European Commission

Rhine Alpine

Third Work Plan of the European Coordinator

Paweł Wojciechowski

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Mobility and Transport

Disclaimer

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Abbreviations

CAPEX	Capital expenditures
CEMT	Conférence Européenne des Ministres des Transports (Classification of European Inland Waterways)
CEF	Connecting Europe facility
cf.	compare
CNC	Core Network Corridor
DG MOVE	European Commission – Directorate General for Mobility and Transport
e.g.	for instance
EFSI	European Fund for Strategic Investments
EGTC	European Grouping for Territorial Cooperation
ERTMS	European Rail Traffic Management System
EU	European Union
EUR	Euro
GDP	Gross Domestic Product
ICT	Information and communication technology
ITS	Intelligent transport systems
IWW	Inland waterway
KPIs	Key performance indicators
MoS	Motorways of the Seas
pkm	passenger-kilometres
OPEX	Operational expenditures
p.a.	per year / annual
RALP	Rhine-Alpine Corridor
RFC	Rail freight corridor
RIS	River information service
RRT	Rail-road terminals
TEN-T	Trans-European Transport Network
tkm	ton-kilometres
TMS	Transport market study

Country Codes (ISO 3166):

BE	Belgium
CH	Switzerland
DE	Germany
FR	France
IT	Italy
NL	the Netherlands

1 Towards the Rhine-Alpine Corridor updated work plan

1.1 Introduction

Transport, which has been part of one of the two founding policies present in the Treaty of Rome, holds a preeminent place in the European Union integration process. At a juncture when momentum for the European project is waning, it is the right time to deliver on political commitments, act on promises and progress with implementation. Transport is at the crossroads of the economic, social and environmental goals of Europe, an essential driver for jobs and growth. It underpins both export and competitiveness.

Transport infrastructure plays a key role to completing the internal market through the removal of physical barriers and the introduction of soft measures. Infrastructures need to be constructed, maintained and upgraded through investments within a coherent corridor vision, which takes into account the growing demand for fast, reliable, high-quality, seamless movement of goods and persons.

"Connecting to complete" and "connecting to compete" emerge as mottos for the creation of a single European transport area. Completing the transport network can provide a competitiveness boost and growth potential. This, however, will become reality only if all stakeholders act cooperatively. The corridor approach contributes significantly in addressing main strands such as:

- balancing private and public interests, exploring potential areas of joint activity and collaboration, including through innovative financing schemes,
- reconciling short term and long term plans and vision, taking into account demand projections, and sustainability challenges within the larger European and global policy and economic framework, and
- above all, matching words with deeds, recognizing the need for the requisite firm political will, in the absence of which, even the best conceived project will flounder.

The Third Work Plan provides a common vision, based on the compilation of work of all stakeholders towards the final realisation of the Corridor. The joint interest of all Members States and regions involved is the crucial driving force behind the Work Plan. It is there to provide a coordinated framework of cooperation for the prioritization of the various steps needed to realise the Corridor.

1.2 Road map for setting up the Work Plan III

This Third Work Plan for the Rhine-Alpine Corridor is the result of an iterative workflow that started already in 2013 with the support of the Member States, all relevant stakeholders and a team of external consultants responsible for an analysis of the Corridor that was summarised in a First Corridor study.

Based on the achieved results, the First Corridor Work Plan was published in May 2015 after a consultation process with the Member States.

Subsequently, the work on the updating and refinement of the First Work Plan started in September 2015 with the second phase of the Corridor study that is running until 2017 and aiming to achieve an enhanced database for the further development of the Corridor. Three additional Corridor Fora were held between September 2015 and June 2016 presenting and discussing the next steps for updating the corridor study and the Work Plan.

The Second Corridor Work Plan was presented to the Member States in July 2016. After a consultation process with the Member States, the Second Work Plan was adopted and published in December 2016.

The interim results of the second Corridor study and identified main issues for the development of the Core Network Corridors were presented and discussed in a Corridor Meeting during the TEN-T Days in Rotterdam in June 2016. Afterwards, the work on the updating of the Corridor study continued. Four more Corridor Fora were held between September 2016 and October 2017. Furthermore, dedicated Working Group meetings with stakeholders from Urban Nodes and Regions, Ports and Inland Waterways and Rail-road terminals were organised in 2017, discussing and collecting specific targets, critical issues and requirements. This consultation process allowed fine-tuning a coordinated corridor approach.

These activities were complemented by various visits, seminars, exchanges and bilateral meetings with national and regional authorities, private and public sector representatives, as well as civil society in the Member States concerned. The collaborative approaches of all Member States as well as the valuable contributions by Switzerland have been instrumental in this endeavour.

To support the logical follow-up of the consecutive work plans since 2015, it is of key importance to monitor the developments related to the transport infrastructure and nodes on the Corridor. As projects are progressing and innovations and new technologies are deployed, the relevant characteristics are bound to advance along with the physical and operational capabilities of the infrastructure and nodes. In addition, evolving legal environment influences the use of the infrastructure, the degree of interoperability and set the framework for changes and future adoption of technology. All these aspects have to be monitored. It is vital for a fully functional and efficient corridor to collect related information in a centralised manner, appropriately assess their impact and disseminate the information to the relevant entities. For this reason, this work plan is based on the results of the 2014 corridor study in combination with the new findings gathered in the framework of the follow-up corridor study (running from 2015 until 2017).

The European Commission contracted the consortium of consultancy companies (responsible also for the first corridor study) for the provision of technical support. The consortium consisted of HaCon Ingenieurgesellschaft mbH (Germany) (lead partner); KombiConsult GmbH (Germany); Panteia B.V. (the Netherlands); PricewaterhouseCoopers Advisory SpA– PwC (Italy); Rapp Trans AG (Switzerland) and Stratec S.A. (Belgium). Their main tasks were: update of the compliance analysis of existing infrastructure with the requirements of the TEN-T Regulation; devise a plan for removal of physical and technical barriers as well as the deployment of interoperable transport systems (projects' list); identification of potential gaps in the Corridor development by 2030; identification and compilation of existing and potential administrative and operational barriers along the Corridor; proposal and evaluation of measures eliminating identified barriers, especially focussing on cross-border issues; analysis of nodes with regard to barriers to the full development of the Corridor.

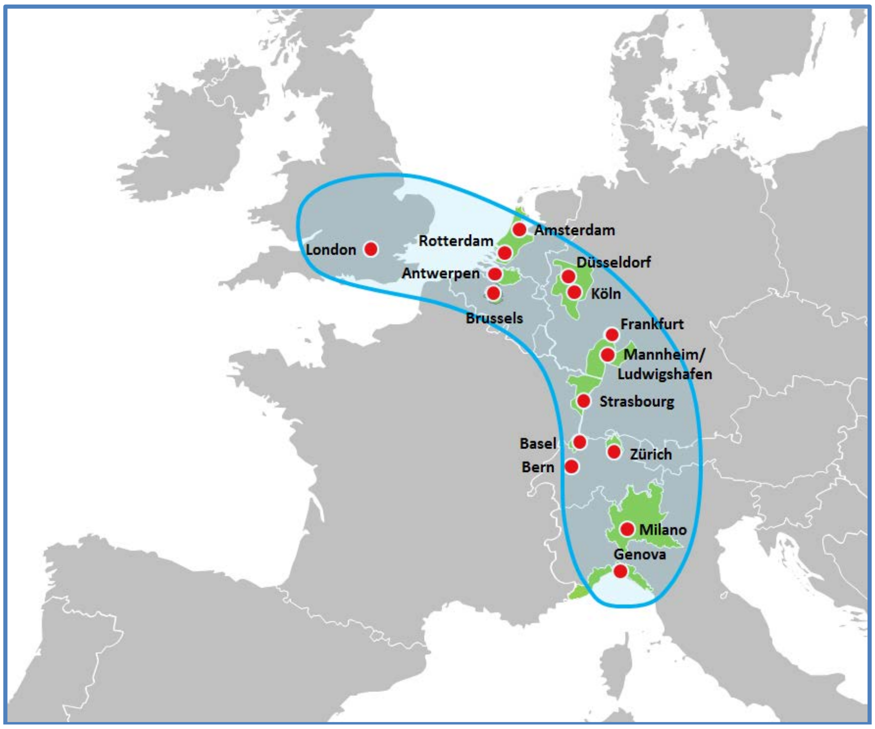
The following chapters of this Third Work Plan describe the main findings of the comprehensive analysis and the permanent stakeholder consultations as well as the progress already made towards the further development of the Rhine-Alpine Corridor. In the final section, a set of recommendations taking stock of the experiences and the results of the second Corridor study will be presented. They include not only technical parameters. It is also necessary to derive political conclusions taking into account where priorities have to be set and which type of approach has to be taken according to the various technical, economic, environmental and social aspects that have emerged during the exploitation of the study.

2 Characteristics of the Rhine-Alpine Corridor

The Rhine-Alpine Core Network Corridor is one of the nine corridors of the core network, defined in the Trans-European Network for Transport (TEN-T), based on Regulations (EU) 1315/2013 and 1316/2013.

The regions it encompasses, count among the most densely populated and economically strongest in Europe. Altogether, more than 70 million people live, work and consume in the catchment area of the Rhine-Alpine Corridor. Leading manufacturing and trading companies, production plants and distribution centres are located within. The Corridor runs through the so-called "Blue banana", which includes major EU economic centres such as Brussels and Antwerpen in Belgium, the Randstad region in the Netherlands, the German Rhine-Ruhr and Rhine-Neckar regions, the Basel and Zürich regions in Switzerland and the Milan and Genova regions in Northern Italy (cf. Figure 1).

Figure 1: Europe's "Blue Banana



The Corridor encompasses some of the Europe's leading ports, like Rotterdam, Antwerpen, Amsterdam, Zeebrugge, North Sea Port[1], Duisburg and Genova, which function as entry and exit points to the Corridor transport network and are prime examples for seamless multimodal transport chains.

Along the Rhine-Alpine Corridor, more than one billion tonnes of freight are transported annually, resulting in a GDP of more than 2,700 billion EUR, representing 19% of EU's total GDP (based on 2010 figures). The Rhine-Alpine Corridor is generally well developed which makes it a "forerunner" for other corridors, especially with regard to initiatives on innovations and new technologies that pave the way into the future.

[1] Merger of the Ports of Ghent (BE) and Zeeland Seaports (NL)

However, for the full compliance with the TEN-T standards and to allow for a seamless connectivity throughout Europe until 2030, some critical issues have to be addressed such as rail capacity bottlenecks, road congestion, noise, pollution and quality of life in urban areas, the replacement of disparate safety and signalling railway systems, incomplete ERTMS deployment, insufficient fairway depth at some sections of the Rhine River, upgrades of lock capacity, alternative fuels' infrastructure, cross border operations, and vast maintenance issues of existing infrastructure.

Finally yet importantly, the Rhine River is an important route on the Corridor for the transport of containers and bulk commodities especially between the North Sea ports and Germany, France and Switzerland.

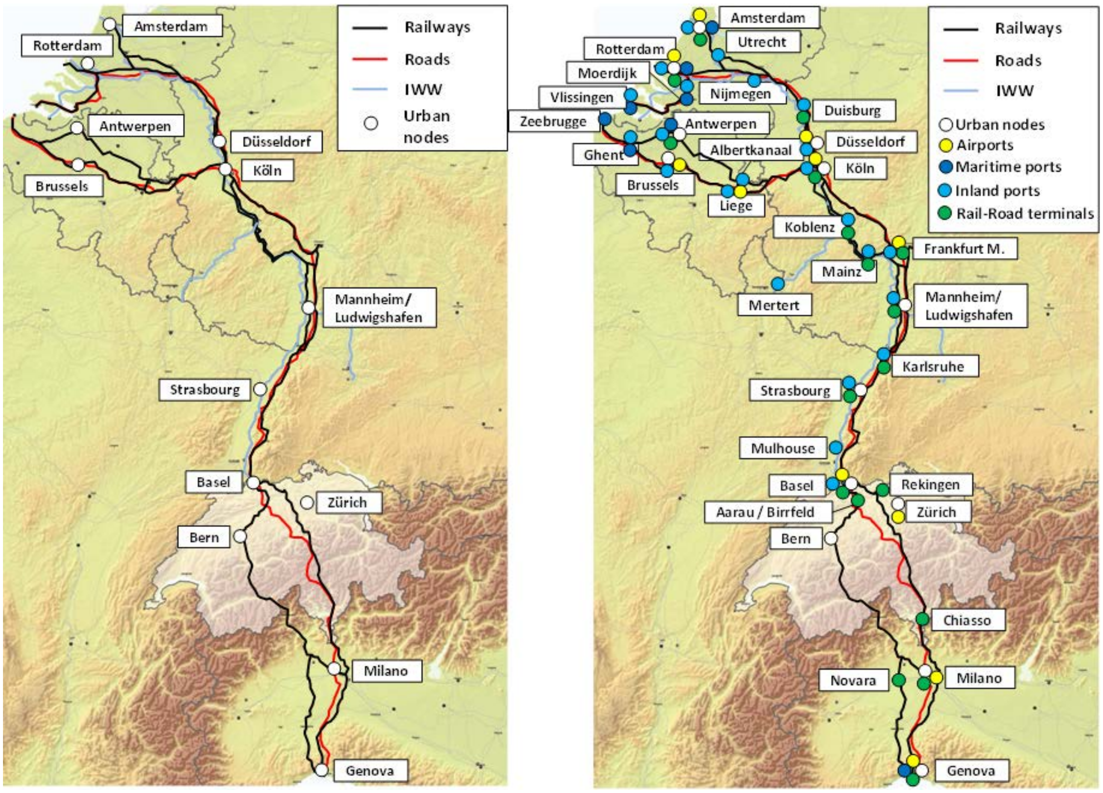
2.1 Alignment

The Rhine-Alpine Corridor runs through five Member States and Switzerland. France was added to the catchment area of the Corridor in light of the relevance of inland waterways and their ports along the river Rhine. Moreover, Luxembourg's inland port of Mertert is included in the Corridor.

The main branches of the Rhine-Alpine Corridor are:

- Genova – Milano – Lugano – Basel;
- Genova – Novara – Brig – Bern – Basel;
- Basel – Karlsruhe – Mannheim – Mainz – Koblenz – Köln;
- Köln – Düsseldorf – Duisburg – Nijmegen/Arnhem – Utrecht – Amsterdam;
- Nijmegen – Rotterdam – Vlissingen;
- Köln – Liège – Brussels – Ghent;
- Liège – Antwerpen – Ghent – Zeebrugge.

Figure 2: Outline of the Rhine-Alpine Corridor



Source: Regulation 1316/2013 Annex 1, Part 1 / HaCon

The definition of the Corridor, the general alignment, urban nodes and the logistics nodes (airports, inland ports, seaports, rail-road terminals) are based on the provisions of the TEN-T Regulation (EU) 1315/2013 and CEF Regulation (EU) 1316/2013. The corridor alignment, set in the regulations, is supplemented by the analysis of the available TENtec data and information on Member States' infrastructure planning.

In agreement with the Member States and dialogue with the Corridor Forum, the rivers Moselle and Neckar in Germany as well as the French inland ports on the Rhine (Strasbourg and Mulhouse) have been integrated for further analysis. Inland waterways in Belgium are not included in the Rhine-Alpine Corridor, but are of importance for its strategy and further development; information on them has been used for the transport market study analysis.

The Corridor has 13 core urban nodes, spread over five Member States and Switzerland (cf. Table 1).

Table 1: Overview of corridor nodes

Country	Urban nodes	Airports	Seaports	Inland ports	Rail-Road Terminals	Total
NL	2	2	4	6	2	**16**
BE	2	2	3	5	1	**13**
DE	3	3	-	8	7	**21**
FR	1	-	-	2	1	**4**
CH	3	2	-	1	4	**10**
IT	2	2[2]	1	-	3	**8**
Total	**13**	**11**	**8**	**22**	**18**	**72**

The 8 **maritime ports** (among them the ports of Rotterdam, Amsterdam, Antwerpen, Genova, North Sea Port and Zeebrugge) are main exit and entry nodes of the Corridor. Ports serve as a link to the hinterland and play a crucial role in connecting road, rail and inland waterways. The connection of the maritime ports for freight transport is critical for the import of goods from outside the Corridor.

