European Commission

Rhine Danube

Fifth Work Plan of the European Coordinator

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Disclaimer

Abbreviations

ABS	Eisenbahn-Ausbaustrecke (DE) - Railway extension line
AF	Alternative Fuel
AFIF	Alternative Fuels Infrastructure Facility
AIS	Inland Automatic Identification System
b/bn	Billion
C-ITS	Cooperative Intelligent Transport Systems
CEE	Connecting Europe Express
CEF	Connecting Europe Facility
CEMT	Conférence Européenne des Ministres des Transports
CNC	Core Network Corridor
DG MOVE	European Commission – Directorate General for Mobility and Transport
DTP	Danube Transnational Programme
EC	European Commission
EDP	ERTMS Deployment Plan
EEAS	European External Action Service
EGD	European Green Deal
EGTC	European Group of Territorial Cooperation
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EMS	European Maritime Space
ERTMS	European Rail Traffic Management System
ERDF	European Regional Development Funds
ESIF	European Structural and Investment Funds
EU	European Union
GDP	Gross Domestic Product
GHG	Greenhouse gases
GNS	Good Navigation Status
INEA	Innovation and Networks Executive Agency (EU)
ITS	Intelligent Transport Systems
IWW	Inland waterway
km	kilometre
KPI	Key performance indicator
LNG	Liquified Natural Gas
LPG	Liquefied Petroleum Gas
LU	Loading unit
m	metre
mn	Million
MoS	Motorway(s) of the Sea
MoT	Ministry of Transport
MTMS	Multimodal Transport Market Study
MS	Member States of the European Union
n.a.	not available / not applicable
n.L.	nad Labem (Czech place name), at Elbe River
NTP	National Transport Plan
NUTS	Nomenclature des unités territoriales statistiques
OEM	Orient/East-Med (Corridor)
RD	Rhine-Danube (Corridor)
p.a.	per year / annual
RFC	Rail Freight Corridor
RIS	River Information Services
RRF	Recovery and Resiliency Facility
RRT	Rail-road Terminal
RU	Railway Undertaking

SESAR	Single European Sky ATM Research Programme
SSMS	Sustainable and Smart Mobility Strategy
SSS	Short Sea Shipping
SSTPA	Secure Truck Parking Areas
SUMP	Sustainable Urban Mobility Plan
TEN-T	Trans-European Transport Network
tkm	ton-kilometres
TMS	Traffic Management System
TNL	trans-national
WG	Working Group
WP	Work Plan

Country Codes after ISO 3166:

AT	Austria
BG	Bulgaria
CZ	Czech Republic
DE	Germany
FR	France
HU	Hungary
RO	Romania
RS	Serbia
SK	Slovakia
UA	Ukraine

1 Towards the Rhine-Danube Corridor 5th Work Plan

1.1 Introduction

The 5th version of the Work Plan of the **Rhine-Danube Corridor** highlights the main results of the Corridor development and defines the priority work areas to ensure a multimodal, seamless and environmentally friendly Rhine-Danube CNC by 2030. It is of utmost importance to use the remaining time to deliver a technically compliant and operationally functioning Corridor.

The 5th Work Plan is the last one to be adopted under the current TEN-T Regulation (EU) No 1315/2013, which aims to implement Corridor infrastructure focusing on greening the impact of transport to ensure growth and competitiveness, increasing energy efficiency and enhancing safety. We are now called to address the Corridor development and operation in a completely new transport landscape shaped from the unprecedented events of the COVID-19 pandemic, the visible impacts of climate change, the automation and digital revolution, as well as political developments such as UK's withdrawal from the EU and the new financing opportunities offered for the financing of transport infrastructure by the Recovery and Resilience Facility (RRF).

The COVID-19 pandemic presented unparalleled challenges to all sectors across the globe, with transport being one of the most profoundly affected. European countries were no exception; with severely reduced mobility and restricted connectivity, passenger transport modes suffered a considerable decline, with the freight sector witnessing disruption of entire supply chains. This economic downturn forced several countries to delay, change or even put on hold infrastructure development plans. The interrupted flow of skilled labour and material supply through border closures or disrupted logistic chains led to delays, which, however, proved to be manageable in the RD countries, reducing the uncertainty of project delivery. An evident increase in force majeure claims for contractual coverage was reported, as well as cost claims to compensate for these delays and additional expenditures incurred.

In addition, in the period following the launch of the previous Work Plan in June 2020, and in the context of the COVID19 travel and meeting restrictions, the communication between the Member States, stakeholders and DG MOVE was maintained through the remote organisation of the 15th and 16th Corridor Forum Meetings (March and November 2021), as well as a dedicated Corridor Workshop (June 2020). Moreover, three Working Group Meetings on Ports and Inland Waterways were organised (Nov 2020, Mar 2021, Nov 2021), while the RD Corridor was also part of the Motorways of the Sea-Basins Workshops organised for the Black Sea (Oct 2020). The European Coordinators continued to keep in touch bilaterally and to hold key meetings to progress projects further. As an emblematic initiative during the European Year of Rail, the Connecting Europe Express was criss-crossing 26 countries in September and October 2021. With more than 100 stops and 33 border crossings it was a great opportunity to connect different stakeholders, share experiences and hold meetings that underline the importance of rail for future mobility.

The pandemic has therefore, on the one hand, shown the importance of having a resilient transport system in place, while on the other, triggered a significant revisit of priorities. The need to turn towards the twin green and digital transformation is reinforced even further as part of the agenda to boost post-pandemic recovery. To this end, the evolution of the RD Corridor must focus on accelerating the green, digital and

modal shift; the blueprint for this change was set by the European Green Deal[1], as well as one of its main delivery vehicles for transport, EU's Sustainable and Smart Mobility Strategy[2].

Given its high proportion of total greenhouse gas emissions, EU's goal of at least 55% greenhouse gas reduction target by 2030 and climate neutrality by 2050 will be reached only by introducing clear and ambitious policies. The Sustainable and Smart Mobility Strategy (SSMS) lays the foundation for how the European transport system will achieve: a) an irreversible shift to zero emission mobility, b) seamless, safe and efficient connectivity, and c) a more resilient single European transport area for inclusive connectivity. Among other, these must result in a considerable increase of the market share of the more sustainable rail and waterborne transport modes.

The TEN-T policy will have to be a catalyst for bringing its network closer to the above ambitious vision. In this regard, in line with the Action Plan included in the Communication on the Green Deal and the SSMS, a proposal for a revision of the TEN-T Regulation based on an impact assessment was put forward by the Commission and adopted on 14 December 2021 following a public consultation. A few months earlier, EU's Connecting Europe Facility (CEF) 2.0 programme was adopted to run from 2021 to 2027 with a view to fund the development of high-performing, sustainable infrastructure in the fields of transport, digital and energy. This second edition of the programme is also targeted at facilitating the post-COVID recovery and building a climate-neutral EU.

Moreover, in order to speed up the completion of the TEN-T, the Commission adopted the so called "Smart TEN-T Directive"[3] in July 2021 that sets out measures aimed at reducing delays encountered in the implementation of projects related to the network. The Directive limits the entire permitting process to three years and provides greater clarity to project promoters regarding permit granting, public procurement and other procedures. The Commission also recently rolled out the largest ever legislative package of 13 proposals (8 revisions and 5 brand new), namely "Fit for 55", aiming to align EU policy with the mandates of the Green Deal and the EU Climate Law.

Furthermore, the Eastern part of the Danube is almost at the border between the EU and Ukraine and thus is directly impacted by the consequences of the aggression of Russia to Ukraine. It also represents one of the major route still connecting this country to the Black sea through the Sulina canal in Romania. These recent events have shown the importance of improving the resilience of the corridor but also highlighted some hidden vulnerabilities that would need to be tackled in the short to medium term.

In light of the above, the present document will be geared especially towards the notion of sustainable and future-oriented mobility, improved resilience, as well as towards combatting climate change by promoting modal shift and innovation deployment. In this way, Member States and stakeholders can scale the level of investments in emissions reduction and consider more effective action and funding in support of their implementation. The Work Plan highlights the current and expected compliance gaps along the RD Corridor, identifies specific bottlenecks for each transport mode and addresses other key elements for the transport sector, such as

[1] *COM (2019) 640 final*
[2] *COM (2020) 789 final*
[3] *Directive (EU) 2021/1187*

the deployment of alternative fuels or the development of urban nodes. It also includes the impact of the above mentioned EU legislations and programmes

The TEN-T Revision

On 14 December 2021, the European Commission adopted a legislative proposal for a **revised Regulation for the development of the trans-European transport network (TEN-T)**. The proposal is the result of a comprehensive evaluation of the existing legal framework, extensive Member States and stakeholder consultation and an in-depth assessment of the impacts of the changes proposed. The revised TEN-T Regulation shall contribute to the objectives of the **European Green Deal (EGD**) and of the **Sustainable and Smart Mobility Strategy (SSMS)**. The proposal is accompanied by an update of the 2013 TEN-T planning methodology, a report on the implementation of TEN-T during the years 2018 and 2019 as well as a communication on the extension of the TEN-T network to the EU neighbouring third countries.

In order to adequately address the objectives of the EGD and SSMS, the revision of the TEN-T Regulation aims at reinforcing the contribution of the TEN-T to the decarbonisation and digitalisation objectives of transport policy. In particular, the revised Regulation makes sure that the appropriate infrastructure basis to alleviate congestion and reducing GHG emissions is provided. To that end, the revised TEN-T Regulation includes firm incentives to shift transport demand towards more sustainable forms of transport. The aim is two-fold: a) to increase the number of passengers travelling by rail through the development of a competitive and seamless high speed rail network throughout Europe; and b) to shift a substantial amount of freight onto rail, inland waterways, and short sea shipping.

The overall objective is to develop and complete a competitive and interoperable TEN-T network at highest standards, which is gradually developed in three steps: the core network by 2030, the extended core network by 2040 and the comprehensive network by 2050.

To that end, the revised TEN-T Regulation introduces a number of **new or reinforced infrastructure requirements**, which promote the development of infrastructure of sustainable forms of transport.

With regards to **rail transport,** the proposal foresees the requirement to enable the P400 loading gauge on the entire network and the extension of existing core network requirements to the entire comprehensive network (22.5 tons axle load, 740 m train length) or to the extended core network (100 km/h line speed). In addition, a minimum line speed of 160km/h is introduced for passenger lines of the core and the extended core network and the installation of ERTMS on the entire network by 2040 while decommissioning existing national class B systems is made mandatory. In terms of **waterborne transport**, the revised Regulation defines a "good navigation status" through minimum requirements (2.5 m navigable channel depth and 5.25 m height under bridges) that shall be complemented by specific requirements per river-basin. **Short sea shipping** shall be promoted in a wider perspective by integrating all components of the maritime dimension into a new concept called European Maritime Space. In the field of **road transport**, the focus is on improving the quality of roads as to increase road safety and to augment the number of rest areas and safe and secure parking along the TEN-T network. Finally, the proposal for a revised Regulation foresees an increase in the number of **multimodal freight terminals** along the TEN-T in order to promote multimodality as well as the inclusion of all EU **urban nodes** of at least 100.000 inhabitants into the network, thereby also ensuring that each NUTS-2 region is represented by an urban node. For the latter, the requirement to implement a Sustainable Urban Mobility Plan (SUMP) and the development of transhipment facilities (multimodal freight terminals and passenger hubs) is imposed.

In order to achieve the targets and to fulfil the objectives of the EGD and the SSMS an intermediary **deadline of 2040** is proposed to be introduced for the new standards on

the core network and for advancing the existing standards to the comprehensive network, notably the deployment of ERTMS.

One major new element will be the integration of the nine Core Network Corridors with the eleven Rail Freight Corridors in a common set of "**European Transport Corridors**". The alignment of these new corridors will be defined in the TEN-T Regulation and will thus repeal the existing alignment of corridors in the CEF II Regulation. While striving for maximum stability of the existing TEN-T network, this merger brings certain changes such as the identification of an extended core network which will fully integrate into the corridors.

Similarly, the current system of **European Coordinators** shall be reinforced. Based on their work plans which shall be elaborated every four years, the Commission shall adopt an implementing act for each work plan, setting clear milestones to be implemented by the respective Member States. The elaboration of the work plans shall be complemented by annual status reports. Last but not least, the role of European Coordinators as observers in single entities for the implementation of cross-border projects shall be institutionalised.

The proposal is now being negotiated with the European Parliament and the Council for a possible entry into force of the revised TEN-T Regulation in the course of 2023.

1.2 Achievements along the Corridor (including expected ones before start of CEF 2)

In total, 130 actions have been completed between the beginning of 2019 and the first half of 2021, at a total investment cost of € 6.2 bn. An overview of the key projects is presented herein, with emphasis on those that contributed to the achievement of Key Performance Indicators (KPI), an essential aspect for the completion of the TEN-T Corridors:

The CEF-funded upgrading of the Sighișoara - Coșlariu and Coșlariu - Simeria lines, completed in 2020 with total investment costs of nearly €1.5 bn, brought a large part of the northern Romanian Corridor route in line with the TEN-T requirements.

In the Czech Republic, several projects were concluded, which modernised the existing infrastructure and contributed to speed increase and capacity enhancement, especially between the DE/CZ border and Praha. Several of these actions were funded by CEF which highly contributed to implement this section of the Corridor. Some examples are: "Modernization of the line Rokycany – Plzeň", "Junction Plzen, 2nd and 3rd construction" or "Optimization of the line Beroun (including) - Kraluv Dvur". The upgrade of the multimodal terminal Ostrava – Paskov made this terminal accessible for 740m trains and the upgrade of the Negrelli Viaduct (Praha railway junction) is a key element to connect the Vaclav Havel International Airport to the railway network (total costs: € 54.4 mn).

Along the German section of the Danube several CEF funded actions were completed, that improved the operability and the navigation status, such as the deepening of the fairway of the Lower Main, the upgrade of the Danube between Regensburg and Straubing and the new construction of Carl-Ulrich Bridge in Offenbach (total investment costs: € 480 mn).

The action "Upgrading of the Freilassing – D/A border - Salzburg section of the TEN core network corridor Rhine – Danube Corridor (2014-EU-TM-0267-W – CEF €13 million) concerned the construction of a third rail track on the cross-border section Freilassing-Salzburg between Austria and Germany to overcome an existing bottleneck was completed by end December 2020.

CEF also contributed to the upgrade of the Port of Enns in Austria.

In Hungary, RIS (River Information Services) has been introduced and has replaced the Hungarian Inland Navigation Information System (HIR) at the end of 2019; furthermore, the CEF funded actions along the Hungarian section of the Danube are progressing well.

As a CEF funded Corridor flagship action, "FAIRway Danube" is providing on-time harmonised information about the Danube shallow sections and water levels, identifying priority measures as well as measures to implement large scale work to ensure and improve good navigation status along the whole Danube. CEF also funded the upgrade of the port of Giurgiu (Green Port Giurgiu), which turned the port into the first "Green Danube Port", thereby representing a special position on the RD Corridor. This CEF-funded action had total investment costs of € 15.6 mn.

Another important IWW measure, was the finalisation of the modernisation of the Cernavoda, Agigea and Ovidiu locks, which will improve navigation conditions (total costs: € 122 mn).

An improvement in terms of intermodality, was the CEF-funded completion of the rail line from Bucureşti International Airport to Bucureşti North Rail Station at the end of 2020.

Achievements in terms of road transport was the construction of the motorway sections (Hričovské Podhradie - Lietavská Lúčka, Budimír – Bidovce, Lietavská Lúčka – Žilina) of the D1 in Slovakia with total investment costs of € 695 mn.

An additional completed project was the CEF-funded construction of a new Danube bridge between Komárom (HU) and Komárno (SK), which was finalised at the end of 2020. The cross-border action promotes the development of both road and inland waterway transport.

2 Characteristics of the RD Corridor

2.1 The new alignment under CEF2

The Rhine - Danube (RD) Corridor is one of the TEN-T Core Network Corridors (CNC) depicted in Figure 1, spanning across 9 Member States (Austria, Bulgaria, Croatia, Czech Republic, France, Germany, Hungary, Romania, and Slovak Republic) and 4 neighbouring countries (Serbia, Bosnia and Herzegovina, Moldova, Ukraine). It constitutes a key intermodal transport corridor for Europe, connecting through IWW, rail, road and nodal infrastructure Central Europe, the Western Balkans and the Black Sea, with the Danube as its defining element.

Several segments of the RD Corridor overlap with other CNCs, especially with the Orient/East-Med Corridor and on shorter sections, the Rhine - Alpine Corridor, the Scandinavian - Mediterranean Corridor, the Baltic - Adriatic Corridor and the Mediterranean.

The alignment of the Corridor consists of the following main connections, as reported in the maps of the Core and Comprehensive Network of the TEN-T Guidelines (Regulation 1315/2013) and according to Annex 1 of the CEF Regulation 1316/2013:

- Strasbourg – Stuttgart – München – Wels/Linz
- Strasbourg – Mannheim – Frankfurt – Würzburg – Nürnberg – Regensburg – Passau – Wels/Linz
- München/Nürnberg – Praha – Ostrava/Přerov – Žilina – Košice – UA border
- Wels/Linz – Wien – Bratislava – Budapest – Vukovar
- Wien/Bratislava – Budapest – Arad – Brasov/Craiova – București – Constanţa – Sulina

The CEF Regulation (EU) 1315/2013 designates 14 urban nodes, 12 core airports, 19 inland ports of which one is also a maritime port, as well as 22 nodes with rail-road terminals (RRTs) to the RD Corridor.

