GUIDELINE FOR SMALL-SCALE LOW-COST IMPROVEMENTS FOR RAIL FREIGHT

D.T2.3.10

FINAL version

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Thematic work package T2 - Multimodal freight transport pilot actions complementing OEM corridor development

O.T2.2.1 - Pilot actions for new and innovative intermodal services

D.T2.3.10: Guideline for small-scale low-cost improvements for rail freight

FOREWORD

In your hands you hold the final deliverable of the CORCAP Pilot Action “Small-scale low-cost improvements for rail freight transport along the OEM corridor and related railway networks”. This Pilot Action, implemented by the CORCAP Project Partner Győr-Sopron-Ebenfurth Railway (GYSEV), forms part of the Technical Work Package 2, comprising multimodal freight transport pilot actions complementing the development of the OEM-corridor.

The CORCAP project aims to realise activities for a better coordination of stakeholders in the field of transport and spatial planning, contributing to the creation of more efficient rail freight transport in central Europe along the Orient-East Med Corridor (OEM-corridor). The present deliverable summarizes ideas and findings of previous deliverables under the Pilot Action, which also formed inspiration and input to the “Corridor Capitalisation Plan” for the Győr-Moson-Sopron-Burgenland Region, which were developed jointly by the Partners with a view on facilitating the interaction of regional and transport infrastructure development. Overall, the CORCAP-project outlines solutions how to deliver tangible benefits for more efficient freight transport and provides a blue-print for how to add value to the TEN-T corridors and their rail freight backbone, the EU Rail Freight Corridors. Focusing on small-scale low-cost improvements, the present guideline also outline measures, which are suited to increase the effectiveness and benefits from large-scale projects in the corridor.

This final deliverable of the Pilot Action defines in an introductory section the understanding of the subject and puts it in a broader policy context at EU and national level. It also explains, how small-scale low-cost improvements contribute to addressing overall challenges for rail freight.

In a second section a system approach is described, identifying in principle measures of improvements, taking stock on experiences and “good examples” from railway systems globally.

Afterwards the system approach is applied on the Brno-Budapest section of the Orient/East-Med Corridor and adjacent networks, showing selected cases, how elements of the approach could be applied. In this context, also the TEN-T Demo-Train, operated between Sopron and Budapest on 20 October 2021 as part of the CORCAP Pilot Action, is presented.

The Guideline concludes with recommendations for both concrete measures to be taken in the Brno-Budapest section of the corridor as well as general recommendations for how to better incude small-scale low-cast improvements for rail freight in national and European infrastructure and spatial planning. In this sense, the Guideline serves both as a source of inspiration for planners and stakeholders in the Orient/East-Med Corridor, but also for stakeholders and parties concerned in other European corridors and regions.

The Guideline was developed based on extensive research and analysis of good practice in many parts of Europe and beyond. During the elaboration a frequent exchange with project partners and stakeholders took place and input and feedback was gathered during workshops and meetings from a wide range of experts and interested parties.

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1. POLICY CONTEXT

Improvements of the rail freight system have to be seen in a context of European, national and regional policies to promote rail as an efficient and environmentally friendly transport mode, which contributes to strengthen the competitiveness of European industries and businesses at regional, national, European and global level and to improve cohesion. Key policy initiatives are presented in this chapter.

While small-scale low-cost improvements for rail freight are usually not explicitly mentioned, these policies nonetheless form the policy framework, which justifies the consideration and implementation of such kind of improvements.

1.1. The "European Green Deal"

The "European Green Deal" is a comprehensive set of policy initiatives proposed by the European Commission and supported in January 2020 by the European Parliament with the overarching goal to make Europe the first climate-neutral continent. This goal which should be achieved until 2050.

Figure 1: Rail as a transport mode will play a key role for achieving the objectives of the European Green Deal (Source: railfreight.com)

The European Green Deal recognizes climate change and environmental degradation as existential threats to Europe and the world and provides a roadmap for making EU's economy sustainable, building on a growth strategy where:

- there are no net emissions of greenhouse gases by 2050
- economic growth is decoupled from resource use
- no person and no place are left behind

It aims at actions boosting the efficient use of resources by moving to a clean, circular economy, restoring biodiversity and cutting pollution. It also outlines investment needs and financing tools, paving the way for a just and inclusive transition. Overall, the EU plans to finance the policies set out in the Green Deal through an investment plan – InvestEU - , forecasting investments of at least 1 trillion euros. By a so-called "Just Transition Mechanism" the EU will provide financial support and technical assistance to help people, businesses and regions most affected by the move towards the green economy, with the aim to mobilise at least 100 billion EUR over the period 2021-2027 in the most affected regions. Existing legislation shall be reviewed on its climate merits, but also new legislation may be introduced. A European Climate Law is proposed to turn the political commitment into a legal obligation and to trigger investments.

In order to reach the targets, actions in all sectors of the economy will be required, including

- investments in environmentally-friendly technologies
- support to industrial innovation
- rolling out cleaner, cheaper and healthier forms of private and public transport
- decarbonising the energy sector
- ensuring buildings are more energy efficient
- working with international partners to improve global environmental standards

Transport accounts for a quarter of the EUs greenhouse gas emissions and these continue to grow. Consequently, a sustainable and smart mobility strategy – for both freight and passenger traffic – forms an essential element of the European Green Deal. The Green Deal re-confirms earlier objectives, i.a. the objective to transport a higher share of freight by rail or water.

Railways must play a key role and are indispensable to achieve the objectives of the European Green Deal, since rail is the most energy-efficient transport mode and – with a large part of the European rail network electrified – the mode least dependent on a specific primary source of energy. It is the most advanced transport mode when it comes to the possibility to make use of energy from renewable sources.

Modal shift to rail allows for quick reductions in greenhouse gas emissions from the transport sector. Contrary to certain beliefs that the environmental advantage of rail may become reduced or even eliminated with the electrification of other transport modes – it cannot be expected even in the longer term that other transport modes will reach a similar level of environmental performance as rail. The reason for this is that the environmental performance of rail is inherent to the railway system through the steel-wheel on steel-rail principle, giving a low friction. It is mostly this particular characteristic, which to a large extent explains the good environmental performance of rail versus other modes. Even with electrification of other transport modes (in particular road) these will not reach the same level of energy-efficiency. With a view on certain environmental challenges even arising from the generation of renewable energies, energy-efficiency will remain an important (and possibly even become an even more important) aspect; thus, rail will maintain its environmental advantage, justifying its demand to continue playing a key role in European transport policy and the European Green Deal.

1.2. The EU White Paper on Transport

While by now already more than ten years have passed since the publication of the last EU White Paper on Transport, it still deserves attention, since it formed the basis of much of what is included in the European Green Deal in the area of transport, and thus still reflects basic ideas, objectives and principles of EU transport and rail policy.

The European Commission laid down key policy objectives of European transport policy in its White Paper on Transport from 2011. As overarching objective was defined to contribute to a reduction of Greenhouse Gas Emissions (GHG) by 60 % until 2050 by strengthening the participation of rail and waterborne transport in the transport market.

The prominent role of rail in EU transport policy is concretized in the objective to shift 30 % of long-distance road freight (>300 km) to more energy-efficient modes of transport by 2030, increasing this figure to 50 % by 2050. Since the waterway network is less dense than the rail network and in view of logistical requirements, in many cases this means a shift to rail; consequently, rail freight ton-kilometres on the European network are expected to increase by 87 % compared to 2005.

The White Paper underlines the importance of integrating transport modes. For the rail freight system, connections with maritime transport play a central role, reflecting the increasing role of rail in the hinterland traffic of most major European seaports. Therefore, proper connections of all core network seaports to the European rail system is a further objective of the White Paper. The Orient/East-Med RFC connects several seaports, both on the Black Sea, the Aegean Sea and at its northern end even at the North Sea and Baltic Sea.

The EU rail policy is based on two 'pillars' – a market pillar and a technical pillar. The market pillar aims at market opening and better governance of the railway system, while the technical pillar aims at technical harmonization across borders and simplified procedures for railway undertakings wishing to operate across Europe, while ensuring the safety of the railway system, with the objective of reducing the administrative burden and costs in particular for traffic crossing borders. The rail freight market has been gradually opened in the EU since 2003 and has been entirely open since 2007. On the technical side the deployment of a harmonized European Rail Traffic Management System (ERTMS) is a cornerstone for technical harmonization in the European railway system and another key objective of the White Paper.

The White Paper defines the ultimate goal of EU railway policy to create a truly Single European Rail Area (SERA), which would largely eliminate national borders for the market actors and users of the European railway system. When fully implemented, a Single European Rail Area would create a harmonized railway market with a rail network of continental dimensions, which should enable rail to fully exploit its competitive system advantages when it comes to transport over long distances.

In order to strengthen the concept of the Single European Rail Area, speeding up its implementation and reflecting the urgent need for improvements in cross-border traffic, the EU Commission had initiated the concept of international Rail Freight Corridors (RFCs), established along key routes for European rail freight and aimed at fostering cooperation between the national railway infrastructure managers and between Member States along these corridors. The RFCs are based on an EU Regulation (Regulation (EU) 913/2010). The White Paper on Transport defines these RFCs as a backbone of the European freight transport system. The Orient/East-Med Rail Freight Corridor No. 7 (RFC OEM) is one of these RFCs. In the following the concept of the Core Network Corridors and the RFCs, with RFC OEM as an example, is described in more detail.

1.3. The Trans-European Network for Transport (TEN-T) and Core Network Corridors

The EU rail policy is complemented by an infrastructure policy in the form of the Trans-European Networks for Transport (TEN-T) and with the Connecting Europe Facility (CEF) and the structural funds as financing instruments.

The importance of rail freight in the TEN-T policy is reflected by the fact that a dedicated Core Network for freight, covering the main railway lines for freight transport, has been defined in the TEN-T Regulation. Article 39(2a) also sets binding minimum infrastructure standards to be implemented on this network by 2030 (Regulation (EU) 1315/2013):

- 740 m train length
- 22.5 t axle-load
- 100 km/h line speed
- ERTMS
- Electrification

While the target values may appear moderate in comparison to technical possibilities and the standards of other large railway systems in the world, where much longer and heavier freight trains already operate today, they nonetheless constitute an improvement compared to today in many parts of Europe (in particular regarding the train length requirement). Their inclusion in an EU Regulation has to be considered as a historic breakthrough insofar as it means, that this Regulation for the first time defines with binding, legal force a minimum infrastructure standard for a coherent European rail network to be achieved by a concrete deadline.

Within the TEN-T policy a number of Core Network Corridors (CNCs) have been defined as an instrument to foster implementation of the Core Network (Regulation (EU) 1316/2010). Fig.__ shows a map of the Core Network Corridors; they are geographically largely aligned with the EU Rail Freight Corridors, but not fully identical, since both corridor concepts have different aims.

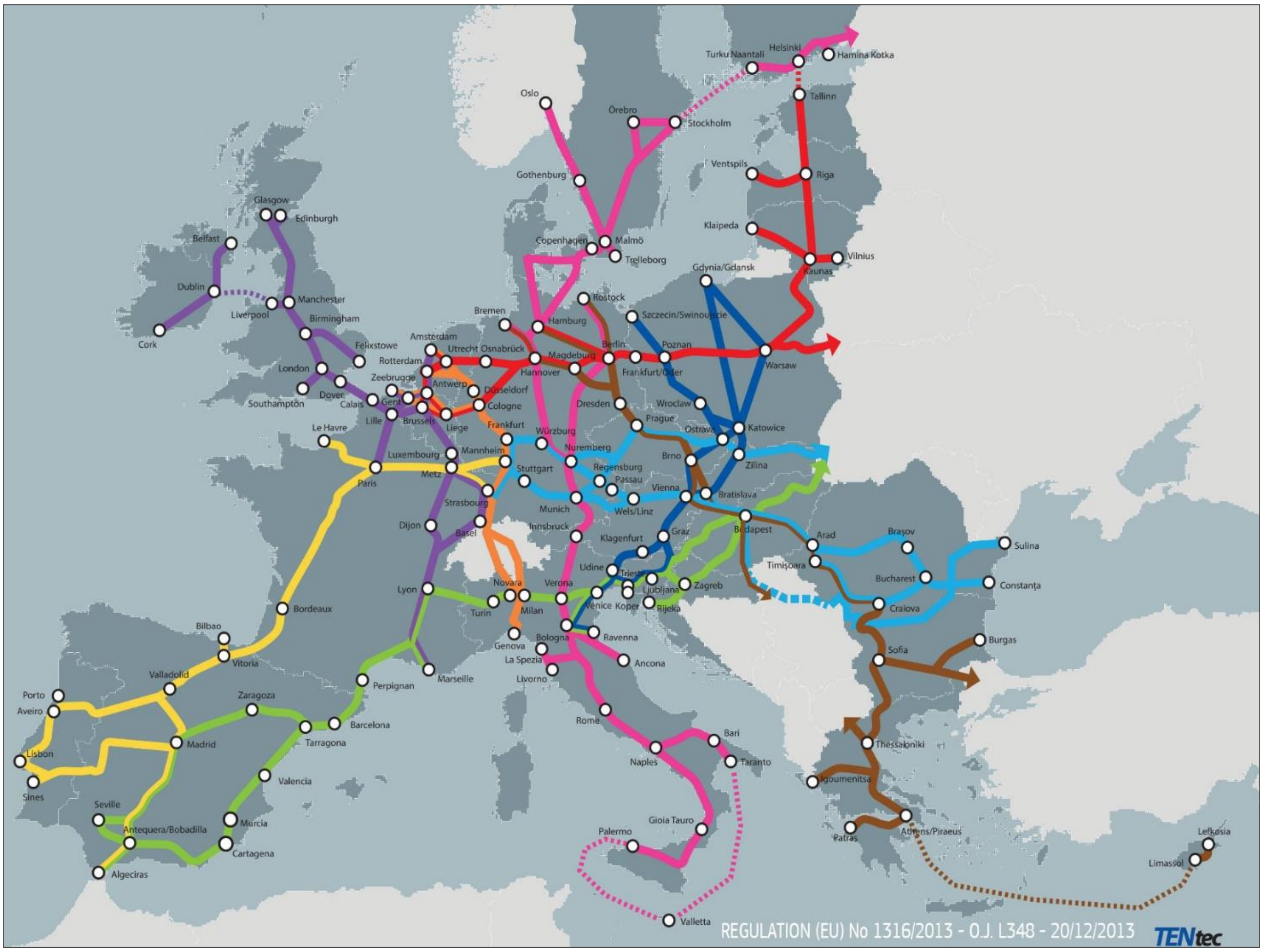

Fig. 2: The Core Network Corridors (CNCs) have been established with the aim to facilitate the implementation of the TEN-T Core Network. The CNCs comprise a subset of the Core Network (Source: European Commission).

1.4. The EU Rail Freight Corridors

The EU Rail Freight Corridors form the rail freight backbone of the multimodal TEN-T network and the Core Network Corridors (CNCs) of the EU. Both corridor concepts complement one another. The RFC-Regulation does not contain target standards for the railway infrastructure of the corridors, but the TEN-T-Regulation defines minimum infrastructure requirements for the Core Network for freight (see Chapter 1.3). The Connecting Europe Facility (CEF) provides funding for infrastructure investments in the TEN-T Network and the governance structures of the RFCs. Both help to strengthen the attractiveness of the RFCs and the competitiveness of rail as a transport mode in both types of corridors. Table 1 compares the key characteristics of the RFC and CNC concepts.

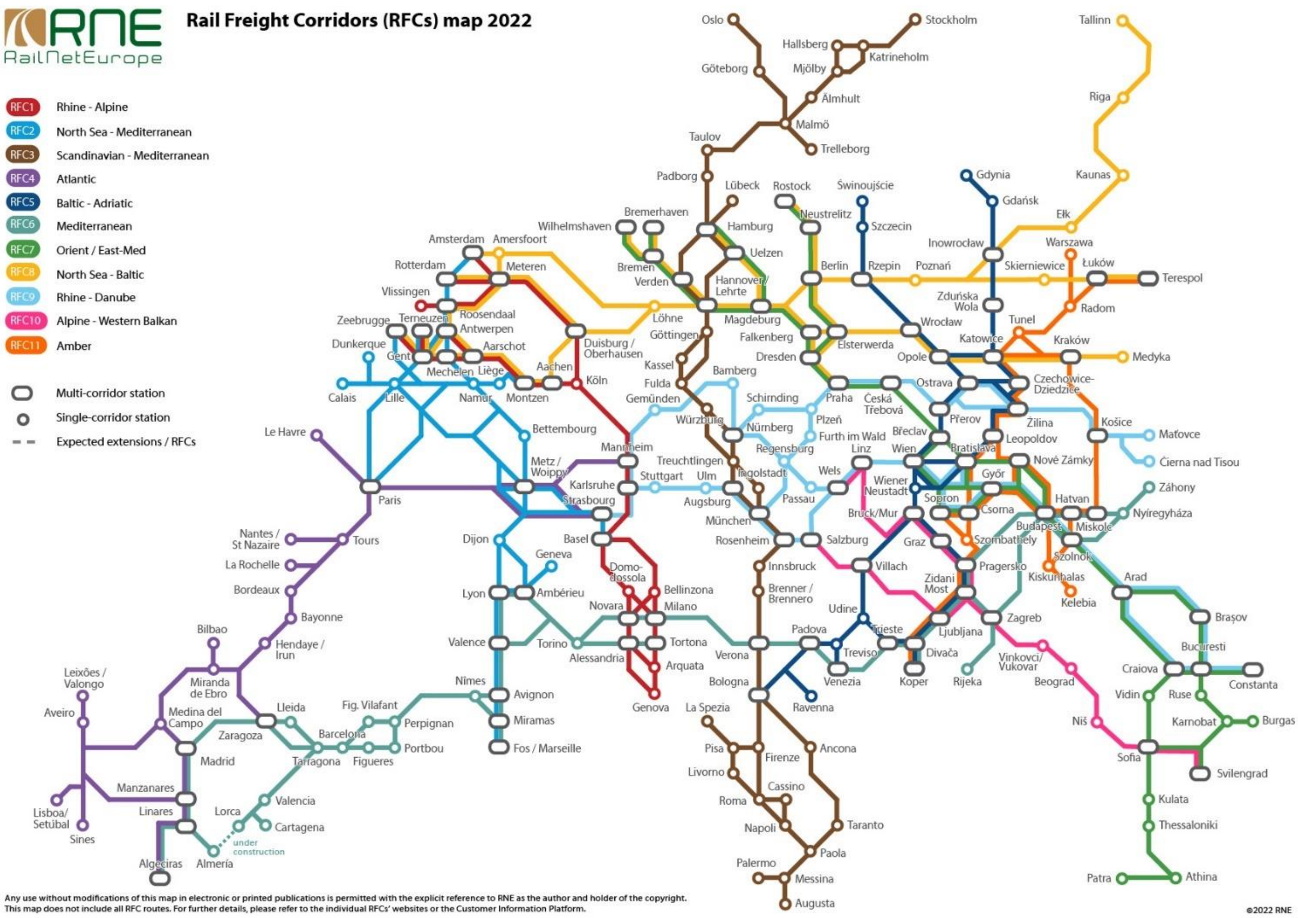

Fig. 3: Map of EU Rail Freight Corridors 2022; the map is for information only and shows the main routes of the corridors; further lines can be designated to a corridor. / Source: RailNetEurope

Core Network Corridors (CNC)	Rail Freight Corridors (RFC)
Multimodal (rail, road, aviation, inland waterways and ports)	Rail transport
Passenger and freight traffic	Freight focus
Only Core Network lines	Core Network lines, Comprehensive Network lines and non-TEN-T lines
Mainly oriented at infrastructure	Mainly oriented at traffic operations and administrative processes
One EU Coordinator per CNC	Dedicated, permanent governance structure for each RFC
	One RFC in each CNC

Table 1: Key characteristics of CNC and RFC. (Source: author's adaption from the respective regulations)

1.5. National policies

National polices in the field of infrastructure and transport are in general terms reflecting EU transport policies, though the priorisation of objectives may vary to some extent. However, the aim to strengthen the role of rail transport is supported by the national transport policies of all countries along the OEM-corridor.