The **river Rhine** is an important route for the containers and the transport of bulk commodities especially between the North Sea ports and Germany, France and Switzerland. Therefore securing the reliable navigation of the Rhine is of the utmost importance. This also applies to barge services in the inland ports along the Moselle, Main and Neckar.

International **rail** is a key feature on the Corridor. For international passenger transport, connections between agglomerations in neighbouring countries are crucial. For rail freight, transport flows along the entire Corridor play an important role, in particular for intermodal transport volumes from and to the seaports and the transit via Switzerland. Against this background, Rail Freight Corridor Rhine-Alpine belongs to the first European rail freight corridors made operational in November 2013 as required by Regulation (EU) 913/2010.

[2] The node of Milano has three core airports: Linate, Malpensa and Bergamo Orio al Serio

Since all modes of transport are represented on the Corridor, multimodality for both passenger and freight transport plays an outstanding role. It has to be taken into consideration that the 18 rail-road terminals from Table 1 only represent their geographical location. Inland ports, rail-road platforms and airports can have more than one facility per specific location. In total, 72 multimodal platforms exist across the Corridor. Duisburg stands out in particular with ten identified Rail-Road terminals, five of which even deal with three modes, connecting rail, road and inland waterways infrastructure. Among others, important **multimodal nodes** are:

- the **ports** of Antwerpen and Rotterdam, which are among the world's leading seaports and - along with the ports of Amsterdam, Zeebrugge, Genova, North Sea Port and Moerdijk - are the largest multimodal nodes. These ports benefit from international maritime connections, inland waterway transport services (only in the North Sea ports), rail freight and road transport.
- for the execution of maritime and continental intermodal transport, a net of **rail-road terminals** (RRT) is located along the Corridor. Beside the seaports, main locations are Duisburg, Köln, Mannheim/Ludwigshafen, Basel, Novara and Milano.
- the 11 **airport nodes** with 13 single core network airports along the Corridor have a total volume of 220 million passengers and a combined transport volume of 6.8 million tonnes per year. The airports of Amsterdam and Frankfurt are important hubs for passenger and freight transport. Other airports with considerable traffic flows on the Rhine-Alpine Corridor count among the top 20 European airports: Brussels (freight/passenger), Liège (freight), Düsseldorf (passenger), Köln/Bonn (freight) and Milano Malpensa (freight).

Close cooperation between the different corridors exist as overlaps occur – altogether eleven sections and nodes of the Rhine-Alpine Corridor overlap with one of the other core network corridors (cf. Table 2). On some overlapping sections only specific modes overlap; for instance between Antwerpen and Aarschot, only rail has been taken into account for the Rhine-Alpine Corridor.

All Belgian inland waterway projects, which could enhance the Rhine-Alpine Corridor such as the Seine-Scheldt project,[3] have been taken into account in the North Sea – Mediterranean Corridor. Similarly, in the context of the Dutch core network, some sections have been assigned to two or more corridors.

Table 2: Overview of corridor overlap per section

Section / node	Corridor	Overlapping with corridor[4]
Amsterdam – Utrecht	Rhine-Alpine	North Sea-Baltic North Sea-Mediterranean
Rotterdam – Moerdijk	Rhine-Alpine	North Sea-Baltic North Sea-Mediterranean
Utrecht – Betuwe line	Rhine-Alpine	North Sea-Baltic
Köln – Liège – Brussels	Rhine-Alpine	North Sea-Baltic
Köln – Aarschot	Rhine-Alpine	North Sea-Baltic

[3] Seine-Scheldt is a transnational project whose purpose is to connect and improve the connection between the Rhine, Scheldt and Maas basins with the Seine basin.
[4] Source: HaCon based on TENtec analysis

Section / node	Corridor	Overlapping with corridor[4]
Antwerpen – Aarschot	Rhine-Alpine	North Sea-Mediterranean North Sea-Baltic
Liège – Antwerpen	Rhine-Alpine	North Sea-Baltic
Antwerpen - Zeebrugge	Rhine-Alpine	North Sea-Mediterranean
Strasbourg – Karlsruhe – Mannheim – Mainz	Rhine-Alpine	Rhine-Danube
Mannheim Strasbourg	Rhine-Alpine	Atlantic
Milano	Rhine-Alpine	Mediterranean

The country specific length of infrastructure per mode for the Rhine-Alpine Corridor is shown in Table 3 (inland waterways include the rivers Moselle and Neckar on German-Luxembourgish territory). With about 3,225km, rail is the backbone of the Corridor (with the highest share in Germany). Road has 26% of the length share, inland waterway (IWW) has a share of 24% of the total network. Germany has the largest share (49%) on all modes on the Rhine-Alpine Corridor. The respective shares of total network length of Belgium, the Netherlands, Italy and Switzerland vary between 9% and 14% for all transport modes. France with its part of the IWW network has a share of 3% of the corridor's total length.

Table 3: Lengths per mode along the Rhine-Alpine Corridor by country

Mode	NL		BE		DE		CH		IT		Total
	[km]	share of total	[km]	share of total	[k]	share of total	[km]	share of total	[km]	share of total	[km]
Rail	435	13%	499	16%	1,322	41%	560	17%	409	13%	**3,225**
Road	260	15%	275	16%	708	41%	286	17%	192	11%	**1,721**
IWW[5]	218	14%	-	-	1,155	73%	21	1%	-	0%	**1,577[6]**
Total	**913**	**14%**	**774**	**12%**	**3,185**	**49%**	**867**	**13%**	**601**	**9%**	**6,523**

Table 3 above demonstrates that the Rhine-Alpine Corridor encompasses all modes of transport and, given its features, can be regarded as a particularly complex and mature corridor.

2.2 Compliance with the technical infrastructure parameters of the TEN-T guidelines in 2017

To achieve an up-to-date overview on the compliance of the Rhine-Alpine Corridor with the requirements of the TEN-T Regulation, the technical parameters of the Corridor have been analysed for all sections and infrastructure nodes. The results of the compliance analysis have also been checked with the analysis of the Key

[5] Belgian inland waterways are not part of the alignment but are analysed in the Corridor characteristics and the transport market study

[6] France is also part of the IWW network, with a share of 183km (12% of the IWW network and 3% of the corridor's total length)

Performance Indicators (KPIs) performed for the Corridor. The results of the analysis with regard to major parameters are presented below:

- **Railways**: ERTMS-equipped infrastructure, interoperability and safety of national networks, full electrification, and – for the purpose of freight transport - line speed of at least 100 km/h, axle load of at least 22.5 t, the possibility of running trains with a length of 740 m as well as rail connection to multimodal nodes;
- **Roads**: reduction of congestion, interoperability on the network, safety, availability of clean fuels and reduction of emissions;
- **Seaports**: availability of alternative fuels and intermodal connections;
- **Inland ports** and **inland waterways**: minimum of CEMT class IV, adequate capacity of transport, continuous bridge clearance, good navigability, RIS and intermodal connections; availability of alternative fuels at core ports
- **Air**: rail connection to the airport, implementation of the Single European Sky, availability of clean fuels;
- **Multimodality** and **intermodality** on the Corridor: interconnection of transport modes at the nodes, real-time information in the transport chain and communication to the users at the stations; for rail-road terminals: transhipment track length of at least 740m, full electrification of the terminals rail tracks, the ability of handling all types of loading units.

Most infrastructure characteristics of the Rhine-Alpine Corridor are compliant with the TEN-T requirements. Table 4 lists only the infrastructure characteristics that deviate most from the requirements; infrastructures that comply fully with the criteria are not listed. It must be stated that although infrastructures are compliant, other operational restrictions - such as safety and noise emission prevention - limit full conformity.

Table 4: Compliance with TEN-T requirements

	NL	BE	DE	FR	CH	IT	Total
Railways							
Train length ≥ 740m	100%	100%[7]	100%[8]	-	100%	0%	87%
Line speed ≥100km/h	95%[9]	82%	100%[10]	-	90%	100%	95%
ERTMS deployment	50%	18%	0%	-	26%	0%	12%
Roads							
Availability of clean fuels	available	available	available	-	available	available	100%
Inland waterways[11]							
Min. draught 2.5m	100%	-	74%	90%	100%	-	82%
Min. height under bridges 5.25m	100%	-	100%	100%	100%	-	100%

[7] Operation of 740m long trains is theoretically possible in Belgium and Germany. Restrictions e.g. due to capacity bottlenecks during peak hours are likely to occur (cp. text above); however, it is not possible to mathematically measure the impact of these restrictions on the compliance, hence the 100% compliance rate in the table.

[8] See footnote 7

[9] In 2016 the Netherlands were granted derogation from this requirement for the railway line in the Port of Rotterdam due to a negative cost-benefit analysis.

[10] There are some speed limit restrictions for junctions in the area around Köln (10km in total).

[11] See footnote 5

The Rhine-Alpine Railway Network

Regarding the rail characteristics, all sections are electrified and have a track gauge of 1,435 mm. However, as Table 4 shows, a wide gap exists in ERTMS implementation, with only 12% of the rail sections being currently equipped. Germany and Italy can be identified as critical bottlenecks in the corridor-wide ERTMS rollout. Current interoperability constraints result from the different safety systems in use. In this context, ERTMS plays a key role in supporting rail interoperability and should be applied throughout, including in border crossings. In this regard, the *Commission Implementing Regulation (EU) 2017/6 of 5 January 2017 on the European Rail Traffic Management System European deployment plan* provides detailed information based on the work of ERTMS Coordinator Karel Vinck.

Rail interoperability is further complicated by the difference in electrification systems between participating countries, which potentially hinders border crossings, requiring railway undertakings to use dedicated locomotives or train outfits.

Italy's rail sections do not allow 740 m trains in operation; however, increase in track length to accommodate such trains is planned on most sections by early 2020s. In Switzerland, 740 m trains are operating on both routes as of the end of 2016. In Belgium, 740 m trains cannot be operated during peak-hours. However, investments are foreseen to facilitate the movement of 740 m trains on the Belgian part of the rail freight corridors. In Germany, 740 m trains can be operated at certain times in line with the timetable. Such diverging situation in different Member States creates a serious obstacle to seamless international freight traffic flows. To address the problem, the German Federal Transport Infrastructure Plan includes a first priority project called "passing loops for 740 m trains". In order to increase train length, it is necessary to have a sufficient number of side tracks. A study, performed by Rail Freight Corridor Rhine-Alpine demonstrated that with limited financial resources serious gains in capacity (of up to 15%) could be achieved.

There is a need to develop the required levels for maximum axle load of 22.5 tonnes particularly on the line to the port of Vlissingen. Freight line speeds are restricted in Belgium and Switzerland (bordering into Italy) as well as on the line leading to the port of Vlissingen and in and around the urban area of Köln. These sections with lower speed are not deemed problematic by the infrastructure manager because they are separate freight lines that can be used to avoid conflicts with passenger services. Still, the fulfilment of these criteria is very high on the Rhine-Alpine Corridor with only individual sections needing upgrades. In parts of Switzerland and Italy, restrictions on the intermodal loading gauge exist, which are set to be upgraded by the early 2020s.

Multimodal terminals

As explained before, multimodality plays a crucial role for the Corridor and the further development. Besides pure rail-road terminals, tri-modal terminals connecting IWW, rail and road, as well as bi-modal barge-road terminals, support the multimodal functioning of the Corridor. All intermodal terminals grant a non-discriminatory access. On the other hand, only 41% of the sites are electrified. The main compliance issue of the multimodal terminals however is the train length. Currently, only 11 of in total 65 identified terminals[12] provide transhipment tracks of at least 740 m length. One can argue that the cargo handled is of high specific weight so that the maximum permitted train weight is in reality the lowest common denominator rather than the train length,

[12] This number represents the terminals in the locations presented in Figure 2 according Regulation 1315/2013

or that the shunting yard would allow splitting of trains and handling its sections, or that the corresponding rail network does not allow longer trains either. Nevertheless, the existing situation with regard to the length of transhipment tracks creates a real burden for an efficient supply of intermodal transport services.

The greatest challenge for the present sites is their access to the rail infrastructure (single sided, non-electrified, annex to shunting yard or port railway line) and the limitation of the (wagon) train length by either the reception/departure siding or the transhipment track(s).

The Rhine-Alpine Road Infrastructure

The Corridor's extensive road network fulfils, largely, the TEN-T requirements. The availability of clean fuels' infrastructure is still underdeveloped in Switzerland and Italy while important progress is being achieved in Belgium. In border crossing sections and around important multimodal nodes as well as ports, there is a substantial unmet demand for secure truck parking, in particular for UK-bound traffic. In turn, this jeopardizes compliance with the applicable driving time regulations and creates a safety and security hazard by forcing trucks to park off-ramps and outside the designated areas. The policy of the night-time driving ban for trucks in Switzerland creates a bottleneck for cross-border road transport.

The Rhine-Alpine IWW Network and the Inland Ports

The IWW network on the Corridor is fully compliant with the requirement of the CEMT class IV. Nevertheless, some of the Rhine sections are not navigable during extreme aridity and low water and these bottlenecks influence navigability and efficiency on the entire Rhine basin. The main compliance issues identified are the draught limitations along the Rhine in Germany where only 74% of the waterways fulfil this criterion. Insufficient lock capacity and mooring places, especially near Lobith - a vital cross-border section between the Netherlands and Germany, emerge as critical priorities. Lock capacity is similarly an issue along the Neckar and Moselle rivers. However new mooring capacity near Lobith is expected to be completed by 2022-2024. Moreover, to improve the situation, the German Federal Transport Investment Plan includes upgrade (Neckar) and new construction (Mosel) of lock chambers.

The Rhine-Alpine Maritime Infrastructure

The maritime port infrastructure complies with almost all criteria.

The Rhine-Alpine Air Transport Infrastructure

The main compliance issue for the airports along the Rhine-Alpine Corridor are the missing connections to the rail network in Basel, Milano Linate, Genova and Rotterdam. For Genova a project has already been approved, with works expected to end in mid-2020s. For Linate, a project planning to connect the airport with the underground line (Metro Line 4) is being implemented and is expected to be completed by 2022. The airports of Bergamo and Liège are exempted from the obligation to have rail connection. Nevertheless, the implementation of a new rail link to the future cargo terminal at Liège airport is planned (Carex Project). A rail connection to Bergamo airport is also planned.

Clean fuels are not available at the Corridor airports.

2.3 Progress of corridor development

Since the first work plan published in May 2015, a great progress has already been made throughout the entire Rhine-Alpine Corridor and all transport modes. In total, 16 infrastructure projects and important studies have been completed and implemented.

The total investment sum of these measures amounts to 13 billion EUR. The most important and representative projects are highlighted and described underneath.

Gotthard Base Tunnel

The Gotthard Base tunnel runs through the Swiss Alps. With a length of 57 km, it is the world's longest and deepest rail tunnel. It represents a significant step towards increasing the competitiveness of rail for the transport of freight and passengers on the Rhine-Alpine Corridor. By significantly increasing the transport quality and capacity, it is a vital step towards a well-connected Europe.

Intermodal hub Rhine-Ruhr

The Intermodal Hub Rhine-Ruhr represents a new generation of intermodal gateway terminals. Duisburg was chosen as a location because it offers excellent connections to the main rail axis in Europe. Main function is the transhipment of loading units between trains, ensuring a seamless pan-European connection between the maritime ports and the hinterland.

