Special Report

A European high-speed rail network: not a reality but an ineffective patchwork

About the report Since 2000, the EU has been investing €23.7 billion into high speed rail infrastructure. There is no realistic long term EU plan for high speed rail, but an ineffective patchwork of national lines not well linked since the European Commission has no legal tools and no powers to force Member States to build lines as agreed.

Cost-efficiency is at stake, because not everywhere very high speed lines are needed, as the cost per minute of saved travel time is very high, going up to €369 million, and as the average speeds only amount to 45 % of the maximum capacity, while cost overruns and construction delays are the norm rather than the exception.

Sustainability is low, effectiveness of the investments is lacking and EU added value is at risk with three out of seven completed lines having low passenger numbers leading to a high risk of ineffective spending of €2.7 billion EU co-funding. Moreover, nine out of 14 lines and stretches have insufficient high numbers of passengers, and 11 000 national rules still exist, although the Court already asked in 2010 to lift these technical and administrative barriers.

Executive summary

High-speed rail is a comfortable, safe, flexible and environmentally sustainable mode of transport. It brings environmental performance and socio-economic benefits which can support the EU's transport and cohesion policy objectives. Since 2000, the EU has provided 23.7 billion euro of co-funding to support high-speed rail infrastructure investments.

We found that the EU's current long-term plan is not supported by credible analysis, is unlikely to be achieved, and lacks a solid EU-wide strategic approach. Although the length of the national high-speed rail networks is growing, the Commission's 2011 target of tripling the number of kilometres of high-speed rail lines by 2030 will not be reached: 9 000 km of high-speed line are currently in use, and around 1 700 km of line was under construction in 2017. On average, it takes around 16 years for new high-speed lines to proceed from the start of works to the beginning of operations.

There is no European high-speed rail network, and the Commission has no legal tools and no powers in the decision making to ensure that Member States make rapid progress towards completing the core network corridors set out in the TEN-T Regulation. As a result, there is only a patchwork of national high-speed lines, planned and built by the Member States in isolation. This patchwork system has been constructed without proper coordination across borders: high-speed lines crossing national borders are not amongst the national priorities for construction, even though international agreements have been signed and provisions have been included in the TEN-T Regulation requiring core network corridors to be built by 2030. This means a low EU added value of the EU co-funding of high-speed rail infrastructure investments.

The quality of the assessment of real needs in the Member States is low, and the alternative solution of upgrading existing conventional lines is not often given due consideration, even though the savings achieved when this option is used can be significant. The decision to build

high-speed lines is often based on political considerations, and cost-benefit analyses are not used generally as a tool to support cost-efficient decision-making.

High-speed rail infrastructure is expensive, and is becoming more so: on average, the lines we audited cost 25 million euro per km (not taking into account the more expensive tunnelling projects). The costs involved could in fact have been far lower, with little or no impact on operations. This is because very high-speed lines are not needed everywhere they have been built. In many cases, trains run on very high-speed lines at far lower average speeds than the line is designed to handle. The cost of a line increases proportionally with the design speed, and infrastructure capable of handling very high-speed operations (300 km/h or more) is particularly costly. Such high- speeds, however, are never reached in practice: trains run on average at only around 45 % of the line's design speed on the lines audited, and only two lines were operating at an average speed above 200 km/h, and none above 250 km/h. Average speed so far below the design speed raises questions as to sound financial management.

We assess sustainability of the EU co-funding to be at risk. Judging by a benchmark, a high-speed line should ideally have nine million passengers per year to be successful. However, on three of the seven completed high-speed lines we audited, the number of passengers carried was far lower. The infrastructure cost of these lines was 10.6 billion euro, to which the EU provided around 2.7 billion euro. This means that there is a high risk of ineffective spending of EU co-funding on these lines. Our assessment of the number of people living in the catchment areas of the audited lines indicates that nine of the 14 audited lines and cross-border connections did not have enough potential passengers to be successful. These include the three lines indicated above carrying a lower number of passengers compared to the benchmark of nine million.

In 2010, we issued a report calling for urgent action to lift all technical, administrative and other barriers to rail interoperability. However, we found that these barriers still persist in 2018. The rail passenger market is not open in France and Spain. There is on-track competition in Italy and, to a limited extent, in Austria; in these Member States, services were more frequent and of higher quality, whereas ticket prices were lower. Integrated ticketing systems, and greater attention paid to monitoring and standardising customer satisfaction and punctuality data, could further improve the passenger experience.