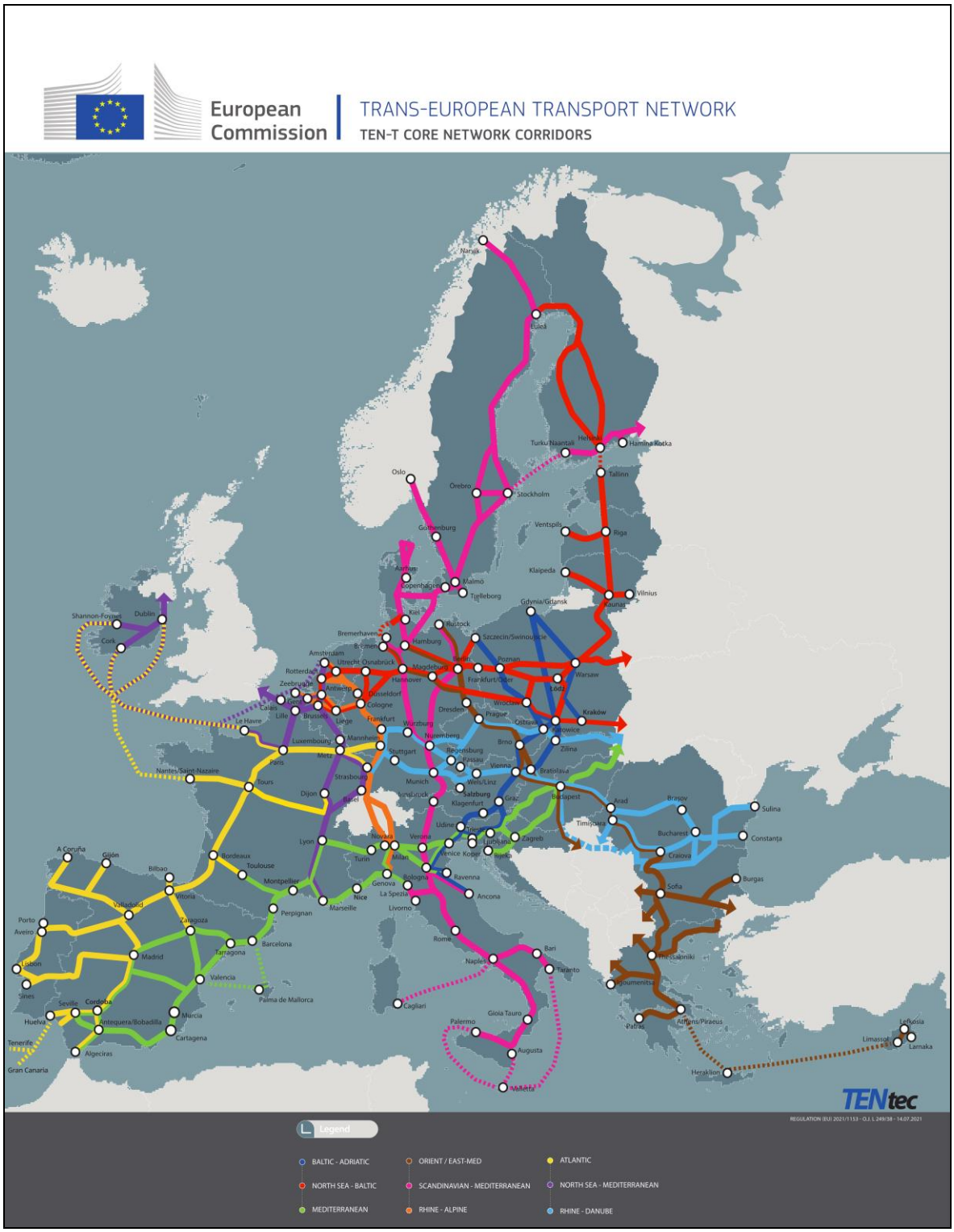
The revised CEF Regulation (EU) 2021/1153 opts among other to add to the configuration of the Core Network's Corridors with a view to develop cross-border links between Member States and third countries and ensure a better connectivity between core nodes and cross-border projects. In the case of the RD, new sections relate to 653 km of road, rail and IWW extensions in Hungary, Romania and Slovakia, as shown in Figure 2.

In Hungary the Corridor extension refers to short IWW sections of the Tisza river from Szeged to the Serbian border (13km).

In Romania, the rail and road alignments are extended from Timișoara to Moravița towards the border to Serbia (ca. 64km) and towards Bulgaria from București to Giurgiu (ca. 55km).

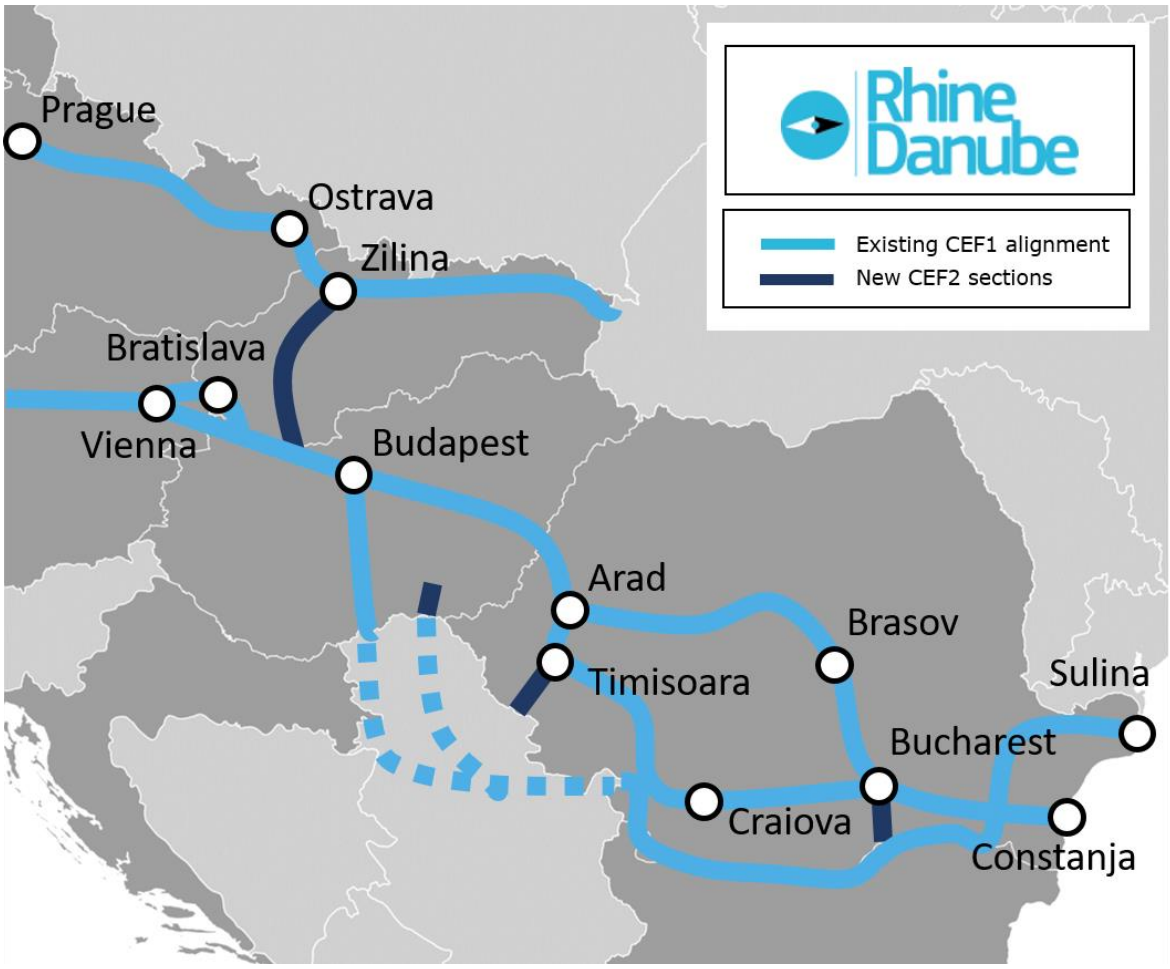
In Slovakia, the IWW alignment was extended by the river Vah from Žilina to Komárno where it flows into the Danube (243km).

Figure 1: The 9 TEN-T Core Network Corridors



Source: DG MOVE - TENtec, 2021

Figure 2: RD Corridor – New alignment



Source: Panteia, RD study team, 2021

2.2 Compliance by 30.06.2021 – current situation with the technical infrastructure parameters of the TEN-T guidelines by 2030

TEN-T Regulation (EU) 1315/2013 puts forward binding minimum infrastructure targets for the Core Network Corridors' transport infrastructure that need to be met by December 2030, the latest. To assist the monitoring towards achieving these values, Key Performance Indicators (KPI) are defined for all modes that measure the extent to which these are realised. This section provides an update to the characteristics of the Corridor by tracking and monitoring the achievements in terms of KPI's per section and node. Current compliance levels reflect the status of the infrastructure network as of June 2021.

Rail Compliance

The allocation of the described compliance status to the corridor alignment achieved by 06/2021 is shown in Figure 3, considering the rail parameters 'Electrification', 'Line speed ≥ 100 km/h', 'Axle load ≥ 22.5 tonnes' and 'Track gauge = 1435 mm'. Additionally, 'Missing links' are pointed out. Referring to these parameters, the current compliance situation on the corridor is as follows:

- Most parts and several countries (AT, FR, HU, SK) are completely electrified. Not electrified parts are particularly located in Germany (Markt Schwaben – Freilassing, Nürnberg Schirnding - DE/CZ border and Regensburg – Furth im Wald – DE/CZ border, with continuation in the Czech Republic to Plzeň via Domažlice. Other affected lines are in Romania (small part of the Bucureşti ring line and the new CEF-II extensions Timişoara - Stamora Moraviţa – Border RO/RS and Bucureşti - Giurgiu).
- All rail lines along the Rhine-Danube Corridor feature the standard track gauge of 1435 mm.
- A throughgoing line speed of at least 100 km/h is provided on the freight lines in France, Germany and Austria[4]. Small incompliant sections have been identified in Budapest and Bratislava areas (Petržalka – Rajka, Bratislava – Petržalka) as well as between Čierna nad Tisou and the Ukrainian border. Moreover, the lines Česká Kubice – Domažlice (CZ) and the CZ/SK cross-border section Hranice na Moravě – Púchov are concerned. The latter is now partially compliant, thanks to a finalised project in 2020.

  The biggest problems regarding line speed are to be noticed in Romania. Large parts of the southern Corridor route (sections Arad – Timişoara – Filiaşi and Videle – Bucureşti) are concerned. The same applies for the Bucureşti ring line and the lines Timişoara - Stamora Moraviţa – border RO/RS and Bucureşti – Giurgiu, now foreseen to be supported through CEF2.

  In the section Predeal - Brazi – Bucureşti, the line speed does not meet the requirements of the TEN-T regulation, as the initial upgrade project parameters did not include the lengthening of the lines in stations or specific measures that can allow speed increase. The infrastructure manager has an ongoing study to improve traffic conditions and eliminate speed restrictions; this study shall be

[4] *Some countries show small incompliant sections within the nodes, particularly in the surroundings of big stations (e.g. München, Wien). Such cases must be evaluated separately with regards to the potential measures to be taken.*

finalised at the end of 2022. Upon consideration, the consultant has proposed an "additional" project that includes ancillary upgrade measures for final elimination of incompliance.

- The corridor compliance situation regarding axle load is comparable to the line speed, as described above: some countries (here: Austria, Slovakia) provide 22.5 t on their entire Corridor network. In other countries, single lines are not yet compliant. This is the case in France (Strasbourg – Border FR/DE), in Germany (Garching – Freilassing) and in the Czech Republic (Česká Kubice – Domažlice – Plzen). Hungary shows several, however rather short incompliant parts (Rajka - Hegyeshalom, Szolnok - Szajol, Békéscsaba - Lőkösháza and some sections inside Budapest node).

  In Romania, compliance regarding the axle load criterion is low, many lines only allow for 20 t, such as the entire southern Corridor route, the Bucureşti ring line and some sections of the northern route (Arad - Simeria and Sighișoara – Predeal). Again, the new CEF-II extensions Timişoara - Stamora Moraviţa – Border RO/RS and Bucureşti – Giurgiu are not compliant, as well.

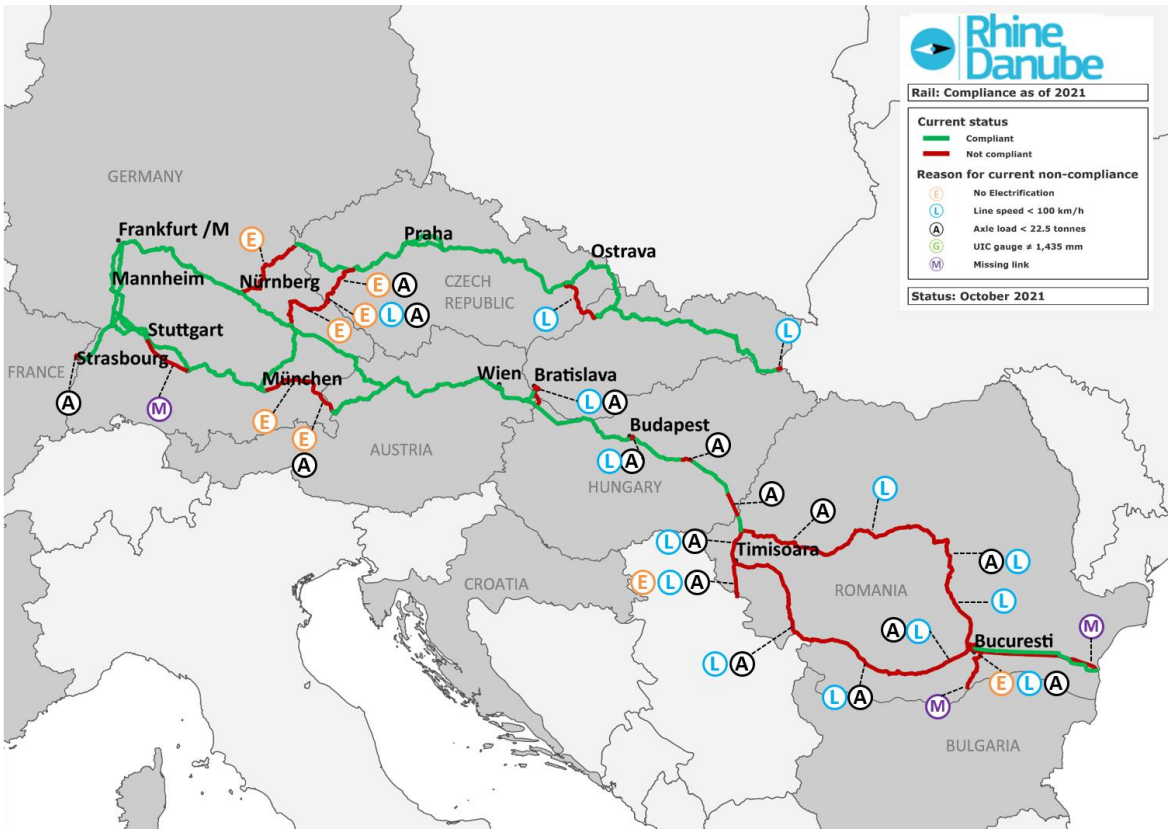
Next to the parameters displayed in the compliance map, the permitted train length (TEN-T requirement of 740m) and the intermodal gauge (P/C 70/400 as market related benchmark) were also analysed:

- Regarding the train length, the Corridor shows a heterogenous picture: In France, Germany, Austria and Hungary, 740m train operation is permitted on all Corridor freight lines. In contrast, the entire part in the Czech Republic and Slovakia is non-compliant. In Romania, incompliant parts are located on the northern route (sections Sighișoara – Predeal - Bucureşti), while projects are currently implemented and financed through CEF, on the southern route between Timişoara and Filiaşi (including extension to Stamora Moraviţa – Border RO/RS) as well as on the Bucureşti ring line with continuation to Giurgiu where works are however planned in the next years.
- Continuous train operation with at least P/C 70/400 intermodal profile is already possible on the "Black Sea" branch from Germany via Austria and Hungary to Curtici (RO). In contrast, compliance is missing on the short French section Strasbourg – Border FR/DE and on the Romanian network as well as on some sections of the "CS" branch, namely in Germany (Hersbruck – Marktredwitz, Regensburg - Maxhütte-Haidhof) and in the Czech Republic (Kolín - Pardubice and Hranice na Moravě – border CZ/SK).

Finally, missing links with a view on the overall 2030 targeted Corridor alignment are found in:

- Germany: New high-speed connection Stuttgart – Ulm
- Romania: New high-speed connection Bucureşti – Constanţa

Figure 3: Rail compliance 2021



Source: Panteia, RD study team, 2021

Rail-road terminals compliance

The KPIs for rail-road Terminals (RRT) are not explicitly laid down in the Regulation; instead, they are derived from market needs to make intermodal transport competitive to road. The analysis of the 41 RRTs that are currently in operation in the RD core nodes revealed that these market-driven parameters have been improved compared to the previous Work Plan, however still on rather low level.

- The largest compliance refers to the capability of the terminals to handle all three types of standard loading unit types (containers, swap bodies, semi-trailers). With status of June 2021, 53% of the RD terminals fulfil this criterion. Non-compliance is mostly due to the respective market orientation (e.g.: focus on maritime transport or on key customers with special logistics profiles).
- The compliance rate for electrified access is 29%. Even more, the limited length of the handling tracks creates a real burden for an efficient supply of intermodal transport services. Only five terminals (12%) are accessible to 740m trains.

In general, the current RRT situation is not satisfactory. To a large part, this is due to the historical development: many of the existing rail-road terminals were constructed as re-use of obsolete sidings in the peripheral areas of marshalling yards or port areas. Thus, their railway infrastructure is characterised by a one-side connection to the main line, non-electrification and short usable length of the transhipment tracks. Moreover, due to their location within existing infrastructure, they show no or only very limited expansion options. Therefore, the layout of these terminals does not correspond to the requirements of market-driven transport services, namely:

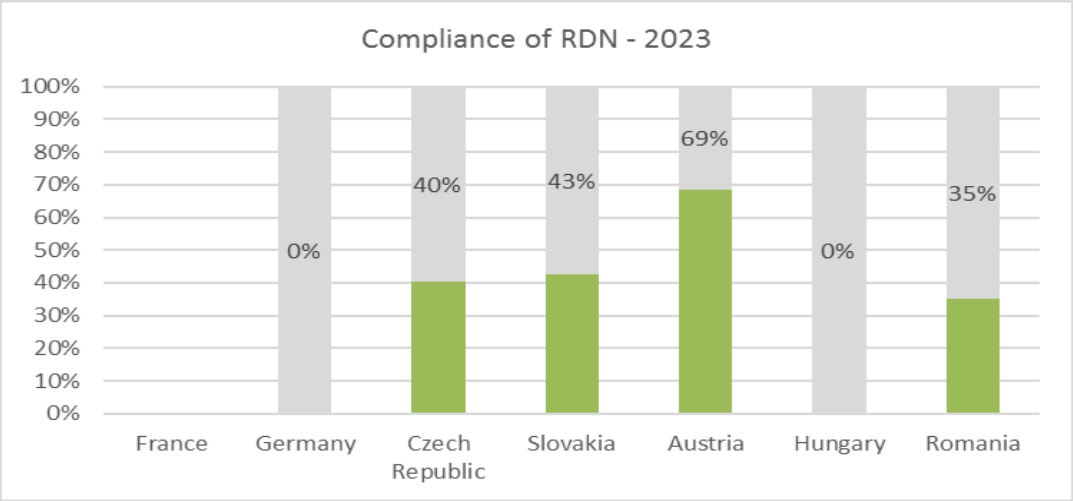
- Access by 740m trains
- Possibility of electrified train arrival/departure
- Both-side connection to the main line

Despite this fact, several of these "historically grown" terminals are still in operation and are only gradually/partially being replaced by modern facilities.

