Viersen-Venlo	Germany	18.0	Single track	Use alternative route via Emmerich (180 trains/day) or double track in totality
9	Aachen-Herzogenrath	Germany	12.8	local bottlenecks and tunnel	Rehabilitation of existing tunnel and removal of local bottlenecks

No	Link	Country	Length (km)	Reason for bottleneck	Potential Solution(s)
10	Darmstadt-Karlsruhe	Germany	104.4	Insufficient number of tracks	Use between Darmstadt and Mannheim and between Darmstadt and Wörth parallel North-South routes on West side and East side of the main line.
11	Koblenz-Königsbach	Germany	1.3	Insufficient number of tracks	Use an alternative route
12	Lenzburg-Othmarsingen	Switzerland	2.0	Insufficient number of tracks	Construction of additional tracks
13	Mühle Horn tunnel / Sargans	Switzerland	15.3	Single track tunnel	Second parallel tunnel; tunnel length only 133 m, rest of the line is already double-tracked
14	Bern-Thörishaus	Switzerland	7.0	Very high traffic	Third track construction
15	(Basel -) Muttenz - Frick (- Zurich)	Switzerland	48.3	High traffic	Third track construction
16	Lausanne - Geneva	Switzerland	54.3	High traffic	Third track construction
17	Milan-Monza	Italy	9.6	Signalling	Euroloops implementation at least or two tracks more
18	Bottarone-Tortona	Italy	28.1	Signalling	Euroloops implementation, Third track construction
19	San Giuseppe-Ceva	Italy	24.8	Single track, high slope (30‰)	Euroloops implementation
20	Finale Ligure- San Lorenzo al Mare	Italy	51.7	Single track. Block system	Euroloops implementation + siddings or double track.
21	Tardienta - Lérida	Spain	127.3	Single track	Euroloops implementation
22	Cerdanyola-Mollet	Spain	22.0	double track with an high mixed traffic (important suburban trains increasing)	New by-pass
23	Reus-Fontscaldes	Spain	18.9	Single track	Euroloops implementation
24	Bailleul-Lille	France	28.2	Signalling	Euroloops implementation
25	Lens-Douai	France	28.8	Signalling	Euroloops and railway nodes improvement
26	Villeneuve-Saint-Georges-St Michel sur Orge	France	16.5	Signalling	Euroloops implementation
27	Epernay-Châlons en Champagne	France	30.2	Signalling	Euroloops implementation
28	Lyon	France	10.6	Congestion at Lyon's node of Lyon Part-Dieu	ERTMS L1 with Euroloops + use the future complete CFAL by-pass
29	Moirans-Grenoble	France	21.1	Too many trains + Block system	Block system improvement + possibly a third track
30	Avignon-Tarascon	France	21.2	Block system	Block system improvement (ERTMS)
31	Carcassonne-Narbonne	France	58.1	Block system	Block system improvement (ERTMS)
Total			**1,583.5**		

As far as the 2025 full scenario, 14 links presenting bottlenecks have been identified, with a total length of 738.1 kilometres.

Table 43: 2025 full scenario bottlenecks

No	Link	Country	Length (km)	Reason for bottleneck	Potential Solution(s)
1	Kirkkonummi-Naantali	Finland	166.0	Single track	Favour just one direction of traffic with the Toijala-Humppila line or Double track
2	Asta-Hovsta	Sweden	37.3	Single track	Siddings or Double track
3	Göteborg-Vargarda	Sweden	64.6	Signalling	- Signalling improvement - Reduce the X2000 speed or increase the freight trains speed
4	Karlstad-Charlottenberg	Sweden	88.5	Single track	Double track
5	Viersen-Venlo	Germany	18.0	Single track, Signalling	Use alternative route via Emmerich (180 trains/day) or double track in total
6	Bonn - Koblenz	Germany	41.3	Track number	Alternative route
7	(Basel -) Muttenz - Frick (- Zurich)	Switzerland	48.3	Track number	Construction of a third track
8	Lausanne - Geneva	Switzerland	54.3	Track number	Construction of a third track
9	Cerdanyola-Mollet	Spain	22.0	Double track with high mixed traffic	Barcelona Great by-pass between Girona and Tarragona (New double track 220 Km).
10	Bottarone-Voghera	Italy	11.9	Signalling	Improve ERTMS with euroloops. Theoretical capacity would be increased to 320 trains.
11	Finale Ligure- San Lorenzo al Mare	Italy	51.7	Single track	Improve ERTMS with euroloops and siddings or double track.
12	Recco-La Spezia	Italy	77.2	Track number	Construction of a third track
13	Bailleul-Lille	France	28.2	Track number	Alternative route via Hazebrouck-BethuneLens-Douai to decrease the number of freight train Construction of a third track
14	Lens-Douai	France	28.8	Track number	Construction of a third track
		Total	**738.1**		

Cost of proposed solutions

In order to estimate the cost of the alternative proposed solutions per scenario, a unit cost of each rail infrastructure investment is used, which is presented in the following Table.

Table 44: Investments Costs per Rail Infrastructure Unit

Rail Infrastructure	Costs in Euro (€)		
	Cost per m	Cost per km of track	Cost per train unit
Loading Gauge upgrade UIC B to B1 - Soffit	30,000		
Upgrading to rolling motorway		15,000	
Tunnel construction	100,000		
Track construction - double - rural		15,000,000	
Track construction - single - rural		10,000,000	
Track construction - double - suburban		30,000,000	
Track construction - single - suburban		20,000,000	
Electrification plus signalling - single track		2,000,000	
Electrification plus signalling - double track		3,000,000	
Electrification only - single		1,600,000	
Electrification only - double		2,400,000	
ERTMS Level 2 (ETCS 2 + GSM-R) double track		150,000	
ERTMS Level 1 (ETCS 1 + GSM-R) double track		100,000	
ERTMS Level 1 (with euroloops, ETCS 1 + GSM-R) double track		130,000	
ERTMS Level 1 (with euroloops, ETCS 1 + GSM-R) single track		110,000	
GSM - R		50,000	
ERTMS On board equipment - pre-equipped train			1,000,000
ERTMS On board equipment - complete retro fit			2,000,000
Noise barriers (new line and 1 side)	1,200		
Noise barriers (line in operation and 1 side)	3,000		

The distribution into time for the abovementioned investments is made according to the values presented in the next Table.

Table 45: Investment Distribution

Investment distribution	
for large civil engineering works (5 years)	year 1: 10%, year 2: 20%, year 3: 30%, year 4: 20%, year 5: 20%
for normal civil engineering works (3 years)	year 1: 20%, year 2: 40%, year 3: 40%

Another cost component, which must be added in order to estimate the total cost of the alternative proposed solutions per scenario, is the maintenance cost of each piece of rail infrastructure, as presented in the following Table.

Table 46: Maintenance Costs per Rail Infrastructure Unit

Rail Infrastructure	Costs in Euro (€)	
	Cost per km of single track	Cost per km of double track
Infrastructure general maintenance (maintenance 70%, renewal 30%)	52,000	104,000
Infrastructure high used maintenance (UIC class 1 to 4)	79,400	158,800
Infrastructure medium used maintenance (UIC class 5 to 6)	53,900	107,800
Infrastructure low used maintenance (UIC class 7 to 9)	30,800	61,600
Maintenance track only (general cost)	31,200	62,400
Maintenance track only UIC class 1 to 4)	47,640	95,280
Maintenance track only UIC class 5 to 6)	32,340	64,680
Maintenance track only UIC class 7 to 9)	18,480	36,960
Maintenance Electrification Catenary (general cost)	9,672	19,344
Maintenance Electrification Catenary (UIC class 1 to 4)	14,768	29,537
Maintenance Electrification Catenary (UIC class 5 to 6)	10,025	20,051
Maintenance Electrification Catenary (UIC class 7 to 9)	5,729	11,458
Maintenance Signalling (General cost)	4,836	9,672
Maintenance Signalling (UIC class 1 to 4)	7,384	14,768
Maintenance Signalling (UIC class 5 to 6)	5,013	10,025
Maintenance Signalling (UIC class 7 to 9)	2,864	5,729
Maintenance Structure (Tunnels, bridges) general cost	3,640	6,188
Maintenance Structure (Tunnels, bridges) (UIC class 1 to 4)	5,558	9,449
Maintenance Structure (Tunnels, bridges) (UIC class 5 to 6)	3,773	6,414
Maintenance Structure (Tunnels, bridges) (UIC class 7 to 9)	2,156	3,665
Maintenance Structure (technical buildings, signal box) general cost	2,600	2,600
Maintenance Structure (technical buildings, signal box) (UIC class 1 to 4)	3,970	3,970
Maintenance Structure (technical buildings, signal box) (UIC class 5 to 6)	2,695	2,695
Maintenance Structure (technical buildings, signal box) (UIC class 7 to 9)	1,540	1,540
Renewal ballast and sleepers (track width change as well)	236,000	472,000
Complete renewal track (rails, ballast and sleepers)	1,200,000	2,400,000

It is mentioned that UIC classes are calculated taking in account gross tonnage train, train speed and number of axles per day on a track. For simplicity reasons, this is transposed to number of trains per day, as follows (FERRMED network, with a high running train number is considered in this study in the upper category: UIC class 1 to 4.):

- UIC class 1 to 4 : more than 100 trains per track per day
- UIC class 5 to 6: between 20 and 100 trains per track per day
- UIC class 7 to 9: less than 20 trains per track per day

Additional cost components, which must be added, are the depreciation period and the residual value of each rail infrastructure after 30 years, as presented in the following Tables.

Table 47: Depreciation Period per Rail Infrastructure

Rail Infrastructure	Depreciation period (years)
Tracks	20-40
Tracks (UIC class 1 to 4)	25
Tracks (UIC class 5 to 6)	32
Tracks (UIC class 7 to 9)	40
Bridges	50
Tunnels and large civil engineering works	100

Table 48: Residual Value after 30 years per Rail Infrastructure

Rail Infrastructure	Residual value
Tunnel	95%
Bridge	85%
New line and by-pass with tunnels & bridges	66%
New signalling	0%

Subsequently, after taking all the above-mentioned cost components into consideration, the links where the bottlenecks are detected and two alternative solutions (description, cost, implementation year) are presented for each of the scenarios (2020 reference, 2020 medium, 2025 reference, 2025 medium, 2025 full scenario).

The following Table presents a summary of the bottlenecks identified and their respective solutions, together with the cost components, such as the implementation cost, the regular and periodic cost of maintenance and the residual value of the investment after 30 years, for each of the scenarios (2020 reference, 2020 medium, 2025 reference, 2025 medium, 2025 full scenario).

Table 49: Summary of bottlenecks, solutions and cost per scenario

Scenario	Solution	Total number of bottlenecks	Total length	Cost (million €)			
				Implementation	Maintenance*		Residual value**
					Regular	Periodic	
2020 Reference	1	17	641.7	5,072.5	66.6	68.6	3,297.5
	2			8,932.5	77.6	86.1	4,450.5
2020 Medium	1	18	722.6	6,195.7	76.9	83.5	4,096.7
	2			12,151.7	104.1	112.4	8,015.3
2025 Reference	1	29	1,807.1	7,508.8	178.4	192.5	4,816.4
	2			19,160.0	222.5	242.5	12,184.7
2025 Medium	1	31	1,583.5	13,220.2	189.2	205.1	8,669.2
	2			21,105.0	227.6	246.6	14,005.5
2025 Full	1	14	738.1	10,657.3	100.6	109.0	7,274.9
	2			17,130.9	132.3	142.9	10,264.3

(*) Regular annual maintenance costs for section(s) in case of including solution, periodic maintenance costs (e.g. for gravel replacement) in case of including solution.
(**) Estimated residual value after 30 years of the implementation of the measures.

Cost of Rail city by-passes

Besides the bottleneck solutions, including Barcelona Great by-pass, a supplementary cost element, which must be added in order to estimate the total cost of the implementation of each scenario, is the cost to construct other by-passes for the large cities (not included in Reference Scenario, like Brussels, Dijon, Hamburg, Koblenz, Lille, Valencia) and the cost for the Paris Great by-pass, together with the cost for noise barriers.

Especially for the Paris Great by-pass, it is noted that it is necessary to upgrade 420 km of current double track between Montérolier and Culmont Chalindrey, which would cost around 1.3 billion Euros. The current route between Le Havre and Dijon via "Paris Grande Ceinture" is 70 km shorter (520 km) than the route via the Paris great by-pass (590 km).

The cost to construct large cities by-passes, Paris Great by-pass and noise barriers is presented in the next Table (description, unit, average cost per unit and existing quantity in the area of the FERRMED Great Axis Rail Network).

Table 50: Cost of large cities by-passes and noise barriers implementation

Category	Implementation Cost			
	Description	Unit	Average cost per unit or per km ('000 € 2007)	Quantity
By-passes of large cities	average km: 40, number of large cities to take into account: 6		40,000	240
	km and cost of Lyon by-pass for new tracks building + Paris great by-pass upgrading	(Paris great by-pass upgrading)	1,400,000	
Noise barriers		Per kilometre	3,000	

Taking the above into consideration, the cost of construction for the by-passes of large cities for each scenario for target year 2025 is estimated. The subsequent Tables are displaying this cost for the medium, full, and the full FERRMED+ scenarios.

Table 51: Large cities by-passes and noise barriers cost

Category	Implementation Cost			
	Description	Average cost per unit or per km ('000 € 2007)	Quantity	Total (in million € 2007)
2025 medium scenario				
By-passes of large cities	Average km: 40, number of large cities to take into account: 6	40,000	240	9,600
	km and cost of Lyon by-pass for new tracks building + Paris great by-pass	1,400,000		1,400
Noise barriers		3,000	336	1,009
			Total	**12,009**
2025 full scenario				
By-passes of large cities	Average km: 40, number of large cities to take into account: 6	40,000	240	9,600
	km and cost of Lyon by-pass for new tracks building + Paris great by-pass	1,400,000		1,400
Noise barriers		3,000	616	1,848
			Total	**12,848**
2025 full FERRMED+ scenario				
By-passes of large cities	Average km: 40, number of large cities to take into account: 6	40,000	240	9,600
	km and cost of Lyon by-pass for new tracks building + Paris great by-pass	1,400,000		1,400
Noise barriers		3,000	928	2,783
			Total	**13,783**

<u>Cost of FERRMED "standards" implementation</u>

An additional cost element, which must be added in order to estimate the total cost of the implementation of each scenario, is the cost to facilitate the implementation of the FERRMED "standards".

Table 52: Cost of FERRMED "standards" implementation per unit

FERRMED standards implementation	Rail infrastructure upgrading			
	Description	Unit	Average cost per unit or per km ('000 € 2007)	Quantity
Spain (1668mm)	Track gauge	single track	1,200	
Broad gauge to UIC gauge	Track gauge	double track	2,400	497
	Track gauge	single track pre-equipped + switches	354	0
	Track gauge	double track pre-equipped + switches	708	518
Loading gauge	Loading gauge UIC A, B to B1	3% of the line	30,000	9,743
	Loading gauge UIC A, B to C	6% of the line	60,000	664
Rolling motorway	Rolling motorway (low floor gauge)	double track	300	3,049

Axle load	Axle load 20t to 22,5t	km of track	236	693
	Axle load 22,5t to 25t	km of track	1,200	16,304
Train length	Train length of 750m	siding of 1000m	26,000	
	Train length of 1500m	siding of 2000m	35,000	
Electrification	Electrification (keep AC or DC)	single track	1,600	17
	Electrification (keep AC or DC)	double track	2,400	237

Moreover, in order to estimate the cost of the implementation of the FERRMED "standards" in the 2025 reference scenario, the inventory of the network is resented in the next Table.

Table 53: 2025 Reference Scenario inventory on FERRMED Great Axis

Network	Standard (km)	Broad (km)	Total (km)
Core Network km	7,259	1,015	**8,274**
Feeders km	11,228	2,615	**13,843**
Total FERRMED network	18,487	3,630	**22,117**
Total FERRMED network converted into km of single track (sidings included)			**48,181**

Taking the above into consideration, the cost of the implementation of the FERRMED "standards" for each scenario for the horizon year 2025 is estimated. The subsequent Tables are displaying this cost for the medium, the full, and the full FERRMED+ scenarios.

Table 54: FERRMED "standards" implementation cost

FERRMED standards implementation	Rail infrastructure upgrading			
	Description	Average cost per unit or per km ('000 € 2007)	Quantity	Total (in million € 2007)
2025 medium scenario				
Spain (1668mm)	Track gauge	1,200		
Broad gauge to UIC gauge	Track gauge	2,400	596	1,431
	Track gauge	354		
	Track gauge	708	622	440
Loading gauge	Loading gauge UIC A, B to B1	30,000	292	8,769
	Loading gauge UIC A, B to C	60,000		
Rolling motorway	Rolling motorway (low floor gauge)	300	3,049	915
Axle load	Axle load 20t to 22,5t	236	693	164
	Axle load 22,5t to 25t	1,200		
Train length	Train length of 750m	26,000	455	11,820
	Train length of 1500m	35,000	537	18,786
Electrification	Electrification (keep AC or DC)	1,600	17	27
	Electrification (keep AC or DC)	2,400	237	569
			Total	**42,920**

FERRMED standards implementation	Rail infrastructure upgrading			
	Description	**Average cost per unit or per km ('000 € 2007)**	**Quantity**	**Total (in million € 2007)**
2025 full scenario				
Spain (1668mm)	Track gauge	1,200		
Broad gauge to UIC gauge	Track gauge	2,400	1,417	3,401
	Track gauge	354		
	Track gauge	708	622	440
Loading gauge	Loading gauge UIC A, B to B1	30,000	292	8,769
	Loading gauge UIC A, B to C	60,000		
Rolling motorway	Rolling motorway (low floor gauge)	300	3,049	915
Axle load	Axle load 20t to 22,5t	236	693	164
	Axle load 22,5t to 25t	1,200		
Train length	Train length of 750m	26,000	909	23,639
	Train length of 1500m	35,000	537	18,786
Electrification	Electrification (keep AC or DC)	1,600	17	27
	Electrification (keep AC or DC)	2,400	237	569
			Total	**56,709**
2025 full FERRMED+ scenario				
Spain (1668mm)	Track gauge	1,200	516	619
Broad gauge to UIC gauge	Track gauge	2,400	1,745	4,187
	Track gauge	354		
	Track gauge	708	622	440
Loading gauge	Loading gauge UIC A, B to B1	30,000	201	6,026
	Loading gauge UIC A, B to C	60,000	42	2,495
Rolling motorway	Rolling motorway (low floor gauge)	300	3,049	915
Axle load	Axle load 20t to 22,5t	236		
	Axle load 22,5t to 25t	1,200	16,304	19,565
Train length	Train length of 750m	26,000	461	11,998
	Train length of 1500m	35,000	985	34,459
Electrification	Electrification (keep AC or DC)	1,600	17	27
	Electrification (keep AC or DC)	2,400	237	569
			Total	**81,299**

Other costs

In "other costs" category the cost for the ERTMS implementation, the cost for the rolling stock automatic coupling, the cost for the Spanish rolling stock to be transposed into UIC track width, the cost for the New lines investments, the cost for the improvement of Ports & Terminals, and the cost for the Electric reinforcement of the network, are included.

In order to make all the abovementioned calculations, the number of freight wagons and engines (units of rolling stock) that are serving the network is used, which is presented by country in the following Table.

Table 55: Number of freight wagons and engines per country

Country	wagons	engines	Comment
France	80,000	3,300	
Germany	100,000	4,000	estimation
Italy	50,000	1,800	estimation
Belgium	35,000	1,100	
Netherlands	30,000	1,000	estimation
Luxemburg	4,000	150	
Spain	10,000	300	estimation
UK	50,000	1,800	estimation
Switzerland	11,000	1,500	
Denmark	20,000	800	estimation
Sweden	30,000	1,200	estimation
Norway	20,000	1,000	estimation
Finland	20,000	1,000	estimation
Total	460,000	18,950	

Additionally, the cost of electric substations implementation is used, with the connection, according to the current type, which is presented in the Table that follows.

Table 56: Electric substations implementation cost

Current type	Space between 2 substations (km)	Substation cost (million € 2007)	Connection cost (million € 2007)	Total (million € 2007)
1,5 kV CC	15 - 17	3,5	20KV: 0,4	4
			90 kV: 2,5	6
3 kV CC	17 – 25	3,5	20kV: 0,4	4
			90 kV: 2,5	6
25 kV 50 Hz	around 50	6	5	11
15 kV 16 2/3 Hz	around 25	3,5	3,5	7,5
Current type	**implementation number units for 100 km of lines**	**Investment cost for 100 km of lines (million € 2007)**	**Reinforcement number units for 100 km of lines**	**Investment for 100 km of lines (million € 2007)**
1,5 kV CC	6	30	1	5
3 kV CC	5	25	1	5
25 kV 50 Hz	2	22	0,5	5,5
15 kV 16 2/3 Hz	4	30	0,5	4

A summary of the costs' categories is listed in the following Table.

Table 57: Other implementation costs per category and per unit

Category	Implementation Cost			
	Description	Unit	Average cost per unit or per km ('000 € 2007)	Quantity
ERTMS implementation	Infrastructure	Single track	120	1,970
	Infrastructure	Double track	150	13,733
	Engines	Not equipped	2,000	8,000
	Engines	Pre-equipped	1,000	4,000
	Engines	Equipped	0	3,000
Rolling stock automatic coupling	Engines (passenger & freight)		25	19,000 (of which 4,000 new equipped between 2015-2025)
	Wagons (1st step)	Stock of 500,000 wagons(of which 10% new wagons equipped between 2015-2025	22	180,000
	Wagons (2nd step)		22	450,000
Rolling stock to UIC track width	New electric engines		4,000	
	Electric engines	Gauge powered axle change	1,000	300
	wagons + coaches	gauge wheel-set change	130	10,000
New lines investments	Algeciras-Malaga-Motril-Almeria new line		24,000	350
	HSL Tarragona - Castelló		22,000	135
	Lorca-Moreda (Granada) new link		25,000	182
	Moreda - Granada upgrading (elect + double track)		20,000	22
Ports & Terminals	Ports & terminals			
	Genoa port : Investment tunnel under Apennine for dry port implementation	20 km double stack tunnel + terminal + rail links	3,700	
Electric reinforcement	Substations 25kV AC with connection to HV network		11,000	1 more every 200 km
	Substations 15 kV AC with connection to HV network		7,500	1 more every 200 km
	HBV (catenary with feeder)		1,000	some particular places
	Substations 750v, 1,5kV CC, 3kV cc with connection to HV network		5,000	1 more every 100 km

After making all the above assumptions and calculations the "other costs" are estimated for each of the scenarios of the horizon year 2025. The subsequent Tables are displaying this cost for the medium, the full, and the full FERRMED+ scenarios.

Table 58: Other costs

Category	Cost implementation			
	Description	**Average cost per unit or per km ('000 € 2007)**	**Quantity**	**Total (in million € 2007)**
2025 medium scenario				
ERTMS implementation	Infrastructure	120	157	19
	Infrastructure	150	3,325	499
	Engines	2,000	2,000	4,000
	Engines	1,000	3,000	3,000
	Engines	0	3,000	0
Rolling stock automatic coupling	Engines (passenger & freight)	25	10,000	250
	Wagons (1st step)	22	180,000	3,960
	Wagons (2nd step)	22		
Rolling stock to UIC track width	New electric engines	4,000	20	80
	Electric engines	1,000	80	80
	wagons + coaches	130	1,500	195
New lines investments	Algeciras-Malaga-Motril-Almeria new line	24,000		
	HSL Tarragona - Castelló	22,000		
	Lorca-Moreda (Granada) new link	25,000		
	Moreda - Granada upgrading (elect + double track)	20,000		
Ports & Terminals	Ports & terminals			42,000
	Genoa port : Investment tunnel under Apennine for dry port implementation	3,700		
Electric reinforcement	Substations 25kV AC with connection to HV network	11,000	17	186
	Substations 15 kV AC with connection to HV network	7,500	15	114
	HBV (catenary with feeder)	1,000	35	35
	Substations 750v, 1,5kV CC, 3kV cc with connection to HV network	5,000	45	226
			Total	**54,644**
2025 full scenario				
ERTMS implementation	Infrastructure	120	1,970	236
	Infrastructure	150	13,733	2,060
	Engines	2,000	4,000	8,000
	Engines	1,000	4,000	4,000

Category	Cost implementation			
	Description	**Average cost per unit or per km ('000 € 2007)**	**Quantity**	**Total (in million € 2007)**
	Engines	0	3,000	0
Rolling stock automatic coupling	Engines (passenger & freight)	25	13,000	325
	Wagons (1st step)	22		
	Wagons (2nd step)	22	320,000	7,040
Rolling stock to UIC track width	New electric engines	4,000	30	120
	Electric engines	1,000	120	120
	wagons + coaches	130	3,000	390
New lines investments	Algeciras-Malaga-Motril-Almeria new line	24,000	350	8,400
	HSL Tarragona - Castelló	22,000	135	2,970
	Lorca-Moreda (Granada) new link	25,000	182	4,550
	Moreda - Granada upgrading (elect + double track)	20,000	22	440
Ports & Terminals	Ports & terminals			48,000
	Genoa port : Investment tunnel under Apennine for dry port implementation	3,700		3700
Electric reinforcement	Substations 25kV AC with connection to HV network	11,000	23	248
	Substations 15 kV AC with connection to HV network	7,500	20	152
	HBV (catenary with feeder)	1,000	23	23
	Substations 750v, 1,5kV CC, 3kV cc with connection to HV network	5,000	60	301
			Total	**91.075**
2025 full FERRMED+ scenario				
ERTMS implementation	Infrastructure	120	1,970	236
	Infrastructure	150	13,733	2,060
	Engines	2,000	6,000	12,000
	Engines	1,000	4,000	4,000
	Engines	0	3,000	0
Rolling stock automatic coupling	Engines (passenger & freight)	25	15,000	375
	Wagons (1st step)	22		
	Wagons (2nd step)	22	450,000	9,900
Rolling stock to UIC track width	New electric engines	4,000	40	160
	Electric engines	1,000	160	160
	wagons + coaches	130	4,000	520
New lines investments	Algeciras-Malaga-Motril-Almeria new line	24,000	350	8,400
	HSL Tarragona - Castelló	22,000	135	2,970
	Lorca-Moreda (Granada) new link	25,000	182	4,550

Category	Cost implementation			
	Description	Average cost per unit or per km ('000 € 2007)	Quantity	Total (in million € 2007)
	Moreda - Granada upgrading (elect + double track)	20,000	22	440
Ports & Terminals	Ports & terminals			48,000
	Genoa port : Investment tunnel under Apennine for dry port implementation	3,700		3,700
Electric reinforcement	Substations 25kV AC with connection to HV network	11,000	34	371
	Substations 15 kV AC with connection to HV network	7,500	30	228
	HBV (catenary with feeder)	1,000		
	Substations 750v, 1,5kV CC, 3kV cc with connection to HV network	5,000	90	452
			Total	**98,522**

Total cost per scenario

The total cost per scenario is the accumulative result of all the cost components described in the previous sections, that is to say:

- bottlenecks,
- by-passes,
- FERRMED standards,
- other costs and
- maintenance.

The following Table presents the cost of implementation or construction of the abovementioned categories, and the total cost for each of the scenarios of the horizon year 2025 (medium, full and full FERRMED+).

Table 59: Total costs for the 2025 scenarios

Category	Cost per 2025 scenario (million € 2007)		
	medium	full	full FERRMED+
Bottlenecks	**21,105**	**17,131**	**17,131**
Bottlenecks solving	21,105	17,131	17,131
By-passes	**12,009**	**12,848**	**13,273**
By-passes of large cities	11,000	11,000	11,000
Noise barriers	1,009	1,848	2,783

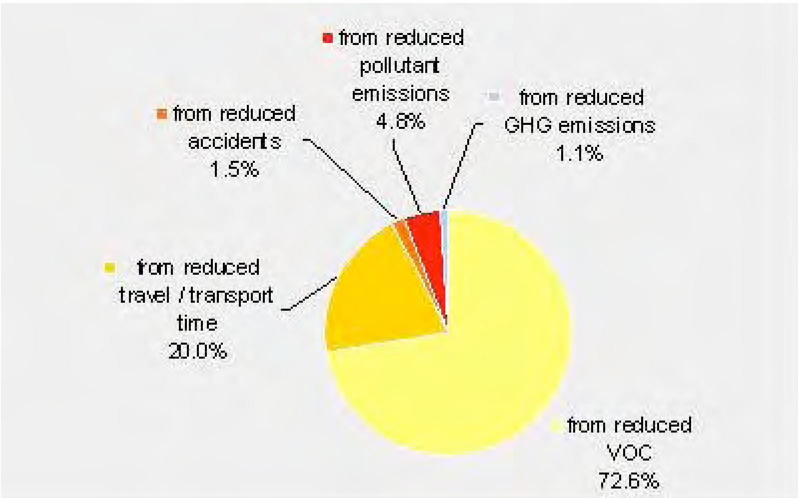
Category	Cost per 2025 scenario (million € 2007)		
	medium	full	full FERRMED+
FERRMED standards	**42,920**	**56,709**	**81,299**
Spain (1668mm)	0	0	619
Broad gauge to UIC gauge	1,871	3,841	4,627
Loading gauge	8,769	8,769	8,520
Rolling motorway	915	915	915
Axle load	164	164	19,565
Train length	30,606	42,425	46,457
Electrification	596	596	596
Other costs	**54,644**	**91,075**	**98,522**
ERTMS implementation	7,518	14,296	18,296
Rolling stock automatic coupling	4,210	7,365	10,275
Spanish rolling stock to UIC track width	355	630	840
Spanish New lines investments	0	16,360	16,360
Ports & Terminals	42,000	51,700	51,700
Electric reinforcement	561	724	1,051
Maintenance	**23,226**	**26,146**	**27,036**
Bottlenecks	1,600	1,360	2,250
Network	9,026	9,276	9,276
Ports & Terminals	12,600	15,510	15,510
Total	**153,903**	**203,910**	**237,771**

8. ECONOMIC & FINANCIAL ANALYSIS

The main results of the benefit estimation in the Medium FERRMED scenario are:

- Principal component with a share of 73 % of total benefits are savings in VOC (mainly by truck, caused by shifts from road to rail) which amount to overall 150 billion EUR discounted. Regarding rail (both passenger and freight) VOCs in the scenarios are higher than in the reference scenario due to more intensive usage.
- Another, though less relevant part of benefits are savings in travel and transport time both for passenger and freight road traffic, which amounts to 41 billion EUR discounted (20 % of total net benefits).
- Accident and environmental benefits together are 7.4 % of total benefits.