For a successful continuation of EU co-funding for high-speed rail infrastructure in the next programming period, we recommend that the Commission should take a number of steps. These include:

1. carrying out realistic long-term planning; and agreeing with the Member States the key strategic stretches to be implemented first, with close monitoring and enforceable powers to ensure that commitments to complete the core EU high-speed rail network are respected;

2. making EU co-funding support linked to earmarked strategic priority projects, effective on-track competition and achievement of results;

3. simplifying cross-border constructions with regard to tendering procedures, the use of "one-stop-shops" for the formalities, and the lifting of all remaining barriers;

4. actions to improve seamless high-speed rail operations for passengers, such as, for example, e-ticketing, simplification of track access charges and improving the reporting to citizens on punctuality and customer satisfaction data.

Observations

EU co-funded investments in high-speed rail can be beneficial, but there is no solid EU-wide strategic approach

High-speed rail is a beneficial mode of transport which contributes to the EU's sustainable-mobility objectives

Investment in high-speed rail infrastructure and operations significantly benefits society as a whole, as it brings to passengers time savings, high levels of safety, security and comfort on-board. Although the relationship is not entirely straightforward[17], various bodies[18] have concluded that high-speed rail also brings environmental benefits as trains have a lower carbon footprint than most other modes of transport.

The Commission's powers are limited, and its plan to triple the length of the high-speed rail network is unlikely to be achieved

The Commission's current long-term plan, set out in the 2011 White Paper and the CEF Regulation (Recital No 11), to triple the length of high-speed rail lines in the EU by 2030 (from 9 700 km in 2008[19] to 30 750 km by 2030) is not supported by credible analysis. Given the state of indebtedness of national public finances (Member State governments are the main investors), the limited return on this public investment, and the time it takes in practice to complete a high-speed rail investment, the goal of tripling the high-speed rail network is very unlikely to be achieved. The Commission has no say in decision-making, and it has no legal tools and no powers to hold Member States to their earlier commitments to build the high-speed lines needed to complete the core network.

Member States plan and decide on their national networks, leading to a patchwork of poorly connected national high-speed networks

EU trans-national corridors are not a priority

Although the TEN-T Regulation defines in its annexes where the high-speed lines are to be built, the Member States alone decide if and when exactly this will happen. They also provide most of the required funding, and they alone are responsible for implementing all of the necessary steps (studies, permits, procuring and monitoring works, and supervising all parties involved).

Within a Member State, many entities have a role to play, and various factors and parameters are crucial to whether or not construction proceed as initially planned. For example: The "Eurocaprail" project aimed to link Brussels, Luxembourg and Strasbourg by high-speed rail, connecting Luxembourg with Brussels in 90 minutes. At its December 1994 meeting in Essen, the Council deemed this project to be one of the 30 "top priorities" for building (works to start not later than 2010, and completion by 2020). By 2004, however, this project was no longer considered a national priority by any single Member State. Even though the EU has provided 96.5 million euro to upgrade the conventional line, journeys from Brussels to Luxembourg currently take up to 3 hours and 17 minutes. This is more than twice the objective set in 2003, and almost one hour slower than in 1980, when the same distance was covered in 2 hours and 26 minutes. As a result, many potential passengers simply travel by road;

Although international agreements have been signed to confirm the political will to establish connections, and although an incentive of 40 % co-funding is available under the CEF Regulation, Member States do not build high-speed lines if they are not considered a national priority, even if

such a line is situated on a transnational corridor and is completing the core network. The Commission's mid-term evaluation report on the CEF confirmed this observation[22].

The Commission has no power to enforce cross-border projects

The Commission currently lacks the necessary instruments to intervene effectively if delays on one side of a border hamper the timely use of high-speed rail infrastructure built on the other side of the border. Moreover, the possibilities for all stakeholders to oppose works are manifold, and may cause delays, or even to stop projects previously agreed upon.

There were several examples noted where the outputs created in one Member State will not be effective for at least another two further decades, because of works not having been completed in a neighbouring Member State

Portugal-Spain connection (Extremadura)

A high-speed rail connection was planned to connect Lisbon and Madrid. However, it was considered too expensive in times of high government debt. Despite 43 million euro of EU co-funding already having been paid to Portugal for studies and preparatory works, no high-speed cross-border rail connection is available. The conventional rail line stops in Evora. At the time of the audit, the works on the Portuguese side had started, while the works on the high-speed line on the Spanish side stopped about six kilometres from the border, as indicated by the arrow in Picture 1.Missing link at the border crossing on the Madrid-Lisbon high-speed line

In addition to lacking coordination of cross-border implementation, a number of other aspects are lacking: (i) there are no "single-corridor entities" to monitor results and impacts on a long term basis for future high-speed rail investments; (ii) there is no time-barring to limit the quantity and duration of legal or administrative action, and no single entity for hearing appeals; and (iii) the assessment of progress of works on a corridor is based on common key performance indicators which are still output-based[28].

