



Study on Mediterranean TEN-T Core Network Corridor

Final Report *3rd Phase*

November 2023



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List of abbreviations

CBA - Cost Benefit Analysis

CNC - Core Network Corridor

EC - European Commission

EIA - Environmental Impact Assessment

ERTMS - European Railway Traffic Management System

EU - European Union

IWW - Inland Water Ways

KPI - Key Performance Indicator

MED - Mediterranean Corridor

MS - Member State

RRT - Rail Road Terminal

TEN-T - TransEuropeanNetwork – Transport

UIC – International Union of Railways

Disclaimer

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Introduction

Since 1 January 2014 significant effort has been placed on developing European transport infrastructure policy, as set in the TEN-T Regulation 1315/2013. The nine Core Network Corridor (CNC) led by a European Coordinator have been set up and the Connecting Europe Facility mechanism, as stated in regulation 1316/2013, has been extensively employed to deliver transport infrastructure to European citizens.

The Mediterranean multimodal TEN-T Core Network Corridor is one of the most important rail axes at European level, linking the ports in the south-western Mediterranean region to the centre of the EU, following the coastlines of Spain, France, and crossing the Alps towards the east. It runs across northern Italy and continues east, through Slovenia, Croatia and Hungary up to the Ukrainian border.

The Phase III **Final Report of the Mediterranean Corridor Study** - in accordance with the terms of reference - describes the progress of the work on the Mediterranean Corridor, taking into account the monitoring and analytical activities carried out in the framework of the contract extension covering the period October 2022 - November 2023 (Amendment 2: MOVE/B1/SER/2018-216/SI2.782834 - Extension of contracts for TEN-T Corridors). In particular, it offers a **comprehensive and up-to-date representation of the progress of the Corridor**, summarising and processing the results of the work done in this and previous phases under Tasks 1, 2, 3 and 4. It also takes into account input from the Corridor Working Groups and Fora (Task 5).

The results presented in this report were analytically developed in the following deliverables, presented to the Commission during the last year of the contract extension, and should be considered in addition to the documents provided in the previous phases:

1. Project Implementation Report 1/2023 (May 2023);
2. 2023 Project List (March 2023);
3. Monthly Reports;
4. Monthly Press Review;
5. Tailor-made notes on Corridor related matters;

Updated Analysis of the Characteristics of the Corridor

The analysis of the characteristics of the Corridor and the State of the Infrastructure has been further updated in the current loop of studies.

Key Performance Indicators (KPIs) are being used to assess and monitor the evolution of the corridors and the potential effects of individual projects or groups of projects.

A common KPI framework has been developed for all nine Corridors, in order to allow for a cross-Corridor comparison.

In the previous phases of work, both the Corridor Study 2 as well as the V Work Plan presented a quantitative assessment of the abovementioned parameters in order to provide the current status of compliance per mode and nodes along the Mediterranean Corridor by 2020 (Corridor Study) and by 2021 (V Work Plan) and to highlight the critical issues, namely the missing links of the infrastructure and the non-compliant sections and hubs, according to the infrastructure targets and definitions set out in the Regulation No. 1315/2013, Article 39.

These parameters, together with the information closely related to them, were further re-evaluated in the present study phase (August 2023) as part of task 3.6 of updating the TENtec database.

Table 1 shows the status of analysed KPI per mode and Member State by 2023 alongside the criteria used to assess compliance.

Table 1: Compliance per Member States with TEN-T requirements by 2023

KPI	Member State						Total	
	ES	FR	IT	SI	HR	HU	2023	2030
Railways								
Electrification	84%	100%	100%	100%	100%	99%	92%	100%
Track gauge	>43% ¹	100%	100%	100%	100%	99%	70%	83%
Axle load	94%	100%	100%	100%	100%	27%	91%	100%
Line speed	100%	97%	91%	26%	100%	92%	93%	99%
Train length	17%	100%	4%	100%	0%	67%	39%	72%
IWW								
CEMT class	-	77%	80%	-	-	-	79%	88%
Draught > 2.5 m	-	100%	80%	-	-	-	88%	93%
Bridge height	-	63%	70%	-	-	-	67%	82%
RIS	-	96%	62%	-	-	-	75%	75%
Road								
Type	100%	100%	100%	100%	100%	97%	100%	100%
Ports								
Rail connection	100%	100%	100%	100%	100%	100%	100%	100%
RRT								
Capability of intermodal units	71%	100%	100%	0%	0%	100%	81%	90%
740 m train terminal accessibility	57%	0%	75%	0%	0%	100%	55%	65%
Electrified train terminal accessibility	57%	100%	75%	0%	0%	100%	67%	67%
Airports*								
Connection to rail – all airports	57%	50%	57%	0%	0%	0%	48%	67%

¹ This figure shows the percentage of Spanish rail MED Corridor with UIC gauge. However, it is important to note that pre-existing lines in Iberian gauge cannot be enforced to change their gauge, so from the perspective of the Regulation those lines would be compliant. For this reason, although the percentage of the railway network belonging to the MED Corridor and physically with UIC gauge is 43%, the level of compliance is higher.

KPI	Member State						Total	
	ES	FR	IT	SI	HR	HU	2023	2030
Connection to rail (HS) – main airports	0%	100%	0%	-	-	0%	17%	67%

*The KPI “Connection to rail – all airports” has been calculated considering all the airports of the core network directly connected with the railway network. The compliance value in 2021 decreases to 17% when applying the more restrictive criterion of rail connection with high speed lines for the main airports of the core network (Connection to rail (HS) – main airports) with only Lyon airport currently compliant. By 2030 all main airports will be compliant with this KPI except for Budapest airport where completion of the work is in doubt.