Motorway A11

The motorway A11 that connects Bruges and Knokke-Heist in West Flanders (Belgium) was opened in September 2017. The new route runs over 12km, has three exits and nine wildlife crossing structures. The key elements are the two mobile bridges over the Baudouin Canal. The A11 was built to fulfil three objectives: to provide a better access to the port of Zeebrugge, to improve the quality of life by separating the local traffic from the freight one, and to promote the tourism in the region. Regarding the latter, 15 kilometres of new bike paths were constructed. The project has been financed under the Project Bond Initiative.

Maasvlakte 2 rail connection upgrade

The Rhine-Alpine seaports are key access points to the worldwide transport flows. Establishing state-of-the-art hinterland connections is crucial for the success of the Corridor. The upgrade of the rail connection of Maasvlakte 2 in the port Rotterdam significantly enhances freight traffic operation for the Port of Rotterdam. It increases even further the utilisation of the successful Betuwe line.

Milano Malpensa airport rail link

Rail accessibility to the Milano Malpensa airport was greatly improved in 2017 with a new connection between Terminal 1 and Terminal 2, which has made it possible to significantly expand the potential user base. The rail link, co-funded by the European Commission under the TEN-T/CEF program, started operations last December and achieved good results in terms of traffic. Nine months later 2.3 million passengers used the service, 28% more than the previous year in the same period.

Start of works on Emmerich – Oberhausen line

As a main arteria for rail, the line between Emmerich and Oberhausen connects the Rhine-Ruhr metropolitan area to the north with the Netherlands, in particular with the North Sea ports: it forms the direct link to the Betuwe line. To the south, the route is the rail backbone of the Rhine-Alpine Corridor, continuing through Köln, the Rhine valley and Basel to Northern Italy. Construction works have started in January 2017 with the aim of extending the line's capacity by separating passenger and freight transport.

Beside the pure infrastructure development, a strong cross-country cooperation has been pursued, proving the case of a border-free Europe. Examples for these international initiatives are:

Consolidation and strengthening of the Upper Rhine

This project improves the Upper Rhine ports' accessibility and strengthens the Rhine as a central hub for the TEN-T network.

Interregional Alliance for the Rhine-Alpine Corridor

The European Grouping of Territorial Cooperation "Interregional Alliance for the Rhine-Alpine Corridor EGTC" continues the strategic initiative CODE24. It was established in 2015 in order to facilitate the transnational cooperation between partners along the axis and to manage the important challenges of the corridor development.

3 Transport Market Analysis

3.1 Results of the multimodal transport market study

The purpose of the Transport Market Study (TMS) for the Rhine-Alpine Corridor is to analyse the current and prospective market conditions along the Corridor, with current and future utilisation levels of transport modes.

For freight transport, the Rhine-Alpine Corridor shows strong links between Germany, the Netherlands and Belgium. The flows of these countries add up to 307.2 million tonnes, 83% of the total international freight activity of the Corridor. Currently, intermodal transport to and from Italy on the Corridor originates mainly in Europe (continental transport), however with a planned improved connection between the Port of Genova and the hinterland, the maritime volumes moving to Switzerland and Germany are expected to grow.

The main cross-border commodities identified are machinery and transport equipment, fuel products (liquid and dry bulk), building material and ores. The favoured mode of transport for these commodities (hinterland transport) is inland waterways followed by road. Individual port statistics confirm this analysis.

For current passenger demand, expressed in number of trips, three major bidirectional traffic flows have been identified: between Belgium and the Netherlands, between Germany and Switzerland and between Germany and the Netherlands representing 25%, 23% and 19% of total traffic respectively. The dominant mode for international passenger flows in the Corridor is road.

Air transport, as expected for the catchment area, represents only a small part (4.1%) of total passenger demand. The main flows are identified between Germany and Switzerland, the Netherlands and Switzerland as well as Germany and Italy.

Future volumes

There have been two study initiatives on future volumes in this work plan. The first one – the TMS – includes a compliance scenario. The second one – the results of which are presented in Chapter 6 of this Work Plan – looks at the decarbonisation impact of the Corridor.

The various national forecasts investigated in the TMS pointed out at the importance of sea transport (especially for Belgium, the Netherlands and Italy), the sovereignty of road in the cases of Germany, Italy and the Netherlands and the expected growth for rail in the case of Switzerland, Germany and the Netherlands.

In 2014, the modal shift effects of the Work Plan measures were calculated. In order to depict the potential effect of changes on the Corridor, the TMS looked at the transport performance of the relevant sections. A model was employed using three runs: 2010 (basis), 2030 (baseline) and 2030 (compliance). The baseline forecast used GDP assumptions for 2030. The "compliance" to TEN-T standards scenario was defined considering a number of assumptions, such as full compliance with the TEN-T requirements, as well as a broader concept of seamless interoperable railways and a trend of wide-spread introduction of road tolling systems[13].

The analysis at origin/destination level for future transport flows demonstrates a significant growth potential for the central part of the Corridor, especially for rail in the areas close to Köln, Frankfurt and Mannheim, as well as in Switzerland and Italy.

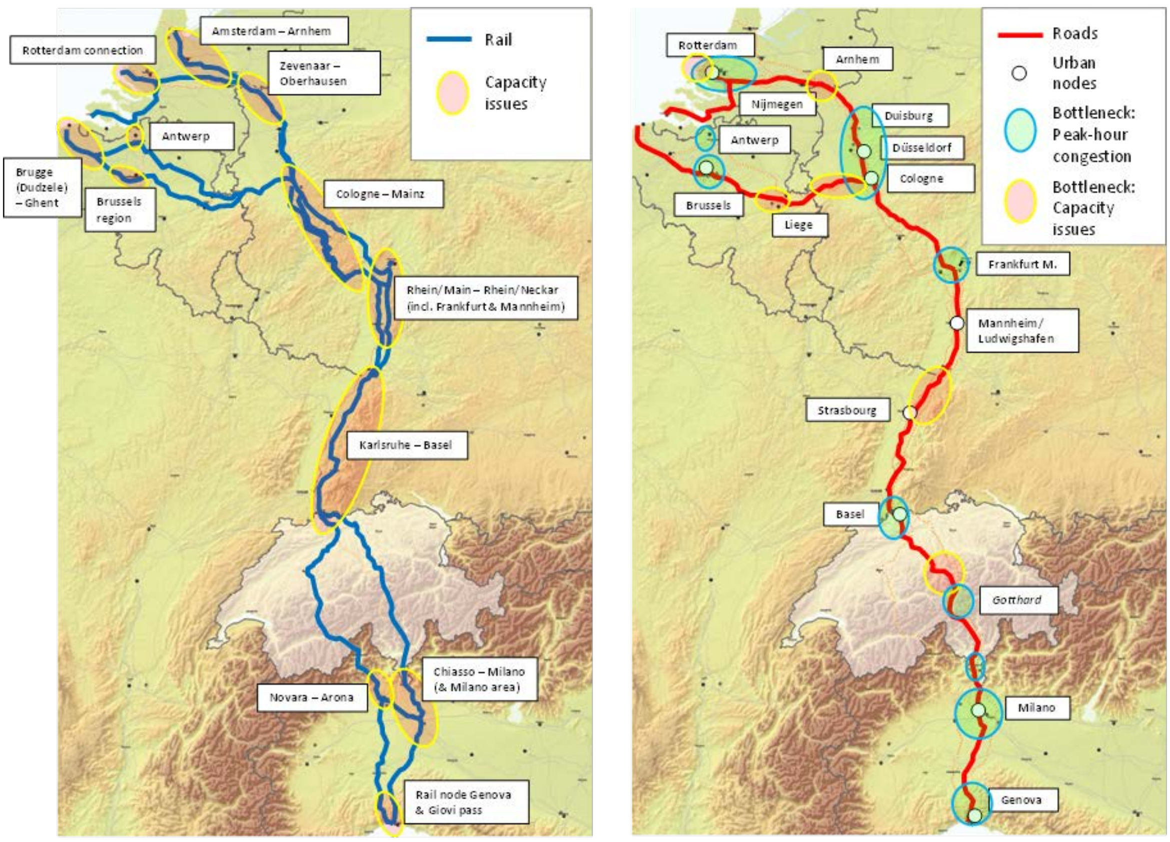
[13] In line with existing legislation on road charging

By implementing the measures needed to comply with the TEN-T requirements, a desired modal shift from road to rail and inland waterways will occur by 2030. If the requirements are not met, the modal split is expected to stay at the same levels. Because the Corridor is quite advanced, compliance is not the greatest bottleneck. The model results underline this. Going further or beyond compliance with the network yields greater decarbonisation impacts, compare to the compliance scenario. This is shown in the section 6.4 "Modal shift and impact to decarbonisation and climate change adaptation".

3.2 Capacity issues along the Rhine-Alpine Corridor by 2030

As already stated, the Corridor infrastructures present high level of development and of compliance with TEN-T standards. At the same time, they face one of the highest traffic flows of passengers and goods in Europe, resulting in important capacity bottlenecks. Often, capacity restrictions and congestion have been detected in and around the urban nodes and agglomerations for rail and road (cf. Figure 3).

Figure 3: Capacity issues for rail and road



Railways

In Germany, noticeable capacity issues have been identified in particular in the following sections and nodes:

- Emmerich – Oberhausen;
- Köln - Mainz;
- Rhein/Main – Rhein/Neckar, including the nodes of Frankfurt and Mannheim;
- Karlsruhe – Basel.

In the Netherlands, the capacity on the line from Amsterdam to Arnhem via Utrecht is identified as critical. The Meteren freight line is highly utilised and would require additional capacity or a bypass. Between Zevenaar and Oberhausen there are prevalent capacity issues and the third track is needed; the construction phase itself causes bottlenecks due to limited availability of a second track. Diversionary routes are therefore needed, in particular during the construction phase of the third track. The Brabant route in the south of the Netherlands, while not being on the Corridor, could be considered in this regard.

In Belgium, a large flow of domestic and international rail passenger traffic is dependent on the capacity of the railway link between Brussels-South and Brussels-North. This link, called the North-South junction, is the main rail bottleneck for international high-speed rail services in Belgium. A feasibility study, co-funded from CEF, is currently being conducted to identify preferred solution(s) to remove this major bottleneck. Moreover, capacity bottlenecks exist on an important axis from the port of Zeebrugge to Ghent: between Dudzele - Brugge and Brugge - Ghent.

In Switzerland, there is an issue of limited track capacity in the Basel area connecting to Germany. The Simplon rail tunnel cannot cope with safety requirements. The recent opening of the Gotthard Base tunnel is however expected to have a beneficial impact.

On the Italian network critical capacity bottlenecks are identified around the Giovi pass, between Chiasso - Milano, Novara - Oleggio, Oleggio - Arona, Rho - Gallarate, Tortona - Voghera, Pavia - Pieve Emanuele and Milano Rogoredo - Pieve Emanuele. Additionally the rail nodes of Genova, Novara and Milano require upgrades to cope with capacity, service quality and accessibility requirements.

Finally, because of the fact that the corridor rail lines often pass through densely populated areas, level crossings can cause safety, punctuality and capacity issues.

Roads

Road capacity bottlenecks are common. Serious traffic congestion problems are recorded along many highway sections on the Corridor. These occur in particular around urban nodes and in border crossing sections, as well as close to the infrastructure nodes. Congestion in peak hours is due to the fact that high capacity motorways are used as main access routes into the urban centres. Thus, long distance traffic is conflicting with local use of road infrastructure. In some urban areas (for example around Genova) congestion is aggravated by high seasonal tourist traffic.

With some of the road infrastructure being in a matured stage of its lifespan, maintenance work has to be performed. Construction and upkeep may lead to further capacity limitations.

Another critical issue on the motorways is the scarcity of secured parking for trucks. With driving time limitations drivers are bound to stop regularly for breaks, often close to nodes. This is increasing the pressure on available rest areas close to nodes along the Corridor. A particular challenge is the night-time driving bans in Switzerland. This leads to forced overnight stops at the borders with Italy and Germany.

Inland waterways and seaports

Capacity for inland waterway transport and maritime access on the Corridor along the Rhine is in general sufficient but can be a problem in periods of drought. A possible review of the working time legislation might imply the need for additional berthing places with an adapted on-shore infrastructure. For the rivers Moselle and Neckar as well as for Strasbourg, lock capacity has to be adapted. For Mosel and Neckar, the German Federal Transport Investment Plan includes measures to improve the situation. Moreover, Strasbourg requires a better connection and electrification of port rail lines and improvements to the stocking capacity for empty containers.

The Belgian ports of Antwerpen, Ghent and Zeebrugge face a number of connectivity and capacity issues. The port of Antwerpen needs upgrading of sea locks, a second rail freight access and upgrades of bridges. In Ghent, the capacity of the cross-border Terneuzen (NL) locks emerges as a critical issue. For the port of Zeebrugge the major bottleneck concerns its different gauge connection to the IWW network; moreover rail investments are foreseen to improve the capacity (optimisation of the railway infrastructure inside the port and construction of new tracks) and the multimodal chain characteristics (among others marshalling yards) of this port. Furthermore the installation of a new lock is planned.

The port of Rotterdam has to secure sufficient capacity both for future developments in the port and connections to its hinterland. Maintaining its capacity and upgrading of the Caland Bridge and the Suurhoff Bridge are critical issues in the Port of Rotterdam. In addition, the new Theemswegtracé will provide more capacity to the harbour line. Amsterdam and Genova[14] require an improved maritime access – given their space/territorial constraints. These ports are limited in their physical expansion planning, which requires further efficiency upgrades and improvements in accessibility of the port areas from the land and maritime side. In the port of Genova a re-configuration of the maritime access to the Sampierdarena Port Basin is planned and the final design scheme of a major bypass of the existing highway western access to the city was approved, with works to begin in 2018.

[14] The port of Genova together with the Port of Savona and Vado ligure forms a unique governance, operational, administrative and financial legal entity called the Western Ligurian Sea Port Authority

4 The Rhine-Alpine CNC identified projects to be realised by 2030

4.1 General overview

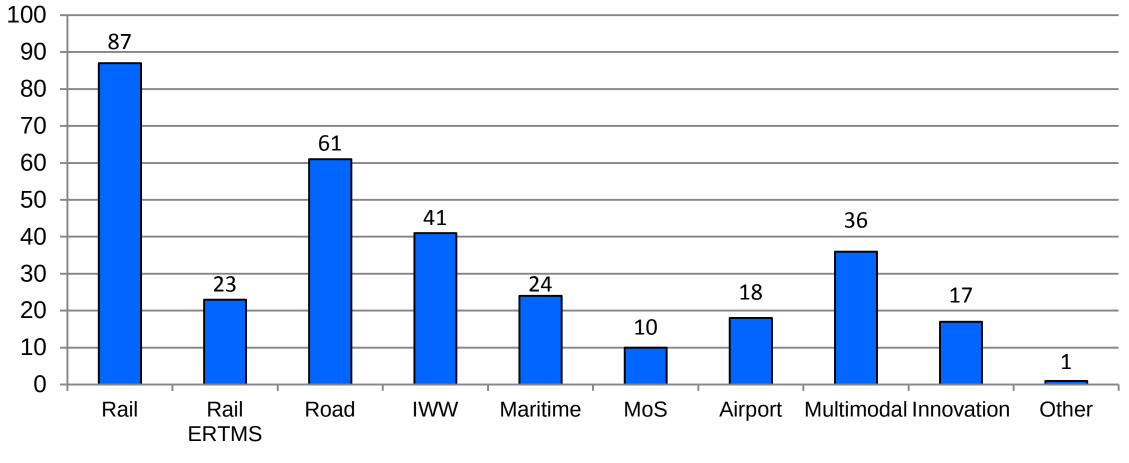
One of the main goals of the revised corridor study was to identify and describe all projects necessary for the completion of the Corridor. This final project list is originally based on the project list of the 2014 corridor study described in the first Work Plan. This 2014 list was updated and enriched with the 2015 CEF projects, selected CEF 2016 proposals, national transport plans, operational programmes on transport and the Rail Freight Corridor implementation plans. Throughout the entire process, several consolidation rounds with the Members States and Corridor Forum stakeholders ensured a harmonious and well-coordinated project list.