Figure 27: Composition of user benefits by item of benefit in the MFS



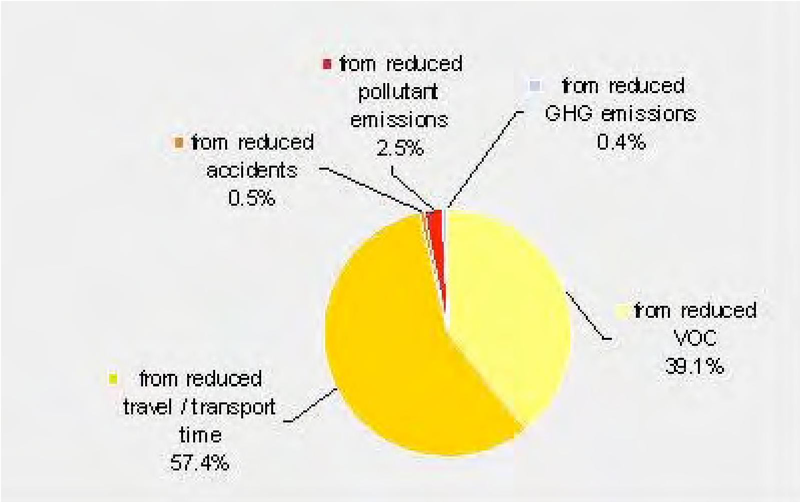
The main results of the benefit estimation in the Full FERRMED scenarios are:

- With overall discounted net savings in travel and transport time of 285 billion EUR (57 % of total benefits), time savings are much more relevant than in the MFS. In contrast to the MFS where the positive impact was mainly concentrated on the road (due to shift from road to rail) in the FFS / F+FS benefits can be particularly obtained from passenger and freight rail due to improvements in capacity and line speeds.
- More than one third of the total benefits are savings in VOC (almost completely by truck, caused by shifts from road to rail) which amount to overall 228 billion EUR

discounted net savings. As already observed in the MFS more intensive usage of rail infrastructure (both passenger and freight) contributes to higher VOCs for rail.

- Benefits resulting from savings in accidents, pollutant and GHG emissions are of here of lesser importance, contributing to the total benefits only with overall 3.4 %, compared to 7.4 % in the Medium FERRMED Scenario.

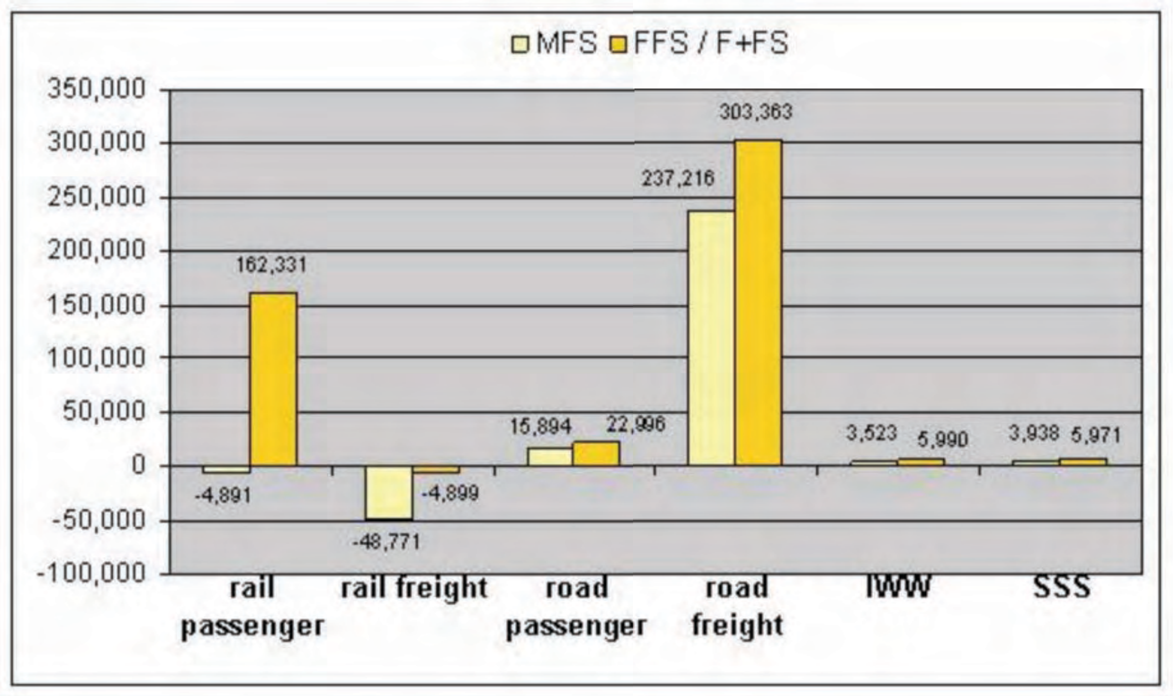
Figure 28: Composition of user benefits by item of benefit in the FFS / F+FS



CBA results have been further disaggregated in order to highlight distributional issues concerning the shares of benefits by mode. As shown in the next Figure, the overall amount of benefits results from reduced road transport and traffic due to improvements in rail infrastructure (i.e. capacity improvements caused by shifts from road to rail). Rail passenger traffic mainly benefit from the FERRMED standards infrastructure upgrade (e.g. from the ERTMS implementation, that enables trains to circulate with higher speeds on the network), especially in the FFS / F+FS, when almost all measures regarding the railway system are to be implemented.

In contrast, rail freight mode shows negative benefits due to higher transport and traffic volumes associated with a higher train traffic performance with increasing freight volumes shifted from the road to the rail. In other words, costs savings in more efficient rail freight transport are outweighed by more rail freight traffic. In the Medium FERRMED scenario, all net benefits come from cost savings in road haulage. In the Full FERRMED scenarios, savings from rail passenger transport and traffic also play an important part.

Figure 29: Discounted benefits by scenario, mode and type of transport



CBA Indicators

The Cost Benefit Analysis results in a positive Economic Internal Rate of Return (EIRR) of 5.0 % in the MFS, 11.1 % in the FFS and 8.9 % in the F+FS. The respective benefit-cost ratios are 1.2, 2.0 and 1.7. This means that in all scenarios the investments for the FERRMED project will be outweighed by the benefits resulting from improved rail transport quality leading to a modal shift from road to rail. The results are summarised in the next Table.

Table 60: Summary measures of social value*

Scenario	Net Present Value – NPV (million Euro)	Economic Internal Rate of Return – EIRR (%)	Benefit / Cost Ratio – BCR
MFS	10,780	4.97	1.155
FFS	93,783	11.09	1.993
F+FS	76,453	8.85	1.684

(*) social discount rate: 3.5%

Sensitivity tests

Sensitivity analyses are usually carried out in economic appraisals in order to identify the project's critical variables and to determine the variation in results if these input parameters turn out to be different from the underlying assumptions. This analysis has been done by letting certain project variables vary according to a given percentage change and observing the subsequent variations in both financial and economic performance indicators. Variables have been varied one at a time, while keeping the other parameters constant.

The investment and maintenance costs as well as the VOC especially for road freight mode (HGV) have been identified as variables for which a variation of 10% gives rise to a corresponding significant variation in the indicators base value (as shown in the next Table).

Table 61: General sensitivities

sensitivity contents	Variation of sensitivities compared with respective base case results: MFS			FFS			F+FS		
	NPV [bn €]	EIRR [%]	B/C [-]	NPV [bn €]	EIRR [%]	B/C [-]	NPV [bn €]	EIRR [%]	B/C [-]
Base case	10.8	5.0%	1.2	93.8	11.1%	2.0	76.5	8.8%	1.7
by-pass investment costs excluded	16.6	6.0%	1.3	99.7	12.0%	2.1	82.3	9.5%	1.8
	+5.9	+1.0pp	+0.1	+5.9	+0.9pp	+0.1	+5.9	+0.7pp	+0.1
+10% investment and maintenance costs	3.8	4.0%	1.1	84.3	9.8%	1.8	65.3	7.7%	1.5
	-6.9	-1.0pp	-0.1	-9.4	-1.3pp	-0.2	-11.2	-1.1pp	-0.2
-10% of VOC for all means of transport	4.9	4.2%	1.1	86.5	10.5%	1.9	69.1	8.4%	1.6
	-5.8	-0.8pp	-0.1	-7.3	-0.5pp	-0.1	-7.3	-0.5pp	-0.1
-10% of VOC for HGVs only	3.6	4.0%	1.1	85.2	10.5%	1.9	67.9	8.3%	1.6
	-7.2	-1.0pp	-0.1	-8.6	-0.6pp	-0.1	-8.6	-0.5pp	-0.1
+10% of VOC for HGVs only	18.0	5.9%	1.3	102.3	11.7%	2.1	85.0	9.4%	1.8
	+7.2	+1.0pp	+0.1	+8.6	+0.6pp	+0.1	+8.6	+0.5pp	+0.1
-10% of VOC for all rail vehicle types only	12.6	5.2%	1.2	95.8	11.2%	2.0	78.5	9.0%	1.7
	+1.9	+0.3pp	+0.0	+2.0	+0.1pp	+0.0	+2.0	+0.1pp	+0.0
-10% of VOC for FERRMED trains only	12.3	5.2%	1.2	94.4	11.1%	2.0	77.0	8.9%	1.7
	+1.5	+0.2pp	+0.0	+0.6	+0.0pp	+0.0	+0.6	+0.0pp	+0.0
-10% of VoT for passenger mode	10.6	5.0%	1.2	87.1	10.6%	1.9	69.7	8.4%	1.6
	-0.1	-0.0pp	-0.0	-6.7	-0.5pp	-0.1	-6.7	-0.4pp	-0.1
-10% of VoT for freight mode	9.4	4.8%	1.1	89.7	10.8%	1.9	72.3	8.6%	1.6
	-1.4	-0.2pp	-0.0	-4.1	-0.3pp	-0.0	-4.1	-0.3pp	-0.0

pp = percentage points

Moreover, two other sensitivities in the FFS were calculated, taking into consideration modification in the traffic model and leading to variation in transport and traffic performance data:

- **Sensitivity A** assumes no speed increase after 2015 (i.e. same speed as in MFS for both passenger and freight). This would lead to a corresponding decrease in NPV's base value of about 39 %.
- **Sensitivity B** assumes no speed increase after 2015 (i.e. same speed as in MFS for both passenger and freight) and no reduction of terminal transfer time and costs (i.e. terminal transfer time equal to those in the MFS). This would lead to a corresponding decrease in NPV's base value of about 52 %.

Cash-Flow Analysis of the FERRMED Great Railway Axis Network

As mentioned in the introduction to this report, the cash-flow analysis is carried out for the entire FERRMED Great Rail Axis Network so that it encompasses all projects which form the proposed investment scenario. The cash-flow analysis is presented for the 3 scenarios defined in the Supply & Demand Analysis, the Technical Analysis and the Cost-Benefit Analysis, i.e.

- MEDIUM FERRMED scenario
- FULL FERRMED scenario
- FULL+ FERRMED scenario

to show the possible sources and forms of financing. Bearing in mind both the type and scope of this study, some definitions and statements should be taken into account to recognise the possibilities, but also the limitations of any cash-flow analysis made at this early stage of the project cycle of the FERRMED Rail Network.

- The cash-flow analysis covers the period 2013-2045, to ensure full compatibility with the Cost-Benefit Analysis and to cover a full 20-year operation period of the last investments in 2025.
- At this stage of the planning phase, any cash-flow analysis necessarily remains hypothetical and a pro-forma type as the various financial stakeholders and the scope of their involvement are not known yet. Thus the results provide an overall indication and orders-of-magnitude of required funds to be used as one of the key

informations for strategic discussions on the next planning stages of the FERRMED Great Rail Axis Network.

- The cash-flow analysis combines various financial options and models to take account of the different types of railway investments. E.g. financing of railway related port infrastructure should be handled differently from ERTMS investments or traditional track improvements.
- Peculiar financing issues like specific financing or contractual conditions can only be treated in very preliminary and sometimes symbolic form as any detailed financial issues must be analysed at project level rather than at axis or corridor level. This holds similarly for special financial ratios such as debt-equity ratio, debt-service ratio etc.
- The financial analysis aims at identifying the financial requirements of the rail infrastructure managers, which are in the FERRMED Axis usually public entities or public companies. The financial situation of the rail transport operators, which are separate entities and often private companies, are not considered in financial analysis. Operating costs of railway transport are anyhow not eligible for EU financing.

The financial assumptions which underlie this cash-flow analysis are mainly derived from the practice of EU transport financing and the summarised conclusions presented above. The rules of the EC for funding of TEN-T projects represent an important source for defining the possible involvement of EU sources (EC and EIB). The main sources of funding considered relevant for financing of the FERRMED Great Rail Axis Network are considered to be:

- National public entities such as Ministries of transport, public railway companies (like RFF, DB, RENFE, etc), regional and local authorities (cities, regional governments, etc.)
- EC
- EIB
- Private sector (in the framework of PPP projects)
- Commercial banks.

For the individual types of infrastructure investment of each of the 3 scenarios, the following break-down of financing sources has been assumed, as a working hypothesis, based as far as possible on practice and rules of TEN-T funding:

Table 62: Sources of funding of the initial investment cost of the 3 scenarios by type of investment (in % of total cost)

Type of investment	National public entities	EC	EIB	Private PPP investors	Commercial banks	Total
Railway infrastructure upgrading incl. noise protection walls	70	15	15	-	-	100
ERTMS	50	25	25	-	-	100
Rolling stock (automatic coupling + Spanish UIC gauge roll. stock)	70	15	15	-	-	100
New rail lines in Spain	10	10	10	50	20	100
Ports & terminals	10	10	10	50	20	100
Electric power upgrading	70	15	15	-	-	100
Bottleneck investments	70	30	0	-	-	100
Bypasses	40	15	15	20	10	100

The financial involvement of the EU (EC and EIB) would only in exceptional cases, namely ERTMS investments, exceed the range of 25-30 % of total eligible cost. EU aid is split between the EC and EIB in approximately equal shares, based on current practice of TEN-T financing. The Bank's new financial instrument LGTT, should be considered at the individual project level.

The involvement of the private sector in terms of PPP projects in whatever form (concession, BOT, BFOT etc.) is considered more likely for rail related infrastructure investments in the new lines in Spain, ports, terminals and urban bypasses than e.g. for traditional upgrading of tracks (by sidings, modification of gauge etc.). However, it seems unlikely that industrial suppliers would be prepared to become PPP investors e.g. for the installation of ERTMS or for upgrading of rolling stock (by automatic coupling) and electric power. The PPP models foreseen by RFF for the bypasses of Nîmes and Montpellier hopefully become pilot cases for other similar projects on the FERRMED Great Rail Axis Network.

Furthermore it has been assumed that commercial banks would give financial support to private PPP investors by commercial credits. The main funding sources and their shares assumed for financing of each of the scenario investments are summarised in the following table.

Table 63: Possible financing sources of the FERRMED investments 2013-2025 by scenario (costs in billion € of 2007)

Source of investment	FERRMED Scenario					
	MEDIUM		FULL		FULL+	
	Total investment cost	in %	Total investment cost	in %	Total investment cost	in %
Total investment cost	**130.7**	100%	**177.8**	100%	**210.7**	100%
National public entities (Govern., public rail companies, regional authorities)	61.5	47.0 %	77.4	43.5 %	99.7	47.3 %
EC (TEN-T, Cohesion & Struct. Fund etc.)	18.4	14.1 %	24.7	13.9 %	30.0	14.2 %
EIB	18.1	13.8 %	24.7	13.9 %	30.0	14.2 %
Total EU Funds (EC + EIB)	36.5	27.9 %	49.4	27.8 %	60.1	28.5 %
Private PPP investors	23.2	17.8 %	36.2	20.4 %	36.2	17.2 %
Commercial banks	9.5	7.3 %	14.7	8.3 %	14.7	7.0 %

The shares assumed in the cash-flow calculation for the different financing sources are considered possible and realistic for the following reasons:

- It is clear in most large-scale transport investments that at least half of the funds should come from national public entities and authorities.
- The share of combined EU funding (EC and EIB funds), which is here in each of the scenarios some 28 %, represents approximately the maximum what the funding rules of the EU would allow (irrespective of exemptions such as ERTMS).
- The overall share of funds from private PPP partners is approximately in line with the potential of PPP funding estimated by DG TREN at a maximum of 20 %.
- However, if the private sector (PPP partners and commercial banks) would not participate in the assumed intensity of some 24-28 %, the respective financing gap has entirely to be balanced by the national public entities so that their share would reach more than 50 %.
- Thus the overall shares estimated for the main financing stakeholders can be considered as objectives which can be reached under favourable conditions. Less favourable conditions would go to the detriment of the national public entities which

would have to compensate the financing gap as a higher financing share cannot be expected from the combined EU sources.

The cash-flow tables show there would be significant financial gaps during the operation period due to debt service, reinvestments and only partial coverage of the current cost of operation and maintenance of the infrastructure facilities by rail freight traffic. However, this result is not surprising and in line with the financial performance and practice of many railway infrastructure managers in Europe. In the cash-flow calculations the simplified assumption has been made that the remaining part of the infrastructure operation and maintenance cost would be covered by financial contributions from rail passenger traffic and the rest of the liquidity deficits by public subventions. As a consequence of the financial gaps, the FIRR's (Financial Internal Rate of Return) and the NPV (Net Present Value, discounted at 6 %) are negative for each of the scenarios.

9. PROPOSED SCENARIO & PRIORITISATION OF INVESTMENTS

Multi Criteria Analysis

A multi-criteria analysis (MCA) is a complement to CBA and Financial analysis in case substantial impacts cannot be expressed in monetary terms. Under certain circumstances, the ranking of projects or programmes may change when including non-moneterisable impacts. Or, projects/ programmes showing in the CBA an EIRR below the benchmark of the social discount rate (SDR) may be shown to produce other benefits which would justify financing and implementing such projects nevertheless.

The CBA of the different FERRMED implementation scenarios shows reasonable (MFS) to good results (FFS and F+FS) above the benchmark of 3.5% SDR. It is hence not necessary to carry out an MCA to justify the usefulness in socio-economic terms of the FERRMED strategy. It is however useful to review the full range of objectives in order to determine whether or not the effects to achieve such objectives are adequately reflected in the CBA and to determine subsequently which additional aspects should be included in an MCA.

- **Interoperability** in the context of the FERRMED concept has two aspects: on the one side to overcome the barrier of different track gauges in Spain and the rest of continental Europe; on the other side to overcome the frictions due to different electricity supply systems and different signalling systems in the various countries. The FERRMED concept covers full interoperability across all state borders through the implementation in the core network through new railway lines in Spain, the ERTMS signalling system on the main FERRMED network as well as through the operation of multi-system locomotives. The implementation of these standards are reflected in the investment cost while the impacts are reflected in increased commercial speeds of trains and hence the modal shift between road, inland and maritime shipping. The benefits are adequately covered in the CBA.
- **Co-modality** is considered by the European institutions as a key element to improve the efficiency of the EU transport system. The FERRMED concept enhances co-modality and intermodality through a substantial improvement of railway efficiency

and a programme of port expansion/renewal and new or upgraded intermodal inland terminals. The effects are mainly to be seen in the reduction of delay times at terminals which are implemented in the traffic model, again attracting more freight to the railways from other modes. Thus impact covered by CBA.

- The improvement of **safety and security** in transport operations has been on the EU agenda for the past three decades already. This aspect is covered in the standard CBA by specific accident rates for each mode of transport and the impact on injuries and fatalities as well as material damages combined with social cost values of individual effects of accidents. Although there are shortcomings to the interpretation of statistical accident data and to accident research in general with regard to causes and responsibilities, it is considered that accident rates related to the traffic or transport performance of each mode are adequate to cover the impact of increased transport demand and of modal shifts.
- The **reduction of environmental damages** of the transport system is one of probably the most important objective at present times. Transport activities in connection with the required transport infrastructure cause effects in various domains:
    - Toxic emissions form burning fossil fuels with their effect on the health of persons exposed and damages to buildings, forests and (mis)harvests.
    - GHG emissions and their impact on climate change.
    - Noise emissions can be affecting the health of persons living in the vicinity of transport infrastructure depending on the force and frequency i.e. on local conditions.
    - Effects of vibrations of vehicle movements.
    - Impact on nature and landscape mainly in terms of the land used for transport infrastructures.
    - Pollution of water and soils by fuels and toxic products in accidents.
    - Others, including damages in urban and in sensitive areas.

While toxic and GHG emissions are included in the strategic MCA, other impacts are closely related to local conditions and can be assessed in projects where alternative alignments are clearly defined to be able to quantify and monetarise such impacts. They are not normally included in MCAs.

- **Improved transport systems** and **transport technology** are included in the CBA through transport costs on the one side and better transport performance on the other side.
- Contribution to **macro-economic employment** and **competitiveness** is difficult to assess; the investment costs can taken as a proxy base. Improved competitiveness of transport companies indirectly covered by impact on modal split.
- **EU cohesion** is facilitated by the FERRMED concept, in particular to better integrate Southern and Northern EU countries with core EU countries (France, Germany) Spain and Scandinavian countries.
- **Decongestion of existing infrastructures** is already partly reflected in the CBA by the modal shift of freight from road to rail and by reducing rail traffic on the conventional lines. The importance of this objective is high enough to include this criterion in the MCA, albeit with a small weight.

The objectives described above are generally in line with the objectives of the EU to develop the Trans-European Network (TEN-T) for rail (Priority criteria of the TEN-T guidelines of 2004 (Art. 5)):

- Relevance for the international key links.
- Relevance for the national networks.
- Promotion of the interoperable rail network.
- Promotion of optimisation and intermodality in transport.
- Promotion of safety and environmental objectives.
- Ensured sustainability.

The objectives of EU policies are included separately in the MCA below to the extent to which they are not already reflected in the traffic forecasts and the subsequent CBA.

Each objective/ criteria is assigned a weight; all weights must add to 1 or 100%.

Each scenario is assigned a value on a scale between 1 and 10 according to the individual scenario contribution to achieving the objective.

Table 64: Matrix for the multi-criteria assessment of FERRMED Scenarios

	Weight (%)	Medium scenario	Full scenario	Full + scenario	Observations
Cost-benefit analysis	65	5	10	8	
Financial Analysis	20	10	5	4	Based on financial affordability due to shortage of funds
Macro-economic impacts	10	6	8.5	10	Related to investment costs
Facilitation of access to remote areas (interconnectivity and cohesion)	5	8	10	10	
Decongestion of existing infrastructure	-	-	-	-	already reflected in traffic forecasts and CBA
Environmental risks	-	-	-	-	Environmental impacts that are not included in CBA cannot be assessed in this strategic study
MCA Result	**100**	**6,3**	**8,9**	**7,5**	

The algorithm of the MCA is to multiply the points of each scenario column with the weight and to add up the values.

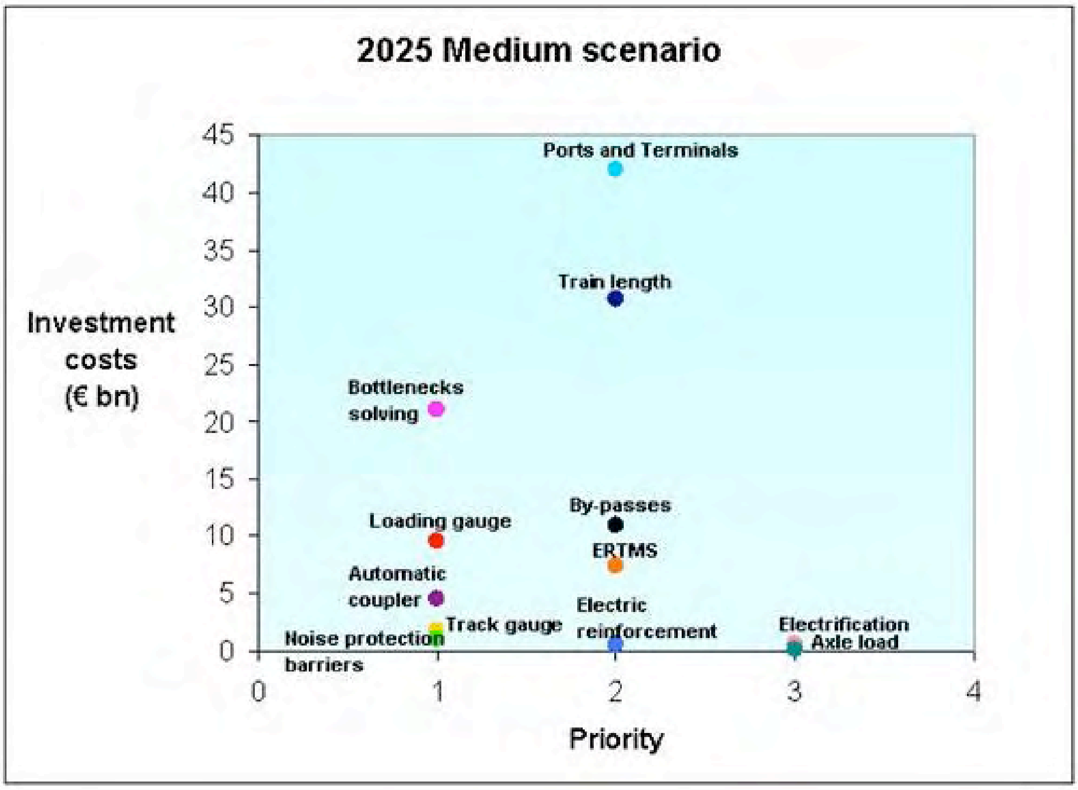
The result of the MCA is in fact similar to that of the CBA albeit with somewhat more moderate differences. The CBA results are thus robust. Even moderate changes in the weights and the values attributed to each scenario are not expected to reverse the CBA result.

Investment priorities

Interoperability and the general performance of the railway system are key elements in order to reduce transportation costs and travel time while increasing rail transport reliability and punctuality. Hence they are crucial in order to increase the rail market share in the FERRMED-network to 30 – 35%. For this reason, FERRMED Association is looking, as well, for locomotive and wagon new concepts, adapted to the proposed infrastructure standards.

Most of the standards refer to infrastructure limitations. However, rolling stock might impose other restrictions on the standards and interactions between the different standards. Therefore it will not always be possible to obtain the maximum limit as defined by the FERRMED-standards even if allowed by infrastructure. A graphical presentation of priorities (1 being the highest) and cost of recommended actions for each scenario follows.

