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Rhine Alpine



Second Work Plan of the
European Coordinator

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This report represents the opinion of the European Coordinator and does not prejudice the official position of the European Commission.

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Abbreviations

CCNR	Central Commission for the Navigation of the Rhine
CEF	Connecting Europe Facility
CEMT	Conférence Européenne des Ministres des Transports (Classification of European Inland Waterways)
cf.	Compare
CNC	Core Network Corridor
EIB	European Investment Bank
EGTC	European Grouping of Territorial Cooperation
ERI	Electronic Reporting International
ERTMS	European Rail Traffic Management System
ETIS	European Transport policy Information System
EU	European Union
GDP	Gross Domestic Product
ICT	Information and communications technology
IWW	Inland waterways
Km	kilometre
KPI	Key performance indicator
LNG	Liquefied natural gas
M	metres
mm	Millimetres
MoS	Motorways of the Seas
MTMS	Multimodal transport market study
NEAC	European Transport Forecast Model
No.	Number
Nts	Notices to skippers
O/D	Origin and destination
PIANC	International Navigation Association
RFC	Rail freight corridor
RIS	River information system
RRT	Rail-road terminals
TEN-T	Trans-European Transport Network
TMS	Transport market study
UNECE	United Nations Economic Commission for Europe
WP	Work Package

Country Codes after ISO 1366:

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

1 Towards the updated work plan of the Rhine-Alpine Corridor

In May 2015 I took over from Ana Palacio the function of the European Coordinator of the Rhine-Alpine Core Network Corridor. The date coincided with the approval of the first work plan of the Corridor. The update – being presented now - aims at providing a comprehensive overview of the strengths and weaknesses of the Corridor. It highlights the opportunities and addresses what has to be tackled, constructed, upgraded or maintained in order to remove bottlenecks and missing links, enhance cross-border sections and improve inter-modality and interoperability.

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. Against this background, Europe's transport infrastructure plays a key role to completing the internal market through the removal of physical barriers and the introduction of soft measures. Furthermore, in today's interconnected world, neither scope nor vision can be exclusively limited to the European internal market, but has to incorporate the broader global context where economic gains, and likewise economic challenges, no longer stop at the border. It is, therefore, necessary to change the mental framework to understand that today's world no longer allows thinking in terms of a single mode or even country.

"Connecting to complete" and "connecting to compete" emerge as mottos for the creation of a single European transport area. Completing the transport network - in particular its core - interlinking modes and nodes, can provide a competitiveness boost and growth potential. This, however, will become reality only if all stakeholders act cooperatively. In this context, three main strands emerge:

- 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.

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. Infrastructures need to be constructed, maintained and upgraded through smaller and large-scale investments within a coherent corridor vision, which takes into account the growing demand for fast, reliable, high-quality, seamless movement of goods and persons.

As part of the preparation of this work plan, discussions with the Member States concerned, as well meetings of consultative Corridor Fora and working groups on ports, inland waterways and regions took place, in order to fine-tune 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 work plan published in 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 till 2017).

The consortium of consultancy companies (responsible also for the first corridor study) was contracted by the European Commission for the provision of technical support. The consortium consists 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 are: 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.

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 Antwerp 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 Genoa 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, Antwerp, Amsterdam, Zeebrugge, Duisburg and Genoa, 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 (LNG for inland waterways for instance) which pave the way into the future.

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 and pollution 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, cross border operations, and vast maintenance issues of existing infrastructure.

Last but not least 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.

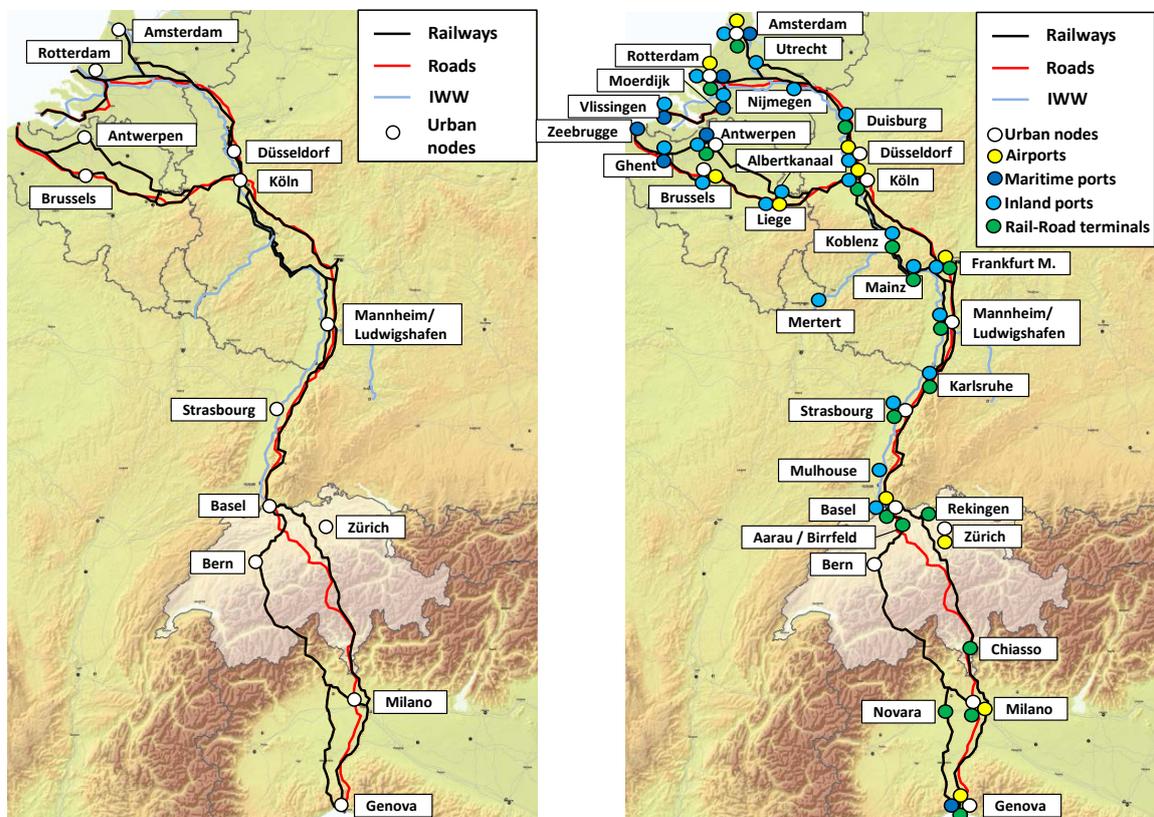
2.1 Corridor alignment

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 Merttert is included in the Corridor.

The main branches of the Rhine-Alpine Corridor are:

- Genoa – Milan – Lugano – Basel;
- Genoa – 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 – Antwerp – Ghent – Zeebrugge.

Figure 2: Outline of the Rhine-Alpine Corridor



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 alignment of 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 ¹	1	-	3	8
Total	13	11	8	22	18	72

The 8 **maritime ports** (among them the ports of Rotterdam, Amsterdam, Antwerp, Genoa 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.