Decision-making lacks reliable cost-benefit analyses

"Very high-speed" is not needed everywhere

Investment in high-speed lines is only justified if high-speed yields can be achieved: the larger the population base (future demand) and the greater the travel time elasticity[31] and speed yield, the greater the benefits of developing a high-speed line. A case-by-case approach is therefore needed to decide whether a full very high-speed line is needed. This decision is important, as construction costs are higher when design speeds are higher. Lines with maximum speeds of up to 160 km/h are at least 5 % cheaper to build than lines with speeds above that limit. This is because the tracks on higher-speed lines need to be further apart. Up to 160 km/h, the standard spacing is four metres; above that speed, the required line spacing is at least 4.5 metres. This means that tunnels need to be wider, which is more expensive.

Cost-efficiency checks are rare

High-speed rail infrastructure is more costly than conventional rail, both to build and to maintain. In given circumstances, however, very high-speed services, operating at 300 km/h or more, may provide limited additional travel time savings, compared to trains running on upgraded conventional lines. Therefore, the option of upgrading existing conventional lines to increase speeds, rather than building a very high-speed line, should also be considered, as it could result in significant cost savings.

A citizen's view: a real-life assessment of travel times, prices and connections, of passenger-services and of stations and their catchment area

Travel times and ticket prices, are important factors for success

Ticket prices may vary widely (e.g. according to the time of day, and the availability of special offers). However, this work was done on a sufficient scale (data on more than 5 000 return trips was collected) to allow us to realistically assess the options for travelling between the origin and destination pairs on the audited lines. The following messages came out of this analysis. On speed: High-speed rail is often much faster (on average 30 % to 50 % of travel time) than conventional rail. Air travel (from take-off to landing) is faster than high-speed rail. However, when assessing real total travel time from city centre to city centre, including the travel to the airport and boarding procedures, high-speed rail is often competitive. On ticket prices: High-speed rail is often much cheaper than air travel. Last-minute bookings for both transport modes are more expensive than tickets booked in advance.

The "city centre to city centre" analysis told us the following: The high-speed rail connection is the fastest travel option: even air travel takes longer from door to door and is more expensive. This explains why high-speed rail has increased its market share considerably on this line in recent years.

Further improvements needed to rail ticketing, and in monitoring passenger-services data

Published research on high-speed rail[34] suggests that ticketing flexibility and punctuality enhance intermodal competitiveness and promote sustainable success. These could be developed further.

The Commission has started to collect service-related data and indicators on the developments in the use of rail networks, and on the evolution of framework conditions through its Rail Market Monitoring Scheme (RMMS) platform. However, this data has been inconsistent up to now, as common standards were not comprehensively applied until the end of 2017. Moreover, only a limited set of data is currently collected in respect of high-speed rail as opposed to conventional rail; it covers the areas of infrastructure charging, capacity allocation, infrastructure investment and public-service obligations covering high-speed rail.

The number and location of stations are both important

Having the right number of stations is vital to a line's success and to its operational sustainability[35]. If a line has very few or no intermediate stops, the overall speed between origin and destination is high, and competitiveness with other modes of transport is optimal; however, this is detrimental to sustainability, as fewer potential passengers living along the line can use it. In contrast, if there are more stops on a line, its average speed is lower, and competitiveness with other modes of transport is at stake, but more passengers can board, increasing ticket income.

To assess the potential number of users of a high-speed line, we also examined the catchment areas of each of the ten high-speed lines and four cross-border lines in the audit[39]. Some stations do not have sufficient numbers of passengers in their immediate catchment areas, and are located too close to each other. This reduces the overall effectiveness of high-speed services, because they must stop too often without reaching many new passengers, or it makes daily train management overly complicated to ensure acceptable ridership figures.

While the Commission's plan is to connect all core network airports to the rail network by 2050, preferably by high-speed rail, only a few high-speed rail stations currently have a direct high-speed connection to an airport. High-speed rail and air can be complementary (by delivering passengers to an airport, high-speed rail can enlarge the airport's catchment area, and air passengers may decide to use a given airport because of a seamless and fast rail connection after landing). However, we found that it is complicated for passengers to combine high-speed rail and air travel.

To be successful and competitive, high-speed rail stations should be well located.

1. They should be easily accessible to travellers by many modes of transport, including walking and cycling, and offer suitable public transport facilities and parking spaces at affordable prices.

