EUROPEAN UNION AGENCY FOR RAILWAYS

Making the railway system work better for society.

Report
FOSTERING THE RAILWAY SECTOR THROUGH THE EUROPEAN GREEN DEAL

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EXECUTIVE SUMMARY

At the peak of the COVID-19 crisis in April 2020, the estimated decrease in daily fossil CO_2 emissions due to global confinement was –17%. The overall decrease of carbon emissions for 2020 is estimated to be from -4.2% to -7.5% by organisations such as Nature Climate Change, the International Monetary Fund and the International Energy Agency. It will take an annual emission reduction of exactly this magnitude to limit climate change to a 1.5 °C warming over the next decades. These figures show ***how challenging it will be to reach the climate goals of the Paris Climate Agreement****. Furthermore, most changes observed during the crisis do not reflect structural changes in the economic, transport or energy systems. Surface transport, being the second most emitting sector in the EU, accounts for nearly half the decrease in emissions during confinement. It is the one of the key sectors for reaching both the EU targets and the Paris Agreement objectives.*

Rail transport has an undeniable green competitive advantage and, as such, may substantially contribute to the objectives of the Green Deal:

- ***RAILWAY TRANSPORT: mass transport mode with the lowest emissions***
- ***RAILWAY TRANSPORT: low impact on air quality***
- ***RAILWAY TRANSPORT: transport mode with the lowest external costs***
- ***RAILWAY TRANSPORT: sovereign mode of transport***
- ***RAILWAY ASSETS: long life expectancy***

In order to foster the rail sector for achieving the climate objectives, it is necessary to launch a strategy for a rail renaissance through multiple measures:

- *Connect major urban areas in Europe by rail*
- *Connect top 30 airports to the railway network*
- *Develop a European network of night trains*
- *Eliminate the railway bottlenecks*
- *Foster an industrial railway policy*
- *Create a 'Eurocontrol' for rail*
- *Finance railway projects*

This report by the European Union Agency for Railways aspires to contribute to the forthcoming strategy on sustainable and smart mobility in Europe of the European Commission.

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During the COP21 in Paris in December 2015, 195 countries have adopted the first world-wide legally binding agreement on climate[1]. This agreement has defined an international action plan aiming at mitigating the climate change effects by limiting the increase of temperature to below 2 degrees compared to pre-industrial levels. The European Union is politically committed to play a leading role in building an environmental policy at world level. Indeed, before the ratification of this agreement by the EU in 2016, the EU adopted legally binding acts to proactively limit the climate change effects in its strategy 2030 adopted in October 2014 and reviewed in 2018. With the introduction of the von der Leyen Commission, the targets established should be accompanied by a large investment programme, the European Green Deal. It is of outmost importance to use this programme to foster the development of railway within the EU using the green competitive advantage of this mode of transport in a wider mobility strategy.

I. EU TARGETS AND EUROPEAN GREEN DEAL

A) EU targets

The 2030 climate and energy framework includes EU-wide targets and policy objectives for the period from 2021 to 2030.

Member States are obliged to adopt integrated National Energy and Climate Plans (NECPs) for the period 2021-2030 and to develop national long-term strategies by 1 January 2020, and ensure consistency between their long-term-strategies and NECPs.

The key targets for 2030

At least 40% cuts in greenhouse gas emissions (from 1990 levels): this target should be achieved by cutting emissions by 43% (compared to 2005) for EU emissions trading system (ETS) and by cutting by 30% (compared to 2005) for non-ETS sectors. It must be noted that civil aviation is part of this ETS although until the end of December 2023 it applies only to intra-EEA flights

At least 32% share for renewable energy

At least 32.5% improvement in energy efficiency

The ambition is to **reach a carbon neutral economy in the European Union by 2050.**

[1] https://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf

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B)European Green Deal

In a communication from December 2019[2], the European Commission developed a global and intersector roadmap to reach those targets and to "turn an urgent challenge into a unique opportunity". The main aim of the European Green Deal is to transform our economy and society to put it on a sustainable path. This should require a massive public investment programme together with major efforts to direct private capital towards climate and environmental action.

sustainable and smart mobility — **increase and better manage the capacity of railways**

The Green Deal is composed of various elements going from "a zero pollution ambition for a toxic-free environment" to "mobilizing industry for a clean and circular economy". The strategic elements in the railway sector is named **"accelerating the shift to sustainable and smart mobility"**. The Commission announces that a strategy for sustainable and smart mobility will be developed in 2020.

