# White Paper Innovative Rail Freight Wagon 2030

## The "5 L" future initiative as a basis for growth in rail freight transportation


**TU Dresden**

Institute of Railway Systems, Public and Urban Transport

**TU Berlin**

Department

Rail Vehicles



**September 2012**

PDF-Version

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PDF-Version

1st edition, Dresden, September 2012
Technical Innovation Circle for Rail Freight Transport

Printed by:
addprint AG, Dresden-Bannewitz

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# Preface

This White Paper should be understood as a collection of proposals for coordinated implementation of the initiative "Innovative Rail Freight Wagon 2030". It represents a clear strategy for further development of one of the most important resources for rail freight transportation: the rail freight wagon. Over recent decades, the rail freight market and the wagon manufacturing industry have not paid sufficient attention to this product, either by using modern technologies or by better integrating it into transport logistics chains.

The "Technical Innovation Circle for Rail Freight transportation" (TIS), consisting of representatives of wagon manufacturers, suppliers, customers and shippers, wagon owners, railway undertakings and scientific researchers, has drawn up viable proposals for how rail freight wagons can be further developed and new properties and technologies introduced on a step-by-step basis between now and 2030.

These proposals focus on new-build vehicles but can to some extent also be applied to rebuilds, if this makes economic and environmental sense.

Intelligent resource management in transport logistics chains will enable the innovative rail freight wagon 2030 to offer considerable potential for growth, efficiency and sustainability of rail freight transportation. As a result this White Paper is also aimed at persuading policymakers and regulatory authorities to support the implementation of appropriate measures.

Isolated improvement of individual freight wagon components is unlikely to result in any significant advantages in terms of growth and competitiveness when it comes to the strategically important integration into modern and global logistical transport chains. The only way to ensure further growth and economic efficiency for rail freight transportation, while at the same time meeting environmental targets, is to simultaneously integrate several improvements to form an overall concept for an innovative freight wagon. At the same time this is an important way of achieving an effective and tangible reduction in noise pollution, maintaining public acceptance of rail freight transportation and thus counteracting possible operational restrictions. This will promote and support the interlinking of transport modes to create modern logistics systems as encouraged by politicians and encourage the efficient use of already existing infrastructures.

The innovative rail freight wagon 2030 will help to underline the strengths of rail freight transportation. To achieve this it is important to further encourage the cooperation of all players, supporters, regulatory authorities, scientific institutes and policymakers in order to pave the way for and implement specific, coordinated measures from 2014 onwards.

Existing technologies and modules can provide a basis for making a rapid start at both national and European level. Further developments and accompanying research can and must be systematically integrated in a multi-stage process. The basis for joint action by the main players must be a common understanding – transcending individual companies and fields – of how to take rapid and targeted action in six stages between now and the year 2030.

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# Summary

Rail freight transportation is a system service. A multitude of players, participants and service providers bear a high degree of responsibility for its attractiveness and performance. On the one hand the advantages of rail freight transportation – such as very high efficiency in terms of land use and energy consumption, and low greenhouse gas emissions – are well known in social terms; on the other hand, rail's market share of freight transportation and its economic efficiency continue to be limited.

This White Paper focuses on the scope for enhancing efficiency by **further developing** one of the most important key resources for transporting rail freight – **the rail freight wagon**. It summarises the most important considerations and most feasible solutions with regard to the innovative rail freight wagon 2030 as a growth driver for rail freight transportation in the EU, including Switzerland.

The central idea of the innovative rail freight wagon 2030 consists of an **overall technical and operational concept** for its design and use. To achieve this, new scope has to be created to encourage an efficient, coordinated and ongoing innovation process at both national and international level. A cross-company and cross-sectoral team composed of representatives of growth-oriented railway undertakings, customers and shippers, wagon owners (such as freight wagon leasing companies or railway undertakings), as well as wagon builders and their suppliers has been systematically discussing and developing this approach for two years with the support of scientific expertise.

The step-by-step transition towards the innovative rail freight wagon 2030 will be made possible by targeted introduction of technologies and modules that already exist to a large extent or are already at an advanced stage of testing. Their selection and integration will be consistently oriented towards increasing competitiveness and growth through economic efficiency, tangible customer benefits, and – more than ever – towards environmental protection and resource conservation. The innovative rail freight wagon will open up new technological possibilities that have hitherto not been used or have only been used for special transportation tasks, and will immediately generate high operational and logistical benefits as well as bringing about a lasting improvement in public acceptance of rail transportation. This approach includes above all shorter journey times, more productive deployment of freight wagons, greater benefit from size advantages, increased load capacity, more up-to-date and higher quality information on transport and load status, a significant reduction in noise emissions, and lower life-cycle costs. The full use of technical and operational possibilities will at the same time increase the utilization rate of the existing rail infrastructure and globally improve the attractiveness of the rail freight wagon for customers and operators as well as for policymakers and society.

As a key element of rail freight transportation, the innovative rail freight wagon 2030 needs to be supported and promoted by all interested parties. No significant contribution to growth can be expected from improvements to isolated aspects of the conventional freight wagons currently in operation. The main route to increased growth, combined with protection of the environment and conservation of resources is the innovative rail freight wagon. The current barriers to design, integration of new or existing modules and rail freight wagon operation must be overcome. Financial resources need to be focused and earmarked for sustainable growth. And further benefits for technology, freight operations and the environment can be generated by accompanying research and specialized activities.

Based on the innovative rail freight wagon 2030, the

**"5 L" future initiative**

offers the possibility of boosting competitiveness and achieving successful and sustainable growth in rail freight transportation.

The "5 L" future initiative creates a framework for **five growth factors** that have been identified for successful introduction of the innovative freight wagon:

**Low noise – Lightweight – Long-running – Logistics capable – LCC-oriented**

The technical and operational solutions underlying the growth factors and securing their effects are not panaceas. The available components and modules must be combined and supplemented in new ways and with a focus on function and objectives. At the same time the attractiveness of the European wagon manufacturing industry on global markets will be enhanced.

If a growth target is set of increasing the modal share of rail freight transportation in the EU 27 to 25 % by 2030, then this means rail will account for a total of 286 billion additional tkm, on the basis of previously forecast transport performance. It will mean that these countries, as desired and expected, will deliver a substantial contribution towards decoupling economic growth and $CO_2$ emissions. The effect will be enhanced by the action being taken in Switzerland to support measures aimed at further increasing the share of rail in trans-alpine freight transportation. On the other hand the precondition for such growth being achieved in all countries is an improvement in the economic efficiency of rail freight transportation – which is why the innovative rail freight wagon particularly focuses on this target.

The establishment of the interest group comprising railway undertakings, shippers, wagon leasing companies and wagon manufacturers and their suppliers will significantly increase the efficiency and effectiveness of future public and start-up funding programmes. In close coordination with the industry associations in the sector and the competent authorities, funding and policymakers can rely on clear strategies. This will contribute to creating a real chance of introducing the innovative rail freight wagon in practice across the EU and in Switzerland.

A combination of two strategies will ensure practical application of the innovative freight wagon 2030: firstly the construction of new wagons and secondly the retrofitting of existing ones. Rapid, coordinated action is needed from 2014 to 2030. If retrofitting of wagon fleets extends beyond this time frame, the chances for realisation and growth of the innovative freight wagon will not only be reduced, but the consensus achieved would be significantly impeded at an early stage.

Timely availability of sufficient funding for the initiative will ensure the required lead-time for the wagon building industry. This lead is important and urgently required if there is to be **a coordinated and internally harmonised multi-stage programme beginning in 2014** for the manufacture and market launch of the innovative rail freight wagon by German and European railways as well as by relevant service providers.

Compared to the current situation, global, cross-border operation of the innovative rail freight wagon will also produce further positive effects in terms of modernisation and greater competitiveness of rail freight transportation. This includes in particular greater efficiency through standardisation, process optimisation, noise reduction and simplifications in railway production as well as at its interfaces.

This “White Paper Innovative Rail Freight Wagon 2030” and the proposed “5 L” initiative present well-founded and coordinated reflections and strategies. Their **implementation by 2030 is strongly recommended**. The success of the innovative rail freight wagon will pave the way for massive growth in rail freight transportation and will guarantee future-proof and sustainable rail freight mobility.

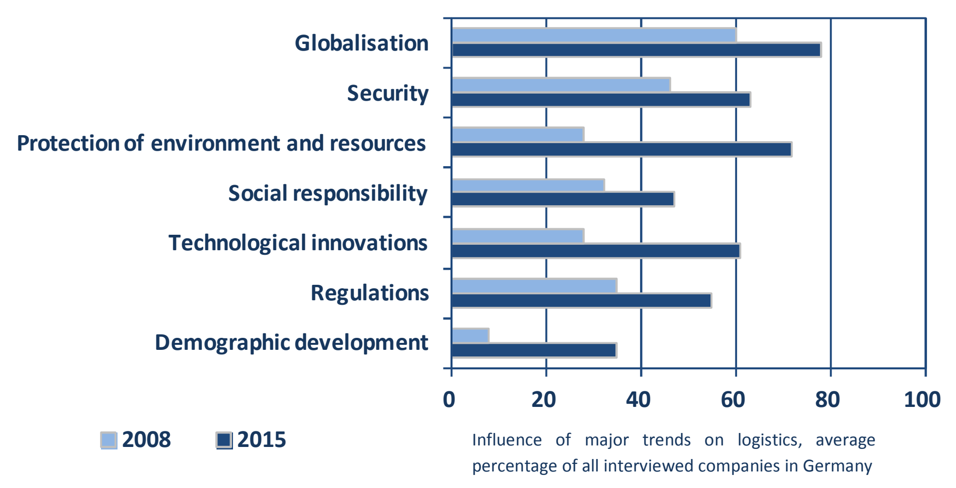
1

# Future challenges for rail freight transportation

## 1.1 Growth and change in the freight transportation market

The freight transportation market as a whole depends directly on global economic developments. Following the setbacks of the 2008 economic crisis, the European economy gradually recovered in the years to 2011. Despite the difficulty of forecasting economic cycles, growing demand for transport can be assumed over the coming years. As production technologies continue to develop – especially in the manufacturing sector – freight customers will require improved logistics capabilities from transport providers. Scientific analyses summarising the future challenges for freight transportation and services have identified the following major trends for logistics in Germany (Fig. 1-1):

Fig. 1-1: **Major trends in logistics (tendency in Germany)**



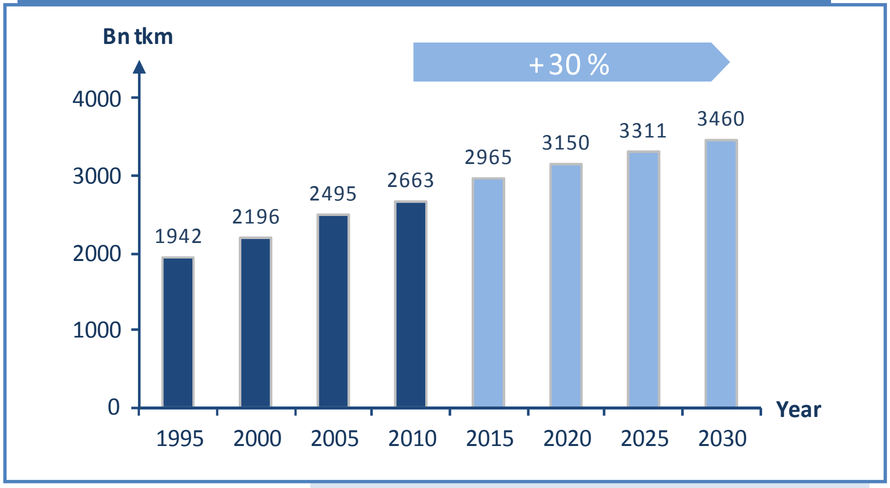

Source: BVL: Study on trends and strategies in logistics 2008: The core messages, 2008

It is above all globalisation – characterised by the worldwide networking of production and economic transactions – that challenges logistics providers and transport companies to offer and deliver customised **international transportation** across frontiers.

The increasing national and international division of labour will in future require more freight to be moved over long distances between production sites.[1] The sheer volume of goods involved will result in an increase in total freight transport performance in coming decades, as demonstrated in Fig. 1-2.