ERTMS compliance

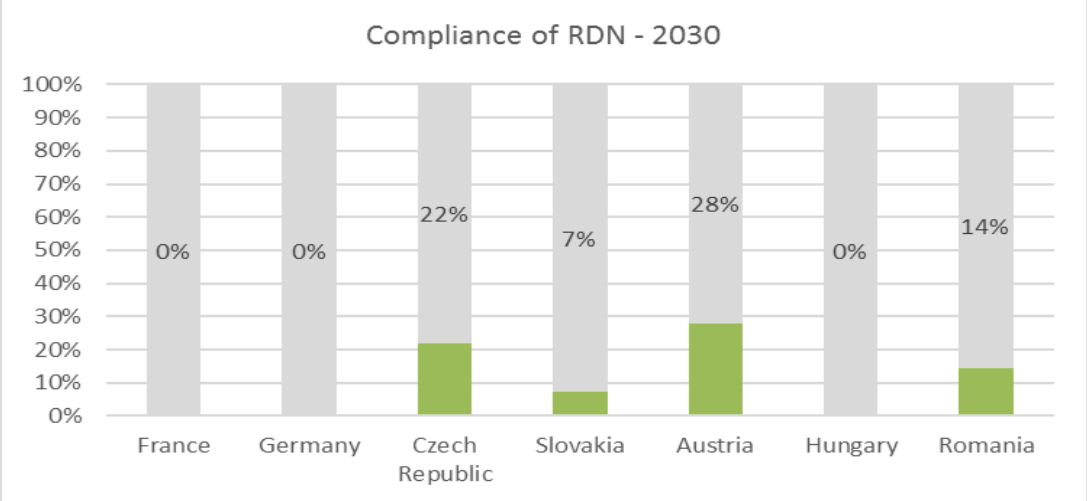
The total length of the RDN corridor is 5910 km, including the CEF 2 extension. According to the ERTMS Deployment Plan (EDP), 1570 km and 2060 km are expected to be operational by 2021 and 2023 respectively. Overall, ETCS is in operation on 10% of RDN, while GSM-R on 60% of the corridor. In September 2021, 30% of the RDN length planned in the EDP by 2023 is in operation with ETCS. Given the current deployment figures and considering that some Member States have already notified delays in implementation, it will not be possible to meet the ERTMS EDP deadlines in this corridor by 2023. The following graphs show the current status of ETCS deployment by Member States on the RDN as percentage of the 2023 and 2030 targets.

Figure 4: Current status of ETCS deployment by MS (in % of 2023 target)



Source: ERTMS DMT - DG MOVE, 2021

Figure 5: Current status of ETCS deployment by MS (in % of 2030 target)



Source: ERTMS DMT - DG MOVE, 2021

IWW compliance

The Corridor compromises 4.071 km of inland waterways, covering sections of the rivers Danube, Main, Sava and Tisza. With the inclusions of the new sections in Slovakia, parts of the Vah river are part of the RD Corridor now.

In total, 90% of the inland waterway network is classified as a class IV waterway or higher. This is excluding the 112 km long Danube-București channel, a missing link that is still to be constructed, and some sections in Slovakia (Vah) and Croatia (Sava). A draught of 2,50m is targeted to be reached at 87% of the inland waterways. Shortfalls relate to the Danube between Straubing and Vilshofen (1,6m at 94% of days per year), in addition to a few sections on the Vah river and the Sava river in Croatia.

Two bridges over the Danube in Germany offer a clearance below 5.25m (2311.27 rkm: Railway bridge Bogen – 5.0m; 2225.75 rkm: *Luitpoldbrücke* Passau – 5.15m) and two bridges along the Main (59.55 rkm: Rail and road bridge Auheim – 4.85m; 252.32 rkm: *Alte Mainbrücke* Würzbürg – 4.45m).

Two of the bridges (Railway bridge Bogen, *Alte Mainbrücke* Würzburg) can represent a particular challenge for the navigation of passenger vessels and would also represent an obstacle if container transport on the Danube develops. Information Services are available along the Inland Waterway Core Network (except for the Vah River) but to a different extent and quality. International and national exchange of fairway or traffic related data between the RIS operators is not always ensured.

A particular challenge for the Rhine-Danube Corridor is the extent to which the targeted fairway depth is met. Achievement of targeted depths varies dynamically as it depends not only on the waterway infrastructure conditions, but mainly on the hydrologic circumstances as it has been the case during the Summer 2022. In particular for free-flowing river sections, they are challenging to be met. As it is in the interest of shipping companies to avoid costly interruptions and unaffordable groundings, they usually load their ships based on the available water level data and forecasts and including an appropriate safety margin. In order to load the vessel according to the expected infrastructure conditions, precise water level forecasts in combination with up-to-date riverbed measurements are needed.

The CEF funded action *FAIRway Danube* publishes a yearly report on the condition of the fairway and the implementation of national action plans along the Danube[5]. A main aspect of this report is to highlight critical locations, where the targeted fairway depth is not met. In order to cope with the current climate change challenges that would probably lead, in the near future, to a lower volume of rain in the area of the Danube – with the consequences that more sections of the river might be affected along the year by water level constraints, a strengthened coordination of the dredging operations as well as an increased budget to carry out dredging operations will be required.

The recommended target of the *Fairway Rehabilitation and Maintenance Master Plan*[6] is to provide a fairway depth exceeding 2.5 m at least on as many days per year as

[5] http://www.fairwaydanube.eu/docategory/project-files/

[6] https://www.viadonau.org/en/company/project-database/top-aktuell/fairway-danube

show actual water levels equal to or above the statistical Low Navigable Water Level (LNWL)[7].

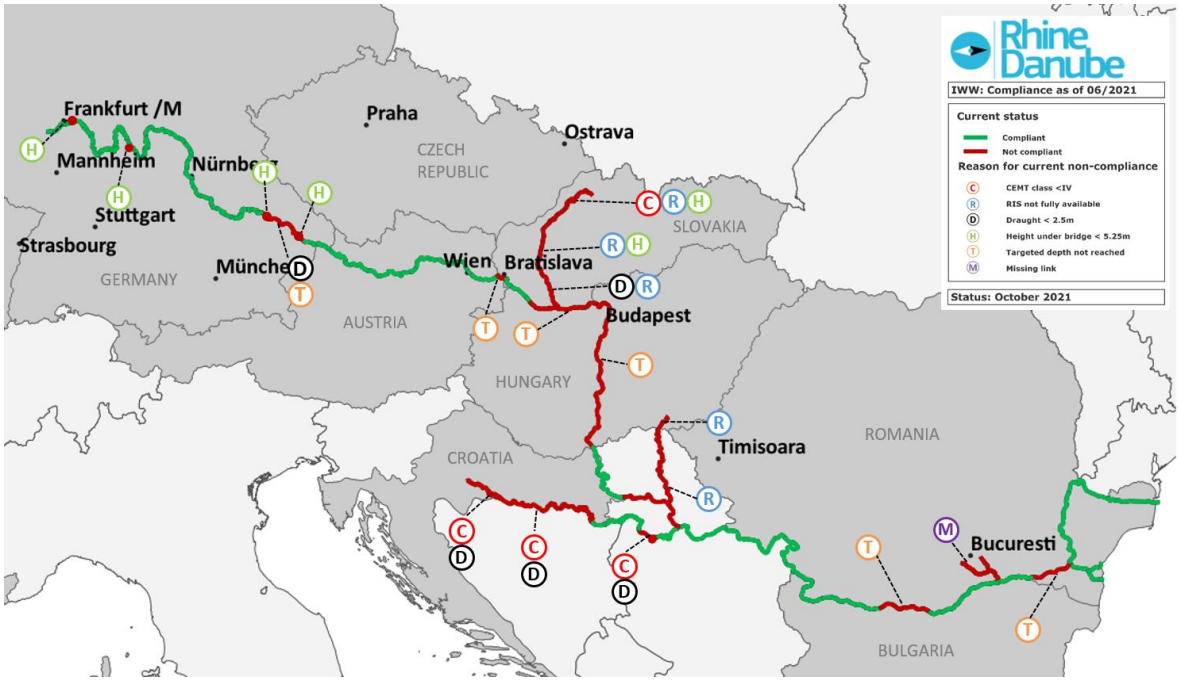
Table 1 lists the main critical sections based on the analysis of the FAIRway Danube project for the year 2020.

Table 1: Overview of key critical locations regarding fairway depth ≤ 2.50m in 2020

Critical Location	Number of days with fairway depths ≥ 2.50m	Number of days with water level ≥ LNWL
Devín (SK)	337	363
Štúrovo / Komárom (incl. Nyergesújfalu - SK/HU)	286	362
Göd (HU)	291	366
Dömös (HU)	281	366
Budafok (HU)	322	366
Solt (HU)	235	340
Cochirleni (RO)	302	356
Belene/Milka/Kondur Island	340	350

Source: FAIRway Danube, 10/2021 – compiled by RD study team 12/2021

Figure 6: IWW compliance 2021



Source: RD study, 2021

Port compliance

All 19 ports comply with the CEMT IV class connection KPI and with the KPI requirement to have at least one freight terminal open to all operators in a non-discriminatory way and application of transparent charges. Only two ports, Komarom

[7] LNWL = the water level reached or exceeded at a Danube water gauge on an average of 94% of days in a year (i.e. on 343 days) over a reference period of several decades

(HU) and Cernavodă (RO), have no fully functional rail connection to the hinterland and the rest of the network.
The majority of the Corridor core ports (19) comply with the requirements set by the TEN-T Regulation. The situation is similar in view of railway connection; only two ports, Komarom (HU) and Cernavodă (RO), have no fully functional rail connection to the hinterland and the rest of the network.
Currently, alternative fuels supply facilities are available only in the port of Ruse (Bulgaria). In the port of Enns (Austria), the alternative fuel facility (LNG station) is currently equipped for trucks only, while its waterside is neither constructed for vessel berthing nor equipped for supply of LNG to vessels. Therefore, it cannot be considered as fully compliant with the KPI related to alternative fuels supply facilities. Plans for alternative clean fuel facilities have been reported by the ports of Budapest, Constanţa, Enns and Bratislava, while some of the remaining core ports on the Corridor took part in the LNG Master Plan on the Rhine-Main-Danube axis, meaning that plans for provision of alternative clean fuels facilities might be considered at a later stage depending on the timing of actual introduction of LNG fuelled vessels into operation on the Danube, creating the initial demand.

Road compliance

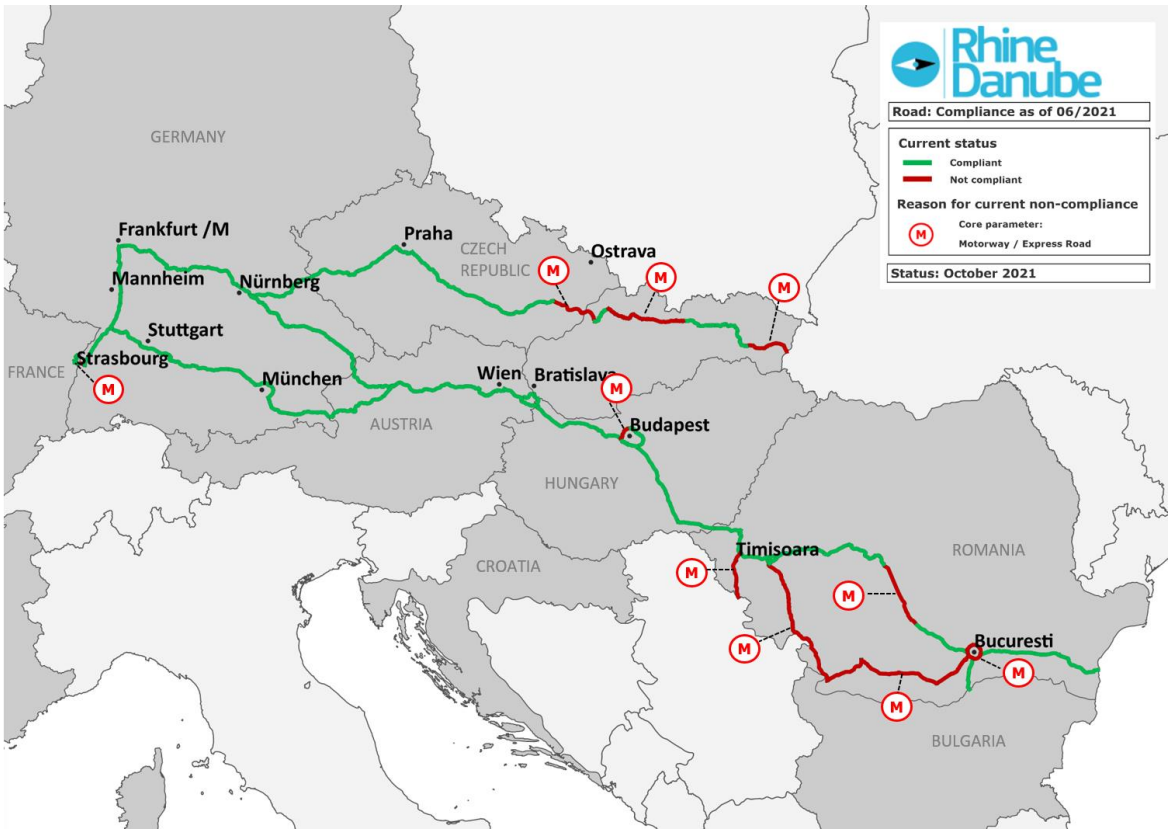
No missing road links exist along the Corridor. Currently 78% of the total Corridor length, including the new section, meets the motorway or express road standard. The length of the non-compliant road sections is 1019 km, the majority of which are in Slovakia (145 km or 14% of the total non-compliant road sections) and in Romania (784 km or 77%, of which 256 km are common sections with the OEM CNC). Capacity bottlenecks exist, predominantly in the western parts of the Corridor and especially around big cities and suburban areas of main nodes.

At least one type of alternative fuel is offered along 99% of the Corridor length. Alternative fuels are widely available along the CNC motorways, however the level of supply varies from country to country. There is a good coverage with LPG stations in all RD countries, while the number of CNG stations is significantly smaller. Electric charging stations are available in urban nodes and have good coverage of intercity sections in Germany, Austria and Slovakia, but the number of such is yet limited in Czech Republic, Hungary and Romania and quasi non-existent in Bulgaria However this aspect has been covered in the Resilience and Recovery Plans (RRP) through the setting up of new legislations aiming at incentivizing environmentally friendly road transport and through targeted investment to increase the number of refuelling stations for alternative fuels on the network.

Intelligent Transport Systems (ITS) deployed along the Corridor for road traffic and interface with other modes of transport are providing relatively limited real-time traffic and weather information. C-Road is the platform of Member States working on the deployment of C-ITS (Cooperative Intelligent Transport Systems) services, which allows vehicles to communicate with other vehicles, with traffic signals, roadside infrastructure as well as road users. This system has the potential to improve road safety and road transport efficiency. Investments in C-ITS test infrastructures have been made in Austria, Czech Republic, Germany and Hungary for connecting the vehicle with the infrastructure, but these are not Corridor specific.

Safe and Secure Truck Parking Areas (SSTPA) hardly exist along the RD Corridor. Two dedicated truck parking areas along the German RD route are registered in ESPORG[8] as well as one in Bulgaria and one in Romania. The Romanian one is also the only (gold) certified[9] SSTPA, which serves the traffic along the common section of RD and OEM CNCs.

Figure 7: Road compliance 2021



Source: Panteia, RD study team, 2021

Airport compliance

There are in total 11 airports along the Rhine-Danube Corridor, which can be assigned to Core Network nodes. According to part 2 of Annex II of Regulation 1315/2013 there are 6 dedicated main airports that shall be connected with the trans-European rail network by 2050 wherever possible with a high-speed rail network connection: Frankfurt, München, Stuttgart, Praha, Wien and Budapest.

Out of these major airports, Praha and Budapest do not have a rail connection, but are to be connected by 2050. Relevant studies are under preparation.

Alternative clean fuels are not available at most airports as no fixed storage tank facilities for aviation biofuel are reported to be in use in any airport, except for Frankfurt airport. Although, airports such as Stuttgart, München and Wien are increasingly using alternative fuels for airport ground services (e-mobility, hydrogen, CNG, LPG). They have also recently introduced charging or fuelling stations. All

[8] ESPORG is the organization within Europe for all parties interested in secure truck parking and navigation https://www.esporg.eu/

[9] Four level certification scheme includes bronze, silver, gold and platinum SSTPA

airports have cargo terminals, which are open to all operators in a non-discriminatory way.

2.3 Evolution over time of the KPI's per Member State

2.3.1 KPI Analysis

With the arrival of CEF 2 and the addition of new links to the RD Corridor, it is an appropriate moment to take a look at the collective results achieved so far with regard to the compliance of its network with the technical parameters of the TEN-T Regulation. It is important to obtain a consistent historical evolution of KPIs from 2014 to 2020 on a Corridor level, as well as on an individual Member State level, the latter giving out a more comprehensive picture. Breaking down the KPI monitoring at country level will better highlight where problems exist, particularly when it comes to the rail infrastructure status and, consequently, potential for modal shift.

Accordingly, the tables below show how the technical parameters have developed between 2016 and 2020 for the RD rail, road and IWW network[10]. Table 2 presents the compliance percentage of the technical parameters per Member State in 2020 for the Corridor sections as defined under CEF 1[11]. The percentage difference in the "compliance with the technical parameters" between 2016 and 2020 is shown in Table 3.

The tables reveal that the overall KPI-status is already high for numerous parameters, but also that progress on the KPIs that still need to be improved is often on a low level. It also shows that much progress is still needed over the next decade to achieve full compliance with technical parameters in 2030. Of course, it should also be mentioned here that in addition to the technical parameters, the administrative and operational conditions are similarly crucial for a functioning transport network.

The specific situation in each country is discussed in the sections that follow.

Table 2: Status of the rail, road and IWW technical parameters in 2020 per RD CNC Member State for the CEF 1 alignment

		AT	FR	DE	CZ	SK	HU	RO	BG	HR
Rail	Track gauge = 1,435 mm	√	√	√	√	√	√	√		
	Electrification	√	√	79%	91%	√	√	98%		
	Line speed ≥ 100 km/h	√	√	√	96%	88%	98%	43%		
	Axle load ≥ 22.5 tonnes	√	0%	97%	92%	√	83%	25%		
	Train length ≥ 740 m	√	√	√	0%	0%	√	52%		
IWW	CEMT IV or higher	√		√		√	√	√	√	30%
	Permissible Draught ≥ 2.5 m	√		90%		√	√	√	√	30%
	Bridge height ≥ 5.25m	√		45%		√	√	√	√	√
	RIS fully available	√		√		√	√	√	√	√
Road	Express way/motorway	√	√	99%	88%	66%	93%	42%		

Note: Member States complying with a KPI are marked with a "√". Grey indicates that the KPI is not applicable for these countries. Source: RD study team, 2021

[10] For the figures relating to the technical parameters, the following aspects should be taken into account: missing links are excluded in the figures; figures may slightly deviate from earlier reported figures due to data corrections, some of which have been corrected retrospectively; the figures are taken from a dataset constructed for the RD corridor and are based on TENtec, but not directly from TENtec; certain short sections could be subject to derogations from the standard, therefore, full compliance with the standard may not be expected.

[11] The compliance rates given in this section refer to those of the CEF 1 CNC sections. Only the CEF 1 sections have been used for this comparison, as no historical data is available for the newly added CEF 2 sections.

Table 3: Difference in compliance percentage of the technical parameters between 2016 and 2020 for the rail, road and IWW CEF1 RD CNC network per RD Member State

		AT	FR	DE	CZ	SK	HU	RO	BG	HR
Rail	Track gauge = 1,435 mm	√	√	√	√	√	√	√		
	Electrification	√	√	-	-	√	√	1%		
	Line speed ≥ 100 km/h	√	√	√	5%	-	-	-52%		
	Axle load ≥ 22.5 tonnes	√	-	-	-	√	-	2%		
	Train length ≥ 740 m	√	√	√	-	-	3%	34%		
IWW	CEMT IV or higher	√		√		√	√	√	√	-
	Permissible Draught ≥ 2.5 m	√		-		√	√	√	√	-
	Bridge height ≥ 5.25m	√		-		√	√	√	√	√
	RIS fully available	√		√		√	√	√	√	√
Road	Express way/motorway	√	78%	1%	2%	3%	-	3%		

Notes: Member States complying with a KPI are marked with a "√". Grey cells indicates that the KPI is not applicable for these countries. "-" denotes that there is no KPI evolution. Source: RD study team, 2021

2.3.2 Austria

The RD alignment in Austria covers 498 km rail, 322 km IWW and 485 km road sections, as well as a core airport and 5 rail-road terminals of which 2 are inland ports.