Figure 30: Priority of recommended actions – 2025 medium FERRMED scenario

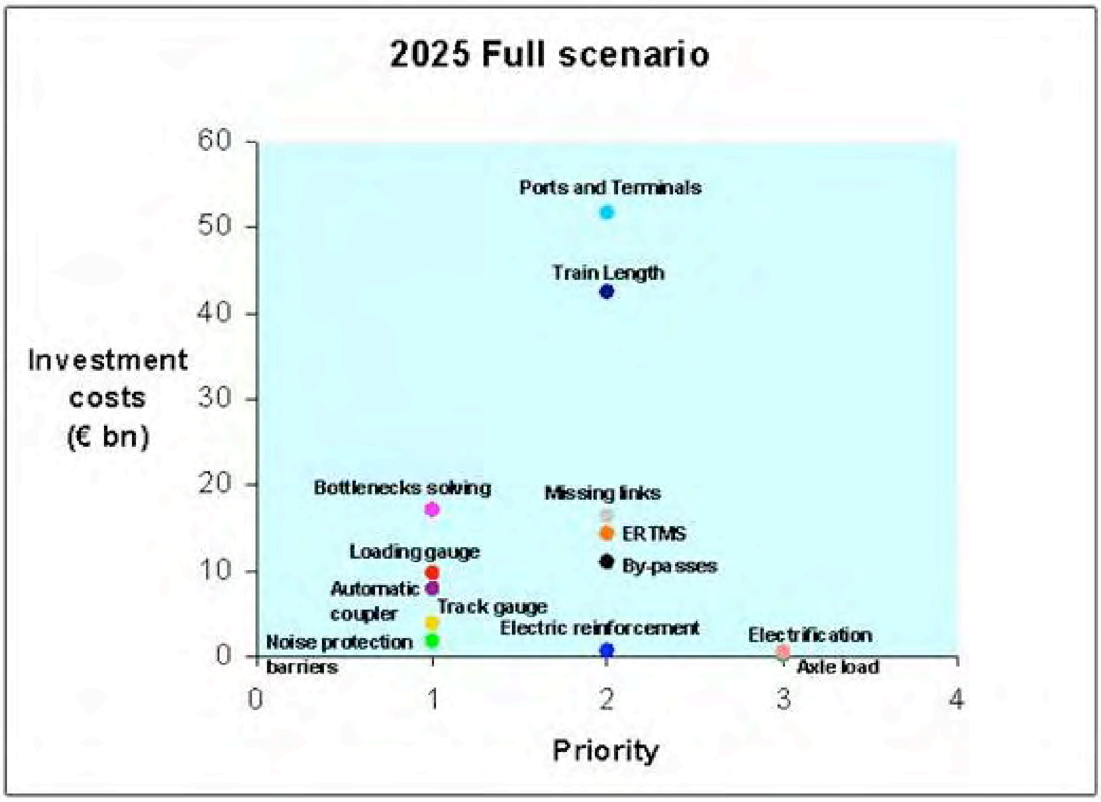


- **Priority 1:**
  - Track gauge in UIC standard 1,435 mm in Spain between French Border and Valencia.
  - Bottlenecks solving.
  - Loading gauge in UIC B1 or equivalent as PC 410 at least, upgrade some axes for rolling motorway.
  - Automatic coupler (traction and compression efforts + wire transmission) for 180,000 wagons on a total rolling stock of 500,000 wagons (36%) and for 10,000 locomotives on a total rolling stock of 19,000 engines of which 4,000 new locomotives already equipped before their use. The total rolling stock equipped with autocoupler will be 14,000 units (74%).
  - Environmental measures as noise barriers on around 336 km of total length.

• **Priority 2:**
  - o Electric reinforcement with 77 substations in additional and 35 high booster voltage.
  - o ERTMS implementation, on 5,000 locomotives with retrofit for 2,000 of them, Installation on board for 3,000 of them pre-equipped. 3,000 new locomotives will be equipped in 2025 before put in use. The total locomotive rolling stock ERTMS equipped will be 8,000 engines on 15,000 units (53%).
  - o By-passes of mainly cities.
  - o Increase the freight train length up to 1,500 m on FERRMED Core Network and up to 1,000 m on feeder lines with implementing on the rail network around 1,000 sidings of which 455 1,000 m sidings and 537 2,000 m sidings.
  - o Ports and terminals improvements.

• **Priority 3:**
  - o Electrification of the remaining lines not still electrified.
  - o Axle load increasing from 20t to 22.5t concerning remaining lines of secondary feeder lines for a total length of 236 km.

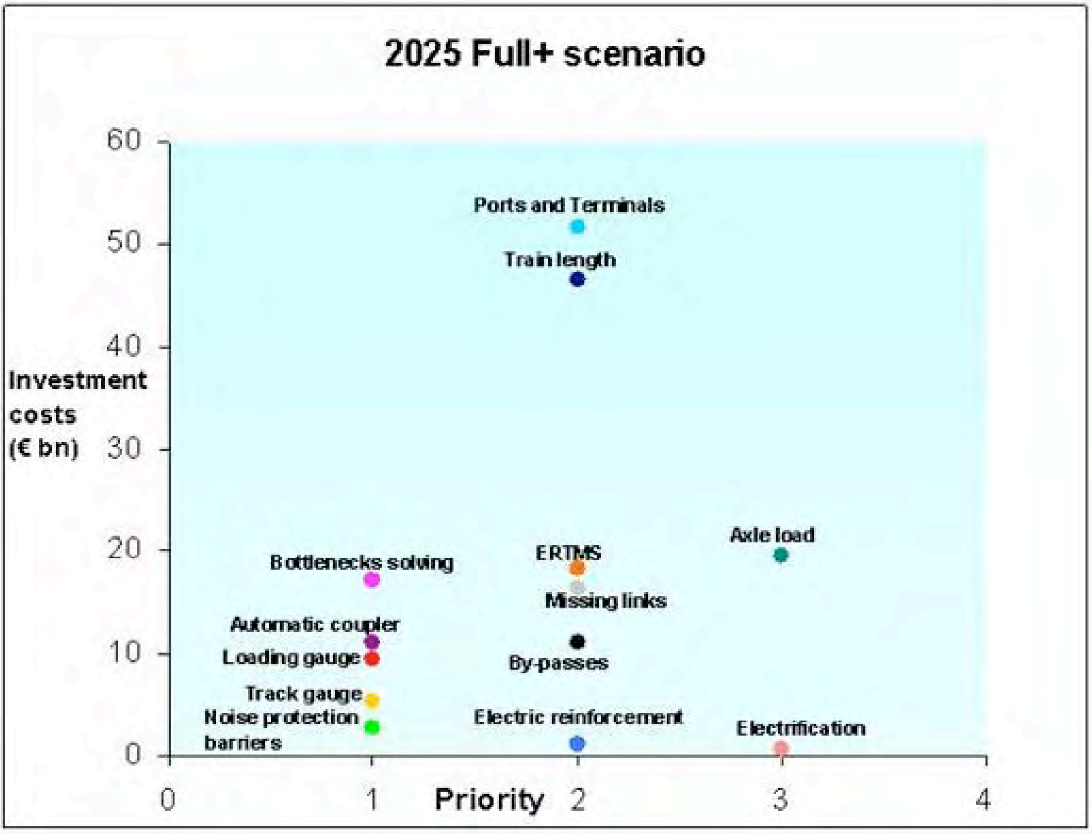
Figure 31: Priority of recommended actions – 2025 full FERRMED scenario



- **Priority 1:**
  - o Track gauge in UIC standard 1,435 mm in Spain between French Border and Algeciras with new mixed coastal line between Almeria and Algeciras.
  - o Missing link: Tarragona-Castelló (HSL).
  - o Bottlenecks solving.
  - o Loading gauge in UIC B1 or equivalent as PC 410 at least, upgrade some axes for rolling motorway.
  - o Automatic coupler (traction and compression efforts + wire transmission) for 320,000 wagons on a total rolling stock of 500,000 wagons (64%) and for 13,000 locomotives on a total rolling stock of 19,000 engines of which 4,000 new locomotives already equipped before their putting in use. The total rolling stock equipped with autocoupler will be 17,000 units (89%).
  - o Environmental measures as noise barriers on around 616 km of total length.
- **Priority 2:**
  - o Electric reinforcement with 103 substations in additional and 23 high booster voltage
  - o ERTMS implementation, on 8,000 locomotives with retrofit for 4,000 of them, Installation on board for 4,000 of them pre-equipped. Note 3,000 new locomotives will be equipped in 2025 before putting in use. The total locomotive rolling stock ERTMS equipped will be 11,000 engines on 15,000 units (73%).
  - o By-passes of large cities.
  - o Missing links: Almería-Motril-Málaga-Algeciras, Lorca-Moreda and Moreda-Granada.
  - o Increase the freight train length up to 1,500 m on FERRMED Core Network and on main feeders and up to 1,000 m on remaining feeders with implementing on the rail network around 1,500 sidings of which 909 1,000 m sidings and 537 2,000 m sidings.
  - o Yards improvement in ports with a new link between Genoa sea port and new Genoa dry port beyond Apennines, marshalling yards and Terminals, construction of new intermodal platform.
- **Priority 3:**
  - o Electrification of the remaining lines not still electrified.

- o Axle load increasing from 20t to 22.5t concerning remaining lines of secondary feeder for a total of 236 km.

Figure 32: Priority of recommended actions – 2025 full+ FERRMED scenario



- **Priority 1:**
  - o Track gauge in UIC standard 1,435 mm in Spain on the whole Core Network and on some feeders as well (including new high speed line Tarragona – Castellón).
  - o Missing links: Tarragona-Castelló (HSL).
  - o Bottlenecks solving.
  - o A part of main axis like Rotterdam - Duisburg – Lyon – Torino will be upgraded to UIC C gauge, the remaining network will upgrade to UIC B1 or equivalent as PC 410 at least with a high development of rolling motorway.
  - o Automatic coupler (traction and compression efforts + wire transmission) for 450,000 wagons on a total rolling stock of 500,000 wagons (90%) and for 15,000 locomotives on a total rolling stock of 19,000 engines of which 4,000

new locomotives already equipped before their putting in use. The total rolling stock equipped with autocoupler will be 19,000 units (100%).

  - Environmental measures as noise barriers on around 928 km of total length.

- **Priority 2:**
  - Electric reinforcement with 154 substations in additional.
  - ERTMS implementation, on 8 000 locomotives with retrofit for 4 000 of them, Installation on board for 4 000 of them pre-equipped. Note 3 000 new locomotives will be equipped in 2025 before putting in use. The total locomotive rolling stock ERTMS equipped will be 11 000 engines on 15 000 units (73%).
  - By-passes of large cities.
  - Missing links for Almería-Motril-Málaga-Algeciras, Lorca-Moreda and Moreda-Granada..
  - Increase the freight train length up to 1,500 m on FERRMED Core Network and on main feeders and up to 1,000 m on remaining feeders with implementing on the rail network around 1,500 sidings of which 461 1,000 m sidings and 985 2,000 m sidings.
  - Yards improvement in ports with a new link between Genoa sea port and new Genoa dry port beyond Apennines, marshalling yards and Terminals, construction of new intermodal platform.
- **Priority 3:**
  - Electrification of the remaining lines not still electrified.
  - Axle load increasing from 22.5t to 25t on the FERRMED Core rail Network (with a first priority to upgrade remaining lines from 20t to 22.5t at least).

10. ENVIRONMENTAL CONSIDERATIONS

Introduction

Against a downwards trend in greenhouse gas (GHG) emissions in Europe since 1990, transport generated emissions have risen and continue to rise. A shift in transportation mode from road to rail was targeted as a key objective of the European Union's transport policy that was set out in the White Paper, "European Transport Policy for 2010: Time to Decide", September 2001. This shift in mode was aimed at reducing GHG emissions from the transport sector. The mid-term review of the White Paper, "Keep Europe Moving. Sustainable Mobility for our Continent", 2006, modified this policy objective promoting modal shift, where environmentally appropriate, particularly over long distances, in congested corridors and in urban areas. FERRMED's vision of a business orientated rail network that encourages a significant shift in the mode of freight transport from, road to rail, particularly on long distance journeys is, therefore, fully in line with current EC policy and has a number of environmental implications.

It is beyond the scope of a strategic study, such as this, to analyse the environmental impacts and benefits of individual schemes, however, there are a number of overarching considerations that have been made within the framework of the study and these are set out below. Environmental considerations are dealt with three headings viz; Noise, Emissions and Identification of Potential Conflicts.

Noise

Traffic generated noise affects millions of people across Europe and its health effects include annoyance, sleep disturbance, disturbed cognitive function, cardiovascular disease and mental illness. Road traffic is the highest contributor to the problem, followed by aircraft and then rail.

The FERRMED Rail Network, described and analysed in this study, comprises, in the main, existing lines on established routes. There will be an increase, however, in the noise generated on these lines arising from an increase in overall traffic and, in particular, in the proportion of heavier and longer freight trains. It is also likely, in specific cases that the perceived nuisance arising from rail generated noise will increase owing to the intermittent nature of rail traffic when compared to road traffic.

The degree to which rail traffic noise will rise above acceptable limits for neighbouring populations will be assessed during the feasibility stage of each capital scheme. The extent, therefore, of the noise attenuation works that will need to be incorporated into the development of the FERRMED Rail Network, in order to mitigate noise nuisance, cannot be determined at this stage. However, in order to take account of the likely order of costs for noise mitigation the costs of noise barrier provision has been built into the unit costs for upgrading existing or constructing new lines, presented in the Technical Analysis section of this study.

Emissions

As stated above the EU has made commitments within its transport policy to take action to reduce transport related emissions, particularly of GHGs . In April 2009 it adopted a new package of legislative measures aimed at ensuring that the Union meets its target reduction in GHGs of 20% of the 1990 level, by the year 2020. Transport, as a sector, is targeted within the Climate and Energy Package and is charged with making a 10% cut in its 2005 GHG levels by the year 2020.

The modal shift from road to rail, for long distance freight transport, described in the Supply and Demand Analysis section of this study, will bring with it a decrease in the emission of pollutants and greenhouse gases (GHG). The level of emission reduction has been assessed by calculating the production of pollutants and CO_2 for each transport mode, for the Medium and Full / Full+ FERRMED Scenarios, and comparing these quantities with those calculated for Reference Scenario. The savings have been monetarised and considered as benefits within the Cost Benefit Analysis, which forms part of the Global Study's Socio Economic Analysis. Emission reduction quantities are summarised in Table below:

Table 65: Reduction in Pollutant and Greenhouse Gas Emissions 2016 – 2045 (tonnes)

Pollutant/ Greenhouse gas	Medium FERRMED Scenario	Full FERRMED Scenario	Full FERRMED+ Scenario
NoX	805,182	1,004,694	1,004,694
NMVOC	5,794	8,281	8,281
SO_2	199,841	242,682	242,682
PM	27,558	35,013	35,013
CO_2	128,099,118	145,410,934	145,410,934

The economic benefits arising from emission reductions, as a proportion of the total benefits generated by the implementation of the FERRMED Rail Network are, given in Table below:

Table 66: The Economic Benefits Arising from Emission Reduction as a Proportion of Total Benefit

Emission Reduction	Medium FERRMED Scenario	Full FERRMED Scenario	Full FERRMED+ Scenario
Pollutants	5.3%	2.7%	2.7%
Greenhouse Gases	1.3%	0.5%	0.5%
Total	**6.8%**	**3.2%**	**3.2%**

The proportion of benefits arising from reduction of emissions is small, however, any reduction in pollution or greenhouse gas production is to be welcomed. For a complete discussion and analysis of the environmental benefits arising from emissions reduction, the reference is the Socio Economic Analysis of this study.

The actual quantities of CO_2 saved, in the years 2020, 2025, 2035 and 2045 are shown in the table below. These are the savings calculated in relation to the emission levels that would occur if current transport trends continued i.e the Reference case.

Table 67: CO2 Savings at Strategic Years

	2020	2025	2035	2045
Medium FERRMED Scenario. CO2 reduction (Mt/year)	4.599	3.905	4.459	5.606
as % of Reference Scenario CO2 emissions	0.579%	0.473%	0.516%	0.621%
Full / Full+ FERRMED Scenario. CO2 reduction (Mt/yr)	3.173	4.857	5.361	6.678
as % of Reference Scenario CO2 emissions	0.408%	0.591%	0.623%	0.743%

Although these savings, in percentage terms, are small, when viewed against the background of rising transport demand and the dominance of the biggest emitter within the freight market, namely road haulage, they are to be welcomed as a contribution to the transport industry's recently imposed GHG reduction target. [1]

Identification of Potential Conflicts

Protected Sites

The development of the FERRMED Rail Network will entail construction activity at numerous sites, many of which will be in long established rail routes, when upgrading or reinforcing existing lines; others some will be in new, green or brown field sites, particularly where city bypasses are concerned. The FERRMED Global Study has identified the locations of a number of bottlenecks in the existing network and sets out proposals for their solution. There are also a number of recommendations for the construction of bypasses and new lengths of track. These infrastructure proposals are at a high level and are strategic in nature and no consideration has been given at this stage of possible track alignments or locations of structures.

Within the countries of the Red Banana are many environmentally sensitive and important sites. Council Directive 79/409/EEC, on the conservation of wild birds, affords Special Protection Area (SPA) status to areas considered particularly significant in terms of avian ecology, and is commonly known as The Birds Directive. Council Directive 92/43/EEC, on the conservation of natural habitats and wild flora and fauna, establishes Sites of Community Importance (SCIs) and Special Areas of Conservation (SACs). These sites have particular importance for biodiversity and the instrument is commonly known as the Habitats Directive.

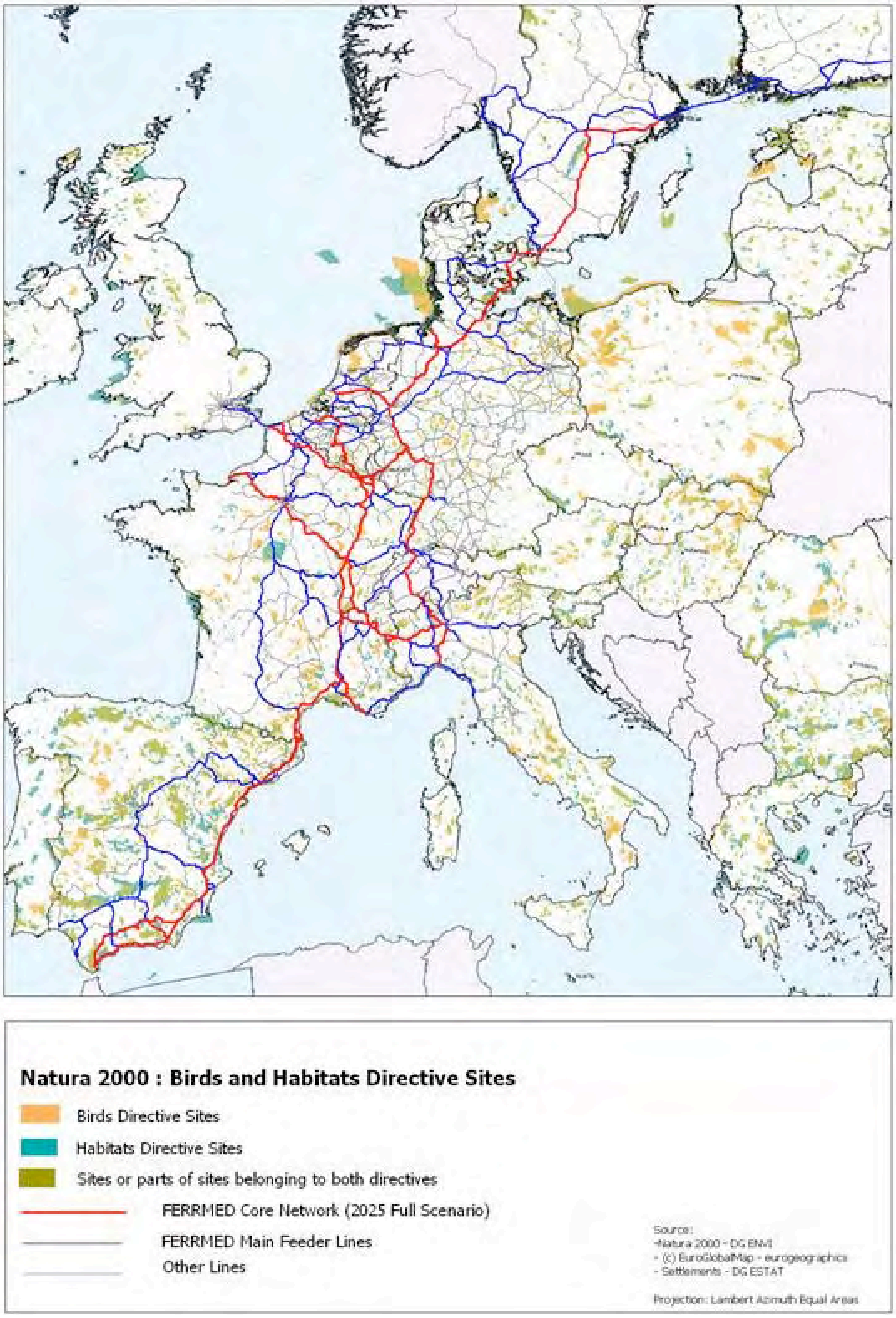
Natura 2000 is the EU wide network of protected areas established under both the Habitats and Birds Directives. Figure 33 shows the FERRMED Rail Network, in 2025, superimposed upon a high-level map of sites established under those directives and

[1] In the case of the Mediterranean corridor between Algeciras and Cerbere, one study funded by "Diputació de València-Xarcia de Municipis valencians cap a la Sostenibilitat and under the direction of Universidad Politécnica de Madrid and Diputación de València" was made to asses the CO2 emission reduction due to the implementation of FERRMED targets.

which form part of the Natura 2000 network. Some components of the Rail Network, be they core or feeder lines, either pass through or in close proximity to protected areas. In many cases, these rail routes will pre-date the establishment of the nature protection areas and will have been constructed before the emphasis on conservation, biodiversity management and environmental impact that currently prevails became commonplace.

Although construction and other human activity is not necessarily prohibited in all areas established under the Birds and Habitats Directives, their location and particular characteristics will inform route decisions and will influence design and construction practice. Whilst the focus of FERRMED Rail Network is business and its need for transport efficiency and intermodality, the development of the network cannot take place without proper consideration of its impacts on the environment. Careful planning, rigorous impact assessments, innovative design and appropriate mitigation measures will be required in order that the Rail Network develops in a sustainable way and that the positive economic benefits foreseen are realised.

Figure 33: The FERRMED Rail Network Relative to Natura 2000 Sites



Design

EC Directive 97/11/EC provides the legislative framework for the assessment of environmental impacts for infrastructure and other developments. Construction of lines for long distance railway traffic is covered included in Annex I of the directive and, therefore, a full Environmental Impact Assessment (EIA) is required for such projects. Other railway projects not included in Annex I, such as smaller permanent way projects and the construction of terminals and intermodal facilities, are included in Annex II and the Directive and these may require a full EIA, depending upon circumstances.

Treatment of the EIA process is not required here but it is clear that the various projects that will be brought forward during the development of the FERRMED Rail Network will be subject to either full or partial assessment. The EIA will highlight particular impacts that will need to be mitigated within the design of the project. The detailed design of each capital project will also need to take account of the long-term sustainability of the asset by careful consideration of landscape, ecology and bio-diversity, archaeological and cultural heritage, land use and materials. Whole life operation and maintenance of the assets will also be important considerations for the design, such that impacts caused by future work can be minimised.

Environmental Management during Construction

The greatest influence on a railways project's long-term environmental impact will be its design; however, the actual construction process itself has the potential to create significant impacts. It is vital then, that best practice in environmental management during construction is brought to bear upon the capital projects brought forward in the development of the FERRMED Rail Network.

Construction work should be planned, not only for delivery of the projects within budget and on time, but also for minimal environmental impact in the construction phase. Construction Environmental Management Plans (EMPs) should be produced which would include:

- Permissions and Consents
- Communications Plan
- Traffic Management Plan

- Noise and Vibration Management Plan
- Dust and Air Quality Management Plan
- Ecology Management Plan
- Hydrology and Aquatic Resources Management Plan
- Lighting Management Plan
- Waste Management Plan
- Emergency Plan

Proper environmental management of construction activity will benefit works contractors by efficient use of resources, through minimisation of waste, and will be closely linked with their obligations under Health and Safety law. Minimisation of vibrations, dust and noise and robust emergency planning will not only reduce the impact on the natural environment but on the public and work force alike. Production and adherence to an EMP should form part of the selection process for works contractors and a high priority placed on best practice construction management.

11. MARKET OPINION

During the elaboration of the FERRMED Study, a questionnaire was prepared and interviews were realized with the main actors of the logistics chains within the FERRMED market. This questionnaire included a set of questions regarding the current network, estimations for future demand, future plans and needs concerning regulation and control and the opinion of the different actors for the implementation of the FERRMED standards. The actors that participated in the market analysis were classified to sectors: infrastructure owners/ managers, transport and logistics companies, shippers and manufacturers, and various Associations. The results of this survey are presented below per sector.

Infrastructure Owners/ Managers

With regards to the current situation, the infrastructure owners/ managers that were interviewed highlighted that the main operating problems include lack of coordination between the different ports and terminals, time consuming approval procedures for rail traffic, lack of interoperability of personnel and infrastructure in international rail traffic and the priority of passenger rail traffic over freight. In addition, bottlenecks are caused due to inadequate infrastructure, lack of capacity, different rail width, signalization and electrification among different networks, accessibility problems, barriers to liberalization and the differences between regulations applied in different countries.

According to infrastructure owners/ managers, the lack of rail infrastructure in the terminals, the restrictive length of available rail track, non efficient links to the national and international road and rail network, delays due to passenger trains and inflexible networks, result in capacity restrictions. Regarding the use of freight terminals, the problems encountered mainly concern intermodal operations in peak hours which are mostly caused by unbalanced arrivals/ departures of hinterland traffic. Another common problem is related to customs authorities that create barriers to direct access of trains to the combined transport terminal area and hamper the efficiency of the planned slot system. Some underlined the need for more intermodal terminals, while others noted that there is no need for new terminals, at least until demand for rail transport significantly increases.

However, in Spain, it was a coincided argument that current and future terminals need to be adapted at least to 750 m train length.

With regards to future actions, according to infrastructure owners/managers, a solution is needed on electricity issues (locomotive changing in each country) and harmonization of locomotives homologation (a crosschecking list could be set up). There is also a need for legislation changes on train drivers training issues and network authorization of engine-staff in all EU countries. Capacity is also needed to be increased and more flexible railway operations to be applied. The use of double tracks is also supported by some infrastructure owners/ managers, while it is suggested that connections with ports should be freight dedicated (not mixed).

Infrastructure owners/ managers expect growth in European markets and additional demand for freight transport during the period 2008 – 2025. The projects that will be implemented during this period include new terminals, improved connections, more homogenous distribution of incoming hinterland traffic, more storage areas, new equipment, upgraded facilities, etc. Optimisation of logistics and operation is also required. There is also a need for change on regulations (rail equipment & harmonisation), need for European standardisation and education harmonization.

Regarding the implementation of the FERRMED standards, this is considered, by the time being, to be a difficult procedure for most of the infrastructure owners/ managers that were interviewed. First of all, it is revealed that the implementation of the FERRMED standards suggests a very high financial investment and requires time. Concerning the standard of 1,500 m long trains, it is noted that it is difficult to operate long trains in terminals (also in ports), as most of them are designed for shorter trains and in general, train length should be adapted to facilities of main nodes.

Concerning the standard of 12 ‰ slope, this is considered to be the optimum, but the slope relevant to the geography. Some infrastructure owners/ managers agreed that there are standards that can be reached: common operating and monitoring system for all the FERRMED Railway axis, UIC standards use, provision of an efficient intermodal terminal network, of timetables and capacities for 24h-traffic, harmonisation of bureaucratic requirements and procedures, keeping low cost of infrastructure use, introduction of R+D+4i management philosophy. Finally, some interviewees consider the FERRMED Rail

Network as a very interesting initiative, while others doubt if the Network has to include other important hinterland routes.

The interviewed infrastructure owners/ managers are presented in the following Table:

Table 68: Interviewed Infrastructure Owners/ Managers

Organisation/Company	Country
Port of Antwerp	Belgium
Terminal E.C.E (Renory- Port of Liege)	Belgium
Rail Net Denmark	Denmark
Port Autonome de Marseille	France
Port Autonome du Havre	France
Port de Rouen	France
Lyon Terminal	France
DC Transport Infrastructure (port of Bremen)	Germany
DC Transport Infrastructure (port of Duisburg)	Germany
DC Transport Infrastructure (port of Hamburg)	Germany
Genoa Port Authority	Italy
S.I.T.O. - Turin Freight Village	Italy
Port of Rotterdam	Netherlands
CFL Multimodal	Luxembourg
Port of Barcelona	Spain
Puerto Bahia de Algeciras	Spain
IFERCAT	Spain
Puertos del Estado	Spain
Port of Tarragona	Spain
Port of Valencia	Spain
ABERTIS	Spain

Transport and Logistics companies

Transport and logistics companies indicated that the main problems encountered include different safety requirements, different electrification, different maximum train length, different track gauges, problems detected at border crossings, such as congestion and different administrative formalities, problems related to train drivers, etc. Some companies referred to the issue of limited capacity due to prioritisation of passenger traffic, congested nodes, inefficient operation and co-ordination of rail traffic and absence of infrastructure management flexibility. It was also stated that the lack of investments in the equipment and the workface of the railway operators and the deplorable service quality of many railway operators suggest other significant problems. In addition, some companies stressed the fact that port terminals and port terminal access are usually very expensive.

With regards to future actions, according to transport and logistics companies, more investments in railway infrastructure, equipment, workforce and staff are needed. Doubling of tracks for freight network is considered a very important investment. Construction of new depots of more capacity and improvement of the inland access to the ports suggest very important actions, as well as more flexible infrastructure management, better co-ordination between the infrastructure managers and the railway operators.

Transport and logistics companies expect growth in market and additional demand for freight transport during the period 2008 – 2025. Regarding the projects that will be implemented during this period, the focus will be on rail, road and intermodal facilities. In many cases, logistics nodes will be strengthened and new intermodal facilities will be constructed.