National transport policies are also mirrored in the special objectives as well as the concrete projects laid down in the Transport Operational Programmes, which form the basis for EU-contributions to the funding of (infrastructure) projects in the countries concerned. These are of particular importance for most of the countries along the OEM-corridor, since the majority are Cohesion Fund countries, where EU contributions are an indispensable funding source for many investments.

In the case of Hungary for example, the Transport Operational Programme include the upgrading of the TEN-T elements in Hungary both for rail (and also for road) transport, the fostering of intra-regional connections and intermodal hub developments together with eco-friendly and public transport developments.

1.6. Territorial Agenda 2030

The Territorial Agenda 2030 emphasizes the importance of environmentally friendly transport, while acknowledging that "(a)ccess to intermodal freight and passenger transport is important for all places in Europe. Efficient and environmentally friendly transport solutions are ever more important to achieving climate, air pollution, noise objectives, accessibility and connectivity of all regions in Europe. This includes transport modes individually, as well as combined transport. We will further improve links between regional planning and the development of Trans-European Networks (TEN), especially along core network corridors. Linking all places with major transport nodes supports international trade connections and local development opportunities."

Worth to mention is, that even the Territorial Agenda refers explicitly to corridors: "(L)inks and flows between places, especially along corridors, affect the possibilities to realise potential or respond to challenges". Thus, with the project following a corridor approach, it very well matches with the expectations expressed in the Territorial Agenda.

1.7. EU Macro-Regional Strategies

Transport and mobility improvements are also prominently addressed by EU Macro-Regional Strategies. Most relevant for the central section of the OEM-corridor is the EU Strategy for the Danube Region (EUSDR).

The first of the four pillars of the EUSDR is "Connecting the Region", comprising the priority "Improve mobility and transport connections". Within this priority i.a. the following targets are defined:

- "Support efficient freight railway services and improve travel times"

- "Support fully functional multi-modal TEN-T Core Network Corridors"

- "Support the development of efficient multimodal terminals at sea, river and dry ports (...) and ensure their connectivity and access through integration of all modes of transport and efficient logistics services"

- "Support safe and sustainable transport and mobility in the Danube Region".

2 MARKET REQUIREMENTS AND CHALLENGES IN EUROPEAN RAIL FREIGHT

Rail freight in Europe is facing a number of challenges which need to be addressed if rail wants to maintain and strengthen its competitiveness on the transport market. Small-scale low-cost improvements are certainly alone not sufficient to address these challenges, but can make an important contribution.

The main challenges, which are also relevant for the OEM Corridor, are the following:

2.1. A quality challenge

The quality and reliability of rail freight services, not least in terms of punctuality, are today in many cases still insufficient, in particular in international traffic. Remarkable improvements have certainly been made in specific traffics and transport lanes, especially in the trainload and intermodal market segments, but these ‘good examples’ are still too much an exception and not the rule, and good quality in rail freight services is not always stable over longer periods of time. The lack of quality and reliability has a twofold impact: it hinders rail from meeting customer expectations – leading to low customer satisfaction and lost business opportunities – but also leads to higher costs, since staff and asset utilization declines, and there is a need to provide back-up resources in the form of drivers, locomotives and wagons and a need for extensive ad hoc-planning.

Quality problems are indeed a challenge on the Orient/East-Med Corridor, especially for train services over longer distances. In spite of generous timetable margins of up to almost a full day, for example on the route between Svilengrad at the Bulgarian-Turkish border and Sopron at the Hungarian-Austrian border, train services are still facing frequent and severe delays, which in the past has repeatedly led to the cancellation of services and transfer to other modes and/or routes, in particular to ferry routes between the northern Adriatic ports (primarily Trieste) and Greek and Turkish ports.

A further aspect of quality is major traffic disruptions on important freight routes in Europe. Several incidents during recent years highlight the importance of taking the aspects of robustness and resilience in the event of major traffic disruptions more into account in order to ensure a good and constant quality in rail freight; the need for diversionary routes of reasonable standard and capacity should be particularly mentioned in this context.

2.2. A cost challenge

Costs have been and – realistically seen - will remain a very important factor for the choice of a transport solution. If rail wants to remain competitive (and ideally improve its competitiveness), irrespective whether in an all-rail transport solution or as part of an intermodal transport chain, it has to address this challenge. The cost efficiency of a transport solution is usually measured in costs per net ton-kilometre. An effective way to strengthen the cost competitiveness of rail is to realize economies of scale, by moving more payload (tons or cubic-meters) per wagon and per wagon meter, by moving more wagons per train – i. e. longer and/or heavier trains – and by handling more trains on the rail network. While over several decades other transport modes have made huge progress in strengthening their economies of scale – one important factor explaining their success – rail is lagging behind and needs to improve. International transport is particularly concerned, since the weakest link of a transport route often defines the efficiency over the entire transport distance – and the longer the transport route, the bigger the likelihood of ‘hitting’ a weak link. Since cross-border links were often neglected and were not usually an investment priority in national infrastructure planning, many international rail routes for freight are affected. Slow progress in the harmonization of processes and operational rules across borders, including language issues, is aggravating the problem.

The situation on the OEM-corridor illustrates these problems very well. Major parts of the central section of the corridor through Hungary and Romania are, for example, limited to 20 t axle-load (compared to the usual 22.5 t in Europe), the weakest links on the lines to both Greece and to the Turkish border do not allow more than 550-m-long trains (compared to the target value of 740 m, which also is achieved on certain parts of the corridor) and there are still short, but very persistent, electrification gaps between Romania and Bulgaria, requiring a change of traction two times within relatively short distances. Local improvements have been made, such as a new cross-border bridge across the Danube between Vidin and Calafat, but cannot be capitalized upon due to a lack of continuity of infrastructure standards, as in the given example where the approaching lines on both sides have not been upgraded and such upgrades are not in view in the short term. Also in Western Hungary, the mostly single-track network of connecting corridors in the region hampers rail freight.

2.3. A service challenge

The changes and increasing diversification in the transport market in terms of goods structure result in increasingly specific logistical demands for different traffics. A trend from non- or low-processed base goods to highly processed goods in an advanced stage of the production chain increases the demand for specific service characteristics. An example is the need for temperature-controlled transport, where rail today is often unable to provide service features comparable to those of road or air transport. Another example is highly time-sensitive goods, requiring fast and precise delivery

Especially when it comes to Central-Eastern Europe, average speeds of freight trains are still comparably low. At the same time the creation of a high-quality and increasingly dense motorway and expressway network in this region – of a standard, which by no means is lower than in Western Europe – has dramatically reduced transit times in road freight. Thus, the sometimes very low average speed of freight trains in Central-Eastern Europe becomes increasingly a competitive disadvantage for rail.

Another dimension of service is the ability to respond quickly to market demands, i.e. to develop and implement transport solutions at short notice independently from fixed timetable periods. Also, accessibility to rail freight services, both in geographical terms as well as in terms of easiness of use, can be seen as a dimension of the service challenge. This includes, for example, response time to customer enquiries, the availability, accessibility and efficiency of access points to the rail freight system (last-mile infrastructure and related services) and the provision of information before, during and after the execution of a transport, such as information about the Estimated Time of Arrival (ETA). Here it is important to note that the response time to customers is in turn heavily influenced by response times between different actors of the rail sector, e.g. between infrastructure managers and railway undertakings in connection with capacity requests. Adding new features to the service portfolio of rail – both towards the 'final customers', i. e. the shippers, as well as internally between railway market actors – and speeding up internal and external business processes, e. g. through digitalization, will be crucial to enable rail to respond to changing logistical market demands and to enter into new – or previously lost – market segments. This will be necessary if rail is to grow its modal share. Small-scale low-cost improvements, e.g. in and around terminals and nodes, can contribute to this. In a broader perspective, better coordination of traffic and spatial planning is important, where in particular rail freight needs to be better taken into account.

While the above aspects are to varying degrees generally true for rail freight in Europe, there is one specific aspect which affects the OEM corridor more than others: the lack of intermodal infrastructure in the form of modern, efficient intermodal terminals in southeastern Europe. In large parts of central, northern and western Europe a dense network of intermodal terminals has evolved over the past decades, fueled by dedicated funding programs on European and national level and often strong support on regional level, possibly even leading to a risk of 'over establishment' of terminals and cannibalization effects between neighboring terminals. In contrast, relatively few intermodal terminals exist in southeastern Europe and those which exist often have outdated infrastructure and handling equipment. Even more cumbersome is that even some of the (few) newer or modernized terminals are not always in line with pending standards in rail freight, e. g. with regard to train lengths. There is a hen-and-egg-problem here. The, often, low standard of the rail network and slow progress in its modernization does not encourage terminal owners to invest in a standard which they cannot capitalize upon in the near future, while the low standard of terminals may, in the longer term, cause problems in fully reaping the benefits of improvements to the rail network.

2.4. A political and societal challenge

Not least due to its good environmental performance, but also due to high safety, rail as a transport mode generally enjoys a good reputation and high political and societal acceptance. Nonetheless, there are issues which need to be addressed in order to maintain this acceptance in the future. In the field of rail freight a particular concern is rail noise. Technical measures are currently under implementation, both trackside and on the vehicles, which will lead to a substantial reduction of noise from freight trains in the coming years. This is important in order to avoid possible future restrictions on the operation of freight trains, which could lead to an undesired shift from rail to road, aggravating instead the problems of noise (as well as other environmental problems) from road transport. Another societal challenge is an ageing population in combination with high levels of retirements among the rail workforce. It is therefore important to increase the attractiveness of jobs in rail freight operations and to make use of the opportunities from digitalization and automation of processes in rail freight.

A problem affecting rail in many central and southeastern European countries – and this means also affecting the OEM corridor – is that the above statement about the good reputation of rail is only to a limited extent true for these countries. Both political decision-makers as well as the general public still to some extent consider rail as an outdated, old-fashioned mode of transport from the ‘communist era’, leading to strong political and public pressure to prioritize investments in the road system. If improvements of the rail system are taking place, these are often targeted at passenger traffic rather than freight (“freight doesn’t vote”), though the introduction of high-speed passenger services, having the potential to act as a game-changer in the public perception of rail in many other countries, is still largely absent in many countries along the OEM-corridor.

2.5. A European challenge

More than 50 % of European rail freight (measured in ton-kilometres) is cross-border and this share tends to increase. This trend is fueled by the globalization of goods production and consumption, leading to both more complex and longer supply chains.

Generally, rail’s competitiveness increases with distance; distance allows rail to compensate for higher costs at the ends of the transport chain. However, this advantage, which rail should have over long distances, is in Europe often reduced – if not eliminated – by a lack of interoperability at national borders, since in the rail system these borders are almost always also ‘system borders’ with regard to technical, operational, regulatory and managerial aspects. Often market share and competitiveness in national traffic is higher than in international traffic and declines as the number of borders to be crossed increases (Fig. 1). The objective must therefore be to create a truly Single European Rail Area, eliminating cost-driving system borders as much as possible; this concerns both the hardware, i. e. technical interoperability, as well as soft factors in the form of technical, operational and administrative rules and processes.

In parts of the OEM-corridor and its connecting networks, also the layout of the rail network creates frequent bottlenecks, causing similar effects. In Western Hungary and in the border region in Slovakia, for example, trains entering the OEM-corridor coming via the Amber corridor from Slovenia, have to change travelling direction up to three times on a distance of less than 140 km (on the section Zalaszentiván – Csorna – Komárom – Komárno – Dunajska Streda).

In the freight business we can note two, to a certain degree diverging trends since the beginning of the 1990s. When it comes to train operations, we can in fact see an increasingly 'European' approach by the market actors directly involved, i. e. mainly railway undertakings (freight train operators), but also intermodal operators. Both incumbents and new entrants operate in open access, often with their own resources – locomotives and drivers – across borders. There is clearly increased commercial orientation towards customers. At the same time infrastructure and traffic management continued (and still continues) to follow a rather national approach. This can be explained by a number of factors:

- The functions are in the hands of public national infrastructure managers.
- Railway networks are natural monopolies and consequently there are no market incentives for the infrastructure managers to improve customer orientation.
- The main user of European rail networks is, with few exceptions, passenger traffic. Thus, infrastructure managers tend to focus on this market segment, also because passenger traffic usually receives higher public and political attention ('freight does not vote').
- Railway infrastructure is usually publicly financed and is strongly oriented towards national policy objectives and political considerations. Regarding the countries of the Orient/East-Med Corridor, a positive aspect is that there are quite a number of new (even private) stakeholders active in the rail freight market. This shows that there are market actors who still see prospects for developing business in the rail freight market in this region of Europe.

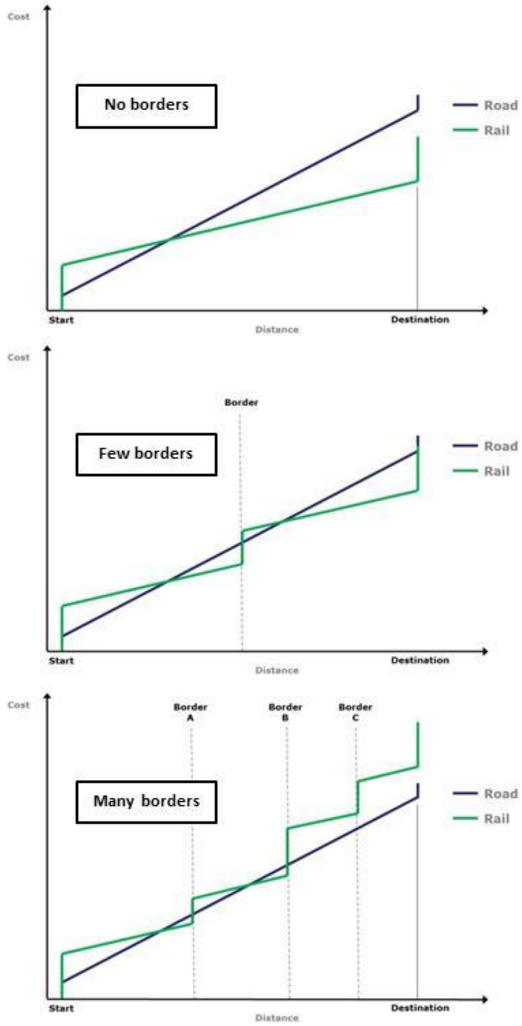

Figure 4: The impact of borders on the competitiveness of rail in freight transport.

3 SMALL-SCALE LOW-COST IMPROVEMENTS IN THE CONTEXT OF RAIL FREIGHT DEVELOPMENT

3.1. Definition

The scope of this study are, as expressed in the title, *small-scale low-cost* improvements of infrastructure for rail freight. This term refers partly to the physical size of a project, e.g. its spatial extension, and partly to the investment volume. The qualification as small-scale low-cost is chosen in first hand to discern projects suggested in this CORCAP Pilot Action from large-scale projects which both regarding their physical size and investment volume are clearly in a league of their own. In this latter "league" would be large-scale projects as for example long sections (several tens or hundreds of kilometres) of new or heavily modernised railway lines, in case of modernisation often with new sub- and superstructure and partly with changes of the alignment; such projects often include the construction of (many) major bridges and/or longer tunnels. These projects often require investment volumes with a three-digit amount of million Euros and more. In the OEM-corridor such kind of projects are for example the planned new tunnel under the Erzgebirge or the high-speed lines planned in Czech Republic.

In contrast to these stand projects and measures as for example locally adapting track layouts by moving switches and/or signals to facilitate train operations in a yard, extension of sidings for overtaking/passing of trains and extension or addition of tracks in selected yards and terminals, but also construction of shorter new line sections of up to a few kilometres, as for example triangle tracks which are locally connecting two railway lines in the vicinity of a station.

Also "freight-bypasses" around certain nodes could still qualify as small-scale low-cost in comparison to the aforementioned large-scale projects, however, in this and certain other cases an assessment has to be made case-by-case; a freight-bypass across more or less open flat land and a length of some kilometres could still be considered as a small-scale low-cost project, while a bypass requiring extensive tunnelling and/or long bridges and with more substantial length of several tens of kilometres around bigger cities or conurbations could very well evolve into a large-scale project.

The latter example shows that an exact demarcation is difficult and that there is some flexibility in the qualification of a project as small-scale low-cost. A common denominator of most small-scale low-cost projects is that they are local, limited to a certain yard, station or terminal or with an extension of typically not more than around ten kilometres and an investment volume of up to a two-digit number of million Euros. However, not all small-scale low-cost projects need to be purely local - an electrification of a railway line of up to several tens of kilometres might very well still qualify as a small-scale low-cost project, if it is not connected to a major renewal or upgrading of the entire track sub- and superstructure. An assessment always has to take into account the relation to the entirety of railway and/or transport infrastructure projects.

Finally, several small-scale low-cost projects may also form part of a major scheme of improvements in a network or along a corridor. While the individual projects may be still local, such as an extension of sidings aiming at allowing longer freight trains, a coordinated implementation of several of such projects together could generate important and positive "corridor effects" and increase – and sometimes even be a pre-condition for – the value and impact of the improvement. Even from a project financing and management point of view it could make sense to coordinate several small-scale low-cost improvements, even across national borders, and gather them in a package forming a larger "multi-location" project.

3.2. Role and importance

Small-scale low-cost investments have an – often underestimated and therefore so far not fully exploited – potential to bring an important contribution to the development of the rail freight system and to the TEN-T network and the functioning of the TEN-T corridors and EU Rail Freight Corridors. Small-scale low-cost projects can:

1) **deliver quick benefits**, since planning and implementation often can be carried out faster than large-scale projects. The impact on the efficiency of train operations can locally be very important. Taking into account that first- and last-mile operations often stand for a disproportionally high share of the total cost in a transport chain, such improvements can have a huge, and sometimes even decisive, impact on the competitiveness of the train services on certain routes and or for certain goods flows.
2) **deliver tangible improvements at a relatively low cost**. Investment needs in rail infrastructure allowing step-change improvements in rail passenger traffic are often high, since in passenger traffic travel time and frequency are key factors of attractiveness; drastically increasing speed and capacity for passenger trains often requires major adaptations of the railway infrastructure – in case of long-distance traffic sometimes the construction of entirely new high-speed lines. Compared to these, major improvements in rail freight often are already possible with rather moderate investments. Thus, in a situation of limited available budgets the relative benefits which could be achieved might often be rather huge in freight traffic.
3) **play an important role in strengthening the added value of large-scale infrastructure improvements**. In this context a corridor-oriented planning and investment approach can be of particularly high value. One example are the cross-alpine routes where several base-tunnels (Lötschberg- and Gotthard- and – under construction – the Brenner and Semmering base tunnels) allow an important increase in train weights and train lengths, due to the reduced gradients. However, the full potential of these very high investments can today still not be fully exploited due to infrastructure constraints both on the northern and southern approach routes to the base tunnels. Thus, with targeted and (relatively) small-scale and low-cost investment on the lines leading to the base tunnels, the value of these very large-scale investments would substantially increase.