Evolution over time of the KPI’s per Member State

The analysis of the KPIs at country level better highlight areas of concern, particularly regarding the state of rail infrastructure, which is currently the main challenge.

Spain

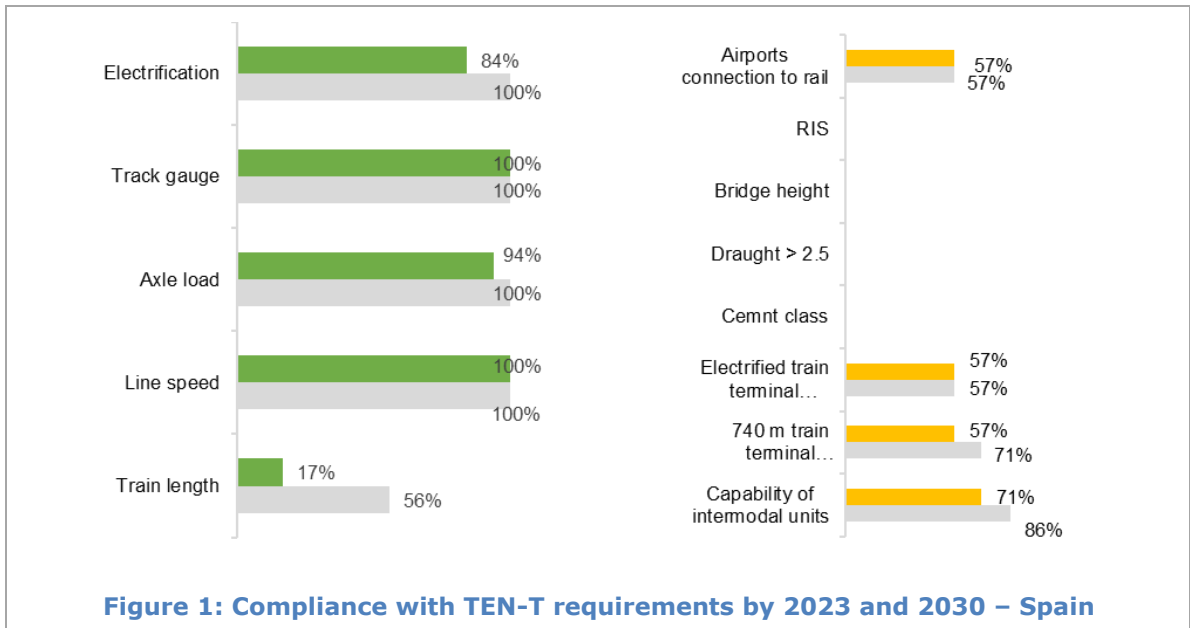
Spain

Electrification lacks on sections Bobadilla-Algeciras and Zaragoza – Teruel – Sagunto, where compliance is planned for 2030. The required **axle load** of 22.5 t is allowed on almost all the sections in Spain as well as the required minimum line speed of 100 km/h for freight lines.

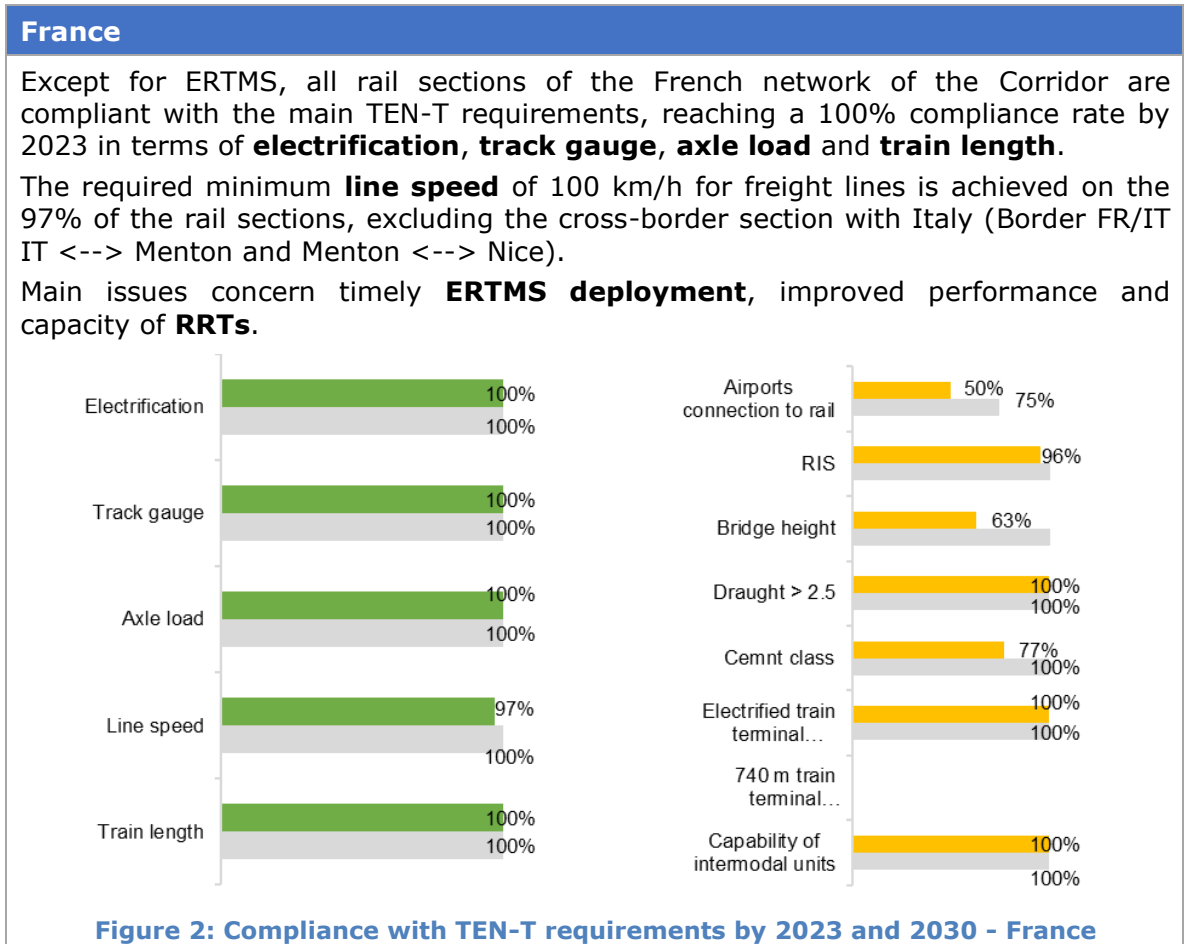
Track gauge, all lines will be compliant in 2030. However, it does not mean that all lines belonging to the Corridor will have international gauge. This is because pre-existing lines in Iberian gauge (prior to the approval of Regulation 1315/2013) are exempted from meeting this KPI.