With regards to regulation and control, it is noted that transport and logistics companies have to pay for the use of the railway infrastructure, while this is not a similar case for the road or inland waterways transport. In addition, the European Commission regulations and directives affect positively their business (open access, financial instruments etc) but also negatively (refusal for compensation for delays). According to transport and logistics companies, external costs should be allocated to all transport modes. Full implementation of deregulation and harmonisation process is also required. Less restrictive and more flexible agreements between the infrastructure manager and the ports are also needed.

Regarding the implementation of the FERRMED standards, most of transport and logistics companies have a positive attitude towards this perspective. The FERRMED Great Axis Network is considered as an ambitious and important project which will enhance EU economy. Most of them also agree that the most important standards to be implemented are the long train length, the axle load and signalling. It is acknowledged that there are difficulties in the FERRMED standards implementation, mostly due to financial reasons, but some of the standards are achievable by 2025. Some of them stated the standards that could be achieved until 2015 (mainly "availability of a network of intermodal terminals", "Transport system management shared between several rail operators", "Availability of capacity and traffic schedules 24/7") and until 2025 (mainly "Harmonisation of administrative formalities and social legislation", "ERTMS system").

Some further comments and suggestions were made regarding the improvement of the FERRMED Great Axis Network. First of all, it was stated that the importance of the FERRMED Network depends on the economic development, as well as the competition between rail and road traffic, especially as far as parallel routes are concerned. It was also supported that all stakeholders should be involved in Great Axis Network development, including logistics companies. Another comment was that the role of the FERRMED Network is considered to have positive effect on European markets, but competition by short-sea shipping is also expected. Regarding the investments to be made in the main corridors included in FERRMED Great Axis Network, it was stated that these should be based on national funding. The suggestions made include the following:

- Road and inland waterways taxing for use of the infrastructure and external costs.
- Study of the real environmental impact of short-sea and deep-sea navigation.
- Legislative measures in terms of authorizations of circulation for the HGV.
- Rail users support (green certificates).

The interviewed transport and logistics companies are presented in the following Table.

Table 69: Interviewed Transport and Logistics Companies

Organisation/Company	Country
TRW	Belgium
EUROPORTE 2	France
GEFCO	France
NOVATRANS	France
RAILINK Europe	France
Transfesa	France
DGG (Deutsche GVZ - Gesellschaft mbH)	Germany
Kombiverkehr GmbH & Co. KG	Germany
Kühne & Nagel AG	Germany
TX Logistik AG	Germany
Lorry Rail	Luxembourg
CHINA SHIPPING	Spain
COMSA	Spain
Autoterminal	Spain
Rhenus Logistics	Spain
SETRAM	Spain
TCB	Spain

Shippers and Manufacturers

According to the shippers and manufacturers that were interviewed, the main problems encountered regarding the current rail network include different electrification/ rail width/ maximum train length/ signalling, long stops at border crossings, different train safety requirements, taxes and administrative formalities and different regulations in each country. In addition, it was underlined that in some cases “enormous” delay, poor transport capacity and poor reliability of the railways is experienced. Problems have been detected regarding storage capacity at ports and terminals; while in some cases a considerable lack of loading and unloading capacity was noted. Other restrictions concern the operation time, as in many cases no operations take place during the night, and the fact that port terminals are rather expensive. It was also stated that often negotiations with rail operators are time consuming.

Implementation of rail projects, improvement of railway infrastructure, investments in railway access and loading-unloading facilities, promotion of freight terminals, improvement of port accessibility, extension of operations during the night, and less expensive services are actions that were suggested. In addition, liberalization of ports and freight market will improve efficiency and performance. Growth in market and additional demand for freight transport during the period 2008 – 2025 is expected according to the interviewees.

Regarding the implementation of the FERRMED standards, although some hesitation was expressed regarding the feasibility of implementation, all interviewees agreed that it suggests an optimal future scenario for the rail market. Track gauge, maximum train length and maximum axle load standards were considered as the most important FERRMED standards.

The interviewed shippers and manufacturers are presented in the following Table.

Table 70: Interviewed Shippers and Manufacturers

Organisation/Company	Country
Décathlon	France
BASF, Ludwigshafen	Germany
Arcelor - Mittal	Luxembourg
CELSA	Spain
SEAT S.A.	Spain
SHARP	Spain
VOSSLOH	Spain
Centre Européen de Fruits et Legumes	Belgium
MERCADONA	Spain

Associations

According to the associations that were interviewed, interoperability problems are detected due to different technical characteristics, lack of harmonization in signalling systems and electrification, lack of interconnections, operational issues (such as the need to change drivers at border crossings), lack of international recognition for drivers' certification, drivers not being familiar with other countries' legislation and language, administrative formalities, different political priorities, lack of full liberalization, etc. Some associations referred to congestion problems detected in some parts of the network especially at ports and terminals or in urban areas. Capacity problems are detected due to conflict between freight and passenger services, infrastructure deficiencies, type of vehicles available, rail track length at terminals and lack of reliability on railway links.

The associations referred to the problems concerning the use of freight terminals. First of all, it was noted that congestion in freight terminals is frequently detected. There are often time schedule restrictions and platforms designs allowing for reduced rail length. In addition, it was stated that the role of the terminal agents is not clear and there is lack of collaboration between the national networks. Finally, most associations support that more intermodal terminals are needed.

With regards to future actions, improvement of availability of capacity, port hinterland connections, rail access to ports, railway infrastructure, port infrastructure and terminal equipment, freight dedicated lines, optimal traffic management, construction of new lines, construction of marshalling yards, installation of efficient software in terminals, implementation of real-time information systems for international freight transport are considered as the most significant measures. In order to proceed with these actions, more investments are needed. It was also supported that rail transport should be considered at European level. In addition, independency of railway infrastructure managers and independency of regulators and railway authorities is considered as a necessity. Finally, it was stated that legal and political actions related to ports should be implemented.

The associations that took part in the interviews expect growth in European market and additional demand for freight transport in Europe and on the FERRMED Great Axis Network for the period 2008 – 2025. There is no clear estimation on modal split during the period 2008 – 2025; however rail share is expected to increase. The projects that will be implemented during this period include new lines, new infrastructure, electrification and double tracks, construction of intermodal facilities, expansion of the existing refineries, international expansion of business, development of European freight corridors, etc. Changes in operating practices, harmonisation of regulations and of the charging policy on EU level are necessary. Furthermore, it was stated that a harmonised international multimodal document of transport is needed in order to facilitate co-modality. Liberalization of the rail market and separation between infrastructure managers and rail operators is also needed.

The implementation of all FERRMED standards is considered as a difficult procedure by most of the associations that took part in the survey. However, generally, they believe that the FERRMED Standards implementation and the improvement of FERRMED Great Axis Rail Network Axis are ambitious and important projects, which will enhance EU economy and will have significant impact on transportation costs, reliability of freight transportation and the environment. Many of the associations do not expect that the full implementation of the FERRMED standards is possible before 2025. In addition, maximum train length (1,500 m) and maximum axle load (25 t) are not considered feasible by some of the interviewed persons, while dedicated freight lines are considered to be very costly and involve several other difficulties. Some of these persons expressed that the train length standard could be excessive, while on the contrary, maximum train length of 750 m can be considered adequate.

Some further comments and suggestions were made regarding the improvement of the FERRMED Great Axis Network. It was stated that transport on the FERRMED Great Axis Network should be undertaken by simplified operations and regular trains. The implementation of the FERRMED standards should be made on national basis and the FERRMED Network should be integrated in the TEN-T development. It was also supported that the development of the FERRMED Network should ensure equal treatment of public and private rail companies, promote interoperability and fair allocation of the external transportation cost to each transport mode. Finally, it was stated that local needs must be considered and FERRMED should concentrate on political marketing.

The interviewed associations are presented in the following Table.

Table 71: Interviewed Associations

Organisation/Company	Country
European Intermodal Association	Belgium
Danish Ports	Denmark
Comité pour la Transalpine Lyon-Turin	France
Compte-rendu CCIMP-INEXIA	France
CRCI Bourgogne	France
CRCI Languedoc-Roussillon	France
CRCI Rhône-Alpes	France
IBS	Germany
Provincial Government of Niedersachsen	Germany
Netherlands Institute for Transport Policy Analysis (KIM)	Netherlands
AML	Spain
ASCER	Spain
Asociacion Empresarial Quimica Tarragona	Spain
BCL	Spain
Cambra de Comerc de Barcelona	Spain
CIERVAL	Spain
Collegi Oficial Enginyers Industrials de Catalunya	Spain
Consorci de la Zona Franca	Spain
EMTE Instalaciones	Spain
Foment del Treball	Spain
General Director of Transports and Logístics,Infrastructures and Transport Council, Generalitat Valenciana	Spain
Gobierno De La Region De Murcia	Spain
European Railway Infrastructure Managers	Multi-country
TRADISA	Spain

12. LEGAL AND POLICY FRAMEWORK

The most important of EU legislation regarding European railways is summarized in the following Table.

Table 72: EU Legislation regarding European Railways

EU Legislation	Main purpose
Directive 91/440/EC	Development of Community's Railways
Directive 95/18/EC	Licensing of railway undertakings
Directive 95/19/EC	Allocation of railway infrastructure capacity and the charging of infrastructure fees
First Railway Package	
Directive 2001/12/EC	Access rights for international freight services and clarification of the relationship between the state, the infrastructure manager and the railway undertakings
Directive 2001/13/EC	Licensing of railway undertakings
Directive 2001/14/EC	Allocation and charging for infrastructure and safety certification
Directive 2001/16/EC	Interoperability of the trans-European conventional system
Second Railway Package	
Directive 2004/49/EC	Rail safety and improved access to the market for rail transport services
Directive 2004/50/EC	Amendment of the Interoperability Directive (2001/16/EC)
Directive 2004/51/EC	Acceleration of the freight market liberalization
Regulation 881/2004	Establishment of the European Railway Agency
Third Railway Package	
Directive 2007/58	Open access rights for international rail passenger services
Directive 2007/59	Certification of train drivers operating locomotives and trains at the European railway network
Additional Legislation	
Regulation 1371/2007	Rail passengers' rights and obligations / minimum quality standards
Regulation 1370/2007/EC	Public passenger transport services by road and rail
Directive 2005/47/EC	Working conditions of mobile workers engaged in interoperable cross-border services in the railway sector
Regulation 91/2003/EC	Rail transport statistics
Regulation 1192/2003/EC	Amendment of Regulation 91/2003/EC on rail transport statistics
Regulation 450/ 2008	Customs Code: rules, arrangements and procedures applicable to goods traded between the European Community and non-member countries
Directive 2004/17	Coordination of the procurement procedures of entities operating in the water, energy, transport and portal services sectors
Directive 2008/57/EC	The New Interoperability Directive – establishes the conditions to be met in order to achieve interoperability within the Community rail system
Regulation 1335/2008/EC	Amendment of Regulation 881/2004 establishing the European Railway Agency
Directive 2008/110/EC	Amendment of the Directive 2004/49/EC on railway safety

One of the main bottlenecks that need to be addressed in order for the rail freight traffic to continue to increase and become more cost-effective is the lack of network capacity for freight transportation. Rail freight traffic needs to have access to routes capable of handling more and longer trains and at the same time have access to routes that allow higher axle loads and loading gauges. Rail across Europe needs gauge enhancement in order to become more competitive and to be able to face and overcome the "advantages" of road transport, which is considered to be the major competitor of rail. Rail freight will need more capacity for long term growth. Even though new routes are needed in order to have more capacity available, it is possible to increase capacity of the existing network through regulatory and administrative reforms. This consists of a key area for action.

Different requirements for freight and passenger transport require different treatment, which in the case of railway means realistic solutions, starting with the optimization of the existing infrastructure capacity. Parallel lines (for passenger and freight traffic) on the main corridors and by-passes of busy urban centres could be two ways of capacity optimisation.

Introduction of new operational priority rules

Another suggestion which is considered necessary is to set more fair priority rules within congested networks in order to give freight traffic an advantage. Priority rules must be used in an efficient way, in order to favour some categories of freight, especially freight which is considered "sensitive" to time delays. In general, flexible traffic management for freight is necessary, given the fact that freight traffic is less predictable than passenger traffic. Thus, it is difficult to estimate in advance – for instance at the beginning of each year – the amount of capacity needed for freight traffic operations.

Development of a unified charging policy

Another issue that needs to be dealt with in order for the European rail freight market to be strengthened is the charging policy set on national and European level. It is of great importance that a simple and efficient charging structure is developed, as current pricing systems further enhance the complexity of the rail transport industry itself and are not appealing to customers. The lack of competitive prices, compared to road freight transport consists one of the major problems that the rail sector has to face. Developing a unified charging policy within the EU, which will be based on the "polluter pays" principle, will become a tool for shifting freight transport from road to rail.

Apart from developing a smart charging policy for the rail freight sector itself, it is necessary to include external costs in the road pricing policy within Europe as well. Within this framework, the European Union introduced the Eurovignette Directive in 2006, which sets the foundations for more efficient and fair pricing for freight transport and examines all possible ways for internalizing external costs for all transport modes. It is of great importance that all EU Member States develop transport policies and charging policies which will reflect the main guidelines of the Eurovignette Directive.

Consistent implementation of EU Directives

Another significant issue to be addressed is the liberalization and competition of the rail market. It is necessary that full liberalization and free competition is achieved, based on the common and consistent implementation of the EU Directives, which will eventually lead to a truly open and unified rail sector across all European countries. Currently, it seems that each national rail market is at a different stage of development, while the competition framework of each market is not based on the same principles. Moreover, the legal framework for the European rail sector is set at EU level. However, in order for the rail freight traffic to grow and become more efficient and competitive, compared to other transport modes, the legal framework set by the EU needs to be implemented nationally, while the current market entry barriers need to be lowered. This way, it is possible for the rail freight operators to offer more attractive and of high quality services to their customers. In addition, infrastructure managers need to be independent, in order to be able to ensure safety, high quality services and efficient use of the network.

Development of freight preference rail corridors

Regarding the freight "preference" corridors these are considered a very important tool for enhancing rail competitiveness and efficiency. Most involved parties in the rail sector believe that in order for the rail freight market to be able to successfully compete with the road transport market, it is necessary to develop a number of freight dedicated corridors, which will allow for long and high capacity trains to operate on regular basis. However, due to the fact that developing freight "preference" corridors across Europe can be a rather overwhelming task, especially in financial terms, political action at ministerial level is necessary, regardless of the legal framework. In general, trying to enhance competitiveness for rail freight should not be limited to legislature actions, as this alone has proven to be insufficient over the past years. Furthermore, infrastructure managers and national governments should co-operate in managing rail freight corridors, while the railway undertakings could also be involved in the process.

Promoting rail freight transport across Europe is a complicated task that needs a lot of effort at both EU and national level. It is of great significance to recognize the fact that the railways can provide for environmentally sustainable transport across Europe, with less negative impacts, while they can also contribute in increasing transport's efficiency and affordability. Within this framework, it is very important that all EU Member States implement the European transport policies, setting, thus, the foundations for a unified, efficient, competitive and affordable rail sector.

FERRMED "technical standards" application

As far as the countries examined within the present report are concerned, based on the data collected and presented, regarding the regulatory framework, within which the railway sector of these countries operates, several bottlenecks were detected. These bottlenecks mainly refer to administrative issues, transport policies as well as the railway legislation of each country. The analysis of these bottlenecks was based on the FERRMED standards included. In the following Table, the findings regarding the FERRMED standards and whether these are met within the examined counties are summarized.

EU Railway Corridors Management

In order to support international freight rail transport, it is of great significance to promote common management criteria and control systems at EU level. European rail corridors, such as the FERRMED Great Axis Network, need to be managed at EU level.

Table 73: FERRMED Standards in the FERMED countries - administrative and legal perspective

FERRMED Standard	Belgium	Denmark	Finland	France	Germany	Italy	Luxembourg	Netherlands	Norway	Spain	Sweden	Switzerland	UK
Electrified line (25,000 volts)	x	√	√	x (3)	x	x	√	x	x	x	x	x	x
Priority or exclusiveness to common freight traffic	x	x	x	x	x	x	x	x	x	x	x	x	x
UIC C gauge	x	√	√	x	x	x	x	√	x	x	x (1)	x (1)	x
Trains length reaching 1,500 meters	x	x	x	x	x	x	x	x	x	x	x	x (1)	x
3,600 < tons of loading capacity < 5,000 tons	x	x	x	x	x	x	x	x	x	x	x	x	x
ERTMS system with "two ways working" along the tracks	few parts (2)	x	x	few parts (2)	x	most parts (4)	total network (2)	all parts (4)	x	few parts (2)	x	few parts (2)	x
Availability of capacity and traffic schedules for freight transportation 24 hours a day and 7 days a week	√	√	√	√	NA	√	NA	NA	NA	NA	NA	x	NA
Harmonization of the administrative formalities and the social legislation	x	x	x	x	x	x	x	x	x	x	x	x	x
Transport system management shared with several rail operators (free competition)	√	√	√	√	√	√	x	√	√	√	√	√	√
Favourable and homogenous fees for the use of infrastructures, bearing in mind the socioeconomic and environmental advantages of the railway	x	x	x	x	x	x	x	x	x	x	x	x	x

(1) very few parts, (2) under construction, (3) only in some parts, (4) commercial service or under construction

13. SUMMARY OF PROPOSALS/ CONCLUSIONS

RAIL FREIGHT TRAFFIC

By applying only the planned / committed projects by the national and regional authorities (Reference Scenario), the road sector will continue to have the lion's share in the future freight transport market (76% between freight inland modes and 82% between passenger modes in 2025).

For long distance traffic, rail transport can be competitive with road. For trips of more than 500 km, the rail share within the inland modes in the Red Banana Countries in 2025 would be 21%, and for more than 1,000 km this value would increase to 25%.

The next table shows the growth of traffic in freight modes (in Red Banana Countries) between scenarios analysed by the Study:

Growth (tonnes-km)	Road	Rail	IWW	Sea	Total All	Total Inland
2020 Reference/ 2020 Medium	-1,8%	10,7%	-0,5%	-0,1%	0,1%	0,0%
2025 Reference/ 2025 Medium	-1,4%	8,4%	-1,0%	-0,5%	0,1%	-0,1%
2025 Reference/ 2025 Full	-2,0%	15,6%	-1,8%	-0,8%	0,7%	0,2%
2025 Full/ 2025 Ports	0,4%	0,6%	1,5%	5,4%	0,6%	2,2%
2025 Full/ 2025 Objective Achieved	-2,2%	9,7%	0,0%	0,0%	0,0%	0,0%

As expected, Rail presents a higher increase of transport performance in Red Banana, due to the FERRMED standards implementation.

The implementation of the FERRMED Proposals and Standards impacts the freight transports system in Red Banana in a positive way, reversing the trend observed regarding the role of road freight transport.

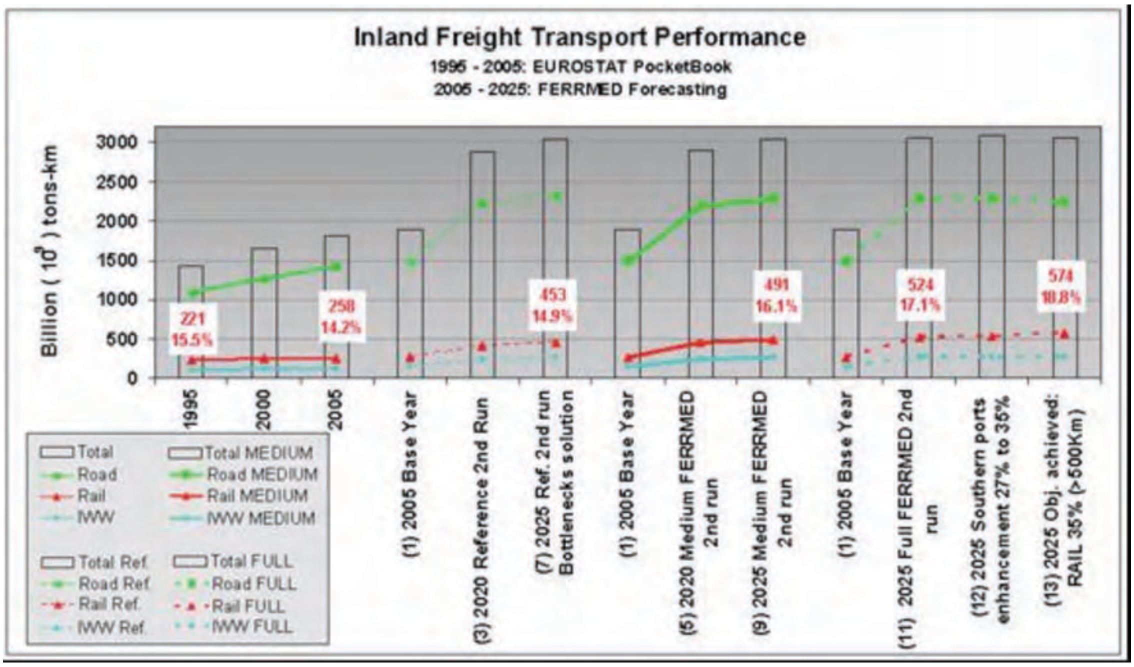
The FERRMED Standards and proposals implementation aims at improving rail service, operations and infrastructure and therefore railway reliability and quality. If these improvements are applied to the rail system at the same time as the generalized costs changes forecasted for the Road sector (mainly the Eurovignette Policy and the increase in fuel prices), they will have an impact directly on the expected modal shift from road to rail. However, this situation could change when the internalisation of external costs will be applied to all the other transport modes

The freight transported (in tonnes-km) in the Red Banana countries by train increases significantly between the Reference and the FERRMED Scenarios:

- From 409.5 billion to 453.2 billion tonnes-km between 2020 Reference Scenario 2nd run and 2020 Medium FERRMED 2nd run;
- From 452.7 billion tonnes-km in the 2025 Reference Scenario 2nd run to 490.6 billion tonnes-km in the 2025 Medium FERRMED 2nd run and 523.5 billion tonnes-km in the 2025 Full FERRMED 2nd run.

Comparing inland trips longer than 1,000 km, rail transport will be able to transport 26.4% of tonnes-km in Red Banana in the case of Medium FERRMED and 28.2% in the case of Full FERRMED. The next figure shows how the FERRMED Scenarios are able to reverse the trends, comparing the results of the model with real data from EUROSTAT related to the EU25.

Figure 34: Freight transport performance by mode for all FERRMED scenarios



To conclude, the results of the Reference Scenarios indicate that the planned and committed projects, in general terms, will be able to stop the tendency to loss modal share suffered by the freight rail sector in the last decade.

Nevertheless increase in rail market share is achieved through the implementation of a full set of measures aimed at improving the European Rail System acting at global level, on all the possible facets: interoperability, network infrastructure, security, services, operations and rolling stock.

The FERRMED Standards and Proposals resulted in being a valid set of answers to this need for a global improvement of the European Rail System in order to achieve the modal shift from road to rail, which is the first step towards a sustainable Freight Transport System.

PROPOSED INVESTMENTS

In order to reach the above presented FERRMED implementation traffic scenario, significant investments need to be made.

Between the base year network (2005) and the reference scenarios networks, there are notable changes, mainly in crossings between Denmark and Germany, Netherlands and Germany, France and Italy, France and Spain and all along the Mediterranean coast of Spain.

All the projects, officially planned, are taken into account in the 2025 Reference scenario FERRMED Rail Network. The total length of the FERRMED Great Axis Rail Network increases by 7.6%, from 20,562 km in 2005 to 22,117 km in 2025 Reference scenario.

The Study proposes the following additional investments:

[illegible]

Solutions to bottlenecks are presented in Annex 3.

[illegible]

- Hamburg and Koblenz, in Germany.
- Brussels in Belgium.
- Lyon, Lille, Dijon in France. The North-East ring around Paris (called Grande Ceinture) is not congested, but some parts of it may present difficulties for freight trains. It is suggested mainly for Le Havre port, in order for freight trains to be able to run on a large by-pass which exists, an important upgrade is required, namely electrification, gauge, signalling and switches changing. The route of this great Paris by-pass is: Le Havre – Motteville - Monterolier – Amiens – Reims - Chalons-en-Champagne – Dijon.
- Barcelona (North Girona – South Tarragona bypass: this Great bypass solves congestion and common tunnels for high speed line and conventional line in Girona station and in Montmeló) and Valencia in Spain.

[illegible]

Regarding the FERRMED “technical standards” the main recommendations of the Study are the following:

- Track width with UIC standard gauge (1,435 mm): In order to develop the freight rail traffic between Spain and Europe remaining countries, it is necessary as a first priority to change the track width from broad gauge to UIC standard gauge on the Spanish Mediterranean coast between the French border and Valencia and as a second step between Valencia and Algeciras. The problem is different for Finland (1,524 mm broad gauge), where on one hand, the Finnish rail network is not directly linked with the West European rail networks except by sea ferries and on the other, it is linked with the Russian rail network and the ones of the ex-Soviet Union countries, which have nearly the same track width (1,520 mm).

- Double track (2x2) on the Core network: one double track for high speed passenger train and one another double track for freight and regional trains at least. But in order to obtain a high level of quality in rail freight transportation, it is necessary to separate local passenger trains from freight trains in suburbans areas. Sometimes when the lines are congested, mainly near the large cities, the only one solution is to build a by-pass to guarantee a freight rail traffic 24/7 and therefore to have a true business oriented rail network.
- Loading gauge: UIC C gauge for new lines and progressively on the FERRMED Core network.
- Lines suitable for freight trains with 22.5 to 25 tonnes per axle with new lines built to accept 25t per axle (E4 code in UIC standards).
- A maximum slope of 12 ‰ and limitations on the length of the ramps.
- Trains with loading capacity from 3,600 to 5,000 tonnes.
- Sidings and terminals suitable for 1,500 m. trains. 750 m trains in the European rail freight network are required. The first step could be the generalization of 500 m trains (Italy, UK and Spain), then the implementation of 1,000 m trains on the Core network and main feeders and finally of 1500 m trains provided that automatic coupler, new brake system and radio command or wire transmission between engines are applied.

[illegible]

It is also recommended to implement the following:

- Automatic couplings are essential for FERRMED freight trains. The current coupling and braking system makes it impossible to go past 1,000 m. This implementation requires the modification of nearly the entire wagons pool. The implementation of auto-coupler necessitates adapted wagon or new wagon with central beam structure. Nowadays, a large number of wagons running on the European rail network have adapted structure to receive an autocoupler. This one must be an automatic buffing and draw coupler able to transmit electric or electronic synchronous information and orders between the locomotives distributed along the very long and heavy train. Wire transmission or radio control for automatic couplings should be implemented.

- ERTMS system with “two ways working” along the tracks.
- Electrified lines with preferentially a 25 kV AC 50Hz electric traction power supply.
- Spanish new lines in Mediterranean Corridor.
- Spanish rolling stock conversion to 1435 mm track width

The philosophy of a business orientated rail freight network, such as that promoted by FERRMED, is interoperability and interconnectivity between countries and regions. It is clear, then, that in order for the benefits illustrated by this study’s cost benefit analysis to be realised, the track width of the conventional existing line at the crossing of the Pyrenees, in the FERRMED Core Great Axis, must be changed to International standards. The cost of doing so compares favourably with that for the construction of a new Transpyrenean line.

The development of terminals should also be examined together with the development of specific European freight transport corridors, such as the FERRMED Rail Network.

It has been detected that some areas seem to be lacking significant main terminals. These areas consist of regions mostly in France, Spain, Germany and Italy. Also, some smaller needs are detected in Sweden, Netherlands, Switzerland and Belgium. Finally, it is noted that there are some more areas which seem to have minor needs in all countries influenced by FERRMED Rail Network, which will be larger through the years due to the increase of freight traffic volumes and the promotion of the Axis.

INVESTMENT COST

The total cost per scenario is the accumulative result of all the cost components described in the previous sections, that is to say:

- Bottlenecks,
- By-passes,
- FERRMED standards,
- Other costs and
- Maintenance.

The following Table presents the cost of implementation or construction of the abovementioned categories, and the total cost for each of the scenarios of the targeted year 2025 (medium, full and full FERRMED+).

Category	Cost per 2025 scenario (million € 2007)		
	medium	full	full FERRMED+
Bottlenecks	**21,105**	**17,131**	**17,131**
Bottlenecks solving	21,105	17,131	17,131
By-passes	**12,009**	**12,848**	**13,273**
By-passes of large cities	11,000	11,000	11,000
Noise barriers	1,009	1,848	2,783
FERRMED standards	**42,920**	**56,709**	**81,299**
Spain (1668mm)	0	0	619
Broad gauge to UIC gauge	1,871	3,841	4,627
Loading gauge	8,769	8,769	8,520
Rolling motorway	915	915	915
Axle load	164	164	19,565
Train length	30,606	42,425	46,457
Electrification	596	596	596
Other costs	**54,644**	**91,075**	**98,522**
ERTMS implementation	7,518	14,296	18,296
Rolling stock automatic coupling	4,210	7,365	10,275
Spanish rolling stock to UIC track width	355	630	840
Spanish New lines investments	0	16,360	16,360
Ports & Terminals	42,000	51,700	51,700
Electric reinforcement	561	724	1,051
Maintenance	**23,226**	**26,146**	**27,036**
Bottlenecks	1,600	1,360	2,250
Network	9,026	9,276	9,276
Ports & Terminals	12,600	15,510	15,510
Total	**153,903**	**203,910**	**237,771**

[illegible]

The Cost Benefit Analysis results in a positive Economic Internal Rate of Return (EIRR) of 5.0 % in the MFS, 11.1 % in the FFS and 8.9 % in the F+FS. The respective benefit-cost ratios are 1.2, 2.0 and 1.7. This means that in all scenarios the investments for the

FERRMED project will be outweighed by the benefits resulting from improved rail transport quality leading to a modal shift from road to rail. The results are summarised in the next Table.