[1] See: Fraunhofer IIS: Economic frame conditions of freight transport (Wirtschaftliche Rahmenbedingungen des Güterverkehrs) – comparative study of transport modes in the frame of logistics processes in Germany. Study, Nuremberg, Fraunhofer IRB Verlag, 2008, p. 14

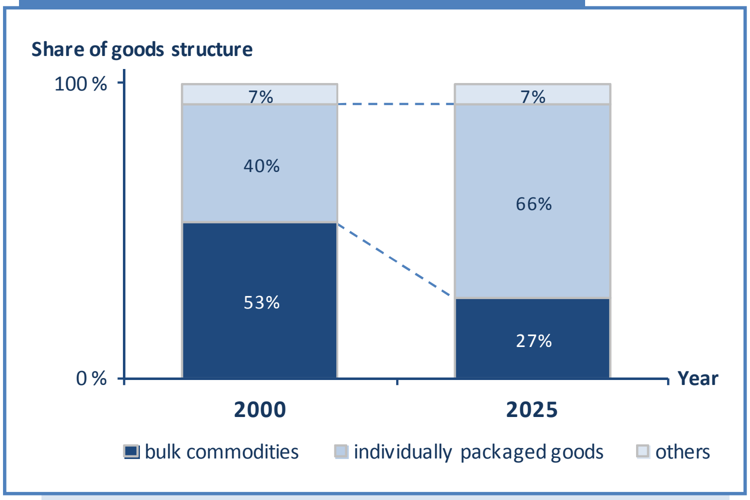
Fig. 1-2: **Development of freight transport performance in EU 27**




Source: European Commission/DG TREN: EU energy trends to 2030 – Update 2009, 2010 (baseline scenario)

Products will increasingly be oriented towards global markets, and demand for their individualisation and for added services to enhance the value of physical products will increase. From an economic point of view this will cause a so-called **goods structure effect**: a change in the type and composition of transported goods from heavy bulk commodities that are well suited for rail transportation, e.g. coal and ores, to more lightweight, high-value goods in smaller consignment volumes and requiring high quality transportation (Fig. 1-3).[2]

Fig. 1-3: **Goods structure effect in Germany**

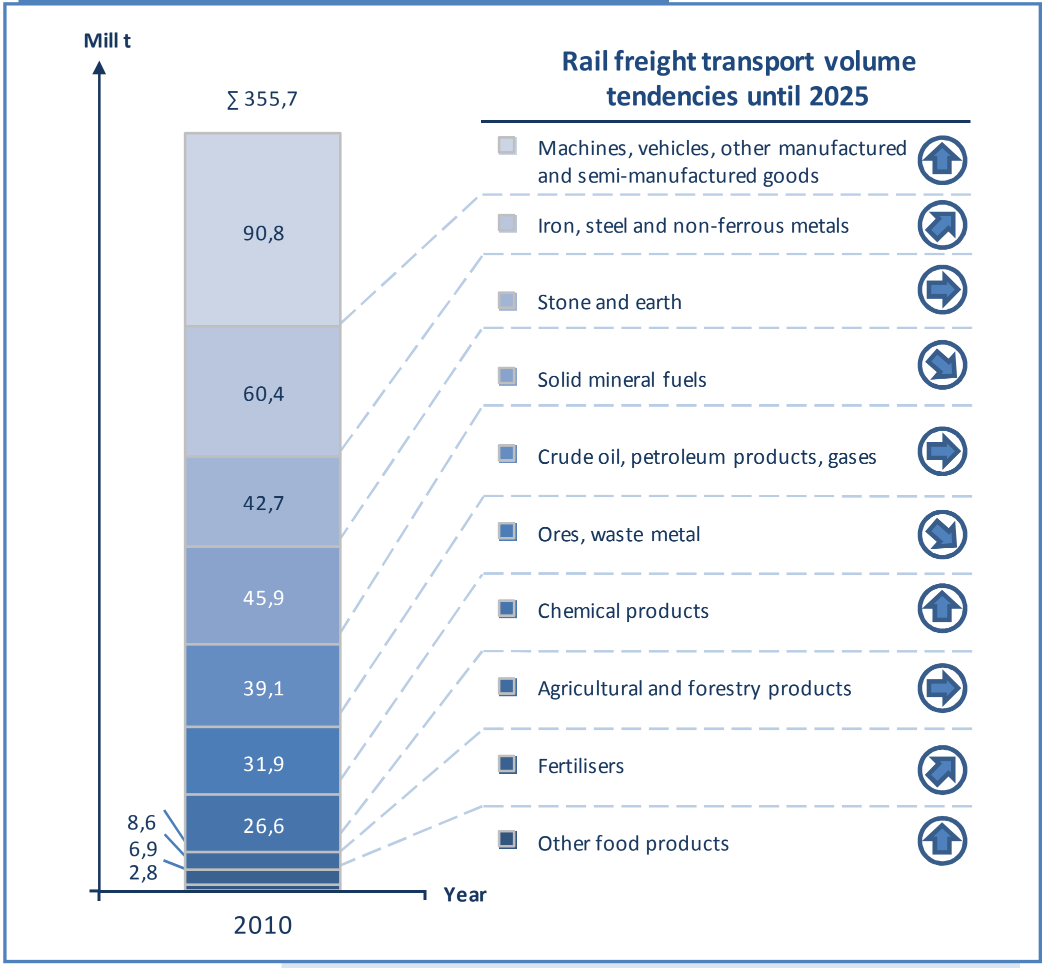



Source: Institute for Mobility Research, The Future of Mobility – Scenarios for the Year 2025, first update, 2005

[2] See: Fraunhofer IIS: Economic frame conditions of freight transportation – study for the transport mode in the framework of logistical processes in Germany (Wirtschaftliche Rahmenbedingungen des Güterverkehrs – Studie zum Vergleich der Verkehrsträger im Rahmen der Logistikprozesse in Deutschland). Study, Nuremberg, Fraunhofer IRB Verlag, 2008, p. 14

Rail as a transport mode is especially affected by this effect, due to the fact that most of its existing customers are in bulk commodity sectors. In some cases their transport volumes will even decrease over the coming years (Fig. 1-4).

Fig. 1-4: **Shares of rail freight volumes in Germany**




Source volumes: Federal Statistical Office: Traffic actual 11/2011, 2011
Source for tendencies: Intraplan Consut/BVU: Forecast of transport interaction across Germany 2025, 2007

In addition to changes in the international interlinking of company locations, globalisation and the improved scope for automation and information processing mean that new production and logistics concepts are constantly being developed – and freight and information flows are being globally optimised. This is referred to as the **logistics effect**, which is further boosted by an increase in time-critical transportation.[3]

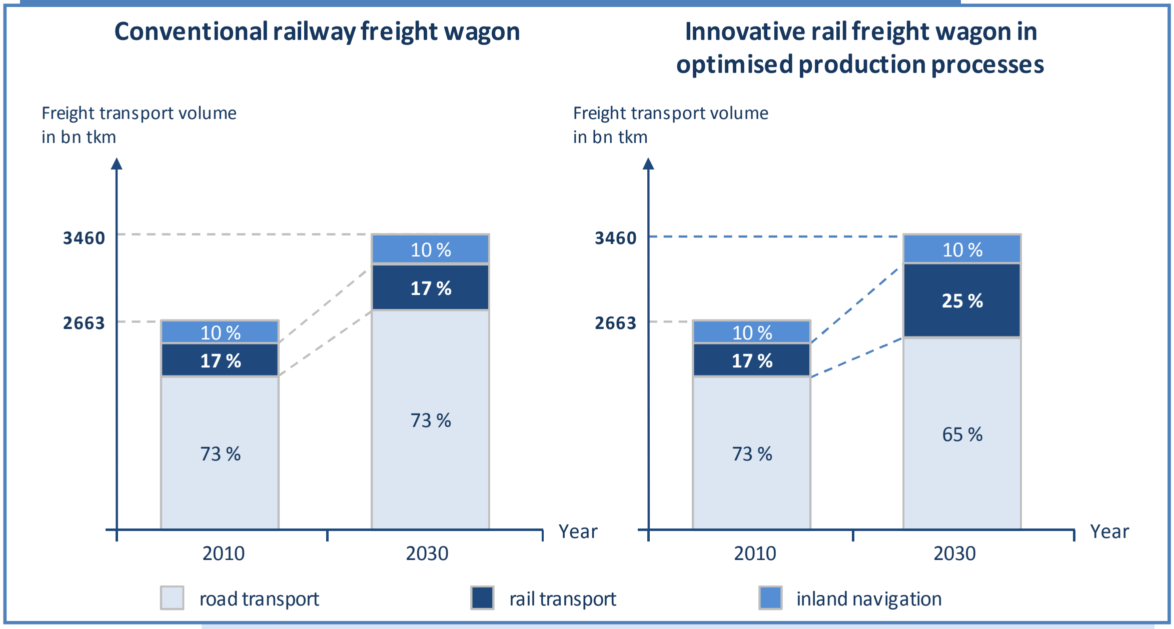
Transport modes are responding to these megatrends. At the same time they are

[3] See: Fraunhofer IIS: Economic frame conditions of freight transportation – study for the transport mode in the framework of logistical processes in Germany (Wirtschaftliche Rahmenbedingungen des Güterverkehrs – Studie zum Vergleich der Verkehrsträger im Rahmen der Logistikprozesse in Deutschland). Study, Nuremberg, Fraunhofer IRB publisher, 2008, p. 14

increasingly having to process more electronic data than in the past and adapt their information technology to customer requirements.

The aforementioned effects have an impact on distribution of transport volumes among the individual transport modes – the so-called modal split. Unless rail transportation becomes more efficient, other modes, mainly road transportation, will absorb the increased freight volumes described above at both national and international level, (see Fig. 1-5). A change in the modal split by 2030 should be achieved, among other things, by innovation in the design and use of rail freight wagons. The associated technological improvements in the European standard-gauge network will increase the attractiveness and efficiency of rail freight transportation for logistics chains.

Fig. 1-5: **Development of selected shares of modal split in EU 27 until 2030**

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|---|---|
| Source for the conventional rail freight wagon: | European Commission/DG TREN: EU energy trends to 2030 – Update 2009, 2010 (baseline scenario) |
| Source for the innovative freight wagon: | own potential estimate, TIS, 2011 |

Without a modal split shift in favour of rail, the growth in freight transportation will clash with the ambitious targets set by national and European environmental and climate protection policies. To improve the competitiveness of rail freight transportation, it is necessary

- to rapidly increase the attractiveness, economic efficiency and performance of rail freight transportation on a large scale
- to adapt to the requirements of logistics chains and
- to achieve improvements for the environment and climate and reduce harmful emissions.

If a clear target is set of increasing the modal share of rail freight transportation in EU 27 to 25% by introducing the innovative rail freight wagon, then current transport forecasts indicate that an additional 286 billion tkm would be transported by rail. Germany's share would be more than 22 billion tkm.[4] This would enable these countries to respond to expectations that they should make a substantial contribution to decoupling economic growth from $CO_2$-emissions. Furthermore, the policies pursued by the Swiss would heighten this effect, as they support measures to further increase the modal share taken by rail, especially for transalpine traffic. On the other hand, in all countries this growth can only be achieved if the economic performance of rail freight transportation is improved – which is where the innovative rail freight wagon comes in.

To achieve this, what is needed in addition to innovation and effective measures are carefully targeted supporting activities by all the players concerned and in all aspects of rail freight transportation. This applies especially to driving forward modernisation of technical components and their application. Funding must be clearly focussed on further developing the rail freight wagon to increase its efficiency and sustainability. The freight wagon is currently – and will remain in the foreseeable future – one of the most important resources for rail freight transportation

## 1.2 Contribution to a sustainable freight mobility concept

Forecast of market trends in freight transportation indicate that it is growing more and more important to base transport and logistics services on a long-term freight mobility concept, taking into account and bringing together economic, environmental and social requirements. The common transport policy defined by the EU Commission is based on Sustainable Mobility as a mission statement[5]. This approach is based above all on the idea of protecting resources in the interest of citizens, but without any major impact on their future mobility needs. With a number of remaining uncertainties, consistent implementation of the conceptual approach still depends on clarifying a large number of individual issues, on developing the necessary regulatory instruments and on a number of marginal constraints.

If all aspects of sustainability are to be integrated into an adequate freight mobility concept, then an effective contribution from rail freight transportation is of great interest. Today approximately 20% of total $CO_2$ emissions come from the transport sector – with one third of this generated by road freight transportation alone. More than 70% of total

4 See: European Commission/DG TREN: EU energy trends to 2030 – update 2009. Study, Luxembourg, Publications Office of the European Union, 2010, p. 67 & p. 87, each baseline scenario

5 See: European Commission: White Paper 2011: Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system . White Paper, Brussels, Publications Office of the European Union, 2011, p. 3

traffic depends on the availability of fossil fuels.[6] Rail freight transportation can substantially contribute to improving this situation. Decisions are already being taken today to provide traction energy on electrified lines increasingly from renewable energy sources.[7] The goal of the European Commission is to cut $CO_2$ emissions in the transport sector by 20% by 2030 (compared to 2008) and by 60% by 2050 (compared to 1990) as well as to considerable reduce energy consumption.[8] Even with further improvement of the environmental balance of road freight transportation, it is essential that rail transport should account for the lion's share of transport volume growth.

Added to these objectives and possibilities are demands – at the interface between environmental and social aspects of sustainability – for freight mobility to

- be quieter,
- be cleaner,
- require less land and
- offer better working conditions.[9]

The crucial factor for the future of rail freight transportation in Europe, including the use of freight wagons, is the noise factor, and relevant innovations will be measured by the extent to which they solve this challenge. It is also clear that freight transportation, as part of a logistics chain, serves the exchange and supply of goods to society. From a social point of view, freight transportation is therefore a crucial element in securing an adequate quality of life.

A modern fleet that improves the performance of transport and logistical chains is essential for the economic sustainability of freight mobility. The EU model gives equally high priority to the building of new vehicles as to future infrastructure building. Both elements play an important role in ensuring the attractiveness of business locations and their ability to support logistics.[10] For rail freight transportation, the freight wagon is one of the central resources with a crucial impact on economic sustainability. It is the link between rail transport and related logistics.