Spain will be compliant with all rail KPI’s in 2030 except for **train length** (expected level of compliance by 2030 of 56%). Currently only the conventional line Madrid-Valencia and the section between Barcelona and the French border can accommodate trains up to 740m long.

In terms of connectivity of nodal infrastructures to the Corridor, the **rail connection between the airports and the railway network** is currently poor in Spain (0% compliance for main airports), but major investments are being made in this area. It is worth mentioning the ongoing investments in the high-speed rail link at the Adolfo Suarez-Madrid Barajas airport (expected completion date 2030) and the new access to Barcelona's El Prat airport (expected completion date 2024). In terms of investments aimed at improving accessibility of **RRTs** works have been awarded for the rail link to the La Llagosta standard gauge multimodal terminal.



France



Italy

Italy

KPIs concerning **electrification**, **axle load** and **track gauge** reached full compliance.

The required minimum **line speed** of 100 km/h for freight lines is achieved on 92% of the railway network. Non-compliant sections include border sections with Slovenia (Border IT/SL IT / Sezana II - Villa Opicina) and some sections of the Genova node (Genova Sampierdarena - Genova P. Principe and Genova Voltri - Genova Sampierdarena). The use of such sections by freight trains will be reduced by the operation of the Terzo Valico dei Giovi (2026) which will cause a rerouting of a significant share of freight trains on other sections of the Genova Node, reaching the target.

A **train length** remains a problem. 740 m trains are only allowed on 4% of the Italian network, with a limited number of already compliant sections located in Northern Italy.

A large number of investments is ongoing. Works on the cross-border sections Turin-Lyon and on the high speed railway link Terzo Valico dei Giovi foresee the achievement of all the railway KPIs. In addition, the new high-speed lines (Milano - Brescia - Verona - Vicenza - Padova), are expected to achieve all the railway KPIs. Other relevant planned works include the upgrading of some sections of the Mediterranean Corridor (Torino - Milano, Verona - Padova - Venezia, Venezia - Trieste, Bologna - Padova, Milano - Piacenza - Bologna, Genova - Ventimiglia) to 750 m train length.

Further efforts are required in terms of connectivity of nodal infrastructure to the Corridor. Several projects are planned to improve **airport accessibility**, including Genoa, Bergamo and Venezia airports, where accessibility upgrades are expected to be completed in 2030, and Linate, where the connection of the airport with the metro line (Line 4) was completed by 2022.

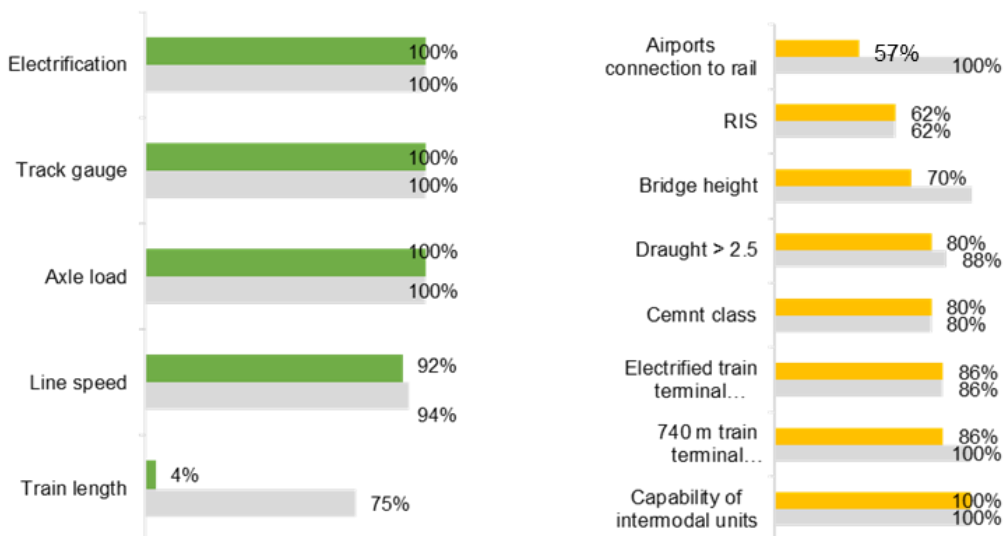


Figure 3: Compliance with TEN-T requirements by 2023 and 2030 - Italy

Slovenia

Slovenia

Line speed represents the only category, which is currently not compliant. It will be achieved after the completion of the second track between Koper and Divača, as well as the upgrade of the section Zidani Most - Dobova.