Scenario	Net Present Value – NPV (million Euro)	Economic Internal Rate of Return – EIRR (%)	Benefit / Cost Ratio – BCR
MFS	10,780	4.97	1.155
FFS	93,783	11.09	1.993
F+FS	76,453	8.85	1.684

(*) social discount rate: 3.5%

The results of the CBA confirm that the FERRMED concept is indeed meaningful from a societal point of view and across all regions and countries within the area of influence of the main and feeder rail lines in the FERRMED Great Axis Network and the European Union in general.

Each of the three FERRMED scenarios turns out with positive results regarding all three CBA indicators: net present value, economic internal rate of return and benefit cost ratio.

The indicator of most significance is the EIRR. The Full FERRMED Scenario with an EIRR of over 11 % has an excellent rating considering that this is the average of a large number of individual projects with many of these if taken individually would have a much better economic return.

The difference between the Medium and the Full FERRMED Scenarios suggests that the implementation of the FERRMED standards would attract, because of its high system advantages, freight to the railways thus reducing waste of resources in terms of transport operating costs, the time of transport and accident and environmental costs.

The implementation of FERRMED standards in their maximum values (all lines at 25tons/axle, all wagons and significant amount of locomotives with automatic couplings, full application of UIC-C gauge, etc) on the whole network would consume significantly more economic resources with partially estimated additional benefits.

The results suggest that it makes more sense in economic terms to aim at full FERRMED standards on the Core Network and main feeders which would be broadened continuously rather than go for intermediate solutions. This is largely due to the fact, that passenger transport benefits greatly from the investments to improve freight transport.

With the results of the CBA as presented, the next step would be to establish a programme of priority projects to show the way how to implement the FERRMED programme.

For individual projects, individual pre-feasibility and feasibility studies are required under subsequent assignments, at a later stage of the project cycle, to review the feasibility of such individual projects. Such individual feasibility studies (i.e. project by project) are anyhow a prerequisite for financing of specific projects.

[illegible]

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There is in Europe already a widespread preparedness to finance rail projects provided they are feasible and sustainable; preparedness, feasibility and sustainability might grow with the increasing awareness of the environmental and capacity problems of road transport.

The bulk of funds for Europe-wide transport corridor projects (as is the FERRMED Great Rail Axis Network) must come from national public sources. The respective financing portion should be more than 50 % of total funds required. Discussion with International Financing Institutions should start in short term. These can be based on the costs provided by this Study.

A substantial portion of the total funds required for Europe-wide transport projects can be expected to be co-financed by the EC / DG TREN and EIB. This portion could reach up to 30 %, in specific cases, e.g. ERTMS projects, even more. As the investments foreseen for the FERRMED Great Rail Axis Network meet the funding rules of the EC, substantial funds from the various EU sources can be expected.

The involvement of the private sector in terms of PPP projects in whatever form (concession, BOT, BFOT etc.) is considered more likely for rail related infrastructure investments in the new lines in Spain, ports, terminals and urban bypasses than e.g. for traditional upgrading of tracks (by sidings, modification of gauge etc.).

[illegible]

The emissions savings have been monetarised and considered as benefits within the Cost Benefit Analysis, which forms part of the Global Study's Socio Economic Analysis. Emission reduction quantities are summarised in Table below:

Pollutant/ Greenhouse gas	Medium FERRMED Scenario	Full FERRMED Scenario	Full FERRMED+ Scenario
NoX	805,182	1,004,694	1,004,694
NMVOC	5,794	8,281	8,281
SO_2	199,841	242,682	242,682
PM	27,558	35,013	35,013
CO_2	128,099,118	145,410,934	145,410,934

The economic benefits arising from emission reductions, as a proportion of the total benefits generated by the implementation of the FERRMED Rail Network are, given in Table below:

Emission Reduction	Medium FERRMED Scenario	Full FERRMED Scenario	Full FERRMED+ Scenario
Pollutants	5.3%	2.7%	2.7%
Greenhouse Gases	1.3%	0.5%	0.5%
Total	**6.8%**	**3.2%**	**3.2%**

The actual quantities of CO2 saved, in the years 2020, 2025, 2035 and 2045 are shown in the table below. These are the savings calculated in relation to the emission levels that would occur if current transport trends continued i.e the Reference case.

	2020	2025	2035	2045
Medium FERRMED Scenario. CO_2 reduction (Mt/year)	4.599	3.905	4.459	5.606
as % of Reference Scenario CO_2 emissions	0.579%	0.473%	0.516%	0.621%
Full / Full+ FERRMED Scenario. CO_2 reduction (Mt/yr)	3.173	4.857	5.361	6.678
as % of Reference Scenario CO_2 emissions	0.408%	0.591%	0.623%	0.743%

Although these savings, in percentage terms, are small, when viewed against the background of rising transport demand and the dominance of the biggest emitter within the freight market, namely road haulage, they are to be welcomed as a contribution to the transport industry's recently imposed GHG reduction target.

Whilst the focus of FERRMED Rail Network is business and its need for transport efficiency and intermodality, the development of the network cannot take place without proper consideration of its impacts on the environment. Careful planning, rigorous impact assessments, innovative design and appropriate mitigation measures will be required in order that the Rail Network develops in a sustainable way and that the positive economic benefits foreseen are realised.

The degree to which rail traffic noise will rise above acceptable limits for neighbouring populations will be assessed during the feasibility stage of each capital scheme. The extent, therefore, of the noise attenuation works that will need to be incorporated into the development of the FERRMED Rail Network, in order to mitigate noise nuisance, cannot be determined at this stage. However, the Study has taken into account noise barriers in the total investment costs.

Treatment of the EIA process is not required here but it is clear that the various projects that will be brought forward during the development of the FERRMED Rail Network will be subject to either full or partial assessment.

Construction work should be planned, not only for delivery of the projects within budget and on time, but also for minimal environmental impact in the construction phase. Construction Environmental Management Plans (EMPs) should be produced.

[illegible]

It is necessary to set more fair priority rules within congested networks at EU level in order to give freight traffic an advantage. Priority rules must be used in an efficient way, in order to favour some categories of freight, especially freight which is considered “sensitive” to time delays.

It is of great importance that a simple, homogeneous and efficient charging structure is developed, as current pricing systems further enhance the complexity of the rail transport industry itself and are not appealing to customers. It is of great importance that all EU Member States develop transport policies and charging policies which will reflect the main guidelines of the Eurovignette Directive.

It is necessary that full liberalization and free competition is achieved, based on the common and consistent implementation of the EU Directives, which will eventually lead to a truly open and unified rail sector across all European countries.

Regarding the freight “preference” corridors these are considered a very important tool for enhancing rail competitiveness and efficiency.

ANNEXES

1. Glossary

Term	Explanation
APPRAISAL	The ex-ante analysis of a proposed investment project to determine its merit and acceptability in accordance with established decision-making criteria.
APPRAISAL PERIOD	Number of years for which forecasts are provided in the CBA.
ASTRA	model for strategic assessment of transport policies and investments (2000)
AUTOMATIC BLOCK	Block system in which the fixed signals for the block section are operated automatically by the passage of trains.
BASIC INTERVAL TIMETABLE	Consists in a repetitive traffic program at each hour of the day. It improves readability for passengers (timetable easier to memorize) and optimises the capacity of a railway line. Freight can thus run at every hour of the day, including rush hours through the main agglomeration.
BENEFIT-COST RATIO (BCR)	The ratio of the discounted sum of all future costs and benefits except investment costs to the discounted sum of investment costs.
BLOCK SYSTEM	Guarantees train spacing. The track is divided in block sections which admit the presence of one train. Shorter the block systems are, more the trains can succeed one another quickly.
BY-PASS	Passing track
CAPACITY	The total number of possible paths in a defined time window, considering the actual train path mix or known developments respectively and the infrastructure manager's own assumptions.
CESAR	Co-operative European System for Advanced Information Redistribution for clients of the operators UIRR members.
CODETEN	Strategic Assessment of Corridor Developments, TEN Improvements and Extensions to the CEEC/CIS
COMBINED TRANSPORT	Intermodal transport where the major part of the journey is by rail, inland waterways or sea and any initial/or final legs carried out by road are as short as possible.
CONSTANT PRICES	Prices that have been deflated by an appropriate price index based on prices prevailing in a given base year. They should be distinguished from current or nominal prices.
CURRENT PRICES (NOMINAL PRICES)	Prices as actually observed at a given time. They refer to prices that include the effects of general inflation and should be contrasted with constant prices.
DIOMIS	Developing Infrastructure Use and Operating Models for Intermodal Shift
DISCOUNTING	The process of adjusting the future value of cost and benefits to the present by a discount rate
DOUBLE TRACK	Section of infrastructure with two adjacent guide-ways or tracks.
ECONOMIC COSTS	Economic costs are the costs to society as a whole of the use of resources valued at undistorted market prices and net of transfer payments (taxes, subsidies.
ECONOMIC INTERNAL RATE OF RETURN (EIRR)	The discount rate at which a stream of costs and benefits has a net present value of zero. The economic internal rate of return is compared with a benchmark in order to evaluate the performance of the proposed project.

Term	Explanation
ERTMS	European Rail Traffic Management System: signalling system and traffic management using the ETCS for the control command and the GSM-R for the data transmissions.
ETCS	European Train Control System: Automatic control system of the trains by valise for European rail networks.
FIXED EQUIPMENT FOR OCCASIONAL WRONG-TRACK WORKING	Allows both directions of traffic which improve robustness. In case of incident on a track, it is possible to divert a part of the traffic on the other track, usually dedicated to trains running in the opposite way.
FLYOVER	To avoid train crossings, it is possible to build railway interchanges, in permitting the track crossing by a bridge for example (above or below).
GSM-R	Global system for mobile communications for railways: communication system based on the standard of mobile telephony GSM and using specific frequencies for the railway.
HSL	High speed line
HST	High speed train
IMPACT	A generic term for describing the changes or the long term effects on society that can be attributed to the project.
IMPULSE	Interoperable Modular Pilot plants Underlying Logistic System in Europe
INFRASTRUCTURE MANAGER	Any public or private body or undertaking responsible in particular for establishing and maintaining railway infrastructure, as well as for operating control and safety systems.
INFREDAT	Methodology for collecting intermodal freight transport data (EU FP4 project)
INTERMODAL TRANSPORT	The movement of goods in one and the same loading unit or road vehicle, which uses successively two or more modes of transport without handling the goods themselves in changing modes.
INTEROPERABILITY	Capacity of a material to circulate on railway networks presenting different technical characteristics.
INVESTMENT COST	Capital cost incurred in the construction of the project
IQ	Intermodal Quality (EU FP4 project)
LEVEL CROSSING	Crossing of a railway and a road at the same level.
LINE	A link between two large nodes and usually the sum of more than one line section.
LOGIQ	Intermodal Decision: The Decision – Making Process in Intermodal Transport (EU FP4 project)
MAINTENANCE COST	Cost for maintaining infrastructure: regular/routine (annual) maintenance costs and periodic (fixed interval) maintenance (including extraordinary maintenance, e.g. reinvestment costs)
MANUAL BLOCK	Traffic control, where a block system is operated manually, in conjunction with communication means between block posts.
MARKET PRICE	The price at which a good or service is actually exchanged for another good or service or for money, in which case it is the price relevant for financial analysis.
MORANE	Mobile radio for RAilway Network in Europe (name of the GSM-R development in Europe and name of the European consortium in charge to implement the system in Europe)
MULTI-CRITERIA ANALYSIS	MCA is an evaluation methodology that considers many objectives by the attribution of a weight to each measurable objective. In contrast to CBA, that focuses on a unique criterion (the maximisation of social welfare), Multi-criteria Analysis is a tool for dealing with a set of different objectives that cannot be aggregated through shadow prices and welfare weights, as in standard CBA.

Term	Explanation
MULTIMODAL TRANSPORT	Carriage of goods by two or more modes of transport
NEAC	European Transportation model (2000) that describes all freight transport within and in relation with Western and Eastern European regions
NET PRESENT VALUE (NPV)	The sum that results when the expected costs of the investment are deducted from the discounted value of the expected benefits.
NEW OPERA	New European Wish: Operating Project for a European Rail Network (Coordinated Action in the area of joint European railway research)
NODES	Points of a network in which at least two lines converge. Nodes can be stations or junctions. They can be differently sized, depending on the number of converging lines and their task.
OPERATING COST	Cost incurred in the operation of an investment, excluding depreciation or capital costs.
PANTOGRAPH	Apparatus for collecting current from one or more contact wires or overhead conductor rails, formed of a hinged device designed to allow vertical movement of the pantograph head.
PARTLY PERMISSIVE AUTOMATIC BLOCK	Automatic block system where a signal may be passed, when displaying stop, either with the authorization of a traffic controller or after the expiration of a pre-determined time period.
PROMOTIQ	Conditions for the promotion of a new generation of intermodal transport services and operators (EU FP4 project)
RAIL LOADING GAUGE	The profile through which a rail vehicle and its loads (wagons – ITUs) must pass, taking into account tunnels and track-side obstacles. There are 4 basic gauges recognised by UIC: international gauge, A, B, C gauge. In principle, the smallest loading gauge may not be exceeded throughout the transport journey. Restrictions regarding the width and height of the load in curves have to be taken into account.
RAILPAG	Railway Project Appraisal Guidelines
RESIDUAL VALUE (RV)	The net present value of assets at the end of the final year of the period selected for evaluation analysis (project horizon).
ROLLING MOTORWAY (Ro-La)	Transport of complete road vehicles, using roll-on roll-off techniques, on trains comprising low-floor wagons throughout.
ROUTE	Consecutive lines and nodes as a whole between a defined origin and destination.
SCENARIO ANALYSIS	A variant of sensitivity analysis that studies the combined impact of determined sets of values assumed by the critical variables. It does not substitute the item-by-item sensitivity analysis.
SCENES	SCENES (4th Framework Programme EU Commission, 2000), whose main objectives were to produce transport demand scenarios for the EU for 2020 and beyond
SENSITIVITY ANALYSIS	The analytical technique to test systematically what happens to a project's earning capacity if events differ from the estimates made in planning. It is a rather crude means of dealing with uncertainty about future events and values. It is carried out by varying one item and then determining the impact of that change on the outcome.
SHUNT	Is a short section of a new line allowing to avoid a black point of the existing network.
SIDING	Track, other than the main running line, generally used for shunting movements.

Term	Explanation
SIGNAL BOX	Independent technical installation which permits : to operate point switches and signals, to establish, to engage and to destroy routes, to indicate the operation states and to ensure the protection of the circulations and of the worksites.
SIGNALLING	Informs the train driver of the block sections occupation.
SINGLE TRACK	Track design in which a single guide-way or set of rails carries vehicles moving in both directions.
SOCIAL DISCOUNT RATE	The rate at which future year benefit and cost values are discounted to the present. It attempts to reflect the social view on how the future should be valued against the present.
SOCIO-ECONOMIC COSTS AND BENEFITS	Opportunity costs or benefits for the economy as a whole. They may differ from private costs and benefits to the extent that actual prices differ from accounting prices.
TEN-STAC	Scenarios, traffic forecasts and analysis of corridors on the Trans-European Network
TRACK GAUGE OR TRACK WIDTH	The distance between the internal sides of rails on a railway line.
TRAFFIC	Movement of means of transport (vehicles, trains, vessels, etc.)
TRAFFIC PERFORMANCE	Measure of movement of means of transport over a distance (vehicle-km, train-km, vessel-km)
TRAFFIC VOLUME	Measure of movement of means of transport at a given point (e.g. number of vehicles per hour, per day, per year)
TRAIN PATH	Represents the theoretical train passing in the traffic program. Without train path reserved in advance, a train cannot run.
TRANSPORT	Movement of goods or/ and passengers
TRANSPORT PERFORMANCE	Measure of movements of passengers or freight (passenger-km, tonne-km)
TRANSPORT VOLUME	Measure of movement of passenger or freight (passengers, tonnes)
TRANS-TOOLS	Tool for Transport Forecasting and Scenario testing)
USE-IT	Uniform System for European Intermodal Tracking and Tracing
VEHICLE OPERATING COSTS (VOC)	Costs of moving a vehicle, train, vessel over a given distance (€ per vehicle-km, train-km, vessel-km)

Note: Definitions partly taken from the “Guide to Cost-Benefit-Analysis of investment projects” 2008, European Commission, Directorate General for Regional Policy

2. Technical characteristics of the 2005 FERRMED Rail Network

Country by Country and line by line Analysis

Some examples of Core Network lines

Sweden														
Core Network														
Section	Freight ID	Length (meters)	Track number	Track gauge	Loading gauge	Max Train Length (meters)	Max Axle Load (t/axle)	Max Train Load (t)	Bridges (>20m)	Tunnels	Slope (‰)	Signalling	GSM-R	Power Type
Stockholm-Alvsjö	2004253	8365,67	2	Standard gauge	GB1	650	22,5t	1400	Yes	Yes	ok	Automatic Block System	Yes	15kV
Alvsjö-Södertälje	2004256	25199,32	4	Standard gauge	GB1	650	22,5t	1400	Yes	Yes	ok	Automatic Block System	Yes	15kV
Södertälje-Järna	2004261	14730,45	2	Standard gauge	GB1	650	22,5t	1400	Yes	No	ok	Automatic Block System	Yes	15kV
Järna-Flen	2004361	50986,46	2	Standard gauge	GC	650	25t	1400	No	No	ok	Automatic Block System	Yes	15kV
Flen-Katrineholm	2004360	29828,70	2	Standard gauge	GC	650	25t	1400	No	No	ok	Automatic Block System	Yes	15kV
Katrineholm-Hallsberg	2004362	65167,61	2	Standard gauge	GC	650	25t	1400	No	No	13,0	Automatic Block System	Yes	15kV
Hallsberg	2004363	4634,36	2	Standard gauge	GC	650	25t	1400	Yes	No	ok	Automatic Block System	Yes	15kV
Hallsberg-Mjölby	2002852	94137,85	1	Standard gauge	GB1	650	22,5t	1400	No	No	ok	Automatic Block System	Yes	15kV
Mjölby-Nässjö	2004430	86881,65	2	Standard gauge	GB1	650	22,5t	1400	Yes	No	ok	Automatic Block System	Yes	15kV
Nässjö-Vrigstad	2004432	38377,73	2	Standard gauge	GB1	650	22,5t	1400	Yes	No	ok	Automatic Block System	Yes	15kV
Vrigstad-Alvesta	2004431	47706,18	2	Standard gauge	GB1	650	22,5t	1400	Yes	No	ok	Automatic Block System	Yes	15kV
Alvesta-Hässleholm	2004425	97566,70	2	Standard gauge	GB1	650	22,5t	1400	Yes	No	ok	Automatic Block System	Yes	15kV
Hässleholm-Karlarpsby	2004356	21198,17	2	Standard gauge	GB1	650	22,5t	1400	Yes	No	ok	Automatic Block System	Yes	15kV
Karlarpsby-Lund	2004355	45148,01	2	Standard gauge	GB1	650	22,5t	1400	Yes	No	ok	Automatic Block System	Yes	15kV
Lund-Malmö	2004358	14691,53	2	Standard gauge	GB1	650	22,5t	1400	Yes	No	ok	Automatic Block System	Yes	15kV
Malmö-Danish border	2004377	13608,75	2	Standard gauge	GB1	650	22,5t	1400	Yes	No	12,4	Automatic Block System	Yes	15kV

Denmark

Core Network

Section	Freight ID	Length (meters)	Track number	Track gauge	Loading gauge	Max Train Length (meters)	Max Axle Load (t/axle)	Max Train Load (t)	Bridges (>20m)	Tunnels	Slope (‰)	Signalling	GSM-R	Power Type
Oresund	2003827	15805,49	2	Standard Gauge	GC	735	22,5t	2000	Yes	Yes	ok	Automatic Block System	No	25kV
Hellerup-Kobenhavn	2003828	3924,71	2	Standard Gauge	GC	835	22,5t	2000	No	No	ok	Automatic Block System	No	25kV
Kobenhavn-Vesterbro	2004837	1168,23	2	Standard Gauge	GC	835	22,5t	2000	No	No	ok	Automatic Block System	No	25kV
Vesterbro-Frederiksberg	2004991	1429,23	2	Standard Gauge	GC	835	22,5t	2000	No	No	ok	Automatic Block System	No	25kV
Frederiksberg-Rodovre	2004990	6244,13	2	Standard Gauge	GC	835	22,5t	2000	No	No	ok	Automatic Block System	No	25kV
Rodovre-Hedehusene	2004989	15754,70	4	Standard Gauge	GC	835	22,5t	2000	No	No	ok	Automatic Block System	No	25kV
Hedehusene-Rorup	2004988	18318,79	4	Standard Gauge	GC	835	22,5t	2000	No	No	ok	Automatic Block System	No	25kV
Rorup-Ringsted	2004987	21399,20	2	Standard Gauge	GC	835	22,5t	2000	No	No	ok	Automatic Block System	No	25kV
Ringsted-Knudstrup	2005191	14470,64	2	Standard Gauge	GC	835	22,5t	2000	No	No	ok	Automatic Block System	No	25kV
Knudstrup-Odense	2005190	85193,33	2	Standard Gauge	GC	835	22,5t	2000	Yes	Yes	ok	Automatic Block System	No	25kV
Odense-Fredericia	2005189	58290,84	2	Standard Gauge	GC	835	22,5t	2000	Yes	No	ok	Automatic Block System	No	25kV
Fredericia-Lunderskov	2003297	32412,30	2	Standard Gauge	GC	835	22,5t	2000	No	No	ok	Automatic Block System	No	25kV
Lunderskov-Brunde	2003616	46736,76	1	Standard Gauge	GC	835	22,5t	2000	No	No	ok	Automatic Block System	No	25kV
Brunde-Tinglev	2003617	30572,05	1	Standard Gauge	GC	835	22,5t	2000	No	No	ok	Automatic Block System	No	25kV
Tinglev-Padborg	2002426	667,87	1	Standard Gauge	GC	615	22,5t	2000	No	No	ok	Automatic Block System	No	25kV

Germany

Core Network

Section	Freight ID	Length (meters)	Track number	Track gauge	Loading gauge	Max Train Length (meters)	Max Axle Load (t/axle)	Max Train Load (t)	Bridges (>20m)	Tunnels	Slope (‰)	Signalling	GSM-R	Power Type
South Münster (1)	2002584	1935,34	2	Standard gauge	GB	750	22,5t	3000	No	No	ok	Automatic Block System	Yes	15 kV
South Münster (2)	2002585	907,77	2	Standard gauge	GB	750	22,5t	3000	No	No	ok	Automatic Block System	Yes	15 kV
South Münster-Buldern	2002061	19137,30	2	Standard gauge	GB	750	22,5t	2820	No	No	ok	Automatic Block System	Yes	15 kV
Buldern-Bossendorf	2002060	22880,92	2	Standard gauge	GB	750	22,5t	3000	No	No	ok	Automatic Block System	Yes	15 kV
Bossendorf-Gladbeck	2003046	21192,75	1	Standard gauge	GB	750	22,5t	2940	No	No	ok	Automatic Block System	Yes	15 kV
Gladbeck-Bottrop	2003048	8498,83	2	Standard gauge	GB	750	22,5t	3000	No	No	ok	Automatic Block System	Yes	15 kV
Bottrop	2002985	5544,89	2	Standard gauge	GB	750	22,5t	3000	No	No	ok	Automatic Block System	Yes	15 kV
Bottrop junction	2004752	975,05	2	Standard gauge	GB	750	22,5t	3000	No	No	ok	Automatic Block System	Yes	15 kV
West Bottrop	2004748	1119,39	2	Standard gauge	GB	750	22,5t	3000	No	No	ok	Automatic Block System	Yes	15 kV
North-West Bottrop	2002948	477,62	2	Standard gauge	GB	750	22,5t	3000	No	No	ok	Automatic Block System	Yes	15 kV
Bottrop-Oberhausen	2004747	1053,83	2	Standard gauge	GB	750	22,5t	3000	Yes	No	ok	Automatic Block System	Yes	15 kV
Bottrop-Duisburg	2004754	10612,48	2	Standard gauge	GB	750	22,5t	3000	No	No	ok	Automatic Block System	Yes	15 kV
Duisburg-Krefeld	2002424	17051,57	2	Standard gauge	GB	750	22,5t	3000	Yes	No	ok	Automatic Block System	Yes	15 kV
Krefeld-Viersen	2002423	14570,10	2	Standard gauge	GB	750	22,5t	3000	No	No	ok	Automatic Block System	Yes	15 kV
Viersen-Leuth	2003703	16528,52	1	Standard gauge	GB	750	22,5t	2775	No	No	ok	Automatic Block System	Yes	15 kV
Leuth (dutch border)	2003704	1454,60	2	Standard gauge	GB	750	22,5t	2020	No	No	ok	Automatic Block System	Yes	15 kV
Duisburg-Düsseldorf	2004758	22087,86	2	Standard gauge	GB	750	22,5t	3000	No	Yes	ok	Automatic Block System	Yes	15 kV
Düsseldorf-Biesenbach	2004761	22424,15	2	Standard gauge	GB	750	22,5t	2925	No	No	ok	Automatic Block System	Yes	15 kV

Netherlands														
Core Network														
Section	**Freight ID**	**Length (meters)**	**Track number**	**Track gauge**	**Loading gauge**	**Max Train Length (meters)**	**Max Axle Load (t/axle)**	**Max Train Load (t)**	**Bridges (>20m)**	**Tunnels**	**Slope (‰)**	**Signalling**	**GSM-R**	**Power Type**
Rotterdam-Lombardijen	2002881	8442,00	2	Standard gauge	GC	750	22,5t	1500	No	No	ok	Automatic Block System	Yes	1,5 kV
Lombardijen-Barendrecht	2001519	3360,89	2	Standard gauge	GC	750	22,5t	1500	No	No	ok	Automatic Block System	Yes	1,5 kV
Barendrecht	2001252	1954,59	2	Standard gauge	GC	750	22,5t	1500	No	No	ok	Automatic Block System	Yes	1,5 kV
Barendrecht-Zwijndrecht	2001253	7747,31	2	Standard gauge	GC	750	22,5t	1500	No	No	ok	Automatic Block System	Yes	1,5 kV
Zwijndrecht-Langeweg	2001251	16224,54	2	Standard gauge	GC	750	22,5t	1500	No	No	ok	Automatic Block System	Yes	1,5 kV
Langeweg-Breda	2002884	14659,89	2	Standard gauge	GC	750	22,5t	1500	No	No	ok	Automatic Block System	Yes	1,5 kV
Breda-Tilburg	2002918	18905,46	2	Standard gauge	GC	750	22,5t	1500	No	No	ok	Automatic Block System	Yes	1,5 kV
Tilburg	2002919	3496,37	2	Standard gauge	GC	750	22,5t	1500	No	No	ok	Automatic Block System	Yes	1,5 kV
Tilburg-Boxtel	2002917	16065,03	2	Standard gauge	GC	750	22,5t	1500	No	No	ok	Automatic Block System	Yes	1,5 kV
Boxtel-Eindhoven	2002914	21358,60	2	Standard gauge	GC	750	22,5t	1500	No	No	ok	Automatic Block System	Yes	1,5 kV
Eindhoven-Horst	2002934	38643,44	2	Standard gauge	GC	750	22,5t	1500	No	No	ok	Automatic Block System	Yes	1,5 kV
Horst-Blerick	2002935	10037,44	2	Standard gauge	GC	750	22,5t	1500	No	No	ok	Automatic Block System	Yes	1,5 kV
Blerick-Venlo	2000803	1600,96	2	Standard gauge	GC	750	22,5t	1500	No	No	ok	Automatic Block System	Yes	1,5 kV
Venlo-German border	2000802	2872,27	2	Standard gauge	GC	750	22,5t	1500	No	No	ok	Automatic Block System	Yes	1,5 kV