The RD rail network fully complies with the KPIs, except for the ERTMS implementation between Salzburg and St. Pölten and on the section east of Wien towards Hungary.

All road sections on the RD Corridor were already compliant to the TEN-T requirements.

The connection of the Wien airport to the long-distance rail network was finalised in 2014. Although there are no storage tank facilities for aviation biofuel, the airport is using alternative fuels in fleet for airport ground services.

The rail-road terminals in Wien and in Wels lack a 740m train accessibility, but in Wien upgrades were made to obtain electrified access.

The ports in Enns and Wien are compliant to all KPIs except for alternative fuels supply facilities, although the port of Enns is currently equipped with a LNG station for trucks only.

The inland waterway sections in Austria are compliant to the TEN-T requirements. An ongoing river engineering project on the Danube east of Wien is continuously improving the fairway draught.

2.3.3 Bulgaria

The Bulgarian part of the RD Corridor refers only to the inland waterway and inland ports. In the north it shares about 470 km of inland waterways with Romania with the port of Vidin in the west and Ruse in the east of the country.

The inland waterways sections are compliant to the KPIs, although they are characterised by a large number of critical locations regarding the required fairway depth of 2.5m. Monitoring reports show that the targeted fairway depth isnot regularly met in the areas of Svishtov, Ruse (Belene) and Silistra. Setting regular maintenance on these sections is a critical aspect that need to be better tackled.

Both ports are compliant to the TEN-T requirements, except for the availability of clean fuels. Although not part of the port of Ruse, a LNG station in the port area was opened in 2017 by the private operator Bulmarket.

2.3.4 Croatia

The Croatian part of the Corridor runs for more than 500 km along the rivers Danube and Sava with the two core ports Slavonski Brod (Sava) and Vukovar (Danube). About 300 km of the Sava River form the border between Croatia and Bosnia.

The Danube sections are fully compliant with the technical parameters, whereas about 250 km of the Sava (Sisak – Slavonski Brod, Oprisavci – Šamac) do not fulfil the required CEMT class and the minimum fairway draught.

Both ports fulfil the TEN-T requirements except for the availability of clean fuels, like most other ports along the Corridor.

2.3.5 Czech Republic

The Czech Republic is located in the northern part of the RD Corridor network, connecting Germany in the west and Slovakia in the east with rail and road lines. Airports in Praha and Ostrava, and several rail-road terminals are also part of the Corridor.

On the Czech rail network, there are major deficiencies, mainly in terms of delayed ERTMS deployment and insufficient train length along the entire Corridor. Several projects to address these bottlenecks have been implemented in recent years, but only minor improvements on short sections can be seen.

Although more than 90% of the rail network already fulfil the requirements for electrification, line speed and axle load, there are some short non-compliant sections towards the border to Germany and between Prerov and Ostrava.

All multimodal terminals in the Czech Republic are non-compliant with the following parameters: electrification, 740 m length accessibility, and the transhipment of all types of intermodal standards LU types. The only progress has been made on the Ostrava-Paskov terminal, which has been upgraded and is now accessible for 740m long trains.

Also, slow progress has been made in order to link Praha Airport to the high-speed railway in recent years. The preparation for provision of clean fuels at the airport is still an issue.

2.3.6 France

France is represented in the Rhine-Danube Corridor with only one short rail and road section between Strasbourg and the FR/DE border. On this section, the compliance rate for road increased between 2014 and 2020, thanks to upgrading the route from Illkirch-Graffenstaden to the FR/DE border to "Motorway" status. Concerning rail, only the axle load criterion is not yet compliant; in this respect, no progress was achieved between 2014 and 2020.

2.3.7 Germany

Germany is one of the main contributors to the Rhine-Danube Corridor network. It shows the biggest length of rail sections (1823 km) as well as the largest number of rail-road terminals and airports. In addition, Germany ranks second in terms of the length of inland waterway (768 km) and road network (1191 km) as well as inland ports.

Moreover, Germany has a central location within Europe and a strong economic footprint. For these reasons, infrastructure in Germany and the connections to neighbouring countries have always been of high quality and with adequate capacity, even before the TEN-T regulation came into force. This is also reflected in the KPI values of 2014.

Regarding the evolution of the compliance rates of rail, road and IWW between 2014 and 2020, no quantitative progress can be stated. This is due to the fact, that the infrastructure was either already compliant with the set requirements in 2014 or compliance gaps are subject to ongoing/planned projects, mostly laid down in the German Transport Master Plan. In exceptional cases, projects are not foreseen yet or will not close the compliance gaps completely.

Currently non-compliant rail sections are: München – Freilassing (axle load and electrification), Nürnberg - DE/CZ border (electrification), Regensburg - DE/CZ border (electrification), "Stuttgart 21" + High-speed line Stuttgart – Ulm (missing link) – all of these sections are covered by projects that will be completed by 2030.

Regarding inland waterways, the most critical section is between Straubing and Vilshofen (ca. 80 km), where a decision to increase the draught to 1.80 m (+ 20 cm) was taken (but which is below the requirement of 2.50 m). The so-called *Variant A* (river control measures) aims to increase the number of days per year with an effective draught of 2.50 m by 56 days to 200 days/year. The works for the first part of the section (Straubing – Deggendorf) started in July 2020. For the second part (Deggendorf – Vilshofen) the planning approval procedures are still ongoing.

Two bridges on the Main (Alte Mainbrücke Würzburg, Auheim) and two on the Danube (Eisenbahnbrücke Bogen, Luitpoldbrücke) offer a clearance below 5.25 m.

Moreover, all RD road sections in Germany are compliant with the "motorway" criterion except a short section between Neuried and Offenburg.

The picture is also clear for airports and inland ports. All German airports[12] were already connected to rail in 2014. The same applies to rail and waterway connections of the German inland ports. Availability of alternative fuels, however, remains an issue to be solved in the upcoming years.

Finally, regarding the market-driven indicators for rail-road terminals, the compliance rates of the German RRTs are comparably high compared to those of other countries. Nevertheless, the accessibility with electric traction and 740m trains in particular needs to be improved to reach the envisaged goals of modal shift. This will be however a matter of the terminal operators and only be done if financially feasible.

2.3.8 Hungary

Hungary is crossed by three Core Network Corridors, the Rhine-Danube, the Orient-East Med, and the Mediterranean.

Despite progress in the implementation of a number of projects, there has recently been no significant change in the state of KPIs. Full compliance with regard to track gauge, electrification and train length is achieved. Earlier discrepancies can still be observed, as in the case of railways, the lack of ERTMS application on a great number

[12] *Listed in part 2 of Annex II of Regulation 1315/2013*

of lines, the lower maximum axle load on certain lines and the lower maximum operating speed on a few lines.

Along the Danube there are numerous critical locations where the targeted fairway depth is not sufficiently achieved. This refers to Nyergesújfalu in the SK/HU border section, Göd, Dömös, Budafok in the area (north) of Budapest and Solt in the middle of the section between Budapest and the border with Serbia.

Regarding RRTs, compliance is still low in terms of electrified access and 740 m train accessibility.

Moreover, the western section of the circular motorway ring around the capital, Budapest, is still missing, given delays in its construction.

The Budapest airport also remains an unresolved issue with the absence of a heavy rail connection despite existing project(s), mainly due to pending decisions on potential alternative solutions.

2.3.9 Romania

With more than 4100 km Romania plays a crucial role in the development of the RD Corridor for all kind of transport modes. The corridor alignment stretches from the borders with Hungary and Serbia in the (south) west to the Black Sea in the east.

The compliance rates in the rail sector are comparatively low. This refers mainly to the KPIs line speed (43% compliant), axle load (25%) and train length (53%), although the latter one has been improved on several sections (Curtici – Coșlariu, Bucureşti – Constanţa, Timişoara – Orșova) in the last years. The KPI-rate for line speed has actually decreased due to rehabilitation works on many sections and will increase again when finalised.

Regarding the road sector, motorways between the HU/RO border and Arad Timişoara and Lugoj have been completed in 2015, as well as the section Orăștie – Sibiu in 2016. Work for the motorway ring in Bucureşti, the section Lugoj - Deva and Sibiu – Pitești have already started. The southern part of the Corridor between Lugoj – Calafat – Craiova – Bucureşti is still non-compliant. The four new sections in Romania cover the RD Corridor extensions towards the border with the Republic of Serbia (Timişoara - Voiteg – Moraviţa, following the E70/59 road) and the border with Bulgaria (Bucureşti – Giurgiu, following the E85/5 road). Only the latter section is an express road and complies with the road class KPI. All new sections offer alternative fuels in its vicinity.

Another critical issue in the realisation of multimodality is the lack of operational rail-road terminals in Romania.

The inland waterway sections are characterised by some critical locations in the area of Corabia, Călărași and Cernavodă where the targeted fairway depth was not regularly met.

All ports in Romania (6) are fully compliant to the KPIs except for the availability of clean fuels and a missing rail connection in the port of Cernavodă. Plans for alternative clean fuel facilities have been recently reported by the port of Constanţa.

The airport in Bucureşti is connected to rail since end of 2020.

2.3.10 Slovakia

The RD Corridor in Slovakia covers two branches: In the north, it runs from the border with the Czech Republic via Prešov and Košice to the Ukrainian border in the east. Further south, Slovakia provides a short connection between Austria and Hungary in the area of Bratislava. The Corridor alignment consists of railway lines, inland waterways (Danube, Vah) and a road network, as well as an airport, two inland ports and 4 rail-road terminals.

The overall KPIs-status of the rail sections is relatively high, with the exception of a possible train length of 740 m and the introduction of ERTMS, both of which have not yet been achieved on the entire network.

Very slow progress has been made on the Slovak road network, where almost half of the roads are still not classified as motorways (northern branch). This causes capacity issues on the long road sections, and moreover, construction works on several motorways sections have been gradually delayed.

The inland waterways network covers 2 rivers: the Danube, which is fully compliant with the technical parameters and the river Váh, which in some parts does not fulfil the requirements on minimum height under bridges and minimum draught. Moreover, no RIS have been implemented for the whole length of the river Vah. Critical locations with regard to the minimum fairway depth occur regularly in the Štúrovo/Komárno area and in Devin.

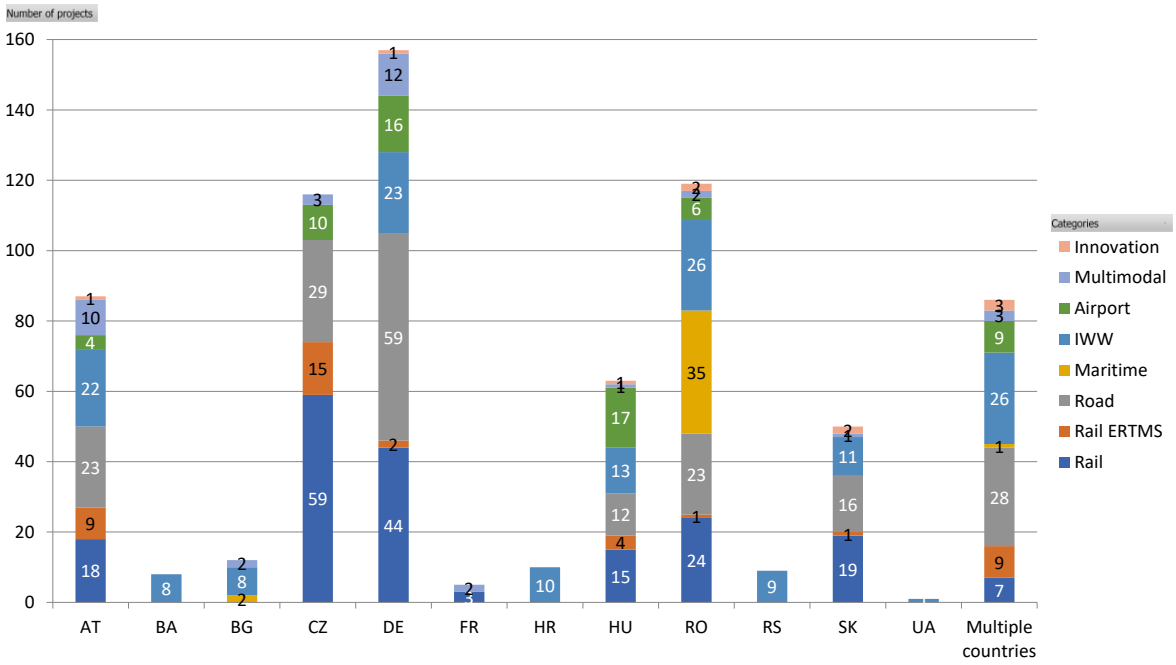
Only one (Žilina – Teplička) of 4 rail-road terminals on the Slovakian part of the RD Corridor is electrified and accessible for 740m trains. Neither of the other 3 terminals is compliant with the KPIs, and moreover no progress has been made to improve the parameters. Moreover, the airport Bratislava is not connected to rail.

3 Inventory of what has still to be realised by 2030

The RD project list is the central supporting tool for monitoring and coordinating the development of the Corridor and analysing the degree to which implementation is on track for meeting the 2030 milestone. Results presented herein refer to a project implementation status as of June 2021. The project list comprises 723 projects with total costs of € 107.3 bn. This figure represents "official" project costs that were verified and approved by Member States and stakeholders. For projects without official costs values, the consultant provided estimations, leading to additional costs of € 23.2 bn.

More than 30% of the projects (230) are assigned to project categories rail + rail ERTMS. The other categories are represented as follows: 190 road, 157 inland waterway, 62 airport, 38 maritime, 36 multimodal and 10 innovation projects. Regarding geographical allocation, most projects come from Germany (157), followed by Romania (119), Czech Republic (116), Austria (87), Hungary (63), Slovakia (50), Bulgaria (12) and Croatia (10). 86 projects are allocated to two or more countries, as shown in Figure 8.

Figure 8: Number of projects by country and category (project implementation status 06/2021), total = 723 projects



Source: Hacon analysis based on the 2021 updated project list, RD study team, 10/2021

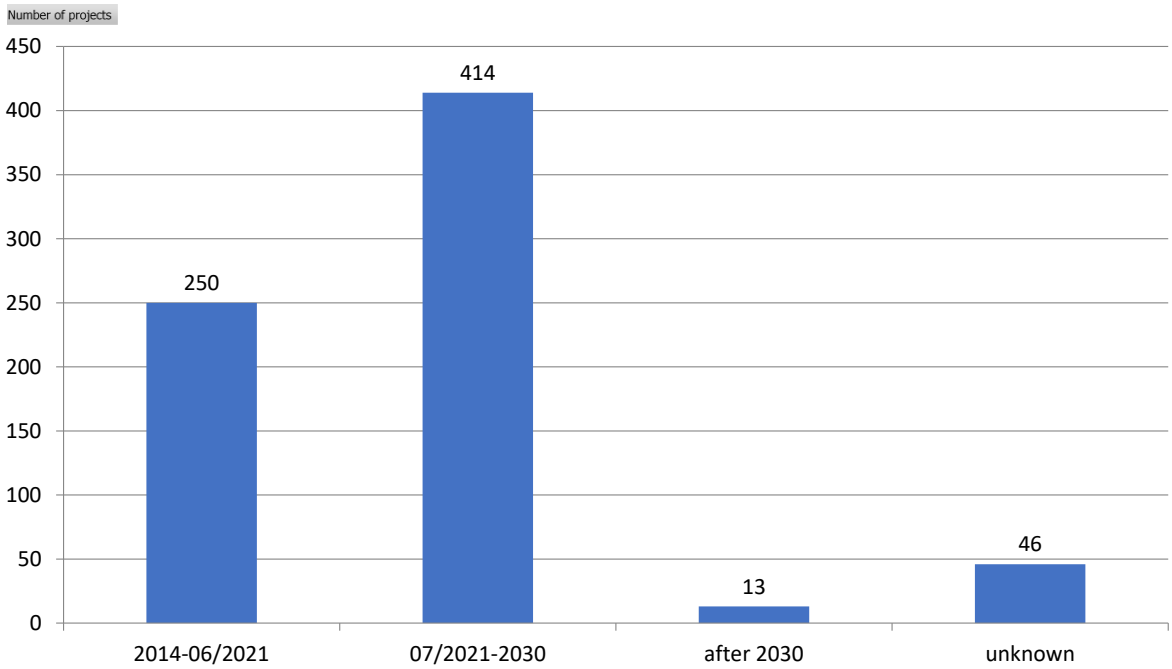
As Figure 9 depicts, nearly one third (250) of the projects have already been concluded by June 2021. These completed projects are still included in the analysis to document the progress made on the Core Network Corridor since the implementation of EU Regulations 1315/2013 and 1316/2013.

In the remaining time until 2030, 414 (57%) projects are planned to be finalised. 13 projects are scheduled to be completed after 2030, twelve more than in the previous Work Plan. This is in line with a tendency that became evident throughout the bi-annual monitoring: the finalisation of projects is increasingly shifted to a later date; this applies for postponements inside the "07/2021-2030" time cluster and also towards dates beyond 2030. As large-scale projects are particularly affected by these

delays, the financing and funding needs are being concentrated within an increasingly shorter period of time.

46 projects (= 6%) have no dedicated finalisation date. This missing information is either due to to actual uncertainty about end dates or due to lack of data. The overall trend is that the number of such projects is decreasing.

Figure 9: Number of projects on the RD Corridor by completion time cluster (project implementation status 06/2021), total = 723 projects



Source: Hacon analysis based on the 2021 updated project list, RD study team, 10/2021

The "official" ongoing and planned projects form the basis for the projected state of compliance for the Corridor in 2030.