2. They should offer multiple well-functioning high-speed rail connections, as well as a sufficient number of trains throughout the day.

3. They should contribute to economic activity in the surrounding area (the "regeneration" or "re-urbanisation" effect).

High-speed rail sustainability: effectiveness of the EU co-funding at risk

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If a high-speed line is to be successful and the investment sustainable, it should be able to carry a high number of passengers. We assessed this element in two ways: by benchmarking the passenger numbers carried over time, and by analysing the number of people living in the catchment area along the line.

Box 2

The operations of the Shinkansen

The Shinkansen train and high-speed rail operations in Japan, allow us to make a wider comparison of high-speed rail operations on a global scale.

The 550 km high-speed line from Tokyo to Osaka is very successful, carrying 163 million passengers per year. There are many reasons for this success: the line connects megacities with populations of several million; trains run on dedicated tracks at a very high frequency (up to 433 trains per day); service reliability and punctuality are outstanding (in 2016, the average delay was less than 24 seconds throughout the year); and there are state-of-the-art safety and security measures in the stations and along the line, as well as sufficient support to travellers in stations.

The competitiveness of high-speed rail compared to other modes of transport: there is no "polluter-pays" principle yet

A carbon-based taxation system is a tool to consider the impact on the environment of the different transport modes. Currently, there is no operational arrangement within any EU Member State comparable to Switzerland's dedicated Railway Infrastructure Fund, which is part-financed from taxes imposed on lorries transiting the country. Switzerland's approach reduces the financial burden on taxpayers for building and maintaining the railway network, since it directly channels tax income levied on one transport mode to investment support for another.

Conclusions and recommendations

Executive summary

The Commission remains committed to the conclusions and the identified measures following from the strategy outlined in the 2011 White Paper and continues to put forward and implement the actions necessary to fulfil the objectives set out in the document. The TEN-T Regulation provides for a strategic and ambitious rail network planning from an EU perspective covering whole of the EU. The TEN-T regulation constitutes the main strategic and implementing tool to achieve those general objectives.

The TEN-T Regulation provides for a strategic planning from an EU perspective covering whole of the EU and detailing those parts of the railway network that are to be developed according to the high speed (HS) standards. The Commission considers that the deadlines for the development of the TEN-T set out in the Regulation are binding and it makes every effort to ensure that the deployments of the high-speed railway infrastructure concerned are made in a concerted and synchronised way across the EU. The tool of the core network corridors has been specifically designed to maximise synergies between the efforts made by different Member States and their infrastructure managers. Eventually, by 2030, all those elements will have to be interconnected. They can then benefit from the efforts made by the Commission in other areas to promote market opening and interoperability.

The Commission believes that the EU funding increases EU added value as the cross border, bottlenecks and missing links would otherwise not be adequately addressed or prioritised.

In order to ensure that longer distance journeys by high speed rail are attractive and competitive compared to aviation, very high speed services are often economically justified, with different characteristics for freight and passenger transport that are assessed on a case by case basis. Data on average speeds is likely to change once the network is completed, since the data reflects current services with an incomplete network.

The provisions included in the transport chapter of the CBA Guide (2014) are designed to allow for a rigorous and methodologically sound analysis of HSR investments, whose analytical framework for identification and evaluation of costs and benefits, and calculation of the socio-economic viability, does not differ from any other transport investments. The factors highlighted by the ECA should be assessed alongside broader policy objectives, such as encouraging modal shift in particular to address climate change and local air quality.

The inclusion of minimum passenger volumes may pre-empt project solutions that can be relevant vis-à-vis their territorial development needs.

Therefore, a guidance focusing on key requirements for CBA at EU level should be flexible enough to enable country-, sector- and project-specific features to be factored in the project appraisal on a case-by-case basis.

The fourth railway package, adopted in 2016, foresees the lifting of barriers to interoperability, enhancing safety and liberalising passenger rail markets. These will be implemented starting from 2019, with certain transitional periods.

Conclusions and recommendations

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This Regulation defines the EU infrastructure policy for transport and the criteria to identify the projects of EU common interest. It establishes the core and comprehensive network and concerning the rail network defines where high-speed needs to be deployed with associated targets and a timeline (2030 for the core, and 2050 for the comprehensive network), which the Commission considers binding although depending on the availability of financial resources in the Member States.

While the Commission is indeed not directly involved in the decision -making in the Member States, the tools in the TEN-T and CEF Regulations allow the Commission to verify that the Member States comply with their commitments under the Regulations – notably the core network corridors – and to take action where necessary.

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In 2017, the Commission launched a comprehensive study on the internalisation of external costs with the aim of assessing the extent to which the "user pays" and "polluter pays" are implemented in the EU countries across modes, and as contribution to the relevant policy debate.