Luxembourg														
Core Network														
Section	Freight ID	Length (meters)	Track number	Track gauge	Loading gauge	Max Train Length (meters)	Max Axle Load (t/axle)	Max Train Load (t)	Bridges (>20m)	Tunnels	Slope (‰)	Signalling	GSM-R	Power Type
Belgium border-Rodange	2001111	812,79	1	Standard gauge	GB	700	22,5t	1000	No	No	15	Automatic Block System	No	25 kV
Rodange-Pétange	2000626	3284,51	1	Standard gauge	GB	700	22,5t	1000	No	No	15	Automatic Block System	No	25 kV
Pétange-Luxembourg	2000627	18673,22	1	Standard gauge	GB	700	22,5t	1000	No	No	ok	Automatic Block System	No	25 kV
Luxembourg	2001241	900,76	2	Standard gauge	GC	700	22,5t	1000	No	No	ok	Automatic Block System	No	25 kV
Luxembourg-Alzingen	2001242	4436,85	2	Standard gauge	GC	700	22,5t	1000	No	No	ok	Automatic Block System	No	25 kV
Alzingen-Bettembourg	2003122	6249,28	2	Standard gauge	GC	700	22,5t	1000	No	No	18	Automatic Block System	No	25 kV
Bettembourg-Dudelange	2001245	5127,32	2	Standard gauge	GC	700	22,5t	1000	No	No	18	Automatic Block System	No	25 kV
North Luxembourg	2001243	1207,26	2	Standard gauge	GC	700	22,5t	1000	No	No	ok	Automatic Block System	No	25 kV
Luxembourg-Oetrange	2002792	10620,51	1	Standard gauge	GC	700	22,5t	1000	No	No	18	Automatic Block System	No	25 kV
Oetrange-Wasserbilig	2002791	26545,01	2	Standard gauge	GC	700	22,5t	1000	No	Yes	18	Automatic Block System	No	25 kV

Belgium															
Core Network															
Section	Freight ID	Length (meters)	Track number	Track gauge	Loading gauge	Max Train Length (meters)	Max Axle Load (t/axle)	Max Train Load (t)	Bridges (>20m)	Tunnels	Slope (‰)	Signalling	GSM-R	Power Type
South Gent	2001949	5293,82	4	Standard gauge	GB1	600	22,5t	2300	Yes	No	ok	Automatic Block System	No	3 kV
Gent	2001951	1220,11	2	Standard gauge	GB1	600	22,5t	2300	Yes	No	ok	Automatic Block System	No	3 kV
Gent-Lokeren	2001952	20037,96	2	Standard gauge	GB1	600	22,5t	2300	Yes	No	ok	Automatic Block System	No	3 kV
Lokeren-St Niklaas	2000513	13170,27	2	Standard gauge	GB1	600	22,5t	2300	Yes	No	ok	Automatic Block System	No	3 kV
St Niklaas-Antwerpen	2000512	25395,13	2	Standard gauge	GB1	600	22,5t	2300	No	Yes	16,9	Automatic Block System	No	3 kV
Antwerpen-Mortsel	2002119	5356,71	2	Standard gauge	GB1	600	22,5t	1000	Yes	No	ok	Automatic Block System	Yes	3 kV
Mortsel-Lier	2002122	9258,98	2	Standard gauge	GB1	600	22,5t	1000	Yes	No	ok	Automatic Block System	No	3 kV
Lier-Aarschot	2000246	25493,02	2	Standard gauge	GB1	600	22,5t	1000	No	No	ok	Automatic Block System	No	3 kV
Aarschot-Leuven	2001226	19566,51	2	Standard gauge	GB1	600	22,5t	1000	No	No	ok	Automatic Block System	No	3 kV
Leuven-Ottignies	2003107	28090,05	2	Standard gauge	GB1	600	22,5t	1000	No	No	ok	Automatic Block System	No	3 kV
Ottignies-North Charleroi	2001294	34825,41	2	Standard gauge	GB1	600	22,5t	1000	No	No	ok	Automatic Block System	No	3 kV
West Charleroi	2001304	2427,73	2	Standard gauge	GB1	600	22,5t	1000	No	No	ok	Automatic Block System	No	3 kV

France														
Core Network														
Section	Freight ID	Length (meters)	Track number	Track gauge	Loading gauge	Max Train Length (meters)	Max Axle Load (t/axle)	Max Train Load (t)	Bridges (>20m)	Tunnels	Slope (‰)	Signalling	GSM-R	Power Type
Mâcon-Quincieux	2000954	44097,57	2	Standard gauge	GB1	750	22,5t	3200	No	No	ok	Automatic Block System	No	1,5 kV
Quincieux-Collonges-Fontaine	2001216	10550,72	2	Standard gauge	GB1	750	22,5t	3200	No	Yes	ok	Automatic Block System	No	1,5 kV
Collonges-Fontaine-St-Clair	2013017	4630,55	2	Standard gauge	GB	750	22,5t	3200	No	Yes	ok	Automatic Block System	No	1,5 kV
Quincieux-Lyon-Vaise	2013018	15039,09	2	Standard gauge	GB	750	22,5t	3430	No	Yes	ok	Automatic Block System	No	1,5 kV
Lyon St-Clair-Lyon Guillotière	2001211	5295,39	4	Standard gauge	GB1	750	22,5t	3200	No	No	ok	Automatic Block System	No	1,5 kV
Lyon-Vaise-Lyon-Perrache	2001445	5251,96	2	Standard gauge	GB	750	22,5t	3430	No	Yes	ok	Automatic Block System	No	1,5 kV
Lyon Guillotière-Sibelin	2013016	16113,77	4	Standard gauge	GB1	750	22,5t	2690	No	No	ok	Automatic Block System	No	1,5 kV
Sibelin-Chasse-sur-Rhône	2013015	1840,70	4	Standard gauge	GB1	750	22,5t	3225	No	Yes	ok	Automatic Block System	No	1,5 kV
Lyon-Perrache-Badan	2000091	15862,39	2	Standard gauge	GB1	750	22,5t	3430	No	No	ok	Automatic Block System	No	1,5 kV
Chasse-sur-Rhône-Givors-Canal	2000092	3224,15	2	Standard gauge	GB1	750	22,5t	3225	No	Yes	ok	Automatic Block System	No	1,5 kV
Badan-Givors-Canal	2000093	2040,87	2	Standard gauge	GB1	750	22,5t	3430	No	No	ok	Automatic Block System	No	1,5 kV
Givors-Canal-St-Romain-en-Gal	2000098	10536,50	2	Standard gauge	GB1	750	22,5t	2465	No	Yes	ok	Automatic Block System	No	1,5 kV
St-Romain-en-Gal-Peyraud	2000101	34703,01	2	Standard gauge	GB1	750	22,5t	2465	No	Yes	ok	Automatic Block System	No	1,5 kV
Peyraud-Le Pouzin	2000956	63172,76	2	Standard gauge	GB1	750	22,5t	2465	No	Yes	ok	Automatic Block System	No	1,5 kV
Le Pouzin-Villeneuve-lès-A.	2000960	96521,85	2	Standard gauge	GB1	750	22,5t	2465	No	Yes	ok	Automatic Block System	No	1,5 kV
Villeneuve-lès-A.-Avignon	2003300	4923,04	2	Standard gauge	GB1	750	22,5t	3200	Yes	Yes	ok	Automatic Block System	No	1,5 kV
Avignon-Cavaillon	2001438	34810,61	2	Standard gauge	GB1	750	22,5t	3200	Yes	Yes	ok	Automatic Block System	No	1,5 kV

France														
Core Network														
Section	Freight ID	Length (meters)	Track number	Track gauge	Loading gauge	Max Train Length (meters)	Max Axle Load (t/axle)	Max Train Load (t)	Bridges (>20m)	Tunnels	Slope (‰)	Signalling	GSM-R	Power Type
Ambérieu-Culoz	2001321	50137,79	2	Standard gauge	GB	750	22,5t	1940	Yes	Yes	ok	Automatic Block System	No	1,5 kV
Culoz-Aix-les-Bains	2001323	22902,70	2	Standard gauge	GB	750	22,5t	1940	Yes	Yes	ok	Automatic Block System	No	1,5 kV
Aix-les-Bains-Chambéry	2001134	12626,74	2	Standard gauge	GB	750	22,5t	1940	Yes	Yes	ok	Automatic Block System	No	1,5 kV
Chambéry-Montmélian	2001138	12840,89	2	Standard gauge	GA	750	22,5t	1200	Yes	Yes	30	Automatic Block System	No	1,5 kV
Montmélian-St-Pierre-d'A.	2001139	12468,06	2	Standard gauge	GB	750	22,5t	1200	Yes	Yes	30	Automatic Block System	No	1,5 kV
St-Pierre-d'A.-Modane	2001140	71852,02	2	Standard gauge	GA	750	22,5t	1200	Yes	Yes	30	Automatic Block System	No	1,5 kV
Modane-Italian border	2000119	10272,96	2	Standard gauge	GB	750	22,5t	1200	Yes	Yes	30	Automatic Block System	No	1,5 kV

Switzerland

Core Network

Section	Freight ID	Length (meters)	Track number	Track gauge	Loading gauge	Max Train Length (meters)	Max Axle Load (t/axle)	Max Train Load (t)	Bridges (>20m)	Tunnels	Slope (‰)	Signalling	GSM-R	Power Type
Basel	2003490	3034,92	3	Standard gauge	GB1	750	22,5 t	3250	Yes	No	ok	Automatic Block System	Yes	15 kV
Basel-Pratteln	2001883	7108,93	2	Standard gauge	GC	750	22,5 t	3200	No	Yes	ok	Automatic Block System	Yes	15 kV
Pratteln-Liestal	2003477	5211,73	2	Standard gauge	GC	750	22,5 t	3200	No	Yes	ok	Automatic Block System	Yes	15 kV
Liestal-Olten	2003476	23402,73	2	Standard gauge	GB1	750	22,5 t	3250	Yes	Yes	ok	Automatic Block System	Yes	15 kV
Olten North	2001875	1996,67	2	Standard gauge	GB1	750	22,5 t	3250	Yes	Yes	ok	Automatic Block System	Yes	15 kV
Olten South	2001871	1083,20	2	Standard gauge	GB1	750	22,5 t	3250	Yes	Yes	ok	Automatic Block System	Yes	15 kV
Olten-Worblaufen	2001873	59301,64	2	Standard gauge	GC	750	22,5 t	3200	No	Yes	20,0	ETCS	Yes	15 kV
Worblaufen-Bern	2001095	612,89	2	Standard gauge	GC	750	22,5 t	3200	No	Yes	20,0	ETCS	Yes	15 kV
Bern	2001094	885,18	2	Standard gauge	GC	750	22,5 t	3200	No	Yes	20,0	ETCS	Yes	15 kV
Bern-Gümligen	2000677	6260,58	2	Standard gauge	GB1	750	22,5 t	3250	Yes	No	ok	Automatic Block System	Yes	15 kV
Gümligen-Rotache	2001057	12923,24	2	Standard gauge	GB1	750	22,5 t	3250	Yes	Yes	ok	Automatic Block System	Yes	15 kV
Rotache-Brig	2001058	92687,54	2	Standard gauge	GC	1500	22,5 t	3250	Yes	Yes	16,0	ETCS	Yes	15 kV
Brig-Italian border	2000266	10305,86	2	Standard gauge	GB1	750	22,5 t	3250	Yes	Yes	25,0	Automatic Block System	Yes	15 kV

Italy														
Core Network														
Section	**Freight ID**	**Length (meters)**	**Track number**	**Track gauge**	**Loading gauge**	**Max Train Length (meters)**	**Max Axle Load (t/axle)**	**Max Train Load (t)**	**Bridges (>20m)**	**Tunnels**	**Slope (‰)**	**Signalling**	**GSM-R**	**Power Type**
Swiss border-Iselle	2000264	11085,37	2	Standard gauge	GB1	N.C.	22,5t	2300	No	Yes	ok	Automatic Block System	Yes	15 kV
Iselle	2000521	1509,50	2	Standard gauge	GB1	N.C.	22,5t	2300	No	Yes	25	Automatic Block System	Yes	15 kV
Iselle-Bertonio	2000522	3127,22	2	Standard gauge	GB1	N.C.	22,5t	2300	No	Yes	25	Automatic Block System	Yes	15 kV
Bertonio-Domodossola	2000523	14446,35	2	Standard gauge	GB1	578	22,5t	2300	No	Yes	25	Automatic Block System	Yes	15 kV
Domodossola	2000275	850,00	2	Standard gauge	GA	578	22,5t	2300	No	No	ok	Automatic Block System	Yes	3 kV
Domodossola-Premosello	2000276	14681,00	2	Standard gauge	GA	560	22,5t	2300	No	No	ok	Automatic Block System	Yes	3 kV
Premosello-Gallarate	2002161	65522,00	2	Standard gauge	GA	375	22,5t	2300	Yes	Yes	ok	Automatic Block System	Yes	3 kV
Gallarate-Busto Arsizio	2002162	7100,00	2	Standard gauge	GB1	590	22,5t	2300	No	No	ok	Automatic Block System	Yes	3 kV
Busto Arsizio	2000299	148,89	2	Standard gauge	GB1	620	22,5t	2300	No	No	ok	Automatic Block System	Yes	3 kV
Busto Arsizio-Rho	2000313	17672,00	2	Standard gauge	GB1	445	22,5t	2300	No	No	ok	Automatic Block System	Yes	3 kV
Rho-Certosa	2000917	11882,00	4	Standard gauge	GB1	605	22,5t	2300	Yes	No	ok	Automatic Block System	Yes	3 kV
Certosa-Milano	2000916	4942,89	6	Standard gauge	GB1	565	22,5t	2300	Yes	No	ok	Automatic Block System	Yes	3 kV
Milano	2000923	5209,25	8	Standard gauge	GB1	565	22,5t	2300	Yes	No	ok	Automatic Block System	Yes	3 kV
Milano-Rogoredo South	2000922	2388,41	6	Standard gauge	GB1	585	22,5t	2300	No	No	ok	Automatic Block System	Yes	3 kV
Rogoredo-Bottarone	2002699	42625,35	2	Standard gauge	GB1	520	22,5t	2300	Yes	No	ok	Automatic Block System	Yes	3 kV
Bottarone-Voghera	2002698	11854,68	2	Standard gauge	GB1	685	22,5t	2300	No	No	ok	Automatic Block System	Yes	3 kV
Voghera-Tortona	2000918	16200,00	2	Standard gauge	GB1	630	22,5t	2300	No	No	ok	Automatic Block System	Yes	3 kV

Spain														
Core Network														
Section	Freight ID	Length (meters)	Track number	Track gauge	Loading gauge	Max Train Length (meters)	Max Axle Load (t/axle)	Max Train Load (t)	Bridges (>20m)	Tunnels	Slope (‰)	Signalling	GSM-R	Power Type
Port-Bou-Colera	2001819	2102,22	2	Broad gauge	GB	450	22,5t	1020	No	Yes	ok	Automatic Block System	No	3 kV
Colera-Girona	2001816	67000,00	2	Broad gauge	GB	450	22,5t	1020	Yes	Yes	15,0	Automatic Block System	No	3 kV
Girona-Massanes	2001817	29501,96	2	Broad gauge	GB	450	22,5t	1020	Yes	No	ok	Automatic Block System	No	3 kV
Massanes-Granollers	2019001	41000,00	2	Broad gauge	GB	450	22,5t	1020	Yes	Yes	15,0	Automatic Block System	No	3 kV
Granollers-Mollet	2019075	16339,54	2	Broad gauge	GB	450	22,5t	1020	Yes	Yes	15,0	Automatic Block System	No	3 kV
Mollet-Rubi	2019090	22253,40	1	Broad gauge	GB	500	22,5t	900	Yes	Yes	ok	Automatic Block System	No	3 kV
Rubi-Castellbisbal	2019091	4232,32	2	Broad gauge	GB	350	22,5t	900	Yes	Yes	ok	Automatic Block System	No	3 kV
Castellbisbal-Sant Vicenç de Calders	2019003	50189,96	2	Broad gauge	GB	450	22,5t	1580	Yes	No	14,0	Automatic Block System	No	3 kV
Sant Vicenç de Calders	2019005	2380,88	2	Broad gauge	GB	450	22,5t	1580	Yes	Yes	ok	Automatic Block System	No	3 kV
Sant Vicenç de Calders-Tarragona	2001936	28271,07	2	Broad gauge	GB	450	22,5t	1580	Yes	Yes	ok	Automatic Block System	No	3 kV
Tarragona-Aldea	2001937	59379,86	1	Broad gauge	GB	450	22,5t	1020	Yes	No	ok	Automatic Block System	No	3 kV
Aldea	2001944	6199,14	2	Broad gauge	GB	450	22,5t	1020	No	No	15,0	Automatic Block System	No	3 kV
Aldea-Freginals	2001940	10624,27	2	Broad gauge	GB	450	22,5t	1020	Yes	No	15,0	Automatic Block System	No	3 kV
Freginals-Ulldecona	2001941	14614,26	2	Broad gauge	GB	475	22,5t	1020	Yes	No	15,0	Automatic Block System	No	3 kV
Ulldecona	2001942	9363,72	2	Broad gauge	GB	475	22,5t	1020	No	Yes	15,0	Automatic Block System	No	3 kV
Ulldecona-Benicassim	2001933	62671,39	2	Broad gauge	GB	475	22,5t	1020	Yes	Yes	15,0	Automatic Block System	No	3 kV
Benicassim-Castello de la Plana	2001838	21247,05	2	Broad gauge	GB	475	22,5t	1020	Yes	No	15,0	Automatic Block System	No	3 kV

Spain

Core Network

Section	Freight ID	Length (meters)	Track number	Track gauge	Loading gauge	Max Train Length (meters)	Max Axle Load (t/axle)	Max Train Load (t)	Bridges (>20m)	Tunnels	Slope (‰)	Signalling	GSM-R	Power Type
Castello de la Plana-Sagunt	2001837	39670,47	2	Broad gauge	GB	475	22,5t	1020	Yes	Yes	14,0	Automatic Block System	No	3 kV
Sagunt-Valencia	2001835	29512,32	2	Broad gauge	GB	475	22,5t	1020	Yes	No	ok	Automatic Block System	No	3 kV
Valencia-Silla	2001833	13009,51	2	Broad gauge	GB	410	22,5t	1110	Yes	Yes	ok	Automatic Block System	No	3 kV
Silla-Xativa	2019076	40101,57	2	Broad gauge	GB	410	22,5t	1090	Yes	No	ok	Automatic Block System	No	3 kV
Xativa-La Encina	2001612	57661,23	2	Broad gauge	GB	410	22,5t	1090	Yes	Yes	14,0	Automatic Block System	No	3 kV
La Encina-Alicante	2001750	71332,50	1	Broad gauge	GB	360	22,5t	910	Yes	Yes	17	Automatic Block System	No	3 kV
Alicante-Alquerias	2001751	73498,24	1	Broad gauge	GB	350	22,5t	1090	Yes	Yes	14	Without Block System	No	0 kV
Alquerias-Alcantarilla	2001749	18523,03	2	Broad gauge	GB	320	22,5t	1090	No	No	ok	Automatic Block System	No	0 kV
Alcantarilla-Librilla	2001747	22895,52	1	Broad gauge	GB	320	22,5t	710	No	No	16	Without Block System	No	0 kV
Librilla-Lorca	2001748	53051,89	1	Broad gauge	GB	320	22,5t	710	Yes	Yes	16	Without Block System	No	0 kV
Lorca-Dolar	2000144	95669,47	1	Broad gauge	GB	400	22,5t	550	Yes	Yes	28	Automatic Block System	No	0 kV
Dolar-La Calahorra	2000143	5241,12	1	Broad gauge	GB	400	22,5t	550	Yes	Yes	ok	Automatic Block System	No	0 kV
La Calahorra-Moreda	2000142	19301,00	1	Broad gauge	GB	400	22,5t	550	Yes	Yes	22	Automatic Block System	No	0 kV
Moreda-Granada	2000146	39552,50	1	Broad gauge	GB	450	22,5t	650	Yes	Yes	24	Without Block System	No	0 kV
Granada-Bobadilla	2001145	120554,00	1	Broad gauge	GB	360	22,5t	570	Yes	No	27	Without Block System	No	0 kV
Bobadilla-Ronda	2000147	123063,91	1	Broad gauge	GB	450	22,5t	650	Yes	Yes	24	Without Block System	No	0 kV
Ronda-Algeciras	2001146	54994,50	1	Broad gauge	GB	360	22,5t	670	Yes	No	23	Automatic Block System	No	0 kV

3. Maps

2005 Reference Results

Relative capacity in 2005

Relative capacity in 2005 Reference FERRMED network

Residual capacity in 2005

Residual capacity in 2005 Reference FERRMED network

Bottlenecks in 2005 Reference

Main bottlenecks in FERRMED network in 2005

2025 Reference Results

Relative Capacity in 2025

Relative capacity in 2025 Reference FERRMED network

Residual capacity in 2025

Residual capacity in 2025 Reference Scenario FERRMED network

Bottlenecks in 2025 Reference

Main bottlenecks in FERRMED network in 2025

2025 Reference Scenario Rail Network

2025 Medium FERRMED Scenario Network

Bottlenecks in FERRMED Network in 2025 Medium scenario

2025 Full FERRMED Scenario Network

Bottlenecks in FERRMED Network in 2025 Full scenario


2025 FERRMED Full Rail Network
Cities
Ferry
Other railway lines
FERRMED Core Network
Feeder
0 100 200 400 Km
Production : INEXIA's GIS
Source : FERRMED Trans-tools - Eurogeographics

3. Proposed investments

2020 reference scenario bottlenecks solutions

No	Link	Solution 1			Solution 2		
		Description	Cost (mil. €)	Year	Description	Cost (mil. €)	Year
1	Kirkkonummi-Naantali	3 km of sidings for passing x8 + new operating management	480.0	2020	Double track x 166 km	2,490.0	2025
2	Laxa-Charlottenberg	double track x 64,9 km	973.5	2025	Double track x 88,5 km	1,327.5	2025
3	Oslo-Sarpsborg	ERTMS L1 with euroloops	13.4	2020	ERTMS L1 with euroloops	13.4	2020
4	Viersen-Venlo	alternative route via Emmerich for 40 to 50 trains/day	-	2015	Signalling improvement	1.0	2020
5	Weinheim-Karlsruhe	(Alternative route between Darmstadt and Manheim) + (alternative route between Darmstadt and Ludwigshafen + double track electrification x 29 km Germersheim - Wörth + 10 km Karlsruhe bypass to Rastatt)	337.0	2025	Alternative route between Darmstadt and Manheim + double track x 19 km Weinheim-Heildelberg + 10 km Karlsruhe bypass Rastatt	630.0	2025
6	Lenzburg-Othmarsingen	Third track both directions x 2,5 km	67.5	2020	Two tracks more 2,5 km	112.5	2020
7	Mühle Horn tunnel / Sargans	New tunnel of 135m + new track x 2km	61.5	2025	New tunnel of 135m + new track x 2km	61.5	2025
8	Bern-Thörishaus	Third track both directions x 7 km	157.5	2020	Two tracks more x 7 km	210.0	2020
9	Lausanne - Geneva	Third track both directions x 55 km	1,237.5	2025	Third track both directions x 55 km	1,237.5	2025
10	Milan-Monza	ERTMS L1 with euroloops x 10 km	1.5	2020	Two tracks more x 10 km	301.0	2025
11	Savona-Ceva	ERTMS L1 with euroloops x 60 km of single track	6.6	2020	ERTMS L1 with euroloops x 60 km of single track	6.6	2020
12	Finale Ligure-San Lorenzo al Mare	ERTMS L 1 with euroloops x 52 km + 2 km siddings x 4	165.7	2025	Double track x 52 km + ERTMS L 1	785.2	2025
13	Genova-La Spezia	ERTMS L 1 with euroloops x 78 km of double track	10.1	2020	ERTMS L 1 with euroloops x 78 km of double track + 2 km siddings x 3 in each way	195.6	2025
14	Bailleul-Lille	ERTMS L1 with euroloops x 29 km	3.8	2020	ERTMS L1 with euroloops x 29 km	3.8	2020
15	Lens-Valenciennes	ERTMS L1 x 31 km + infrastructure upgrading around 150 M€	154.0	2025	ERTMS L1 x 31 km + infrastructure upgrading around 150 M€	154.0	2025
16	Lyon	ERTMS L 1 x 10 km of double track + CFAL Sud 24 km of double track with 15 km of tunnels,	1,400.0	2025	ERTMS L 1 x 10 km of double track + CFAL Sud 24 km of double track with 15 km of tunnels,	1,400.0	2025
17	Avignon-Tarascon	ERTMS L1 with euroloops x 22 km of double track	2.9	2020	ERTMS L1 with euroloops x 22 km of double track	2.9	2020
Total			**5,072.5**			**8,932.5**	

2020 medium scenario bottlenecks solutions

No	Link	Solution 1			Solution 2		
		Description	Cost (mil. €)	Year	Description	Cost (mil. €)	Year
1	Kirkkonummi-Naantali	3 km of sidings for passing x 8 + new operating management	480.0	2020	Double track x 166 km	2,490.0	2025
2	Stockholm-Hovsta	double track x 37,3 km	559.5	2025	double track x 37,3 km	559.5	2025
3	Göteborg-Herrljunga	Homogeneous speed trains	-	2015	ERTMS L1 with euroloops	1.0	2015
4	Laxa-Charlottenberg	double track x 64,9 km	973.5	2025	Double track x 88,5 km	1,327.5	2025
5	Oslo-Sarpsborg	ERTMS L1 with euroloops	3.1	2020	ERTMS L1 with euroloops	3.1	2020
6	Viersen-Venlo	alternative route via Emmerich for 40 to 50 freight trains/day	-	2015	Signalling improvement	1.0	2020
7	Darmstadt-Karlsruhe	(Alternative route between Darmstadt and Manheim) + (alternative route between Darmstadt and Ludwigshafen) + (double track electrification x 29 km Germersheim - Wörth) + (double track x 19 km Weinheim-Heildelberg) + 10 km Karlsruhe bypass to Rastatt	717.0	2025	New double track x 140 km between Darmstadt and Rastatt	3,150.0	2025
8	Lenzburg-Othmarsingen	Third track both directions x 2,5 km	67.5	2020	Two tracks more 2,5 km	112.5	2020
9	Mühle Horn tunnel / Sargans	New tunnel of 135m + new track x 2km	61.5	2025	New tunnel of 135m + new track x 2km	61.5	2025
10	Bern-Thörishaus	Third track both directions x 7 km	157.5	2020	Two tracks more x 7 km	210.0	2020
11	Lausanne - Geneva	Third track both directions x 55 km	1,237.5	2025	Third track both directions x 55 km	1,237.5	2025
12	Milan-Monza	ERTMS L1 with euroloops x 10 km	0.3	2020	Two tracks more x 10 km	300.0	2025
13	Bottarone-Tortona	third track both directions x 17 km with ERTMS L2 or L1 with euroloops	374.5	2025	two tracks more x 17 km	510.0	2025
14	San Giuseppe-Ceva	ERTMS L1 with euroloops x 25 km of single track	0.8	2020	ERTMS L1 with euroloops x 25 km of single track	0.8	2020
15	Finale Ligure-San Lorenzo al Mare	ERTMS L 1 with euroloops x 52 km + 2 km siddings x 4	161.6	2025	Double track x 52 km	780.0	2025
16	Bailleul-Lille	ERTMS L1 with euroloops x 29 km	0.9	2020	ERTMS L1 with euroloops x 29 km	0.9	2020
17	Lyon	ERTMS L 1 with Euroloops x 16 km of double track + CFAL Sud 24 km of double track with 15 km of tunnels	1,400.0	2025	ERTMS L 1 x 16 km of double track + CFAL Sud 24 km of double track with 15 km of tunnels	1,400.0	2025
18	Avignon-Tarascon	ERTMS L1 with euroloops x 22 km of double track	0.7	2020	ERTMS L1 with euroloops x 22 km of double track	0.7	2020
Total			**6,195.7**			**12,151.7**	