The last-mentioned point clearly shows, that large- scale and small-scale projects and improvements should not be seen as alternatives to each other, but are to a high degree complementary. This clearly calls for a more integrated planning and development approach in the context of the TEN-T and EU Rail Freight Corridors. This would also help to better align the timing of large-scale and accompanying small-scale improvements; this is today coordination is today in many cases lacking, diminishing the benefits of individual investments for users and customers of the corridors concerned.

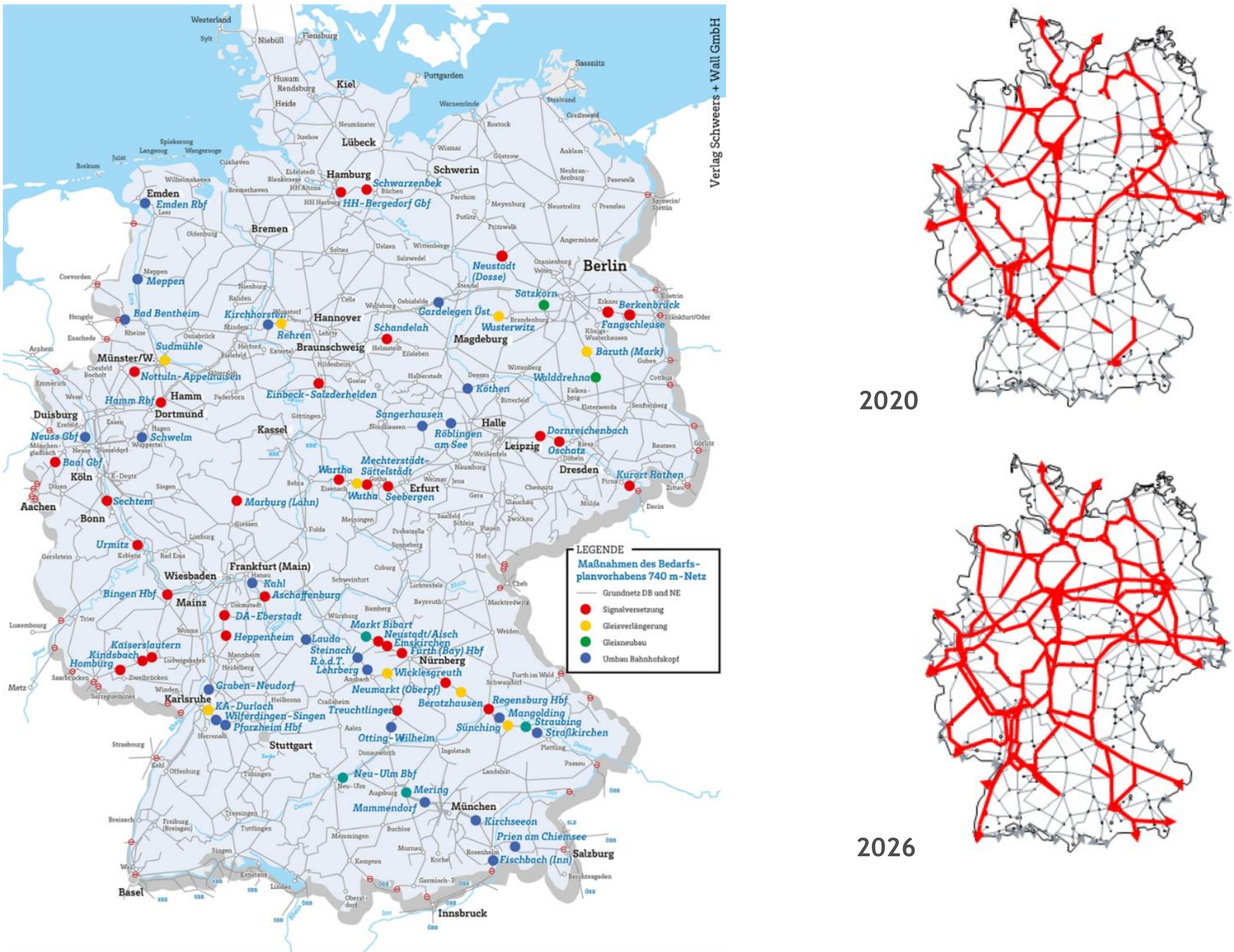

Figure 5: The program for 740 m train length in Germany is an example for how a combination of several small-scale low-cost measures can lead to major improvements in a larger network. On the left side the individual locations and measures enabling the operation of 740 m long trains are indicated (by type of measure: red: moving of signals; yellow: siding extension; green: new track; blue: modification of track layout in stations (Source: VDV). On the right side the networks on which the operation of 740 m long trains in 2020 respectively 2026 will be possible are indicated; further extension of the network is foreseen beyond 2026 (Source: DB Netz). As can be seen, relatively few measures will allow a considerable extension of the 740-m network and ensure continuity of the 740 m-availability in several important corridors, i.a. in German sections of the Orient/East-Med- and Rhine-Danube Rail Freight Corridors.

3.3. Why small-scale low-cost improvement tend to be neglected

Reasons for the negligence of small-scale low-cost investments into rail are manyfold:

1) **The “prestige-factor” of small-scale low-cost improvements is often lower**; overall they receive lower attention in the public awareness, making them less attractive for (political) decision-makers to provide funding for. This is in particular true for projects primary targeted at rail freight.

   A solution could be higher publicity and better communication, highlighting in particular the value of these improvements both on local level and in a broader corridor context, even on an international level. Corridor organisations, such the EU Rail Freight Corridors, as well as corridor-oriented activities in the framework of for example the Interreg-programs, could help to achieve this. The CORCAP-program for the OEM-corridor could be seen as a model, which should be followed up and find application on further corridors in the future.

2) **The administrative effort in relation to the entire project size is often somewhat higher**, both on the side of the project owner as well as on the side of the funding entities (national Ministries and EU institutions). This concerns for example the preparation of funding applications, project management during the implementation phase and reporting. Funding instruments, especially on European level, are often adapted to large-scale projects.

   Several solutions could help to address this problem: One would be to develop dedicated funding instruments for small-scale low-cost improvements with lower administrate requirements. Another solution could be to provide a “funding pot” for small-scale projects for a period of several years, without the need to specify concrete projects and provide full-fledged funding applications in advance, but with the possibility to retrieve funds for certain types of investments and up to a certain limit per investment over the duration of the program. A third approach could be to gather several smaller projects into “packages” of multi-location projects, in order to exploit synergies in the preparation and in project management. Finally, it could be considered to introduce the implementation of accompanying small-scale projects along a corridor as a conditionality for the provision of funding to large-scale projects along the corridor concerned with a view on ensuring the practical exploitability of the potential benefits of the large-scale projects. There are pros and cons connected to each of the above solution approaches, but a balanced combination of two or more of the approaches indicated above could be worth to consider in order to achieve an improvement compared to the status quo. A corridor perspective would be highly valuable in most of the proposed solution approaches in order to support the necessary coordination across borders.

3) Also **planning law is often not facilitating small-scale projects**, since planning procedures are in many cases equally complex and “heavy” as for large-scale projects, e.g. regarding the requirements on elaboration of studies and need for approvals and permits. A specific challenge is that environmental protection provisions are often focusing first and foremost on local environmental impacts while positive global effects are usually not as prominently taken into account, thereby not reflecting the in the past years growing awareness and broad agreement on the severity of global climate change. The development of the railway system can help to reduce Greenhouse Gas Emissions from the transport sector and thus help to fight global climate change. Modal shift (to rail) is indeed one of the most efficient measures to achieve quick reductions of GHG-emissions. Thus, while the local environmental impacts of both a railway project and a road project might be negative, the railway project will likely have a positive global environmental impact – reducing GHG-emissions through modal shift – while a road project would even have a negative impact both on the local *and* on the global level, aggravating climate change. Thus, environmental provisions relevant to planning of transport infrastructure one-sidedly focusing on local impacts are to the disadvantage of rail and entail a risk of a sub-optimal development of the overall transport system from an environmental point of view.

   Thus, it might be reasonable to carefully consider reducing certain requirements for measures exclusively taken within the existing railway right of way or only locally involving an enlargement of the railway area. It should be carefully analysed how environmental provisions in planning law could be adapted to allow a better balancing of local versus global effects of infrastructure projects, in particular taking into account the long-term importance of rail improvement projects for modal shift to rail.

4 MEASURES FOR SMALL-SCALE LOW-COST IMPROVEMENT OF INFRASTRUCTURE

4.1. Signalling measures

Signalling measures include various measures in order to increase the capacity of a railway line. Most common measures are the shortening and harmonisation of block lengths and the addition of signal repetition balises,

Since most railway lines in Europe are mixed traffic lines, signalling measures are often not specific for freight, but benefit all traffic on a line, which is why they are not dealt with in further detail in this study. However, running parameters of freight trains have to be taken into account, when designing the concrete solution on a line or line section. When this is properly done, signalling measures can contribute to facilitate the operation of longer and/or heavier freight trains.

4.2. Extension of sidings

4.2.1. Sidings and train length

"Siding" in the railway context is an umbrella term for a low-speed track distinct from a main through track. Sidings can be found in stations, railway yards and terminals, but also out on railway lines. In the latter case they usually function as passing sidings; as such they are connected to a main track in both ends and allow trains travelling in opposite directions to pass (on single-track lines) or trains travelling with different speeds in the same direction to overtake each other. Sidings in stations and yards are – beyond allowing passing or overtaking - used for marshalling and parking of trains or wagons, but also for loading and unloading, such as in terminals. Sidings only connected in one end to another track are called single-ended or dead-end sidings.

A particular form of sidings are industrial sidings (or industrial spurs), serving directly industries for loading and unloading of freight wagons at a factory or warehouse. Sidings for loading and unloading – may it be in terminals or as industrial spurs – are entry- and exit-points of the rail freight system and form as such part of the so-called "last-mile infrastructure".

As can be seen from the above description, sidings may take different forms and fill a multitude of functions. They play an important role both for access to the rail freight system, for forming and splitting of trains as well as – by allowing passing and overtaking of trains – in traffic operations. The usable length of sidings has a direct impact on the maximum length of trains, which may operate over a line or line section or which can be handled in a terminal.

The train length is one of the main factors influencing the efficiency and competitiveness of rail freight transport – in general longer trains allow rail to realize economies of scale, reducing the unit costs in terms of transport costs per net-ton kilometre (the relation is not linear; there are step-change effects, since increasing train length also increases the train weight, requiring from a certain point additional traction power in form of an extra loco (there are certain other factors as well); however, this does not change the general validity of the statement. A large part of European freight is today operating with sub-optimal train length, mostly due to infrastructure constraints). Therefore, the urge for longer trains is ranking high among the requests by freight railway undertakings to improve the conditions for rail freight.

This also explains why the train length requirement has been taken up among the minimum infrastructure requirements for the Core Network for freight laid down in Art. 39(2a) of the TEN-T-Regulation (Regulation

(EU)1315/2013). The TEN-T Regulation requires the possibility to run freight trains of at least 740 m length (total length, including locomotive(s)) on the Core Network for freight at the latest by 2030.

It is important to note, that the Regulation does not refer to the infrastructure per se – i.e. the length of sidings – but to the length of trains. To which extent this leads to a need to extend sidings (here sidings used for passing, overtaking and formation and splitting of trains are concerned) requires a careful analysis of traffic patterns, market needs and infrastructure. Also, the aspect of timetable stability respectively recovery time in case of traffic disturbances has to be taken into account. Traffic management can help to support the operation of 740 m long trains.

This means that certainly not each siding along the Core Network for Freight has to provide a usable length of 740 m (even today there are on many lines train lengths permitted which exceed the length of sidings on some intermediate places), while at the same time it is neither realistic to operate 740 m long trains without having certain sidings adapted to this train length. Generally, it can be said, that, the more dense the traffic on a line (including passenger traffic!) and the higher the share of freight trains with a length of 740 m, the bigger the need for sidings with a usable length of 740 m. Stations, where formation or splitting of freight trains take place need to be analysed separately.

4.2.2. Cost-efficient extension of sidings

A question which arises is how to implement the extension of sidings in a cost-effecient way. In the following a number of suggestions are made, which could deliver input to an approach allowing longer trains on a line or line section. However, as indicated above, further aspects – such as traffic patterns – naturally need to be taken into account; therefore, it is not always possible to extend sidings "where it is cheapest".

The suggestions presented in this report should be seen as "food for thought"; it is out of question that a final decision on the choice of places where sidings should be and are feasible to become extended requires a thorough and detailed analysis, taking into account a multitude of factors and many specific local conditions. Just to illustrate the complexity of such an analysis, it shall be mentioned that factors such as gradients, curves, location of level crossings, etc. need to be taken into account, to mention only a few. It would go beyond the scope of this study to elaborate such a comprehensive and by necessity very technical guideline. This study does not claim to provide general solutions for all cases in which an extension of sidings is needed. Nonetheless the suggestions below may help to elaborate an approach enabling the operation of longer trains or to increase the number of places capable of handling longer trains with a view on improving the resilience of traffic operations in case of disturbances.

Siding extension in stations or on the line

When the need arises to extend sidings along a railway line in order to allow longer freight trains one of the questions arising is, whether to extend sidings in a (major) railway station or rather (nearby) passing sidings out on the line (we disregard the fact, that this place technically may be a small station).

A first factor which must be taken into account is, whether the station in question is a point of origin or destination of long freight trains, i.e. whether long freight trains need to be formed or splitted at the station, or whether they need to be handled in some other way (e.g. transferred to a terminal from that station or change travelling direction (e.g. at railway nodes where several lines meet)). If this is the case, it will be unavoidable to extend (some of the) sidings in the station concerned.

However, if a station is "only" passed by freight trains and does not have any traffic function for freight (beyond crossing or overtaking of trains), then it might be worth to consider extending nearby passing sidings instead of tracks in major stations, for the following reasons:

- the track layout of major stations is usually more complex than that of passing sidings. Thus, even the need for extension of only one track in a station may trigger a rather comprehensive modification of the track layout with many switches and signals to be moved. An illustrative example is given in the figure below (left graphic): An extension of only one track, here Track 2, requires by necessity the extension of a least one further track, possibly even more. In contrast to this, an extension of a simple passing siding is often easier and requires less extensive works (right graphic). Therefore, the adaptation of a passing siding to longer trains is often cheaper than an adaptation of a station.
- stations are often surrounded by built-up areas, thus land acquisition for enlarging the station could be a challenge respectively be connected with high costs. Further, if the station is located in the vicinity of residential areas, increased freight activities in the station could negatively impact on the societal acceptance of rail freight (though the pure use of a station for passing and overtaking of freight trains certainly would not be as severe as uses such as terminal handling or shunting).

There are, of course, further aspects to be taken into account, such as the distance to the next places able to allow passing or overtaking of longer freight trains and the density of traffic of long freight trains. In corridors with high traffic density, it might be necessary to provide more than one track for passing/overtaking of long freight trains at a certain location. In that case it might be again advantageous to extend tracks in a station.

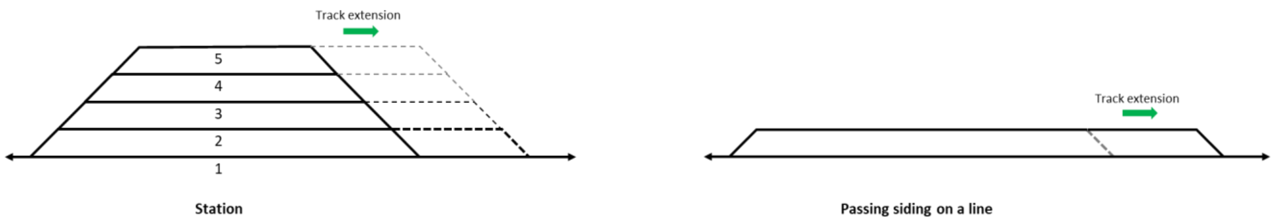

Figure 6: Extension of sidings in stations versus extension of passing sidings (own figure).

Sidings at former or reduced station sites

Structural changes in traffic patterns as well as changes in the way how railways are operated have made a number of minor or medium-sized stations redundant or at least reduced the number of tracks needed in those stations. This concerns in particular station tracks primarily or exclusively used for freight. The concentration of marshalling to few, high-performing marshalling yards has led to the closure of many, especially minor marshalling yards.

A typical layout of a railway station with freight handling – and that was in the past the vast majority of stations – included at least in one end of the station a so-called “headshunt”. This is a track usually of full or almost full train length running parallel to the main through track(s) and facilitating local shunting. It was used to move trains or wagon groups between different yard tracks without the need to enter (and thus block) the main through track(s).

With much of this infrastructure in many places having become redundant or drastically reduced – with the tracks either dismantled or remaining unused – opportunities arise for the establishment of longer sidings. Though train (and thus track lengths) may have been shorter in the past than today (respectively planned in the future), the advantage of using former station sites is that a passing siding can extend over the combined length of the former yard tracks and the headshunt, which in many cases gives a length which comfortably can accommodate substantially longer trains.

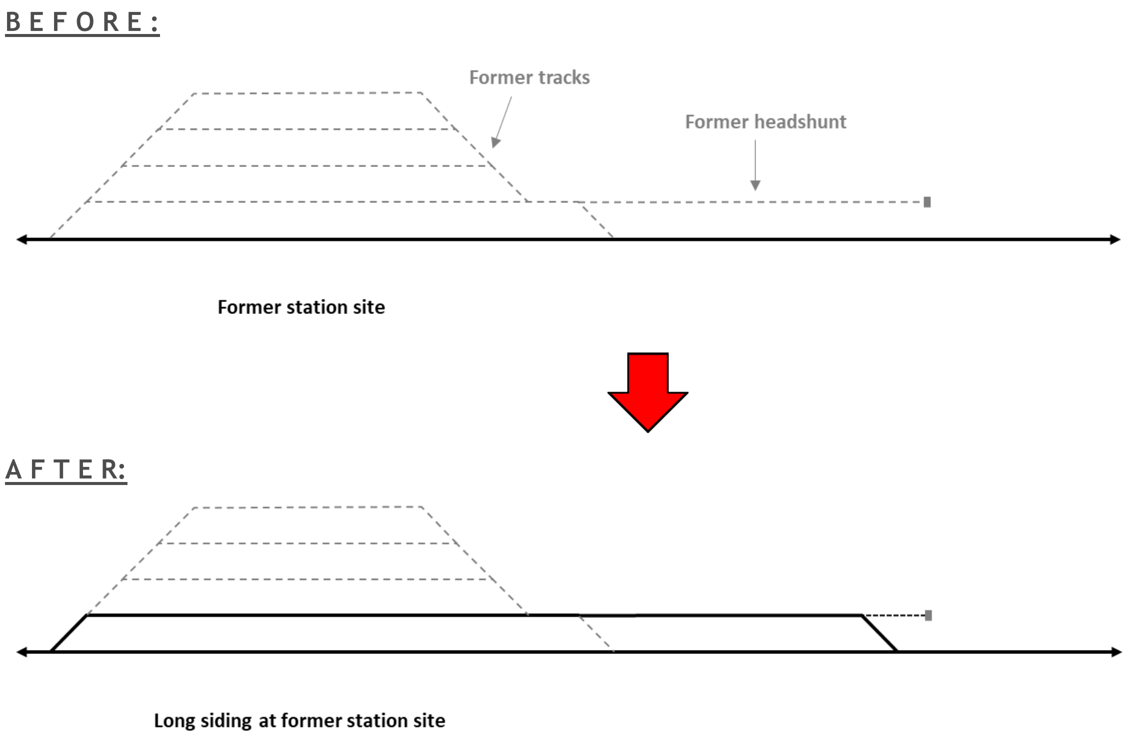

Figure 7: Establishing passing sidings on the land of former stations and freight yards can be a solution to achieve longer sidings, combining the length of the original yard tracks and the so-called headshunt track, earler used for local shunting (own figure).