As regards **train length**, while it is possible for trains 740m long to operate on the Slovenian railway network, certain operational measures or interventions may be required. In order for trains of this length to be able to operate regularly, further investments are needed in the future in railway sidings and in adapting of the signal safety devices.

Another pending issue is the completion of **cross-border sections** with Italy and Croatia. They are, in part, dependent on the agreement with other member states and the works, which can/will be conducted in these countries by 2030.

Among other critical issues, the Ljubljana RRT is not compliant with the KPIs "**Intermodal transshipment capacity**", "**Accessibility of the 740 m rail terminal**" and "**Accessibility of the electrified rail terminal**". However, by 2030 the Ljubljana container terminal is expected to be upgraded and modernised to meet the intermodal KPIs.

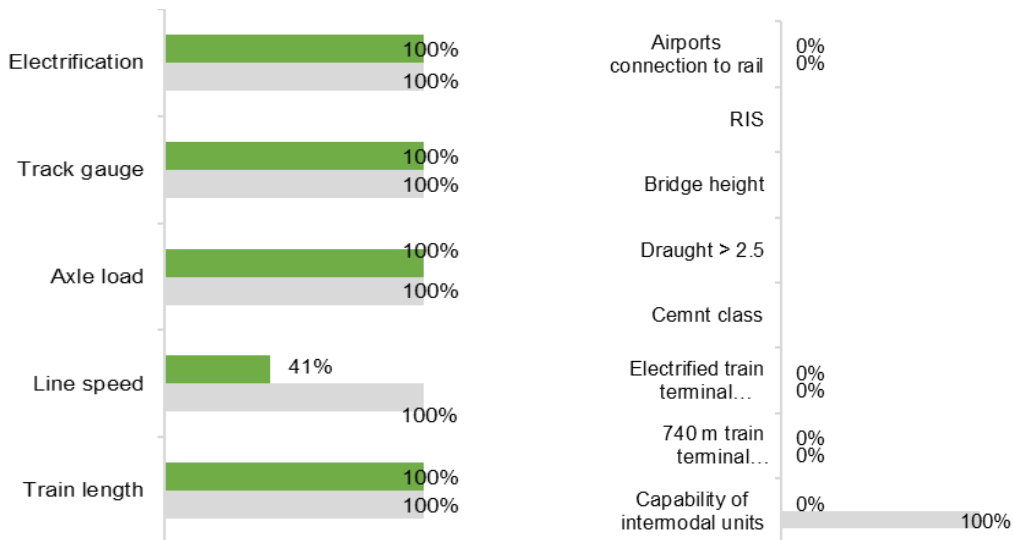


Figure 4: Compliance with TEN-T requirements by 2023 and 2030 - Slovenia

Croatia

Croatia

According to the data currently available, the Croatian network is already compliant with all railway KPIs, achieving a 100% compliance rate in terms of **electrification, track gauge, axle load and line speed, except for the train length** parameter which has currently a compliance level of 0%. Various restrictions are applied on the railway network, allowing a train length between 200 m and 500 m.

By 2030, different railway lines are scheduled to be upgraded including the sections Horvati <--> Karlova and Dugo Selo <--> Botovo, for which the "train length" parameter will also be met. The level of compliance thus rises to 45%.

Major problems are identified in relation to rail links between **airport** nodes and the central rail network and **RRTs**. Zagreb airport, although belonging to the 21 core airports, is not one of the 6 considered to be major airports within the meaning of Regulation (EU) 1315/2013, and therefore subject to the provisions of Article 41(3), which requires connection to the trans-European transport network by 2050. On the other hand, in terms of "**Intermodal transshipment capacity**", "**Accessibility of the 740 m rail terminal**" and "**Accessibility of the electrified rail terminal**", the Zagreb intermodal terminal is currently not compliant with these KPIs although some investments are in the pipeline by 2030.