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[6] See: Federal Ministry of Transport, Building and Urban Development: Freight Transport and Logistics Masterplan , report, Berlin, self-publishing, 2008, p. 11

[7] See: Deutsche Bahn AG: The environmental strategy of Deutsche Bahn AG (Die Umweltstrategie der Deutschen Bahn AG). Presentation, Cottbus, self-publishing, 2009

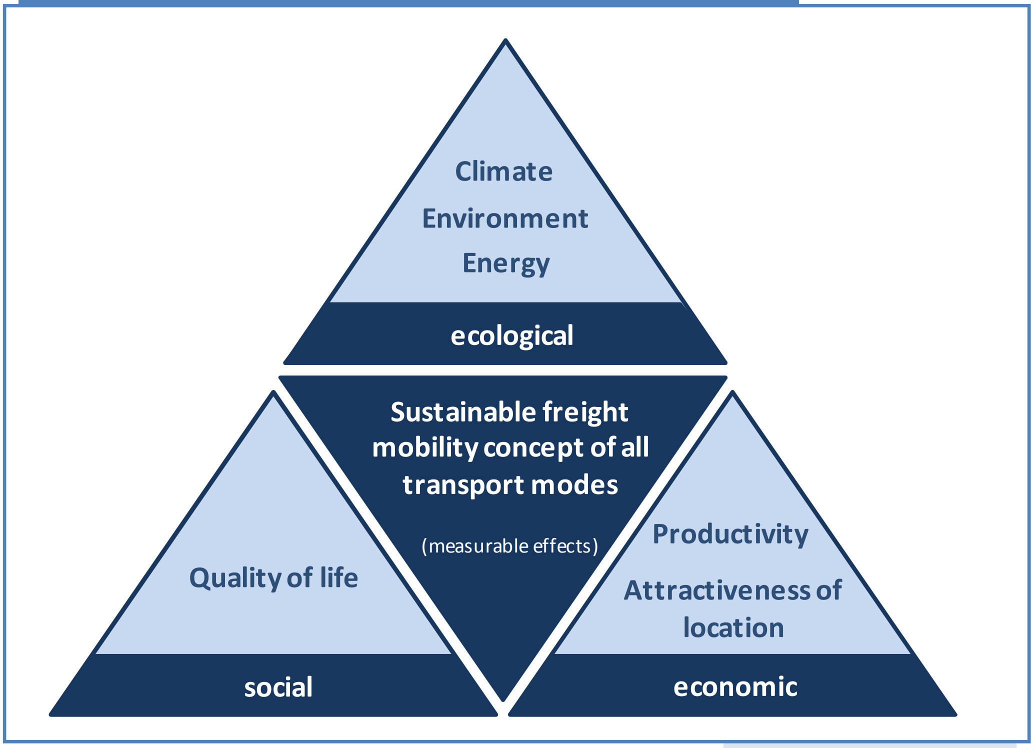
[8] See: European Commission: White Paper 2011: Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system . White Paper, Brussels, Publications Office of the European Union, 2011, p. 3

[9] See: Federal Ministry of Transport, Building and Urban Development: Freight Transport and Logistics Masterplan. Report, Berlin, self-publishing, 2008, p. 6

[10] See: European Commission: White Paper 2011: Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system . White Paper, Brussels, Publications Office of the European Union, 2011, p. 4

The demand for sustainable freight mobility in environmental, social and economic terms challenges rail freight transportation and its resources to respond with innovative concepts and solutions aimed at strengthening all aspects of sustainability (see Fig. 1-6).

Fig. 1-6: **Elements of the sustainable freight mobility concept**




Source: own graph, TIS 2011

Apart from the contributions of individual transport modes to sustainable freight mobility, measurable effects can also be achieved by interlinking them and also by integrating them into logistics chains. Lasting progress of a new order of magnitude in terms of achieving a balance between economic, environmental and social objectives can be expected if flows of goods are interlinked.[11] To have the desired effect and make full use of the potential offered by this approach it is important to interlink solutions and measures when it comes to use of resources. Intelligent resource management thus becomes a crucial factor for sustainability and competitiveness.[12]

[11] See: Delfmann, W. et al.: Key Issues paper for a basic understanding of logistics as a scientific discipline (Eckpunktpapier zum Grundverständnis der Logistik als wissenschafliche Disziplin). Contribution in: Delfmann, W., Wimmer, T. (ed.): Structural change in logistics – science and practice in dialogue (Strukturwandel in der Logistik – Wissenschaft und Praxis im Dialog). Monograph, Hamburg, Deutscher Verkehrsverlag, 2010

[12] See: König, R., Jugelt, R.: Integrating rail freight transport into value added chains. – Approach concepts for cross-company screening of potentials (Schienengüterverkehr in die Wertschöpfungsketten einbinden – Denkansätze zum unternehmensübergreifenden Potenzialscreening). Contribution (p. 14 – 18) in: Güterbahnen 04/2009. Magazine, Dusseldorf, Alba Fachverlag, 2009

## 1.3 Intelligent Resource Management

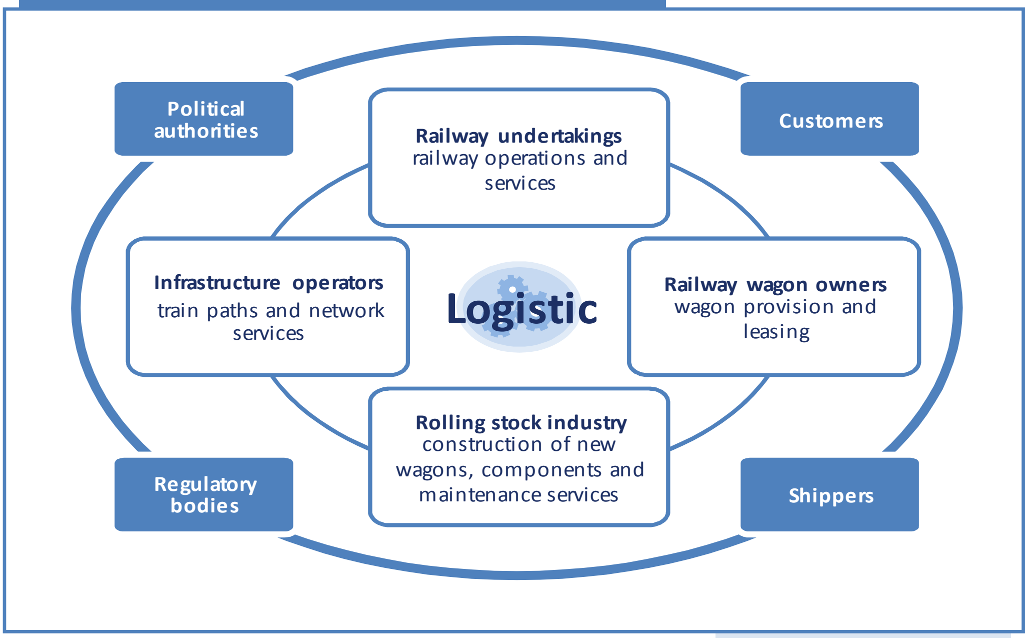
The rail freight wagon and its traction system, the available infrastructure and loading / unloading technology, the process information, production concept and staff are important resources at the interface between rail freight transportation and the customer.

The rail freight wagon as a logistics resource is directly or indirectly influenced by many different parties, who can be basically classified into six groups:

- Customers (such as rail forwarders, operators, shippers)
- Wagon owners/ECM[13] (wagon leasing companies, railways and others)
- Railway undertakings (RU)
- Infrastructure operators (IU)
- Railway industry (rolling stock manufacturers / component manufacturers / maintenance facilities)
- Policymakers and regulatory bodies

These major players have differing responsibilities and interests. They are integrated into the complex system of rail freight transportation, in which there are further participants fulfilling other roles. Their basic interaction and close relationship to logistics are shown in Fig. 1-7.

Fig. 1-7: **Major actors in rail freight transportation**




Source: own graph, TIS, 2010

[13] ECM: Entity in Charge of Maintenance, according to Directive 2008/110/EC as well as Commission Regulation (EU) No 445/2011 of the Commission

Resource management by participants is to be understood as the transformation of resources into benefits.[14] Resource management in interlinked structures is regarded as "intelligent" if knowledge and technology are used in a comprehensive and continuous way to transform resources into benefits. In interlinked structures there must be a greater focus on intelligent resource management aimed at successfully using the rail freight wagon – as an important resource for innovation in freight transportation – to the benefit of customers. It is therefore important to know the relevant interests of the parties involved and to work towards achieving common objectives.

## Duties and interests of major players

Rail freight transportation **customers** are interested in freight wagons that meet their logistics needs, are suitable for the load concerned and the loading/unloading process and offer high-quality transportation. Apart from the availability of consignment-related information, this includes safety, reliability and punctuality as well as predictability of turnaround times. Furthermore, customers have an increasing interest in volume transports and/or high loads. A more favourable environmental balance is becoming increasingly important.

**Wagon owners (keepers)**, e.g. wagon leasing companies or railways, buy rail freight wagons and lease them out or use them for own needs. As so-called "entities in charge of maintenance", it is their duty to carry out maintenance in accordance with the rules and to ensure operational safety. For this reason wagon owners are highly interested in value for money in terms of purchase costs, maintenance and the longevity of the wagons. The use of the innovative rail freight wagon only makes sense for wagon owners if an adequate economic return can be demonstrated. In practice this also involves customers accepting higher leasing costs than are currently involved for existing wagons. As far as investment decisions and willingness to innovate are concerned it is of crucial importance for the positive effects of innovative rail freight wagons to include financial advantages for wagon owners. Their positive impact can be enhanced by detailed information on the life cycle costs of the freight wagon, which is usually available to owners or operators.

**Railway undertakings** use freight wagons to perform transportation and logistics services. They are responsible for ensuring safe railway operations, and they are required to fulfil the relevant quality commitments vis à vis freight customers. Apart from low rental and operating costs, railway undertakings are interested in rail freight wagons with logistics capabilities and high load capacity. Intelligence, logistics capabilities and load capacity are particularly required to contribute to the development of new potential in railway operation

[14] See: Malik, F. Management – Essentials of the trade (Das A und O des Handwerks). Monograph, Frankfurt on the Main, Campus Verlag, 2007, p. 33

or in transport and logistics chains. Furthermore interest in rail freight wagons with low noise and greenhouse gas emissions is steadily increasing. Innovations in this field are acceptable if any increase in the cost of purchasing or leasing wagons, including their components, is compensated by direct advantages in productivity and operating costs.

**Railway infrastructure operators** manage railway infrastructures as public or private undertakings[15], with the infrastructures of the individual operators usually interlinked. This interconnected railway infrastructure is needed for production in rail freight transportation. Optimum interaction between the railway infrastructure and the related technical and operational components of the wheel/rail system is of great importance for railway operations. Infrastructure operators therefore try to achieve the highest possible capacity utilisation of the infrastructure at a defined level of quality and with minimal production, maintenance and operating costs. With a view to increasing the capacity of the railway infrastructure they support the railway undertakings in developing the potential for more efficient utilisation of individual train movements. This can be achieved amongst other things by allowing higher train loads and longer trains, but this requires a further increase of permissible axle loads from the current 22.5 tons to 25.0 tons.

The **rolling stock industry** develops and builds rail freight wagons and their components according to the requirements of wagon owners and – indirectly – their customers. The industry has recently become responsible for certification according to the current EU "Technical Specifications for Interoperability" (TSI) and national regulations. It is therefore interested in high volume production and a clear, standardised regulatory framework. To achieve sustainable innovation management, i.e. the development and marketing of innovative technologies, they need performance data related to currently operated rail freight wagons from wagon owners and railway undertakings.

Laws and regulations for rail freight transportation are issued by **political authorities** while their **regulatory bodies** establish rules aimed at ensuring safety and competition in the sector. Environmental compatibility and interlinking of different transport modes are becoming more and more important. In particular rail's positive carbon footprint means that policymakers wish to significantly and permanently increase the market share of medium and long distance rail freight transportation.

## Importance

For a well-functioning rail freight transportation system and comprehensive intelligent resource management the following requirements have to be met:

[15] General Railway Law of 27th December 1993 (BGBl. I p. 2378, 2396; 1994 I p. 2439) with the latest modification by article 2 paragraph 122 of the law of 22nd December 2011 (BGBl. I p. 3044), § 2 (1)

- Efficient innovation and knowledge management
- Close cooperation of all players despite their different interests
- Consistent focus on benefits and economic efficiency when designing and operating rail freight wagons
- Timely availability of innovative rail freight wagons
- Cross-system interlinking of resources and services

This is the only way that logistical tasks can be completed to a high standard and new market shares can be conquered. New scope for enhancing efficiency and sustainability will open up if the right framework is created to ensure that all players have an interest in optimising the resource represented by rail freight wagons.

Without tapping into known and new functional principles combined with a new understanding of how to handle rail freight wagons, intelligent resource management in rail freight transportation will remain an illusion and its effectiveness will lag behind other transport modes with respect to ever more demanding customer interfaces. A new generation of rail freight wagons and an understanding of how to organise their operational deployment are needed to achieve a stronger orientation towards benefits, comprehensive networking and better sustainability effects in rail freight traffic.

**The competitive position of rail freight transportation can be strengthened and its promising growth targets achieved if the paramount role of promoting the innovative rail freight wagon 2030 and rapidly applying it in customers' current and new logistical chains is realised.**

# 2

# The rail freight wagon as a core element of modern rail freight transportation

## 2.1 Achieving new effects and promoting growth potential

The rail freight wagon serves to bridge space and time in transport and logistical chains. In order to achieve the challenges as described in paragraph 1

- market growth and economic efficiency
- changes in goods structure
- sustainable freight mobility and
- intelligent resource management

there is a need to develop and implement viable concepts. Sustainable application of technology will become a core subject for all current and future decisions by the relevant players. [16] Often rail freight transportation customers and affected parties make demands on the service life, quality and properties of rail freight wagons and their components. Today many of these demands are not yet fulfilled. For sustainable and resource-protecting processes and offers in logistics chains it is therefore crucial to choose **the right way to create an overall technical and operational concept of the rail freight wagon 2030.**

Various activities and measures have improved competitiveness and provided a much-needed boost to efficiency and growth in rail freight since the directive liberalising the sector in 1996. The more successful rail freight transportation is in positioning itself permanently in the transport and logistics chains of its customers, the greater the contribution it can make to protecting the environment and preserving resources, as called for by politicians and the public at large. That is why the goal it has set itself for 2030 of producing an **offer that competes** with the lorry as its main competitor and also delivers an **efficient and high-value service** for its customers is more important than ever.

Rail freight transportation currently suffers from drawbacks that to varying degrees may limit or even generally threaten the attraction of what it offers to transport and logistics chains:

- conception and equipment
- non-productive downtimes (departure and destination locations as well as along the transport chain)
- in some cases high marshalling costs
- low levels of automation.

In most cases the wagons available can be identified as one of the obstacles and share some of the responsibility for the current unsatisfactory situation.

If the competitive position of rail freight transportation is to be improved and the potential

[16] See: Gregori, G.; Wimmer, Th. (ed.): Green paper of sustainable logistics (Grünbuch der nachhaltigen Logistik). Monograph, Vienna: Bundesvereinigung Logistik Austria, 2011, p. 22 f.

for future growth exploited, then existing deficits must be eliminated. On the one hand, it is possible to utilise existing but as yet unused components and modules; and on the other hand there are alternative approaches that require further research and development.

## 2.2 The rail freight wagon at the focus of innovation

An approach to improving the performance of rail freight transportation through the introduction of modern rolling stock technology and its operational impact on railways is theoretically known in Germany and Western Europe. But it is an approach that is not adopted with sufficient consistency and is frequently applied only in small steps or for the purposes of special transportation.