Using parallel tracks of branch lines and industrial spurs

In the past (and partly still today) secondary lines or industrial spurs are branching off from a main line. Sometimes these lines respectively spurs are/were running over some distance parallel to the main line, before they are leaving the joint alignment with the main line. Though running parallel to the main line, they are operationally completely separated.

Sometimes these branch lines or industrial spurs see little use - or are even entirely out of use. In both cases - and if the parallel alignment is sufficiently long - it could be worthwhile making use of them to achieve long passing sidings (see lower graphic in the figure below). In best case only two additional switches will be necessary close to the point where the alignment of the branch diverts from the main line (as indicated in the graphic). In case the branch line or industrial spur is still in use and it has to be ensured that traffic from and to the branch is not hampered even when the siding is occupied by a train, further switches may be needed; the same is true in case entry and exit to the passing siding needs to be made possible from the main through track of the station (both these cases are indicated as “optional” connections in the graphic).

In combination with sidings in the station, the proposed solution could also be used to create “double sidings” with capacity to hold two freight trains behind each other (one train in the station and one in the new siding established on the parallel section of the main line and the branch).

Of course, it has to be noted, that in case there is frequent traffic on the branch line, this solution could impact on the capacity of the main line, since trains from and to the branch would need to use the main line for entering and exiting the station when a freight train is occupying the passing siding.

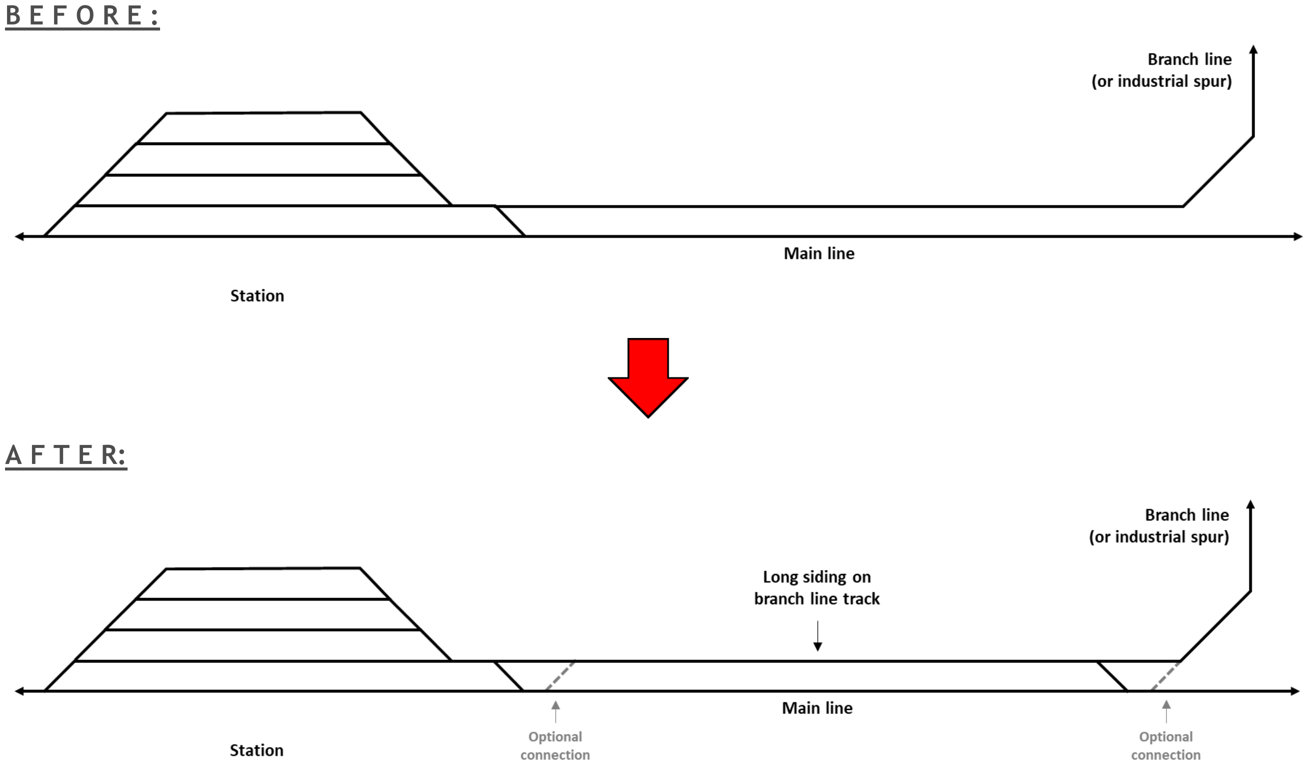

Figure 8: Sparsely used or un-used branch lines or industrial spurs running parallel to a main line before branching off could be used to establish long passing sidings (own figure).

4.3. Target values for train length

In case extensions of sidings are necessary to allow the operation of longer freight trains, it is recommendable to analyse at an early stage whether the target length for a certain line or line section should be the legally required minimum (only) – in the case of the Core Network for freight a train length of 740 m – or whether there is a business-case for bigger length.

Analyses made by the Railway Group of the Royal Institute of Stockholm indicate that the optimal train length – from a point of view of train operations efficiency – in many cases in Europe would be around 1.000 m rather than 740 m. Up to 1.000 m long trains could in many cases be hauled by a single four-axle electric freight locomotive without exceeding the maximum train weight, which can be hauled by a single locomotive and without requiring distributed power from a point of view of braking performance (i.e. additional locos at the end or in the middle of a train consist). In a global perspective, i.e. compared to typical train lengths in other major rail freight systems in the world, the target of 740 m constitutes a rather conservative value.

An important aspect in this context is, that the cost for extension of a siding – as a general rule - tends to decrease per meter of extension, since the overall cost for extension consists of a fixed part, relating to the need to open a work site, to move switches and signals, etc, and a variable part, relating to the magnitude of the extension, i.e. the number of meters which a switch, signal, etc is moved. Thus, per meter of extension the costs should – in general – go down when extending a siding by for example 300 m instead of 50 m. Of course, the actual cost is strongly influenced by the individual conditions, such as topography, curves, gradients and the possible presence of bridges, tunnels or buildings; these conditions can widely vary at each individual location. To be taken into account is further, that in case of a higher target value for extension of sidings probably also the number of sites concerned along a line or line section increases.

An analysis of the feasibility and business-case for train length beyond the legal minimum requirements should be made with a long-term perspective (taking into account that infrastructure investments are long-term and therefore "cement" infrastructure parameters for a long period of time) and ideally for a corridor or section of a corridor used by a significant number of trains with common origin and destination points (e.g. ports, marshalling yards or major terminals).

4.4. Improving terminals

Terminals are an important part of the infrastructure for rail freight, forming entry- and exit points of the rail freight system. As such they are part of the so-called last-mile infrastructure for rail freight. Two types of terminals can be discerned, (a) intermodal terminals and (b) general cargo terminals. The difference between both is in first place the type of cargo which can be handled and, depending on this, their equipment.

Intermodal terminals are intended for trans-shipment of standardized intermodal loading units between different modes, primarily road and rail (sometimes even inland waterways); some intermodal terminals also offer train-train trans-shipment (hub-terminals, gateway-terminals). The most common types of intermodal loading units are ISO-containers, semitrailers and swap-bodies and the most common types of handling equipment gantry cranes and reach-stackers. ISO-containers are used in maritime shipping and thus dominate in port-hinterland traffic, while semitrailers and swap-bodies play an important role in continental Combined Traffic (i.e. transport relations which do not involve maritime shipping).

General cargo terminals are intended for loading and unloading of conventional freight wagons and the handling equipment is consequently cargo-specific. Loading and unloading may happen under open sky or under roof. There are also terminals, sometimes referred to as "railports", which offer both, handling of intermodal loading units and of general cargo.

The further development of terminals is important to increase the attractiveness and competitiveness of rail freight. The following measures can contribute to further improve the efficiency of terminal operations and to decrease transshipment costs and times.

4.4.1. Extension of transshipment tracks

As already indicated earlier in this study, increasing the train length is one of the most efficient and by railway undertakings most demanded technical measure to improve the competitiveness of rail freight. The possibility to operate longer trains depends on the one side on the line infrastructure and on the other side on the possibility to handle trains at the points of origin and destination of the trains. Terminals belong to these origin and destination points.

The ability to handle freight trains of a certain length can at a minimum level be ensured by providing dedicated arrival and departure tracks of sufficient length at a terminal or in a yard in its vicinity. Between the arrival and departure tracks and the transshipment tracks – where the loading and unloading is taking place – the trainsets are transferred as shunting movements. If the transshipment tracks are shorter than the maximum train length permitted in the arrival and departure tracks, the trainsets have after arrival to be split and moved to the transshipment tracks in separate consists, respectively be consolidated again before departure. This is taking extra time and may require extra shunting resources in form of locos and personnel; thus, an insufficient length of transshipment tracks hampers the efficiency of terminal operations and the competitiveness of intermodal transport.

The target should be to “harmonize” the usable length of arrival and departure tracks as well as transshipment tracks at at least 740 m, i.e. in line with the target value for the train length in the Core Network for freight. The extension of transshipment tracks to full train length should ideally be done in combination with adaptation of the track layout to permit the direct entry and exit of trains from and to the main line (in very small terminals separate arrival and departure tracks may even be omitted, if transshipment tracks are connected to the main line in both ends (see next paragraph)).

4.4.2. Connections to the main line at each end of the terminal

A further step to improve the efficiency of terminal operations – and even to allow new types of train services – can be taken by connecting the terminal at both ends to the main line, instead of only at one end. Again, at a minimum level this should be ensured for the separate arrival and departure tracks (and usually these are connected in both ends already today), but ideally even the transshipment tracks would on both sides become connected to the main line, allowing direct entry and exit in either direction.

Connecting the transshipment tracks at each end to the main line would allow new types of train services: While today intermodal trains in most cases are point-to-point services, i.e. connections between two terminals, in the future “liner trains” making short intermediate stops (ca. 20 – 60 minutes) for quick loading and unloading of loading units could complement the service portfolio in intermodal transport. This production model would resemble the train operating principle in passenger transport, where trains also make intermediate stops to allow passengers to board and disembark. Such a new production model could help to enlarge the market for intermodal transport by attracting freight flows, which for the time being are too small to be served with the traditional production model of full-length point-to-point trains. Such type of liner trains are since many years successfully in operation in Japan.

Combining the two aforementioned measures of improvement – i.e. the extension of tracks and the connection to the main line at each end of a terminal – allows to define different “levels” or “steps” of improvement for intermodal terminals, as shown in the table below.

Level	Feature / measure	Impact on efficiency of terminal operations / competitiveness of intermodal transport	Comment
1	≥ 740 m long arrival and departure tracks (not necessarily identical to transshipment tracks)	+	Minimum requirement to receive trains making use of TEN-T infrastructure parameters
2	= Level 1, plus: ≥ 740 m long transshipment tracks	++	Leading to improved cost and time efficiency of terminal operations, reducing need for shunting operations (no splitting of trainsets)
3	= Level 2, plus: Direct entry and exit to/from transshipment tracks from/to main line (at one end)	+++	Leading to improved cost and time efficiency of terminal operations, reducing further - and partly eliminating - need for shunting operations
4	= Level 3, plus: Transshipment tracks at each end connected to main line	++++	Leading to improved cost and time efficiency of terminal operations, reducing further - and potentially eliminating - need for shunting operations; Creating possibilities for new production models in intermodal transport (liner trains with intermediate stops)

Table 2: Features respectively measures to improve intermodal terminals and their impact on the efficiency of train operations respectively competitiveness of intermodal transport (own elaboration).

4.4.3. Electrification of end sections of transshipment tracks

In Europe the majority of the main line network is electrified; consequently, freight trains in long-distance traffic are mostly hauled by electric locomotives. However, in intermodal terminals (and partly general cargo terminals) electrification of the handling area is not possible, since an overhead wire above the tracks would hinder the loading and unloading by crane or reachstacker. Therefore, trainsets usually have to be moved from and to the transshipment tracks by local diesel shunting locomotives.

This can be avoided by electrifying the end sections of the transshipment tracks just to the point where the handling area begins, so that the (electric) locomotive just remains under the overhead wire, while the first wagon already is in the non-electrified track section, allowing it to be loaded and unloaded.

The electrification of end sections of the transshipment tracks makes sense in particular in terminals allowing direct movements between the transshipment tracks and the mainline. It would facilitate primarily the departure of trains (arriving trains would probably have the locomotive in the wrong end), however, even shunting with electric line-haul locomotives instead of separate diesel shunting locomotives is a solution.

Coupling the electric locomotive to the trainset when the train is still in the transshipment track can also help to speed up departure since certain train preparation processes (e.g. brake test) can take place while loading and unloading is still on-going.

The first photo below shows an example of a terminal with electrified end sections of transshipment tracks. In the foreground of the picture the catenary of the overhead wire is clearly visible; it just ends before the handling area starts. The second photo shows an electric locomotive coupled to a train and placed just at the end of the electrified end section.

Figure 9: Intermodal terminal with end sections of the transshipment tracks electrified (foreground). In the handling area itself the tracks are not electrified (Source: Wikimedia)

Figure 10: Electric locomotive in a terminal with electrified end sections of transshipment tracks. The front part of the locomotive is still in the electrified section, with one pantograph lifted to the overhead wire, while the rear part of the locomotive is already in the none-elecrified section. (Photo: Sondermann/KTL)

It should be mentioned that the importance of electrification of end sections of transshipment tracks is sometimes considered being of less importance today, since new locomotive concepts in form of electric locomotives with “last-mile package” began to enter the market some years ago. Such locomotives operate as conventional electric locomotives when running on a railway line, but are equipped with separate propulsion – usually a small diesel motor or electric power from on-board power storage (batteries or super-capacitators) – and thus able to move trainsets over shorter distances on non-electrified tracks.

However, the number of electric locomotives with last-mile package is still relatively low and also comes with a higher cost. Thus, terminals intending to attract more traffic could still improve their competitiveness with help of electrification of end sections of transshipment tracks.

4.4.4. Adaptation of terminal access tracks for “momentum entry”

A further way to improve operations in intermodal terminals is to make use of a unique characteristic of the railway system – the low friction between steel wheel and steel rail. This leads to long braking distances - which in the context of operation in terminals can be turned into an advantage.

The principle of “momentum entries” (in German: Schwungeinfahrt) is that electric locomotives enter a terminal with their train, lower the pantograph – still moving – before the overhead wire ends, and let the train coast on the non-electrified transshipment tracks. The kinetic energy of the train is sufficient to move the train to the end of those tracks, where ideally the electric overhead wire starts again.

With this operating method electric locomotives are able to move their train to the right position even on non-electrified tracks in a terminal without the need to make use of shunting locomotives or to rely on a “last-mile package” (i.e. propulsion independent from the power supply via the electric overhead wire).

The principle of momentum entries is successfully applied since many years in several German intermodal terminals, such as München-Riem, Stuttgart-Kornwestheim and Ludwigshafen, as well as in port terminals of HHLA and Eurogate in Hamburg. Even in the new “Megahub Lehrte”-terminal close to Hanover, designed for train-train transshipment and with transshipment tracks connected to the main line in both ends, this operating principle is planned to be applied.

The maximum efficiency gains in terminal operations can be gained by combining momentum entries with electrification of the end sections of transshipment tracks, since this would allow the locomotives to re-enter an electrified track section when coming to a stand-still at the end of a transshipment track, and to depart again from there to continue the journey.

As with the electrification of end sections of transshipment tracks the importance of momentum entries in principle might be expected to gradually decline with more electric locomotives with last-mile package entering the market. However, as mentioned earlier, locomotives with last-mile capability are still few and are also more expensive. Thus, the principle of momentum entries will likely represent a cost-efficient solution for many operators and terminals even in the future.

While momentum entries are an operational measure rather than an infrastructure measure, they nonetheless put certain requirements on the infrastructure: For the first the track layout must allow for a direct entry from the main line to the transshipment tracks of a terminal. For the second it is crucial that the train is able to maintain a certain minimum speed in order to enter the beginning of the non-electrified section with sufficient kinetic energy to coast through the entire non-electrified track section. Further, certain adaptation of signalling may be needed as well as possibly adaptation of operational rules.

4.4.5. Further measures in terminals

There is generally a need to constantly develop the network of rail freight terminals in order to adapt to changing market needs, stemming from new localisation patterns of industries and businesses and new logistics concepts, as well as in order to make use of innovative technology and keep pace with developments of the rail network in terms of standard. The aspect of 740 m long trains is here a central one and has already been mentioned.

Especially in Central-Eastern Europe there is a need to develop the network of terminals in terms of quality (standard) and quantity (density). While in parts of Western Europe already a level of “saturation” has been reached regarding the terminal network density – with the risk of “cannibalisation effects” in case further terminals would be added – the network of terminals in parts of Central-Eastern Europe is still rather sparse.

An approach to bundle volumes, increasing the traffic base of a terminal – and also of trains serving the terminal – is to establish combined terminals for intermodal and non-intermodal cargo (sometimes called “Railports”). Non-intermodal cargo can be bulk-cargo (like sand, gravel, etc.), break-bulk and general cargo (such as goods transported in bags, drums, palletized goods, etc.). This approach could in particular be considered for locations where a critical mass might be difficult to achieve – at least in an initial phase – to justify establishment of a terminal when exclusively targeting one type of traffic. But even in case such a critical mass can – or already is – reached, combined intermodal and non-intermodal terminals could create synergies increasing their growth potential and creating higher flexibility to respond to market changes. The figure below shows the principle system layout of a combined intermodal and non-intermodal goods terminal (Railport).

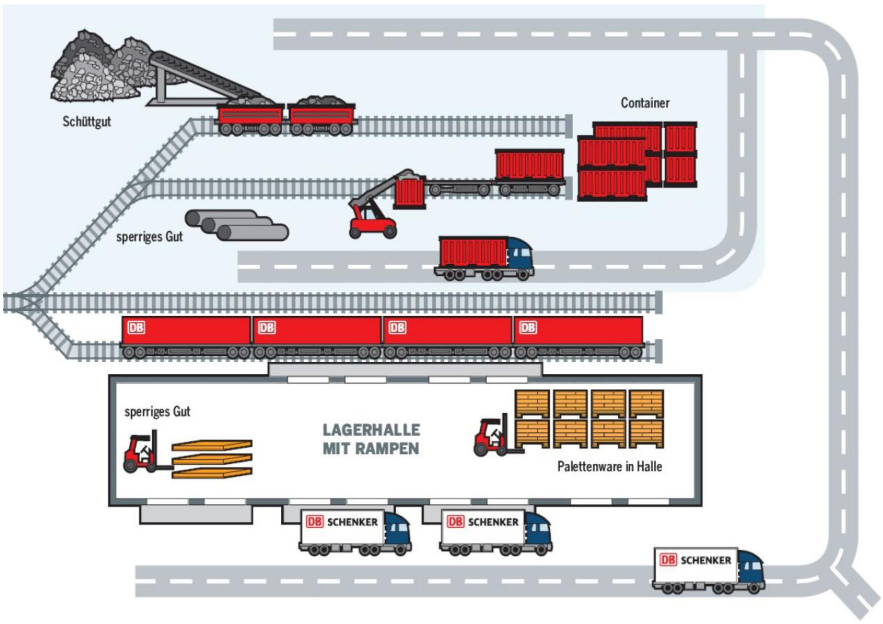

Figure 11: System layout of a Railport, a freight terminal for intermodal and non-intermodal freight. The terminal allows handling of bulk cargo under open sky (upper part of the graphic), intermodal loading units (center) and palletized and break-bulk goods under roof (lower part of the graphic). (Source: DB Schenker).