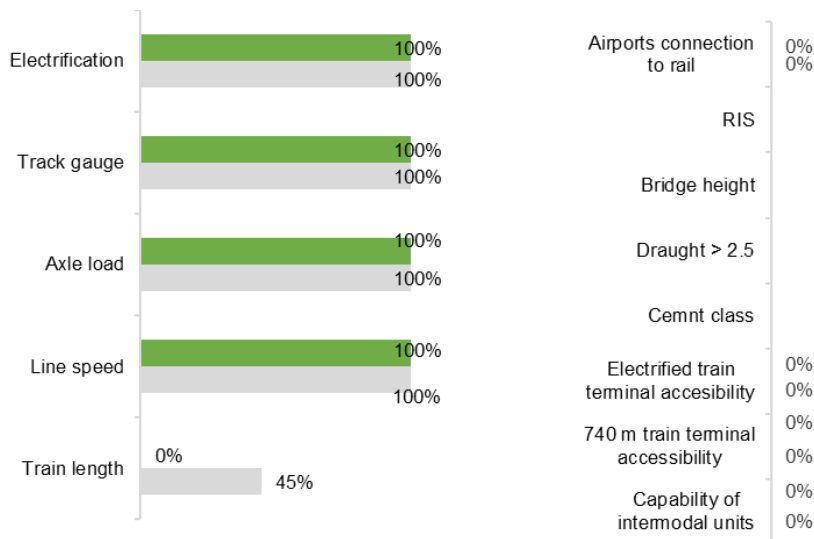


Figure 5: Compliance with TEN-T requirements by 2023 and 2030 - Croatia

Hungary

Hungary

In Hungary the most problematic KPIs are the **axle-load** and **train length** parameters. Most railway sections are ready for 21 tonnes compared to the 22.5 tonnes required by European standards. However, 22.5 tonnes may be allowed under special conditions (speed reduction and restrictions, etc.). The percentage of sections complying with the train length standard is 67%. On the non-compliant sections, restrictions are in place on the circulation of 740 long trains, with limitations up to 600/650 m. However, for both the parameters analysed, full compliance (100%) is expected by 2030.

The compliance status of the Hungarian network with respect to the **maximum speed** parameter is 92% at the current status. Non-compliant sections are Budapest Ferencvaros <--> Cegléd where the maximum speed is 80 km/h between Ferencváros and Kőbánya-Kispest, between Kőbánya-Kispest and Cegléd it is 100 km/h and Murakeresztur <--> Gyekenyes (part 2) with speed limitations of 80 km/h on part of the section.

Electrification and **track gauge**, the compliance rate is 99%.

In terms of connectivity of nodal infrastructure to the Corridor, the Budapest Liszt Ferenc International airport is not yet connected to the main Hungarian railway passenger network (while the freight train connection is ready). However, this bottleneck is expected to be eliminated with the construction of a rail link providing good connection between the airport, Budapest city centre and several other destinations (project status: feasibility study, planning, obtaining permits, tender documentation, EIA performed).

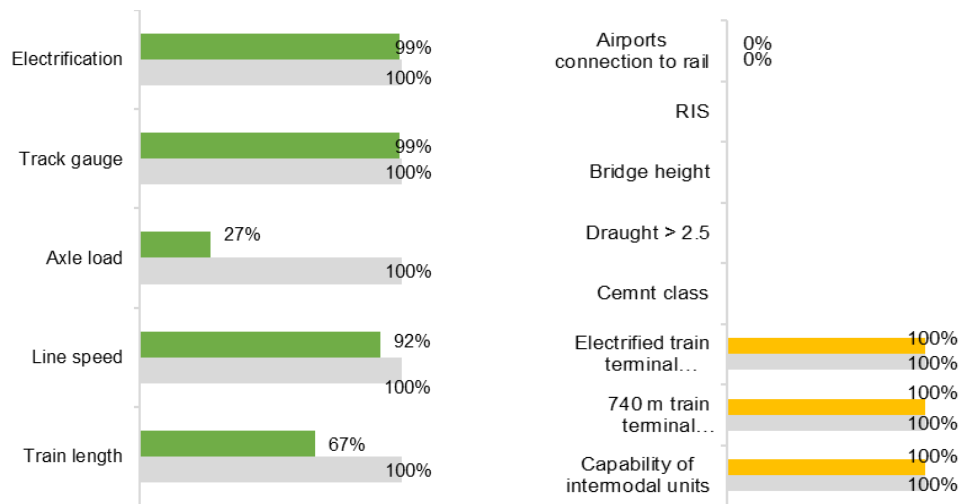


Figure 6: Compliance with TEN-T requirements by 2023 and 2030 - Hungary

Overview bottlenecks and missing links

As a continuation of the analysis carried out so far, the following section offers a summary of key bottlenecks and missing links that may adversely affect transport activities within the Mediterranean Corridor. Despite numerous ongoing and planned infrastructure projects along the Corridor, identifiable bottlenecks and gaps persist, primarily due to unplanned projects by Member States or substantial delays, particularly in the rail sector. The analysis has been consolidated for each transport mode, reporting data for each individual Member State.

Railway

The figure below shows the level of expected compliance of the **rail network** along the Mediterranean Corridor in 2030 by considering the railway parameters "Electrification", "Line speed ≥ 100 km/h", "Axle load ≥ 22.5 tonnes" and "Track gauge = 1,435 mm".