Since all transport modes are represented on the Corridor, multimodality for both passenger and freight transport plays an outstanding role. It has to be taken into

¹ The node of Milan has three core airports: Linate, Malpensa and Bergamo Orio al Serio

consideration that the 18 rail-road terminals from Table 1 only represent its geographical location. Inland ports, rail-road platforms and airports can have more than one facility per specific location. In total, close to 60 multimodal platforms exist across the Corridor. Duisburg stands out in particular with ten identified multimodal platforms, five of which even deal with three modes, connecting rail, road and inland waterways infrastructure. Among others, important **multimodal nodes** are:

- The **ports** of Antwerp and Rotterdam, which are among the world's leading seaports and - along with the ports of Amsterdam, Zeebrugge, Ghent, Genoa, Vlissingen 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 Milan.
- The 13 **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 Milan Malpensa (freight).

Close cooperation between the different corridors exist as overlaps occur – altogether seven sections 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 Antwerp and Aarschot, only rail has been taken into account for the Rhine-Alpine Corridor.

All Belgian inland waterways projects which could enhance the Rhine-Alpine Corridor such as the Seine-Scheldt project² 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 section³

Section / node	Corridor	Overlapping with corridor
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
Antwerp – Aarschot	Rhine-Alpine	North Sea-Mediterranean North Sea-Baltic
Liège – Antwerp	Rhine-Alpine	North Sea-Baltic

² 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.

³ Source: HaCon based on TENtec analysis

Section / node	Corridor	Overlapping with corridor
Antwerp – Zeebrugge	Rhine-Alpine	North Sea - Mediterranean
Strasbourg – Karlsruhe – Mannheim – Mainz	Rhine-Alpine	Rhine-Danube
Mannheim	Rhine-Alpine	Atlantic
Milan	Rhine-Alpine	Mediterranean

The **country specific lengths of infrastructure per mode** for the Rhine-Alpine Corridor are 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 25% 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 17% for all transport modes.

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

Mode	NL		BE		DE		CH		IT		Total [km]
	[km]	share of total	[km]	share of total	[km]	share of total	[km]	share of total	[km]	share of total	
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
IWW⁴	218	14%	-	-	1,155	73%	21	1%	-	0%	1,577⁵
Total	913	14%	774	12%	3,185	49%	867	13%	601	9%	6,523

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

2.2 Compliance with the technical infrastructure parameters of the TEN-T guidelines (including KPI's analysis results)

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 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

⁴ Belgian inland waterways are not part of the alignment, but analysed in the Corridor characteristics and in the transport market study

⁵ France is also part of the IWW network, with a share of 183km (12%)

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;
- **Air:** rail connection, 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, communication to the users at the stations and freight transshipment.

Most infrastructure characteristics of the Rhine-Alpine Corridor are compliant with the TEN-T requirements. Table 4 lists only the infrastructure characteristics which deviate most from the requirements; infrastructures that comply fully with the criteria are not listed. It must be considered, however, 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% ⁶	100% ⁷	-	100%	0%	87%
Line speed ≥ 100 km/h	95% ⁸	82%	100% ⁹	-	90%	100%	99%
ERTMS deployment	50%	18%	0%	-	26% ¹⁰	0%	12%
Roads							
Availability of clean fuels	100%	100%	100%	-	41%	46%	84%
Inland waterways¹¹							
Max. draught > 2.5m	100%	-	74%	90%	100%	-	82%
Min. height under bridges >5.25m	100%	-	100%	100%	100%	-	100%

The Rhine-Alpine Railways Network and Rail Road Terminals

Regarding the rail characteristics, all sections are electrified and have a track gauge of 1,435mm. 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

⁶ 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.

⁷ See footnote 6.

⁸ 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.

⁹ There are some speed limit restrictions for junctions in the area around Köln (10km in total).

¹⁰ Including Gotthard base tunnel to be opened for regular traffic in December 2016.

¹¹ See footnote 4.

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.

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 740m trains in operation; however increase in track length to accommodate such trains is planned on most sections by early 2020s. In Switzerland 740m trains will be operating on both routes as of the end of 2016. In Belgium, 740m trains cannot be operated during peak-hours. In Germany 740m 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. 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. Freight line speeds are restricted especially in Belgium and Switzerland (bordering into Italy) as well as on the line leading to the port of Vlissingen and in the area around Köln. This is usually due to operational restrictions on curves and crossover sections. 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. As regards rail-road terminals, the 2014 corridor study indicated that increasing capacity within terminals and the corresponding infrastructure is required for further growth in multimodal transport.

The Rhine-Alpine Road Infrastructure

The Corridor's extensive road network fulfils, to a great extent, 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 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. The main compliance issues identified are the draught limitations along the Rhine in Germany, where only 74% of the waterways fulfil this criterion. Insufficient minimum height under the bridges is a problem for the accessibility to the Swiss ports of Muttenz and Birsfelden. 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.

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 airports along the Rhine-Alpine Corridor are the missing connections to the rail network in Basel, Milan Linate, Genoa and Rotterdam. For Genoa a project has already been approved, with works expecting 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 being planned (Carex Project). A rail connection to Bergamo airport is also planned.

Clean fuels are not available at the Corridor airports.

3 Results of the Multimodal transport market study (MTMS)

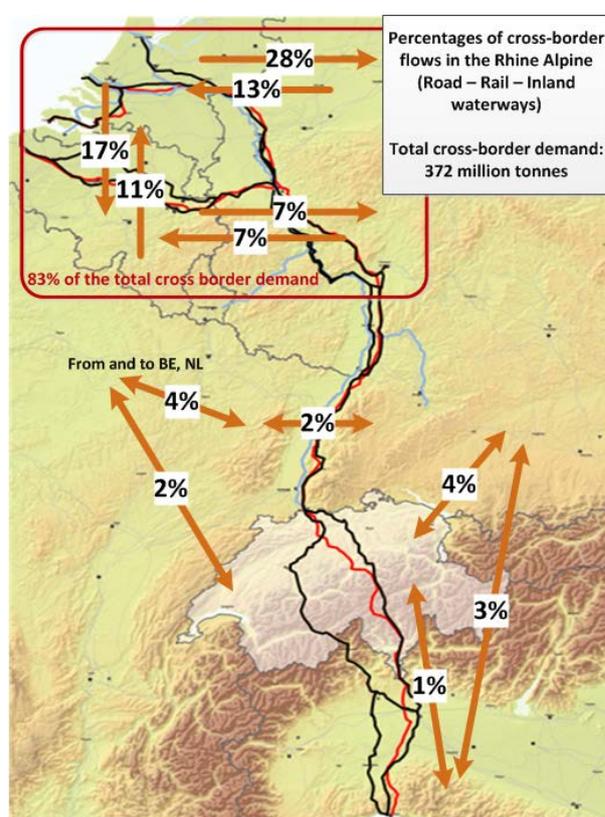
The purpose of the Transport Market Study (TMS) for the Rhine-Alpine Corridor is to analyse the current and prospective market conditions along the Corridor, with current and future utilisation levels of transport modes.

3.1 Current market characteristics

International freight transport demand

Current market characteristics¹² show that for cross-border traffic within the Rhine-Alpine Corridor rail has a share of 12%, road 34%, and inland waterways 54%. The cross-border traffic volume was estimated at 372 million tonnes in 2010 (cf. Figure 3). This covers 37% of the total estimated demand in the catchment area including all traffic flows (international and domestic). Total demand is estimated slightly above 1 billion tonnes.