Previous activities have concentrated (and still do) on reducing the cost of individual elements of the system – rail infrastructure, marshalling yards, workshops, process interfaces, traction units and deployment of staff. This is also one of the reasons why current profitability and growth are inadequate. The substantial levels of growth required in the rail freight transportation sector in Germany and the EU to improve sustainability are unlikely to be achieved on the basis of existing technology.

Furthermore it has to be remembered that modern operational processes for rail freight transportation are increasingly standardised and based on industrial production methods.

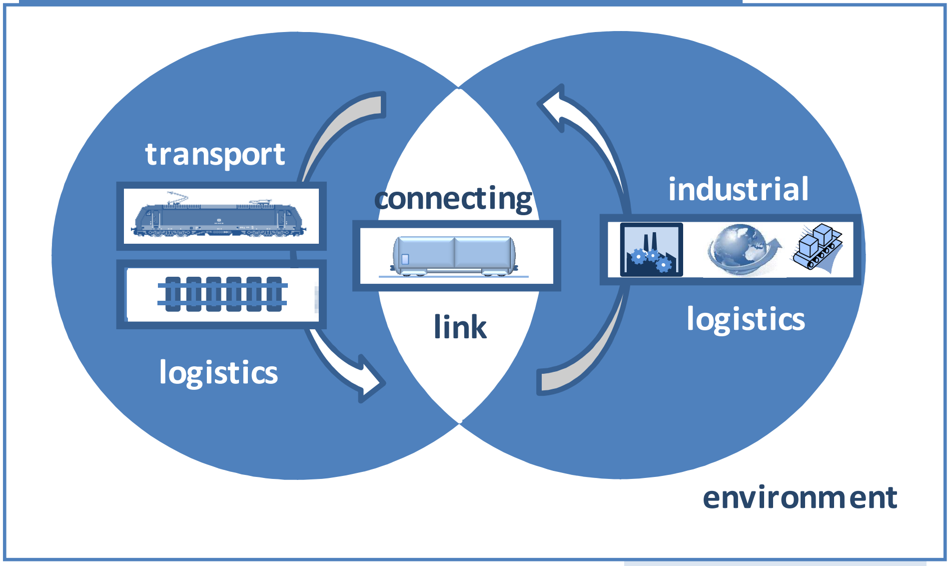
A systemic view of the use of rail freight wagons enables crucial drivers of growth and sustainability to be identified.[17] This is the intelligent connecting link between rail transport logistics and industrial logistics at the customers' sites (see Fig. 2-1). Viewed from this angle and taking into account the equal degree of focus on economic, environmental and social factors by transport logistics and industrial logistics, innovations can be introduced in the fields of

- rail freight wagons and operational processes
- rail freight wagons and logistics
- rail freight wagons and climate / noise / energy.

The innovations will be able to fully develop their impact especially if they are simultaneously introduced in a coordinated fashion and are not confined to particular companies or territories. To achieve this, new scope for action has to be created with national and international approval.

[17] See. König, R.; Jugelt, R.: New ways of integrating rail freight transport into the value-added chain of logistics (Neue Wege für die Einbindung des Schienengüterverkehrs in die Wertschöpfungsketten der Logistik). Contribution (p. 115 – 120) in: Scientific magazine of the Technical University of Dresden, vol. 58. Magazine, Dresden, self-publishing, 2009

Fig. 2-1: **The rail freight wagon as an element of logistics**




Source: own graph, TIS, 2010

The requirements of transportation and logistics as well as the function of the innovative rail freight wagon as a linking element result in both familiar and new approaches to innovation in rail freight transportation in terms of

- dimensions,
- vehicle components,
- operational and process optimisation,
- asset intelligence (sensor technology, tracking, condition monitoring) and
- environment.

To achieve competitiveness and growth for rail freight transportation, one important question is how and to what extent the scope offered by modern rolling stock technology and process optimisation can be developed and applied between now and the year 2030 to achieve

- increased efficiency
- cost reductions in the production process
- increased customer benefits

The dominant role of the rail freight wagon at the centre of the implementation of innovation and in the development of the effects and advantages of the measures is demonstrated in Fig. 2-2.

Fig. 2-2: **Major innovation potential in rail freight transport 2030**

| | Locomotive | Rail freight wagon | Infra-structure |
|---|---|---|---|
| **Dimension size** | | | * optional |
| Longer freight trains up to 1500 m | x | x | x |
| Mass increase where needed | x | x | x |
| Optimization of speed | x | x | |
| **Wagon components** | | | |
| Automatic coupler | x | x | |
| Electro-pneumatic brake | x | x | |
| Radio-based distributed traction and brake control | x | x | x |
| Innovative traction concepts | x | | |
| Innovative noise-reduction concepts | x | x | x |
| **Operational processes** | | | |
| Uniform set of maintenance rules | | x | |
| Condition-based maintenance | | x | |
| Partial automation | x | x | x * |
| **Sensor technology/Asset intelligence** | | | |
| Vehicle bus/Data line | x | x | |
| GPS/Galileo/RFID | x | x | x |
| **Dispatching control** | | | |
| Integration into logistical chains | | x | |

Source: own graph, TIS, 2011

Figures 2-1 and 2-2 and the relevant relationships lead to the conclusion that **the innovation potential of the rail freight wagon has been seriously underestimated in the past**. The resulting lack of sufficient attention to its further development must be corrected without delay and as rapidly as possible. Innovation will lead to improved efficiency and effectiveness in the use of rail freight wagons.

## 2.3 Overcoming the undesirable impact of rail traffic

The rail freight wagon is the key to substantially and measurably reducing the undesirable impact of rail traffic. It directly influences noise emissions and – depending on the numbers involved – also the need for space. Modern rail freight wagons can transport significantly greater payloads in relationship to their net mass, which makes it possible to increase the load with the same size of fleet. The specific use of lightweight design technologies facilitates innovative approaches.[18]

Rail freight transportation also offers significant advantages in terms of greenhouse gas emissions and energy consumption compared with road and air transport. Even now the use of conventional rail freight wagons consumes only about one third of the energy per tonne-km compared with a lorry.[19] Rail as a transport mode also has one further considerable advantage compared to the road in terms of the relationship between transport performance and land use. A double-track, well-aligned electrified railway line with state-of-the-art signalling offers the same transport capacity with an overall width of 12 m as a 44 m-wide motorway with four lanes in each direction. In other words, the land required for a road is almost four times that of a railway line![20]

These clear environmental advantages have to be weighed against varying challenges in terms of noise in certain locations, for which satisfactory and complete solutions have to be found more rapidly than in the past. Undesirable noise emissions from rail freight transportation are mainly radiated from the wheels, rails and sleepers.[21] Adequate noise-reduction cannot therefore just involve the vehicles alone – all three system components have to contribute. At present there is not yet any technically and commercially mature design for rail freight wagons that sufficiently reduces noise emissions.

The growing burden of freight transportation on the road infrastructure will cause more traffic congestion, with ensuing loss of time and additional exhaust gas emissions. The EU Commission, for example, forecasts a 50% increase in overload-related costs by 2050.[22] Some of these expected capacity bottlenecks can be counterbalanced by better integration with rail transport or by shifting completely to rail. But to achieve this there is a need to further increase the attractiveness of rail freight transportation both as a complement and an alternative to the lorry by integrating it into the complex logistics chains of industry and global trade. This can take place by using innovative rail freight wagons to offer advantages for customers and logistics networks. Existing and proven potential models

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18 See: König, R.; Hufenbach, W.; Adam, F.: Innovative freight wagon through lightweight construction (Innovativer Güterwagen durch Leichtbau). Presentation, Dresden, self-publishing, 2008

19 German Railway Industry Association (VDB) e.V.: Figures and Facts: Railway industry and climate protection (Zahlen und Fakten: Bahnindustrie und Klimaschutz). Presentation, Berlin, self-publishing, 2010

20 Gregori, G.; Wimmer, Th. (ed.): Green paper on sustainable logistics (Grünbuch der nachhaltigen Logistik). Monograph, Vienna: Bundesvereinigung Logistik Österreich, 2011, p. 82

21 See: Hecht, M.; Lang, H.-P. et al: Acoustics – airborne noise and vibrations from rail traffic (Luftschall und Erschütterungen aus dem Schienenverkehr). Contribution (p. 229 – 242) in: Lübke, D. et al: Handbook "The railway system" (Handbuch: „Das System Bahn"). Monograph, Hamburg, DVV Rail Media, 2008

22 See: European Commission: White Paper 2011: Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system. White Paper, Brussels, Publications Office of the European Union, 2011, p. 5

will also help create synergy effects and shift more freight to rail (e.g. products from the automotive, chemical and steel industries, semi-finished and finished products). [23] This will increase rail's modal split share of freight transportation and enhance the sustainability of transport and logistics.

[23] See: König, R., Jugelt, R.: Integrating rail freight transport into value added chains. – Approach concepts for cross-company screening of potentials (Schienengüterverkehr in die Wertschöpfungsketten einbinden – Denkansätze zum unternehmensübergreifenden Potenzialscreening). Contribution (p. 14 – 18) in: Güterbahnen 04/2009. Magazine, Dusseldorf, Alba Fachverlag, 2009

3

# The “5 L” future initiative as a basis for new growth in rail freight transportation

## 3.1 Purpose and goal of the "5 L" future initiative

The high growth requirements of rail freight transportation call for immediate answers that can be rapidly implemented. In the interests of enhancing the competitiveness of rail freight transportation, the further development of the rail freight wagon needs to be pursued with thoroughness and determination.

**A well-founded and comprehensive concept for a sustainable technology campaign "Innovative rail freight wagon 2030" has to be implemented.**

The costs and risks of such a technology campaign are, however, huge and constitute a major challenge. No single player in the rail freight transportation sector can successfully promote and implement it alone. The innovation process has to be newly set up within the European railway sector – both horizontally and vertically – and must be pursued with determination. The investments and innovations required must result in evident benefits for all participants. For this purpose, the Technical Innovation Circle Rail Freight Transportation has drawn up the

**"5 L" future initiative**

vertically across the sector and brought it to maturity. It serves as a basis for increasing the competitiveness of rail freight transportation and for using the innovative rail freight wagon 2030 to expand the sector according to the principles of sustainability. At the same time it opens up the required scope for combining all the necessary activities and measures and paving the way for the innovative rail freight wagon.

The "5 L" future initiative provides the framework for the **five growth factors** that have been identified as essential for successful implementation of the innovative rail freight wagon:

**low noise – lightweight – long-running – logistics-capable – LCC-oriented.**

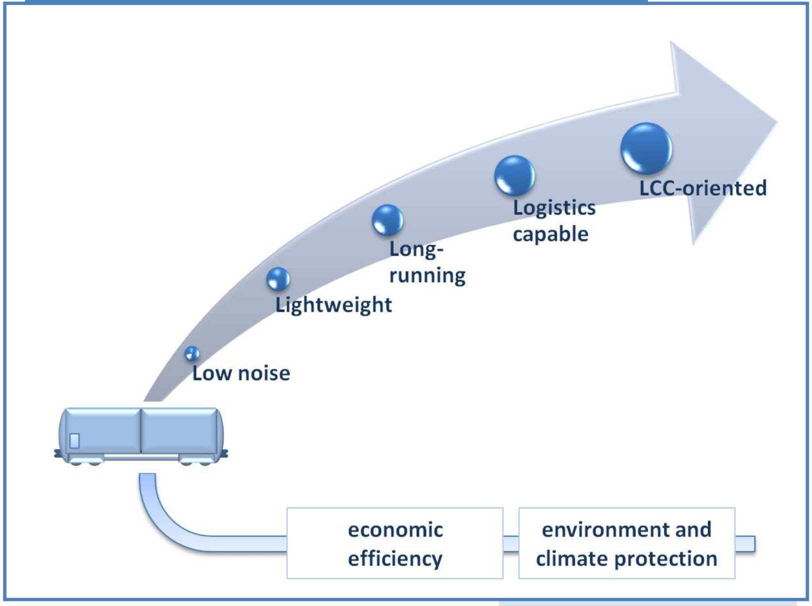
These growth factors, which are critical for success, include the following essential properties:

- Low noise: significant reduction of noise emissions towards the current levels of rail passenger vehicles
- Lightweight: higher payload, less net mass
- Long-running: reduction of downtimes and unproductive times, increased average annual mileages, very high / higher reliability
- Logistics-capable: possibility of integration into supply chains, service quality better than/equal to road and air transport
- LCC-oriented: integration of LCC-oriented components, with procurement costs rapidly amortised over product lifetime and more than compensated for by cost

reductions in operation and maintenance – with the effect of reducing overall cost over lifetime

The approach that has been developed combines a quantum increase in efficiency and effectiveness with a rapid and significant reduction in the undesirable consequences of transportation. The innovative rail freight wagon will constitute an alternative to the lorry and at the same time will be positioned as a future-ready partner for integrated transport and logistics concepts. This fits exactly with objectives regarding sustainable mobility and competitiveness. All in all, the degree of economic and environmental orientation of rail operations, the impact on rail freight transportation growth and the implications for the environment and climate protection will prove a yardstick for the effectiveness of the innovations represented by the rail freight wagon 2030 (see Fig. 3-1).

Fig. 3-1: **Growth factors for rail freight transport**




Source: own graph, TIS, 2011

It will be of great advantage for the practical and future-oriented implementation of the growth factors if

- concrete objectives for action to achieve the potential offered by the innovative rail freight wagon have been defined and
- a staged programme of implementation is drawn up by 2030.

The "5 L" future initiative combines and focuses the development and implementation activities needed to make the innovative rail freight wagon a reality by 2030. It is an expression of the determination of all the participants and supporters to fundamentally improve the rail freight wagon and develop a **new order of magnitude for its core properties** which in the past were either missing or merely embryonic, thus making the benefits accessible for the various players involved.