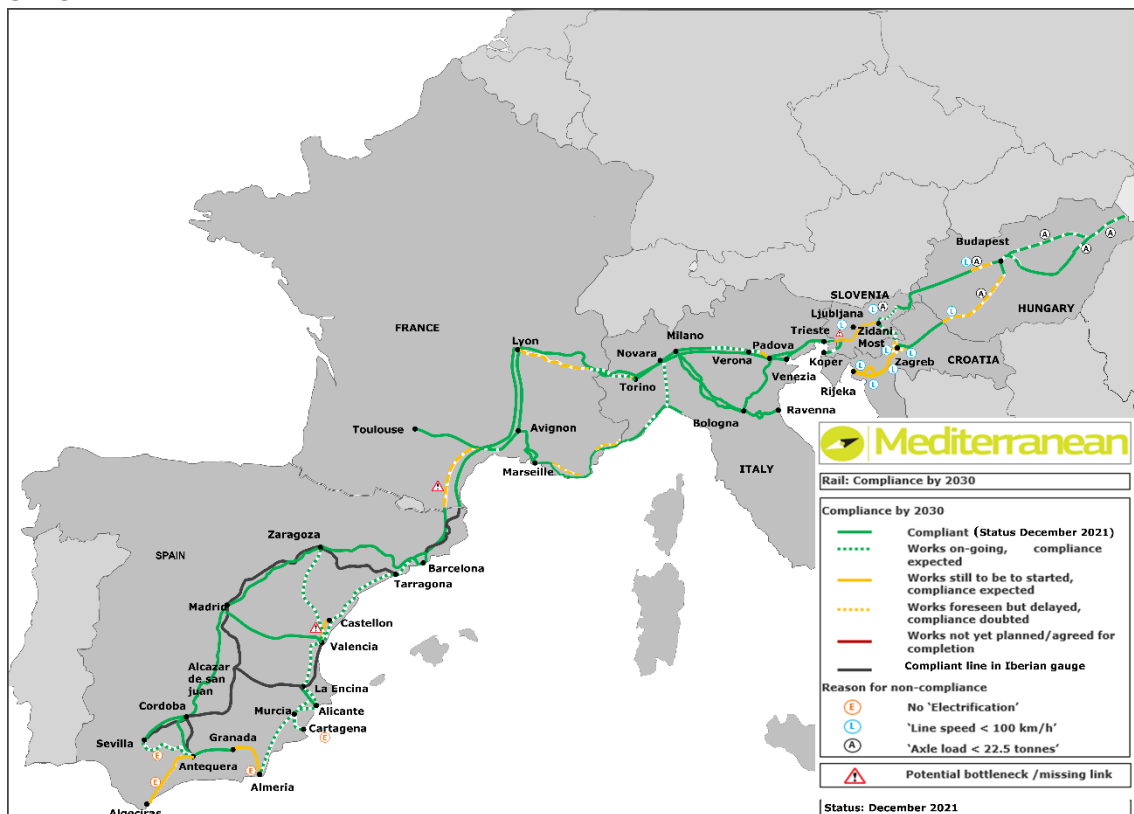


Figure 7: Rail compliance map by 2030 overview (data status December 2021)

The key remains the improvement of **cross-border sections**:

- Italy – France:** the new railway link **Lyon-Turin** with a 57km base tunnel as the main part is the main project of the whole Mediterranean Corridor. On the Italian side, the **Avigliana-Orbassano** section's access line planning is in progress (final design underway), with the historical line that will meet most TEN-T parameters except for train length. Ongoing infrastructure works on the **Bussoleno-Avigliana** historical line involve technological upgrades, while plans for loading gauge upgrades and achieving a passenger line speed > 160 km/h are pending. In France, discussions on the phasing and consistency of access line improvements (new sections and upgrades) are ongoing.
- Spain – France:** the UIC rail cross-border connection between Spain and France is achieved through the **Le-Perthus tunnel**. Both the extension of the UIC gauge to the south (Algeciras), currently ongoing in different sections, and

the construction of the missing link between Montpellier and the end of the Le Perthus section are very important to realise the potential of the tunnel.

- **Italy – Slovenia:** following the common decision to postpone the construction of a new railway line until after the 2030, currently, efforts are focused on upgrading the **existing two-track line between Trieste/Aurisina and Divača** to meet TEN-T standards. However, achieving a speed increase on this section is challenging due to significant geographic constraints (16‰ gradient from Italy to Slovenia), posing a risk of non-compliance.
- **Slovenia – Croatia:** the entire cross-border stretch between the capitals needs upgrading. In Slovenia, the **Ljubljana – Zidani Most** and **Zidani Most – Dobova** railway sections are set for reconstruction by 2030. Croatia is currently reconstructing the **Zagreb – Savski Marof** (HR/SI Border) section, with completion expected in 2024.
- **Croatia – Hungary:** the cross-border section (**Botovo-Gyékényes**) on the main railway line connecting Zagreb and Budapest requires upgrades to comply with TEN-T standards. While the upgrading and construction of a new second track on the Croatian side of the Križevci-Koprivnica-Hungarian state border railway section were initially scheduled for completion by 2025 due to delays.

Proceeding with the analysis by **Member State**, the following main problems arise:

Spain

- **The second platform projects between Castellón and Valencia, coupled with a tunnel across Valencia**, are currently underway (preliminary design ready, public information and EIA procedure in progress). This section is presently utilized by diverse services, encompassing freight, commuter, regional, and high-speed trains, linking ports and major cities. The forthcoming UIC tracks will be exclusively reserved for high-speed services, thereby creating more capacity for freight traffic on existing tracks. The new tunnel in Valencia serves two fundamental purposes for the Mediterranean Corridor: enabling unimpeded north-south passenger services and improving connectivity between urban and regional networks.
- **The Granada-Almería railway electrification and adaptation to UIC gauge** are targeted for completion by 2030. Track renewal is underway on the Antequera-Algeciras line, with electrification pending an environmental impact assessment update for a small stretch. Preparatory work for electric supply substations began in March 2019. UIC gauge upgrades and other construction are ongoing. Infrastructure for Murcia's connection to the high-speed network is nearly complete. A functional analysis is being developed for planning rail services on the Antequera-Granada-Almería line, with results expected in early 2022.