Figure 3: Cross-border freight international demand



Country-wise, the Corridor shows the strong links between Germany, the Netherlands and Belgium. Figure 3 demonstrates that the main corridor flows are between these three countries; their flows add up to 307.2 million tonnes, 83% of the total international freight activity. The highest import and export flows are between Germany and the Netherlands with 152 million tonnes, representing 41% of the cross-border corridor demand. Commodity-wise, 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, which has been confirmed by individual port statistics.

¹² ETISplus, 2010

Today, intermodal transports to and from Italy are mainly land connections, but with the improved connection between the Port of Genoa and the hinterland, the volumes moving to Switzerland and Southern Germany are also expected to grow.

International passenger transport demand

For 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, covering 87% of the total trips (in 2010¹³ more than 95,000 thousand trips for all international flows and almost 67,000 thousand trips for the three major bidirectional flows). Rail represents almost 9% of the total international traffic flows with the main traffic flow observed between Italy and Switzerland, followed by the flow between Germany and Switzerland. Other major rail flows are between the Netherlands and Germany as well as Belgium and the Netherlands. 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.

3.2 Market forecasts

The MTMS looked into the available European and national forecasts so as to provide insight on the potential growth in the Corridor countries.

National forecasts for freight transport

The various national forecasts investigated in the MTMS 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. The latest scenario for Germany in tonne-kilometre (*Verkehrsverflechtungsprognose 2030* (2014)) indicates few changes in the projections, especially in relation to the total growth (more moderate in the case of Germany), and the rail share (higher due to lower road traffic). A new national scenario was also published in the Netherlands (CPB/PBL (2015), *Toekomstverkenning Welvaart en Leefomgeving, Cahier Mobiliteit*, Den Haag: Planbureau voor de Leefomgeving), indicating that freight demand (in tonnes) for road is expected to grow faster than rail and inland waterways. The Belgian report of the Federal Planning Bureau "*Perspectives de l'évolution de la demande de transport en Belgique à l'horizon 2030*" forecasts that road transport will still be dominant mode by 2030 with the share of 70% of the tonne-kilometres.

Model forecasts for freight transport

In order to depict the potential effect of changes on the Corridor, the MTMS 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 tolling¹⁴.

¹³ Source: ETISplus (2010)

¹⁴ In line with existing legislation on road charging

With regard to the baseline run, the freight demand expected a moderate growth up to 2030 with an increase of 1.7% per year for all transport modes (road, rail and inland waterways), resulting in a total growth of about 40% for each transport mode. Applying the policy interventions on the compliance scenario, these 2010-2030 growth rates change to 36%, 55% and 41% respectively (cf. Figure 5).

Table 5: Mode performance on the Rhine-Alpine links

	Relative growth (2010-2030)	Relative growth (2010-2030)
	<u>without</u> TEN-T interventions	<u>with</u> TEN-T interventions
Road	40%	36%
Rail	41%	55%
IWW	39%	41%

As shown in Figure 5, rail demonstrates the highest growth trend, followed by slightly lower growth for road and inland waterways. By 2030, rail is projected to grow by 55% (instead of 41% without the TEN-T interventions). This is mainly due to the expected decrease in travel costs and times that make rail a more attractive option for hinterland transport.

Table 6: Modal split for the Corridor alignment

	2010	2030	2030
		<u>without</u> TEN-T interventions	<u>with</u> TEN-T interventions
Road	28.8%	28.8%	27.5%
Rail	20.4%	20.5%	22.2%
IWW	50.8%	50.7%	50.3%

Figure 6 shows that the impact of the measures on the Corridor is mainly reflected on rail which is expected to increase both its share and volumes, particularly by 2030. The inland waterways maintain a strong position in the Corridor, while road slightly decreases its share. Therefore due attention will need to be given to measures that further strengthen inland waterways.

3.3 Conclusions of transport market study

The analysis at origin/destination level 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.

For inland waterways, the links from Rotterdam - following the Rhine - to Duisburg and Frankfurt are the busiest on the network. For road, the largest potential for growth is demonstrated around urban areas. These capacity needs by 2030 were also confirmed in the supply side analysis for the Corridor, in terms of both network and terminal capacity. Potential capacity problems in the Netherlands (related to the lock of Amsterdam and the high throughput times) will emerge in the period until 2030.

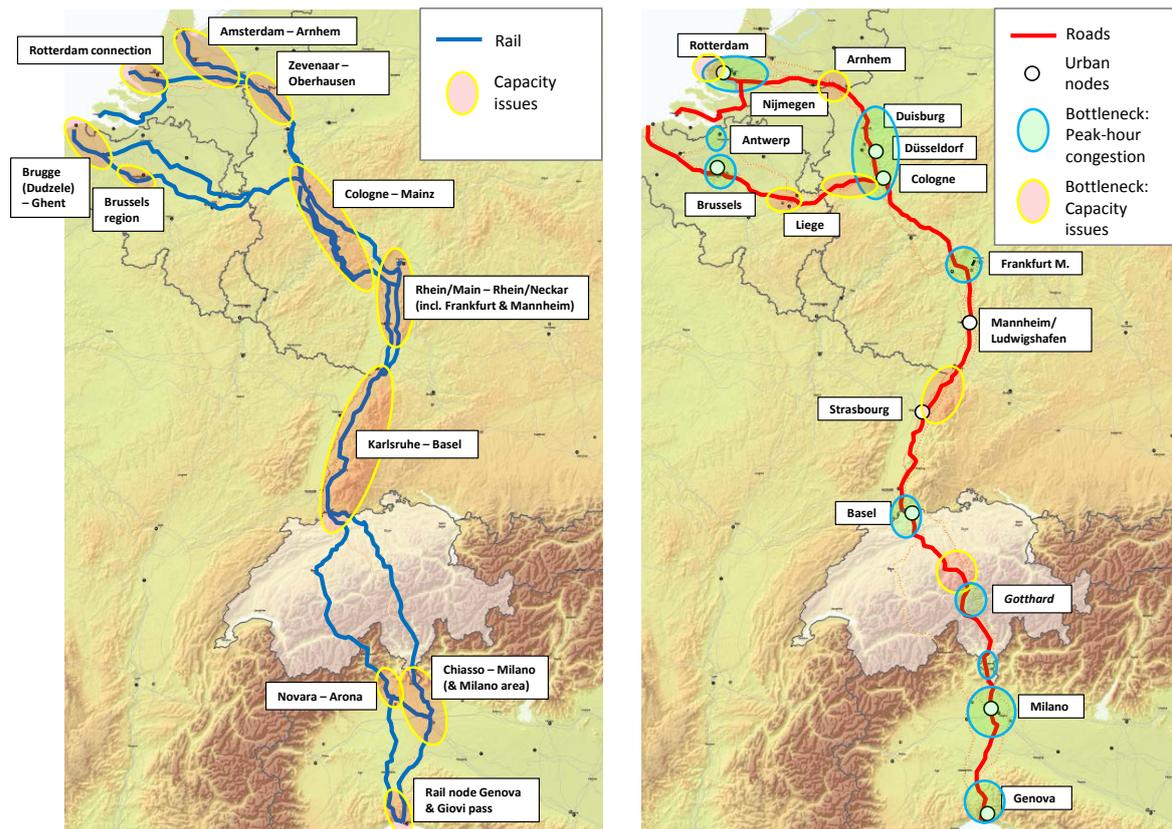
The road network demonstrates a more evenly distributed flow, with the exception of traffic around urban nodes. Next to the network limitations causing congestion around urban nodes, the capacity of rail-road terminals could also be affected by the potential growth.