**Thanks to its new properties in logistics chains, the innovative rail freight wagon will be a driver of growth in the rail freight transportation sector.**

The aim is to propose and prepare appropriate policy measures while the technology for the innovative rail freight wagon 2030 is being developed and its sustainable application is being prepared. The “5 L” future initiative, with the five growth factors it has identified, offers an appropriate framework and concentrates the implementation phases of the various individual measures.

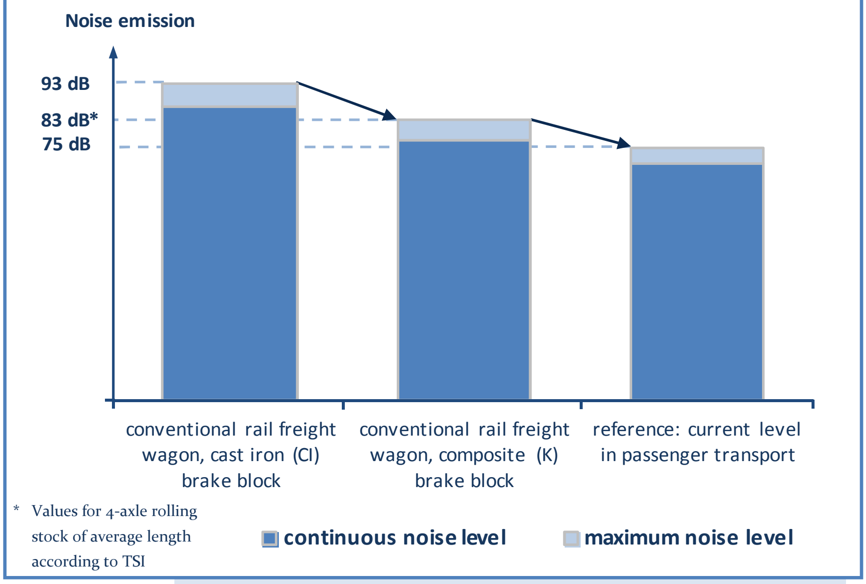
## 3.2 The growth factor “*low noise*”

One crucial prerequisite for acceptance of this projected growth in rail freight transportation – as demanded for environmental and transport policy reasons – is that undesirable noise emissions should be reduced. This is particularly important because rail freight transportation often takes place at night, i.e. at particularly noise-sensitive times of the day. [24|25] The required modifications of rail freight wagons are what the growth-factor *“Low noise”* largely refers to the wheelsets, brakes and running gear. The innovative rail freight wagon must be designed in such a way that its overall noise emissions are no greater than those of passenger rail transport (see Fig. 3-2).

[24] See: European Parliament and Council: Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise, Brussels, Publications Office of the European Union, 2002

[25] See also Grotrian, J.: Transport in Switzerland (Verkehr in der Schweiz). Monograph, Zurich/Chur, Rüegger Verlag, 2007

Fig. 3-2: **Reduction of continuous and maximum noise levels**




Source: Schulz, E. (ed.): Railway rolling stock and railway acoustics, 2011

Over and above the current use of rail freight wagons with K-brake blocks that comply with the TSI NOISE[26], there is further scope for noise reduction through measures to avoid wheel flats, increase sound absorption in the running gear, optimize vibration modes and reduce the degree of sound radiation. All these measures are interrelated – not only in terms of the freight wagon itself but also in relation to the particular track that is used. In a global context, noise reduction measures therefore also have to include the rail infrastructure if the undesirable effects of traffic are to be avoided (see also Chapter 2.3). It should be remembered that in the case of rail freight wagons with K brake blocks, two thirds of the noise is radiated from the rails and sleepers.[27] For this reason both the rail freight wagon and the permanent way must contribute to noise reduction.

## 3.3 The growth factor "*lightweight*"

By taking into account the growth factor "Lightweight" a substantial contribution can be made towards achieving general environmental targets regarding conservation of resources and reduction of $CO_2$ emissions in rail freight transportation. This will strengthen the environmental advantages of rail as a transport mode. The conventional rail freight wagons currently in use already consume only a third of the energy of

[26] See: European Commission: TSI NOISE – Commission Decision concerning the technical specifications of interoperability relating to the subsystem "rolling stock – noise" of the trans-European conventional rail system. Decision, Brussels, Publications Office of the European Union, 2011

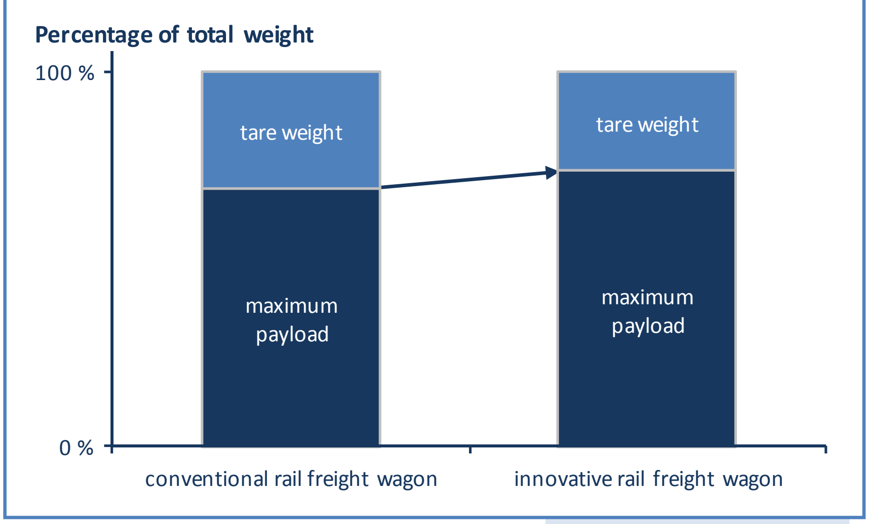
[27] See: Thompson, D.: Railway Noise and Vibration. Monograph, Oxford, Elsevier, 2009, p. 23

conventional lorries per ton-km.[28] A further improved relation between payload and net mass offers two basic possibilities:

- With the same load, the innovative rail freight wagon has a lower total weight than a conventional rail freight wagon
- By taking advantage of the admissible total weight, the innovative rail freight wagon can carry a higher load (see Fig. 3-3)

In addition to contributing to ambitious climate protection targets by reducing specific energy consumption, both options increase the attractiveness of rail freight transportation for customers and wagon owners. Whether it is a case of lighter trains with the maximum permitted length or trains with a bigger payload – in both cases higher productivity can be achieved at comparably low additional cost. Furthermore, the only technical changes concern the freight wagon itself, without any interference in other components of the system.

Fig. 3-3: **Increase in payload share**

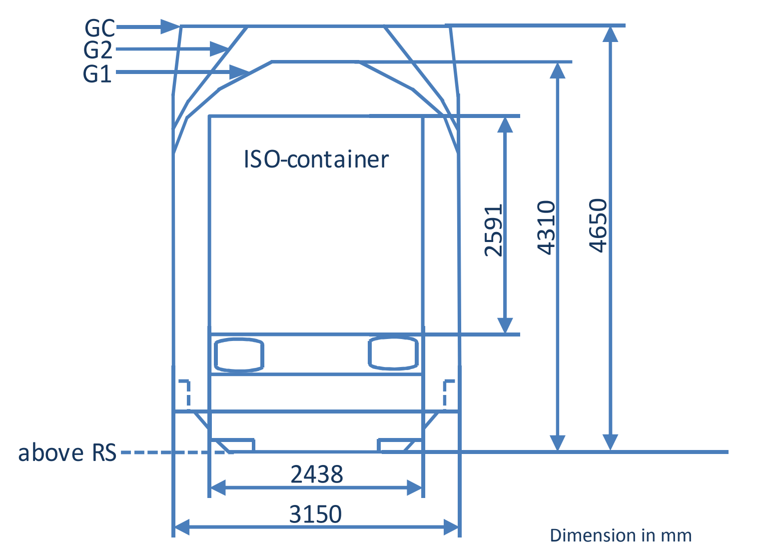



Source: own graph, TIS, 2010

As Figs. 1-3 and 1-4 on trends in freight transportation show, the density of transported goods is set to further decrease in future. Hence the crucial importance of the available freight volume in rail freight wagons for ensuring competitiveness. For this reason it is essential to go beyond the issue of load and also look at limits of the dimensions of rail freight wagons and their external shape. Better use must be made of the loading gauge than at present. Fig. 3-4 shows the external dimensions of a standard ISO-container, the current static G1-loading gauge for rail freight wagons and the GC-loading gauge that is increasingly available on many lines in Europe.

[28] See: German Railway Industry Association (VDB) e.V.: Figures and Facts: Railway industry and climate protection (Zahlen und Fakten: Bahnindustrie und Klimaschutz). Presentation, Berlin, self-publishing, 2010

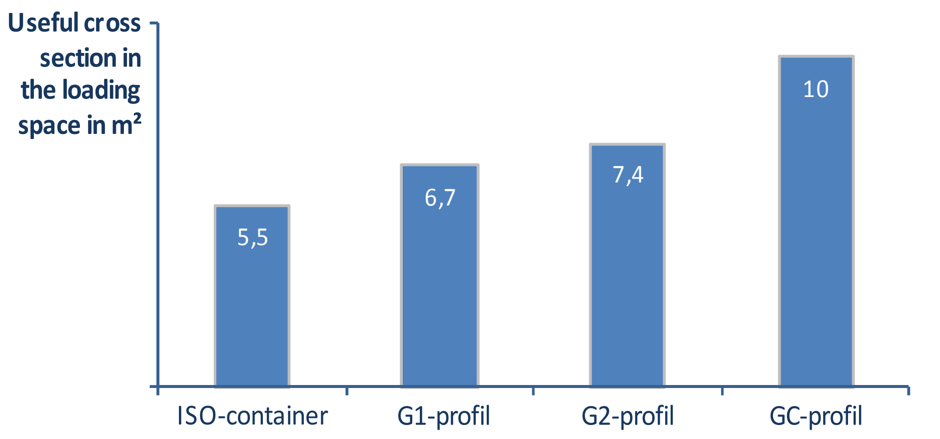
Fig. 3-4: **Clearance gauge comparison (static loading gauge)**




Source static loading gauge: European Commission: TSI WAG, 2007
Graphics: Department Rail Vehicles, TU Berlin, 2011

Fig. 3-5 shows the interior loading cross sections of rail freight rolling stock. It shows that widening from G1 gauge to G2 only increases it by 11%, whereas widening from G1 to GC raises this to 50%. Compared to the ISO-container, the usable cross-section of the cargo space as well as its ability to carry volumes is almost doubled for the GC gauge.

Fig. 3-5: **Usable cross-section of the cargo space for different loading gauges**




Source: Department Rail Vehicles, TU Berlin, 2011

In recent years many lines in Northern Europe and in the northern part of Switzerland have been widened to the GC gauge in order to allow for double-decker passenger traffic. Up till now rail freight transportation has only sporadically benefited from this effect, chiefly in the automotive supply and inter-plant transportation segments. By widening the cross-sections of rail freight wagons, the number of wagons needed on these lines can be reduced by 30%, significantly increasing the attractiveness of rail freight transportation.

The precondition for the network-wide use of this innovation in the EU including Switzerland is – where appropriate – continued modification to the GC gauge of facilities and lines that are exclusively used for rail freight transportation. In most cases this can be achieved with little effort.[29] Significant benefits would ensue in particular for the important international rail freight transportation segment, as in many areas only the G2 gauge – or an even smaller one – is currently available. Apart from these measures it is also important to collect information on existing loading gauges from all railway operators.

## Technical components – lightweight construction

When it comes to lightweight construction is essential to use the right material in the right quantity at the right price and in the right place. The use of new, lighter composite materials with improved properties is supported by the use of static optimisation and new design principles. This makes it possible in some cases to achieve significant weight savings while maintaining at least the same product properties.

For rail freight wagons it is possible to apply lightweight construction principles at the product conception stage when the profile is being defined. This allows for increased useful cross-sections and weight-saving shapes. New composite materials, aluminium and high-tensile steel are increasingly used in manufacturing, with modern welding and joining technologies. Running gear dimensioned for the real maximum tare weight and payload also help reduce the wagon's net mass.

The energy efficiency of the innovative rail freight wagon can be further increased by

- improved aerodynamics,
- an optimised tare weight to payload ratio
- radially steering running gears with significantly reduced curve resistance.

In specific cases measures to improve energy efficiency can result in energy savings of up to 25%.[30|31]

[29] See: Voges, W.; Sachse, M.: New dimensions for freight transport (Neue Dimensionen für den Güterverkehr). Contribution (p. 606 – 610) in Eisenbahntechnische Rundschau 10/1998. Magazine, Darmstadt, Hestra-Verlag, 1998

[30] See: Shoeib, R.: Experimental investigation on the reduction of the aerodynamic resistance of hopper wagons through covers (Experimentelle Untersuchung zur Reduzierung des aerodynamischen Widerstandes von Schüttgutwaggons durch Abdeckungen). Thesis, Berlin, Technical University Berlin, 2011

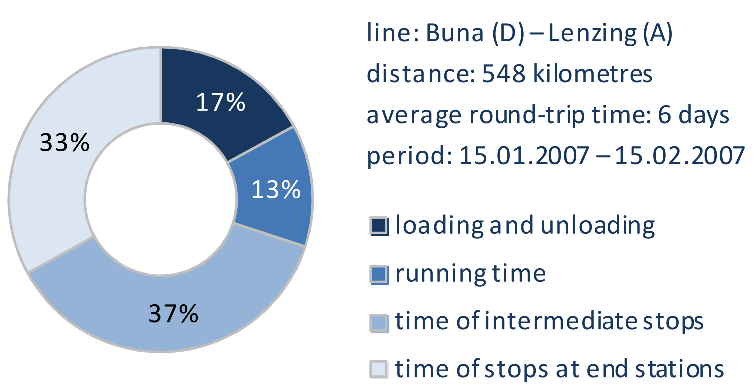
[31] See: Hecht, M.; Keudel, J.: Improved energy efficiency through radially steering running gears (Verbesserte Energieeffizienz durch radialeinstellendes Fahrwerk). Contribution (p. 42 – 47) in: Der Eisenbahningenieur 05/2006. Magazine, Hamburg, Tetzlaff Verlag, 2006

## 3.4 The growth factor "*long-running*"

The annual mileages of rail freight wagons are spread across a very wide range and vary between 10,000 and 150,000 km/year. This has nothing to do with the maximum speed of freight transportation but rather is the result of frequent and long unproductive times (see Fig. 3-6). There is therefore a need to increase freight wagon mileages and improve their operational productivity.