The final project list of 2017 consists of 318 projects; it also includes projects that have been already implemented but were not completed when the Regulation 1315/2013 was set into force in 2013. Compared to the 2014 Work Plan this means an increase by 42 projects and compared to the Work Plan of 2016 an increase by 101 projects. This growth is mainly due to additional projects that have been added by the Member States or other stakeholders, but also because of the optimised methodology of the handling of overlapping projects.

Regarding the categorisation of projects, it has to be emphasized, that each project is allocated to only one category although many measures could have been assigned to more than one.

The following Figure 4 emphasises the importance of "Rail" (including 23 ERTMS-related measures) which accounts for 35% of the total. These projects include a vast range of measures, from noise reduction to new constructions of high-speed passenger lines. Compared to that, the other modes of transport (namely "Road" and "IWW") have fewer upgrades planned. Multimodality also plays an important role for seamless transportation chains on the Rhine-Alpine Corridor, pointed out by in total 36 related projects. Finally, there are only 17 projects belonging to the category "Innovation". This low number is however explained by the categorisation that favours the "modal" approach, while projects can belong to one category only.

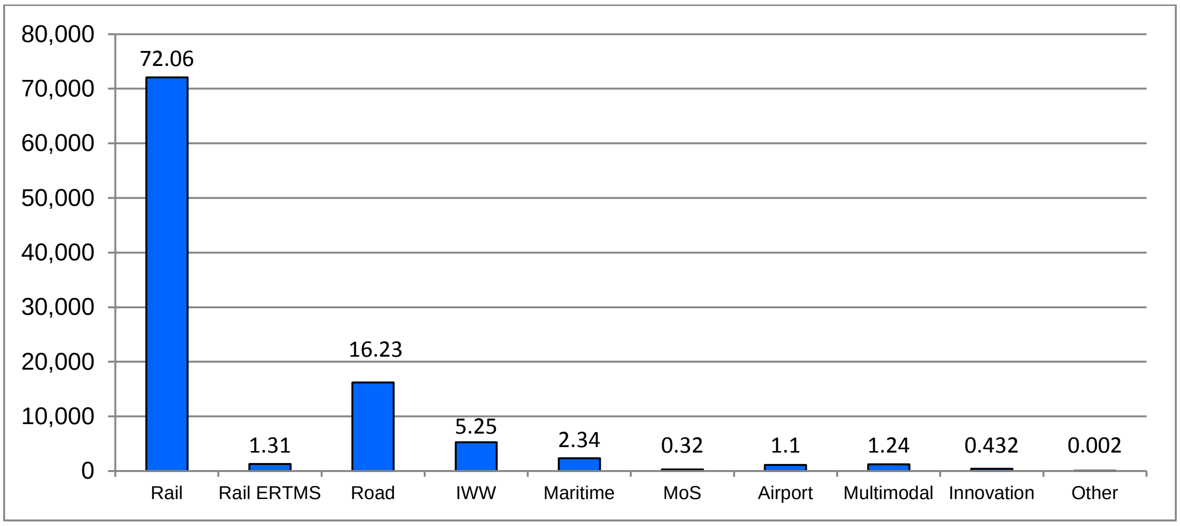
Figure 4: Total number of corridor projects by category



Source: KombiConsult, based on RALP project list

The planned investment per project category (as indicated by Figure 5) shows that rail and ERTMS have by far the highest needs for infrastructural upgrades followed by road projects.

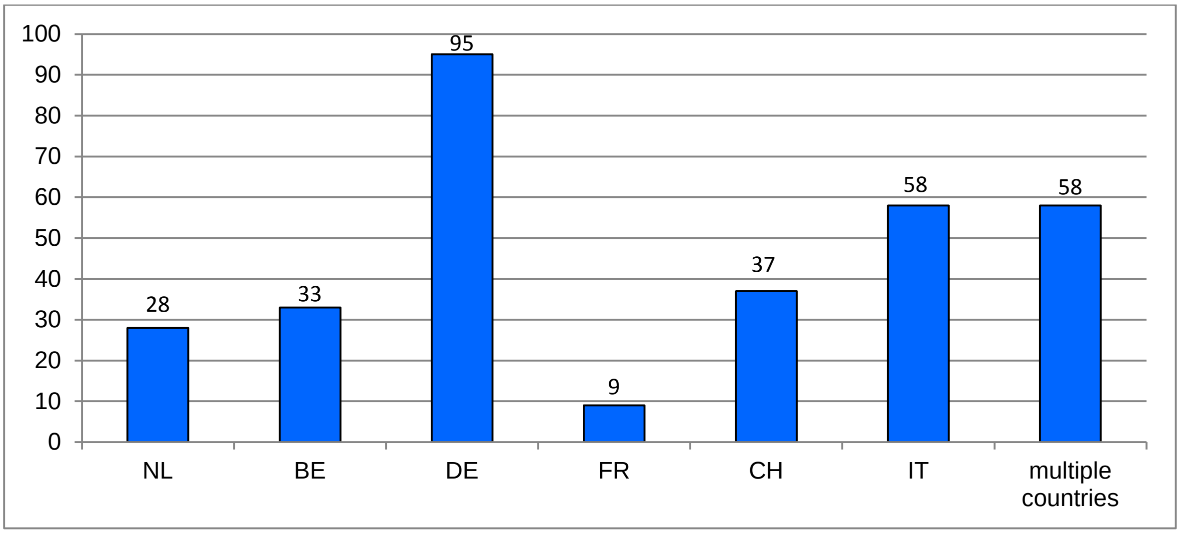
Figure 5: Investments per category in billion EUR



Source: KombiConsult, based on RALP project list

Looking at the project shares per country (Figure 6), it can be said that the number of projects is more or less proportional to the corridor share of the respective country. For example, France, which is only involved with the inland ports of Strasbourg and Mulhouse, accounts for nine projects (3% of the total). In contrast, Germany, representing about half of the corridor network length (see Table 3), also leads the project ranking with 95 projects (30% of the total). Comparing the country shares with the analysis of the second work plan in 2016 it can be observed that the projects concerning multiple countries have more than doubled. This shows that stakeholders are already inspired by the idea of the corridor and that there is a strong development and trend towards a well-connected, seamless Europe.

Figure 6: Number of projects by country



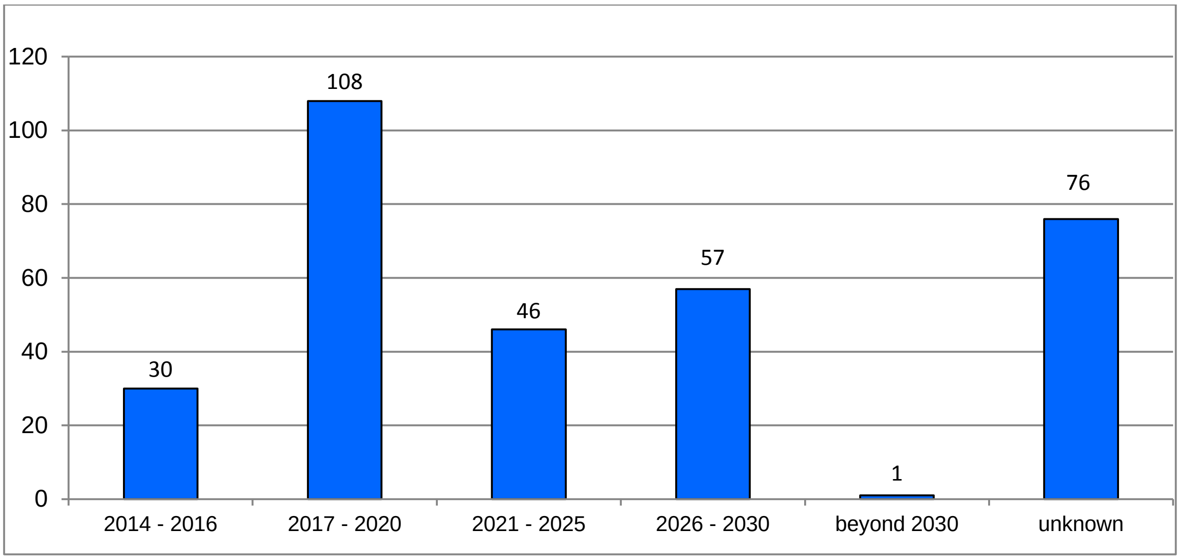
Source: KombiConsult, based on RALP project list

The planned implementation time of the projects is shown in Figure 7. However, not all of these 318 projects are expected to be finalised before 2030. While only for one project the official completion date is after 2030, for 76 projects the implementation date is unknown. Even if for most of these projects the finalisation is expected to happen before 2030, there might still be a number of projects with a later implementation date. In addition, some long-term projects might be delayed so that their actual implementation may move beyond 2030. For many of these projects the implementation depends on the availability of co-financing and other investment possibilities post 2020.

For the others, a grouping of the completion year into the clusters was done: "2014 – 2016", i.e. projects completed since the adoption of the TEN-T Regulation and within the present reporting time; "2017 – 2020", i.e. projects to be completed in the present financing period; and two more intervals until 2030, i.e. the target date for the core network infrastructure to meet the Regulation's requirements.

Thirty projects (9%) have already been completed by the end of 2016. The biggest group (34%) consists of projects, which are expected to be completed by 2020. Another 46 projects (14%) are to be implemented until 2025, while 57 projects (18%) by 2030.

Figure 7: Planned implementation of projects



Source: KombiConsult, based on RALP project list

4.2 Analysis per mode

4.2.1 Rail and Multimodality including ERTMS deployment plan

The transport mode is facing many difficulties along the Corridor, such as the increasing public awareness, which calls for noise reduction measures. An additional issue is the necessary upgrade of nodes and shunting yards to remove existing capacity bottlenecks. However, the most important challenge is to upgrade the sections on the Corridor that cannot cope with the existing and future needs for capacity, which is already stretched to maximum at certain sections in order to accommodate heavy mixed passenger/freight traffic.

The most prominent projects concerning rail infrastructure aim indeed at tackling the capacity issues. These are located at the following sections:

- Zevenaar – Emmerich – Oberhausen;
- Korridor Mittelrhein: Zielnetz I;
- Karlsruhe – Basel;
- Gotthard base tunnel;
- Genova – Tortona/Novi Ligure (Giovi pass);
- Zeebrugge – Brugge – Ghent.

These six projects amount to roughly 30 billion EUR, which is more than 40% of the total investment volume of rail-related infrastructure projects.

On 5 January 2017, the European Commission adopted the Implementing Regulation (EU) 2017/6 on European Rail Traffic Management System European Deployment Plan (ERTMS EDP) that replaces the old deployment plan of 2009. The reviewed ERTMS EDP adapts the geographical scope of deployment to the TEN-T Regulation, and sets new targets for ERTMS deployment on CNC's until 2023. These target dates are firm commitments made by Member States and infrastructure managers during the consultation and negotiations, led by Karel Vinck, European ERTMS Coordinator, between 2014 and 2016.

In 2023, the ERTMS European Deployment Plan will be updated again setting out the precise implementation dates for the remaining part of the Corridors between 2024 and 2030. ERTMS Coordinator proposed this two-step approach for defining the consistent deployment of CNCs by 2030, which was appreciated by all affected stakeholders. This approach ensures that the reviewed EDP sets out dates that are more realistic and therefore it can serve as the basis for business planning of railway undertakings.

The deployment of an interoperable Single European Rail Area is facing numerous barriers. An important step forward was the adoption of the ERTMS Deployment Action Plan15. It defines the actions to remove all identified obstacles with the responsible parties in the frame of well-defined timelines. This Action Plan is the last step in a thorough analysis of the ERTMS deployment in the European Union, followed by detailed negotiations with the Member States and the rail sector, including their commitment in terms of actions and execution times.

4.2.2 IWW & inland ports including RIS deployment plan

For inland waterways, the key is to ensure a reliable navigation along the Rhine River. This also applies to the connected rivers Moselle and Neckar. The Belgian inland waterway network is not part of the Corridor alignment, but plays an important role for the handling of freight volumes along the Rhine-Alpine Corridor.

In order to improve reliable navigation, many projects addressing the extension of fairway depth and lock capacity are part of the project list. However, they will not assure the full compliance of the Rhine with the TEN-T requirement for fairway depth.

The concept of River Information Services (RIS) stands for the most substantial change in the IWW sector for the last decades. From a long-term point of view, RIS aims at supporting traffic and transport management in inland waterway transport as well as enhancing safety, efficiency, reliability and environmental friendliness of the inland waterway transport operations in general.

[15] Commission Staff Working Document SWD(2017) 375 final " Delivering an effective and interoperable European Rail Traffic Management System (ERTMS) – the way ahead", adopted on 14 November 2017

4.2.3 Maritime Ports and MoS

For the Rhine-Alpine Corridor, establishing an efficient connection from the seaport to the existing rail and IWW network is essential for development of the Corridor. An additional focus is on the innovation and on alternative fuels' infrastructure, contributing to better protection of the environment and biodiversity.

The Motorways of the Sea (MoS) represent the maritime dimension of the Core Network Corridors connecting important European nodes. In parallel to this Work Plan, Brian Simpson, the European Coordinator for Motorways of the Sea, delivered on the second version of the MoS Detailed Implementation Plan (DIP).

The document, following extensive consultations with stakeholders and Member States, presents a number of recommendations to shape the MoS programme of tomorrow in close coordination with other European Coordinators.

The DIP singles out the key three future development priorities:

- environment;
- integration of maritime transport in the logistic chain;
- safety, traffic management and human element.

The MoS work programme is instrumental in identifying future TEN-T policy maritime objectives and it clarifies the main areas that would require EU financial contribution in order to help the maritime industry to improve its environmental and safety performance.

It also includes a number of suggestions with the objective to contribute to the increased efficiency of the logistic chain within the nine Core Network Corridors by pointing out to gaps in terms of maritime links.

Brian Simpson's work programme comprises also a set of recommendations defining possible future funding objectives with regard to maritime dimension of the TEN-T policy, paying particular attention to future trends in Short Sea Shipping in Europe and the crucial MoS contribution to better connectivity with peripheral and outermost regions.

The document makes an effort to characterize the main bottlenecks and investment needs in the comprehensive network of ports as well as point out the main inadequacies when it comes to current network of MoS links.

4.2.4 Road infrastructure, including ITS deployment

Road plays a major role in ensuring accessibility and connectivity of the regions by providing interconnections between transport infrastructure of long-distance traffic and regional or local traffic. As the road network on the Corridor fulfils already the standards of a motorway or an expressway, the envisaged measures aim mostly at the modernisation of the network (outdated road sections, bridges, parking areas, etc.). To reduce for instance the air pollution and enable sustainable and low-emission road traffic, improving the use of clean fuels is another main topic for road.

The most prominent projects concerning road infrastructure are:

- ring of Brussels (upgrade);
- ring of Antwerpen (upgrade and Oosterweel connection);
- extension of A15 motorway to solve the missing link south of Arnhem;
- major bypass of Genova (Gronda autostradale).

Intelligent Transport Systems (ITS) are supportive and innovative services relating to transport and traffic management. The ITS provide information for various users and makes safer, more coordinated and smarter use of road transport networks.

4.2.5 Airports

Similar to the seaports, also for airports, a seamless multimodal connection is crucial for both passenger and freight transport. Rail connections are established for almost all relevant nodes, with the exception of Bergamo (Milano), Liège and Rotterdam/The Hague. Nevertheless, coping with the ever-increasing demand for capacity remains a challenge for the already existing rail connections from and to the airports.

The projects identified in the list - such as Malpensa Rai link, S-Bahn connection in Frankfurt and Genova airport rail connection - address those challenges.