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.

4 Capacity issues

As already stated the Corridor's infrastructures present high level of development and of compliance with TEN-T standards. But at the same time they face one of the highest traffic flows of passenger 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; both for rail and road (cf. Figure 4).

Figure 4: Capacity issues for rail and road 2015



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 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.

In Belgium a large flow of domestic and international rail 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 at the moment. The opening of the Gotthard Base tunnel will have a beneficial impact upon its entry into service in late 2016.

On the Italian network critical capacity bottlenecks are identified around the Gavi pass, between Chiasso - Milan, Rho - Gallarate, Tortona - Voghera, Milan - Pavia. The line section Novara (Vignale) – Oleggio – Arona faces potential capacity restrictions in the future as a result of traffic increase from Domodossola and Luino. Additionally the rail nodes of Genoa, Novara and Milan 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 Genoa) 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 ban 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. For the rivers Moselle and Neckar as well as for Strasbourg, lock capacity has to be adapted. 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 Antwerp, Ghent and Zeebrugge face a number of connectivity and capacity issues. The port of Antwerp 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 emerge as a critical need. Another main bottleneck is the connection to the rail network from the left bank of the port of Antwerp. 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. 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. Amsterdam and Genoa 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 Genoa a re-configuration of the maritime access to the Sampierdarena Port Basin is planned and a major bypass of the existing highway western access to the city is under project approval.

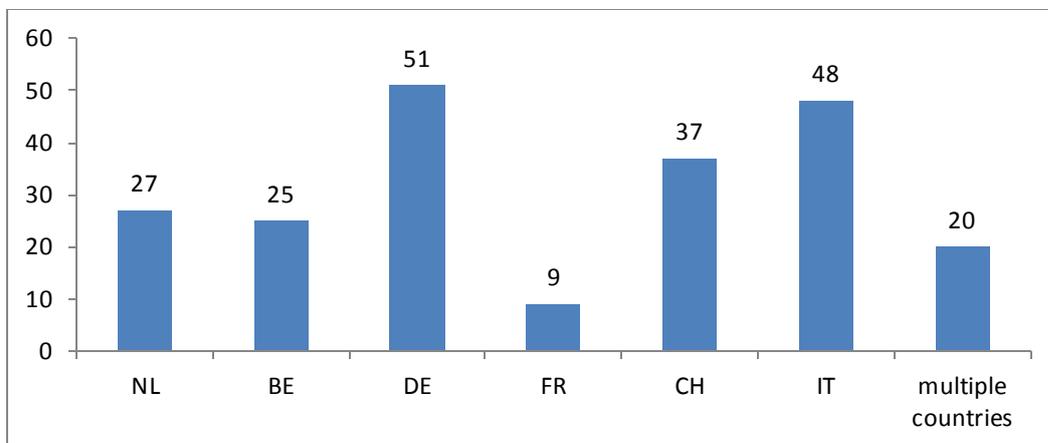
5 The identified planned projects

One of the main goals of the revised corridor study was to update the list of projects necessary for the completion of the Corridor. The list was enriched by input from additional stakeholders along the Corridor as well by the review of essential documents such as the 2014 CEF-call, national transport plans and the implementation plan of the RFC Rhine-Alpine. Several consolidation rounds with the Member States and forum stakeholders ensured a harmonious project list.

The following summarises the main results of the evaluation of the project list of the Rhine-Alpine Corridor. Altogether, 217 projects have been identified.

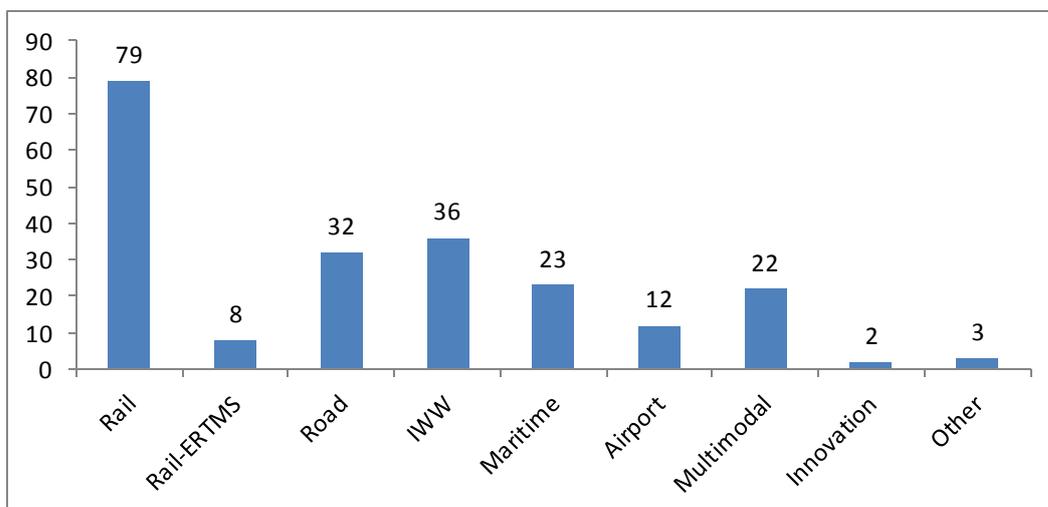
The following Figure 5 presents the distribution of projects per country and Figure 6 their distribution per category.

Figure 5: Distribution of projects per country



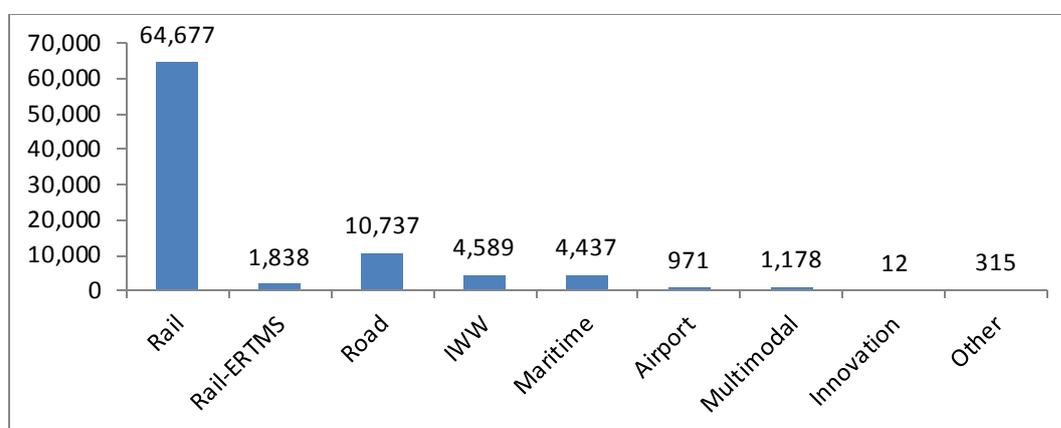
Projects are distributed relatively evenly across the countries involved. While Germany, Italy and Switzerland are involved in the vast majority of the projects, France only has a small share with 9 projects (however only the French inland ports of Strasbourg and Mulhouse are taken into account). Close to 10% of the projects involve more than one country.