Fig. 3-6: **Example of round-trip time in wagon load traffic**

**Shuttle traffic chemical tank wagon – components of round-trip time**




Source: Measurement by Rail Vehicles Department, TU Berlin, 2007

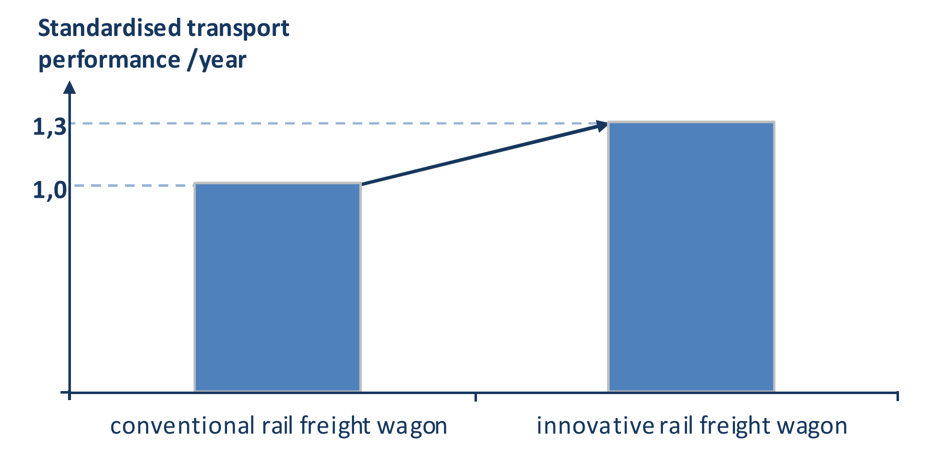
In recent decades loading and unloading operations have been successfully speeded up. But there is also a need to speed up the process of putting together a train following shunting operations. In this area, wagon inspection and brake testing have to be reduced in terms of time and cost, as has happened in the passenger rail segment.

Although malfunctions of individual rail freight wagons are relatively rare, their impact on the entire train is very significant. The locomotive and the other rail freight wagons cannot continue when a malfunction of a single wagon occurs. Thus it is important to work towards a further reduction in unscheduled downtimes and repair times.

Outside Europe, train condition monitoring portals are used with great success for gathering data on the state of the vehicles. Data is captured by independent private firms and then sold to the wagon owners. It has to be clarified whether these systems are more efficient than on-board condition monitoring systems where the data remains directly in the hands of the owner.

The growth factor "long-running" will also improve the punctuality of rail freight transportation, which is at present unsatisfactory in some cases. This would then fulfil a basic condition for the next element: "logistics-capable".

Fig. 3-7: Speeding up **processes – increasing transport performance**



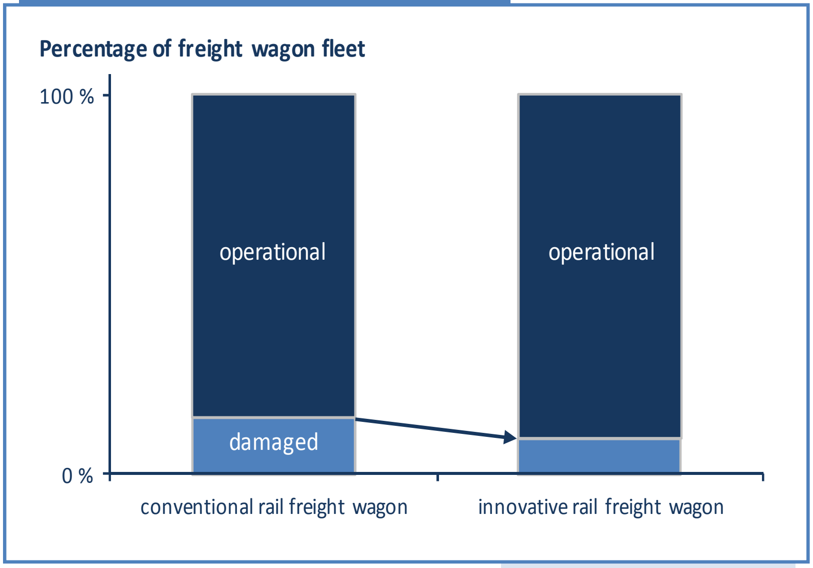

Source: own graph, TIS, 2010

Realisation of the growth factor "long-running" serves the purpose of further enhancing transportation performance in tkm/year as shown in the example in Fig. 3-7. It can be achieved by improving coordination of loading and unloading, integrating the rail freight wagon into the customer's superordinate logistics control and improving technical reliability.

## Technical components – increasing the availability and automation of the coupling technology

Passenger traffic and locomotives have significantly increased their productivity in recent years through the use of sensor technology. Examples are the single-person brake test from the driver's cab and the direct link to data from condition sensors for programming parallel maintenance procedures with the aim of minimising downtimes and improving reliability. It should be possible to reduce by one third the current capacity buffers caused by damaged wagons even in the case of reliable transport processes (see Fig. 3-8).

Fig. 3-8: **Increase in planning security**




Source: own graph, TIS, 2010

Attempts to introduce diagnostic systems into rail freight transportation have so far been unsuccessful. Nevertheless in recent years, process and IT interfaces between providers of maintenance services to freight wagon owners and railway undertakings have been extensively modernised and delivery management to workshops has been optimised. Sensor technology can now provide input for existing databases, thus further improving the available data. But the issue of the electric power supply on wagons is still not satisfactorily resolved. The conditions for more intelligence that the EU Commission has stipulated as an objective for the transport system of the future are only embryonic in the case of the rail freight wagon. [32]

Low investment costs for rail freight wagons and fixed installations, a high level of system reliability and ease of operation are crucial factors. The one-to-one wagon numbering system and the GCU database[33] for the whole of Europe offer a good basis for further development.

The same goes for the connections between rail freight wagons – the coupling technology. Faster, safer and more ergonomic procedures are possible with automatic coupling systems. These systems must also be compatible with the old screw couplings. Examples in Finland and Turkey demonstrate how even permanent operation with mixed systems can be successfully realised.

[32] See: European Commission: White Paper 2011: Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system. White Paper, Brussels, Publications Office of the European Union, 2011, p. 10 ff.

[33] GCU: General Contract for Use of Wagons – multilateral contract between various actors of the sector specifying the mutual rights and obligations of players in the use of rail freight wagons

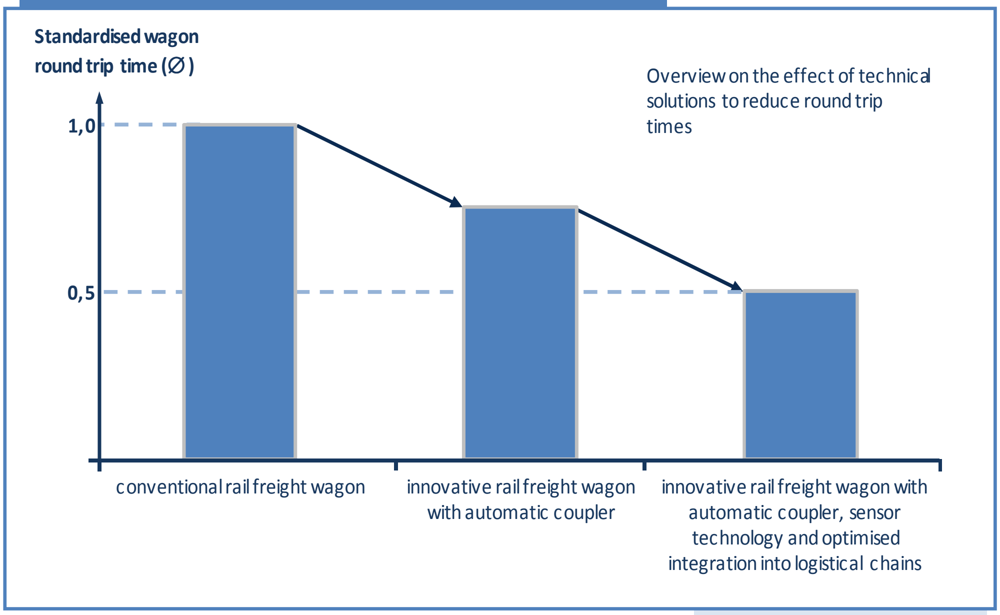
However, this considerably reduces the benefits, and for this reason mixed operation should be limited to as short as possible a transitional period (max. 8 years).

**Automatic couplers** serve above all to considerably simplify operations in marshalling yards. They help speed up certain processes by combining rail freight wagons into new train compositions for example during distribution after shunting or humping. This makes it possible to overcome the dangerous and physically exhausting process of manual coupling that is still needed with screw couplers –a considerable advantage considering demographic change and the increased average age of railway employees; and it is in line with the improvement in working conditions in the transport sector called for in the EU Commission's White Paper. In the USA, a desire to improve working conditions for shunting personnel was the main reason for the statutory introduction of the automatic central coupler in 1893 (Safety Appliance Act), which was completed in 1900.

A further advantage of the automatic coupler – as in the USA and the countries of the former Soviet Union – is the fact that higher tractive forces can be transmitted than with the conventional screw coupler – one of the factors that would allow for longer trains, provided infrastructure and technical conditions permit. These allow for traction and above all train path allocation cost savings. The potential of existing railway lines can be better used by operating longer trains.

A fully equipped rail freight wagon fleet would also make it possible to transmit electrical energy and exchange data via the automatic coupler.

Fig. 3-9: **Reduction of average round trip duration**




Source: own graph, TIS, 2010

With the technical changes described above, the innovative rail freight wagon will contribute to increased efficiency and higher customer orientation across the entire transport chain (see Fig. 3-9) and new operational concepts will become possible.

### Reliability

The commercial availability of rail freight wagons must be increased. The technology used in locomotives has proved that greater complexity and reliability are no longer incompatible, thanks to diagnostics and IT-based maintenance systems. This finding has triggered extensive new procurement and a far-reaching process of modernization of main line locomotive fleets in the last decade. But this technology still has to be adapted to rail freight wagons. Unscheduled maintenance work, whether in workshops or by mobile teams, needs to be drastically reduced.

## 3.5 The growth factor "*logistics-capable*"

Major requirements for increasing the attractiveness and competitiveness of rail freight wagons are

- their ability to be integrated into customers' logistics chains
- the application of sustainable technological concepts, among others for "green logistics".[34]

In this respect the growth factor "logistics-capable" is set to become increasingly important. This is also suggested by the goods structure effect and goods volume effect mentioned in Section 1, as well as by the growing need for sustainable logistical services that conserve resources.

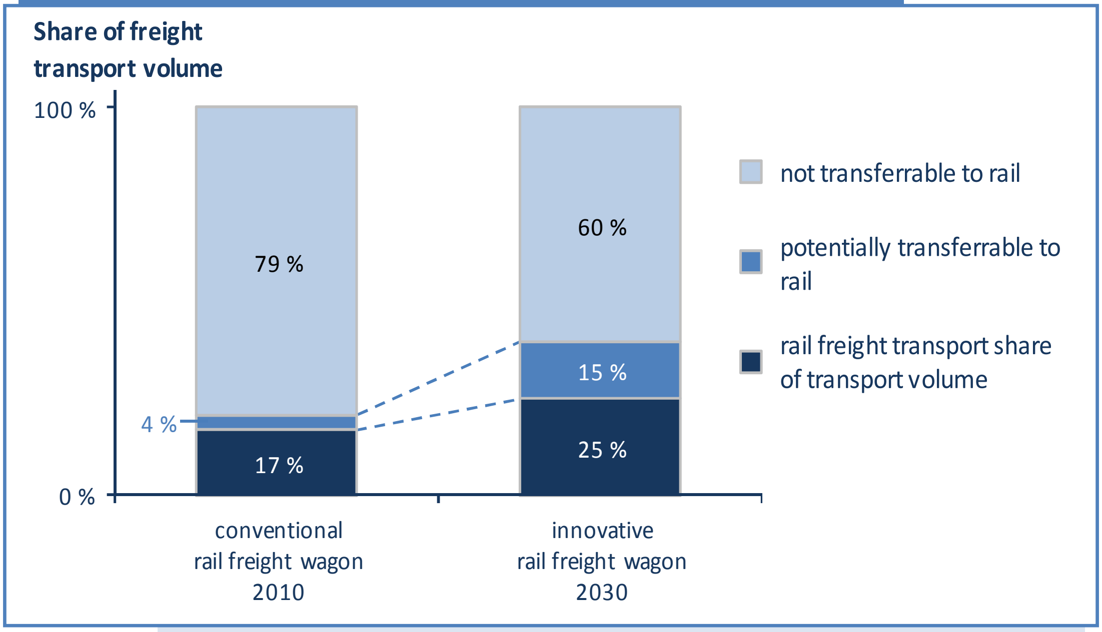
Existing supply chain processes have in many cases reached their limits of optimisation. The main potential for improvement can be found in increased interlinking of service providers, processes and resources. This includes among other things new approaches to bundling of wagon groups and individual wagons through new networking strategies in procurement and distribution, rapid grouping and delivery of partial and complete loads, transfer of international transport from road to rail, and the development of new production technologies in rail freight transportation.