4.2.6 Multimodality

Multimodality is a key component to guarantee an efficient and safe interchange between road, rail and other transport modes (inland waterway, short sea shipping including ferries). A focus is to ensure competitive and seamless transport chains for intermodal services throughout Europe. It has to be noted that the assignment of projects to the category "multimodality" sometimes is difficult as e.g. rail projects linked to the improvement of intermodal loading gauges are related to rail although they improve primarily the competitiveness of intermodal transport.

To cope with the permanently increasing transport volumes, terminal capacity has to be upgraded accordingly. An innovative highlight for the operation of combined transport volumes is the new Intermodal Hub Rhine-Ruhr in Duisburg, which was set into operation in 2016. In this terminal, the new and innovative concept of rail-rail transhipment will be realised. This offers a completely new dimension in the improvement of intermodal connectivity on the Rhine-Alpine Corridor.

4.3 Urban nodes' role in the CNC

Urban nodes are defined as an "urban area where the transport infrastructure of the trans-European transport network, such as ports including passenger terminals, airports, railway stations, logistic platforms and freight terminals located in and around an urban area, is connected with other parts of that infrastructure and with the infrastructure for regional and local traffic"[16]. Urban nodes are further specified as starting points (first mile), final destination (last mile) and/or points of transfer within or between different transport modes for freight and passengers on the TEN-T network.

According to TEN-T Regulation 1315/2013 and the results of the CNC studies, the Rhine-Alpine Corridor core network is characterised by thirteen urban nodes, located in six countries – see also Figure 2.

The node of Strasbourg was added to the RALP Corridor due to the importance of the Alsace region for the inland waterway transport from the North Sea ports. Frankfurt am Main is one of the biggest centres within the Rhine-Alpine Corridor. Rail and road corridor lines on the south-west of the node are part of the Rhine-Alpine Corridor while the inland waterway in the node (river Main) belongs to the Rhine-Danube Corridor. The nodes in Switzerland have been chosen in coordination with the Swiss Ministry of Transport (BAV). Even though Zürich and Bern have been identified as important urban nodes, their connection to the alignments of road and rail is very limited in the core network.

[16] TEN-T Regulation 1315/2013

A compliance check of CNC lines within the urban nodes has been performed. It addressed the requirements of the regulation and has been carried out for the urban nodes according to the KPIs of the project list. In particular, rail parameters taken into account were train length (≥740 m), axle load (≥22.5 t), speed (≥100 km/h), electrification and capacity utilisation[17]. Road sections have been analysed with regard to the parameter "express road/motorway".

Moreover, a last-mile connection compliance check has been carried out for each urban node in order to investigate whether a seamless connection between the long-distance TEN-T infrastructure and regional / local traffic and urban freight delivery on the last mile is achieved. The rail connection of inland ports, trimodal terminals and rail-road terminals to the core network has been analysed according to the parameters of axle load, electrification and train length. Rail connections to airports have been evaluated based on heavy rail connection. Only rail parameters have been taken into account as similar road criteria do not exist.

In addition, improvement projects with reference to non-compliant sections or in case of particular relevance for the urban node have been pointed out.

Corridor rail lines within the urban nodes suffer of different bottlenecks. About 80% of analysed rail parameters per node are compliant while about 20% of them are not satisfying on at least one rail section within the urban node. The totality of the rail corridor is electrified. The rail parameter most afflicted by bottlenecks is "capacity utilisation", that is compliant in about 35% of nodes only. It has to be noted however that this parameter is not a TEN-T requirement. Moreover, the "train length" criterion of 740 m and the "speed" criterion of 100 km/h are not completely fulfilled in two nodes. However, as regards speed restrictions in Köln, limitations refer to separate freight train lines in and around the urban area of the city, which are necessary to avoid operation restrictions for local and long distance passenger transport. No projects with the purpose of achieving the speed and axle load requirements on the non-compliant sections have been identified. At the same time projects focusing on the total or partial resolution of the above-mentioned bottlenecks are planned with a focus on capacity improvement.

Corridor lines for inland waterways have been analysed for eight urban nodes. Except from one bottleneck in Brussels, all IWW parameters per node taken into account are compliant with the regulation. The only parameter, which is not fully compliant, is "height under bridges" in the urban node Brussels. No projects have been foreseen for the resolution of this bottleneck.

The road corridor in Rhine-Alpine nodes is almost fully compliant with the TEN-T requirements.

[17] The parameter "capacity utilisation" is not a TEN-T requirement and has been evaluated in the framework of the corridor study

Table 5: Corridor lines compliance check on the Rhine-Alpine urban nodes

Mode	Parameters	Amsterdam	Rotterdam	Antwerp	Brussels	Düsseldorf	Köln	Frankfurt*)	Mannheim	Strasbourg*)	Milano	Genova	Basel
Rail	Train length (≥ 740 m)	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN	WHITE n.i.	YELLOW P	YELLOW P	GREEN
	Axle load (≥ 22,5t)	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN	YELLOW	GREEN	GREEN	GREEN
	Speed (≥ 100 km/h)	GREEN	GREEN	GREEN	GREEN	GREEN	YELLOW	GREEN	GREEN	GREEN	GREEN	GREEN	YELLOW
	Electrification	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN
	Capacity utilisation	GREEN	GREEN	YELLOW P	YELLOW P	YELLOW P	YELLOW P	YELLOW P	YELLOW P	GREEN	YELLOW P	YELLOW P	GREEN
IWW	ECMT class (≥ IV)	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN	GREY n.a.	GREY n.a.	GREEN
	Draught (≥ 2.5 m)	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN	GREY n.a.	GREY n.a.	GREEN
	Height (≥ 5.25 m)	GREEN	GREEN	GREEN	YELLOW	GREEN	GREEN	GREEN	GREEN	GREEN	GREY n.a.	GREY n.a.	GREEN
	RIS implementation	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN	GREY n.a.	GREY n.a.	WHITE n.i.
	Good navigation status	GREEN	GREEN	GREEN	GREEN	WHITE n.i.	WHITE n.i.	GREEN	GREY n.a.	GREY n.a.	GREY n.a.	GREY n.a.	WHITE n.i.
Road	Express road / motorway	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN	YELLOW	GREEN	GREEN	GREEN

Key:

GREEN	Compliant	WHITE	No information (n.i.)	P	Project fo improvement of non-compliant parameter
YELLOW	Partly compliant / non-compliant	GREY	Not applicable (n.a.)	*)	not part of RALP Corridor according TEN-T regulation

Source: HaCon

In general, results of the analysis show a light discrepancy in terms of corridor lines compliance between different European countries involved in the Rhine-Alpine Corridor. Dutch, Belgian, Swiss and German nodes are almost completely compliant while French and Italian nodes show more bottlenecks. In particular, urban nodes such as Strasbourg, Milano, Genova, Brussels and Köln are characterised by two non-compliant parameters per node. On the other hand, corridor lines in Amsterdam and Rotterdam are fully compliant while Antwerpen, Düsseldorf, Basel and Mannheim only present one not compliant parameter per node.

5 Future challenges

The ultimate objective of the TEN-T development is to close existing gaps, remove bottlenecks and eliminate technical barriers that exist between the transport networks of EU Member States, strengthening the social, economic and territorial cohesion of the Union and contributing to the creation of a single European transport area. This global objective can be further specified:

- improving cross-border sections;
- eliminating missing links;
- achieving interoperability/compliance with TEN-T standards;
- developing multimodality;
- enhancing last-mile connection;
- tackling externalities/sustainability/innovation;
- considering impacts on urban areas;
- improving capacity and removing bottlenecks.

Critical issues can be defined as everything that hinders or prevents the fulfilment of the above mentioned corridor objective by 2030. The critical issues can be divided into technical compliance issues, capacity bottlenecks as well as administrative and operational barriers. The methodology of identifying these critical issues as well as the issues themselves are described and analysed in the following sub-chapters.

5.1 How to identify the Critical Issues

In general, the identification of critical issues is based on the technical compliance analysis of the Rhine-Alpine core network (chapter 2.2), the development of the transport market and the resulting capacity issues by 2030 (chapter3) as well as the analysis of the comprehensive list of projects along the Rhine-Alpine Corridor (chapter 4). In addition, critical issues were discussed in the Corridor Fora and Working Groups with several stakeholders.

For the first work plan, a technical compliance analysis was performed. It compares the currently deployed infrastructure with the official TEN-T requirements and shows where these standards are not met. With the continuation of the studies on the CNCs, the fulfilment of the compliance has been monitored and further discussed with relevant stakeholders and Member States to keep the compliance analysis of the Rhine-Alpine Corridor up-to-date.

The list of projects along the Corridor was finalised in early summer 2017 in an iterative process. It also involved several consolidation rounds with the Members States and Corridor Forum stakeholders to ensure a harmonious and well-coordinated project list.

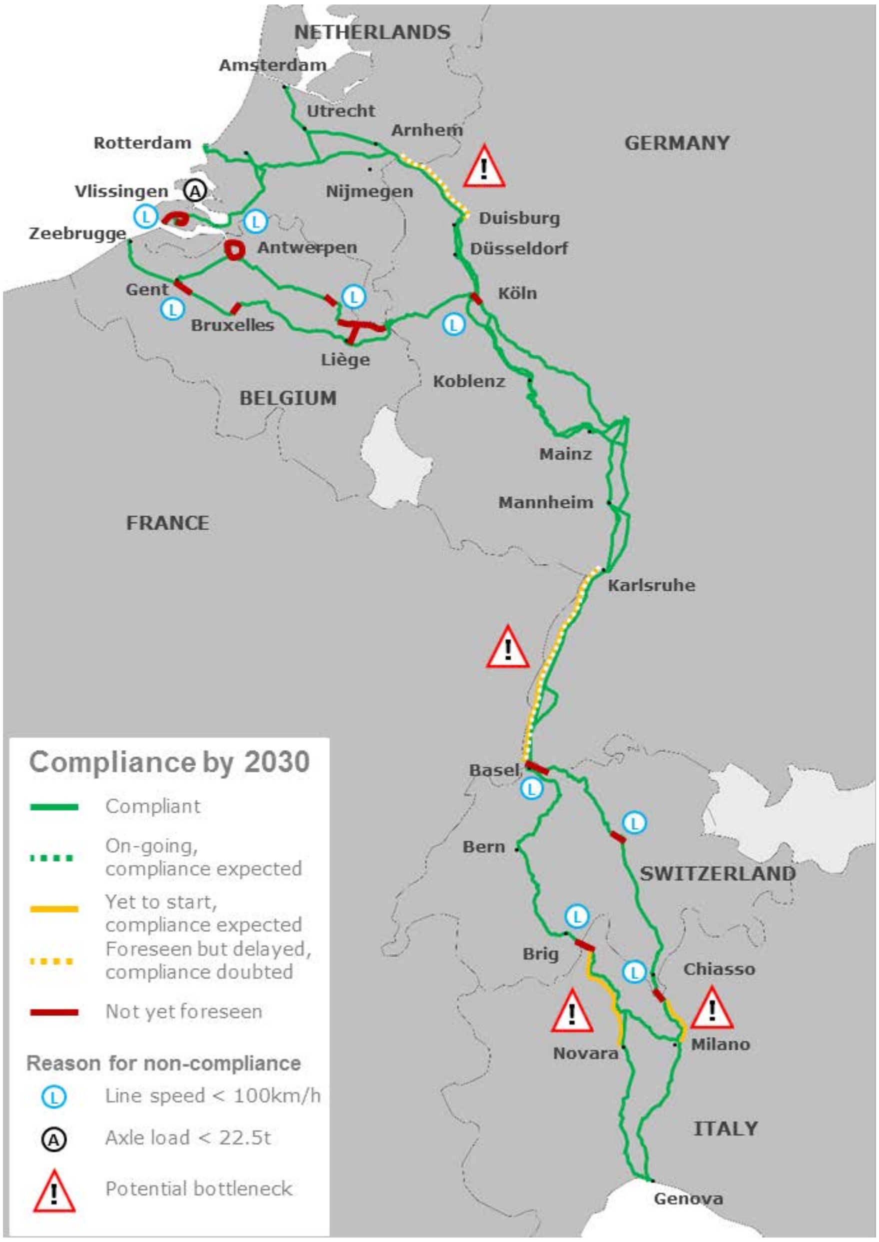
The technical issues were then identified by checking which of the highlighted compliance issues are not tackled by an infrastructure project before 2030. The development of the transport market in combination with the identified infrastructure projects allows for the recognition of future capacity bottlenecks. Other critical issues such as rail noise were identified during the Working Group meetings with stakeholders' experts.

5.2 Technical compliance maps

This chapter presents the results of the technical compliance analysis of the Rhine-Alpine core network for road, rail and inland waterways.

For rail, the main compliance issue is the line speed limitation. The TEN-T standards require that the entire core network allow for at least 100 km/h speed. However, several sections especially in Belgium and Switzerland do not meet this requirement. In addition, in the Vlissingen area the allowed axle load is lower than 22.5 t at a speed of 60 km/h or higher. Moreover, there are some potential bottlenecks where identified infrastructure projects are not expected to be implemented before 2030 (e.g. Karlsruhe – Basel) or their finalisation date is unknown.

Figure 8: Rail compliance by 2030 overview[18]

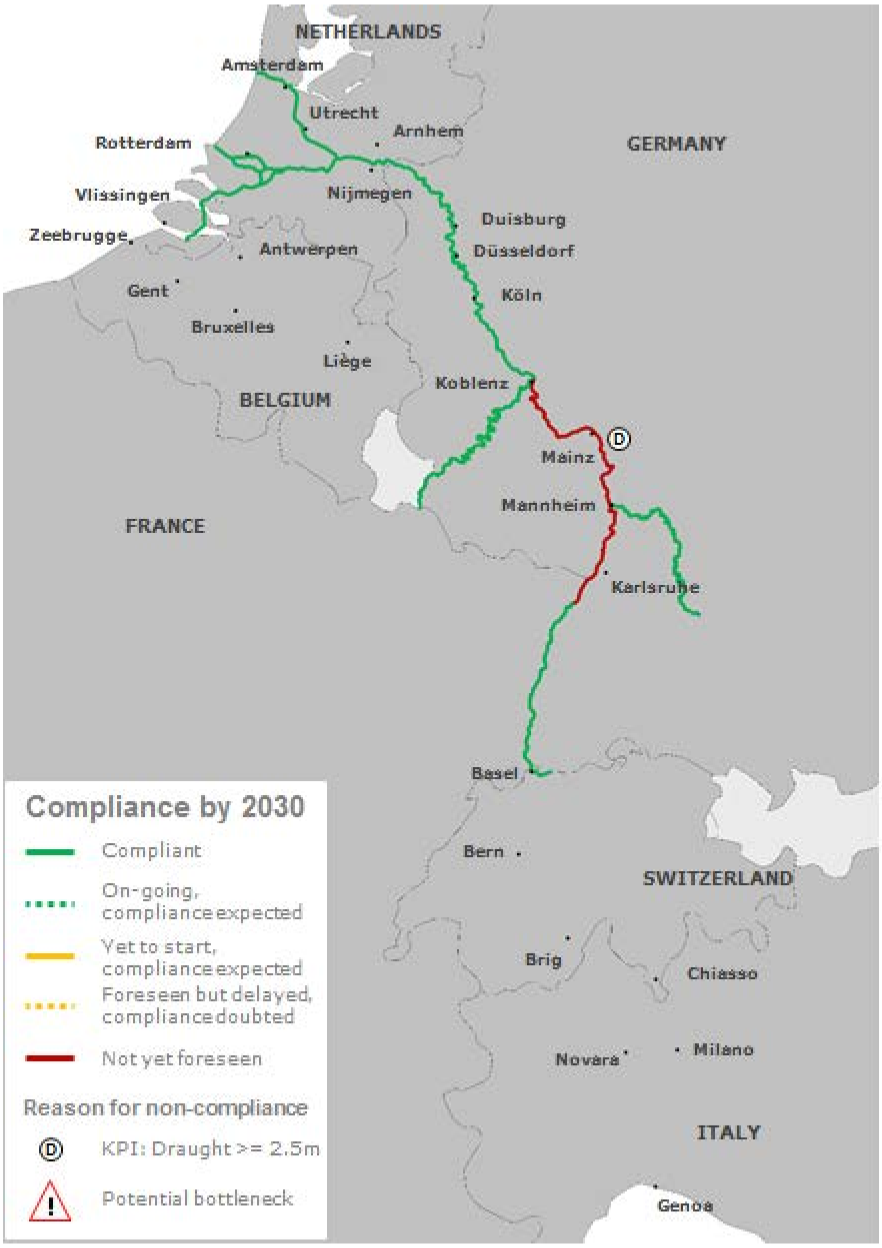


Source: Rapp Trans

[18] In Germany there are some speed limit restrictions for junctions in the area around Köln (10km in total)

For the inland waterways on the Rhine-Alpine Corridor, only one compliance issue is identified. The draught of the Rhine between Koblenz and Iffezheim is below 2.5m. However, the negative consequences spread beyond the section marked in red.