4.5. Industrial spurs

Part of the last-mile infrastructure are also industrial spurs, connecting directly factories and warehouses to the rail network. This solution is of particular interest for customers with major and regular transport volumes. An example of industry sectors which even today in case of new establishment consider and at least partly make use of industrial spurs is the automotive industry and the chemical industry. In both industry sectors rail remains an important part of logistics chains. In general, the potential of industrial spurs is certainly not fully used today. The figure below illustrates the conceptual structure and components of last-mile infrastructure for rail freight.

The establishment as well as the modernisation and adaptation to today's logistical requirements, of industrial spurs could be supported by dedicated support programs. In a few European countries - Germany, Austria, Switzerland and UK - such dedicated support program exist (in Germany on federal and on state level) and the European Commission carried out a study in 2016 on "Design features for support programmes for investments in last-mile infrastructure".

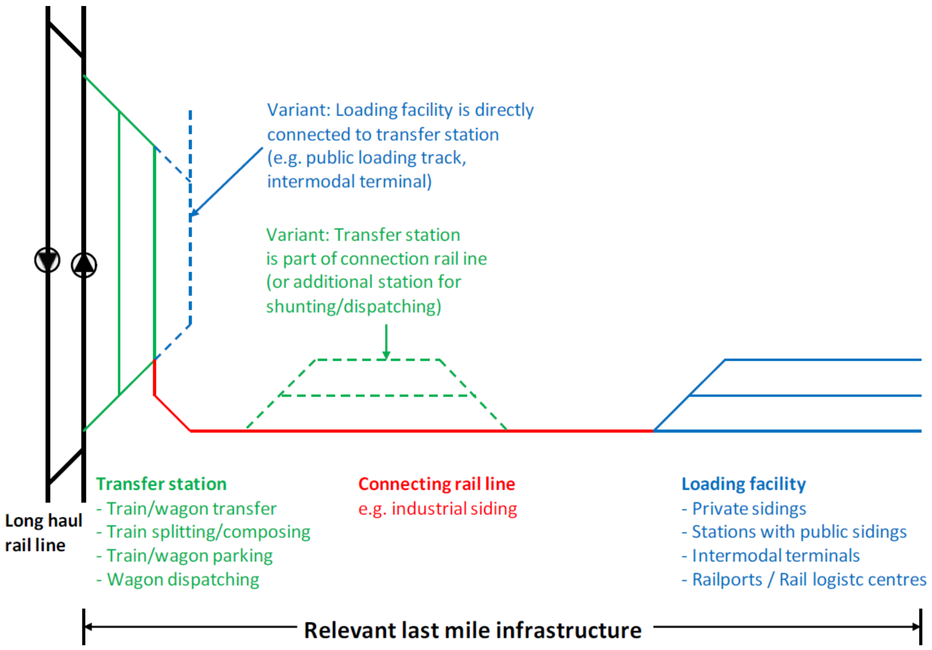

Figure 12: Components of last-mile infrastructure for rail freight. (Source: EU Commission)

4.6. Triangle tracks

Triangle tracks – or connection curves - are shorter track sections, usually of some hundred meters up to a few kilometres, which connect two railway lines which merge nearby, often in a station.

The primary purpose of triangle tracks is to avoid a change of travelling direction for trains changing from one line to the other line. Triangle tracks can be used both by freight and passenger trains and there are plenty of examples where this is the case. However, while in passenger traffic the main objective of using triangle tracks is (today) to reduce travel time, their benefits for freight traffic go beyond the pure time-saving aspect; having the possibility to avoid changing the travelling direction means in freight traffic also eliminating the need for number of operational processes: de-coupling of the locomotive, re-positioning the locomotive to the other end of the train, re-coupling the locomotive and carrying out a (simplified) brake test. These processes require personnel and specific skills and are thus associated with extra costs. In earlier times these processes were also relevant for passenger trains, however, the nowadays wide-spread use of multiple units and push-pull trainsets – i.e. fixed train configurations allowing the train to run in both directions without changing their composition – has made this aspect far less relevant for passenger traffic. A further aspect is, that in passenger traffic there is often a wish to serve the station, allowing passengers to enter and disembark, which in certain cases may prevent passenger trains from making use of triangle tracks.

Triangle tracks can also help to free up capacity in the station where the two lines merge, respectively reduce the need for infrastructure (tracks) in those stations, since trains using a triangle track do not need to pass the station. In this sense, a triangle track constitutes the simplest form of a freight-bypass. However, the term freight-bypass is usually used for more extensive lines around railway nodes; freight-bypasses are longer and may also connect more than two railway lines (see next chapter).

The photo below shows the triangle track at Boba on the line between Budapest and Ljubljana. This triangle track is used mostly by freight trains, while passenger trains often change travelling direction at Boba station, which also is a passenger stop.

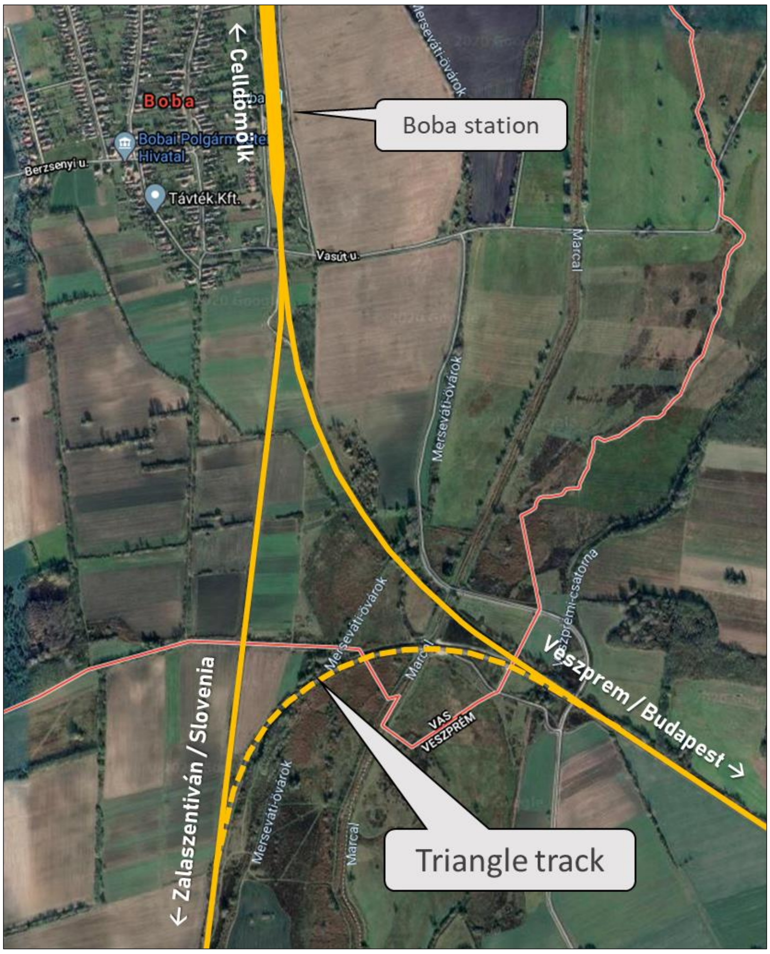

Figure 13: The triangle track at Boba station in Hungary allows freight trains from Budapest towards Slovenia and vice versa to avoid a change of travelling direction. The triangle track is around 1,5 km long.

4.7. Freight bypasses

Freight bypasses are railway lines around ("bypassing") railway nodes, mostly in major cities and conurbations. They relieve the centrally located main stations from freight traffic and allow a separation of freight and passenger traffic in the area concerned. By doing so they help to reduce timetable and capacity conflicts between freight and passenger traffic, but also help reducing negative impacts of freight traffic in central parts of a city, such as noise and risk related to transport of Dangerous Goods.

In some cases, bypasses are also used by passenger trains, either long-distance trains bypassing certain major stops or local trains serving stations along the bypass.

Freight bypasses distinct themselves from triangle tracks, which have been dealt with in the previous chapter, by having bigger length (up to some tens of kilometres) and often connecting to more than just two railway lines. Also, their purpose is not necessarily to avoid changes of travelling direction but rather to provide an alternative route, even if the direction of travel is not changing. Further, freight bypasses are more frequently also double-track, while triangle tracks in many cases are only single-track (exceptions confirm the rule). The track layout of freight bypasses is often more extensive and complex; triangle tracks may be part of freight bypasses in order to ensure the connection to other railway lines crossing the route of a freight bypass.

First freight bypasses were built around the 1880-ies in order to respond to growing traffic and increasing speed differences between freight and passenger trains. An example of an early freight bypass (opened 1909) can be found in Hanover in Germany, shown in the figure below. At those times freight bypasses were often built on an elevated embankment, allowing the bypass to easily cross roads and other railway lines.

However, even nowadays still new freight bypasses are built, one example being the bypass St. Pölten, shown in the second figure below. In contrast to freight bypasses from earlier times, nowadays these lines are often partially running in tunnels or in cuts, in order to reduce barrier effects. Where possible, they are also aligned with other major infrastructures, such as in the case of St.Pölten a motorway.

A special form of bypasses are ring lines for freight around very large cities, such as Berlin, Paris or Moscow. The outer Berlin railway ring (Berliner Aussenring) has a length of 125 km (and is also used by local passenger services). This also shows that freight bypasses can in many cases not be considered as small-scale low-cost. However, since the size – and possible investment cost – for freight bypasses can widely vary, they have been included in this study as a possible improvement measure for rail freight.

Figure 14: Freight bypass in the node of Hanover in northern Germany. The double-track bypass was opened in 1909, runs mostly on an elevated embankment and connects to several railway lines radiating from the city. (Source: Wikipedia)

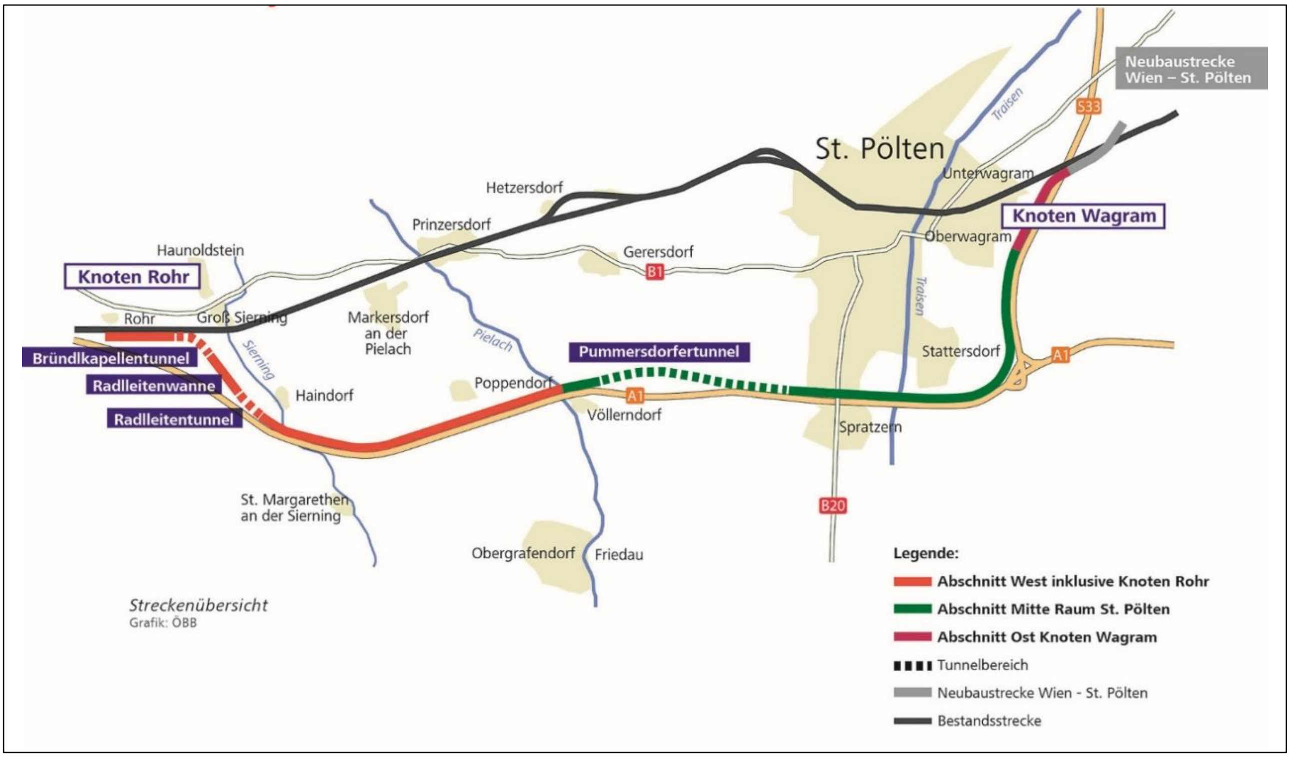

Figure 15: Freight bypass of St. Pölten in Austria, opened in 2017. The double-tack freight bypass is ca. 25 km long, runs mostly parallel to a motorway and comprises three tunnels, of which the longest is 3,5 km long. (Source: ÖBB)

4.8. Creating alternative routes through linking of consecutive secondary lines

Since long-distance freight trains (in contrast to passenger trains) between their origin and destination usually do not have to serve intermediate stations, there is quite some freedom in the routing of a train. In case of large traffic flows this opens for establishing alternative freight routes (corridors) using consecutive secondary lines with relatively less traffic than the main route. Especially in cases where the geographical flow patterns of freight and passenger traffic differ, this could be an interesting option to promote a partial separation of freight and passenger traffic, thus reducing timetabling conflicts.

Another factor which facilitates the use of secondary lines for setting up alternative routes for freight trains is, that freight traffic usually does not require a high maximum speed (as passenger trains do) in order to meet market expectations; thus, freight traffic is – within certain limits – less “demanding” when it comes to the route alignment and can accept routes with tighter curves and lower speed standard. This reduces the likelihood that extensive adaptation of the alignment is necessary in order to make a route suitable for freight.

However, factors which indeed are important for freight are gradients, axle- and meter-loads, train length and loading gauge. With regard to these factors an upgrade of the track sub- and/or superstructure, possibly even tunnels (loading gauge), and adaptation of track layouts in stations or passing sidings may be necessary. Concerning gradients, the establishment of alternative freight routes should ideally not increase the ruling gradient between origin and destination of the freight trains, i.e. gradients on the alternative freight route should not be (substantially) higher than on the route, to which the new route intends to be an alternative. Also, alternative freight routes should be electrified throughout, since the majority of long-distance rail freight in Europe is using electric traction.

An example of an alternative freight route currently under establishment by combining a number of consecutive lines with less traffic is the so-called Eastern Corridor (“Ostkorridor”) in Germany, which creates an additional North-South route for port-hinterland traffic between the German seaports and Southern Germany/Austria/Italy, see the figure below. It should be noted that the railway line constituting the corridor are not necessarily secondary lines in a formal sense, but rather “secondary main lines”.

Figure 16: The "Ostkorridor" in Germany (in the map in green) is an example of a corridor for freight, which is created by linking a number of consecutive lines, which originally have not been built with a view on serving primarily long-distance freight between the German seaports and southern Germany. The purpose of the corridor is to relieve pressure on the traditional North-South routes (in amber colour). (Source: www.ostkorridor.de)

4.9. Electrification of gaps

Electric railways offer generally higher energy efficiency and lower operating costs than non-electrified railways, at least in the European rail network, where electrification is the "standard". Electric traction also avoids local emissions and is usually quieter, two increasingly important factors for the societal acceptance of and political support to railways. Electrification also offers the possibility to introduce regenerative braking, converting the train's kinetic energy into electricity when braking and feeding it back into the power supply system.

In view of the political and public discussion one of the most important features of electrified railways is, that they are independent of a specific primary source of energy. The already high share of electrification of the European rail system, with an even higher share of traffic moving on this electrified network, allows rail to make use of renewable green energy for most of its traffic without technical modification of the railway system as such. This makes railways since many decades the leaders of electro-mobility both in passenger and freight transport. Even with electrification now on the agenda for other transport modes, in particular road transport (though here so far focused on passenger cars rather than heavy goods vehicles), it is unlikely that rail will lose its competitive edge in terms of environmental performance.

With the generation of renewable energy also facing economical as well as acceptance challenges and limits, the aspect of energy efficiency will likely gain in importance in the future. While electrification may not any longer be unique to rail in a longer-term future, rail's ability to *combine* electrification – and thus the possibility to use renewable energy – with an outstanding level of energy efficiency - thanks to the low friction inherent to the steel-wheel-on-steel-rail principle only used by railways – will remain unique for rail and result in rail keeping its leadership role in environmental performance.

With electrification being the "standard", at least in the European main line rail network, electrification gaps in this network have a huge influence on the efficiency of train operations or result in trains making detours in order to avoid electrification gaps. Even if of limited scale in terms of line length, the remaining electrification gaps respectively their elimination consequently play an important role for improving the competitiveness of rail and can cause important positive network effects.

The elimination of electrification gaps on current secondary lines can also help to create new, alternative or complimentary through routes for freight, creating additional capacity and/or allowing a partial separation of passenger and freight traffic in congested sections or nodes, respectively increasing the resilience of the overall rail network in case of major traffic disruptions.

An example of network effects of stemming from an elimination of an electrification gap could be observed in Western Hungary with the electrification of the Mosonszolnok-Csorna-Porpác section of line 16, completed in 2015. This electrification, ca. 87 line-kilometers, created a new, fully electrified through route for port-hinterland traffic from the Adriatic seaport of Koper in Slovenia to both Central Hungary (Budapest) and to various destinations in Slovakia and resulted in an increase of freight traffic on the lines concerned. Traffic volumes increased by 80-120% following the electrification, and even during the COVID-pandemy, traffic volumes remained ca. 60-80% higher than before the pandemy, demonstrating the positive effect of such kind of improvements.

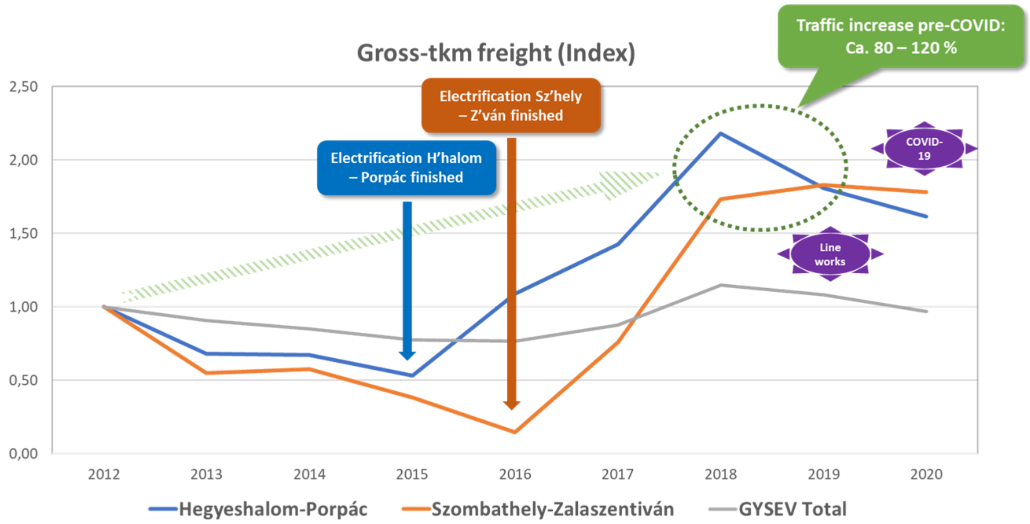

Figure 18: Freight traffic development on GYSEV North-South Axis versus GYSEV total network.