Figure 6: Distribution of projects per category



The figure above emphasises the importance of rail (including ERTMS-related measures). Rail has a share of about 36% of the total. These projects include a vast range of measures, from noise reduction measures over ERTMS deployment to new constructions of high speed passenger lines. Compared to that, the other modes of transport (namely road and inland waterway transport) require fewer upgrades. Multimodality also plays an important role for seamless transportation chains on the Rhine-Alpine Corridor, pointed out by 22 related projects. The project category "other" refers to projects which could not be specifically allocated to a project category, such as metro projects in the Milan node. Finally, the evaluation of the project list shows a lack of innovative measures, with only 2 projects belonging to the category "Innovation". However it has to be underlined that projects have been assigned only to one category and certain number of projects grouped under specific mode could also be regarded as innovative (e.g. LNG in shipping).

Figure 7: Investments per category in million €

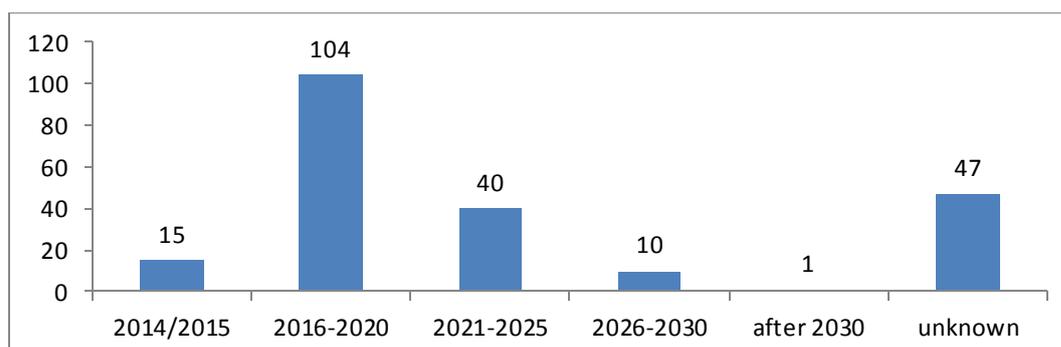


The total investment costs are estimated at some 89 billion EUR. The split per project category confirms the dominant position of rail (incl. ERTMS) with a share of 75% of total costs. Main cost drivers are projects such as the Gotthard Base tunnel in Switzerland (12.15 billion CHF) or the upgrades and new construction of the cross-border section Karlsruhe – Basel (6.6 billion EUR). The most expensive inland waterway project identified in the list is the extension of the fairway depth of the Rhine in Germany (1.19 billion EUR) while in the "road" category - the extension of the ring of Antwerp (3.25 billion EUR).

It has to be noted that this analysis can only serve as an intermediate observation, since there is at this stage missing information on the costs of 26 projects.

The following Figure 8 shows the split per planned implementation date of projects.

Figure 8: Projects according to planned implementation date



It is noticeable that the majority of the improvements along the Corridor are either already finished (15) or will be implemented in the foreseeable future, namely until 2020. Almost all the projects - except one - will be executed in time, meaning by 2030 at the latest. Nevertheless, for 47 out of 217 projects, detailed information on the timeframe is still missing.

A brief overview per mode of transport is presented below.

Railway infrastructure

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 which 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
- Genoa – Tortona/Novi Ligure (Giovi pass)
- Zeebrugge – Brugge - Ghent

These six projects amount to roughly 30 billion EUR, which is close to half of the total investment volume of rail-related infrastructure projects.

Road infrastructure

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 Antwerp (upgrade and Oosterweel connection);
- Extension of A15 motorway to solve the missing link south of Arnhem;
- Major bypass of Genoa (Gronda autostradale).

The total costs of these three projects already add up to roughly 4.4 billion EUR (out of 10.7 billion in total).

Inland waterway infrastructure

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, a lot of 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.

Seaports

For the Rhine-Alpine Corridor, establishing a connection from the seaport to the existing rail network is essential for the seaports to cope with the key role they have for the development of the Corridor as a whole. An additional focus is on the innovative and sustainable LNG fuel infrastructure, protecting both the environment and biodiversity.

Airports

Analogue 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 (Milan), 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 Genoa airport rail connection, address those challenges.

ERTMS

In December 2014, the European ERTMS Coordinator started a consultation with Member States about ERTMS implementation of the Core Network Corridors, with the aim to review the current European Deployment Plan (EDP) of 2009. This activity launched a close dialogue in all TEN-T corridors with the Member States. The Coordinator had numerous bilateral discussions with high-level representatives of the Transport Ministries and Infrastructure Managers. This review process has been closed and the new EDP will be part of the Work Plan for ERTMS 2016. The reviewed ERTMS deployment plan shall cover all the TEN-T Corridors alignments and will be then subject to a Commission adoption procedure to be finalised by the end of 2016.

RIS

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 and environmental friendliness of the inland waterway transport operations in general.

Projects in the field of RIS, with relevance to the Rhine-Alpine Corridor:

- Dutch-German project concerning Vessel Traffic Management Centres of Future RIS (7.7 million EUR);
- RIS enabled European IWT corridor management – CoRISMa (2.814 million EUR eligible costs, TEN-T-funded).
- RIS enabled Corridor Management Execution – RIS COMEX (3.16 million EUR).

Multimodal terminals

Intermodal terminals are a key component to ensure competitive intermodal transport services throughout Europe and to provide for an efficient and safe interchange between road, rail and other transport modes (inland waterway, short sea shipping including ferries).

To cope with the permanently increasing transport volumes, terminal capacity has to be upgraded accordingly. An innovative highlight for the operation of intermodal transport volumes is the new mega hub in Duisburg which will be set into operation in 2017. In this terminal, the new and innovative concept of rail-rail transshipment will be realised. This offers a whole new dimension in the improvement of intermodal connectivity on the Rhine-Alpine Corridor.

6 Infrastructure funding and innovative financial instruments

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 (technological components, including on large infrastructure of key European Interest, brownfield upgrade) or service provision (terminals for freight / passengers, enhancement of infrastructure capacity / performances), a substantial component of the project funding can come from own resources (e.g. equity) and financing resources gathered by the project promoters on the market (e.g. in the form of equity, loans or bonds). The private investors would need to recover their initial costs of capital and receive a reward for the risk born (the higher the risk the higher the return required).

The project may look at conventional lending from public and private banks, alternative financing from institutional investors (e.g. bonds) and at financial instruments (set in Annex 1) 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 (be it a specific legal guarantee or a financial guarantee to ease access to financing).

- 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 (also depending on the budgetary constraints of the public authorities) such as lump sum subsidy (grant), 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 (e.g. grants) and financing.