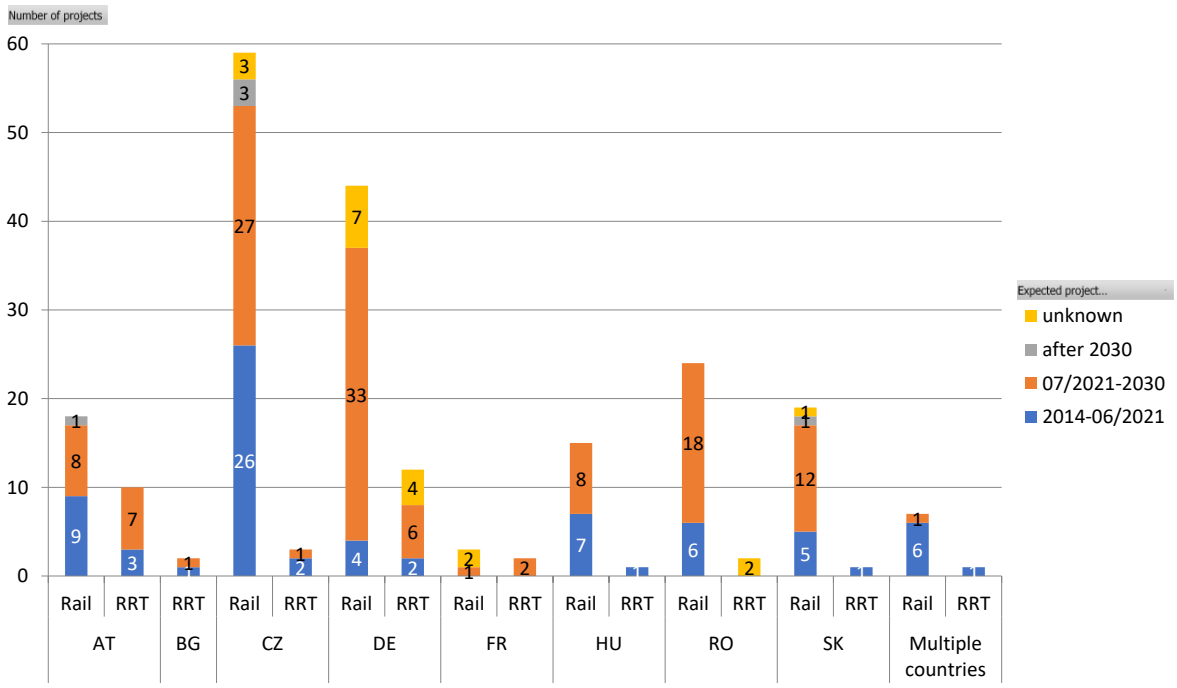
3.1 Rail & RRT

Current compliance levels for rail and RRT have been partly reached thanks to 63 rail[13] and 11 RRT[14] projects that were concluded between 2014 and June 2021 (see Figure 10). Yet, the majority of the 189 rail and 34 RRT actions included in the RD project list is still ongoing or has not even started. Most of these projects (108 rail + 17 RRT) are expected to be finalised by 2030. However, 5 rail projects will miss the 2030 deadline; these are the modernisation of rail infrastructure in the Bratislava and Ostrava nodes, the link between Wien airport and Bruck/Leitha as well as the upgrades of several sections in the Czech Republic. For another 13 rail and 6 RRT projects the finalisation date is unknown.

[13] This section provides main results on projects related to the category "rail". This excludes pure ERTMS projects, which are treated separately in section **Error! Reference source not found.**. However, some of the rail projects, especially large-scale upgrades and new constructions, often include ERMTS implementation too.

[14] RRT projects are a subset of project category „Multimodal".

Figure 10: Rail and RRT projects on the RD Corridor by country (total: 189 rail, 34 RRT; project implementation status 06/2021)



Source: Hacon analysis based on the 2021 updated project list, RD study team, 10/2021

About half of the projects are located in the Czech Republic and in Germany, other main contributing countries are Romania, Slovakia, Austria and Hungary. Eight projects are allocated to several countries; these are mostly pan-European studies or concern vehicle equipment (ERTMS on-board, silent brakes for freight wagons).

The "official" costs of the 189 rail projects sum up to € 69.0 bn. More than half of this total investment is allocated to 10 large-scale projects with each at least € 1.9 bn official costs: ABS/NBS Karlsruhe – Basel, "Stuttgart 21", Frankfurt/Main node upgrade, "Middle Rhine" railway Corridor, ABS/NBS Hanau – Nantenbach, NBS Wendlingen-Ulm, ABS Karlsruhe-Stuttgart-Nürnberg-Leipzig/Dresden, line upgrade Arad – Simeria, ABS München-Mühldorf-Freilassing and ABS/NBS Ulm – Augsburg. All these large-scale projects are yet to be finalised.

RRT projects amount in total € 0.75 bn (official costs). More than half of this total amount is allocated to the new construction of the Cargo Centre Wien South (AT) and for the upgrade of Linz terminal (AT).

Finally, for projects without official cost information, the consultants provided estimations, leading to additional costs of € 9.5 bn for rail projects and € 0.67 bn for RRT ones.

The future rail and RRT compliance with the Regulation requirements depends on the impacts of the ongoing and planned projects (126 rail and 23 RRT). Notably, not all of these projects contribute directly to the (infrastructure) TEN-T parameters, being either studies or targeting other parameters than those defined by KPIs, such as capacity enhancement, noise abatement, vehicle equipment, modernisation of infrastructure or market requirements (especially RRT projects).

Rail RD in 2030

Overall, the rail projects of the Rhine-Danube Corridor suggest significant progress on most Corridor sections by 2030; With respect to the KPIs, the ongoing and planned projects shall enable full compliance with regard to line speed, electrification and axle load as well as on other parameters (line capacity, single track sections, strong inclines) on the following long, connecting sections by 2030:

- "Stuttgart 21" + High-speed line Stuttgart – Ulm,
- München – Freilassing and continuation as high-speed line Salzburg – Wien ("Neue Westbahn"),
- Northern Romanian TEN-T core route Curtici – Arad - Predeal - Brasov-Sighisoara – Bucuresti and continuation via Bucuresti ring line to Giurgiu (RO/BG border)
- Nürnberg - DE/CZ border Cheb – Plzeň
- Žilina – Košice (Liptovský Mikuláš – Poprad-Tatry) and Váh – Strečno

With the exception of Stuttgart - Ulm, all these Corridor sections are also cross-border sections.

On the southern Romanian TEN-T core route Timişoara – Craiova – Bucuresti, several projects are foreseen, aiming at compliance with axle load, line speed, train length and intermodal profile. However, the maturity of these actions is low, and the financing is not secured, so that realisation by 2030 is doubtful.

With regard to the other TEN-T parameters, the rail project portfolio leads to the following expectations for 2030:

- Nearly all gaps of electrification shall be closed by 2030; the only exception is the line Timişoara - Stamora Moraviţa - border RO/RS.
- No improvement is required in terms of track gauge, as the entire Corridor is already compliant in this respect.
- Concerning line speed, the outlook is heterogenous: on the one hand the TEN-T requirements will be achieved in Budapest node and on the Romanian northern route. On the Romanian southern route, compliance might be achieved, if financing is secured. Moreover, the line Furth im Wald/Ceska Kubice (DE/CZ border) - Domažlice will become compliant. On the other hand, gaps will remain on most parts of Hranice na Moravě – border CZ/SK line and on the continuation to Púchov (SK). The same applies for lines Čierna nad Tisou - Cop (UA), Timişoara - Stamora Moraviţa - border RO/RS and sections in Bratislava region (Petržalka – Rajka and Bratislava – Petržalka).
- The axle load requirements could be achieved on almost the entire Corridor by 2030, if appropriate actions are taken in Hungary and the projects on the Romanian southern route are implemented as planned; however, this requires reliable financing and commitment. Under these preconditions, remaining sections with less than 22.5 t permitted axle load only remain between Strasbourg and the FR/DE border and on the line Timişoara - Stamora Moraviţa - Border RO/RS.
- Regarding permitted train length, the Romanian northern route (until Braşov) will be completed by 2030. Apart from this, the future development is unsecure: For the other non-compliant Romanian sections, projects are either not foreseen or not yet financed. The project for the sections Petržalka – Rajka

and Bratislava - Petržalka is scheduled after 2030. Projects are planned on the Žilina - Štrba - Poprad - Cop (UA) line as well as on single sections in CZ, but their financing has not yet been secured.

- Regarding intermodal gauge, the situation will look broadly the same as it does today. Only small sections in Germany and Romania (Brașov – Predeal) shall become compliant. For the remaining non-compliant sections, either no projects are planned, or their implementation is doubtful due to lack of financial commitment.

Rail-road terminals in 2030

The situation of rail-road Terminals (RRTs) on the RD Corridor shall be improved by new constructions and upgrading measures in existing terminals. New terminals are planned in the Czech Republic (Ostrava 2021) and in Romania (Timișoara and Craiova, both without specified finalisation date). With respect to the long-term or even unknown realisation timeline, the completion of most of these projects by 2030 is doubtful. The planned terminal München-Riem at a new location was postponed to "unknown" finalisation date.

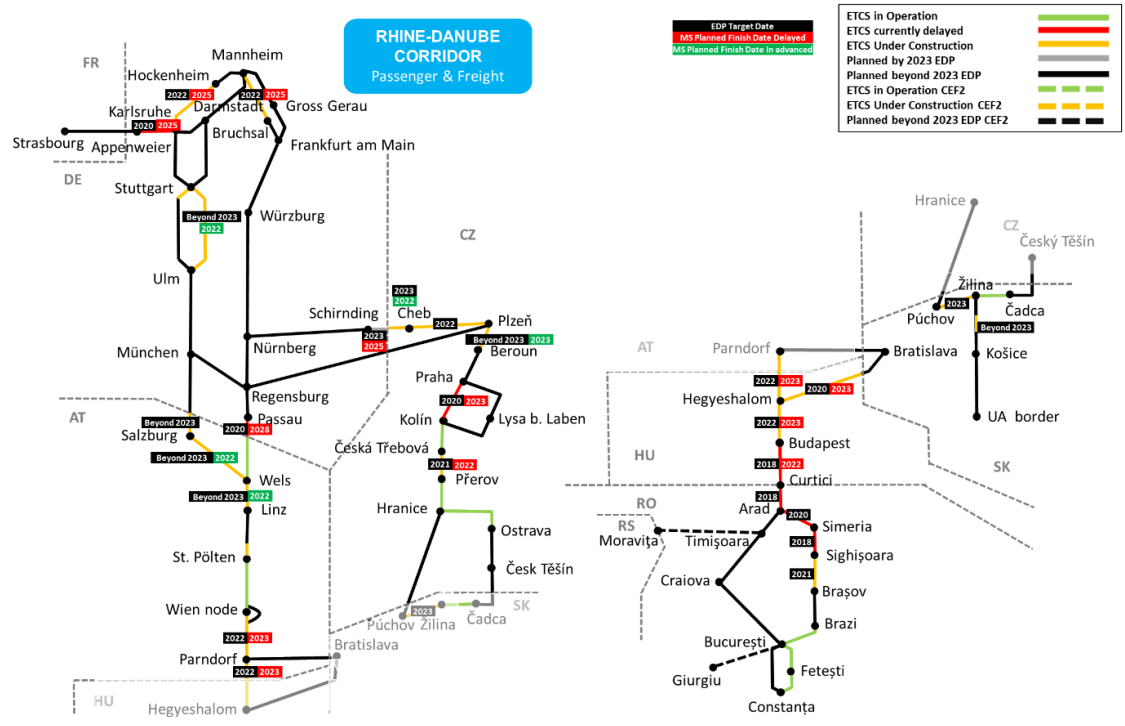
The Strasbourg-Sud terminal is expected to achieve compliance with market-driven KPIs over the next few years. The start of a preparatory study is planned for 2021; the works should then be completed by the end of 2025.

In addition, some upgrading measures are ongoing or planned, mostly to increase capacity. This is the case in Austria (Cargo Centre Wien South, Wels Vbf, Linz Stadthafen), and in Germany (Frankfurt/Main-Ost, Karlsruhe Rbf, Kornwestheim and München-Riem).

3.2 The ERTMS deployment 2023

The following scheme shows the state of play and deadlines for the ERTMS deployment in the RD Corridor, considering the dates of the EDP:

Figure 11: ETCS deployment program on the RD Corridor



Source: ERTMS DMT - DG MOVE, 2021

In France there is only one line included in the RD Corridor, from Strasbourg to the German border, whose commissioning is expected by 2025 according to the French plan.

No ETCS lines are yet in operation in Germany. Sections planned in the ERTMS EDP by 2023 will be delayed and their commissioning is expected by 2025 according to the German plan. Regarding German sections planned in the EDP beyond 2023, and although the entire German network is planned to be equipped by 2035, there are no specific deadlines for the RD sections in the German plan.

In the Czech Republic, some lines in the RD Corridor are in operation. The Czech sections planned in the ERTMS EDP by 2020 and 2021 will be delayed until 2023 and 2022, respectively. Commissioning of the Czech section in the border area between the Czech Republic and Germany is planned by 2022. According to the Czech plan, all RD sections should be in operation by 2030.

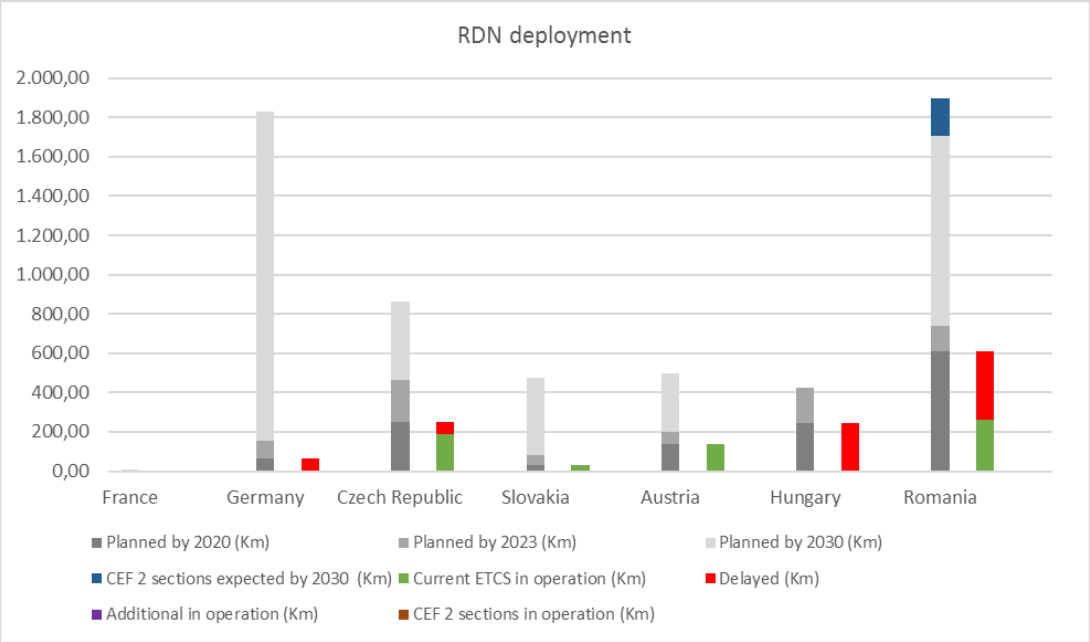
The lines currently in operation in Austria had already been commissioned when the ERTMS EDP was published in 2017. The Austria sections planned in the ERTMS EDP by 2022 will be delayed until 2023. All remaining Austrian sections are planned by 2030 both in the ERTMS EDP and in the Austrian plan.

The line currently in operation in Slovakia had already been commissioned when the ERTMS EDP was published in 2017. The Slovak deployment plan is in line with ERTMS EDP. Therefore, all RD sections will be commissioned by 2030.

In Hungary there are currently no lines in operation, according to the Hungarian plan, all RD sections are planned to be in operation by 2023.

In Romania some lines are currently equipped with ETCS on the RD Corridor. According to the Romanian plan, most lines will be in operation by 2030. However, lines from Timișoara to the Serbian border (Moravița), from Caransebeș (located between Timișoara and Craiova) to București, and the planned high-speed line between București and Constanța are not included in the Romanian plan by 2030.

Figure 12: RD ETCS deployment per Member State



Source: ERTMS DMT - DG MOVE, 2021

3.3 IWW & inland ports including RIS Deployment Plan

78 inland waterway and port projects are ongoing or planned with a completion date from 2022 or later with total costs of € 1.9 bn. For 18 of these projects the finalisation date is still unknown, and no cost information is available for about half of the projects (39).

In summary, the planned projects are expected to increase draught at the Upper Main (Germany) and will contribute to the provision of targeted fairway depths between Wien and Bratislava (Austria/Slovakia). Most critical is the section between Straubing and Vilshofen (ca. 80 km), where a decision to increase the draught to 1.80m (+ 20 cm) was taken (but which is below the requirement of 2.50 m). The so-called *Variant A* (river control measures) aims to increase the number of days per year with an effective draught of 2.50 m by 56 days to 200 days/year. The works for the first part of the section (Straubing – Deggendorf) started in July 2020. For the second part (Deggendorf – Vilshofen) the planning approval procedures are still ongoing.

Several projects aiming at improving the fairway depth in Romania are planned to be completed in 2023 (Călărași – Braila; bank protection on Sulina Channel) as well as the upgrade of the Gabčíkovo locks in Slovakia (end date: 2022).

The deployment of an integrated port information system (RSOE4) in Hungary is scheduled for the end of 2022.

Activities related to the upgrade of the CEMT classification of the Sava are planned but the timing and financing is still unclear, therefore the completion is considered to be at

risk. Intentions to increase the bridge clearance are missing for all of the bridges not complying with regulation 1315/2013.

Started in 2020, the CEF-funded action "FAIRway works", aims to address several bottleneckshindering navigation along the Serbian and Austrian sections of the Danube. Preparations for "FAIRway 2 works", a cooperation between AT, HR and RS, were started in 2020, aiming at accelerating the future works along the Danube and the Sava.

A revision/update of the previously approved feasibility study for the București-Danube channel is planned for 2022.

In terms of port infrastructure, the provision of clean fuel facilities is planned in the port of Enns (2030) and Bratislava (2023). 29 further projects in Danube ports are planned to be completed by 2030.

3.4 Road transport (including ITS, AF deployment)

143 road projects are being currently implemented or are planned to start, out of which 62 refer to the RD Corridor only and the rest are common to the RD and one or more other Corridors. The predominant part of the RD-only projects (84%) involve construction and/or reconstruction of road infrastructure, while 8 projects relate to the deployment of ITS (one in Austria and the rest in Germany), one to the construction of a safe and secure truck parking area (SSTPA) and one project is only a study.

Given the relatively high level of compliance with the motorway/express roads requirement and the projects already identified to address related non-compliant sections, the level of compliance is expected to reach 94% by 2030.

The following sections with a total length of 122 km are expected to be non-compliant by 2030, as no specific works projects have been identified to address the shortcomings:

- Germany: Border section FR/DE Neuried- Offenburg (10.7 km)
- Hungary: Northwest part of Budapest ring road (31.3 km)
- Romania: Alexandria – București (80 km) and new section Timișoara – Moravița (78 km)

In addition, some 136 km of roads are planned to be brought to compliance after 2030:

- Czech Republic: From Lipa to the border with Slovakia (36 km) to be completed in 2032
- Slovakia: Two sections are scheduled for completion by 2032/2033:
  - Border section with Czech Republic to Púchov (26 km)
  - From Bidovce to the border with Ukraine (74 km)

It is important to point out, that there are a number of projects whose timely completion is in doubt, although they are scheduled to be completed by 2030. But either the source of funding for the project has not yet been identified/approved or delays in the implementation are expected. These sections, with a total length of about 420 km, are the following:

- Czech Republic: First part of Kroměříž - Strelna border CZ/SK section (22 km)

- Romania:
  - Lugoj – Drobeta-Turnu Severin (165 km) and Drobeta-Turnu Severin – Maglavit (79 km), which is a common section of RD and OEM
  - Northern bypass of București [15]
  - Craiova – Alexandria (138 km)

Considering the above mentioned doubts, the expected compliance in terms of motorway/express road criterion would be about 91%.

The provision of alternative fuels is a dynamic commercial process, expected to further expand and evolve in the future by providing more different types of fuel. Thus, and considering the currently high level of provision of (at least one type of) clean fuels along the Corridor, it is expected that full compliance will be reached by 2030.

With regard to the availability of SSTPA, four projects are being implemented aiming to improve the conditions for truck drivers. The interventions are located in Germany (one project for improving 39 truck parking areas) and in Austria (two projects for one SSTPA each). The provision of safe and secure parking areas for freight vehicles in the eastern part of the Corridor is lagging behind, there is only one such project under way in Romania. In order the boost the process, this issue requires attention of all relevant stakeholders.