It is clearly stated that a modal shift should be privileged for freight transportation as today 75% of inland freight is carried by road while it should shift onto rail and inland waterways. **Measures to increase and better manage the capacity of railways** and inland waterways should be proposed by the Commission by 2021 together with a new proposal to revise the Combined Transport Directive.

To reach this objective of modal shift, some elements are presented in this communication:

- Digitalisation should enable smarter traffic management and, in addition, for automated and connected multimodal mobility, increase transport efficiency;

Investments

Large volume investment is necessary to achieve the goals of the Green Deal. The European Commission has estimated that achieving

[2] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1588580774040&uri=CELEX%3A52019DC0640

- Fossil-fuel subsidies should end, including the tax exemptions in the civil aviation and maritime sector, so that the price of transport reflect the impact it has on the environment and on health and to establish a level playing field between modes of transport;
- The Emission Trading Scheme (ETS) should be extended to the maritime sector and the EU emissions should be reduced for airline companies. In addition, the extension of this system to the road sector and the correct road pricing should be discussed;
- EU battery industry will be subsidized as an alternative transport fuel.

the current 2030 climate and energy targets will require **260 billion Euros of additional annual investment, equal to ca. 1.5% of 2018 EU GDP.**

While 5 industrial sectors - Energy, Industry, Housing, Transport, and Agriculture - are targeted for substantially lowering emissions, the transport sector is largely considered to be the biggest contributor for decarbonising the economy. Considering the lower environmental impact of the railway transportation compared to other modes of mass transportation (road, air, maritime), the Green Deal clearly should result in an increase of its market share. However, despite its **green competitive advantage**, the railway sector may not be prioritised accordingly. This is the reason why a strategy must be developed to make sure that the railway sector will be considered the backbone of the future mobility strategy in the Green Deal. Two directions should be taken to reach this objective.

On one hand, the green competitive advantage of the railway sector should be recognised. On the other hand, it should be made clear that railway is not a stand-alone option. A multimodal strategy for mobility is needed - with a potential EU-wide responsible organisation, such as a **Land Transport Agency -** in which rail will play a central role due to its vast potential to contribute to the environmental objectives.

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II. MAKING RAILWAY THE BACKBONE OF THE MOBILITY STRATEGY IN THE GREEN DEAL

A) Railway: a greener mode of transport

➔ TRANSPORT: second sector in terms of emissions

In order to make the European Union the first carbon neutral region in the world by 2050, it is necessary to work on lowering the greenhouse gas emissions in the transport sector. Indeed, the trends in emission of greenhouse gas by main sector in the EU-28 between 1990 and 2017 demonstrate that **transport is the second sector in terms of emission, representing 25% of total greenhouse gas emissions,** after the energy supply sector.