France

- In France, the corridor sections are already compliant with TEN-T standards except the cross-border section with Italy and ERTMS. **The former will be solved with the completion of the new base tunnel under the Mont-Cenis (international section of Lyon-Turin) expected in 2032.**
- Delays can be noted with regard to **the new high-speed line Montpellier – Perpignan**; however, construction is scheduled to start in 2025 with completion after 2030.
- Moreover studies and procedures continue on the **improvement of urban rail nodes in Marseille** (as part of the Ligne nouvelle Provence Côte d'Azur project whose completion is expected only after 2030).

Italy

- **Work is ongoing on the cross-border sections** with France (**Lyon -Turin**) and Slovenia (**Trieste – Divača**).
- **Genova-Ventimiglia upgrade**, scheduled for completion by 2030, involves technological renewal and station interventions for accessibility. Achieving compliance with 740m train length is challenging due to orographic constraints.
- **The high-speed railway link “Terzo Valico dei Giovi”** will integrate existing lines and it will be compliant with all the TEN-T regulation standards before 2030.
- Works have started on the **Brescia – Verona** new high-speed line whose completion is planned by 2026. The project also includes the upgrading to four tracks of the line section from Brescia (completion planned by 2028), and the Verona node upgrading (completion planned by 2028). When taking into consideration the full line between Milan-Venice, for both sections **Verona – Vicenza** and **Vicenza – Padua** the completion is foreseen respectively in 2026 and 2029, however the beginning of the works in the section Vicenza - Padua is foreseen in 2023.
- The works on the conventional railway line **Venezia – Trieste** continue with the intention to upgrade the line to TEN-T requirements.

Slovenia

- The initial works on the **second track Divača-Koper** are in progress with minimal to no delay. Works should be concluded between by the end of 2025.
- Works on the section **Zidani Most - Celje** have been concluded at the end of 2021. The last section, which was upgraded was the section between Zidani Most and Rimske Toplice.
- It is also worth mentioning that the successful upgrade of the **Pragersko railway station** (planned to be completed by 2023) would enable improved railway conditions, hence, eliminating bottlenecks and improving KPIs (line speed, axle load and train length), while also ensuring better living conditions for local population by shortening waiting times at railway passages (underpass construction). Upon completion of the project, the track category will be increased from C3 (load 20t/axis) to D4 (load 22,5t/axis), rail-road crossings will be managed, access to platforms will be improved and two new platforms will be built.

Croatia

- Works on the **Hrvatski Leskovac-Karlovac** section are expected to be completed by the end of 2024.
- Despite the delays, **project Dugo Selo – Križevci** (Railway Section Upgrade and Construction of Second Track) is in the implementation phase, and it's expected to be completed no later than the end of the 2025.
- For the **Oštarije – Škrljevo project** (Designs for the upgrade of the railway section) work is in progress and 40 per cent of the completion has now been achieved, however, delays are occurring.

Hungary

- Some sections are not compliant with TEN-T requirements yet. Corridor's lines are not equipped with ERTMS and a number of sections do not correspond to the 22.5 tons axle load and the 740 m train length requirements. Several ongoing projects aim at improving this situation including "Upgrade of the Budapest, Rákos - Hatvan railway section", "Püspökladány - Debrecen: upgrading of the railway line and ETCS", "Bajánsenye - Boba: ETCS 2 deployment", and "Budapest Ferencváros - Székesfehérvár railway line: ETCS2".

RRTs

The primary technical challenge concerning railroad terminals along the Corridor is the **limited length of the tracks, frequently hindering the assembly of trains exceeding 740 meters in length**. This limitation has a significant impact on the productivity and competitiveness of combined transport. Additionally, it is essential to highlight the importance and urgency of enhancing and promoting the adaptation to European standards for connections to maritime ports, terminals, and factories generating freight traffic by rail.

At present the **accessibility for long trains (740 m)**, is ensured by 11 RRTs (Barcelona, Madrid, Murcia, Zaragoza, Bologna Interporto, Cervignano, Milano Smistamento, Novara, Orbassano, Padova and Budapest). Several other projects are planned in order to meet the KPI within 2030.

Inland Water Ways

For the **inland waterways network**, the full compliance for all the infrastructure requirements set by the Regulation is expected by 2030. At present TEN-T requirements are not achieved on the Casale Monferrato-Pavia-Piacenza sections and a short IWW section to Sete.