2025 reference scenario bottlenecks solutions

No	Link	Solution 1			Solution 2		
		Description	Cost (mil. €)	Year	Description	Cost (mil. €)	Year
1	Kirkkonummi-Naantali	3 km of sidings for passing x8 + new operating management	480.0	2020	Double track x 166 km	2,490.0	2025
2	Stockholm-Hovsta	ERTMS L1 with euroloops, double track x 37,3 km	579.0	2025	ERTMS L1 with euroloops, double track x 37,3 km	579.0	2025
3	Göteborg-Herrljunga	Homogeneous speed trains	-	2015	ERTMS L1 with euroloops	10.2	2015
4	Laxa-Charlottenberg	ERTMS L1 with euroloops + double track x 64,9 km	989.2	2020/ 2025	Double track x 207,4 km	3,111.0	2025
5	Oslo-Sarpsborg	ERTMS L1 with euroloops	13.4	2025	ERTMS L1 with euroloops	13.4	2025
6	Hambourg-Elmshorn	alternative route to electrify x 45 km	108.0	2020	alternative route to electrify x45 km + signalling improvement	135.0	2020
7	Viersen-Venlo	alternative route via Emmerich for 40 to 50 trains/day	-	2015	Double track x 16,5 km	247.5	2025
8	Aachen-Herzogenrath	ERTMS L1 with euroloops	1.7	2020	ERTMS L1 with euroloops + new tunnel	401.3	2025
9	Weinheim-Karlsruhe	(Alternative route between Darmstadt and Manheim) + (alternative route between Darmstadt and Ludwigshafen + double track electrification x 29 km Germersheim - Wörth + 10 km Karlsruhe bypass to Rastatt)	337.0	2025	Alternative route between Darmstadt and Manheim + double track x 19 km Weinheim-Heildelberg + 10 km Karlsruhe bypass Rastatt	630.0	2025
10	Koblenz-Königsbach	Operating management	-	2015	Operating management	-	2015
11	Lenzburg-Othmarsingen	Third track both directions x 2,5 km	67.5	2020	Two tracks more 2,5 km	112.5	2020
12	Mühle Horn tunnel / Sargans	New tunnel of 135m + new track x 2km	52.1	2025	New tunnel of 135m + new track x 2km	52.1	2025
13	Bern-Thörishaus	Third track both directions x 7 km	157.5	2020	Two tracks more x 7 km	210.0	2020
14	(Basel -) Muttenz - Frick (- Zurich)	Third track both directions x 49 km	1,102.5	2025	Third track both directions x 49 km	1,102.5	2025
15	Lausanne - Geneva	Third track both directions x 55 km	1,237.5	2025	Third track both directions x 55 km	1,237.5	2025
16	Milan-Monza	ERTMS L1 with euroloops x 10 km	1.3	2020	Two tracks more x 10 km	301.0	2025
17	Milan-Tortona	ERTMS L2 or L1 with euroloops x 71 km of double track + Third track both directions x 17 km with ERTMS L2 or L1 with euroloops	379.3	2025	ERTMS L2 or L1 with euroloops + two tracks more x 17 km	522.9	2025
18	Savona-Ceva	ERTMS L2 x 60 km of single track	6.6	2025	ERTMS L2 x 60 km of single track	6.6	2025
19	Finale Ligure-San Lorenzo al Mare	ERTMS L 2 x 52 km + 2 km siddings x 4	167.8	2025	Double track x 52 km + ERTMS L 2	787.8	2025
20	Genova-La Spezia	ERTMS L 1 with euroloops x 122 km of double track	15.8	2025	ERTMS L 1 with euroloops x 122 km of double track + 2 km siddings x 3 in each way	205.8	2025
21	Tardienta - Lérida	ERTMS L1 with euroloops x 127 km of single track	14.0	2025	ERTMS L1 with euroloops x 127 km of single track + 2 km siddings x 6	194.1	2025

No	Link	Solution 1			Solution 2		
		Description	Cost (mil. €)	Year	Description	Cost (mil. €)	Year
22	Cerdanyola-Mollet	Double track x 10km	200.0	2025	Barcelona by-pass between Tarragona and Girona : new double track x 200km	4,500.0	2025
23	El Burgo de Ebro - Falset	ERTMS L1 with euroloops x 182 km of single track	20.0	2025	ERTMS L1 with euroloops x 182 km of single track + 2 km siddings x 9	290.0	2025
24	Bailleul-Lille	ERTMS L1 with euroloops x 29 km	7.5	2020	ERTMS L1 with euroloops x 29 km	5.8	2020
25	Lens-Valenciennes	ERTMS L 1 with euroloops x 60 km + infrastructure upgrading around 150 M€	157.8	2020/ 2025	ERTMS L 1 x 60 km + infrastructure upgrading around 150 M€	157.8	2020/ 2025
26	Lyon	ERTMS L 1 x 10 km of double track + CFAL Sud 24 km of double track with 15 km of tunnels,	1,400.0	2025	ERTMS L 1 x 10 km of double track + CFAL Sud 24 km of double track with 15 km of tunnels,	1,400.0	2025
27	Moirans-Grenoble	ERTMS L1 with euroloops x 22 km of double track	2.9	2020	ERTMS L1 with euroloops x 22 km of double track + Third track x 22 km	445.7	2025
28	Avignon-Tarascon	ERTMS L1 with euroloops x 22 km of double track	2.9	2020	ERTMS L1 with euroloops x 22 km of double track	2.9	2020
29	Carcassonne-Narbonne	ERTMS L1 with euroloops x 59 km of double track	7.7	2020	ERTMS L1 with euroloops x 59 km of double track	7.7	2020
Total			**7,508.8**			**19,160.0**	

2025 medium scenario bottlenecks solutions

No	Link	Solution 1			Solution 2		
		Description	Cost (mil. €)	Year	Description	Cost (mil. €)	Year
1	Kirkkonummi-Naantali	3 km of sidings for passing x 8 + new operating management	480.0	2020	Double track x 166 km	2,490.0	2025
2	Stockholm-Hovsta	ERTMS L1 with euroloops + double track x 37,3 km	568.5	2025	ERTMS L1 with euroloops + double track x 37,3 km	568.5	2025
3	Göteborg-Herrljunga	Homogeneous speed trains	-	2015	ERTMS L1 with euroloops	-	2015
4	Laxa-Charlottenberg	ERTMS L1 with euroloops + double track x 64,9 km	977.8	2025	Double track x 100,4 km	1,506.0	2025
5	Oslo-Sarpsborg	ERTMS L1 with euroloops	6.2	2025	ERTMS L1 with euroloops	6.2	2025
6	Hambourg-Elmshorn	decrease (-50) the number of freight trains/day by using alternative route to electrify x 45 km	108.0	2020	decrease (-50) the number of freight trains/day by using alternative route to electrify x45 km + signalling improvement	135.0	2020
7	Minden-Wunstorf	(Double track x 2) x 42km	1,260.0	2025	(Double track x 2) x 42km	1,260.0	2025
8	Viersen-Venlo	alternative route via Emmerich for 40 to 50 freight trains/day	-	2015	Double track x 16,5 km	247.5	2025
9	Aachen-Herzogenrath	ERTMS L1 with euroloops	0.8	2020	ERTMS L1 with euroloops + new tunnel	400.0	2025

No	Link	Solution 1			Solution 2		
		Description	Cost (mil. €)	Year	Description	Cost (mil. €)	Year
10	Darmstadt-Karlsruhe	(Alternative route between Darmstadt and Manheim) + (alternative route between Darmstadt and Ludwigshafen) + (double track electrification x 29 km Germersheim - Wörth) + (double track x 19 km Weinheim-Heildelberg) + 10 km Karlsruhe bypass to Rastatt	717.0	2025	New double track x 140 km between Darmstadt and Rastatt	3,150.0	2025
11	Koblenz-Königsbach	Operating management	-	2015	double track x 2 x 2km		2015
12	Lenzburg-Othmarsingen	Third track both directions x 2,5 km	67.5	2020	Two tracks more 2,5 km	112.5	2020
13	Mühle Horn tunnel / Sargans	New tunnel of 135m + new track x 2km	48.0	2025	New tunnel of 135m + new track x 2km	48.0	2025
14	Bern-Thörishaus	Third track both directions x 7 km	157.5	2020	Two tracks more x 7 km	210.0	2020
15	(Basel -) Muttenz - Frick (- Zurich)	Third track both directions x 49 km	1,102.5	2025	Third track both directions x 49 km	1,102.5	2025
16	Lausanne - Geneva	Third track both directions x 55 km	1,237.5	2025	Third track both directions x 55 km	1,237.5	2025
17	Milan-Monza	ERTMS L1 with euroloops x 10 km	0.6	2020	Two tracks more x 10 km	300.0	2025
18	Bottarone-Tortona	ERTMS L2 or L1 with euroloops x 28 km of double track + third track both directions x 17 km with ERTMS L2 or L1 with euroloops	375.7	2025	ERTMS L2 or L1 with euroloops + two tracks more x 17 km	510.0	2025
19	San Giuseppe-Ceva	ERTMS L1 with euroloops x 25 km of single track	0.7	2025	ERTMS L1 with euroloops x 25 km of single track	0.7	2025
20	Finale Ligure-San Lorenzo al Mare	ERTMS L 1 with euroloops x 52 km + 2 km siddings x 4	194.3	2025	Double track x 52 km	780.0	2025
21	Tardienta - Lérida	ERTMS L1 with euroloops x 127 km of single track	3.8	2025	ERTMS L1 with euroloops x 127 km of single track + 2 km siddings x 6	180.0	2025
22	Cerdanyola-Mollet	Barcelona by-pass between North Girona and South Tarragona: new double track x 220km	4,500.0	2025	Barcelona by-pass between Girona and Tarragona: new double track x 220km	4,500.0	2025
23	Reus-Fontscaldes	ERTMS L1 with euroloops x 19 km of single track	0.6	2025	ERTMS L1 with euroloops x 19 km of single track	0.6	2025
24	Bailleul-Lille	ERTMS L1 with euroloops x 29 km	1.7	2020	ERTMS L1 with euroloops x 29 km	1.7	2020
25	Lens-Douai	ERTMS L 1 with Euroloops x 29 km	1.7	2020	ERTMS L 1 with euroloops x 29 km	1.7	2020
26	Villeneuve-Saint-Georges-St Michel sur Orge	ERTMS L1 with euroloops x 33 km of double track	2.0	2020	Two tracks more x 17 km (6 tracks)	510.0	2025
27	Epernay-Châlons en Champagne	ERTMS L1 with euroloops x 31 km of double track	1.8	2020	ERTMS L1 with euroloops x 31 km of double track	1.8	2020
28	Lyon	ERTMS L 1 with Euroloops x 16 km of double track + CFAL Sud 24 km of double track with 15 km of tunnels,	1,400.0	2025	ERTMS L 1 x 16 km of double track + CFAL Sud 24 km of double track with 15 km of tunnels,	1,400.0	2025

No	Link	Solution 1			Solution 2		
		Description	Cost (mil. €)	Year	Description	Cost (mil. €)	Year
29	Moirans-Grenoble	ERTMS L1 with euroloops x 22 km of double track	1.3	2020	ERTMS L1 with euroloops x 22 km of double track + Third track x 22 km	440.0	2025
30	Avignon-Tarascon	ERTMS L1 with euroloops x 22 km of double track	1.3	2020	ERTMS L1 with euroloops x 22 km of double track	1.3	2020
31	Carcassonne-Narbonne	ERTMS L1 with euroloops x 59 km of double track	3.5	2020	ERTMS L1 with euroloops x 59 km of double track	3.5	2020
Total			**13,220.2**			**21,105.0**	

2025 full scenario bottlenecks solutions

No	Link	Solution 1			Solution 2		
		Description	Cost (mil. €)	Year	Description	Cost (mil. €)	Year
1	Kirkkonummi-Naantali	3 km of sidings for passing x8 + new operating management	480.0	2020	Double track x 166 km	2,490.0	2025
2	Asta-Hovsta	3 siddings x 2km	120.0	2020	double track x 37,3 km	559.5	2025
3	Göteborg-Vargarda	Complete ERTMS L1 with euroloops in order to increase capacity from 277 to 300 trains/day	3.9	2015	Complete ERTMS L1 with euroloops in order to increase capacity from 277 to 300 trains/day	3.9	2015
4	Karlstad-Charlottenberg	double track x 64,9 km	973.5	2025	Double track x 89 km	1,335.0	2025
5	Viersen-Venlo	alternative route via Emmerich for 40 to 50 trains/day and 1 sidding x 3km + signalling improvement	46.1	2015	Double track x 16,5 km, Signalling improvement with euroloops	247.5	2025
6	Bonn - Koblenz	Freight traffic distribution between 3 axis : Bonn-Koblenz, Troisdorf-Koblenz-Wiesbaden, Troisdorf-Limburg-Wiesbaden/Frankfurt	-	2015	Two tracks more x 42 km	1,080.0	2025
7	(Basel -) Muttenz - Frick (- Zurich)	Third track both directions x 49 km	1,102.5	2025	Two tracks more x 49 km	1,275.0	2025
8	Lausanne - Geneva	Third track both directions x 55 km	1,237.5	2025	Two tracks more x 55 km	1,425.0	2025
9	Cerdanyola-Mollet	Barcelona by-pass between North Girona and South Tarragona : new double track x 220km	4,500.0	2025	Barcelona by-pass between North Girona and South Tarragona : new double track x 220km	4,500.0	2025
10	Bottarone-Voghera	Complete ERTMS L1 with euroloops x 12 km of double track to increase capacity from 270 to 320 trains/day	0.7	2025	Two tracks more x 12 km	390.0	2025
11	Finale Ligure-San Lorenzo al Mare	Complete ERTMS L 1 with euroloops x 52 km + 2 km siddings x 4	163.1	2025	Double track x 52 km	780.0	2025
12	Recco-La Spezia	Construction of a third track x 78 km	1,170.0	2025	2 tracks more x 78km	1,755.0	2025
13	Bailleul-Lille	Construction of a third track x 28 km	420.0	2020	Two tracks more x 28 km	630.0	2025
14	Lens-Douai	Construction of a third track x 29 km	440.0	2020	Two tracks more x 29km	660.0	2025
Total			**10,657.3**			**17,130.9**	

3. FERRMED PROPOSALS

As a consequence of the Conclusions and Recommendations proposed in the Global Study, FERRMED submits to the European Commission and the Member-States the proposals related to the implementation of the FERRMED standards, and the improvement actions in key sections of the FERRMED Great Axis Rail Freight Network, as described in the following chapters.

3.1 FERRMED Standards Implementation

FERRMED particularly emphasizes adoption of the following freight railway standards:

Reticular and polycentric network all over the EU

In order to turn around the problems in long distance rail freight, we primarily recommend the definition of a European business-oriented priority rail freight network linking all EU locomotive economic regions and the main sea and inland ports. European cohesion and competitiveness need a powerful priority transportation network, reticular and polycentric, linking the main centres of production and consumption with the main ports and airports.

The EU Priority Network would be defined by the EC with required investments directly promoted and supported by the EC and its financing arm, the EIB. In the corridors of this network, two parallel lines are required, as part of FERRMED proposals.

One line should be dedicated for fast moving trains (basically passenger and – in the future – light freight as well) and the other line should be used for conventional speed trains (mixing freight trains with regional passenger trains, within a framework of balanced priority between freight and passengers). In addition to these lines there will be specific by-passes for freight trains in the surroundings of big cities in order to avoid local/ commuter passenger trains, as well as, exclusive freight dedicated lines in main corridors with huge traffic.

Width of the tracks UIC

In the European Union the standard track gauge of 1,435 mm (UIC) is used, with the exception of Finland and Baltic States (1,524/1,520 mm) and Spain and Portugal (1,668 mm). In the case of Finland and Baltic States, benefit of width change would be low because its rail network is linked with the Russian and other Eastern countries' networks. In the case of Spain, FERRMED recommends to primarily convert the following conventional lines to UIC width:

- The Mediterranean corridor along its entire extension (Portbou – Barcelona – Valencia – Murcia – Almería – Málaga – Algeciras;

- The Atlantic Central Corridor from Irun to Valladolid and from there to Portugal and to Madrid and Andalucia;

- The Corridor from Barcelona – Tarragona to Zaragoza and from there to Pamplona/Bilbao and to Madrid;

- The Madrid – Valencia – Murcia Corridor.

Dual gauge should be implemented only as temporary solutions or on short distance feeders to complete the UIC network but not as a long term solution on the main lines.

Maximum line gradient

Larger gradients have a negative impact on the operation of freight trains because it limits the train load. In the case of the construction of new lines, it is recommended to route them with no more than 12‰. Therefore in the "Red Banana" core network, FERRMED proposes the gradual rerouting of the conventional existing lines in order not to surpass the 12‰ gradient.

Signalling

By the time being, FERRMED proposes the application of ERTMS Level 2 in all EU rail core network with GSM-R, ETCS and CBTC.

In the future ERTMS level 3 (where it will be fully operative) could be gradually introduced starting on HSL.

Electrification

FERRMED would like to unify the railway network on 25 Kv, although maintaining the option of 15 kv in some cases.

The idea is to start removing the 750 V DC and 1.5 Kv DC and finally the 3 Kv DC (because of high amperage and high energy losses on the line, particularly in the first two cases). The complete removal of the above-mentioned electrification systems is considered in the FULL FERRMED Scenario.

UIC C Loading gauge

FERRMED agrees with the European regulation that all the new projects must be built with UIC C gauge (GC), which permits the larger containers and the loading of road trailers or heavy goods vehicles on standard wagons. The upgrade of FERRMED network to GC will be undertaken in two steps: before 2025 the network should be upgraded to UIC GB1 which is less costly in the case of old tunnels. Latter, UIC – GC can be introduced gradually taking advantage of the periodical refurbishment of the tracks of existing lines.

Long and heavy freight trains

Longer and heavier trains increase the network capacity and reduce transportation costs. The average length of freight train in the 13 countries is around 400 meters. In order to reduce investment costs and to guarantee

feasibility, FERRMED proposes to increase the train length as close as possible to 750 m in all FERRMED Great Axis Network and to 1,500 m in the core lines and main feeders, allowing the possibility of 3,600 ÷ 5,000 tons of freight capacity by train.

FERRMED proposes to build the new lines suitable for 25 tonnes per axle. The 20 tons sections should be upgraded to 22.5 tons/axle in the entire FERRMED network. For the existing lines, 22.5 tonnes per axle are considered acceptable. The periodical renewal of tracks could be considered so as to gradually convert these lines to 25 tons/axle.

Terminals network

The EC, the member States and the regions should also programme and support the extension and the creation of a network of intermodal public/private terminals specially to related sea and inland ports, to main airports, in the surroundings of the large cities, as well as in multimodal communication centres, in order to facilitate the increase of rail participation in the European wider transportation system.

Freight transportation 24 hours a day and 7 days a week

Availability of capacity and traffic schedules for freight transportation 24 hours a day and 7 days a week necessitates by-passes for free crossings over nodes and large cities at any time.

Operational, management, legal and financial issues

FERRMED recommends accelerating the speed at which Member States adopt EC legislation, regulations and policies on rail transport, particularly those addressing European operational and management standards, regulations and procedures. In that sense, FERRMED proposes:

- The application of "Business oriented "criteria in the definition of rail freight network all over the EU (including the selection of priority projects);

- The utilization of a network approach in the definition of priorities, rather than a specific line or corridor approach;

- To develop two levels of rail transportation systems in the EU:
  - The EU priority network (core network) to be managed at EC level (including operational coordination); with the corresponding agreement with member states.
  - National basic networks managed at member state level.

- The Implementation of a common Information transportation system (ITS) all over EU rail network;

- The establishment of same priority criteria for passenger and freight train slots assignation and operational control in the conventional lines of rail freight corridors.

- The harmonization of administrative formalities and social legislation regarding rail transportation and
- The application of homogenous fees for the use of the infrastructures all over the EU.

Financing alternatives should (a) incorporate longer term alternatives more appropriate for project financing (15 to 20 years), and (b) almost by necessity, an equity component (equity plus long term financing); and (c) bank syndication programmes (for loans and guarantees), to attract the participation of private banks and maximize the use of EIB resources.

Free competition

FERRMED recommends that liberalization and openness to competition of rail transport should be implemented more rapidly by Member States, considering favourable and homogeneus fees for the use of infrastructures, beaning in mind the socio-economic and environmental advantage of the railway.

Share of 30 ÷ 35 % of long distance land transportation

The Study shows that the implementation of the FERRMED standards and the overcoming of the foreseen bottlenecks in the Red Banana will push up the rail freight to 27% of the long distance land traffic. Further growth of the rail share will require additional measures such as assigning external costs among all transportation modes, according the environmental impact of each one, as well as the development of new technologies for rail. FERRMED strongly recommends to the EC and the Member-states the study and implementation of those additional policies. New developments in locomotive and wagon concepts should be supported and implemented.

3.2 High priority lines in FERRMED Great Axis Rail Freight Network (Red Banana)

In line with the conclusions of the Global Study, for the gradual development of the FERRMED Great Axis Rail Freight Network, FERRMED ASBL, proposes a total of **100 short, medium and long-term actions** in order to achieve the FULL FERRMED Scenario targets by 2025.

These actions are geographically located as follows:

i. Finland – Russia (St. Petersburg area):
ii. Baltic States (Estonia, Lithuania, Latvia);
iii. Sweden;
iv. Denmark;
v. Germany and North-West Poland;
vi. The Netherlands, Belgium and Luxembourg;
vii. France and South-East United Kingdom;
viii. Switzerland and North of Italy;
ix. Spain and North Africa.

A) FINLAND – RUSSIA (St. Petersburg area)

Country/Region	Finland – Russia (St. Petersburg area)
Total No. of Actions proposed for the country/region	6
Name of the line/s	*Main Feeder Line St. Petersburg – Helsinki - Turku*
FERRMED Proposed actions	1. To keep the width of the tracks as it is (1524 mm), due to the fact that the main freight traffic is eastern oriented, and to build a parallel line for high speed trains (basically for passengers) 2. To allow the possibility of long and heavy freight trains in the existing conventional lines and to implement, as well, FERRMED Standards regarding loading gauge, signalling systems (ERTMS) and other operational issues 3. To enlarge or to build high capacity multimodal terminals in the most important socio-economic areas and communications centres such as Turku, Helsinki, Kouvola, and Kotka
Name of the line/s	Bothnian corridor (Helsinki, Tornio). Feeder Line
FERRMED Proposed actions	4. To keep the width of the tracks as it is (1524 mm) and to double the number of tracks (two tracks in all line length) 5. Progressive implementation of FERRMED Standards 6. To enlarge or to build high capacity multimodal terminals in most important socio-economic areas and communications centres like Tampere, Kokkola, Oulu and Kemi/Tornio

B) BALTIC STATES (Estonia, Lithuania, Latvia)

Country/Region	Baltic States (Estonia, Lithuania, Latvia)
Total No. of Actions proposed for the country/region	4
Name of the line/s	*St. Petersburg (Russia) – Tallinn – Riga – Kaipeda – Kaliningrad (Russia). Feeder line.*
FERRMED Proposed actions	7. To refurbish the line including electrification where necessary 8. To enlarge - or build high capacity – multimodal terminals in most important socioeconomic areas and communications centres such as Tallinn, Riga, Klaipeda and Kaliningrad 9. To study the possibility of a double gauge tracks (1520 – 1435 mm) 10. To study a possible future fixed link between Helsinki and Tallinn

C) SWEDEN

Country/Region	Sweden
Total No. of Actions proposed for the country/region	8
Name of the line/s	*Core Network Line Stockholm-Hallsberg – Malmö/Helsingborg*
FERRMED Proposed actions	11. To introduce FERRMED standards in the conventional existing line, allowing the possibility of long and heavy freight trains, broader loading gauge and ERTMS signalling system: - Longer trains (1500 m) in the section Hallsberg – Hässleholm – Malmö/Helsingborg; - Double-tracking of section Hässleholm – Helsingborg as access line to a new fixed link over Öresund between Helsinborg and Helsingör; 12. New fixed link Helsinborg – Helsingör over the Öresund with a separate dedicated freight track 13. To build a parallel high speed line Stockholm – Jönköping – Helsingborg/ Malmö, with a branch from Jönköping to Göteborg 14. To enlarge or to build high capacity multimodal terminals in most important socioeconomic areas and communications centres like: Stockholm, Hallsberg, Jönköping, Helsingborg/ Malmö
Name of the line/s	*Main Feeder line Oslo – Göteborg – Helsingborg – Malmö*
FERRMED Proposed actions	15. To introduce FERRMED Standards allowing the possibility of long and heavy trains, broader loading gauge and ERTMS signalling systems 16. To enlarge or to build high capacity multimodal terminals in most important socioeconomic areas and communications centres such as Oslo and Göteborg
Name of the line/s	*Bothnian corridor (Stockholm – Uppsala – Sundsvall - Vännas/Umeä – Boden/Luleå).* *Feeder Line.*
FERRMED Proposed actions	17. To introduce FERRMED Standards allowing the possibility of longer and heavier trains, broader loading gauge and ERTMS signalling system and doubling the number of tracks (two tracks on most of the line) 18. To enlarge or to build high capacity multimodal terminals in most important socioeconomic areas and communication centres such as Uppsala, Sundsvall, Vännas/Umeå and Boden/ Luleå

D) DENMARK

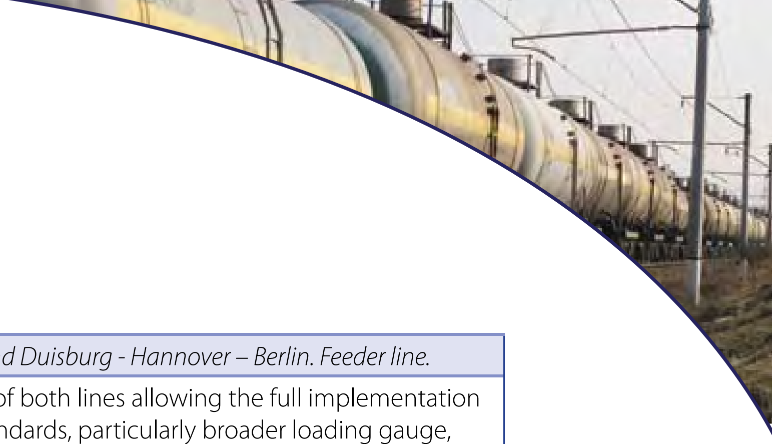
Country/Region	Denmark
Total No. of Actions proposed for the country/region	6
Name of the line/s	*Core Network Line Malmö/Helsingborg – Copenhagen – Lübeck (and derivation Copenhagen – Odense – Kolding – Flensburg*
FERRMED Proposed actions	19. To build a fixed link over Fehmarn Belt 20. To upgrade the line from Ringsted to Rødby A mixed line for high speed trains and freight trains with the necessary sidings are proposed. In medium term a new high-speed line (Copenhagen – Køge – Rødby should be built, increasing corridor capacity and allowing a separation of freight and passenger traffic 21. To build a double-track Copenhagen by-pass line Helsingør – Ringsted – Køge, connecting in Helsingør with a new fixed link Helsingborg – Helsingør over Öresund and in Ringsted/Køge with the access line to the Fehmarn Belt. 22. To double the number of tracks where necessary (two tracks in all the whole line) in the derivation Copenhagen-Odense-Kolding Flensburg 23. To introduce FERRMED Standards allowing the possibility of long (1500 m) and heavy trains, broader loading gauges and the ERTMS signalling system. 24. To enlarge or to build high capacity intermodal terminals in most important socio-economic areas and communications centres such as Copenhagen and the Jutland peninsula

E) GERMANY AND NORTH-WEST POLAND

Country/Region	Germany and North-West Poland
Total No. of Actions proposed for the country/region	15
Name of the line/s	*Puttgarden – Lübeck – Hamburg – Maschen* (this line forms the access line to the fixed Fehmarn Belt link Rødby – Puttgarden).
FERRMED Proposed actions	25. To build a new electrified double-track line Puttgarden – Bad Schwartau(Lübeck) for mixed traffic high-speed and freight. 26. To keep and upgrade most of today's line for local passenger services and in order to function as long passing loops for freight trains 27. At certain places new long passing loops for "flying overtakings" should be built along the new line.
Name of the line/s	Core Network Lines *Lübeck – Hamburg – Bremen – Osnabrück - Münster – Duisburg - Düsseldorf- Köln – Koblenz - Luxembourg/ Apach-Metz and Koblenz - Mainz/Frankfurt - Mannheim – Karlsruhe - Freiburg – Basel*[1]
FERRMED Proposed actions	Due to the existence and possible use of several parallel lines, one of the most important topics in FERRMED standards can be achieved: to provide two parallel lines in the main corridors. It is only also necessary to adopt other main issues of FERRMED standards such as broader loading gauge, longer and heavier trains, ERTMS signalling system, etc. 28. Possible improvements in saturated lines could be requested as is the case in Hamburg surroundings, Ruhr area and Frankfurt area. 29. Refurbishment of the main line in Rhine zone, particularly between Mannheim and Basel; 30. Refurbishment of the main line between Koblenz and Luxembourg as well as the line between Mannheim and Saarbrucken and the line between Offenburg and Strasbourg. 31. To enlarge or to build high capacity multimodal terminals in most important socio-economic areas and communications centres such as Lübeck, Bremen/Bremenhaven, Rurh area, Köln, Koblenz, Mainz/Frankfurt – Ludwigshaven/Mannheim, Karlsruhe, etc..
Name of the line/s	*Lübeck – Rostock – Seczecin (Poland) – Gdansk (Poland) – Kaliningrad (Russia).* Feeder Line.
FERRMED Proposed actions	32. Complete refurbishment between Lübeck and Seczecin in Germany 33. Double track line between Gdansk and Elblog and to complete the line between Elblog and Kaliningrad 34. Partial implementation of FERRMED standards allowing semi long trains (750m, minimum) 35. To enlarge or to build high capacity intermodal terminals in most important socio-economic areas and communications centres like: Rostock, Seczecin, Gdansk and Kaliningrad

[1] These core network lines are supported by several parallel lines in many sections like:
- Lübeck – Lüneburg – Hannover – Minden – Bielefeld – Hamm – Dortmund- Duisburg;
- Hamburg – Verden – Minden – Bielefeld – Hamm – Dortmund – Duisburg;
- Duisburg – Düsseldorf – Köln – Koblenz – Mainz/Frankfurt – Mannheim – Karlsruhe (Eastern parallel line);
- Karlsruhe to Basel through France (Strasbourg – Mulhose)

They are part of the core network, as well, the links between Bremen and Bremenhaven/Wilhelmshaven–Emden/Groningen and between Duisburg and Rotterdam/Amsterdam.