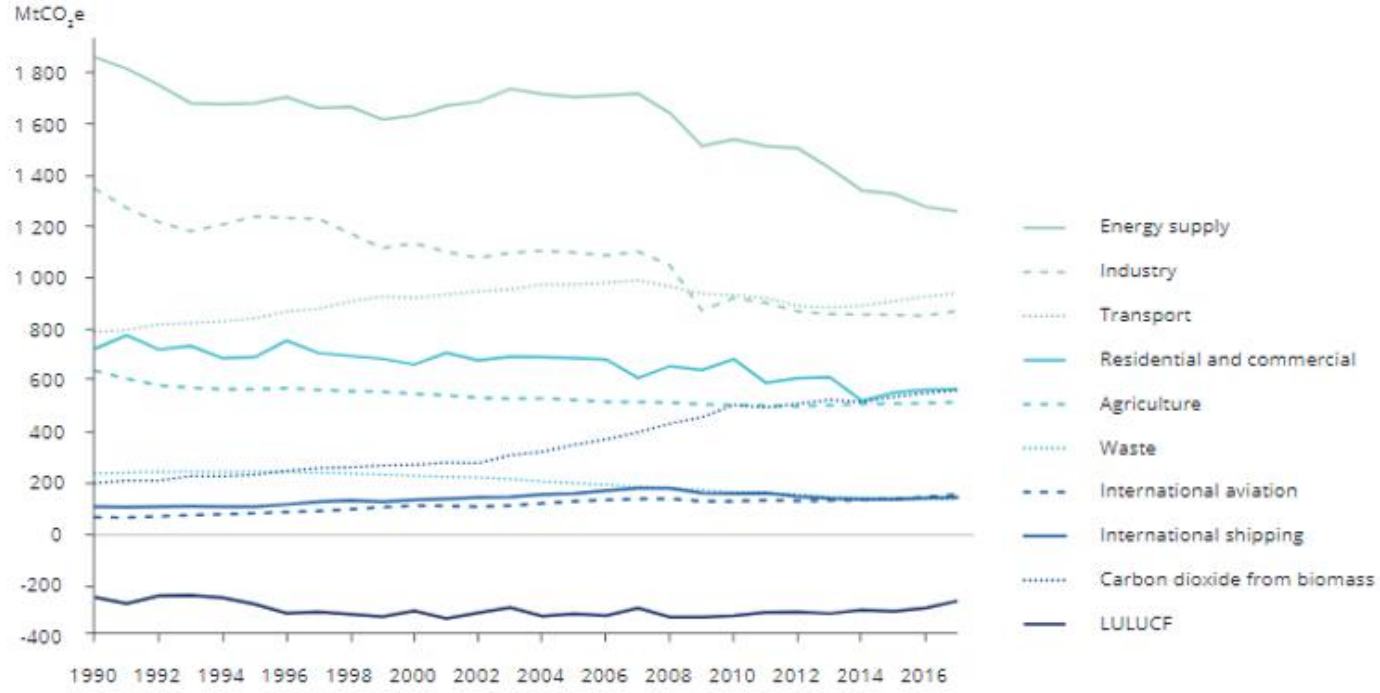

***Figure 1** – Greenhouse gas emissions by main sector in the EU-28, 1990-2017 - Source: EEA*

➔ RAILWAY TRANSPORT: mode of mass transport with the lowest emissions

While most of the sectors have managed to reduce their emissions over time, the transport sector has increased them. More dramatically, the road transportation has increased its emission by 170 Mt CO_2e between 1990 and 2017, 89 Mt CO_2e for international aviation and 35 Mt CO_2e for international navigation. The railway direct emissions **have declined by 66%** in this same period due to the fast electrification of the railway network. In the end, **the emission of greenhouse gas by rail transportation can be considered marginal** as it represents 0.5% of the emission produced by the transport sector.

➔ RAILWAY TRANSPORT: sovereign mode of transport ensuring energy independence

The correlative trend to the increase of GHG emission of the aviation, road and maritime transportation is an increase in the energy consumption for these transport modes. For international aviation, the energy consumption has even almost doubled since 1990.