In this respect, beside the national budget, the funding contribution can effectively come from the EU centralized managed funds, such as the Connecting Europe Facility (CEF) and from decentralized managed funds such as the European Structural and Investment Funds (ESIF) 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 all these 3 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, 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 (project management) and private partners.

Notwithstanding the project self-financing potential linked to user fees, a cautious and innovative approach aimed at exploiting the project' life-cycle and define 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.

The review of the projects on the Rhine-Alpine Corridor's list includes potential new investments for consideration of innovative financial instruments. There are 29 projects (out of 217) with a potential of generating revenues and therefore suitable – in principle – for the use of innovative financial instruments. They could follow on the successful example of A11 motorway linking the port of Zeebrugge to the European motorway network – a 0.5 billion EUR project, the first one financed through the Project Bond Initiative.

7 Critical issues on the Rhine-Alpine Corridor

The infrastructure on the Rhine-Alpine Corridor is in general technically well advanced. With the rail, road and inland waterway systems running widely in parallel, multiple mode options for freight transport are possible. Passenger rail transport is continuous while road offers a dense network of motorways and high capacity alternative routes.

Improving rail cross-border sections and capacity

Geographically, the most prominent bottlenecks along the Corridor emerge at cross-border sections and around urban nodes. The railway cross-border sections, which require upgrades, are:

- Zevenaar –Emmerich - Oberhausen;
- Karlsruhe – Offenburg – Freiburg – Basel;
- Chiasso – Milan and
- Domodossola – Novara.

These projects represent the highest European added value and contain the highest priority to connect cross-border sections. Besides these large projects, smaller scale projects also emerge as critical sections. Due to operational speed limitations, the railway line Glons – Belgium-German border also needs improvement. The railway connection Simplon/Gotthard – Milan Malpensa airport (i.e. the connection from the airport to the Gallarate – Domodossola railway link) will contribute towards the strategic goal of creating a link between the airport terminal and Switzerland. The limited capacity of the North-South Junction in Brussels has a negative impact on international high speed rail services.

Regarding road infrastructure, the bridge near Weil am Rhine (highway A5, Germany) is facing capacity issues. The same holds for the road access route to the Simplon Pass, at the Swiss-Italian border. For inland waterways, Lobith (NL) – at the German-Dutch cross-border section of the river Rhine – lacks sufficient mooring places.

Eliminating missing links

In addition to the already existing high speed line Frankfurt – Mannheim (*Riedbahn*), the planned new line connecting the Rhine/Main and Rhine/Neckar region (*Korridor Mittelrhein: Zielnetz 1*) will enhance the European high-speed railway network.

On Italian territory, the new connection between Genoa – Tortona/Novi Ligure (*Terzo Valico dei Giovi*) could permit a significant expansion in freight transport between Genoa and Northern Italy. Running between the regions of Liguria and Piedmont, it has a length of 53 kilometres and includes 39km of tunnels. Consequently it may require further upgrade of operation standards and capacity between Tortona/Novi Ligure and Milan/Novara.

For roads, one missing link has been identified in the Netherlands: highway A15 needs to be extended towards the German border. The project called ViA15 addresses this issue.

Interoperability/Compliance with TEN-T standards

Most infrastructure characteristics are compliant with the requirements, set in the TEN-T regulation. However, serious issues remain. With only 12% of the rail section currently being equipped with ERTMS, investment is needed. A wide variety of ERTMS projects has been identified and will ensure the deployment of ERTMS along all relevant corridor sections. Line speed is not compliant with the TEN-T requirements of a line speed of 100km/h at some of the tracks in Dutch harbour areas, between

Berneau – Visé – German Border (BE) and near Basel. Longer trains (>740m) cannot operate on the Italian sections. In Germany and Belgium operation of 740m long trains is theoretically possible; problems however occur e.g. due to capacity bottlenecks during peak hours.

Concerning inland waterways, the draught limitations between Koblenz and Iffezheim (DE) are a serious issue; at least parts of this section of the Rhine are likely to remain non-compliant after 2030. The required bridge height (>5.25m) is fulfilled on the entire corridor. On the Moselle and Neckar rivers as well as in Strasbourg, lock capacities are insufficient. Lack of sufficient mooring places should be addressed in most sections of the Rhine. For roads, compliance issues occur only with clean fuels availability in Switzerland and Italy.

Developing intermodality

Along the Rhine-Alpine Corridor 55 well-functioning bi- and tri-modal logistic platforms at the RRT nodes have been identified (cf. Table 7). Bottlenecks are identified in the available capacity and accessibility by different modes. While terminal capacity is currently described as sufficient in the Netherlands, further increases in terminal handling capacity are required, according to market needs. The Netherlands is, for example, studying on the development of a multi-modal logistic rail platform along the Betuweroute (Valburg/Nijmegen), as part of a European Rail Freight Line System along the Rhine-Alpine Corridor. In Germany and Basel (Switzerland) capacity bottlenecks exist. The "Development concept 2025 for intermodal transport in Germany" identifies areas, where an increase of handling capacity is expected. In Belgium, bottlenecks have been identified in Zeebrugge where investments are planned in and to the port to increase the capacity and improve the multimodal chain.

Table 7: Terminals with rail-road transshipment at core nodes

Country	Node	No of terminals	Country	Node	No. of terminals
BE	Antwerp	5	FR	Strasbourg	2
NL	Amsterdam	3	CH	Aarau	2
	Rotterdam	3		Basel	5
DE	Duisburg	10		Rekingen	1
	Frankfurt	3		Chiasso	1
	Karlsruhe	2	IT	Genoa	1
	Koblenz	1	Milan	4	
	Köln	3	Novara	3	
	Mainz	1	Total	55	
Mannheim/Ludwigshafen	5				

Multimodal transshipment capacity is also an important issue, particularly in Ghent, Duisburg (Rhein-Ruhr terminal), Strasbourg, Ottmarsheim, Plochingen, Milan, Novara and Genoa. In France, Strasbourg faces several bottlenecks which concern principally cross-border, interoperability and multimodality issues including a better connection and electrification of port rail lines and improvements to the stocking capacity for empty containers.

With regard to airports along the Corridor, some dedicated to freight transport, such as the Liège airport, hold great potential for linking high-speed rail to achieve efficient throughput of freight. Improvements are needed for the freight hubs and smaller airports along the Corridor, where rail connections will support the integration of co-modal transport chains.

Enhancing last-mile connections

Regarding road infrastructure, the last-mile connections become critical in urban areas, mainly due to peak hour traffic capacity problems. The last-mile connections in all larger core urban nodes (for instance Amsterdam, Brussels, Düsseldorf, Frankfurt, Milan and Genoa) should be improved.

The accessibility in the seaport areas and larger urban areas along the river network needs to be secured. There, the last mile connections are mainly crossing densely populated areas. The inland port of Strasbourg and the seaports of Antwerp and Ghent have insufficient last-mile connections. The port of Genoa is afflicted by limited maritime accessibility for large vessels (above 18.000 TEUs) and limited rail and road accessibility. Furthermore it faces important challenges in the physical expansion space, due to the fact that it is constrained to a strip of land near to the city and its physical layout.

Four core airports along the Corridor also have an insufficient last-mile connection: Rotterdam/The Hague, Liège, Milan Bergamo and Genoa.