3.5 Airports

62 airport projects for modernisation, construction and extension works as well as technological improvements are included in the Corridor list with total investment costs of more than 4.3 € bn. The majority of the investments relates to infrastructure upgrades for passenger transport and operations. New rail connections or improvements are planned for Frankfurt, Stuttgart, București Mošnov, München, Praha and Budapest airports. However, the airports of Praha (Václav Havel International) and Budapest (Ferenc Liszt International) shall be connected to heavy rail by 2050. The connection of Praha airport to the core railway network is planned to be completed by 2029. A connection of the railway line Budapest-Arad to the multi-modal hub at Budapest Airport for freight trains is ongoing, passenger connection is currently only subject of a study.

One initiative has been identified at this stage for the promotion of alternative clean fuels, which is the 'Sustainable airport area - CO2 neutral airport' implemented at Wien aiming at fulfilling the requirements and standards of the 'ACAS - Airport Carbon Accreditation' and 'EMAS Eco Management Systems'

Finally, initiatives are currently ongoing and planned for airports in Austria, Czech Republic, Germany, Hungary and Romania as part of the ongoing Single European Sky Air Traffic Management Research and Development (SESAR) project[16], representing the technological pillar of the Single European Sky.

[15] *Exact length is not available*

[16] *https://www.sesarju.eu/index.php/node/3772*

3.6 Maritime Ports on the RD CNC

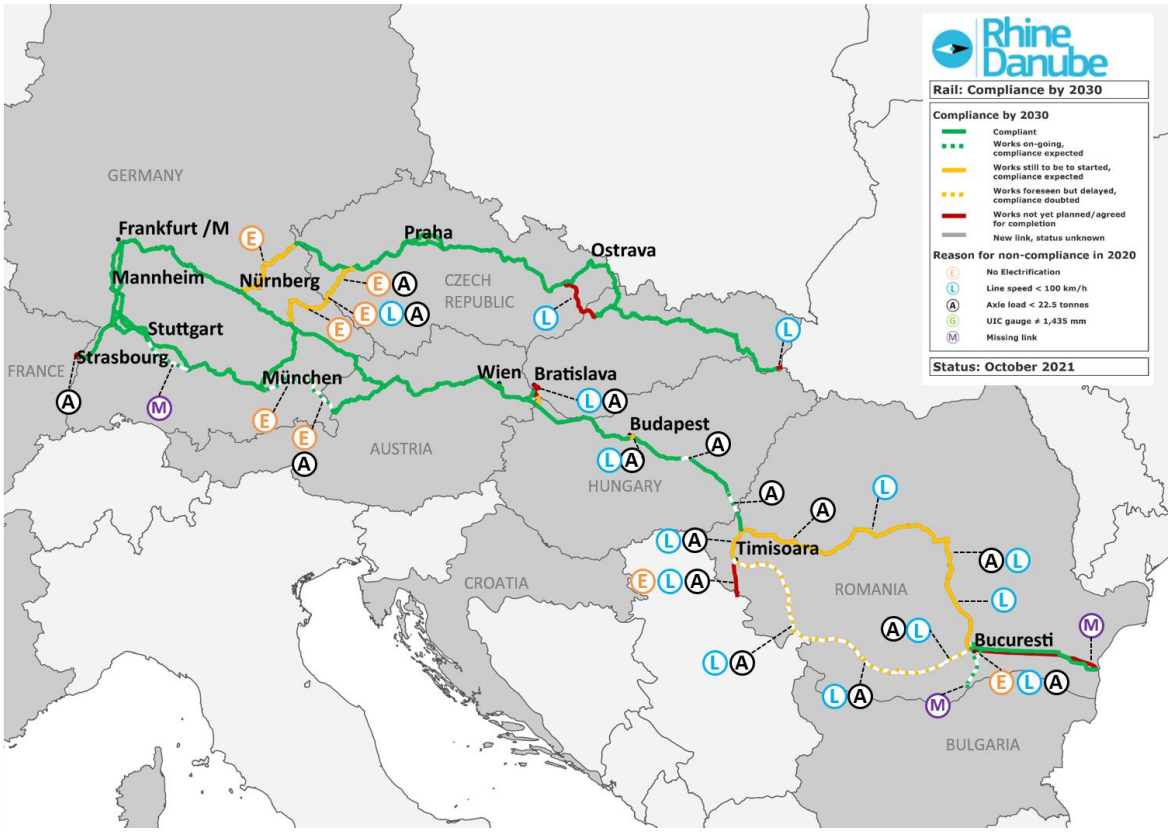
In the only maritime port of the RD Corridor Constanta, there are 28 projects ongoing or planned with completion dates by 2030. These include the KPI-relevant actions of a LNG bunkering station and facilities for ship generated waste, as well as other upgrades of the port infrastructure.

3.7 Overview of Major persisting bottlenecks and missing links

Despite the lengthy portfolio of ongoing and planned infrastructure projects along the RD Corridor, one can still identify persisting bottlenecks and missing links related to projects that are currently not on the agenda of the MS or stakeholders, projects that will not be completed by 2030 and/or projects that are subject to significant delays. With a dedicated view on the year 2030, therefore, a short overview of the identified gaps is provided together with a proposal for additional projects required for technical compliance. The latter is made by the consultant, without prejudice to Article 1(4) of the TEN-T Regulation.

Railway network bottlenecks

Figure 13: Overview of RD rail compliance by 2030



Source: Panteia, RD Study team, 2021

Remaining compliance gaps for the railway network are related to:

- France:
  - Strasbourg – FR/DE border; axle load, intermodal gauge (no project)
- Czech Republic:
  - Hranice na Moravě – CZ/SK border: line speed (except Hustopeče nad Bečvou - Valašské Meziříčí), intermodal gauge (no project)
  - Kolín – Pardubice: intermodal gauge (no project)
  - Entire Corridor network: train length (on single sections, projects are foreseen; financing mostly not secured)
- Romania:
  - Curtici - Arad - Sighișoara – Braşov: intermodal gauge (no project)
  - Brașov – Predeal - Bucureşti: train length (no project)
  - Predeal - Bucureşti - Feteşti – Constanţa: intermodal gauge (no project)
  - Timişoara - Stamora Moraviţa - Border RO/RS: all KPIs (no project)
  - Southern Romanian TEN-T core route Arad – Craiova – Bucureşti: axle load, line speed, train length, intermodal gauge: several projects are foreseen; however, maturity of these actions is low, financing not secured; therefore, the realisation until 2030 is doubtful
  - The high-speed line București – Constanţa will remain a "missing link", as currently no project is foreseen to realise this new line before 2030
- Slovakia:
  - Bratislava – Petržalka and Petržalka – Rajka (HU): line speed (no project), train length (project scheduled after 2030)
  - Entire Corridor network: train length (on most parts in SK, projects are foreseen; financing mostly not secured)
  - Čierna nad Tisou – Cop (UA): line speed (no project)
- CZ/SK border section:
  - Horní Lideč / Lysá pod Makytou – Púchov: line speed (no project)

In addition to the above KPI related issues, operational bottlenecks due to missing capacity deserve special attention. In this respect, Germany is particularly affected. In this respect, Germany is particularly concerned. The "*Infrastrukturzustands- und -entwicklungsbericht 2020*" (report on infrastructure condition and development) by *DB Netze* points out severe capacity constraints (today and in the next years) for the following Corridor sections:

- Würzburg – Fürth
- Mannheim-Waldhof – Zeppelinheim
- Frankfurt (Main) node
- München node

Moreover, single track lines, which currently show no capacity problems with mostly regional traffic, might become severe bottlenecks with the predicted (long-haul) increase of traffic by 2030. In this respect, the following line sections should be monitored in particular:

- Germany: Marktredwitz – border DE/CZ, Regensburg - DE/CZ border, Mühldorf - Freilassing
- Czech Republic: DE/CZ border – Plzeň (both lines from Nürnberg and Regensburg)
- Slovakia: Border-crossing sections between Bratislava and Austria/ Hungary
- Hungary: Békéscsaba – Lőkösháza

In conclusion, in order to ensure that the above remaining bottlenecks for the railway sector are addressed and in turn alleviated, the consultants consider that 31 additional rail projects (not including ERTMS) have to be put forward. Half of them (17) address the parameter "train length", 11 "line speed", 7 "axle load" and 4 "electrification". 12 additional projects aim at achieving P70/400 intermodal gauge on the lines. This KPI is not explicitly required by the TEN-T Regulation, but from the consultant's point of view deemed necessary to improve competitiveness of intermodal transport. In total, € 8.2 bn are roughly estimated as additional costs tom implement these 31 measures.

RRT bottlenecks

With regard to the RRTs, shortcomings range from missing electrification, one-side connection to the main line or short usable length of transhipment tracks. Nevertheless, the biggest bottleneck is related to the poor prospect for developing a modern and robust network of freight terminals that facilitate transhipment and multimodal transport in the eastern part of the Corridor.

Next to rail, another 32 additional projects with totally € 130 mn estimated costs have been proposed for RRTS. This means that about three quarters of the core node terminals on the RD Corridor are in need of actions to be compliant with the three market-driven KPIs "intermodal loading units", "740 m train accessibility" and "electrified train accessibility."

Inland waterway network bottlenecks

Apart from the technical parameters set in the TEN-T Regulation, navigation reliability (or *Good Navigation Status*) is the decisive parameter for IWW. In the current TEN-T regulation *Good Navigation Status* lacks a clear and measurable definition. Therefore, the new Regulation shall stipulate parameters for both *Minimum Requirements* (MR) and *Good Navigation Status* (GNS). The foreseen parameters for GNS comprise:

- Navigable channel depth for free flowing or impounded rivers or respectively/ draught for canals
- Bridge height
- Lock or movable bridge availability

The target values for the GNS parameters shall consider the hydro-morphological characteristics of free flowing and impounded rivers and shall be agreed upon in the Corridors or where applicable in the international cooperation mechanisms such as

river commissions or other established structures of bi-/multilateral cooperation following procedures which could be stipulated in guidelines.

Based on the monitoring of critical locations on the Danube[17] in terms of fairway depth and ongoing actions, it is expected that a *Good Navigation Status* is only partially reached throughout the Corridor. To make inland waterways competitive with other modes of transport, but also more resilient with respect to the climate change, it is of utmost importance to strengthen measures that increase the reliability.

Within the current financial perspective, a number of actions have been funded through CEF along the main cross-border sections in Hungary, Croatia, Slovakia, Bulgaria and Romania. These Actions aimed in particular to ensure that all environmental permits have been acquired to start the works for the upgrade after 2022. Therefore, numerous works projects or studies along these cross-border sections are foreseen from the start of CEF II.

Intentions to increase the bridge clearance are missing for all of the bridges not complying with the Regulation. Two of the bridges (Alte Mainbrücke, Würzburg; rail bridge Bogen, rkm 2311.27) can represent a particular challenge for the navigation of passenger vessels and would also represent an obstacle if container transport on the Danube develops. However, it has to be noted that the 12th century Alte Mainbrücke in Würzburg is a landmark of the city. Therefore, possibly this issue cannot be solved due to the particular historic value.

Another key element for inland waterways to be more and more a real alternative to other transport modes is the removal of administrative barriers and improve institutional capacities to tackle major societal changes. The barriers and procedures that most affect inland waterway transport, were identified in the Danube Transnational Programme (DTP) Interreg project DANTE[18].

The work carried out in the framework of the EU Strategy for the Danube Region (Priority Areas 1a on Inland Waterways and 11 on Security) meanwhile resulted in practical solutions for simplified and harmonised border-crossing procedures along the Danube waterway. The synchronised application of a first set of so-called Danube Navigation Standard Forms (DAVID) was started in spring 2020 with their introduction in Hungary, Croatia and Serbia.

A key element in removing future bottlenecks will be the development the digitalisation of the IWW sector. This is one of the keys to improving the efficiency and reliability of shipping and traffic management, better integrating inland navigation into logistics processes and multimodal chains, and reducing administrative barriers and costs of regulatory compliance.

The main objectives regard to increased institutional capacity in Danube navigation by boosting joint transnational competences and skills in education and public development services were identified in the DTP Interreg project Danube SKILLS[19]

Another aspect on which IWW have to focus on in the future is a fleet modernisation, especially the Danube fleet. The fleet modernisation aims to achieve a higher

[17] *see reports on* National Action Plans: *http://www.fairwaydanube.eu/docategory/project-files*

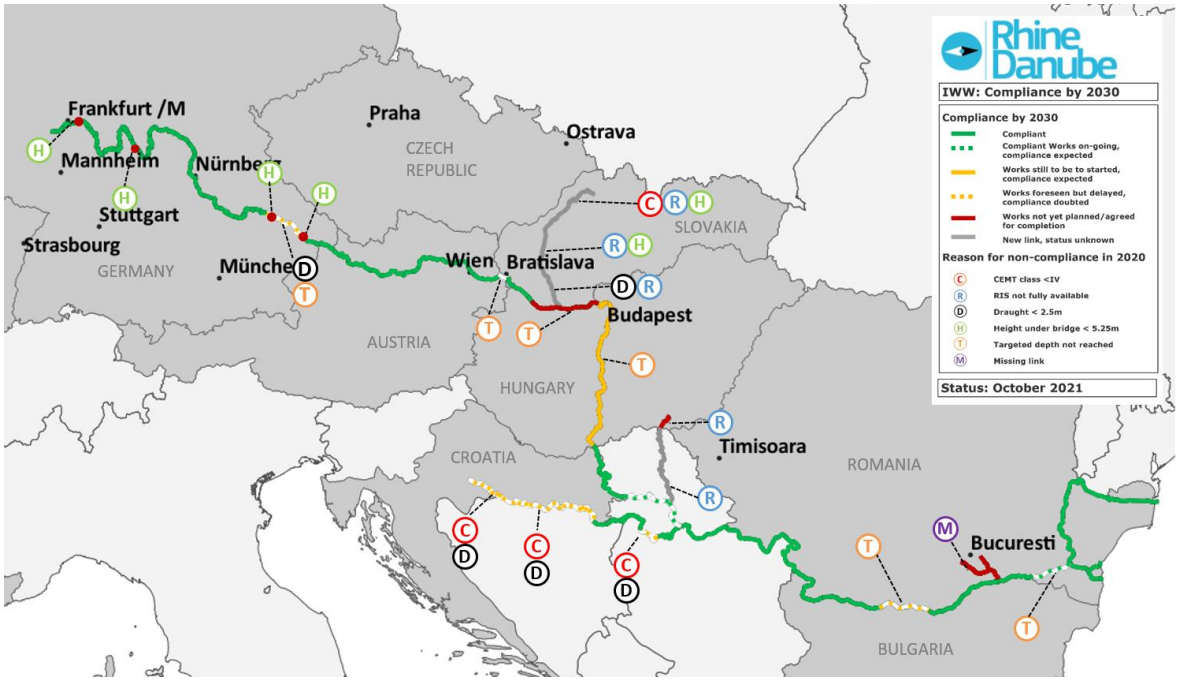
[18] *http://www.interreg-danube.eu/approved-projects/dante*

[19] http://www.interreg-danube.eu/approved-projects/danube-skills

acceptance and use of inland waterway transport as an environmentally friendly transport mode contributing to economic growth and a more sustainable transport system in the Europe. In order to meet the goals of the *European Green Deal* and the *Sustainable and Smart Mobility Strategy* a key focus lies on the transition towards zero emission vessels.

Last but not least, a specific consideration must be addressed on the role that the far-eastern part of the Danube can play to support Ukrainian exports / imports that are heavily affected by the loss of important Black sea / Azov sea ports. While Ukraine can only rely on few Black sea ports for a restricted type of trade – mainly for grain export – the Danube offers a secure route that proved to be an efficient alternative to these seaports. Investments but also new navigation management methods are nevertheless needed in particular in the area leading to the Sulina canal.

Figure 14: Overview of IWW compliance by 2030



Source: Panteia, RD study team, 2021

Port bottlenecks

Lack of functional railway connections are key bottlenecks for the port development. Such railway connections are currently missing in the Hungarian port of Komarom and Romanian port of Cernavoda. In addition, the lack of alternative fuels supply facilities in all but one port is a situation that needs to be tackled in the future project pipelines.

With regard to clean fuels, inland ports do not have facilities for alternative fuels supply at the moment, but the port of Budapest plans an LNG bunker station and the port of Bratislava plans to complete similar facility in 2025. Completion of LNG bunkering station for vessels in the port of Enns is planned for 2030.

Road network bottlenecks

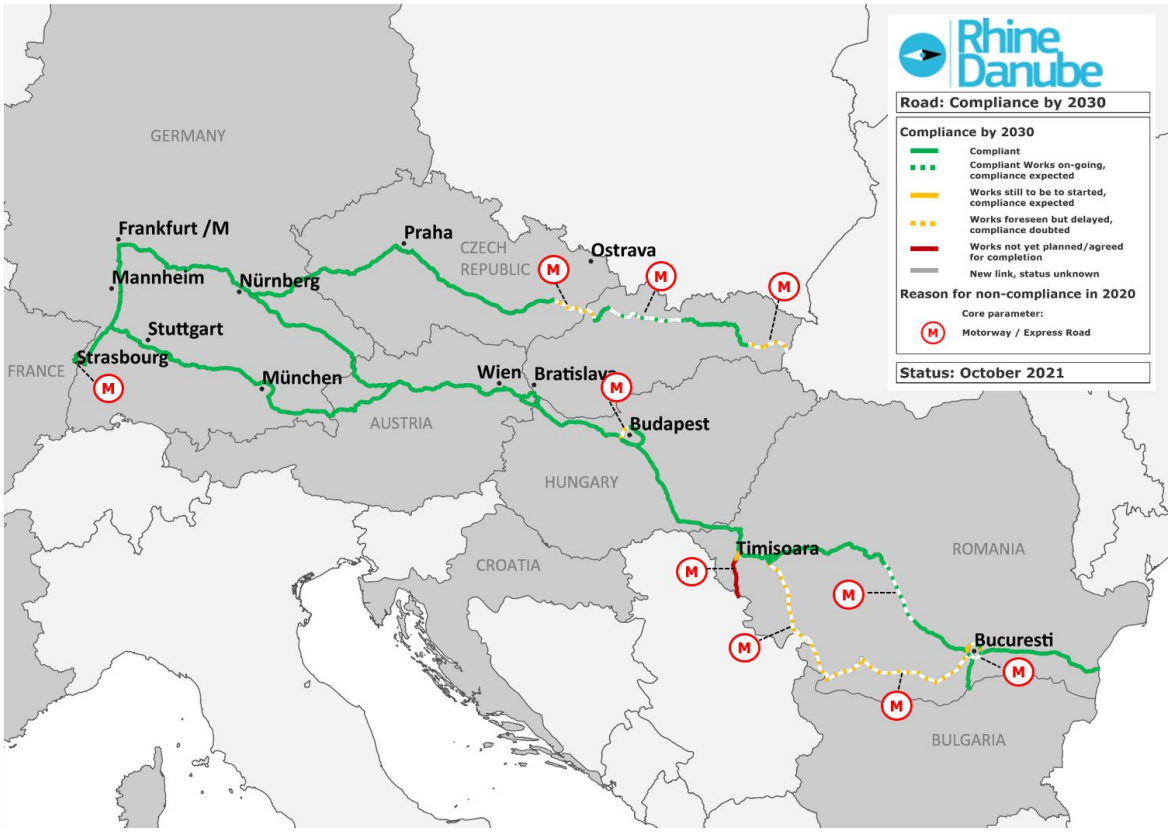
Based on the analysis of the current infrastructure and projects planned for finalisation by 2030 the following additional projects are necessary to achieve compliance with the technical requirements for motorway/express road:

- FR/DE border: Upgrade of existing border section (10.7 km), incl. a bridge over the Rhine at Neuried – Offenburg
- Hungary: Construction of two sections of Budapest ring road (north-west, west: 31.3 km)
- Romania:
  - Upgrade of section between Timişoara and Moraviţa (RO/RS - 61.6 km)
  - Upgrade of existing road section between Alexandria – București (80.4 km)

As already mentioned in chapter 3.4, there are a number of projects whose timely completion is questionable because either the funding source has not been identified or has not yet been approved. The following projects are affected:

- Czech Republic: First part of Kroměříž - Strelna border CZ/SK section (22 km)
- Romania:
  - Lugoj – Drobeta-Turnu Severin (165 km) and Drobeta-Turnu Severin – Maglavit (79 km) - common section of RD and OEM
  - Northern bypass of București
  - Craiova – Alexandria (138 km)

Figure 15: Overview of road compliance by 2030



Source: Panteia, RD study team, 2021

The provision of alternative fuels for trucks remains to this day unsatisfactory, particularly when compared to the respective advancements being made for private users. The provision of SSTPA lags also behind, especially in the eastern part of the Corridor. Finally, present times call for promoting the deployment of digital and smart solutions, i.e.: intelligent transport systems and cross-border interoperable truck

tolling systems, which should increase the efficiency of road infrastructure use, improve safety and contribute in general to the SSMS objectives.