The electrification of railway lines can in many cases still be considered as a relatively small-scale low-cost measure and, if the lines concerned carry (long-distance) freight traffic, cause important positive network and corridor effects.

4.10. Directional running

Directional running means the operational combination of two separate (single-track) lines, with uni-directional traffic on each of them and thus jointly functioning as a double-track line. The rationale behind this way of operation is to achieve the effects of a double track line – in terms of capacity and fluidity of traffic – without the need to invest into double-tracking of single-track lines.

The concept of directional running can be a suitable approach in areas where single track lines are forming geographically parallel routes between major traffic nodes. A pre-condition is that there are no major origin or destination points of traffic flows between those nodes on the single-track lines concerned, since these usually would need to be served in both directions. Alternatively, if such a situation should occur, a possibility is to connect the parallel single-track lines at suitable points in order to allow reverse movements over shorter sections on the "opposite" line.

Directional running is generally only feasible for freight traffic, since passenger trains usually call at intermediate stops, which naturally need to be served in both directions.

For this reason, directional running can be found mainly in railway systems which exclusively or primarily are used for freight, such as in North America. Also, in Europe a large share of main lines is double-track, which reduces the need to consider directional running.

However, it is worth to note that there are some examples of directional running in freight traffic even on European mixed traffic networks (with passenger traffic of course not being subject to directional running). Thus, though the concept of directional running may be overall of rather limited relevance for Europe, it might nonetheless be useful to consider - for freight traffic - in areas or sections of corridors where today (only) parallel single track lines exist.

Examples of directional running in North America

An early example of directional running can be found in Nevada in US, where two parallel, mostly single-track lines between Wells and Winnemucca over a distance of about 290 km are operated as a double-track forming part of Union Pacific's trans-continental route between the San Francisco bay are and Salt Lake City / Chicago. The two lines were originally built and operated by two different companies (Western Pacific and Southern Pacific). Since railroads in US have traditionally been (and are still today) tough competitors when dealing with each other, it was quite a departure from the normal when the two companies agreed to share their tracks to allow directional running. Eastbound traffic was directed to the Western Pacific's Feather River Route and westbound traffic towards California to the Southern Pacific's Overland Route. Though both lines are today under the auspices of the same company, Union Pacific, the operating practice remained in use. Both lines are at various points connected to each other, allowing shorter reverse movements on the "opposite" line in order to reach destinations only served by one of them.

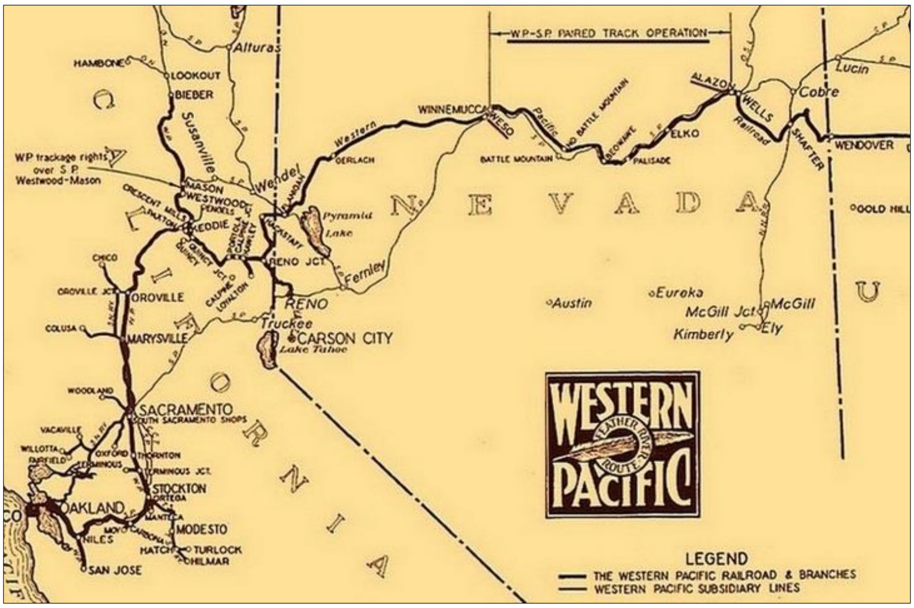

Figure 19: In this map from 1939 the different routes between the San Francisco Bay Area and Utah across Nevada were still operated by two different companies. Though being strong competitors they agreed to share tracks between Winnemucca/Weso and Wells in order to enable directional running – in the map the section concerned is indicated as "W.P.-S.P paired track operation". Source: https://nevadagram.com

A further example of directional running in US occurs between San Antonio and St. Louis, where two mostly single-track routes, each formed through a combination of consecutive single-track lines, form an almost 1.300 km long "double track corridor", see the map below.

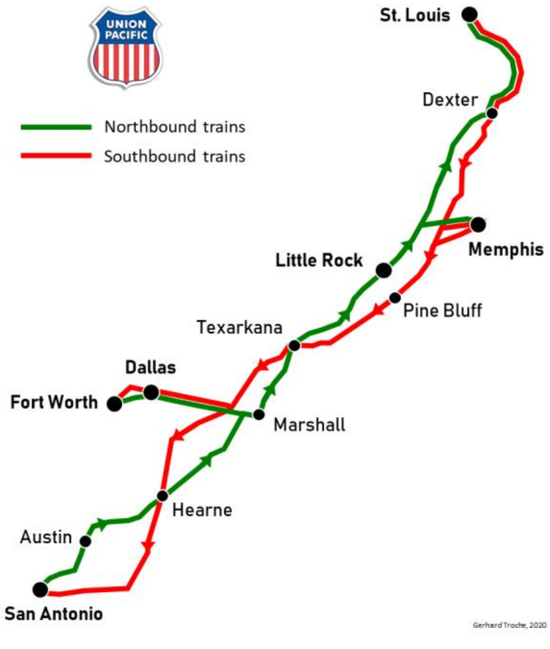

Figure 20: In the San Antonio / Fort Worth – Memphis / St. Louis corridor the US railway company Union Pacific is using directional running in order to maximise the use of the mostly single-track infrastructure.

Another classical example of directional running in North America, in which still today two otherwise competing railway companies cooperate, exists in the British Columbia in Canada, where the railway companies Canadian National and Canadian Pacific each own a single-track line on the opposite sides of the Fraser river. Over a distance of about 260 km both companies have introduced directional running, based on joint arrangements allowing them to operate both lines together as a functional double track. This eliminated for both companies the need for expensive investments into double-tracking in the narrow canyon.

Figure 21: In the Fraser Canyon in Canada single-track railway lines of two companies are running in parallel on opposite sides of the river. Though otherwise competing, the two companies Canadian National and Canadian Pacific are co-operating in this corridor and mutually granting each other the right to use the other's tracks, running in one direction on one side of the river and in the opposite direction on the other side, increasing capacity and fluidity of the traffic.

Directional running in Europe

In Northern Sweden the concept of directional running has been introduced in connection with opening of a new coastal railway between Sundsvall and Umeå in 2010. This new – mostly single-track – line forms together with the older – equally mostly single-track – line in the hinterland a double-track corridor over a distance of about 370 km, with the perspective of becoming extended northwards in the future to a distance of ca. 600 km. The corridor is operated in such a way that the usually lighter northbound trains (due to imbalances in the traffic flows leading to a higher share of empty wagons) use the historic and more curvy and hilly inland route with steeper gradients, while the loaded and heaver southbound trains use the new-built line along the coast.

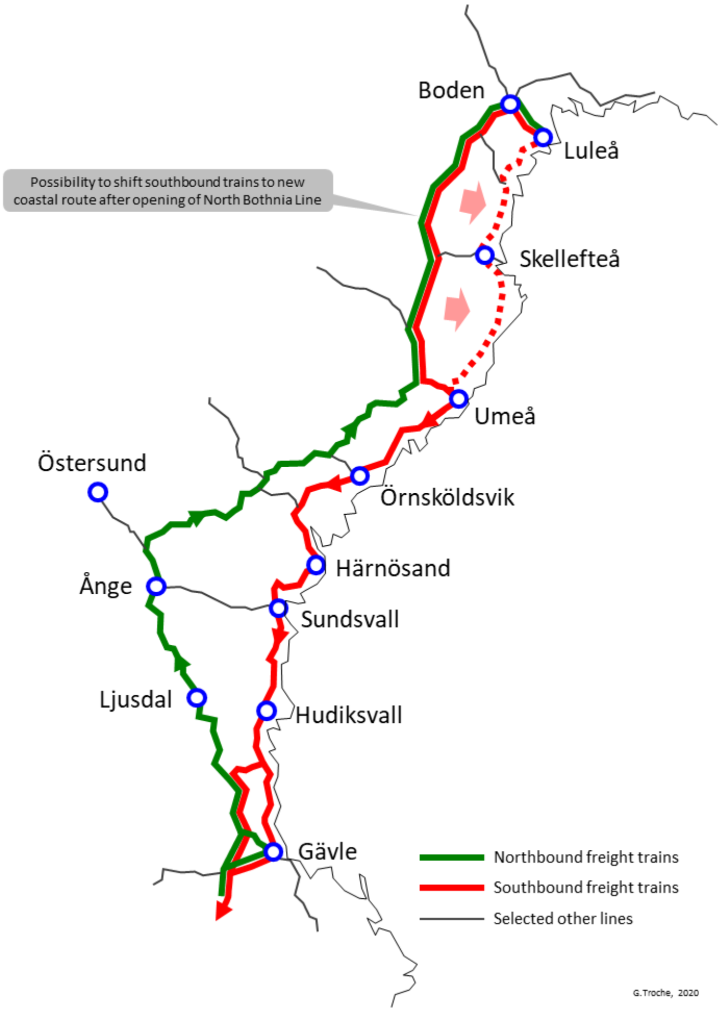

Figure 22: An example of directional running in Europe. In Northern Sweden most of the network is single-track with only few shorter double-track sections. Northbound freight trains usually use the older and more hilly inland line, since many of these trains contain a higher share of empty wagons and are therfore lighter. Loaded, heavier southbound trains use the new-built coastal line with more favourable line parameters. The (air) distance between Gävle and Umeå is ca. 370 km, between Gävle and Luleå ca. 600 km.

The example shows that the concept of directional running is even relevant for Europe in situations where networks or corridors have a high share of single-track and where freight traffic is an important user of the infrastructure.

Benefits can arise from directional running even if it is introduced over shorter distances, either by bridging shorter gaps between double-track sections, or they can function as double-track sections ("islands") on an otherwise single-track line. The benefits of directional running depend, of course, also on the density of passenger traffic on the line sections concerned and the technical line parameters. Under favourable conditions directional running can help to facilitate the operation of longer freight trains, potentially reducing the number of sidings adapted to such train lengths on the respective lines. A case-by-case analysis is necessary in each specific case, in order to assess the benefit and usefulness of directional running correctly.

Taking into account that, especially in Central-Eastern Europe, still a relatively dense network of mostly single-track secondary lines exists, often in areas with comparably low population density and consequently lighter use by passenger trains, the prospects of making use of directional running of freight trains might be a solution to be considered more systematically.

4.10.1. Special case: Directional running in time windows

A special case of directional running, where the direction of traffic is not separated by geography, but by time, can be found on the Luino line in northern Italy, which forms an important access route to the Gotthard line and is part of the Rhine-Alpine corridor.

Normally the ca. XX km long single-track Luino line only would allow the operation of maximum 650 m long trains, due to the limited length of the passing sidings. In order to allow the operation of longer trains, alternating time windows for southbound and northbound trains exceeding the length of 650 m have been introduced. This avoids a situation where two “long” trains (i.e. both of more than 650 m) would meet on line. Trains with up to 650 m are not subject to this arrangement and can enter the line in both directions at any time; if a “short” and a “long” train meet, it is the short train which goes into the siding, while the long train passes on the main through track.

This solution has to be seen as a pragmatic approach to allow the operation of longer freight trains without waiting for a full adaptation of the infrastructure. It is especially suitable in cases of shorter gaps with train length restrictions in a corridor or network. With growing distances of the line section concerned, the solution would, however, become less suitable, since the length of the time-windows would need to increase, which would also increase the negative impact on the fluidity of traffic. As a further factor the density of traffic and the share of trains subject to directional running in time-windows has to be taken into account. At both ends of the line sections concerned, it is also necessary to provide sufficient storage tracks for trains to wait for “their” time-window.

Thus, the solution could primarily be interesting as part of a stepwise approach to allow longer trains; the target should remain to allow unrestricted operation of long freight trains.

5. BETTER INCLUSION OF RAIL FREIGHT IN REGIONAL AND SPATIAL PLANNING

The proper inclusion of rail freight in regional and spatial planning is facing today a number of challenges, explaining the often low attention given to it:

- Generally, freight aspects receive little attention in regional and spatial planning, independent of the transport mode. Freight transport triggers often negative connotations and is rather seen as a "burden", causing problems in terms of noise, taking capacity from passenger traffic and causing risks (especially when Dangerous Goods is concerned). Its contribution to welfare and economy is often not fully recognized.
- Within rail transport a clear priority is usually given to (local and regional) passenger transport, in big cities even to some extent to long-distance passenger transport. Develop integrated system timetables has become popular, with high train frequencies, occupying an increasing part of the infrastructure capacity, especially in and around major conurbations. Capacity needs of freight are often not appropriately taken into account (capacity for freight is often reduced and preferably allocated to night hours.
- In the context of upgrading/modernisation of railway stations infrastructure for freight (yard tracks, industrial spurs) is often removed in favour of e.g. additional passenger platforms, P&R-, B&R-, K&R-facilities, bus stations, etc. Industrial areas are often moved to locations without rail access or – if rail is in the area – rail access (space for track connections, etc.) is not provided.
- There is a lack of awareness of the role and importance of rail freight and its potential to contribute to a sustainable, green transport system and society. Partly as a consequence of this, there is often a public opinion "against" rail freight. While rail freight enjoys a rather broad political support among policy decision-makers on higher (national and European) level, it is often opposed on a local level (NIMBY-attitude).
- Often there is a lack or knowledge about the way rail freight functions and its specific (infrastructure) requirements. Rail freight is more complex than road freight and is a "black box" for many planners. This is partly caused by the fact that freight in general and rail freight in particular is not appropriately addressed in (academic) education of planners – sometimes as a consequence of a combination of a lack of knowledge even among teachers and a lack of interest among students. Thus, spatial and regional planners are often not receiving in-depth knowledge about how rail integrates in modern logistics and the specific legal framework and technical rules surrounding rail freight, nor are becoming familiar with specific funding possibilities for local rail freight infrastructure such as support programs for last-mile infrastructure. Further, planners for natural reasons usually do not have own experience from using rail freight infrastructure or services - in contrast to rail passenger services and infrastructure, which they often become familiar with from daily own use, which gives them at least a certain understanding simply from observing it; rail freight operations are less visible to the general public and thus also to planners. An expert knowledge about rail freight among planners is a rather exceptional case, often due to a genuine personal interest in the matter than as a result of formal education.
- Further, rail freight has withdrawn – or due to absence of a level playing field been forced to withdraw – from many locations through rationalisation of the rail freight system and the absence of right conditions, thus, in some cases leading to the perception, that rail freight is not generating any (longer) local benefits. The centralisation and rationalisation of organisation on the side of the rail sector has often also caused an absence of contacts to the railway sector on the local and regional level. In smaller communities, planners are often not having contact with the rail sector at

all. The rail sector is lacking an approach to pro-actively seek contact and cooperation with regional planners. There are exceptions from this, of course, such as the railway company GYSEV in Western Hungary/Burgenland, which is perceived as an important regional actor and a valuable “asset” for the region; thus, it benefits from a strong regional identification and “good-will” among citizens as well as political decision-makers; however, internationally this is rather an exception, which confirms the rule.

It is clear, that the reasons for the widespread lack of inclusion of rail freight aspects in regional and spatial planning cannot be easily eliminated. Nonetheless, it appears important to take measures to counteract them, since rail freight can and must make an important contribution to achieve a green, sustainable transport system. An important measure must be to increase among local decision-makers and spatial planners the knowledge and understanding about rail freight, both when it comes to its role in the transport system, the way it functions and how it is integrated in modern logistics, the legal, regulatory and technical framework and concrete measures which can be taken to foster its development.

In this context, Interreg projects – like CORCAP – could actually be one means to (re-)establish a closer contact between the rail sector and spatial and regional planners and decision-makers. Bringing these groups together, can help to identify possible actions on a local level to improve both the competitiveness and environmental benefits of rail freight. The guideline, which you are just now reading, has also been elaborated with the intention to spread knowledge about rail freight and to serve as a source of inspiration for improving the conditions for rail freight development.

A further measure could be to include rail freight aspects better into formal planning procedures, e.g. by making binding requirements to address certain aspects for rail freight – e.g. the mapping of infrastructure, market actor and stakeholder views and impact analyses on rail freight – in official planning documents.

A better awareness and understanding of rail freight can be expected to lead to more concrete measures; these could for example include the protection of railway rights of way (even if currently out of use), keeping corridors and areas free for future development of railway infrastructure (including terminals), better location of industrial areas and avoiding conflicting land-use planning, etc. Also, actively making use of and/or promoting support programs for development of local and regional rail freight facilities should be considered.

Thus, in summary the following measures are suggested:

- Raise awareness of importance of rail freight for local and regional businesses and economy
- Improve the understanding of the characteristics of rail freight infrastructure in technical and operational terms at least on a basic level
- Preserving and protecting the railway rights of way, even if currently not used. This concerns both land for line infrastructure as well as for facilities, such as yards and trans-shipment terminals (not only intermodal)
- Reserve land for future development of rail freight infrastructure
- Avoid proximity of conflicting uses (e.g. residential areas in immediate vicinity to railway lines and in particular to freight facilites (noise and dust emissions).
- Promotion of rail freight facilities and services among regional businesses and industries
- Making use of support programs for investments in local and regional rail freight facilities

6. SELECTED EXAMPLES OF POTENTIAL SMALL-SCALE LOW-COST IMPROVEMENTS FOR RAIL FREIGHT IN THE OEM-CORRIDOR

In this chapter selected examples of potential small-scale low-cost improvements for rail freight in the Brno-Budapest section of the OEM-corridor and connecting rail networks are given. This section of the corridor forms the central part of the OEM-corridor and the southern part of CORCAP project area.

The examples presented on the following pages are at different levels of maturity. Some of them are already at an advanced stage of planning, while others are still at the idea stage. Also, one example – an improvement for the Komárom-Komárno node – has been developed within the CORCAP project and should become subject for further analyses.

Figure 23: Overview map of the Brno-Budapest section of the Orient/East-Med corridor

6.1. Connectivity to other corridros

In the area the OEM-corridor connects (and partly overlaps) with other corridors, with which it also exchanges traffic; many trains are either coming from or continuing on one of the other corridors.

In concrete, the OEM-corridor connects here to the following corridors:

- Core Network Corridor and Rail Freight Corridor Rhine-Danube
- Rail Freight Corridor Amber
- Core Network Corridor and Rail Freight Corridor Baltic-Adriatic
- Core Network Corridor and Rail Freight Corridor Mediterranean
- In the vicinity also to Rail Freight Corridor Alpine – Western Balkan
- Various OSJD-corridors

As can be seen, the region is at the crossroads of several international European and Euro-Asian corridors.