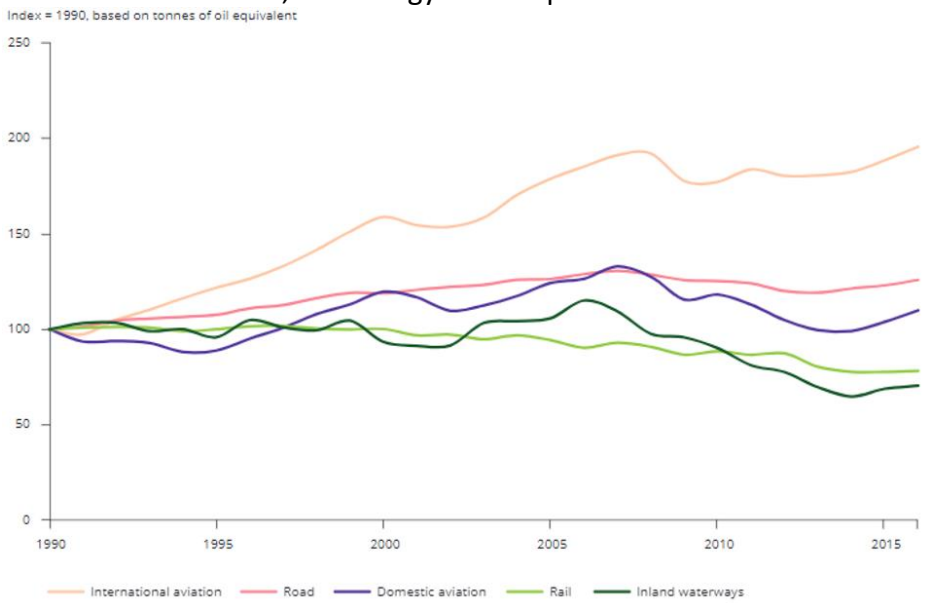

***Figure 2** – Energy consumption by transport mode - Source: Eurostat 2018*

Concerning the energy independence topic, in 2017, the EU dependency rate was equal to 55 %, which means that more than half of the EU's energy needs were met by net imports. This rate ranges from over 95 % in Malta, Luxembourg and Cyprus to below 15 % in Estonia and Denmark. The dependency rate on energy imports has increased since 2000, when it was just 47 % -

improving the efficiency in energy consumption is important for the reduction of greenhouse gas emissions.

The railway sector, on the other hand, only accounts for 1.7% of total EU energy consumption in transport, while in 2016 it carried 11.2% of freight and 6.6% of passengers of all transport modes (land, air and waterways). These figures are EU average modal shares which means that on some corridors or in some Member States, the share of rail is significantly higher. As a conclusion, railway transport can be considered as the most sovereign mode of transport in terms of energy independence, especially if the electrical source of energy is green.

➔ ROAD TRANSPORT: endless cycle of increasing energy needs

Due to EU policies a major advance has been made in making both trucks and cars greener. However, **those efficiency improvements are offset by growth in demand or negated by market trends** (e.g. improved engine efficiency is offset by larger and heavier cars – the so-called 'SUV effect'). Therefore, making benefit from rail advantages is fundamental to reach the climate objectives.

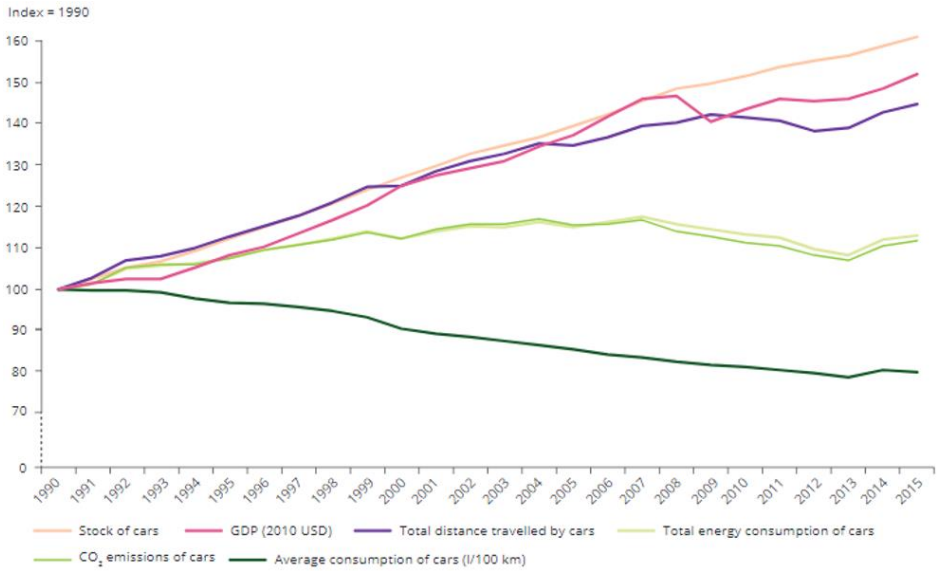

***Figure 3** – Fuel efficiency and fuel consumption in private cars, 1990-2015 – Source: Enerdata (2019), World bank (2019)*