Name of the line/s	*Hamburg – Berlin and Duisburg - Hannover – Berlin. Feeder line.*
FERRMED Proposed actions	36. Refurbishment of both lines allowing the full implementation of FERRMED standards, particularly broader loading gauge, longer and heavier trains, signalling, etc 37. To enlarge or build high capacity multimodal terminals in most important socio-economic areas and communications centres such as Hannover and Berlin
Name of the line/s	*Frankfurt - Nuremberg and Karlsruhe – Stuttgart – Ulm – München. Feeder line.*
FERRMED Proposed actions	38. Refurbishment of both lines allowing the full implementation of FERRMED standards, particularly broader loading gauge, longer and heavier trains, ERMTS signalling, etc 39. To enlarge or build high capacity multimodal terminals in most important socio-economic areas and communications centres such as Frankfurt and Main, Nürnberg, Stuttgart, Ulm and München

F) THE NETHERLANDS, BELGIUM AND LUXEMBOURG

Country/Region	The Netherlands, Belgium and Luxembourg
Total No. of Actions proposed for the country/region	7
Name of the line/s	Core Network lines[2] : *Rotterdam/Amsterdam- Duisburg* *Antwerpen/Brussels – Liège – Aachen – Köln* *Antwerpen/Zeebrugge/Gent/Brussels – Namur – Luxembourg – Metz*
FERRMED Proposed actions	40. To implement FERRMED standards in order to allow broader loading gauge, longer and heavier trains and ERTMS signalling system 41. To improve the accessibility of ports of Rotterdam, Amsterdam, Antwerpen, Brussels, Gent, Zeebrugge and Liège 42. To upgrade the Betuwe line connection with Duisburg in German sector 43. To get a direct connection between Antwerpen and Ruhr area 44. To promote a rail freight by-pass in Brussels metropolitan area 45. To enlarge or to build high capacity intermodal terminals in most important socio-economic areas and communications centres such as: Amsterdam, Rotterdam, Utrecht, Antewerpen, Zeebrugge/Gent, Brussels/Liège, Luxembourg
Name of the line/s	Feeder lines: *Groningen – Bremen* *Amsterdam – Rotterdam – Antwerpen – Gent/Brussels – Lille – Paris* *Duisburg – Liège-Luxembourg*
FERRMED Proposed actions	46. To refurbish these lines in order to facilitate the partial implementation of FERRMED standards (at least freight trains length of 750m)

[2] Benelux, jointly with the western strip of Germany, is the logistic heart of European Union with a high density of rail grid. Beside the core network lines, there are as well several parallel branches to these lines that, in some sectors, facilitate the possibility of separate freight transportation.

The Athus – Meuse line in Belgium, between Dinart and Athus on the border between Belgium and Luxembourg is an outstanding example of dedicated freight line in that respect.

G) FRANCE AND SOUTH-EAST UNITED KINGDOM

Country/Region	France and South-East United Kingdon
Total No. of Actions proposed for the country/region	13
Name of the line/s	Core Network lines : *London – Calais/Dunkerque – Lille – Metz – Dijon* *Le Havre – Rouen – Amiens – Reims – Dijon* *Le Havre – Rouen – Paris – Dijon* *Luxembourg/Apach – Metz – Nancy – Dijon – Lyon – Valence – Avignon -/Marseille – Nimes – Montpellier – Perpignan – Gerone/ Barcelone* *Lyon – Torino/Milano*
FERRMED Proposed actions	47. To refurbish the existing conventional lines in order to allow the full implementation of FERRMED standards, particularly broader loading gauge, long and heavy trains and ERTMS signalling system 48. In fact, between Calais and Langres/Chalindrey; Dijon and Avignon/Nîmes; and Perpignan – Spanish border; two or more parallel lines, one of them for freight, already exists. Then, in order to accomplish FERRMED standards, it is necessary to get one additional parallel line between Langres/ Chalindrey – Dijon; between Nîmes and Perpignan; and a double-track new line between Lyon – Torino/Milano in order to increase capacity/to achieve particularly FERRMED Standards for gradient. 49. To enlarge or to build high capacity intermodal terminals and in most important socio-economic areas and communications centers such as: London, Calais/Dunkerque (linking both cities with a fully refurbished line), Lille, Metz, Dijon, Le Havre/Rouen, Amiens, Reims, Langres/Chalindrey, Dijon, Paris, Metz/Nancy, Lyon, Valence, Nîmes/Montepellier, Beziers/Narbonne, Marseille and Perpignan 50. To avoid bottlenecks in Lille, Paris and Lyon metropolitan areas by building the corresponding by-passes.For Paris, the "Rocade Nord" has to be made. For Lyon it is necessary to complete the entire by-pass and not only the northern part of the CFAL 51. To improve access to Ports (last mile), particularly in Le Havre and Marseille

Name of the line/s	Feeder lines: *Euro-tunnel – London – Southern UK ports (among others : London area harbours – Bristol/Cardiff, Southampton, Portsmouth and Felixstowe)* *Lille – Paris – Limoges – Toulouse – Narbonne* *Toulouse - La Tour de Carol* *Metz – Strasbourg* *Limoges – Clermont - Ferrand – Lyon – Genève* *Dijon – Mulhouse – Strasbourg – Freiburg* *Valence – Grenoble – Chambery* *Marseille – Toulouse – Nice – Genova* *Marseille – Aix- en- Provence – Gap - Briançon*
FERRMED Proposed actions	52. To refurbish these lines in order to facilitate the partial implementation of FERRMED standards (at least freight trains length of 750m) 53. In the case of Euro- Tunnel – London - Southern UK Ports, a key issue is to enlarge the loading gauge. In that sense these ports could be added to the British Channel/Northern Sea mean European Intercontinental Gateway. 54. To enlarge or build high capacity intermodal terminals and in most important socio-economic areas and communications centers such as: Toulouse, Strasbourg, Clermont – Ferrand, Mulhouse, Grenoble and Nice 55. Double track in the line Valence – Grenoble – Chambery (Sillon Alpine Sud)
Name of the line/s	*Transalpine crossings France-Italy*
FERRMED Proposed actions	Medium-term actions (2012-2020): 56. To build a new mixed line Lyon-Torino capable of long and heavy freight trains (till 1500 m length) 57. To build a new high speed line Marseille-Nice 58. To refurbish the line Nice-Genoa (double track and possibility of longer freight trains till 750 m) Long term (2025 and beyond): 59. To refurbish the line Marseille-Aix-en-Provence-Gap-Briançon (arranging the trace in order to reduce the slopes) and building the Montgenèvre tunnel connecting Briançon with Lyon -Torino – Milano line
Name of the line/s	*Trans Pyrenean crossings France – Spain (see actions 93 to 95)*

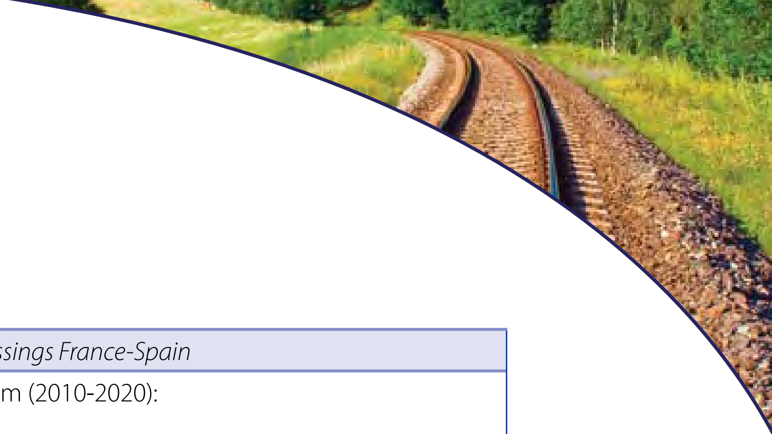
H) SWITZERLAND-NORTH OF ITALY

Country/Region	Switzerland and North of Italy
Total No. of Actions proposed for the country/region	9
Name of the line/s	Core Network lines : *Basel – Bern – Milano - Genoa* *Basel - Zurich - Milano - Genoa* *Lyon – Torino – Milano - Venezia*
FERRMED Proposed actions	60. To refurbish the existing transalpine lines with the construction of base tunnels in order to reduce the slopes and facilitate freight traffic, as is the case with the new tunnels of Lotschberg, Simplon and Sant Gottard 61. To build a new transalpine line Lyon-Torino 62. To build a new line between Milano and Genoa suitable for long and heavy freight trains. 63. To build a new high speed line Torino-Milano-Verona-Venezia-Trieste 64. To refurbish the existing Transpadana line becoming suitable for long and heavy freight trains implementing, as well, other key FERRMED standards like broader loading gauge and ERTMS signalling system 65. To enlarge or to build high capacity intermodal terminals in most important socio-economic areas and communications centres, such as: Basel, Bern, Zurich, Torino, Milano, Alessandria/Rivalta Scrivia, Verona, Padova/ Mestre/Venezia, Trieste, Genoa, Savona, Livorno. 66. To improve access to ports (last mile), particularly Genoa, Savona and Livorno
Name of the line/s	Feeder lines: *Gèneve-Bern-Zurich-Innsbruck* *Nice-Genoa-La Spezia-Livorno/Firenze-Roma* *Milano-Bologna-Firenze-Roma* *Innsbruck-Verona-Bologna* *Domodossola-Torino-Genoa* *Marseille-Torino(through Montgenevre tunnel)*
FERRMED Proposed actions	67. To refurbish the existing lines in the sense of being suitable for intermediate FERRMED Standards (at least with the possibility of 750 meters length freight trains) 68. To enlarge or build high capacity intermodal terminals in most important socio-economic areas and communications centers, such as Geneva, Innsbruck, Livorno, Firenze, Roma and Bologna

I) SPAIN - NORTH AFRICA

Country/Region	Spain, Morocco and Algeria
Total No. of Actions proposed for the country/region	32
Name of the line/s	Core Network lines : *Perpignan-Girona-Barcelona-Castelló-València-Alacant-Murcia/* *Cartagena-Lorca-Almería-Motril-Málaga-Algeciras* *Lorca-Granada-Antequera-Bobadilla-Algeciras*
FERRMED Proposed actions	Short term (2010-2012): 69. Double gauge (1668-1435 mm) in the conventional line Figueres --Girona and Mollet - El Papiol – Port of Barcelona 70. New high speed/mixed line Perpignan-Girona-Barcelona (1435 mm) Short/Medium term (2010-2015): 71. Double gauge (1668 mm- 1435mm) in the conventional line between Portbou - Figueres (with rail ring included) – Girona (keeping temporary the existing conventional line crossing) 72. New additional freight preference line Sant Celoni – El Papiol – Vilafranca del Penedès – Reus – Southern Tarragona with international gauge (1435 m) and connections to ports and inland terminals and main industrial zones, as part of the big Barcelona by-pass 73. To change the width of the tracks in the conventional line Tarragona - Castelló (from 1668 mm to 1435 mm) (with double gauge as a provisional solution). 74. To put double gauge (1668 – 1435 mm) in the conventional line in the section Girona – Sant Celoni and Castelló – Valencia 75. To improve access to ports (last mile), particularly in the ports of Barcelona, Tarragona, Castelló, Sagunt, València, Alacant, Cartagena, and Almería (including UIC 1435 mm gauge) 76. New high speed line Tarragona-Castelló (1435 mm gauge) 77. New freight line Castelló – Valencia – Xativa (1435 mm), with connections to ports and inland terminals. 78. New high speed line València-Alacant-Murcia-Almería (in 1435 mm gauge), from Murcia to Almería on a mixed line (keeping the existing line Murcia-Lorca-Almendricos-Aguilas as a separate line from the new one). 79. Double track/double gauge (1668 mm and 1435 mm) in the conventional line Murcia – Cartagena and to build a freight by-pass in Murcia city. Medium term (2016-2020): 80. New freight preference line Northern Girona – Sant Celoni (in 1435 mm)/completion of the big Barcelona city by-pass 81. New high speed/mixed line Almería-Motril-Málaga-Algeciras suitable for long and heavy freight trains in international gauge (1435 mm) 82. Double gauge tracks (1668 and 1435 mm) in the existing conventional line València – Xativa

FERRMED Proposed actions	83. To change the width of the tracks to 1435 mm, to fully electrify and to put double track everywhere in the existing conventional line Xativa – Font-La Figuera – Alacant – Murcia – Lorca – Aguilas, including Alacant by-pass, and keeping double gauge in the section Alacant – Murcia – Lorca – Aguilas 84. New conventional line Lorca-Granada in 1435 mm 85. Full refurbishment and conversion to international width (1435 m) of the line Algeciras – Bobadilla 86. Refurbishment of the existing line Sevilla – Antequera – Granada – Almería, changing the width of the track to 1435 mm 87. To introduce FERRMED Standards in the refurbished conventional lines from Port Bou to Almería/Málaga/ Algeciras (long and heavy trains, broad loading gauge, and ERTMS signalling system) 88. To enlarge or to build high capacity intermodal terminals in most important socio-economic areas and communications centers, such as: Figueras/Girona, Barcelona Metropolitan Area, Reus/Tarragona, Castelló, València Metropolitan Area, Alacant, Murcia/Cartagena, Lorca-Puerto Lumbreras/Totana, Almería, Motril, Málaga, Algeciras, Granada, Antequera, Sevilla/Cadiz 89. To introduce partial FERRMED Standards (at least freight trains of 750m) in the line Lorca-Granada-Antequera-Bobadilla-Algeciras/ Sevilla.
Name of the line/s	Main Feeder lines: *Barcelona-Lleida-Zaragoza-Pamplona/Bilbao/Madrid* *Sagunt-Zaragoza* *Valencia/Murcia-Albacete-Madrid* *Almería-Granada-Linares-Madrid* *Algeciras-Bobadilla-Cordoba-Linares-Madrid* Secondary Feeder lines: *Barcelona-Vic-La Tour de Carol* *Lleida-La Pobla de Segur* *Zaragoza-Huesca-Canfranc* *Valencia-Cuenca-Madrid*
	90. To implement full FERRMED Standards (long and heavy trains, broader loading gauge and ERTMS signalling system) as well as to change the width in the tracks (to 1435 mm) in the existing conventional lines: - Barcelona/Tarragona-Lleida-Zaragoza -Pamplona/Bilbao/ Madrid - Valencia/Murcia-Albacete-Madrid - Sagunt-Zaragoza 91. To implement intermediate FERRMED Standards (length of trains at least of 750 m) in the lines: – Almería-Granada-Linares-Madrid – Algeciras-Bobadilla-Cordoba-Linares-Madrid 92. To enlarge or to build high capacity intermodal terminals in most important socio-economic areas and communications centres, like: Lleida, Zaragoza, Pamplona, Bilbao, Madrid, Córdoba, Linares, Sagunt and Albacete



Name of the line/s	*Transpyrenean crossings France-Spain*
FERRMED Proposed actions	Short/Medium term (2010-2020): 93. In Spain, to change the width of the tracks in the existing conventional lines: - Portbou-Barcelona-Valencia-Alacant-Murcia/Cartagena - Irun-San Sebastian/Bilbao-Vitoria-Valladolid-Madrid - La Tour de Carol/Puigcerda-Vic-Barcelona - Zaragoza-Huesca-Canfranc Important note: First priority has to be given to Porbou and Irun lines. The refurbishment of these lines jointly with new mixed parallel lines in both Pyrenean ends (Mediterranean and Atlantic) will allow the increase by a factor of 12 to the existing rail freight traffic. This solution is by far less costly and more efficient than to build any additional lines. Long term (2025 and beyond): 94. To enlarge by both ends the line Lleida-La Pobla de Segur: - In the North till Saint Girons and from there to Toulouse. One tunnel of 14,5 Km at 900-1000 meters high will be requested and other forty short additional tunnels will be required as well - In the South till Tortosa, linking with the main line Barcelona-Valencia. 95. To build a new line between Zaragoza-Huesca-Lourdes-Bordeaux/Toulouse. One of the forecasted crossing options requires 60 km of new tunnels between Huesca and Pierrefitte-Nestalas. The main Transpyrenean tunnel will have a length of 41, 7 km and will reach a maximum height of 925 meters
Name of the line/s	*Gibraltar crossing*
FERRMED Proposed actions	Long term (2025 and beyond): 96. A tunnel under Gibraltar strait has to be carefully analyzed due to seismic and tectonic matters, and because of the depth of the Strait and the length of the gallery required in order to allow smooth ramps for the crossing of long and heavy freight trains. For the time being, the interconnection by ferries, adapted to transporting freight train wagons, could be the more pragmatic solution.
Name of the line/s	NORTH OF AFRICA *Tanger-Rabat-Casablanca* *Rabat-Fez-Nador/Ghazaouet-Oran-Alger-Bejaja-Tunis*
FERRMED Proposed actions	97. To refurbish the existing lines and to implement partial FERRMED Standards (length of trains of at least of 750 m) 98. To build a high speed/mixed line between Tanger-Rabat-Casablanca 99. To build a high speed/mixed line between Rabat-Alger-Tunis 100. To enlarge or to build high capacity intermodal terminals in most important socio-economic areas and communications centres like: Tanger, Rabat, Casablanca, Oran, Alger, Bejaja and Tunis

3.3 Lines to be declared as EU priority projects

FERRMED considers that all railway lines included in FERRMED Great Axis Core Network would have to be considered as EU Priority Projects, comprising all actions stated in point 6.2.

Map of the FERRMED Great Axis Core Network

Taking into account that most of the railway corridors included in the FERRMED Great Axis Core Network are already declared Priority Projects, FERRMED Association proposes to add to the current list of priority projects the remaining main core network lines in the Red Banana that do not have this consideration.

Lines to be declared as EU priority projects FERRMED PROPOSAL	
Country	Lines to be declared as EU Priority projects
Germany	*- Luxembourg/Apach* *- Line Bremen-Münster-Duisburg to be included as an extension of corridor number 20.* *- Line Koblenz-Luxembourg -Apach*
France	*- Line Calais/Dunkerque-Lille-Metz-Dijon* *- Line Le Havre-Amiens-Reims-Dijon*
Spain (Mediterranean corridor)	*- Line Tarragona-Castelló-València-Alacant-Murcia/Cartagena-Almería-Motril-Málaga-Algeciras* *- Line Lorca-Granada-Antequera*

4. OTHER FERRMED STUDIES

4.1 Other Studies underway

The FERRMED Locomotive Concept

Developed by ALSTOM; APPLUS; BOMBARDIER; COEIC, COIIV, FAIVELEY, Universitat Politècnica de Catalunya; VOSSLOH

The FERRMED Locomotive Concept was launched by the FERRMED Association in February 2009 in order to identify the key concepts for promoting and developing the future European freight locomotive.

The Study aims at defining the core features of a new versatile and efficient locomotive appropriate to the FERRMED Infrastructure Standards as well as designing a comprehensive framework for its concrete realization. The Locomotive Concept primarily relies on the new locomotive's suitability to long and heavy trains as well as its versatility to operate in terminals.

The Study is expected to be completed in the first quarter of 2010.

The FERRMED Wagon Concept

Developed by Royal Institute of Technology Stockholm (KTH) – Railway Group; Institute of Technology Berlin –TIB

In order to fully exploit the new prospects for rail freight offered by the application of the FERRMED Standards, rolling stock has to be renewed and new train operating methods have to be applied.

To this end, FERRMED intends to develop a new Wagon Concept conceived as a basic platform, compatible with existing rolling stock (interoperability), suitable for long and heavy trains.

At its primary objective, the Study will define an outline of the "Wagon Concept" which will focus on specifications of basic vehicle design, vehicle dimensions and technical equipment. It aims at incorporating state-of-the-art technology and merge different solutions into one wagon concept. It is expected that this concept would allow measuring the effects and benefits of the FERRMED-Standards Implementation.

The Study will be finalized in early 2010.

4.2 Other forecasted Studies (business-oriented)

Mediterranean Orbital Rail Network and multimodal links

To be developed jointly with the Euro Mediterranean Business Association

Rail, ship, road and aerial infrastructures and routes in the Mediterranean basin are currently parts of a fragmented and uncoordinated transport system.

The Global Project known as Trans Mediterranean Orbital Rail Network and multimodal Links -- Renewed transportation system for peace, progress, solidarity and sustainability -- is a multimodal study that seeks to create an interlinked, coordinated and functional rail, ship, road and aerial shipping network allowing for an effective and efficient flow of goods, services and passengers in the Euro-Mediterranean Greater Area.

The aim of this Global Study is to identify a high priority rail, maritime, road and flight network to improve the Trans-Mediterranean multimodal transportation system, including the interconnection with airports, as well as, short sea shipping and intercontinental traffic, among all the main harbours of the Mediterranean / Black Sea and between harbours and their hinterlands.

Illustration x: Mediterranean Orbital Rail Network and multimodal links

The study will consider how to optimise the competitiveness of the Euro-Mediterranean Greater Area though the implementation of a rail freight network that links the main roads and airports and all main Mediterranean Ports between them and with their respective hinterlands in Europe, Near East and North of Africa. This will generate long-term, sustainable economic growth and development and thereby support peace and stability in the region.

Trans-Eurasian Rail Network

The incorporation of Eastern countries to the European Union and the increased trade relationships with Ukraine, Russia and other CIS countries, as well as with China, makes of great interest the business oriented analysis of East-West transportation flows particularly by rail.

The existing lack of interoperability and policy harmonisation in the transportation system causes bottlenecks and unnecessary delays, especially at border crossings.

To facilitate the railway connections with EU recently incorporated countries, and also with Eastern neighbours, removing all kind of barriers, from technical, administrative, organizational and legal point of views, is a big challenge to be solved in order to facilitate trade and to increase the competitiveness of the "added value global chain".

Following the example of the "Supply and Demand, Technical, Socio-Economic Global Study of the FERRMED Great Axis Network and its area of influence", FERRMED would like to carry out another Global Study aiming at defining a key "business-oriented" axes linking Trans-European transport network to the Trans-Eurasian transport networks.

Illustration x: Trans-Eurasian Rail Network

LIST OF FERRMED MEMBERS AND PARTNERS

AB SKF
AB VOLVO
ABERTIS Logistica, S.A.
ADEG (Associació d'Empresaris de l'Alt Penedès, el Baix Penedès i el Garraf)
AEQT (Associació Empresarial Química de Tarragona)
Agence Régionale de Développement de la PICARDIE
ALSTOM Transporte, S.A.
ANESCO (Asociación Nacional Empresas Estibadoras y Consignatarias de Buques)
APPLUS
ARDANUY Ingeniería, S.A.
ASCER (Asociación Española de Fabricantes Azulejos y Pavimentos Cerámicos)
Asociación Grande Industrias del Campo de GIBRALTAR
Association Internationale pour le Tunnel de SALAU
Autoridad Portuaria de la BAHIA DE ALGECIRAS
Autoridad Portuaria de ALICANTE
Autoridad Portuaria de ALMERIA
Autoritat Portuària de BARCELONA
Autoridad Portuaria de CARTAGENA
Autoridad Portuaria de CASTELLON
Autoridad Portuaria de MALAGA
Autoridad Portuaria de MOTRIL
Autoritat Portuària de TARRAGONA
Autoridad Portuaria de VALENCIA
AUTOTERMINAL, S.A.
BARCELONA REGIONAL
BCL (Barcelona Centre Logístic)
BEJAIA Mediterranean Terminal SpA
BOMBARDIER
CADev (Champagne-Ardenne Développement)
CAEB (Confederació d'Associacions Empresarials de Balears)
Cámara Oficial de Comercio, Industria y Navegación de ALMERIA
Cambra Oficial de Comerç, Indústria i Navegació de BARCELONA
Cámara Oficial de Comercio, Industria y Navegación de CARTAGENA
Cámara Oficial de Comercio, Industria y Navegación de CASTELLON
Cámara Oficial de Comercio, Industria y Navegación del Campo de GIBRALTAR
Cámara Oficial de Comercio, Industria y Navegación del Campo de VALENCIA
Cambra de Comerç, Indústria i Navegació de GIRONA
Cambra de Comerç i Industria de LLEIDA
Cambra de Comerç, Indústria i Navegació de MALLORCA, EIVISSA i FORMENTERA
Camara Oficial de Comercio Industria y Navegación de MOTRIL
Cámara Oficial de Comercio, Industria y Navegación de MURCIA
Cambra Oficial de Comerç, Indústria i Navegació de REUS
Cambra de Comerç i Industria de SABADELL
Cambra Oficial de Comerç, Indústria i Navegació de TARRAGONA
Cambra de Comerç i Industria de TERRASSA
CAPEM (Comité d'Aménagement, de Promotion et d'Expansion de la MOSELLE)

CARGOBEAMER AG
CCTT (Coordinating Council on Transsiberian Transportation)
CDM NV
CELSA (Compañía Española de Laminación, S.L.)
CEMENTOS MOLINS, SA
Centre Européen de Fruits et Légumes SCRL
CEPTA (Confederació Empresarial de la Provincia de TARRAGONA)
CEPYMEVAL (Confederación de Organizaciones Empresariales de la Pequeña y Mediana Empresa de la Comunidad Valenciana)
Chambre Régionale de Commerce et d'Industrie de BOURGOGNE
Chambre de Commerce et d'Industrie de DUNKERQUE
Chambre Régionale de Commerce et d'Industrie de LANGUEDOC-ROUSSILLON
Chambre Régionale de Commerce et d'Industrie de LORRAINE
Chambre de Commerce du Grand-Duché de LUXEMBOURG
Chambre de Commerce et d'Industrie de LYON
Chambre de Commerce et Industrie de MARSEILLE-PROVENCE
Chambre Régionale de Commerce et d'Industrie de RHÔNE-ALPES
CIERVAL (Confederación de Organizaciones Empresariales de la Comunidad Valenciana)
COE (Cercle pour l'Optimodalité en Europe)
Colegio de Ingenieros Industriales de ANDALUCIA ORIENTAL
Col·legi d'Enginyers de Camins Canals i Ports de CATALUNYA
Col·legi Oficial d'Enginyers Industrials de CATALUNYA
Colegio de Ingenieros de Caminos, Canales y Puertos de la COMUNIDAD VALENCIANA
Colegio de Ingenieros de Caminos, Canales y Puertos de MURCIA
Colegio de Ingenieros Industriales de la REGION DE MURCIA
Colegio de Ingenieros Industriales de la COMUNIDAD DE VALENCIA
Compagnia Portuale PIETRO CHIESA s.c.a r.l.
COMSA Rail Transport S.A.
Conception Etude Réalisation Logistique (CERL)
Consorci de la Zona Franca de BARCELONA
CROEM (Confederación Regional de Organizaciones Empresariales de Murcia)
CROSSRAIL AG
DB SCHENKER RAIL WEST (EWS - English Welsh & Scottish Railway)
DECATHLON France S.A.S.
DRAGADOS S.P.L.
DUISBURGER HAFEN AG (Duisport)
EIA (European Intermodal Association)
EMTE S.A. (Estudios Montajes y Tendidos Eléctricos)
ERFA (European Rail Freight Association)
ERFCP (European Rail Freight Customer Platform)
ERS Railways BV
EUROMEDITERRANEAN BUSINESS ASSOCIATION
Europakorridoren AB
EUROPORTE 2 SAS (filiale fret d'EUROTUNNEL)
FAIVELEY S.A.
FemCat (Fundació privada d'empresaris)
FGC (Ferrocarrils de la Generalitat de Catalunya)
Foment del Treball Nacional
FORD
Fundació Occitano Catalana (FOC)
FUNDACIÓN ICIL (Institut Català de Logística)

GEFCO
Grand Port Maritime du HAVRE
Grand Port Maritime de MARSEILLE
GRONINGEN Sea Ports
HUPAC INTERMODAL S.A.
IBS (Interessengemeinschaft der Bahnspediteure) e.V.
Institut d'Economia i Empresa IGNASI VILLALONGA
ISL (Institute of Shipping Economics and Logistics)
ISOLOADER EUROPE S.A.
La Transalpine (Comité pour la liaison européenne transalpine Lyon-Turin)
L'EMPRESARIAL (Confederación Independiente de la Pequeña y Mediana Empresa Valenciana)
Logitren Ferroviaria S.A.U.
LOGZ - ATLANTIC HUB, SA
LORRY RAIL S.A.
LTF (Logística y Transporte Ferroviario, S.A.)
LYON TERMINAL
MERCABARNA S.A. (Mercados de Abastecimientos de Barcelona)
NOVATRANS S.A.
PARIS TERMINAL S.A.
PATRONAT CATALUNYA MÓN
PIMEC (Petita i Mitjana Empresa de Catalunya)
Port of ANTWERP
Port de BRUXELLES
Port Autonome de LIEGE
Port of ROTTERDAM
Port de SÈTE, SUD DE FRANCE
PROMÁLAGA S.A. (Empresa Municipal de Iniciativas y Actividades Empresariales de Málaga)
PUNTO FA S.L (MANGO)
RAFTS E.E.I.G. (Rail Freight Transport System)
RAIL FREIGHT GROUP
RAIL LINK Europe
RAILGRUP
SEAT S.A.
SETRAM S.A. (Servicios de Transportes de Automóviles y Mercancías)
STVA
T.R.W. S.A.
TCB S.L. (Terminal de Contenedores Barcelona)
TRADISA OPERADOR LOGISTICO S.L.
TRANSFESA S.A. (Transportes Ferroviarios Especiales)
TRIMODAL Europe B.V.
UPC (Universitat Politècnica de Catalunya)
VOSSLOH España, S.A.