Figure 24: Connectivity to other Rail Freight Corridors in the Brno-Budapest section of the OEM-corridor

6.2. Example 1: Břeclav Node

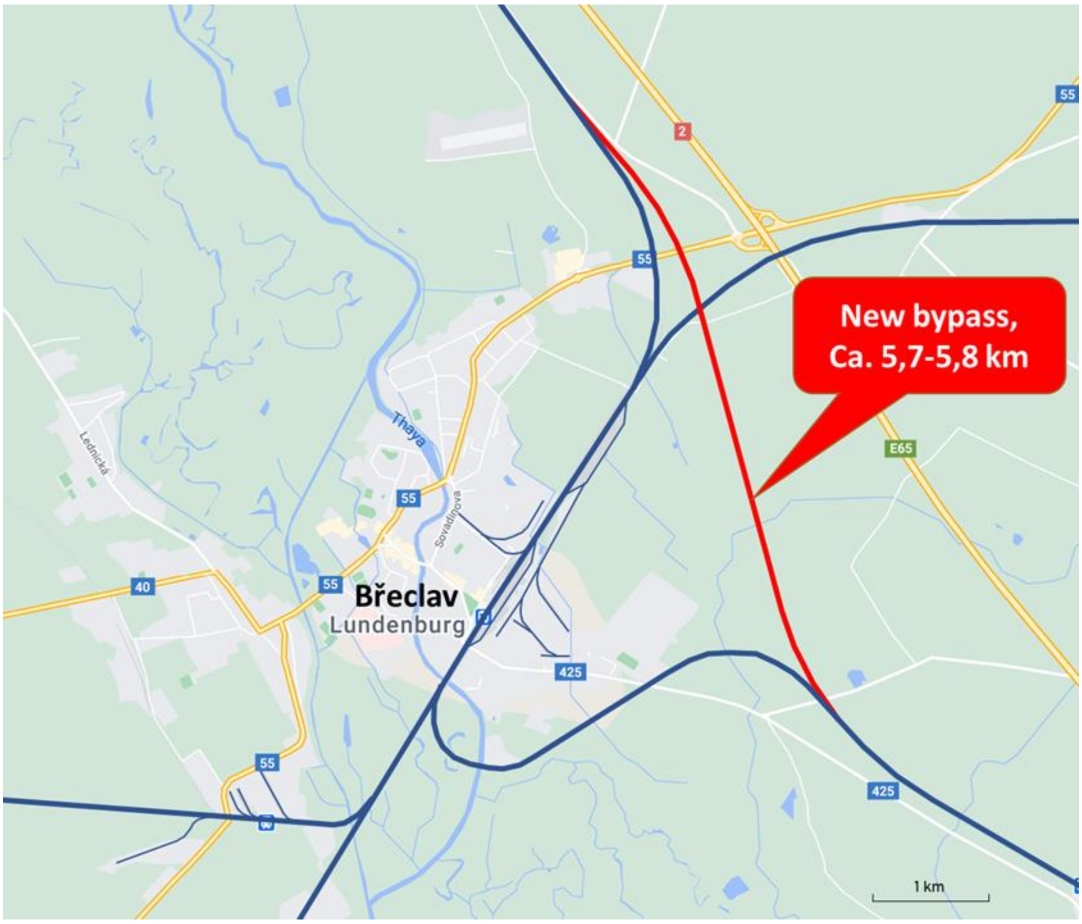

Figure 25: Indicative alignment of a bypass for Břeclav

In Břeclav two important railway lines are crossing each other: The East-West line Prague – Bratislava - Budapest and the North-South line Katowice - Ostrava – Vienna. A relatively short bypass north of the town and station of Břeclav could be relatively easily be built. The benefits would be:

- Avoiding crossing of traffic relations in Breclav station at same level
- Removing part of the freight traffic from the center of Breclav
- Shortening the route for freight trains in East-West direction

The bypass could also be used by certain long-distance passenger trains, which do not require a stop at the station. This could in the future be of particular interest in the context of introduction of high-speed train services in Czech Republic and surrounding countries.

6.3. Example 2: Ebenfurth Node

Figure 26: Indicative alignment of triangle tracks at Ebenfurth.

In Ebenfurth in Burgenland the GYSEV East-West line connects to the ÖBB network. Today, all trains in direction to Vienna, which is the main traffic direction, have to change their travelling direction at Ebenfurht. This concerns both passenger trains to Vienna main station and freight trains to the Vienna central marshalling yard and to destination northwards and westwards from Vienna.

A new double-track conncting curve is planned east of Ebenfurth. The would be complmented by a (new) single-track connecting curve in direction to Wiener Neustadt. This solution would lead to a number of advantages:

- Avoiding changes of travelling direction in all traffic relations
- Increase of capacity due to extension of double-track into Neufeld/Leitha station
- Elmination of potential timetable conflicts and higher timetable stability due to fly-over in direction to Vienna
- Moving rail traffic away from the central parts of Ebenfurth

6.4. Example 3: Komárom-Komárno node

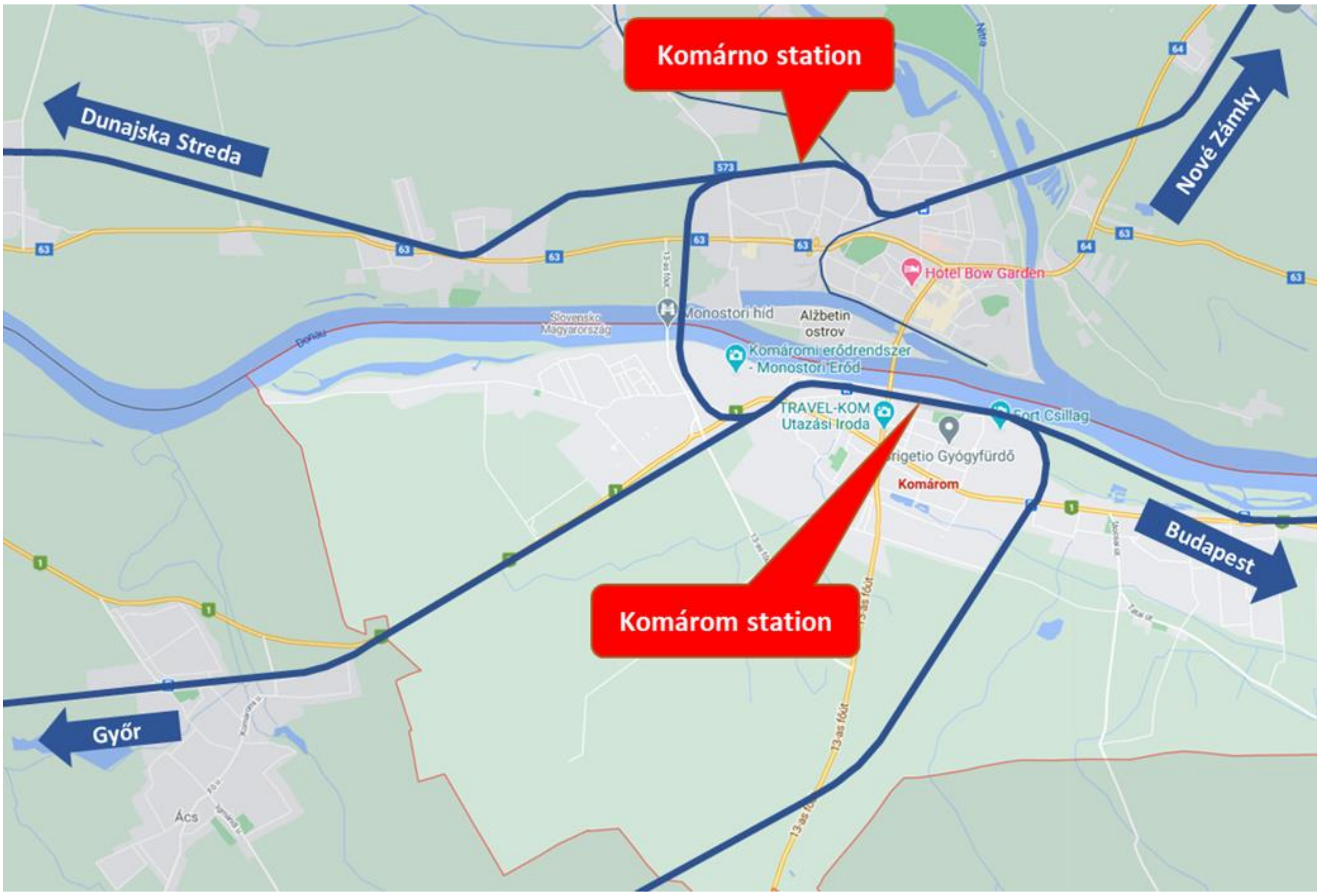

Figure 27: Current layout of the rail network in the Komárom-Komárno double node.

The area of twin cities Komárom on the souithern, Hungarian side of the Danube river and of Komárno on the northern, Slovak side of it consitutes from a railway perspective a complex double node posing severe challenges on cross-border freight trains passing through it.

The main line Győr – Budapest is double-track, while the railway line (Bratislava-) Dunajska Streda – Komárno – Nove Zámky is single track. Both are connected by a single track railway line across the Danube. All lines are electrified, with exception of the line Komárno – Dunajska Streda and a secondary line leading southwards from Komárom.

As illustrated in the figure on the next page, one or two changes of travelling direction are always necessary for trains crossing the Danube, with exception of the relation Budapest – Nove Zámky, which is, however, the least important one in terms of traffic flows.

As part of the CORCAP project potential solutions to tackle this situation have been investigated.

On the Slovak side a relatively straight-forward solution could be identified, by building a circa 1,1 km long triangle track branching of from the existing line north of the Danube bridge and connecting directly to the line to Dunajska Streda (which is supposed to become electrified in the coming years). The alignment is largely across flat, today agriculturally used land. It appears important, however, that this rather simple solution becomes included in local land-use and spatial planning as soon as possible, since there are plans in the area for development of the road network, which would need to be coordinated with the plan for this triangle track. This appears relatively easily be feasible, however, if not done in due time, a later construction of the triangle track could become endangered.

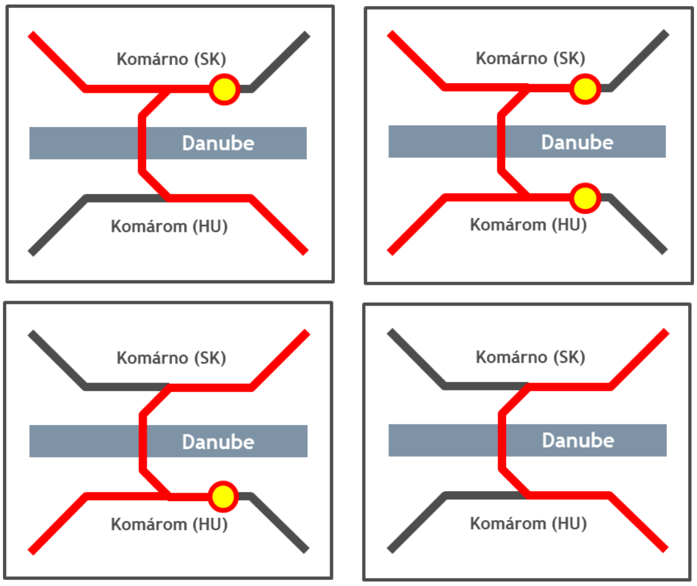

Figure 29: Traffic relations for cross-border trains through the Komárom-Komárno node and the need for changing of travelling direction.

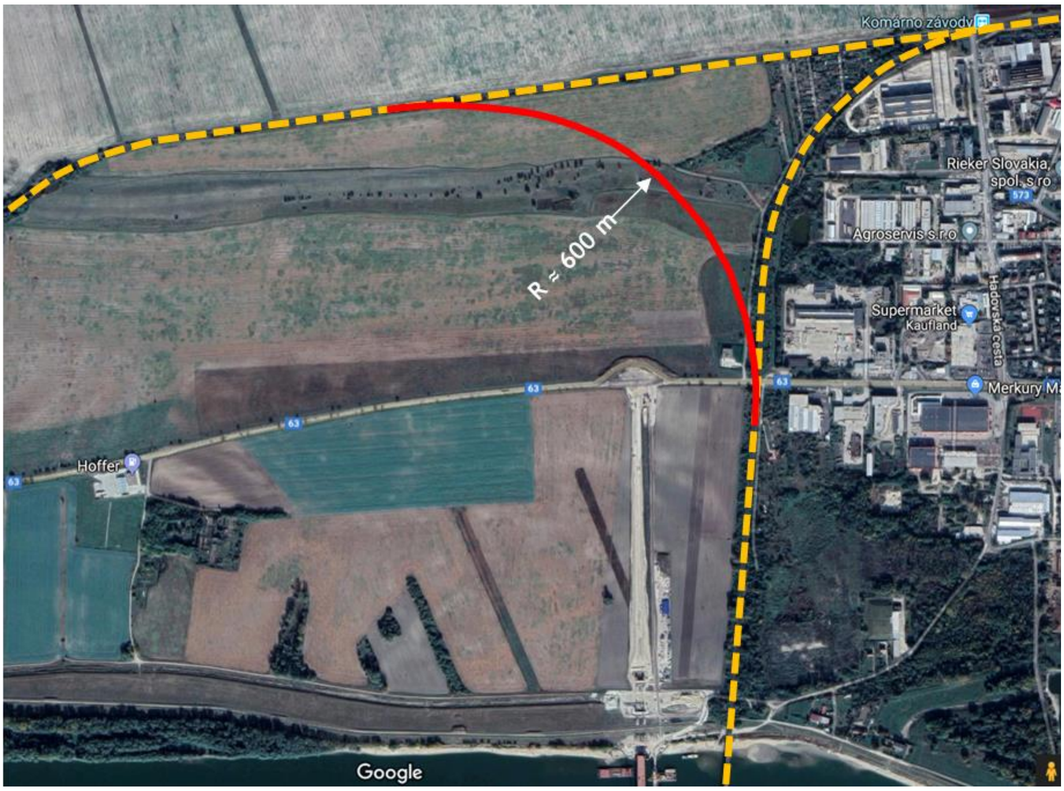

Figure 30: Proposed triangle track west of Komárom station. The Danube is visible in the lower part of this aerial view.

On the southern, Hungarian side the situation is more complex. A simple triangle track between the line coming from the Danube bridge to line towards Győr is not feasible here, since the area is partly built up and a, relatively recently built, adjacent road would would need to be changed substantially.

However, a relatively simple, alternative solution could be found here as well: The suggestion is to build a connecting curve southwest of Komárom, connecting the line Győr – Komárom with the line Székesfehérvár – Komárom, approaching Komárom from the south and running in this area almost parallel at some kilometers distance. The connecting curve would run over flat, today agriculturally used land and would have a length of ca. 5,8 km. The line coming from Székesfehérvár (i.e. from south) would need to be electrified between the place, where the connecting curve joins and Komárom station, a distance of approximately 6,3 km. In this context it should be mentioned, that the the line Székesfehérvár – Komárom might have a role in the future a spart of a new, major freight bypass around Budapest (V0), which probably in any case would involve its electrification. With the proposed solution trains from the direction of Győr towards Slovakia would use the new connecting line, then enter Komárom station from the east and pass it without change of travelling direction, continuing across the Danube bridge.

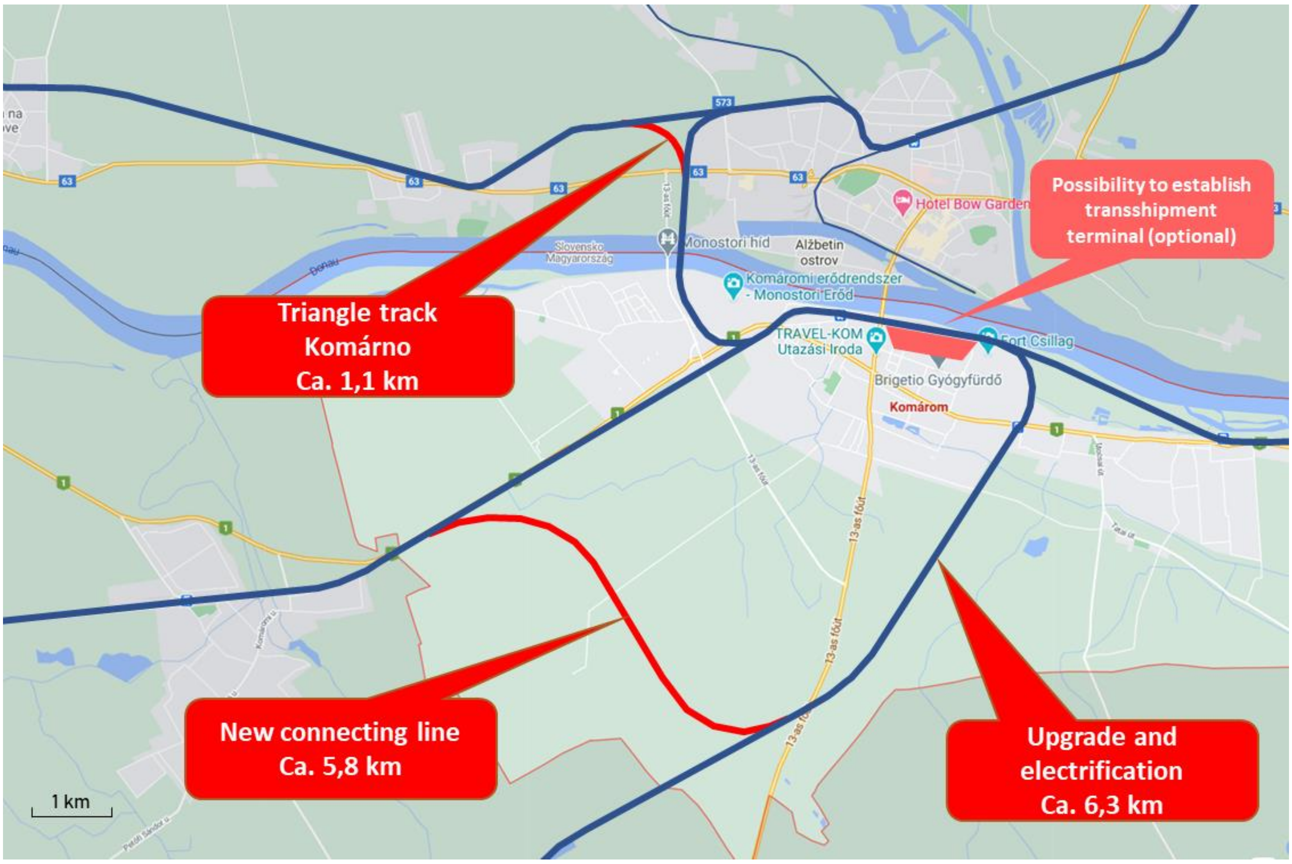

Figure 31: Indicative alignment of proposed triangle tracks and connecting curves in the Komárom-Komárno node.