Airports bottlenecks

The main issue likely to remain unresolved by 2030 is the availability of alternative fuels for aircrafts. In the meantime, some airports have started introducing alternative fuels into their ground services fleets. A study for a rail connection of Budapest airport for passenger transport is ongoing; works are not yet scheduled.

Administrative and operational bottlenecks

As already mentioned in the chapter on the compliance status, administrative barriers are a major obstacle for **inland waterways**. Main challenges in this regard are an unjustifiably high number of authorities involved as well as documents, the majority of which not being standardised and with overlapping information and non-transparent and inconsistent charging policies among Danube countries. Other bottlenecks are the limited use of RIS, the lack of AIS (vessel tracking system) enforcement, the lack of digitalisation and electronic documentation, lack of accepted working languages, shortage of qualified personnel, and lack of transparency in the work of relevant authorities and the unnecessary repetition of the various controls and checks. Therefore, an improvement of the different technological applications together with harmonisation of the complicated administrative procedures would lead to reduced travel times and increase the general attractiveness of IWW.

Different charging practices between Member States are also affecting the smooth transport. Due to different port administration models applied in various Member States, some ports are charging their infrastructure fees based on the load a vessel is loading/unloading, while some ports are charging the same fees based on the vessel capacity, vessel length, sometimes including the time component in the fee calculation. It has been noted that the various charging systems sometimes cause confusion and losses in profits of ship operators and/or shippers/receivers of cargos. This is sometimes due to insufficient information on port charges needed for various freight and voyage calculations (freight rates, operating costs, etc.).

Furthermore, the lack of coordination for putting up projects involving multiple authorities leads to problems: in some Member States, infrastructure managers identified difficulties in preparing/defining projects that need to involve different authorities within a port area (e.g. port authorities and rail authorities managing intraport railways) and beyond a port area. The latter refers to situations when, for example, upgrading a railway link is of lower importance for railway authorities, but it is of high importance for a port.

With regards to the **rail sector**, long waiting times at border-crossings often hamper a smooth transit. Following the *Guidelines to the Core Network Corridor Consultants for the Special KPI on Commercial delivery times***,** the progress of over 1,000 trains running on a regular annual basis on more than 15 train routes along the RD and OEM Corridor combined was analysed.

Data was received from a number of six independent European railway undertakings (RUs), albeit with certain difficulties:

- Data collection methodology and quality is very different across the RUs

- It is difficult to install a consistent monitoring system, as data availability varies considerably (different routes might be used by RUs, routes are discontinued do to factories closing, RUs are changing, etc.)
- RUs often change at borders, thus it is near impossible to receive continuous train data
- Border dwelling times are not reported by RUs

Despite the above, the analysis yielded the following conclusions:

- Planned and actual commercial speed varies widely among different routes and countries
- Commercial speed of freight trains is affected by passenger trains traffic– fewer passenger trains lead to higher commercial speeds for freight trains (e.g.: during night hours or due to COVID-19)
- The Western part of the Corridor depicted reasonable and constant commercial delivery times (50 km/h)
- The opposite is true for the eastern part, where existing trains run through Romania on a very low commercial speed of approx. 15 km/h

Concluding with the **road** sector, certain ITS projects (i.e. CROCODILE) have been successfully carried out. Nevertheless, road tolling systems for trucks and passenger cars remain fragmentized and heterogeneous in terms of charging rules across Member States. At EU level, progress has been made with regard to setting standards for safe and secure parking areas. The progress of establishing and certifying such areas along the Corridor remains however slow; to present, there is still only one such facility in Romania.

4 The deployment plans of MoS, alternative fuels and development of urban nodes

4.1 Deployment plan of Motorways of the Sea (MoS)[20]

Maritime transport plays a key role for the European economy, transporting about 75% of its external trade and approximately 31% of its internal trade. Specifically, short sea shipping (SSS) makes up a majority (up to 60%) of the total maritime transport of goods to and from the main EU ports. With its large network of maritime ports on the TEN-T, the European maritime sector forms an important part of the intra-European transport system. The Motorways of the Sea (MoS) programme is a key instrument in this setting, working towards the ultimate vision of a European Maritime Space (EMS) that is **sustainable, seamless, smart and resilient**.

In the Detailed Implementation Plan (DIP) for MoS, the aim is to provide a sound analysis of priority investment needs to achieve the EMS, centred around four thematic pillars:

1. **Sustainable**: Emphasising on the reduction of GHG emissions and pollution of air, noise and water
2. **Seamless**: enhancing the connectivity with the rest of the TEN-T (the CNCs in particular), other transport modes, peripheral and outermost regions, islands and European neighbourhood countries
3. **Smart**: aligning maritime transport with the European digital agenda
4. **Resilient**: ensuring the EMS is capable of facing exogenous shocks

Maritime ports and their hinterland connections play a key role in achieving these goals. The port infrastructure and the hinterland connections must facilitate the transfer of the European economies to non-fossil fuels, providing appropriate handling and alternative fuels terminals, storage and hinterland infrastructure. Given that the future demand of new fuels is not yet known, investment plans need to be flexible and react quickly with regard to a developing demand and supply.

Due to its relatively high energy efficiency, maritime transport can also play an important role in reducing the climate impact of transport. Especially on long coastal routes, maritime transport should be considered as a serious alternative to road transport. Such coastal services with a reduced carbon footprint should be developed in cooperation with shippers and forwarders.

Ports and port communities are also natural digital hubs, exchanging data with seaborne and land-based transport from all parties involved in the transport chain. Simplifying procedures, harmonised data flows and a common approach to deploy interoperable ICT systems will further facilitate the use of maritime transport.

Finally, the resilience of maritime transport chains requires the cooperation of ship operators, ports and forwarders. Exogenous shocks such as extreme weather events may lead to a temporary breakdown of ports or parts of the hinterland transport chain. To address such possible shocks, alternative shipping routes should be

[20] *https://transport.ec.europa.eu/transport-themes/infrastructure-and-investment/trans-european-transport-network-ten-t/motorways-sea_en*

identified for relevant transport flows. Such alternative shipping routes may involve stakeholders along the TEN-T Core Network Corridors with core and comprehensive network ports.

4.2 Plans for the deployment of alternative fuels infrastructure

The European climate law requires the Union to reduce its net greenhouse gas emission by at least 55% in 2030. Such emission reduction will require a significant contribution from the transport sector. There is now considerable momentum as regards the market uptake of zero- and low-emission vehicles in the EU. However, in order to facilitate transition to a mass market and develop a truly common EU transport market, full connectivity and a seamless user experience along the European transport network for low- and zero-emission vehicles, vessels and aircraft are needed. The TEN-T network has to provide the backbone of this endeavour.

The Commission report on the application of Directive 2014/94/EU of the European Parliament and of the Council on the deployment of alternative fuels infrastructure provides a comprehensive assessment of the state of play of alternative fuels infrastructure rollout in the EU[21]. It shows that market maturity varies considerably, depending on the mode of transport. Although some Member States have raised their ambition, the EU still lacks a comprehensive and complete network coverage of easy-to-use alternative fuels infrastructure, for all modes of transport. The European Court of Auditors has also stressed the significant differences between Member States in deploying charging infrastructure.[22]

This evident difference in both target setting and deployment of alternative fuels infrastructure among Member States is attributed to the lack of a clear, well-defined and binding methodology for them to calculate targets and adopt related measures. The latter was not provided by the Directive 2014/94/EU, while no other obligations were stipulated under CEF1 or TEN-T Regulations.

The Commission is proposing a new Regulation on the deployment of alternative fuels infrastructure, and repealing Directive 2014/94/EU. Being part of the 'Fit for 55' Package of 14 July 2021, the proposal seeks to provide for a dense, widespread network of publicly accessible alternative fuels infrastructure in the EU.

The proposal for a new Regulation sets forth binding requirements for rollout of an infrastructure with a sufficient amount of minimum recharging and refuelling capacity to ensure full cross-border connectivity of light and heavy-duty vehicles throughout the EU. Distance-based targets for fast-recharging infrastructure along the TEN-T network complement national fleet-based targets for recharging light-duty electric vehicles. A combined approach of distance-based targets along the TEN-T network with targets for overnight recharging infrastructure for trucks in safe and secure parking places and targets at urban nodes should further support the electrification of heavy-duty vehicles.

Distance-based targets for deployment of hydrogen refuelling stations, including for each urban node, will also ensure necessary minimum refuelling infrastructure for light- and heavy-duty fuel cell hydrogen vehicles.

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[21] *COM (2021) 103 final*

[22] *Special Report 05/2021: Infrastructure for charging electric vehicles: more charging stations but uneven deployment makes travel across the EU complicated (europa.eu)*

Following the provisions of the proposal for a regulation on alternative fuels infrastructure, shore-side electricity supply should be provided in maritime and inland waterway ports. In addition, an appropriate number of refuelling points for LNG should be put in place at maritime ports and on the road network of the TEN-T core and comprehensive network. Finally, stationary aircraft at airports and commercial transport operation should be able to make use of external electricity supply while parked at gates or at outfield positions at TEN-T airports.

The upcoming proposal for the revision of the TEN-T Guidelines will provide per transport mode cross-references to the Regulation on the deployment of alternative fuels infrastructure and additionally address aspects of private recharging and refuelling infrastructure in certain cases such as freight terminals. Private recharging infrastructure is also likely to be addressed in the upcoming proposal for the revision of the Energy Efficiency of Buildings Directive.

The importance of this issue is also expressed through the Alternative Fuels Infrastructure Facility (AFIF) under CEF 2 with a total budget of € 1.5 bln. The objective of the AFIF call for proposal is to support the deployment of alternative fuel supply infrastructure, contributing to decarbonising transport along the TEN-T network. It will be implemented through a rolling call for proposals launched on 16 September 2021, with five cut-off dates for the submission of proposals until end 2023.

4.3 The development of Urban Nodes by 2030

Urban nodes represent most of the points of origin and destination of transport flows on the Corridors. The effectiveness of the Corridors is therefore impacted by the effectiveness of the first and last miles of the journeys in those urban nodes and it is important to ensure sufficient multimodal connections. Urban nodes can also constitute bottlenecks and missing links on the Corridors; conversely, they can be impacted by the negative aspects of traffic on the Corridors in terms of pollution, noise and safety.

In that perspective, such urban nodes receive sufficient attention in the work of the Corridors as well as in the TEN-T Regulation. On a case by case basis it could be appropriate to set up a Working Group on Urban Nodes in Corridor Fora and to organise meetings of that Working Group on a regular basis.

Regarding the TEN-T Regulation, the Commission adopted on 14 December 2021 a proposal for a revised Regulation which defines more clearly the role of the urban nodes on the network and their constituting elements and sets additional requirements that the Member States should ensure. Those additional requirements include the development of Sustainable Urban Mobility Plans (SUMPs), the use of sustainable urban mobility indicators and the development of multimodal passenger hubs and freight terminals. In addition, the proposal extends the list of recognised urban nodes from the previously limited list of 88 "network defining urban nodes" to all cities of at least 100,000 inhabitants and, for NUTS2 regions without such a large city, the capital of those regions. Depending on the final version that will be adopted by Council and Parliament, the number of urban nodes per Corridor would thus significantly increase.

In this Work Plan, we are still referring to the current list of urban nodes and highlight the key points that still need to be addressed at their level to ensure a good effectiveness of the Corridor.

For rail transport, the seamless connection between the (long-distance) TEN-T infrastructure and the access points (e.g. terminals, ports, airports) plays a decisive role. In this respect, the current situation of the RD urban nodes is often characterised by non-compliance of the last-mile infrastructure. In particular, the train length is restricted on many access lines, requiring additional splitting/composing procedures of the long-haul trains. Certain access lines are not electrified or do not fulfil the 22.5 t axle load requirement. Dedicated projects designed to improve the situation on the last-mile rail infrastructure are currently missing.

Another issue is the ability of rail traffic to bypass certain urban nodes. Such a bypass for freight traffic would relieve the inhabitants from the emissions and risks resulting from freight transit through densely settled metropolitan areas.

With regard to the road sector, a key challenge will be to offer sufficient capacities within the urban fabric. There are cases where ports and terminals are located in very densely populated urban areas with highly congested road links.

In light of the above, interventions should be examined to ensure a seamless connection of long-distance traffic with local traffic, relieve urban bottlenecks from the negative impacts of hinterland transport and also facilitate direct interconnections of the different transport modes within a single urban area.

5 Funding and Financing Tools

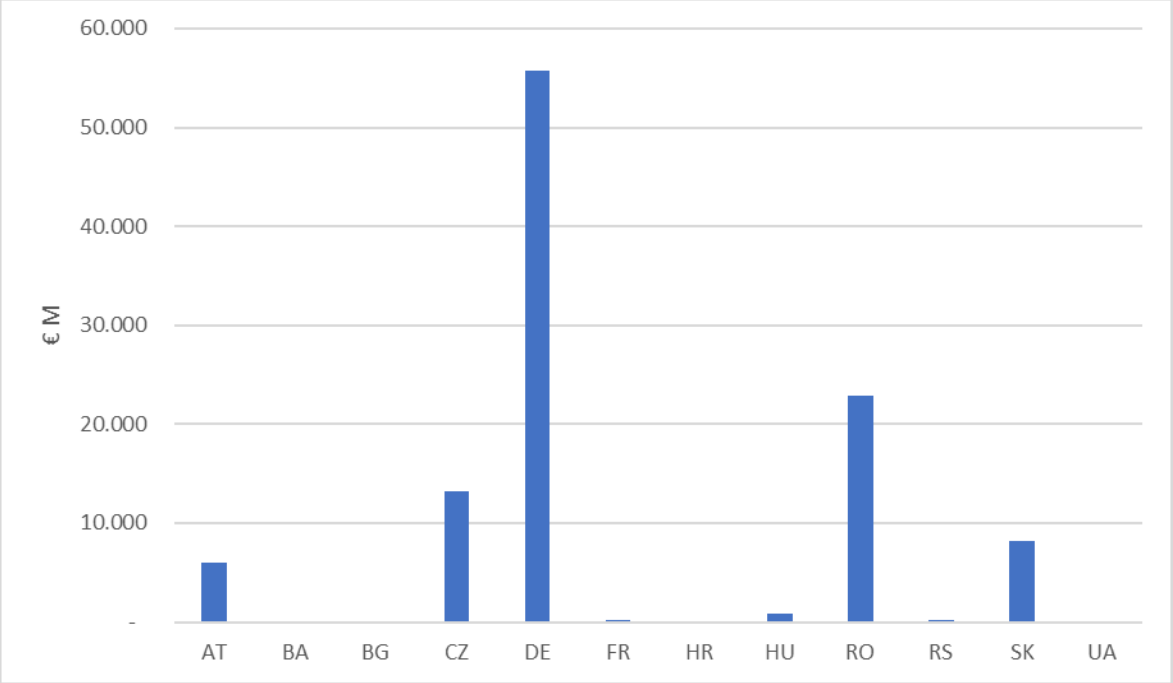
5.1 Update the Corridor funding needs

This section accounts for the economic and financial aspects of the projects included in the RD project list and, more specifically, information on the projects' cost, maturity and financial viability. First of all, the RD project list accounts for a total of 407[23] projects, with a total cost of 109 € bn. Below is the modal split in terms of necessary funding:

- Airport: € 4.6 bn
- Innovation: € 0.04 bn
- IWW: € 4.6 bn
- Maritime: € 2.4 bn
- Multimodal: € 0.9 bn
- Rail: € 68.2 bn
- Rail ERTMS: € 1.5 bn
- Road: € 26.5 bn

The total amount is divided among the Member States as shown in Figure 16Figure 16.

Figure 16: Cost allocation per Member States and Third Countries



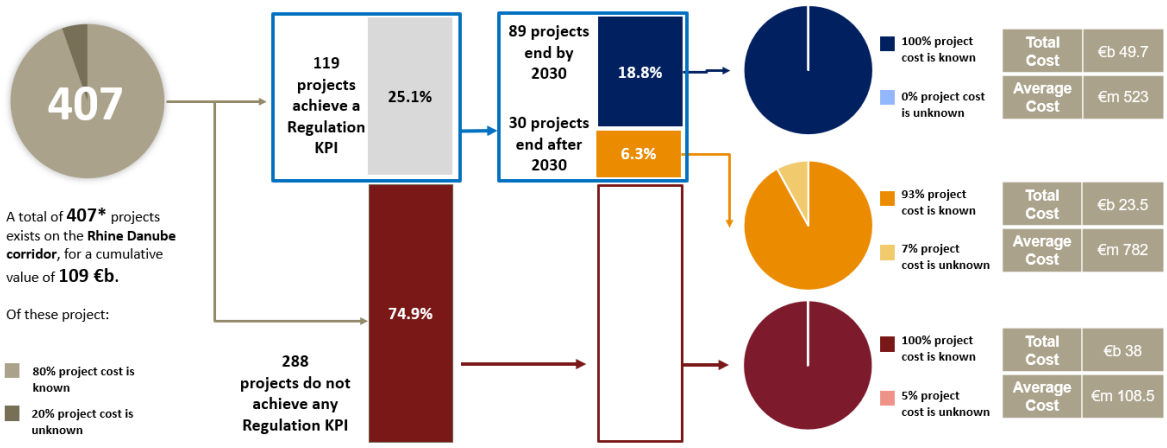
Source: PwC, RD study team, 2021

The financial analysis assessed first the maturity status of the project pipeline, by counting the number of active projects and clustering them through different metrics, such as their contribution to at least one Regulation's KPI, their timing and the

[23] *The analysis only considers projects ending after 31/12/2021*

availability of an official cost figure. As depicted in Figure 17, the vast majority (80%) of the projects have information on cost, and this high share is reflected through the three subcategories.