Tackling Externalities/Sustainability/Innovation

River Information Services (RIS) for inland waterways play an important role in achieving the sustainability goals as defined in the regulation, as well as in increasing interoperability and efficiency in communication between waterway authorities, port authorities and skippers. Much RIS deployment takes place in Germany, Belgium (principally on the Flemish network) and the Netherlands, mainly on the Westerscheldt and on the Rhine. The use of LNG is to be improved by enabling sufficient access to LNG fuelling infrastructure; this should allow for reducing levels of oxide (NOx, SOx) and carbon dioxide emissions.

Another critical issue is the connectivity and communication between actors along the Corridor in order to promote multimodality. To explore to the maximum the benefits of each mode in the transport chain, it is important to have efficient exchange and interface standards, an information technology of high quality and reliability, as well as efficiency in trans-shipment. Within the CoRISMa project the technical and functional concept of a service to provide vessel position information with customization (VPI) has successfully been tested.

In road sector different ITS projects have been performed, leading to intelligent truck parking, freight information services and traffic management services. To reduce air pollution and enable sustainable and low-emission road traffic, improving the use of clean fuels is another main topic for road. Road transport is one of the main sources of greenhouse gas emissions and, in this context, clean fuel alternatives emerge as a priority. In Italy and in Switzerland the development of clean fuels' infrastructure is still ongoing.

Considering impacts on urban nodes

Regarding traffic around urban nodes, challenges exist with respect to the combination of liveability and accessibility. Traffic congestion on the road is identified as a critical issue for every densely populated core node along the Corridor.

Concerning railways it should be noted that while infrastructures are compliant per design, other operational restrictions - such as safety and the prevention of noise emissions - limit full conformity. Rail noise is repeatedly identified as a critical issue for sections running through densely populated areas. This is mainly a problem in the middle-Rhine region in Germany, where rail and road traffic cross the populated Rhine valley. Also on the railway section between the Swiss-Italian border and Milan, noise is

regarded as critical. Belgium faces similar noise issues along the rail freight lines leading to the ports of Ghent, Zeebrugge and Antwerp.

Due to the increased traffic flows, the necessary upgrade of the rail stations of Mannheim and Frankfurt has started. In Frankfurt, two additional tracks should be constructed; in Mannheim an additional platform is needed. On the Italian sections, the service quality and accessibility of the railway stations need improvements. In the Netherlands preparations are ongoing for the upgrading of the rail station Amsterdam Schiphol.

8 Recommendations and outlook by the European Coordinator

The Rhine-Alpine Corridor stands out as an epitome of a mature, complex corridor that includes all modalities and which offers widely applicable insights. 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 revised version of the Corridor study provide a more detailed overview of the strengths, weaknesses and needs of the Rhine-Alpine Corridor. They allowed identifying 217 projects necessary to resolve bottlenecks and reach the compliance with the TEN-T standards. For their implementation, an estimated total amount of some 89 billion EUR is required, which can be regarded as unique value for money if compared against the backdrop of the scale and outstanding performance of the Corridor: freight transport of over 1 billion tonnes and GDP contribution of more than 2,700 billion EUR annually.

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

As it runs through regions that are among Europe's most industrialized and economically advanced, the Rhine-Alpine Corridor confronts relevant characteristic 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 expected 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 3rd and 4th 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; 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 term. Project costs for the fourth track Chiasso – Milan – Monza are estimated at 1.4 billion EUR (completion beyond 2030) and for the doubling of track on Domodossola – Novara section – 0.5 billion EUR. The doubling of the Vignale – Oleggio – Arona

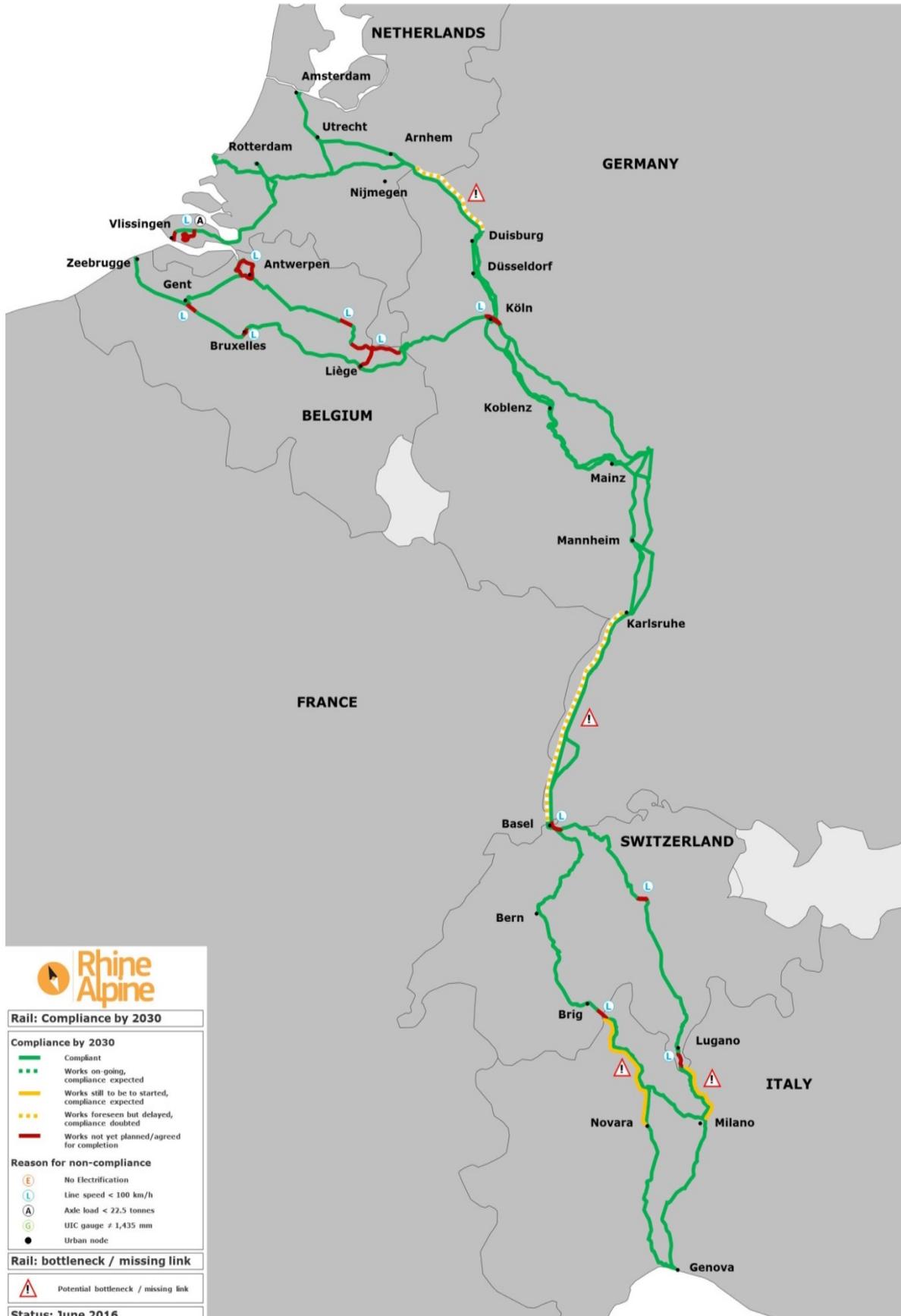
sections has been split in two construction phases and the completion of the first one (Vignale – Oleggio) is foreseen by 2026.