A particularly strong stimulus to increase the attractiveness of rail transportation can be expected from a new way of thinking about the combination of existing and innovative products in both intra- and intermodal transportation. In this context customers are particularly interested in logistics-oriented approaches through so-called co-modality of combined offers of road and rail. The strength of rail as an environmentally friendly transport mode will be increased even more by combining the rail freight wagon with

[34] See: Gregori, G.; Wimmer, Th. (ed.): Green paper on sustainable logistics (Grünbuch der nachhaltigen Logistik). Monograph, Vienna: Bundesvereinigung Logistik Österreich, 2011, p. 20 f.

hybrid or electric road vehicles.[35] Furthermore the innovative rail freight wagon 2030 will offer higher availability and make possible a higher quality and efficiency of transport and logistical services. The position of rail freight transportation as an environmentally appropriate solution for modern transport logistics will further improve between now and 2030 and it can therefore be assumed that there will be even more scope for freight to be transferred to rail as a result (see Fig. 3-10).

Fig. 3-10: **Opening up of new market potential (example of Germany)**




Source for conventional rail freight wagon:

- Transport volume rail freight transport — Federal Office of Statistics: Traffic actual 11/2011, 2011
- Transfer potentials — TransCare AG: Influence of truck toll on the modal split in freight transport, 2006

Source for the innovative rail freight wagon 2030:

- Volume & Transfer potentials — own estimate of potential, TIS, 2011

As described in paragraphs 1.1 to 1.3, growth-orientation, sustainability and intelligent resource management call for interlinking of rail freight transportation with other transport modes and their offers in logistical chains. This potential will be fully achieved if the rail freight wagon is positioned and permanently integrated into the network levels

- supply chain,
- interfaces across transport modes,
- customers' loading facilities
- accompanying process control.

This means more information about the rail freight wagon and its load (among other things by targeted use of sensors) as well as greater transparency along the transport chain. This allows for better integration of rail freight transportation into intermodal

[35] See: Obrenovic, M.: The intelligent rail freight wagon (Der intelligente Güterwagen). Contribution (p. 15) in: Railways 04/2011. Magazine, Mainz: DB Schenker Rail GmbH Mainz, 2011

planning and management systems. Appropriate design measures and marginal conditions will create new offers to increase the useable interior loading gauges, to speed up loading and unloading processes and, if necessary, to load through the bulkhead.

In a world of logistics in which globalisation and sustainability are becoming increasingly important, entire industrial sites and factories depend on well-functioning transport logistics. In Europe and beyond, the above-mentioned interlinking and logistical tasks are therefore a strategically important factor for business success. The rail freight wagon consequently only has a chance if it meets logistics-related requirements:

- Access to or strategic compatibility with networks and processes
- Technological adjustment (properties, material, size)
- Information networking
- Support for automation of associated processes.

In each of these requirements it is understood that the rail freight wagon has to deliver a substantial and new contribution towards reducing energy and resource consumption (improved performance and consumption parameters, reduction of emission values). If it meets these expectations, the innovative rail freight wagon 2030 will occupy a new system-building position in the alternative supply chain as well as achieving society's climate and environmental goals.

## Process-oriented technical innovations – meeting logistical requirements and sustainability expectations

Here the rail freight wagon has a key role to play. It forms the interface between the rail freight transportation system and customers' production systems (connecting link between transport and industrial logistics, see Fig. 2-1). This also partly applies to transport chains in which rail freight transportation would be the right choice for an optimised material flow, but no rail infrastructure may exist at loading and unloading sites. Under these conditions, appropriate solutions for a co-modality of road and rail have to be strengthened in order to achieve economically viable transport solutions.

The installation of Rail Ports[36], or, in more general terms, intermodal platforms can serve as an example. These allow access to the rail freight network for shippers and recipients without their own private siding. The rail freight wagon 2030 supports the interlinking approach that this involves:

- Volume capability (storage space in the wagon that is adapted or adaptable to the size of receptacles and goods to be transported, as well as up to 3.00 m high openings for loading)

[36] Registered trademark of Deutsche Bahn AG

- Fast – where possible automatic – door opening technology (without additional staff, capable of functioning in all seasons)
- Loading and unloading without hindrance, with the possibility for docking to automatic loading and unloading systems (entire wagon length, in future possible bulkhead opening)
- Competitive layout of the loading space based on the goods structure effect
- Grouping and train uncoupling without need for staff and time for coupling process (benefiting from the automatic coupler, see Paragraph 3.4).

Beyond these elements, further innovative approaches to process improvement on the so-called "last mile" are proposed. Such approaches have been scientifically studied or are already being piloted.[37] All are aimed at strengthening the rail freight wagon and its ability to meet the needs of logistics service providers.

## 3.6 The growth factor "*LCC-oriented*"

Though new ideas for design and operation of the innovative rail freight wagon are being developed, it will still remain a product with a relative long lifetime. Against this background and apart from its suitability for high-quality transport services in modern logistics, the economic performance of the innovative rail freight wagon must above all be ensured throughout its whole life-cycle. The costs arising during the separate phases of its life also have to be considered in relation to the benefits, its profitability and revenues as well as to the issue of sustainability. A fundamental distinction between procurement and subsequent costs has to be made (the latter are mainly operating and maintenance costs and end-of-life costs). Purchasing decisions are currently still primarily based on procurement costs, as there is full transparency for these costs at the time of making the decision, whereas the subsequent costs of freight operation in relation to the wagon are still difficult to measure and predict. Furthermore they often vary considerably. In this respect there is an urgent need for well-founded calculations of the total life-cycle costs. Procurement processes can then rely on a basis that takes into account the entire life-cycle of the rail freight wagon.

[37] See: Enning, M.; Dickenbrok, B. et al: FlexCargoRail definition phase. Report, Berlin, self-publishing, 2009

### Technical component – decision-making based on life-cycle costs

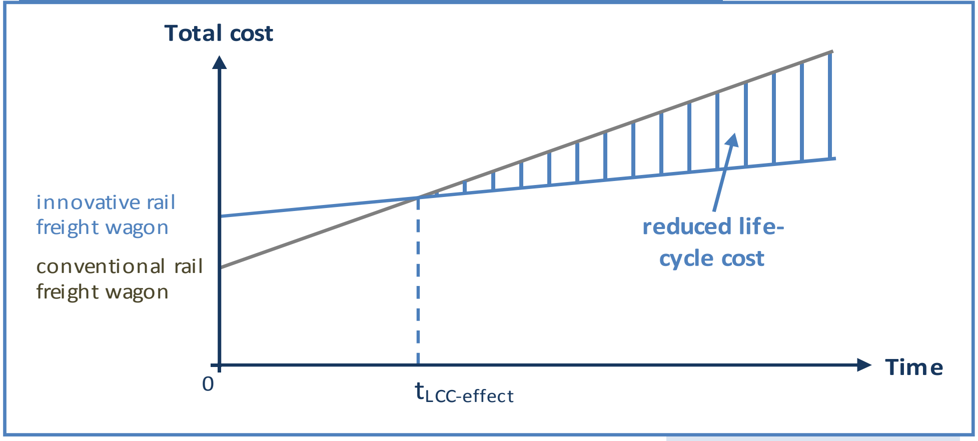
The growth factor "LCC-oriented"" relates to calculating total costs and ensuring that they are as low as possible both at the procurement stage and during the rest of the life-cycle. This across-the-board approach allows for a new way of thinking and acting when selecting components for the innovative rail freight wagon. It may therefore make economic sense to apply changes at the design stage and accept slightly higher initial costs if these can be compensated by subsequent potential benefits and lower costs. A consistent consideration of this trade-off between initial and subsequent costs makes it possible to ultimately reduce the total costs over the life cycle as well as improve the wagon's technical and operational properties.

LCC-orientation requires a transparent information basis that is verified by powerful and route-oriented cost models. Building on this, target-oriented technical, operational and maintenance strategies can be developed and coordinated. This requires the availability of information on cause-and-effect chains and points in time for cost and benefit factors. It is crucial for the different players involved to cooperate across companies to determine these. [38] At the same time the growth factor "LCC-oriented" tries to improve interdisciplinary cooperation between organisations in order to achieve comprehensive and effective solutions in a new sphere of partnership and with the support of scientific institutions.

Lasting cost reductions for operation and maintenance will be achieved through integration of this growth factor into the development of the innovative rail freight wagon. At the same time adaptation to modern logistics requirements will steadily improve, thanks to an understanding of the central life-cycle cause-and-effect chains. This will make an important contribution towards shortening payback times and return of capital employed (ROCE) for the innovative rail freight wagon (see Fig. 3-11).

[38] See Schmidt, M.: Completion of the methodical basis and tools for a life-cycle oriented use of resources for connecting railway lines (Vervollständigung methodischer Grundlagen und Werkzeuge für eine Lebenszykluskosten-orientierte Ressourcennutzung bei Anschlussbahnen). Thesis, Dresden, Technical University Dresden, 2011

Fig. 3-11: **Objective function of reduced life-cycle costs**




Source: own graph, TIS, 2010

A systematic analysis of the life cycle of rail freight wagons and the translation of the obtained results into benefits and sustainability will enable the growth factor "LCC-oriented" to become an important basis for increased competitiveness of rail freight transportation in logistical chains. At the same time it will also be a promising approach to strengthening the result-oriented cooperation of players in the use of innovative rail freight wagons.

4

# The “5 L” future initiative as a co-operative initiative for growth

## 4.1 Systematically opening up all growth factors

In the past, numerous individual technical solutions to improve the different components of the rail freight transportation system have been developed and partly brought to market maturity. Despite this and despite improved market opportunities, the measures have not been able to halt the decline of rail freight transportation's share in the modal split.

In the case of the rail freight wagon as well, too few innovations have been generally accepted. The main reason is the complexity of the system, i.e. the multiple cause-and-effect relationships and the large number of participants with diverging interests and responsibilities. Innovations often have to be financed by participants for whom the benefits they generate are not directly relevant. This is illustrated by the fact that infrastructure managers benefit most from the use of low-wear bogies in rail freight transportation, while they have to be financed by the wagon owner – who also bears the lion's share of noise-reduction measures for rail freight wagons from which residents along the line benefit. Furthermore, target-oriented benefits will only result after a significant portion of the rail freight wagon fleet has been equipped. Fig. 4-1 shows the layout of a rail freight wagon and selected elements for innovations.

Fig. 4-1: **Layout of a conventional rail freight wagon (example tank wagon)**


Source: BASF SE, Ludwigshafen, 2011

Under pressure from the tremendous number and diversity of tasks for improving the competitiveness of rail freight transportation in globalised trade flows, it is important that the future-initiative "5 L" should be coherently and systematically implemented without further delay – as a forward-looking strategy that paves the way for crucial and important growth factors. There is no alternative.

**The desired growth in rail freight transportation will only be possible with investment in rail freight wagon development.**

The coordination of investment strategies for the future-initiative "5 L" can be supported by a new type of interaction between key players in rail freight transportation. The timing is ideal. The course has been set for a new quality of cooperative partnership with the foundation of the "Technical Innovation Circle for Rail Freight Transportation" (TIS) and the direction to be taken by investment is clearly focussed and substantiated. This should help reduce any excessive scattering of investments and their impact. A cross-company and cross-sector approach involving growth-oriented railway undertakings, customers, shippers and wagon leasing companies as well as wagon manufacturers and supply industries is on the increase and set to grow further.

The

**"5 L" future initiative**

creates the space required to ensure systematic concentration of the activities and measures required to develop an innovative rail freight wagon 2030.

Rapid transition to the innovative rail freight wagon will be possible if the relevant technologies and modules are used in a targeted way. Many of them already exist or are at an advanced stage of testing.

There is a need for extensive and targeted funding to support the measures required.

The core idea of the innovative rail freight wagon 2030 contains a global technical and operational concept with the following aims

- to strengthen competition,
- to create growth through economic efficiency and customer benefits
- to protect the environment and resources.

Consistent consideration of the five growth-factors "low noise – lightweight – long-running – logistics capable – LCC-oriented" is crucial to its success.

Fig. 4-2 below provides an overview of selected effects that can be achieved if currently available components of the innovative rail freight wagon are implemented.

In this context, individual technical innovations should not be considered in isolation. The intended effects are produced by the interaction of various innovative components. To achieve growth and competitive advantages for the rail freight wagon, increased productivity, reduction of operational and maintenance costs and environmental consideration are especially important.

Fig. 4-2: **Examples of components and their effects**

| Component | Growth factor | Current | Future | cost: Pur-chase | cost: Operat. & Maint. | Environ-mental aspects | Product-ivity |
|---|---|---|---|---|---|---|---|
| Coupler | Long-running | screw coupler | automatic central buffer coupling | - - | o | o | + |
| Bogie | Low noise<br>LCC-oriented | cast iron brake block (non-TSI wagons) | (K-/LL-block) | - | - | + + | - |
| | | | disc brakes | - - | + | + + | + |
| | | helical springs / laminated springs | air springs | - - | - | + | + |
| | | | rubber springs | - | o | + | o |
| | | rigid wheelsets | steering axles | - | + | o | + |
| Superstructure | Lightweight | steel superstructure | lightweight construction | - - | - | + | + |
| | Logistics ability | G1-clearance gauge | GC-clearance gauge | - | o | + | + + |
| Sensor/Telematics | Long-running<br>Logistics capable<br>LCC-oriented | brake test supervised by staff | automatic brake test | - | + | o | + + |
| | | non-nexistent | GPS-based vehicle location | - | - | o | + |
| | | | vehicle condition monitoring | - - | + | o | + |
| | | | load monitoring | - | - | o | + |
| | Long-running<br>LCC-oriented | line-side hotbox detection | wagon bound hotbox early warning | - | o | o | o |
| Regulations | Long-running | country and operator specific | EU-wide standardisation | + | + | o | o |

Source: own graph, TIS, 2011

In the table positive effects appear as “+”, negative effects as “-”.

If no significant changes are expected, “o” is used.