Altogether, the proposed improvements on both the Slovak and Hungarian side in the Komárom-Komárno node would lead the the following advantages:

- Avoiding changes of travelling directions in all traffic relations

- Freeing up of yard capacity at the Komárom freight yard, which could be used for alternative developments; the prospects for establishing here an intermodal terminal should be investigated, since the area is well connected to the railway system, accessible from all traffic directions and with the capability to provide full train-length transshipment tracks connected to the main line in both ends
- Moving part of the freight traffic away from built-up areas of Komárno

6.5. Example 4: Zalaszentiván Node

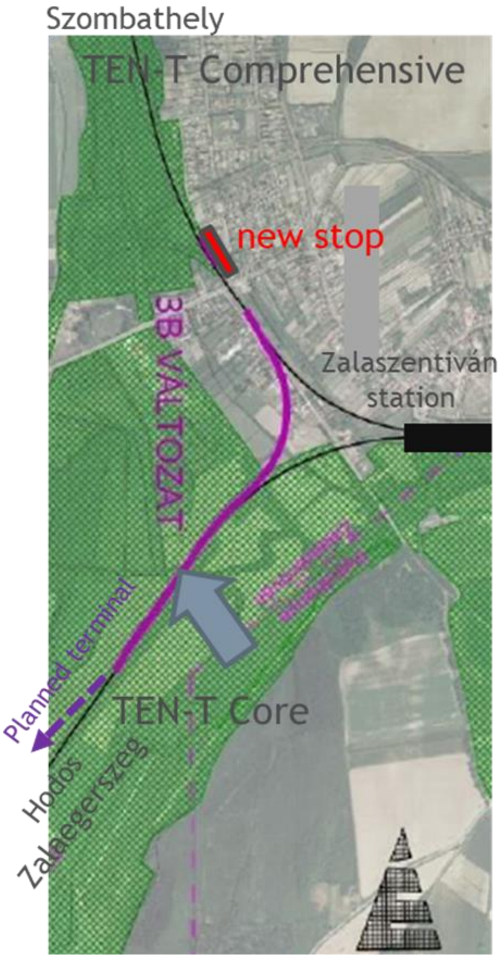

Figure 32: Indicative alignment of triangle tracks at Ebenfurth.

Zalaszentiván is not located directly on the OEM-corridor, but on the Amber Corridor, which connects to the OEM-corridor in the region. There is substantial and growing freight traffic reaching the OEM-corridor via the Amber corridor, mostly port-hinterland traffic form the Adriatic seaport of Koper in Slovenia, to a minor extent also traffic from the seaport of Rijeka in Croatia.

The planned triangle track at Zalaszentiván is an example of a project with high maturity. Land acquistion is on-going, the Environmental Impact Assessment has been carried out, environmental permits and water framework certificate been obtained; a building permit and several other public utility permits have been issued as well. Public hearings have been held without problems.

However, the project is still lacking financing for implementation. Its main benefit would be.

- Avoiding of change of travelling direction for the growing port-hinterland traffic between Koper and destinations in Slovakia and central Hungary

6.6. Example 5: Sopron Terminal

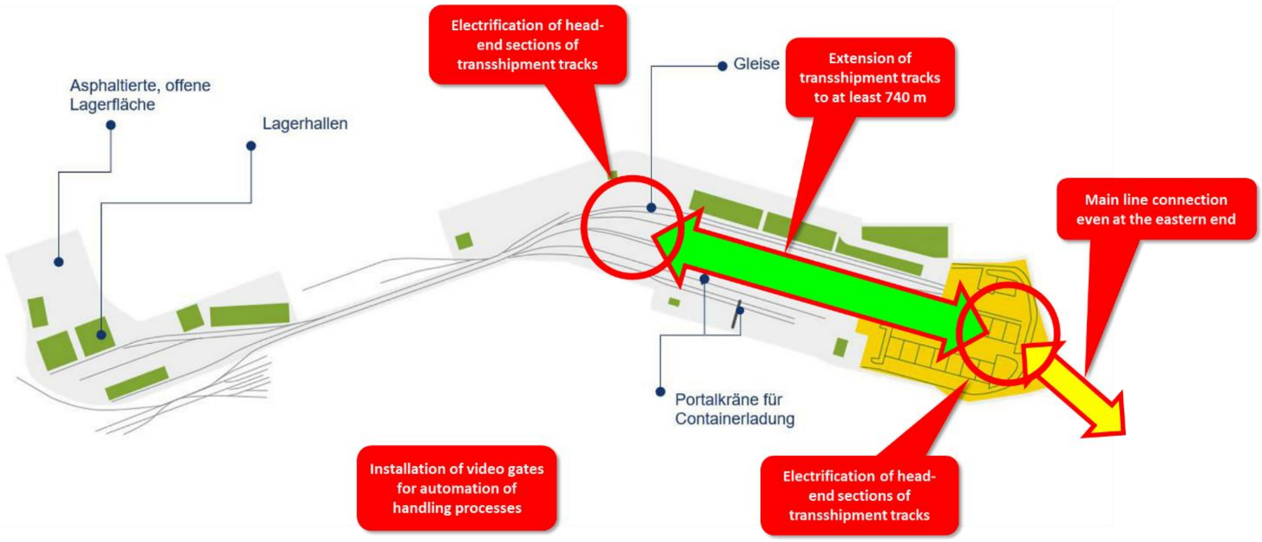

Figure 33: Selected potential measures for improvement of the Sopron Intermodal Terminal.

The Sopron Intermodal Terminal can be developed further through a combination of different measures:

An extension of the transshipment tracks to the TEN-T standard of 740 m is of high priority, in order to being able to handle full-length trains without shunting. In this context, also the possibility for a connection of the eastern end of the transshipment tracks to the main line should be considered. An electrifciation of the head sections of the transshipment tracks would further facilitate efficient train operations. In addition to this measures supporting a partial automation of terminal handling processes should be implemented, such as installation of video gates both at the entry tracks and the road entry.

Overall, these measures would lead to the following advantages:

- More efficient and faster train operations
- No or less shunting needed
- Digitalisation and automation of terminal processes
- Potential introduction of liner train operations (trains making short intermediate stops for loading and unloading)
- Potential introduction of momentum-entry (Schwungeinfahrt)

6.7. Example 6: GYSEV freight axes

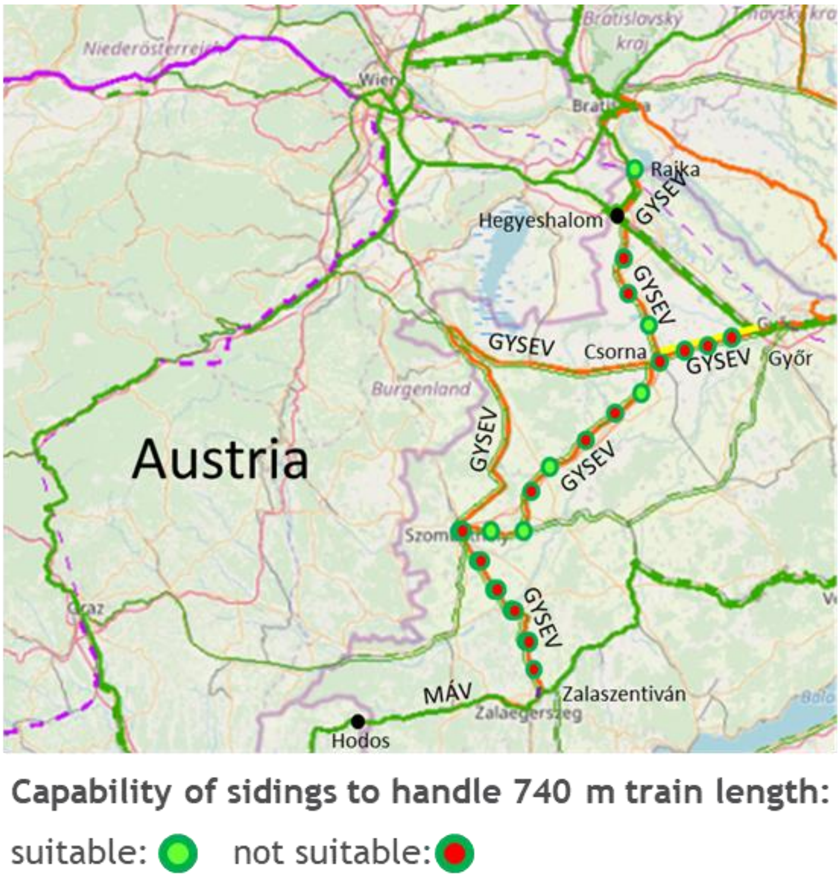

Figure 34: Capability of sidings along part of the GYSEV freight axes to handle 740 m long freight trains.

The capability of the GYSEV North-South axis Rajka – Csorna - Zalaszventiván and the East-West axis Győr – Sopron – Ebenfurth to handle trains with the future TEN-T standard length of at least 740 m will be essential to secure the attractiveness of the routes for international freight trains. The current length limitation is 600-650 m. Allowing a train length will also be important to ensure the competitivness of the Sopron Intermodal Terminal.

In the medium term it is necessary to ensure unrestricted operation of 740 m long trains; as a temporary measure timetabling and traffic management measures should be considered in order to allow longer trains during certain time-windows. This possibility was investigated (and demontrated) in connection with the CORCAP TEN-T Demo-Train described in chapter 7, the first 740 m long freight train between Sopron and Budapest.

Certain stations and sidings along the GYSEV network already can handle 740 m long trains, which facilitates a stepwise introduction of longer trains. However, further stations and sidings will have to be extended in order to allow unrestricted operations.

The main advantages of longer trains are:

- Higher transport efficiency, i.e. lower transport costs and thus higher competitiveness for rail

- Increasing capacity of railway lines
- Ensuring accessibility of the Sopron Intermodal Terminal with 740 m long trains.

It should be mentioned, that further important measures to bring the GYSEV network in line with TEN-T infrastructure requirements are and track upgrade to 22,5 t axle-load (today partly 20,0 t) and implementation of the European Rail Traffic Management System ERTMS.

6.8. Example 7: Electrification Sopron – Wiener Neustadt

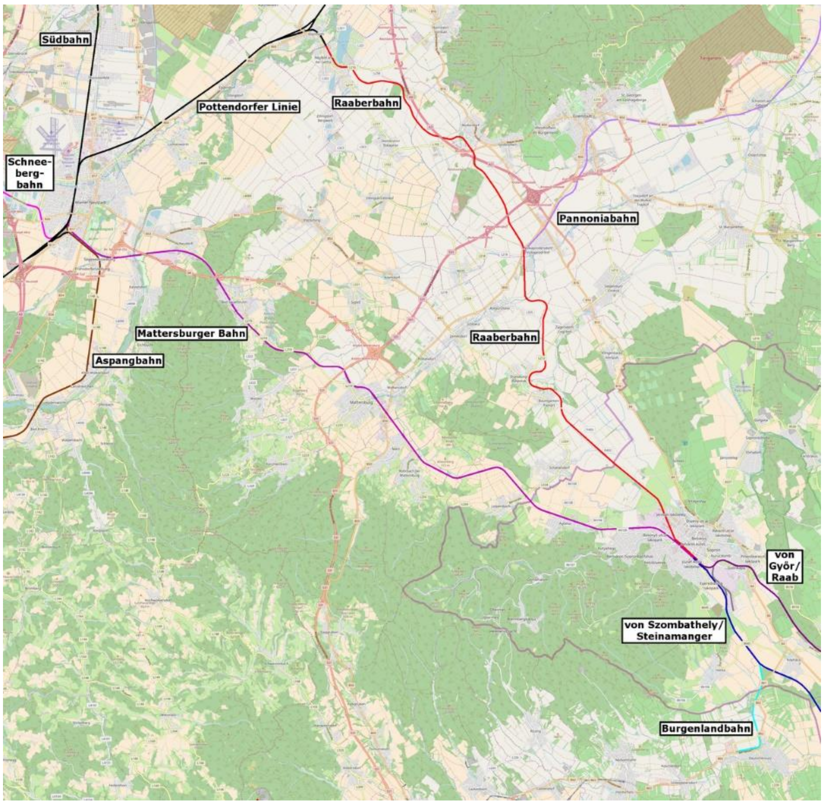

Figure 35: Alignment of the railway line Sopron – Wiener Neustadt (here shown as „Mattersburger Bahn").

The cross-border railway lins Sopron – Wiener Neustadt constitutes today a gap in the network of electrified raiway lines in Burgenland and Western Hungary. An electrification is envisaged. For rail freight, the electrification could help to establish the line as part of a „southern freight by-pass" around Vienna, connecting the Semmering line directly with the Hungarian rail network, without needing to enter into the Vienna conurbation.

Thus, the electrification would have the following advantages:

- Possibility to establish an improved East-West connection between Austria and Hungary, by-passing Vienna
- Increased resilience of the rail network in case of planned or un-planned traffic disruptions on other parts of the network; potential re-routing line in the framework of the EU Rail Freight Corridors Inernational Contingency Management (ICM).

6.9. Example 7: Directional Running in Western Hungary

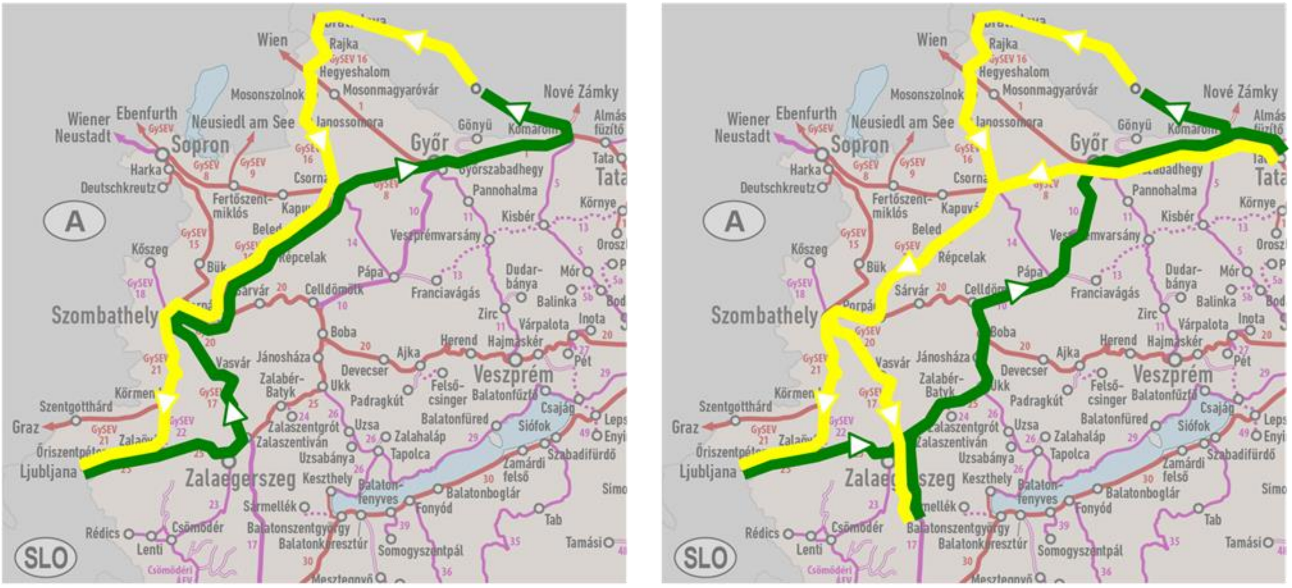

Figure 36: Illustration of possible possible long-term scenarios for directional running in Western Hungary (requires certain infrastructure measures)

Directional running achieves a „double-track effect" by combining the operations on parallel single-track lines. Large part of the Western Hungarian rail network is single track, and though certain double-tracking is expected in the future, a major part will remain single-track, especially in the North-South-direction.

Thus, the possibility to introduce directional running might be part of a solution to provide more and better capacity for freight trains, especially with a view on allowing freight trains of bigger length.

The maps above outline potential long-term scenarios for bi-directional running for freigh traffic in Western Hungary. It must be underlined, however, that the issue requires further analyses and investigation and certain infrastructure improvements would be necessary in order to make the above scenario possible.

Advantages of directional running would be:

- Increasing freight capacity on the mostly single-track network in Western Hungary
- Facilitating introduction of bigger train length (740 m)

6.10. Larger-scale measures planned or under consideration

In the previous chapters a number of selected potential small-scale low-cost measures – to be understood in the sense of the definition in chapter 3.1 – have been outlined. The examples are certainly not exhaustive, but give an impression of which kind of measures would be of particular importance in this region.

It should be emphasized, that there are further rail improvements planned in the nearer or more distant future, which would be of high importance for development of rail traffic – both passenger and freight traffic in the central part of the OEM-corridor and connecting networks. They would, however, be connected to a much higher investment volume than the examples given above, which is why they are not tackled further in this report. Nonetheless, it appears relevant to mention them, since – as has been explained further – larger-scale projects and small-scale low-cost projects are often complementing each other.

As larger-scale projects should be mentioend in particular:

- Double-tracking of Line 8 Győr – Sopron
- Remodelling of the Sopron Node
- Remodelling of the Brno Node
- Freight bypass Bratislava
- Third track on Budapest Southern Railway Bridge (on-going)
- Freight bypass Budapest (V0-line)

7. THE TEN-T DEMO-TRAIN

The TEN-T Demo-Train was the first 740 m long freight train on the 216 km long Sopron – Budapest line, operated by GYSEV CARGO on Wednesday, 20 October 2021. It promoted the TEN-T target standard for freight lines on the TEN-T network and demonstrated the feasibility in principle, to operate selected trains with bigger train length than usually allowed even with the current infrastructure. The train departed from the Sopron marshalling yard and had two passenger coaches attached to it, allowing CORCAP partners and stakeholders from many countries, including from the European Commission, to accompany the train.

The experiences gathered from the TEN-T Demo-Train confirmed earlier preliminary findings of the project and fed into further analyses for the introduction of longer trains. The aim is to provide better conditions for more efficient and competitive rail freight on key routes for freight.

A concrete outcome of the analyses carried during the Pilot Action is, that GYSEV could identify suitable time windows for longer trains on its network, which will allow it to offer train paths with extended train length. This will be gradually implemented following the procedures for national and international coordination of timetables.

The TEN-T Demo-Train was a regular freight train, which was extended with additional freight wagons and the two passenger coaches for the acoompanying project stakeholders. The train had a departure time from Sopron marshalling yard at 10:30 and an arrival time to Budapest-Kelenföld at 13:46, giving an average speed of 65 km/h; the maximum speed was 100 km/h. The train was composed of 45 wagons (including the two passenger coaches) and had a gross weight of 1.141 t. The train was hauled by a modern electric Vectron-locomotive from GYSEV CARGO, decorated in a special livery advertising the environmental friendliness of rail transport. After the platform stop at Kelenföld, which was reached on time and where the passengers got off, the train continued to Budapest-Ferencvaros, where the passenger coaches and additional freight wagons were detached from the train. The total distance covered was 216 km.

Figure 37: Locomotive hauling the CORCAP Demo-Train, before departure at the Sopron marshalling yard.

Figure 38: Group photo in Sopron with the participants of the train journey.

Figure 39: The Demo-Train on the GYSEV-line between Sopron and Győr.

8. CLOSING REMARKS

WIth the participation in the CORCAP project, together with partners from Germany, Czech Republic, Slovakia and Hungary, GYSEV has expressed its interest and strategic commitment to inter-regional cross-border cooperation with the aim to foster the development of rail freight. While GYSEV may not be one of the „large players“ in Europe, it is clearly part of the European rail freight system and wishes to contribute to enable seamless, competitive and environmentally-friendly rail transport across borders. This ambition and commitment has already been before underlined by the fact, that GYSEV takes a leading position in Europe, when it comes to the share of its rail network designated to the EU Rail Freight Corridors. Besides the OEM-corridor – which is at the heart of the CORCAP-project – GYSEV is also Member of the Amber and Rhine-Danube Rail Freight Corridors. GYSEV is convinced, that, in order to secure a bright future for rail freight, it is necessary to think European, but (also) act locally.

WIth the Guideline, which you hold in your hands, GYSEV hopes to spread knowledge about rail freight to a broader audience, in particular to spatial planners and regional decision-makers, but also hopes to bring inspiration to planners and other interested persons in other parts of Europe.