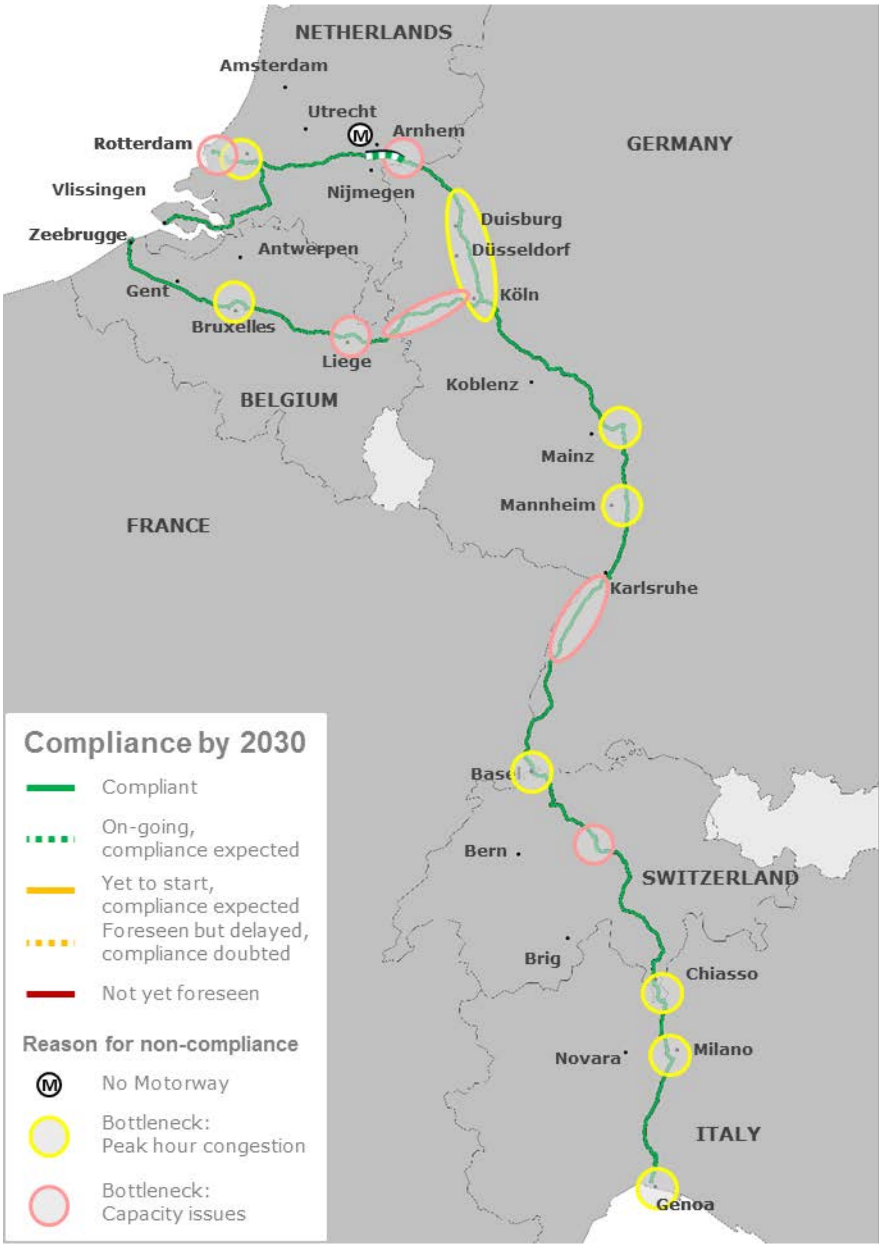
Figure 9: IWW compliance by 2030 overview



Source: Rapp Trans

The road transport infrastructure along the Rhine-Alpine Corridor is in a mature state. Relating to the TEN-T regulation compliance check only one section is not classified as a motorway yet (see Figure 10). The map highlights the identified bottlenecks. They refer specifically to the urban areas where congestion occurs frequently. However, it can be observed that bottlenecks are not exclusively limited to cross-border sections and urban nodes, but are distributed across the entire Corridor.

Figure 10: Road compliance by 2030 overview



Source: Rapp Trans

5.3 Persisting bottlenecks

The global corridor objectives should be fulfilled by 2030. Nevertheless, from today's perspective it cannot be guaranteed that this target can be fully accomplished. This has different reasons:

- for identified bottlenecks, at the moment no projects have been defined, for example the rail line speed limitations on short sections in seaports and urban nodes;
- planned or running projects will not be finished until 2030; the most important example is the complex, 6.6 billion EUR Karlsruhe – Basel rail project which is under construction and should reach an advanced stage (80%) of implementation by 2031, with the final completion date expected before 2041;
- possible delay of important infrastructure projects e.g. due to lengthy permitting procedures and extensive process of public deliberations;
- some bottlenecks cannot be solved due to insurmountable physical or external barriers or strict environmental constraints, for example capacity issues in urban areas.

It can be concluded that a complete fulfilment of the corridor objectives might not be achieved by 2030.

5.4 Persisting administrative and operational barriers

In addition to the aforementioned physical and technical bottlenecks, also administrative and operational barriers hinder the operation and further development of the Rhine-Alpine Corridor. Both have an important impact on the attractiveness of transport routes and modes and thus influence transport demand and modal share.

It has to be noted that this analysis represents the status of 2017 and it is not possible to accurately predict future policy changes that might affect the identified administrative and operational barriers. They relate mainly to differing regulatory requirements across the borders (e.g. in relation to autonomous transport), infrastructure-related issues impairing operations (such as different rail voltages) or administrative issues preventing seamless flows along the Corridor.

For **rail transport**, the main operational barriers stem from the historically founded interoperability issues in the national rail networks. These interoperability issues occur on the cross-border sections, where voltage, signalling and safety systems change. These might directly jeopardize continuity of passenger and freight flows on both sides on the border and influence travel time as well as transport costs negatively. Regarding rail safety systems, the future implementation of ERTMS will provide a big step forward. Differences in rail voltage and different signalling system require the employment of cost-intensive multi-system locomotives with negative effects on the competitiveness of rail transport. Finally yet importantly, language requirements for train drivers pose an extra barrier for cross-border operations.

Operational and administrative barriers have less impact on **inland waterway transport** than on other modes. More important are the external conditions of water levels, fuel prices and navigability. The interoperability is widely ensured and a common classification system for waterways and barges is in place. A current challenge is better integration of ICT services in inland waterway transport supporting seamless international transport chains.

For **road transport**, two important barriers have been identified mainly resulting from different legislation. This concerns especially different tolling systems along the Corridor. In 2016, Belgium introduced a road pricing system for heavy goods vehicles requiring the use of an on-board unit (OBU). For the Netherlands, toll fees are currently under study. Different budgeting systems lead to incoherence in technical equipment of trucks. The night-time driving ban for heavy vehicles in Switzerland poses a capacity challenge on sections leading from Italy and Germany into Switzerland for parking facilities and border crossings.

Despite these issues, the coordination between corridor countries has been actively promoted. Dedicated working groups e.g. for ports and inland waterways have been initiated for the identification, discussion and solving of existing barriers. In addition, a variety of projects involves multiple stakeholders from different countries. This international cooperation ensures a harmonised long-term increase of interoperability across countries involved.

5.5 Cooperation with Switzerland

Switzerland as a non-EU neighbouring country represents an essential part of the Rhine-Alpine Corridor and therefore is of high importance for the corridor development on all transport modes. The trans-Alpine rail and road infrastructure guarantees in particular the efficient interconnection between the Northern and Southern corridor countries. Reflecting this outstanding position, since the very beginning of the Rhine-Alpine Corridor development, Switzerland is playing an active role. Swiss representatives are members of the Corridor Forum and Swiss projects are included in the analysis of the corridor infrastructure. The Swiss infrastructure projects are fully compliant with the TEN-T standards. The infrastructure development is harmonious and coherent.

6 Infrastructure implementation by 2030 and the environmental, socio-economic effects

6.1 What is still to be done

Within the detailed analysis of the Corridor, the focus was not only set on the pure infrastructure and market development until 2030 and the identification of potential gaps. In parallel, so-called wider elements have been addressed in order to obtain a comprehensive picture about impact of the corridor implementation according to the TEN-T Regulation.

The innovative projects and solutions identified on the current project list have been analysed and summarized. Additionally, a horizontal evaluation of the innovation analysis is performed. This compares the RALP innovation with the other eight Core Network Corridors.

An estimation of the effects of the corridor development by inducing economic activity was performed by quantifying GDP growth and additional employment.

The decarbonisation impact of the completion of the corridor, when realizing the projects of the project list, is estimated in a modelling exercise common for all corridors. It demonstrates the effect of the corridor on climate. In addition, the effect of climate on the corridor is presented through a risk assessment of climate change threats to the corridor.

Finally, the financial sustainability of project financing is appraised, particularly with a view to identify funding gaps and potential ways to fill those gaps by other forms of financing.

6.2 Innovation deployment

Innovative projects refer to projects, which involve the use of new technologies improving in some manner parts of the current transport system. A specific definition of "innovation" has been used to identify and classify "innovation" projects along the 9 Core Network Corridors. This definition means that innovative corridor projects have to contribute to at least one of the elements below:

- telematics (including ETCS level 3);
- data sharing and real-time predictive analysis;
- efficient management and governance structures;
- innovative transport services;
- significant safety and security improvements;
- low carbon and decarbonisation;
- innovation dissemination;
- cybersecurity and data protection;
- climate change resilience & transport greening;
- other externalities reduction, e.g. rail noise.

There have been 288 projects evaluated according to their contribution to innovation. There are 71 of them, or 25%, which are seen as innovative referring to the definition above. The total investments for these projects amount to 4.6 billion EUR on the Rhine Alpine Corridor. This amount demonstrates that innovation is not costly, compared to infrastructure projects.

The identified corridor "innovation" projects are 100% transferable, i.e. can be implemented at any location. Projects on the Rhine-Alpine Corridor are 35% scalable, i.e. making it possible to apply the solution in a new field, or that the project has multiplier effects.

Of the 71 "innovation" projects, 14% have been categorised in the “Radical” or in the “Incremental innovation” category, i.e. the state-of-the-art categories. 86% of the projects belong to the "Catch-up innovation" category. The latter have usually been successfully implemented in another region or country, while the state-of-the-art projects set new standards for the next decades, to be applied along the whole corridor.

In terms of modes of transport, road has the most "innovation" projects, followed by maritime and MoS, IWW, rail and finally airport projects. Of the road category, most of the "innovation" projects are on alternative fuels and safe and secure parking. On ETCS level 3 there are no projects confirming that "baseline 3" will be used in the deployment phase.

Looking at the project costs per category, the projects in the "innovation" category have relative low costs per project when compared to typical infrastructure projects linked to one mode of transport. Road "innovation" projects have the highest total costs. A gradual switch from study/pilot phase to implementation phase will lead to increased costs of such projects.

The share of "innovation" projects of the Rhine-Alpine Corridor is relatively high (25%) compared to the across-corridors average of 23.5%. For the Rhine-Alpine Corridor there is a focus on decarbonisation and less attention to the contribution to the development of European technological industry, as it is already in place. As regards decarbonisation, it is interesting to note that the focus is not on modal shift but on the deployment of alternative fuels.

6.3 Impacts on jobs and growth

For the estimation of the impact of the corridor development on growth and jobs, an analysis was performed by applying a multiplier methodology based on the findings of the study "*Cost of non-completion of the TEN-T*"[19]. For this analysis, the measures summarised in the 2017 project list of the Rhine-Alpine Corridor have been assigned to three mutually exclusive categories:

- cross-border projects;
- innovation projects;
- other and thus average projects.

Based on a joint methodology for all Core Network Corridors, the projects which are planned to be implemented over the period 2016 until 2030 and for which cost estimates are available have been taken into evaluation. The 273 measures amount to an overall investment of 99.6 billion EUR. The implementation of these projects on the Rhine-Alpine Corridor will lead to an increase of GDP over the period 2016 until 2030 of 743 billion EUR in total. Further benefits will occur also after the year 2030.

The investments will also stimulate additional employment. The direct, indirect and induced job effects of these projects will amount to 2.14 million additional job-years

[19] Schade W., Krail M., Hartwig J., Walther C., Sutter D., Killer M., Maibach M., Gomez-Sanchez J., Hitscherich K. (2015): “Cost of non-completion of the TEN-T”. Study on behalf of the European Commission DG MOVE, Karlsruhe, Germany

created over the period 2016 to 2030. It can be expected that also after 2030 further job-years will be created by the projects.

Table 6: Rhine-Alpine Corridor development – Estimation of impact on jobs and growth

Number of projects	Total costs (billion EUR)	GDP created (billion EUR)	Job-years created (million)
273	99.6	743.0	2.14

Source: KombiConsult

6.4 Modal shift and impact on decarbonisation and climate change adaptation

Modal shift and impact on decarbonisation

In order to measure the corridors' impact on modal shift and decarbonisation, a set of reference forecasts for the corridor have been constructed, based upon the results of the European Commission's reference forecasts published in 2016. These are reference forecasts for traffic growth and impacts for the Corridor, however, the forecasts do not specifically include changes or shifts assumed to arise directly from the Work Plan measures.

The corridor Member States account for a relatively high share of transport activity (around 35% of the EU28 total). However, the forecasted passenger traffic growth and freight traffic growth is slightly below the EU28 average. Passenger traffic is expected to increase from 165 billion pkm today to 219 billion pkm by 2030 (road, rail and aviation) according to the EU reference scenario 2016. The fastest growing passenger sector is aviation (at 1.8% per annum). Freight traffic is forecasted to increase from 129 billion tkm today to 156 billion tkm by 2030 (road, rail, and inland waterway). The fastest growing freight sector is rail (at 1.8% per annum).

Concerning the emissions of the Corridor Member States, there are currently 18.9 million tonnes of CO_2 equivalent emitted by passenger and freight transport. By 2030, this should decrease to 16.9 million tonnes of CO_2 equivalent according to the EU reference scenario 2016.

In conclusion, the increase of traffic on the corridor will be accompanied by an increase in the transport and energy efficiency, leading to a lower environmental impact.

The next step of the analysis is to present a Corridor Work Plan scenario. This scenario includes the effects of the projects from this Work Plan. Most effects are expressed in network benefits. 33 projects contribute directly to decarbonisation of transport. The main contribution is on alternative fuels, with most of the projects concerning CNG /LNG while electricity/hydrogen projects come second.

Adaptation to climate change

Anticipation of- and adaptation to climate change are crucial topics. Efforts are required to reduce environmental impact of all modes and to make them ever greener.

The national strategies on adaptation to climate change have been analysed. It turned out that there is not one national public strategy in which transport infrastructure is fully integrated.