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The fourth railway package, adopted in 2016, foresees a lifting of barriers to the interoperability, enhancing safety and liberalising passenger rail markets. It will enter into force for High Speed commercial services as of 2019.

Due to the fact that they are new infrastructure built to modern standards and designed from the outset for international traffic, there are considerably less barriers to interoperability on high-speed routes than on the historic network. The key ones which remain arise from different signalling systems, which will be addressed by the progressive roll out of ERTMS baseline 3 and

elimination of "class B" (ie national legacy) systems, and differences in voltage (25kV or 15kV), which can readily be addressed by technical solutions.

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While needing to be at a reasonable level, the charges need to be set at least at the level of direct costs to cover the costs incurred by the train run. The existence and level of mark-ups beyond direct costs depend on the ability and willingness of Member States to provide subsidies to infrastructure managers.

Abbreviations and glossary

Catchment area: An area from which a high-speed rail station can be reached by car in a given time (for the purposes of this report, 15, 30 or 60 minutes).

Cost-benefit analysis (CBA): An analytical tool used to appraise an investment decision by comparing its predicted costs and expected benefits. The purpose of a CBA is to facilitate a more efficient allocation of resources to help decision-makers to make an informed decision about whether or not to implement an investment proposal or possible alternatives.

CEF (Connecting Europe Facility): A mechanism which, since 2014, has provided financial aid to three sectors: energy, transport, and information and communication technology (ICT). In these three areas, the CEF identifies investment priorities that should be implemented in the coming decade. For transport, these priorities are interconnected transport corridors and cleaner transport modes.

CF (Cohesion Fund): A fund, which aims to improve economic and social cohesion within the European Union by financing environment and transport projects in Member States whose per-capita GNP, is less than 90 % of the EU average.

DG MOVE: Directorate-General for Mobility and Transport

DG REGIO: Directorate-General for Regional and Urban Policy

EAV (EU added value): The value resulting from an EU intervention which is additional to the value that would have been otherwise created by Member State action alone. For the purposes of high-speed rail lines, investing EU funds in lines within Member States also creates added value for EU citizens (for example, by facilitating travel and reducing overall travel times). However, expenditure on transnational corridors to complete a core EU network is automatically a stronger candidate for EU action because of its common interest: its EU added value is higher.

ERA (European Union Agency for Railways): An agency, established in 2004, whose objective is to support the development of technical specifications for interoperability, including ERTMS, and to contribute to the functioning of the Single European Railway Area.

ERDF (European Regional Development Fund: An investment fund whose objective is to reinforce economic and social cohesion within the EU by remedying regional imbalances by providing financial support for the creation of infrastructure, and by providing productive job-creating investment, mainly for businesses.

ERTMS (European Rail traffic management System): A major European project aimed at replacing the different national train control and command systems to promote interoperability.

Ex-ante conditionalities: Conditions which must be met before long-term and strategic infrastructure plans can be supported, used as a framework for EU co-funding investment.

High-speed rail: Rail services operating on new, specifically designed lines with a maximum operating speed of at least 250 km/h, and services operating on conventional lines with a maximum operating speed of at least 200 km/h.

INEA (Innovation and Networks Executive Agency): The successor of the Trans-European Transport Network Executive Agency (TEN-T EA), which was created by the European Commission in 2006 to manage the technical and financial implementation of its TEN-T programme. The INEA commenced operations on 1 January 2014 to implement parts of the following EU programmes: the Connecting Europe Facility (CEF); Horizon 2020; and legacy programmes (TEN-T and Marco Polo 2007-2013).

Interoperability: A European Commission initiative to promote a single market in the rail sector. Technical Specifications for Interoperability define the technical standards required to satisfy the essential requirements to achieve interoperability. These requirements include, amongst others, safety, reliability and availability, health, environmental protection and technical compatibility, and make that trains should be able to operate smoothly on any stretch of the European rail network.

MS (Member States): Member States of the European Union.

Ridership: In this context, a measure of the level of use of high-speed lines, defined as the number of passengers using the line divided by the length of the line, in kilometres.

Speed yield: Ratio of actual speed, as experienced by the traveller, to the maximum operating and design speed of the line.

Track access charges: Charges paid by rail operators to the infrastructure manager to recover part of the infrastructure costs.

TEN-T (Trans-European Transport Networks): A planned set of road, rail, air and water transport networks in Europe. The TEN-T networks are part of a wider system of Trans-European Networks (TENs), including a telecommunications network (eTEN) and a proposed energy network (TEN-E).