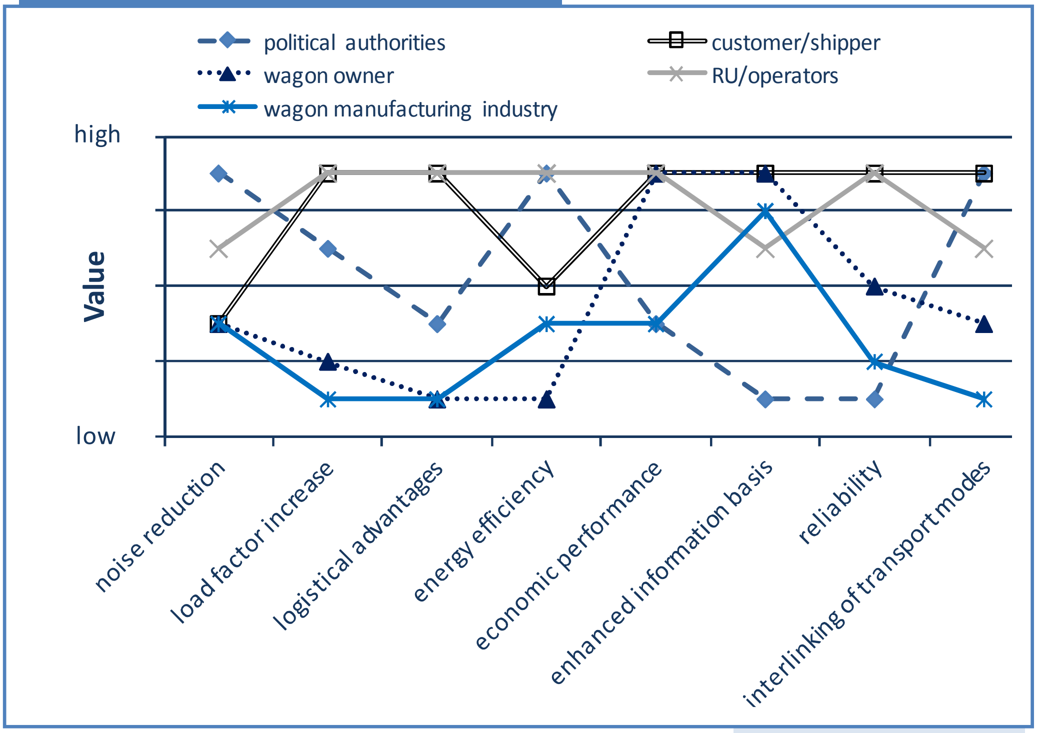
Apart from the achievable technical-operational effects, the extent should not be underestimated to which utilisation of the existing infrastructure will increase as this potential for the innovative rail freight wagon 2030 is systematically exploited. This will require varying levels of investment in infrastructure upgrading in the case of capacity bottlenecks. The innovative rail freight wagon can contribute to reducing such investment – or ideally make it unnecessary – thanks to its properties and effects. At the same time these measures will contribute to considerably increasing the attractiveness of rail freight transportation for customers, operators, political authorities and society in general.

## 4.2 Co-operation between partners

A pre-condition for a well-functioning rail freight transportation system is close cooperation between all the parties involved, despite their diverging interests. This is the only way to provide high-quality solutions to logistical tasks and win new market shares.

Fig. 4-3 illustrates the diverging utility of various different areas of innovation for the relevant players. It becomes clear that in most cases isolated measures only reflect individual interests. An overall optimal result can barely be achieved in this way. Furthermore, changes of the rail freight wagon as a resource in most cases need the support of many players, due to the complex cause-and-effect-chains involved.

Fig. 4-3: **Value curve for different players**




Source: own graph, TIS, 2011

The overall technical and operational concept of the innovative rail freight wagon 2030 can contribute to consistent implementation of innovative solutions provided representatives of all the market players are actively involved in its elaboration. The initiative in the innovation process must be coordinated. The process has to be designed in such a way as to enable a positive return on investment (ROI) for the actively involved players, despite the complexity of the system with its manifold cause-and-effect relations. In doing so there is a common basic understanding that the modal split can only be improved if the potential growth factors identified are developed on a basis of intermodal competition. This also ensures the desired sustainability effects for society as well as the efficiency and effectiveness of transport and logistical processes for the customers of rail freight transportation.

## 4.3 Migration approach – steps towards implementation

Generally speaking two strategies have to be combined for practical application of the innovative rail freight wagon 2030: building of innovative new freight wagons and retrofitting of existing ones. To be successful, this calls for rapid and coordinated action in the period between 2014 and 2030. If retrofitting of wagon fleets extends beyond this time frame, the chances for realisation and growth of the innovative freight wagon will not only be reduced, but the consensus achieved amongst customers and companies will also be significantly impeded in its early stages.

### New-builds

The innovative rail freight wagon 2030 requires such far-reaching changes that a real innovative thrust can only be fully achieved by building new wagons. It is not just a question of the bogies, which will require substantial changes – the same applies to couplers and brakes. Furthermore the superstructures of the innovative rail freight wagon will be different from those of current rail freight wagons.

Although a life expectancy of between 30 and 40 years is to be assumed for rail freight wagons, the conditions under which individual wagons are used may change faster, resulting under certain circumstances in a useful life of less than 10 years. To make it possible to use these wagons for other transport tasks, they must be convertible in terms of technical and economic aspects.

## Retrofitting

In the case of existing wagons it may make sense to retrofit them with innovative technologies in some cases. This is technically particularly easy where central couplers are concerned, as space for their installation has been catered for in wagon design for about the last 35 years (but has not been used, in contrast to most of the rest of the world). Since the introduction of the "Technical Specifications for Interoperability" (TSI), however, provision of this installation space has no longer been required. That is why there is a particularly urgent need for action in this area.

Furthermore, there is the possibility to exchange bogies and retrofit sensor systems. The brake may – as soon as certification is achieved – be equipped with LL-blocks which reduce noise lead compared with traditional cast-iron brake blocks. LL-blocks do not require any change to the braking system as K-blocks do. Rail freight wagons with cost-intensive superstructures, which are therefore not likely to be replaced by new wagons, are particularly suited to retrofitting.

As a consequence of their long life, retrofitting of wagons is often an attractive option. Nevertheless this will always involve a transfer of the properties of new-build wagons. Retrofitting should therefore not be the main focus in the longer term – it will rather be a result of the success of new-build wagons.

## European interoperability

The introduction of the aforementioned technologies only makes sense if they are operationally compatible across Europe, given that 46% of current rail freight transportation volumes is cross-border transport.[39] As mobility improves, this share is even forecast to grow further, although the earlier stipulated requirement for uniform designs or at least design principles should be abandoned in order not to jeopardise innovation. Nevertheless it will be possible to achieve the standardisation of certification requested by the EU Commission[40] as well as compliance with the "General Contract for Use of Wagons" (GCU)[41].

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[39] See: OECD (ed.): Key Transport Statistics – 2010 data. Report, Paris, self-publishing, 2011

[40] See: European Commission: White Paper 2011: Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system. White Paper, Brussels, Publications Office of the European Union, 2011, p. 26

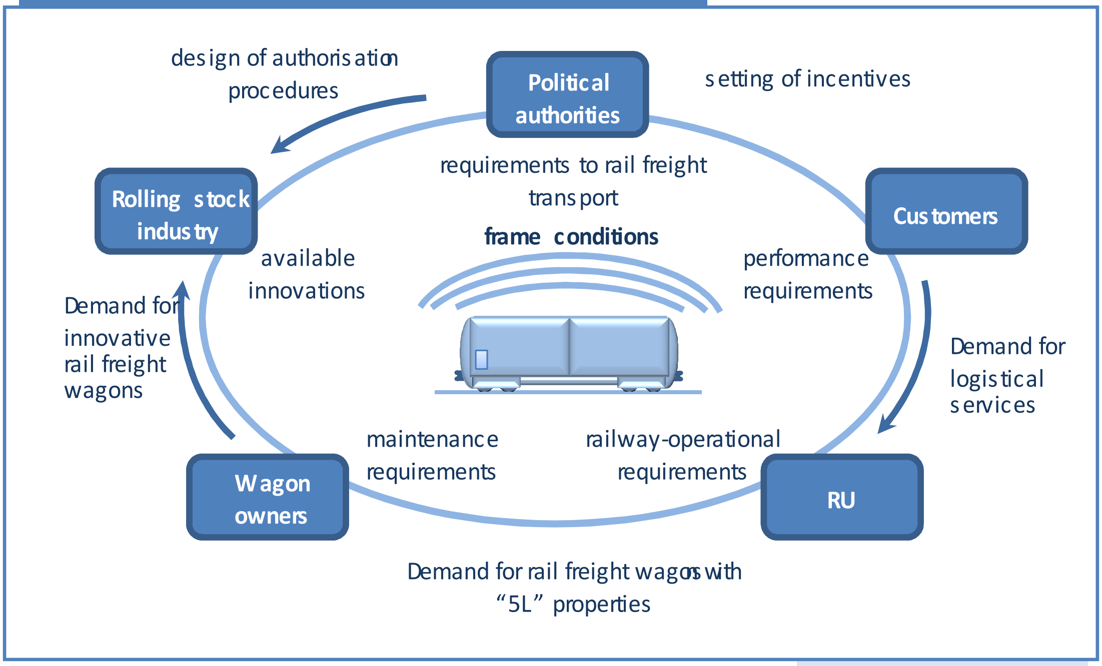
[41] GCU: General Contract for Use of Wagons – multilateral contract between various actors of the sector specifying the mutual rights and obligations of players in the use of rail freight wagons

## Implementation steps

Implementation of the “5 L” future initiative relies on *cooperation across business sectors and companies* on the basis of an overall technical and operational concept. An appropriately designed framework will encourage and accelerate this process. The supervisory and authorising authorities together political decision-makers will need to be involved in the implementation process at an early stage. National activities must be synchronised as far as possible between EU and Swiss national bodies and organisations.

Since the opening of the rail freight transportation market in 2006, powerful players have established themselves in the European rail freight market. With respect to the rail freight wagon as a resource these are the operators and owners of wagons who can – with the agreement of further participants and supporters – launch the process of realizing the innovative rail freight wagon 2030 (see Fig. 4-4).

Fig. 4-4: **Levers for implementing the “5 L” future initiative**




Source: own graph, TIS, 2011

The required rapid transition to the innovative rail freight wagon 2030 does not require lengthy preliminary studies. The basis for a timely start is already there in the form of existing technologies and modules. Further development and accompanying research can and must be systematically integrated as part of a step-by-step process. The basis for common action is an understanding across companies and sectors of the need for target-oriented implementation of the growth-factors.

The **proposal to proceed step by step** with implementation of the "Innovative Rail Freight Wagon 2030" involves:

### Preliminary step 1:

2012 Coordination and approval of an integrated and common procedure (integration of all players according to Fig. 4-4)

### Preliminary step 2:

2013 Definition of "5 L" standards for rail freight wagons

Consistent change management and coordinated action

(with awareness-raising, raising of support)

### Implementation step 1:

**2014 – 2024 Retrofitting and new-building of rail freight wagons**

Integration of further developed technologies and research results

Marketing of innovative solutions by the wagon manufacturing industry

### Implementation step 2:

2025 Proof: effects of noise-reduction in new orders of magnitude

All new rail freight wagons with "5 L" standards

End of acceleration of operational processes

### Implementation step 3:

2025 –2029 End of retrofitting by participating wagon owners to ensure "5 L" standards

### Implementation step 4:

**2030 Full impact on environment, energy and railway infrastructure utilisation**

The "5 L" future initiative offers a clear strategy for the coordination of all participants. This offers a real chance for the practical introduction of the innovative rail freight wagon across all EU countries including Switzerland. The efficiency and intended effectiveness of public support programs and start-up funding will be substantially increased thanks to the existence of an alliance of interests between railway undertakings, customers and shippers, wagon owners and wagon manufacturing industries and their suppliers.

## 4.4 Need for support for the "5 L" future initiative

The trends and conclusions for enhancing the efficiency of rail freight transportation described in this document are consistent with the analysis and the declared will of policymakers. The EU White Paper on Transport states literally**: "Rail, especially for freight, is sometimes seen as an unattractive mode. But examples in some Member States prove that it can offer quality service. The challenge is to ensure structural change to enable rail to compete effectively and take a significantly greater proportion of medium and long distance freight** (and also **passengers – see below). Considerable investment will be needed to expand or to upgrade the capacity of the rail network. New rolling stock with silent brakes and automatic couplings should gradually be introduced."**[42]

The "5 L" future initiative aims to combine and coordinate existing and possible additional funding way so as to achieve lasting, effective innovation and create the right incentives. Adaptation may be necessary in response to particular situations. For example the EU Commission is developing ways to internalise external effects.[43] And Germany is debating the introduction of a bonus system for low-noise rail freight wagons.[44]

Regulatory measures alone will not achieve the desired growth of rail freight transportation. Instead, the benefits of the innovative rail freight wagon 2030 have to be demonstrated through pilot applications in such a way as to ensure that this technology

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[42] European Commission: White Paper 2011: Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system. White Paper, Brussels, Publications Office of the European Union, 2011, p. 8

[43] See: European Commission: Strategy for the internalisation of external costs, Notification, Brussels, Publications Office of the European Union, 2008

[44] See: KCW (ed.): Study for the determination of transaction costs of different incentive models for the conversion of the existing freight wagon fleet to composite brake blocks (Studie zur Ermittlung von Transaktionskosten verschiedener Anreizmodelle für die Umrüstung der Güterwagen-Bestandsflotte auf Verbundstoff-Bremssohlen). Study, Berlin, self-publishing, 2011

will be used for new and important existing transportation operations on the grounds of its economic and environmental efficiency.

Timely availability of adequate funding for the initiative will ensure the required lead-time for the wagon manufacturing industry. This lead is important and immediately required in order to implement a well-coordinated and internally harmonised multi-stage programme starting in 2014 for the manufacture and market introduction of the innovative freight wagon by German and European railways as well as by relevant service providers.

It is of paramount importance for realisation of the step-by-step programme for introduction of the innovative rail freight wagon 2030 to generate and combine sufficient support as early as 2012 and 2013.

**The step-by-step approach constitutes a practicable programme for improving the competitiveness of rail freight transportation, developing its growth factors and achieving the expected and desired effects in terms of environmental improvements, energy consumption and noise reduction through the introduction of the innovative rail freight wagon 2030.**

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