Based on the knowledge, the expected climate effects were identified and a risk analysis was performed, identifying risks based on: threat probability (Low, Medium, and High), exposure of the infrastructure (Low, Medium, and High), and criticality for the network (Low, Medium, and High).

The topics and effects are mostly known for years. Nevertheless, these are actual and relevant for the corridor. Identified high climate risks on the corridor are:

- rail buckling and road degradation in Southern Europe due to higher summer temperatures;
- increased precipitation, floods and heavy rains as well as winds and lightning throughout the corridor - relevant for road, rail and especially aviation. For rail, additional risk comes from the fact that tracks are often near rivers, leading to increased exposure to river flooding;
- more frequent droughts in inland areas and more precipitation at sea areas lead to risks for inland waterway transport. The risks of this are highest upstream. However, due to the long distance nature of inland waterway transport, the effects are present throughout the corridor.

Three projects have been identified on the corridor list, dealing with the topic of climate resilience. All three are linked with RIS, meaning that these projects inform about the consequences of climate change (fairway conditions) in the short term, but do not specifically prevent it in the medium to long term.

Consequently, there is a need to develop further projects addressing for example the greening of inland navigation trough adaptation and modernisation of the fleet, as well as projects and activities ensuring an efficient treatment of waste and a high level of safety against environmental accidents.

6.5 Infrastructure funding and innovative financial instruments and financial sustainability of projects

The development of Core Network Corridors requires, inter alia, a critical mass of investment to take place within a short time framework; therefore, a careful examination of the potential financial sources has to accompany the Corridor planning. Some key criteria to be appraised are reported in this section of the Work Plan.

The projects to be developed can be ranked in three different categories from the point of view of funding and financing needs:

- for several revenue generating projects "closer to the market" in terms of development or service provision, a substantial component of the project funding can come from own resources and financing resources gathered by the project promoters on the market. The private investors would need to recover their initial costs of capital and receive a reward for the risk born.

  The project may look at conventional lending from public and private banks, alternative financing from institutional investors and at financial instruments for instance to cope with the unbalances of cash-flow during its construction and rump-up phase until a sustainable flow of revenues is secured, and also to address particular risks and market failures and secure lending with long maturity. Financial instruments could be provided in the form of credit enhancing and guarantees;
- hard-infrastructure, greenfield, risky, long-term projects such as the majority of cross-border railway connections as well as inland waterways navigability improvements might require a substantial public support through public funding, even if innovative approaches can apply to project development and/or to specific components of the investment. Public funding can be

structured in different ways such as lump sum subsidy, fiscal incentives, and operational deficit coverage as well as availability payment schemes.

- in a variety of intermediate cases the project will require a more limited funding component in order to reinforce its financial viability – these projects could be supported through a blending of funding and financing.

In this respect, beside the national budget, the funding contribution can effectively come from the EU centrally managed funds, such as the Connecting Europe Facility (CEF) while the financing resources may come from the EU financial instruments, such as the CEF Debt Instruments and financial products available under the European Fund for Strategic Investment (EFSI).

For these three different categories of projects, the public intervention with the different degree of intensity is justified on the ground, that these projects of high socio-economic and EU added value, substantially address overall public service obligations, suboptimal investment level, market failures and distortion due to externalities (positive, for the projects supported, including in terms of strategic added-value, and negative for competing modes), and therefore call for the transfer of resources.

When considering the project funding structure in a comprehensive and multimodal setting, earmarking of revenues and cross-financing solutions as well as applying "polluter-pays" and "user-pays" principles ought to be duly explored.

A project can be fully developed through project financing if the revenue stream (secured by public and/or private funding), exceeds the investment and operational costs (CAPEX, OPEX). Such an approach calls for a careful risk sharing between the Member States and private partners.

Notwithstanding the project self-financing potential linked to user fees, a cautious and innovative approach aimed at exploiting the projects' life-cycle and defining clear responsibilities and risk sharing between project promoters, sponsors and implementing bodies is more and more needed to deliver projects on time, cost and quality and to fully exploit the potential, while minimising future liabilities on public budgets.

A pre-condition for project financing is a conducive regulatory and legal environment, in order to set the incentives right to enhance the public and private sector involvement in the delivery of infrastructure investment.

6.5.1 Financial requirements

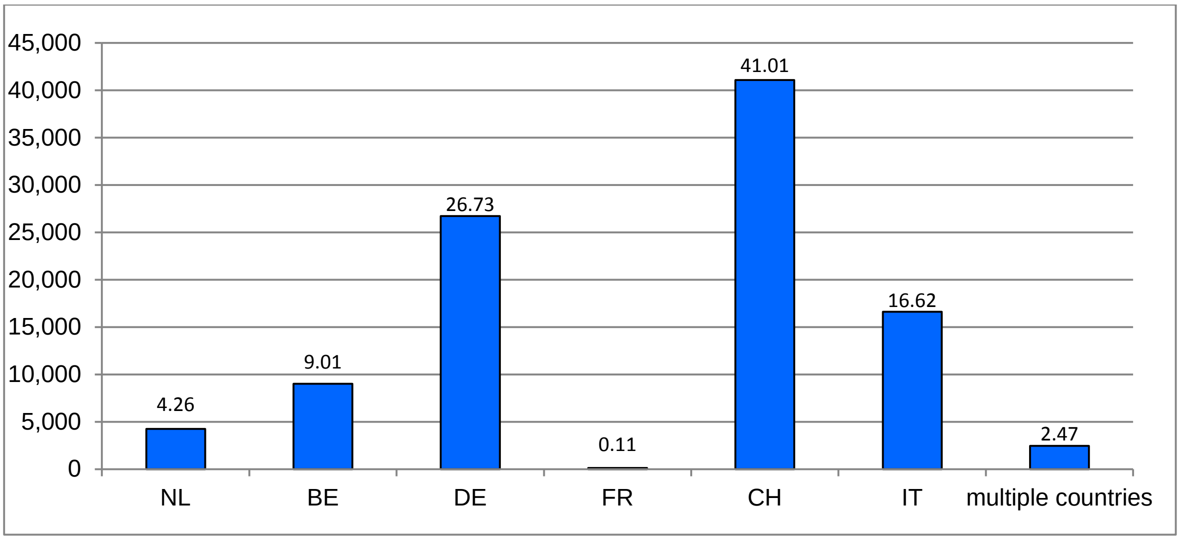
The total project costs identified for the Rhine-Alpine Corridor sum up to 100.3 billion EUR, which means an increase by about 11.5 billion EUR or 11 % compared to the 2016 list. However, for 29 projects (9% of the projects), the total costs are still classified as "unknown".

Rail has the highest share of projects on the list (72%) followed by road (16%). Rail projects are at the same time the most expensive ones: 14 out of 20 projects with a total cost exceeding 1 billion EUR, concern rail, whereas only four projects are assigned to road and two to IWW category.

The assignment of project cost into cost classes shows a large bandwidth, reaching from 90,000 EUR up to more than 12 billion EUR per project.

As Figure 11 shows, 41.0% of the overall costs are assigned to projects in Switzerland, followed by 26.7% for Germany and 16.6% for Italy. Belgium and the Netherlands come next with the share of 9% and 4.2% respectively. The French part in the costs is relatively small because only the inland ports of Strasbourg and Mulhouse are considered.

Figure 11: Total project costs in billion EUR by country



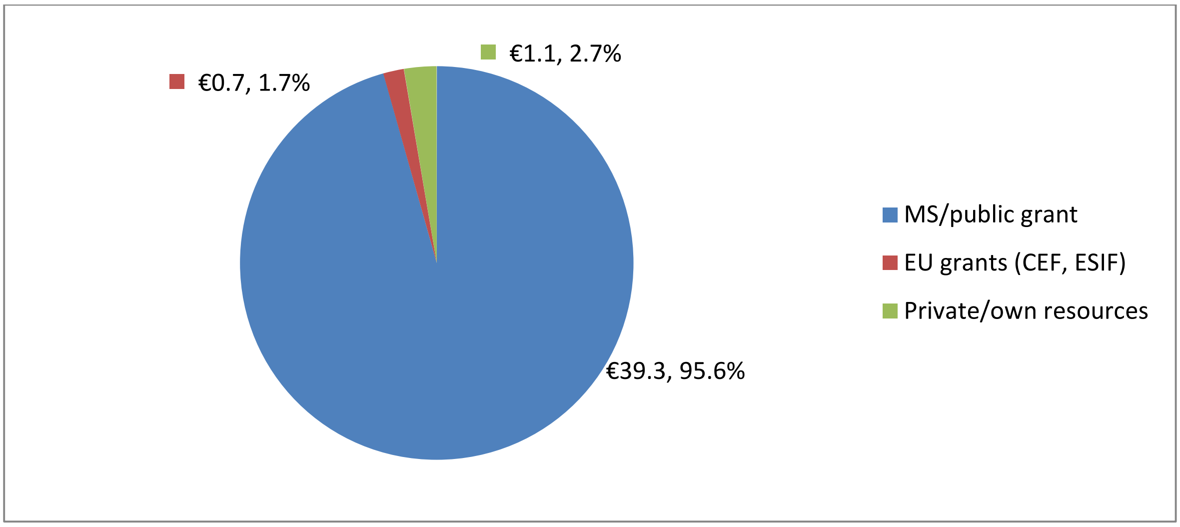
Source: KombiConsult, based on Rhine-Alpine project list

It has to be noted that for a number of projects there was no information on their costs available. While data is almost complete for the Netherlands, there is major information gap as regards Belgium, where for 30% of the projects – i.e. 10 out of 33 – there is no data regarding their costs. This ratio varies between 7% and 8% as regards other corridor countries.

In order to evaluate the ways of addressing high investment needs, an analysis of financial sources has been performed. It concerned projects for which complete financial information[20] was available. The corresponding amount (41.1 billion EUR) is divided into the financial sources as follows:

[20] Complete financial information means that the whole project costs are covered by source of financing, e.g. for a project which cost is € 10 million there are 8 million covered by State funding and 2 covered by EU funding.

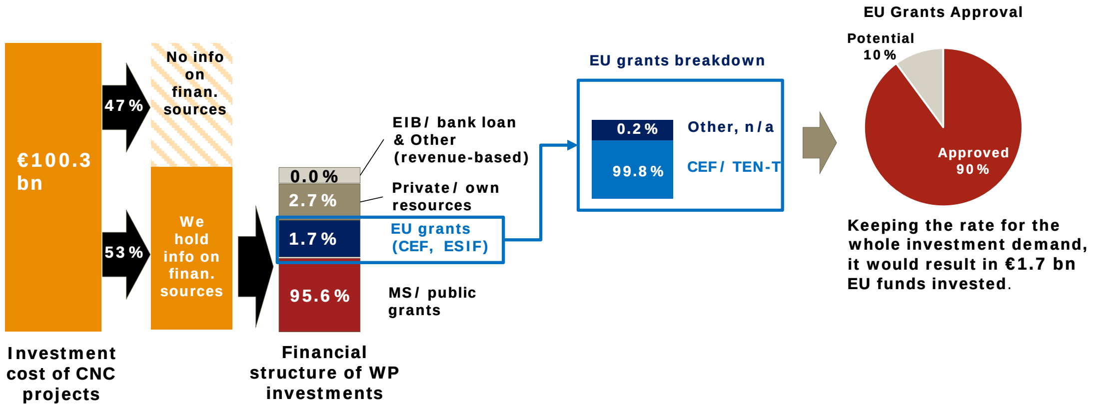
Figure 12: Investment costs in billion EUR per financing sources



The breakdown of funding by EU grants shows the importance of CEF for the Rhine-Alpine Corridor, which does not include cohesion member states.

The analysis leads to the following conclusion (see Figure 13): would the same EU funding ratio (i.e. the above-identified 1.7% for EU grants) be applied to the entire corridor investment amount, it can be expected that over the next years 1.7 billion EUR of CEF funding will be necessary.

Figure 13: Analysis of the funding and financing sources for the RALP Corridor

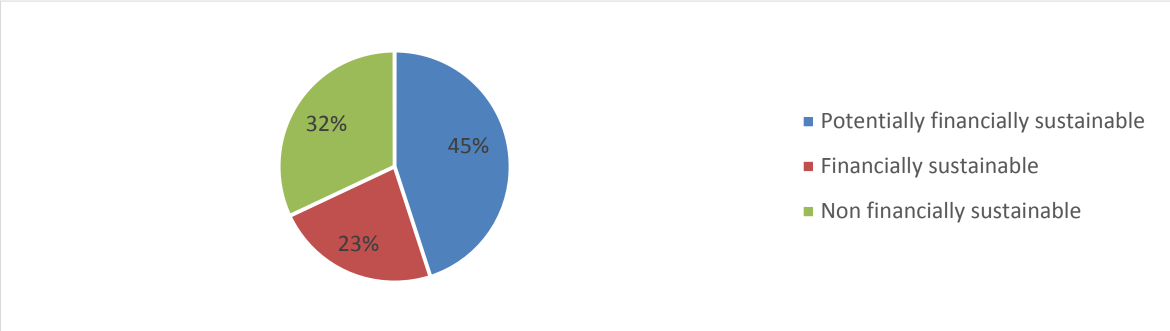


Source: PwC

The review of the projects on the Rhine-Alpine Corridor list includes potential new investments for consideration of innovative financial instruments. Among the projects for which complete information is held, approximately 17% was identified as financially sustainable, while additional 40% of the projects could be financially sustainable, if properly structured. As shown in Figure 14, in terms of investment amounts, these represent, respectively, 23% and 45% of the total amount of capital expenditure of the entire set of projects with available financial information.

Would the same percentages apply to the investment amount relative to all the projects included in the work plan, approximately 23 billion EUR capital expenditures would be relative to financially sustainable projects, and 45 billion EUR would be relative to projects which could be sustainable, if properly structured[21].

Figure 14: Financial sustainability assessment for Rhine-Alpine Corridor



Source: PwC

[21] As per definition, it does not mean that the entire capital expenditure can necessarily be sustained with other-than-grant funding sources. It however means that at least part of the investment can be sustained through financing.

7 Innovative flagship projects

With the "Issues Papers" European Coordinators started, on top of their geographically-based corridor work, an action aiming to advance newer components of TEN-T development and to strengthen corresponding cross-corridor synergies. This initiative opened up a process to ensure that rapidly changing transport and mobility patterns go along with appropriate infrastructure development. The future of the European transport system requires close interaction between infrastructure and transport policy. Therefore, through innovative pilot initiatives across different TEN-T corridors and Member States the innovative and needed projects are started in close cooperation between transport policy and infrastructure stakeholders from different countries.

In the context of the Working Group meetings of the Rhine-Alpine Corridor, numerous topics for such pilot initiatives had been identified and discussed. Within a coordination process, it has been decided for the Rhine-Alpine Corridor to develop an initiative focussing on the sustainable reduction of rail noise. Main goal of this initiative - named "Accept Rail" - is a better protection of citizens against rail noise in order to ensure a higher public acceptance of rail and rail infrastructure projects.

Already today in the Corridor, multiple single measures and projects reducing rail noise are ongoing or planned, covering large bandwidths from improving rolling stock and brake systems, the installation of innovative rail pads in the tracks, the mounting of new windows in houses and flats to new concept for rail operation and maintenance of rail infrastructure. Additionally, in the past years Member States have set into force regulations and fostered programmes for noise reduction.

In order to raise the efficiency, effectiveness and implementation speed of noise measures, the pilot initiative will follow a holistic approach. Based on an analysis and collection of existing technologies, projects and actions, representative test cases will be identified. These test cases will consider specific problems or noise situations along the corridor e.g. in cities or severely affected sections. Together with the stakeholders, adequate single or combined reduction measures will be defined to aggregate their impact in order to reach the highest benefit for the affected citizens in the test cases.

The initiative is structured in three phases. A first phase will identify solutions and define test cases. The second phase is to consist of a detailed study involving experts who would assess current and future technologies; it should lead to assigning appropriate bundles of measures to the test cases in an implementation plan. The third phase would then be the execution of the implementation plan.