These cross-border sections have been highlighted on the map of the Corridor - as presented at the TEN-T Days 2016 in Rotterdam - and are crucial for the performance of the Rhine-Alpine Corridor (cf. Figure 9). 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. This is particularly relevant for those ports (such as Zeebrugge and Genoa) 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.
- **Genoa – Tortona/Novi Ligure:** the so called *Terzo Valico dei Giovi* project should permit a significant expansion in freight transport between Genoa and northern Italy and Europe. Consequently it may require further upgrade of operation standards and capacity between Tortona/Novi Ligure and Milan/Novara. 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 first phase is expected to be completed by 2021.

Figure 9: Compliance map of the Corridor - railways



Projects improving compliance with TEN-T requirements are a priority

Compared to other core network corridors, the Rhine-Alpine Corridor is to a large extent 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-meter trains to run the entire day, instead of only after peak hours. In this regard small-scale investments into sidings 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. Detailed ways how to accelerate ERTMS equipment along the core network corridors are dealt with by the European ERTMS Coordinator, in consultation with Member States.
- Regarding **inland waterways**, for full operational capacity, extensions of the fairway depth are needed on German sections along the Rhine. As indicated on the map presented at the TEN-T Days in Rotterdam (cf. Figure 10), 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.
- Concerning **roads**, many bottlenecks exist around core urban areas (peak-hour congestion). Capacity issues exist near Genoa, the Gotthard tunnel, Strasbourg, Brussels, Antwerp, 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.
- **Seaports** – being the gateways to the Corridor and the major transshipment points for international freight – face a number of capacity and connectivity issues which needs to be resolved, both when it comes to hinterland connections (Antwerp, Zeebrugge, Rotterdam) and maritime access (Amsterdam, Genoa).

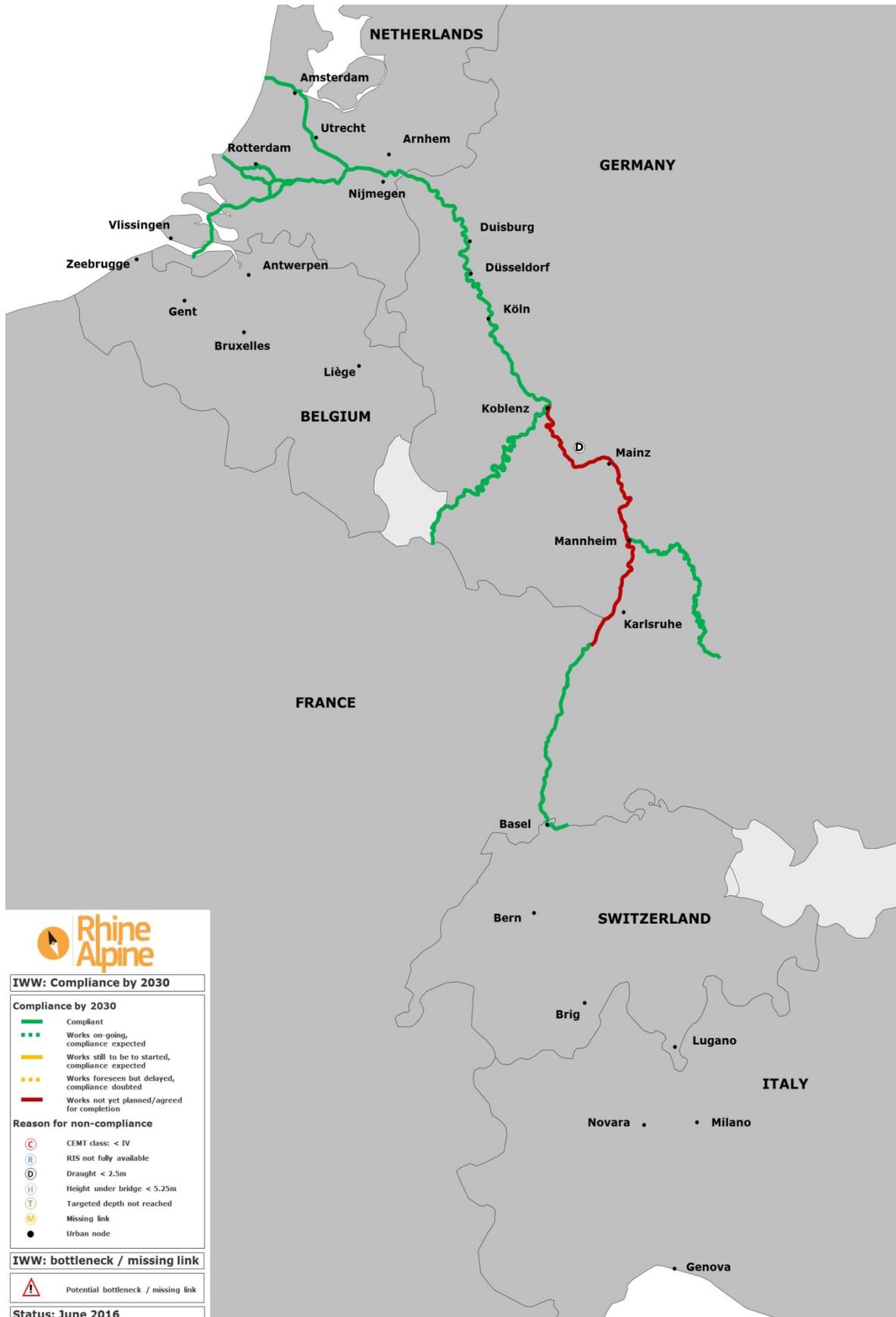
Innovative measures are needed

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 intermodality. 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. In light of the ambitious greenhouse gas emission targets (as defined in the Clean Power for Transport Directive 2014,¹⁵ among others), this can be an important factor. The forthcoming stage of the deployment plan for LNG along the river Rhine is of great importance. In the coming years, efforts need to be focused on supplying ports with sufficient fuels and on installing fuel vessels infrastructure.

¹⁵ Directive 2014/94/EU on the deployment of alternative fuels infrastructure

Figure 10: Compliance map of the Corridor - IWW



Alternative 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.

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 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. Also 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. 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.

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, Antwerp and Zeebrugge). The industry has already introduced anti-vibration and anti-noise measures. Under the Connecting Europe Facility, the European Commission opened up the possibility for financial support for measures which reduce rail freight noise by retrofitting existing rolling stock. 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.

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. The tri-national cooperation between France, Germany and Switzerland for the development of the Upper Rhine ports is an excellent example. A particular attention should also 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 the so-called *Cabina di Regia on logistics* between Liguria, Piedmont and Lombardy regions as well as 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 – can bring mutual benefits.

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 (terminals), for example, a *level playing field* (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 in which the European project has stalled, it is essential that there will be follow-through on commitments, particularly in this corridor whose centrality cannot be overstated.

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Corridor website Rhine-Alpine Corridor

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



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