Figure 17: RD project list cost analysis



* The analysis does not consider projects ending before 31/12/2021

Source: PwC, RD study team, 2021

The next step was to determine the funding sources of the projects, with particular reference to the economic effort of the European Union. Figure 18 shows complete information on the funding sources of projects accounting for € 84.2 bn, or 75.6% of the list's value; of those, € 17.1 bn (19.9%) come from EU funding, with 32.7% accounting for CEF/TEN-T grants and the rest for ESIF and other EU funds. It should also be noted that more than half (57.5% or € 7.9 bn) of the EU funding has already been approved[24]. The remaining share is still listed as "potential", i.e. yet to be applied and confirmed by grant or loan agreements.

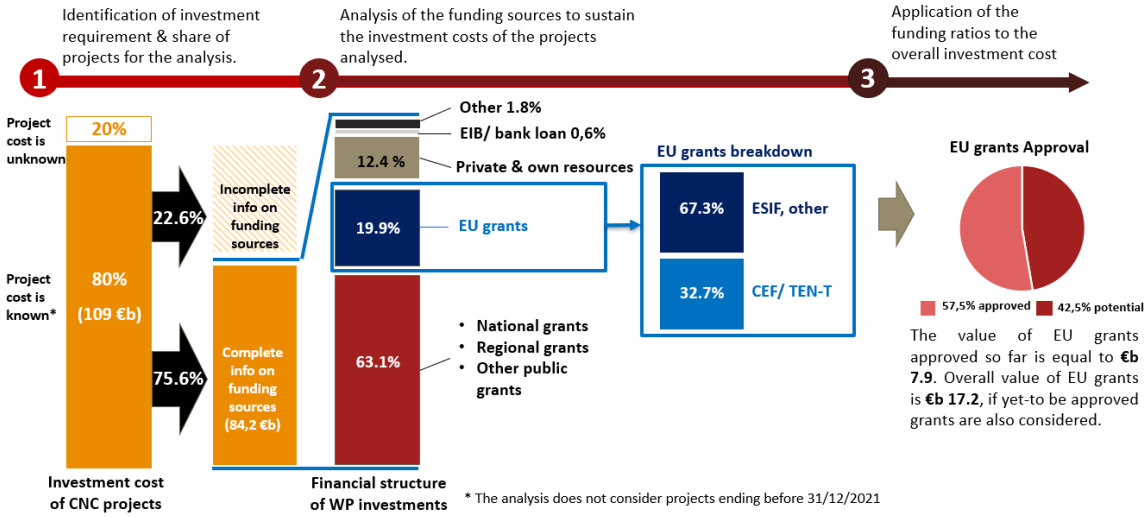
Next to the EU grants is the private financing, notably coming from the EIB: the amount of money the EIB lent to projects in the RD CNC might in fact not be fully represented by the 0.6%[25] (roughly € 531 mn) shown in the graph, due to various reasons, including incomplete reporting from project promoters or unavailability of information prior to the financial closing.

To this extent, it is important to note that EIB only includes mature projects in its pipeline - resulting in a final figure possibly undervaluing EIB's overall contribution to the CNC development. The same applies to other financial institutions.

[24] Only CEF/TEN-T grants marked as approved have been evaluated and confirmed by INEA. Amounts listed as "potential" have no assurance of being secured, and in some cases, they only represent the intention of *the project promoter to submit the request for funding.*

[25] The EIB was not involved in the data collection phase, and has not yet disclosed official figures *concerning its current and expected contribution to the RD CNC development.*

Figure 18: Funding and financing sources analysis of RD project list



Source: PwC, RD study team, 2021

The final step of the analysis determined the financial sustainability of the RD transport infrastructure projects, i.e. the number and value of RD projects able to generate returns from the market to cover the operating costs and possibly a share of the capital expenditure. According to the findings, more than a third (38%) of the projects are potentially financially sustainable as per the aforementioned definition. More specifically:

- 29.6% of the projects, for a total value of € 32.2 bn, are financially sustainable. Projects are classified in this group following either a direct assessment from the project promoter or an analysis by the consultant.
- 8.4% of the project list, for a total value of € 9.1 bn, presents good potential for financial sustainability. Projects included in this category, are considered appropriate based on the consultant's assessment.
- 62% of the project list, for a total value of € 67.5 bn, has low to non-existent potential for financial sustainability. This was based either on a direct assessment from the project owner or on the consultant's analysis.

Financially sustainable projects are relevant because they can be developed with less - or no - impact on public finances, and/or supported with softer support measures (i.e. soft loans, blending instruments, de-risk instruments, etc.) The more infrastructure is developed through projects generating returns from the market, the less the amount of grants and national public finance is needed to complete the TEN-T network. Projects in the transport sector – and in some sub-sectors in particular, i.e. rail, inland waterway, etc. – usually face difficulties being (fully) financially sustainable. Various factors, among which the presence of financing gaps can indeed prevent the project promoter from meeting the desired returns. In this case, projects are potentially financially sustainable, but require some financial aid.

5.2 The Green Deal and the Recovery and Resilience Fund

The Recovery and Resilience Facility (RRF) Regulation has made available 672.5 bn euro in loans and grants to support both reforms and investments undertaken by Member States in the framework of national recovery and resilience plans. The aim is to mitigate the economic and social impact of the coronavirus pandemic and make European economies and societies more sustainable, resilient and better prepared for the challenges and opportunities of the green and digital transitions.

The Annual Growth Strategy for 2021 (AGS) and the Commission's RRF guidelines have identified the development of sustainable, smart and safe transport as a priority for the European recovery and mentioned the deployment of alternative fuel infrastructure among the 7 European flagship initiatives national recovery plans are invited to contribute to.

In this framework and considering the national plans already submitted, the Commission expects Member States to dedicate significant parts of the RRF funding to transport, placing it among the top sectors of the economy to benefit from investments under 'NextGenerationEU'.

While the RRF will finance a large variety of projects, priority will be given to those contributing to the decarbonisation of the transport system in the framework of the European Green Deal. Investments in the rail sector, in particular on the TEN-T network, will therefore have a prominent place. Other priorities will include sustainable urban mobility solutions (including collective transport and active mobility), inland navigation and the electrification of road fleets. In addition, digitalisation of the European transport system will be accelerated by RRF support to investments in ERTMS, ITS or RIS.

5.3 The new CEF2

The CEF 2021-2027 Regulation entered into force on 14 July 2021, applying retroactively from 1 January 2021. The total **budget** for the CEF transport is € 25.807 bn [26]and its division between the envelopes as follows:

- General envelope: € 12.830 bn
- Cohesion envelope: € 11.286 bn
- Military mobility envelope: € 1.691 bn

The **main priorities** of the CEF are:

- Completion of the network: supporting the completion of the TEN-T, with particular priority to cross-border sections and missing links of the Core Network Corridors (60% of general envelope and 85% of cohesion envelope).
- Modernisation of the existing infrastructure: tackle much more decisively the challenge of decarbonisation and digitalisation of the transport sector and support the transition to smart, sustainable, inclusive, safe and secure mobility (40% of general envelope and 15% of the cohesion envelope).
- In line with the Action Plan on Military Mobility, for the first time, support the critical development of civilian-military dual-use transport infrastructure.

[26] *All amounts are in 2021 prices.*

The CEF will contribute at least 60% of its funding to the **climate objectives** (compared to 30% of the overall target of the MFF).

The **blending** of CEF grants with other financial sources will be allowed. This might be implemented either through blending calls (CEF grants in combination with non-EU financial instruments, e.g. commercial banks or national promotion banks) or through blending operations (blend CEF grants with InvestEU).

The CEF will allow the implementation of **synergies** between CEF transport, energy and digital sectors. It will be applied either as "synergetic elements" (it will be possible for each sector to accept as eligible cost ancillary elements pertaining to another sector) or through joint work programmes jointly financed from each sector involved with the possibility to apply the highest co-funding rate of the sectors concerned and 10% top-up.

The Commission adopted the first multiannual work programme 2021-2027 on 5 August 2021. This specifies the funding objectives and budget for the years 2021-2023.

5.4 The inclusion of Military Mobility in the network development plans

As of 2021, military mobility will be taken into account in the Corridor Work Plans. The efforts addressing military mobility are based on the 2018 EU Action Plan on Military Mobility which aims to improve military mobility in 3 key areas of action: transport infrastructure, regulatory and procedural issues, and other cross-cutting topics.

Concerning transport infrastructure, in 2019, the Council of the EU approved the Military Requirements for Military Mobility within and beyond the EU. These requirements identify the geographical scope for military mobility and also define transport infrastructure standards necessary for the armed forces. The gap analysis performed in 2019 by the Commission services and the EEAS emphasises the synergies between TEN-T and military mobility: 93% of the military transport network is also part of TEN-T; and military transport infrastructure standards are mostly compatible with civilian transport infrastructure needs.

Owing to these synergies between civilian and military transport needs, actions aiming to complete TEN-T Corridors can also improve military mobility: in the framework of the new geopolitical changes occurring at the EU borders this has become an overarching priority. The EU's new long-term budget now includes a dedicated € 1.7 bn military mobility envelope as part of the Connecting Europe Facility to co-fund such dual-use transport infrastructure projects. The first CEF call for proposals to improve dual-use transport infrastructure was launched on 16th September 2021. In order to be eligible, projects have to be on both the TEN-T and the military transport network, as well as to address dual-use transport infrastructure requirements identified in the Commission Implementing Regulation (EU) 2021/1328[27].

[27] *Commission Implementing Regulation (EU) 2021/1328 of 10 August 2021 specifying the infrastructure requirements applicable to certain categories of dual-use infrastructure actions pursuant to Regulation (EU) 2021/1153 of the European Parliament and of the Council C/2021/5859,* OJ L 288, 11.8.2021, p. 37.

6 The European Coordinator's recommendations and future outlook

6.1 Real progress made and their operational influence on efficiency

Looking at the number of projects completed since 2014 and the related evolution of KPIs in this period, some moderate progress is evident, albeit slow and uneven.

Coordination between Member States can still be improved and commitments to invest on the key sections of the corridor should more often been followed by a timely implementation.

Focusing on the rail freight sector, a huge part of the Corridor is already well developed, while certain KPIs (esp. train length, line speed) and areas, especially in the eastern part of the Corridor is lacking behind. The deployment of ERTMS has also been rather slow and encounters difficulties in terms of technical capacities in some MS. These bottlenecks have a direct influence on the operational efficiency of the RD Rail Corridor. As per the outcomes of the Rail Commercial Delivery Time analysis, the biggest challenges remain on the sections at the HU/RO border near Curtici. Also, existing trains through other parts of Romania run on an extremely low average speed but are also affected by the poor quality of the rail services offered. The lack of central and accessible terminals on this route is another malus factor affecting operational efficiency. Low rehabilitation progress and project implementation delays can only exacerbate the situation.

On the positive side, however, due to the coordinated actions of the Task Forces on operational improvements at border stations, some of the operational bottlenecks were eliminated. These measures do not necessarily impact the operational speed but help reduce border dwell times along the Corridor borders. Existing political developments should be continued as persistent bottlenecks still exists at some rail and road BCPs.

With regard to Inland Waterways, the recent introduction of the so-called DAVID forms has harmonised border control procedures in the Danube region and will reduce the waiting time at border crossings.

While extensive maintenance dredging and fairway marking activities should have improved the fairway availability on the Danube, there are still numerous critical locations, where the targeted fairway depth is often not reached. The situation has been particularly critical in 2022 due to the very severe draught that affected the water levels of many section on the Rhine and Danube. The upgrade of the critical Danube section Straubing-Vilshofen has finally started and will increase the number of days with a sufficient fairway depth. Nevertheless it will be still below the targeted value. On the Danube, regular dredging activities on critical sections have started too late and where not properly coordinated. This affected heavily the traffic and such situation call for urgent – long term measures – top prevent a repetition of such event.

6.2 Critical issues

The main critical issues for a successful development of the RD Corridor can be summarised as follows:

- There are still several **technical** and **physical gaps** along the Corridor's infrastructure in terms of it missing the necessary quality and TEN-T standards, as shown by the compliance analysis.

- **Operational** and **administrative issues,** particularly a lack of harmonisation and cross-border cooperation are causing bottlenecks especially for rail and IWW transport.

- A lack of **financial resources** only partly compensated by the resources allocated through the Recovery and Resilience Plans (benefiting in particular to Romania)

- **Multi-modality**, key in increasing the efficiency of the Corridor, is in need of improvement, especially due to missing last-mile connections and lack of intermodal infrastructure (e.g. enhancing rail capacities to and from ports, better integration of ports/RRTs into logistic chains).

- A potential modal shift to inland waterways is hindered by the **poor reliability of free-flowing inland waterways**, which is determined on external hydrological conditions, but can be decisively influenced by continuous and flexible, but also increasingly more expensive, maintenance works.

- There is need for improved and **integrated international transport services** (client oriented) on the Corridor, both for freight and passengers, including multimodal travel planner and multinational road tolling.

- Unresolved national bottlenecks are blocking the efficient functioning of the entire Corridor. In addition, there is evidence of **lack of coordination/integration of national strategies/plans** (all modes) towards TEN-T objectives and 2030 milestones, particularly for cross-border sections.
- Additional transport constraints mainly on Danube river also affect the functioning of corridor. Since the beginning of the invasion of Ukraine by Russia, traffic from/to Danube ports has increased sharply. This new dimension of the corridor is addressed more specifically in chapter 6.5.

- Slow progress in the **uptake of new opportunities from digitalisation and automation** that reduce operational costs and increase efficiency.

- The **significant delays** in several infrastructure projects' **implementation pose a serious threat to 2030-compliance** as described under **Error! Reference source not found.**. Several projects are being postponed to a later completion date close to 2030 or even after that. Therefore it is important to reinforce the cooperation between Member States, project promoters and EU supporting tools (PSA, EIB, Hub, etc.), as well as the early involvement of the civil society on a local level.
- Scarcity of **human resources** and **competences** in all project phases including planning, construction and operation and maintenance.

6.3 Future Challenges

In order to fill the identified infrastructure gaps, additional efforts are required with regard to the following aspects:

- **Rail & RRT:** ERTMS deployment, upgrades to achieve 740 m train length for single-track sections, axle load, P/C 70/400 intermodal gauge, required upgrades of RRTs, completion of missing links. One of the key weaknesses of the rail remains the discrepancy in terms of standards along the corridor that undermine the competitiveness of rail transport, for both freight and passengers.

- **IWW:** Ensuring Good Navigation Status, especially regarding the required fairway depth, development of digitalisation and zero-emission vessels, improving the coordination of regular maintenance to increase the resilience of this transport mode with respect to the climate change.

- **Ports:** Improving of rail connections, onshore power supply and provision of clean fuels bunkering facilities

- **Road:** Provision of clean fuels, secure parking's, implementation of motorway/express road standards, ITS deployment and upgrading road safety.

- **Airports:** Heavy rail connections where the expected traffic can ensure enough profitability and provision of clean air fuel in all airports

It is important to recall that 100% KPI fulfilment does not guarantee the efficiency of a Corridor, since operational and legal issues could outweigh all achievements in upgrading infrastructure. Low commercial speed remains the main challenge for long-distance freight rail on the RD Corridor. Therefore, there is need for experience in operational procedures and infrastructure coordination, particular for the rail sector. The Commercial Delivery Time analysis was a good first step; more benefits are expected from the stronger cooperation between CNC and RFC.
Finally, the capacity to complete the important cross-border projects is required. Given that the vast majority of the Corridor projects are national ones, we need to avoid a situation in 2030 of achieving a good patchwork of national corridors/lines that, however, lack cross-border links.

Last but not least, attention should be paid to the:

- **Removal of administrative and operational barriers**

- **New geopolitical challenge and successful inclusion on Moldova and Ukraine in the corridor** This report assesses the situation of the Rhine Danube corridor on a period that ends in February 2022. However, it would have been difficult not addressing in the work programme the new challenges deriving from the changes in the geopolitical situation that are affecting the Eastern part of our continent, including this corridor. On one hand, the effects of the Russian aggression to Ukraine are already visible through the re-direction of a large amount of freight traffic through the Danube and EU Black sea ports. While the massive increase of traffic has represented a heavy burden for the front-line Member States, the new routes liking Ukraine to EU (some of them going through Moldova) also represent an opportunity for the EU as a whole to strengthen its transport system and develop interoperable rail connexions with Ukraine and Moldova. The European Commission has reacted very quickly to support Ukraine's external trade – first and foremost of cereals

- through the setting the so-called "Solidarity Lanes"[28] and foreseeing additional adaptation of the TEN-T Regulation to increase this connectivity through the development of interoperable infrastructure. Needless to say that the increase of political, human and economic ties between Ukraine, Moldova and the EU will definitely also require to further modernize our respective transport connections. The candidate status given to both Moldova and Ukraine will – in principle - also increase the EU financing support devoted to developing long term infrastructure projects. On the other hand, this situation has also revealed some "hidden" weaknesses in the overall EU transport system and in particular on this corridor (both in terms of infrastructure and services). These criticalities must be tackled as they are affecting in particular the good functioning of the Waterborne transport. I will therefore propose – in the coming months - an addendum to the work programme to ensure that these weaknesses are properly assessed and addressed.
Overall, my objective is to ensure that the Rhine Danube corridor offers to all EU citizens and beyond a highly reliable, interoperable and interconnected transport infrastructure, but also a more resilient one to cope with the challenges of the climate change and of the future European integration of Ukraine and Moldova.

6.4 Contribution to the Green Deal

The European Green Deal calls for a substantial part of the 75% of inland freight carried today by road to shift to rail and inland waterways. Similarly, the Smart and Sustainable Mobility Strategy sets concise and ambitious targets for increasing the market share of sustainable modes: rail freight to increase by 50% by 2030 and double by 2050, while IWW and Short Sea Shipping (SSS) by 25% by 2030 and 50% by 2050.

The Core Network Corridors play a key role in the Green Deal, and we must all commit now more than ever to shifting to more sustainable modes of transport and adopting digitisation. The incremental change recorded so far must become a fundamental transformation.

Accelerating the modal shift calls for a major boost in the use of rail and waterborne transport. Therefore, "greening" the RD Corridor will in turn necessitate shift-to-rail projects, increase in capacity, strengthening of cross-border cooperation and coordination of infrastructure and low-carbon technologies (e. g. electrification in rail transport, uptake of clean fuel technology).

At the same time multimodality or, as of lately, "synchro-modality" must be fostered to reap the advantages of the combination of rail freight transport with ports and inland navigation. Therefore, adequate hinterland railway connections from/to the ports are of the outmost importance.

Another vital issue is to strengthen the network of multimodal terminals and hubs, which are key players nowadays; several are part of larger entities, such as Freight

[28] *An action plan for EU-Ukraine Solidarity Lanes to facilitate Ukraine's agricultural export and bilateral trade with the EU COM (217) 12/05/22.*

Villages. Apart from the transhipment infrastructure, these need to be linked with innovative telematics solutions streamlined for the entire logistics chain.

The Corridor must also further explore opportunities in fleet modernisation, electrification, technology innovation in sustainable fuel, deployment of charging facilities, uptake of hydrogen fuel technology, smart ticketing including intermodal mobility, and new infrastructure projects, especially for high-speed rail transport.

Last but not least, capacity to manage disruptive situations and events is important and must be used. This has an impact on investment priorities and the resilience of the Corridor.

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