8 The European Coordinator recommendations and future outlook

The Rhine-Alpine Corridor stands out as an epitome of a mature, complex corridor that includes all modalities. Notwithstanding the present performance of the rail, ports, inland waterway, road and airport components, important challenges arise at present, as well as looking into the future. The Corridor activities of the last twelve months and the final version of the second Corridor study provide a more detailed overview of the strengths, weaknesses and needs of the Rhine-Alpine Corridor. There have been 318 projects identified, which are necessary to resolve bottlenecks and reach the compliance with the TEN-T standards. For their implementation, an estimated total amount of some 100 billion EUR is required, which can be regarded as unique value for money considering scale and outstanding performance of the Corridor.

Large projects are central to resolving cross-border bottlenecks and improving hinterland connections from ports

As the Corridor runs through regions that are among Europe's most industrialized and economically advanced, it confronts specific challenges. One particular challenge regards railways, where the goal is still to create a high-speed and capacity rail network for passenger and freight transport. A separation between these two traffic flows is largely beneficial in order to eliminate capacity constraints and to minimize operational conflicts, which will boost the reliability and performance of both passenger and freight railway traffic. Specifically, three cross-border railway sections merit particular attention:

- **Karlsruhe – Offenburg – Freiburg – Basel**: The infrastructure does not provide sufficient capacity and experiences long travel and transport times. With the entry into operation of the Gotthard Base tunnel in December 2016, it is essential to upgrade the existing tracks (182 kilometres), as well as to construct an extra third and fourth rail track and four tunnels. Project costs are estimated at 6.6 billion EUR. Project has already started and will greatly improve capacity in the short- to medium-term, with 80% of it being completed by 2031. The target date for its final implementation is 2041.
- **Zevenaar – Emmerich – Oberhausen**: The existing line Zevenaar – Oberhausen requires upgrading (construction of a third track, including adjustments to existing bridges, level crossings and switches) in order to accommodate trains from high capacity Betuwe line in the Netherlands. Project costs are estimated at 2 billion EUR. Project has already started with the opening of works in Oberhausen in January 2017; its first stage is expected to be implemented by 2022/23, which – subject to confirmation by the ongoing detailed capacity analysis - would lead to improved capacity of the line. Full implementation of the project might however be delayed due to opposition from local population. It is furthermore crucial to make available – for the time of construction works – detour routes, for example through Venlo and Bad Bentheim.
- **Chiasso / Domodossola – Milan / Novara**: The railway tracks should be upgraded to cope with capacity, service quality and accessibility requirements, in view of the expected traffic from the Gotthard Base tunnel. A technological upgrade on the Chiasso – Milan line will be completed by 2020. Investments allowing for a 4-meter loading gauge and 740-meter trains on Chiasso – Milan and Domodossola – Novara are foreseen in the short to medium term. Project costs for the fourth track Chiasso (Rosales Junction) – Monza are estimated at 1.4 billion EUR (completion beyond 2030). In order to complete the doubling of track between Domodossola and Novara, a project is foreseen on the Vignale –

Oleggio – Arona section for a total cost of 0.5 billion EUR. The completion of the first phase (Vignale – Oleggio) is foreseen by 2026.

These cross-border sections are medium- to long-term projects and they have been highlighted already in the first Work Plan. Their importance was underlined when the rail compliance map of the Corridor was presented at the TEN-T Days 2016 in Rotterdam (see Figure 8). Failure to address them adequately would jeopardize the Corridor's full potential, already offered by high-capacity Swiss base tunnels and the Betuwe line in the Netherlands. This reaffirms the urgent need for Member States to earmark investment money and to provide an implementation planning for these projects, whose prompt construction would benefit the entire corridor.

While cross-border projects remain overall priority, there is also a need to have a closer look at improving hinterland connections by rail from ports. The issue has been reflected in the second Work Plan. It is particularly relevant for those ports (such as Zeebruge and Genova) which have no or limited possibility to use inland waterways. In this regard, two projects merit particular attention and analysis:

- **Ghent – Zeebrugge**: a 3rd track between Brugge and Dudzele (75,2 million) EUR) and an extra 3rd and 4th tracks between Ghent and Brugge (253,6 million EUR) will be built in order to separate freight trains to/from the port of Zeebrugge and the passenger trains. These works will improve the quality, safety and reliability of both passenger and rail freight services along the Rhine-Alpine corridor, amongst others by implementing a split between the slow convoys (freight trains) and fast passenger trains. The first phase of this project will be completed by the end of 2018 with the commissioning of the 3rd and 4th tracks between Ghent and Landegem.
- **Genova – Tortona / Novi Ligure**: the works on the so-called *Terzo Valico dei Giovi* project have already started; this investment should permit a significant expansion in freight transport between Genova and northern Italy and Europe and a corresponding improvement in passenger traffic. The *Terzo Valico dei Giovi* project will consist of a new 53km-long line, including 39 kilometres of tunnels. The total cost of the project amounts to 6.2 billion EUR. The project is expected to be completed by 2021 and the line will be made operational by 2022. Consequently, upgrade of operation standards between Tortona - Milan and Novi Ligure – Novara is planned. On the mentioned lines investments will allow for a 4-meter loading gauge and 740 m trains. A project has already started to construct a third and fourth track between Milan and Pavia on the section Tortona – Milan.

Projects improving compliance with TEN-T requirements are a priority

Compared to other core network corridors, the Rhine-Alpine Corridor is largely compliant with the requirements defined in the TEN-T guidelines. However, certain critical infrastructure characteristics still have to be upgraded:

- To increase the attractiveness and competitiveness of **rail** for international freight services, it is indispensable to allow for 740 m trains to run the entire day, instead of only after peak hours. In this regard, small-scale investments into sidings and marshalling yards can bring considerable benefits in the short term. Moreover, speed and axle load restrictions at certain corridor sections need to be addressed.
- Since the **train control system ERTMS** allows for an increase in capacity, higher speed and improved safety, its full and prompt deployment on the Corridor is crucial. With only 12.3% of ERTMS deployment, serious investments are needed. In this regards the ERTMS Action Plan adopted by the Commission on a proposal from the European ERTMS Coordinator, should now be swiftly

implemented by Member States, infrastructure managers, railway undertakings, supply industry and other relevant stakeholders.

- Regarding **inland waterways**, for full operational capacity, extensions of the fairway depth are needed on German sections along the Rhine. As indicated on the IWW compliance map presented at the TEN-T Days in Rotterdam (see Figure 9), there is a risk of not resolving this issue by 2030. Therefore, projects tackling this problem should be treated with priority. On the Neckar, lock extensions should be made to accommodate large barges with 135m length; on the Moselle river lock capacity is lacking and seriously constraints operational volume. In general, it will be necessary to improve intermodal exchanges with inland waterways in seaports and to strengthen its network. To complete the picture rivers and canals will have to be maintained so as to preserve the good navigation status.
- Concerning **roads**, many bottlenecks exist around core urban areas, mainly during peak-hours. Capacity issues exist near Genova, the Gotthard tunnel, Strasbourg, Brussels, Antwerpen, Liège and Köln (due to restrictions for heavy goods vehicles' traffic on the A1 Rhine bridge). Intelligent transport systems (ITS) hold great potential for road infrastructure. High level of road and tunnel safety must be ensured.
- **Seaports** – being the gateways to the Corridor and the major transhipment points for international freight – face a number of capacity and connectivity issues which needs to be resolved, both when it comes to hinterland connections (Antwerpen, Zeebrugge, Rotterdam) and maritime access (Amsterdam, Genova).

Multimodality needs to be pursued

In view of 2018 being the year of multimodality, one cannot underestimate the benefits of efficient coordination and cooperation between modes. These are indeed crucial to ensure efficient and reliable logistic chains. The incident in Rastatt in August of 2017 led to a near two-month closure of the busiest railroad in Europe, between Mannheim and Basel. It showed the vulnerability of one mode acting alone in a Europe, where national rules and regulations still hinder efficiency of rail transport. The Rhine-Alpine Corridor should use to its advantage the fact that high-capacity, performant rail, road and inland waterway infrastructure runs in parallel. The Coordinator in a concerted action with the relevant stakeholders is ready to develop and support measures, which will address lessons, learnt from the Rastatt incident. In addition, recommendations from the Waldhof incident on the Central Rhine of January 2011 should be considered.

Innovative measures are needed

Apart from the construction, maintenance and upgrade of infrastructure, there are cross-cutting challenges (horizontal issues) which need to be incorporated along the entire corridor and will be beneficial for overall efficiency, sustainability and inter-modality. In this context, River Information Services (RIS), Intelligent Transport Systems (ITS) and ICT systems for rail hold great potential.

Sustainability measures, such as the deployment of LNG, should be encouraged through regulatory coordination at all levels. The dissemination of clean fuel alternatives has to be regarded as a critical issue along the Corridor. At the same time, a mode-specific approach should be pursued and market-driven solutions should prevail.

Mitigation and adaptation to climate change is inevitable

In light of the ambitious greenhouse gas emission targets (as proposed by the Commission under the Clean Power for Transport/Mobility Package,[22] among others), efforts are required to reduce the environmental impact and to make transport ever greener. As examples, projects related to inland navigation greening through adaptation and modernisation of the fleet could thus be further supported; projects and activities ensuring an efficient treatment of waste and a high level of safety against environmental accidents should also be kept in mind. Resiliency is a key objective. The effects of climate change such as extreme weather events need to be taken into account, both in upgraded and newly built infrastructures. To increase its environmental performance, multimodality along the corridor has to be improved.

Innovative financial instruments have to be explored

Sustainable, long-term infrastructure investments are required to implement the Corridor. However, the investment needs of the Corridor are vast and cannot be met by traditional methods only, which highlights the need to consider alternative ways of financing. In this context, European Fund for Strategic Investments (EFSI) can offer key opportunities for the Corridor. Other projects could follow on the successful example of A11 motorway – opened in September 2017 - linking the port of Zeebrugge to the European motorway network. The 0.5 billion EUR project is the first one financed through the Project Bond Initiative.

Keep existing infrastructure in good condition

Given the maturity of the Corridor, infrastructure maintenance and upgrading is as important as the construction of new sections. The full projects' life cycle needs to be taken into account when developing long-term investment strategies. The uniquely high traffic volumes on this Corridor make its infrastructure particularly vulnerable to disruptions; maintenance challenges are present across all modalities: among others, the highways in Germany and Belgium, the locks on the Moselle and Neckar rivers, as well as the railway sections in Italy. Maintaining safe level crossings does not only improve road safety but also reduces accidents-related distortions in rail traffic. In addition, the access routes to the infrastructure belonging to the Corridor should be in good condition, in order to use its full potential. Furthermore, it is equally important to maintain in good condition infrastructure for the provision of traffic managements systems and services.

Reduce external effects of transport

The Rhine-Alpine Corridor faces unique challenges as regards noise and pollution. Noise is a particularly acute problem in Germany (Rhine-Valley), Italy (Milan – Swiss-Italian border) and Belgium (freight lines leading to the ports of Ghent, Antwerpen and Zeebrugge). The industry has already introduced anti-vibration and anti-noise measures. Under the Connecting Europe Facility, the European Commission supported measures, which reduce rail freight noise by retrofitting existing rolling stock. The flagship initiative presented in Chapter 7 will look into other ways of addressing the noise issue. Moreover, development of long-distance rail passenger services could bring benefits by reducing congestion and pollution on roads. Also last mile connections to final destination should be constructed in a way that reduces pollution and noise to the minimum. In this context, the effective collaboration between the industry and the Member States is crucial.

Integrate urban nodes into the corridor

[22] http://europa.eu/rapid/press-release_IP-17-4242_en.htm

Urban nodes – including the secondary ones, not listed in the Annex II.1 of the TEN-T Regulation, should be connected with multimodal links to achieve long-term sustainable mobility on the comprehensive network. Overall goal of the urban node network development is the appropriate interconnection of passenger and freight flows between all modes involved which includes for example the connection between airports and TEN-T railway lines. Furthermore, a seamless connection between the long-distance infrastructure and regional / local traffic and urban freight delivery on the last-mile should be achieved. In corridor nodes, in particular in major sea- and inland ports, local authorities should take into account the need for a long-term development of logistics activities in spatial planning processes, while ensuring a high level of civil participation and acceptance by the population.

Collaboration among stakeholders is critical

Effective coordination is crucial for all European traffic flows. A project influences the performance of the entire corridor, in every country involved, stressing the need to look beyond single projects.

A particular attention should be given to the EGTC "Interregional Alliance for the Rhine-Alpine Corridor", which demonstrates the successful collaboration along the Corridor, with regards to the link between the TEN-T development and regional benefits. Furthermore in the framework of the so-called *Cabina di Regia on logistics* between Liguria, Piedmont and Lombardy regions, a memorandum of understanding was signed between RFI and the three regions with the objective of improving the performances of the rail freight transport. Finally, the Italian-Swiss steering committee should be mentioned.

Moreover, close cooperation with existing international structures - such as the Central Commission for the Navigation of the Rhine (CCNR) and the Rail Freight Corridor Rhine-Alpine (RFC) – can bring mutual benefits. Significant and measurable performance results of interoperability can be expected from the RFC, which has an integrated and regional governance structure gathering all stakeholders: the railway undertakings, the terminals, the infrastructure managers/allocation bodies and the authorities. It is in a unique position to identify and implement the most urgent and efficient rail breakthroughs along the Corridor.

The tri-national cooperation between France, Germany and Switzerland for the development of the Upper Rhine ports is another excellent example. This project, called RheinPorts Information System (RPIS), aims at providing a centralized coordination and thus an efficient management of traffic on inland waterways. However, this remains limited to the Upper Rhine while the need exists for the entire Rhine.

Fair organizational conditions are equally important

This work plan addresses, for the most part, hard infrastructure investments. However, in order to achieve the common objectives, soft measures and organizational conditions are equally important. Regarding organizational conditions, we should take the European perspective as a point of departure. In multimodal platforms, for example, a *level playing field* to assure discrimination-free access is of the utmost importance.

A comprehensive approach is fundamental

The Rhine-Alpine Corridor is part of the trans-European network for transport and should be addressed in the context of that framework. Collaboration and coordination with overlapping corridors as well as interactions with the comprehensive network are of utmost importance in order to secure the future of Europe's transport infrastructure network. The role of investments in the comprehensive network in the overall performance of the core network corridors should not be neglected. Due to the many ports in this corridor, interconnections are needed between the Corridor and Motorways of the Sea as addressed for example in the Italian National Strategic Plan for Ports and for Logistics approved in 2016. Motorways of the Sea aim for a trans-European intermodal, maritime-based logistics chain, which will improve access to markets and bring relief to the over-stretched European road system. In this context, close coordination with the European Coordinator for the Motorways of the Sea is integral to materializing the network effects.

Strong commitment for implementation is needed

Looking ahead, the work and involvement of all stakeholders remains vital. The comprehensive information about the state of play as well as the needs and challenges of the Corridor must be translated into reality. The challenges concentrate all efforts. At this crucial time when Europe is deciding on its future, it is essential that there be follow-through on commitments, particularly in this corridor whose centrality cannot be overstated.

Contact details Rhine-Alpine Core Network Corridor

Paweł Wojciechowski

European Coordinator

Rhine-Alpine Core Network Corridor

Łukasz Wojtas

European Commission

Advisor to the European Coordinator

lukasz.wojtas@ec.europa.eu

Corridor website Rhine-Alpine Corridor

http://ec.europa.eu/transport/themes/infrastructure/ten-t-guidelines/corridors/rhine-alp_en.htm

Contact details:
European Commission – Directorate General for Mobility and Transport
Directorate B – Investment, Innovative & Sustainable Transport
Unit B1 – Transport Networks
http://ec.europa.eu/transport/index_en.htm
email: move-info@ec.europa.eu
Offices:
Rue Demot 28
1049 Brussels, Belgium

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