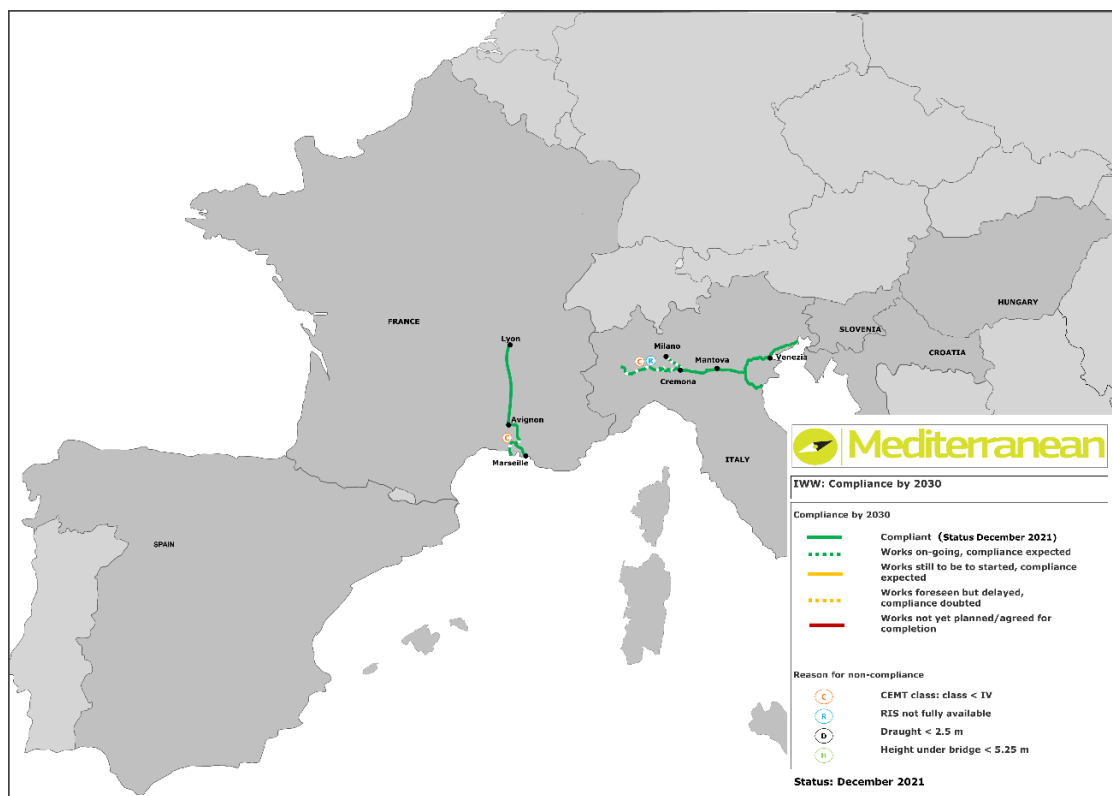


Figure 8: IWW compliance map by 2030 overview (data status December 2021)

Road

Full compliance for the road network is achieved along the Mediterranean corridor. The only currently non-compliant section concerns a few kilometres on the Hungarian-Ukrainian border (Vasarosnameny <--> Beregsurany). Several HU road projects aim at building the cross-border road section between Hungary and Ukraine, which is a major missing road link of the corridor on the external EU border (main projects: Hungary – Ukraine cross border section and Hungary - Western section of the Budapest motorway ring).

Maritime

Regulation (EU) 1315/2013 requires the **connection to the rail** network by 2030. All ports are reported to be already fully compliant with respect to this parameter. Nevertheless, several ports are further improving the rail connection with a view to improving the rail hinterland connection and thereby increasing possibilities for modal shift. For example:

- the investment in Valencia to improve the rail connection within the port's terminals and the Corridor for UIC gauge trains of maximum length of 750m;
- the new railway south access to Barcelona Port;
- the construction of additional rail connecting infrastructure network within the port of Koper;
- the port of Trieste (upgrading the port railway system inside and outside the port area);
- the port of Ravenna (Ro-Ro terminal and railway link).

Airports

Several projects are planned in order to improve airport accessibility on the Corridor:

- for Genova, Bergamo and Venezia airports a project has already been approved, with works expected within 2030;
- a new long-distance train station is foreseen at Nice airport within the Provence Cote d'Azur new rail line project, and a metro (Toulouse aerospace express) is also in project connecting Toulouse airport and main railway station of Toulouse (Matabiau);
- for Adolfo Suárez Madrid-Barajas airport, the high-speed rail connection to Chamartín station is expected for 2030.

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. Among the projects addressing this issue there is the pilot implementation of a green hydrogen production plant at Bologna airport to develop a dual-function facility capable of serving the needs of the airport (airside operating vehicles and co-generator for Terminal needs) but also to provide a charging point for transport services around the airport for passengers (shuttles and buses) and for cargo (trucks and operating vehicles attracted to the cargo city).

Conclusions

The activities presented above are the result of the elaboration of the information updated during the last year of work, in continuation of the results published in the previous Final Report of Phase I and II, and the main deliverables delivered during the respective periods.

During these months the Consultants provided the Commission – performing the activities envisaged in the contract – the relevant information concerning the technical and operational enhancements along the Corridor and collected the most recent information on the projects completed and to be completed.

In particular, the analysis undertaken shows that ongoing and planned investments on the Mediterranean Core Network Corridor should improve the Mediterranean completion compared with current situation but overall the CNC full deployment still faces multiple challenges, mainly due to insufficient node capacity and infrastructural bottlenecks. Homogeneity in the achievement of regular technical standard and requirements is a key factor for success in increasing connection and shifting traffic through environmental-friendly modes: to this extend, great progress was achieved on the Spanish real network to further deploy UIC gauge not only in railway lines but also in the port accesses, but still much needs to be done.

Cross-border sections deployment – above all the Lyon-Turin link – deserve dedicated attention, with plan and construction of access lines to be implemented timely and accordingly. Without this new link the Corridor will not be able to perform its role of the major east-west axis south of the Alps.

Furthermore, the challenges that ports and airports – as key infrastructures of the Corridor – will have to face are not to be underestimated as the completion of hinterland connections (and heavy rail connection for the airports), the digitalization of processes and the assurance in the supply of alternative fuels.

All the above is extremely necessary to reach the full compliance of the Corridor within the time lapse to 2030.