In the freight sector, road remains the dominant mode within the EU also in freight transport and continues to handle around three-quarters of net ton-kilometres. Its weight in the modal mix is however lower than in the passenger transport, remaining around 75%.

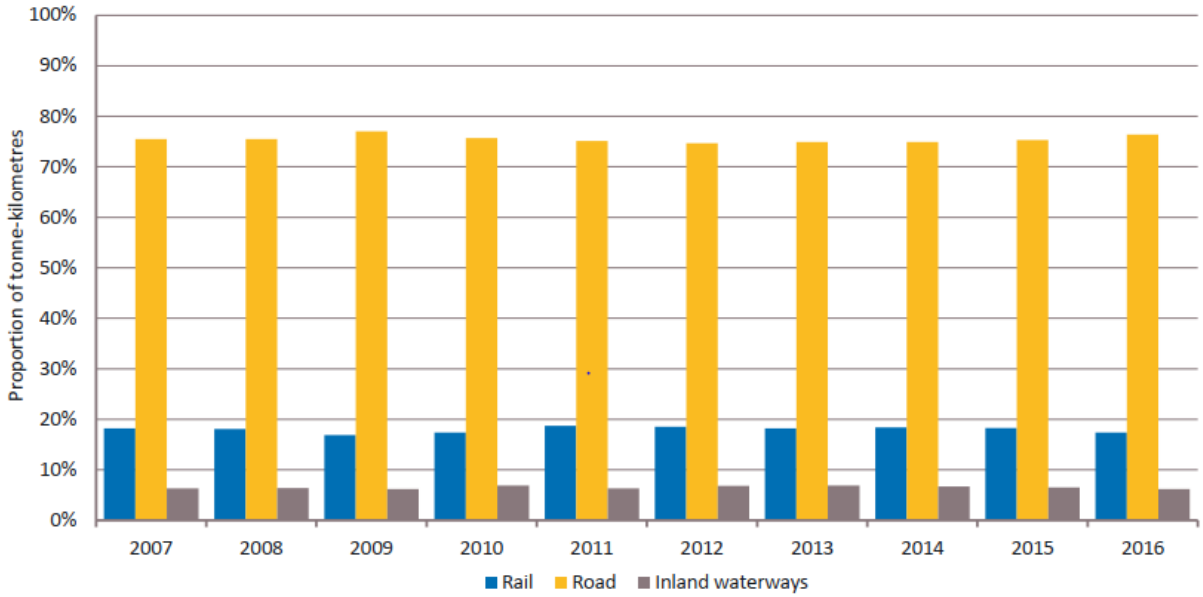

***Figure 4** – Freight land transport modal split 2007-2016 – Source: Eurostat*

➔ Battery Electric Vehicles (BEVs): not a cure all solution

In order to reduce the impact of the road transportation sector on the greenhouse gas emissions, a strategic action plan on batteries has been launched as part of the European battery alliance cooperation platform in order to create a competitive and sustainable battery manufacturing industry in Europe.

However, as counter-intuitive as it might be, producing an electric vehicle is currently more harmful to the environment than producing a conventional one, owing to the extraction and processing of raw materials such as copper, lithium and nickel. Despite its advantages, the environmental impacts in the production of electrical cars are important and are to be considered as **imported pollution** contrary to the combustion cars which pollutes mostly when they are used.

The Green Deal policy indicates a high potential, as well as a corresponding allocation of resources, for the creation of an industry for battery electric vehicles (BEV).

5 Key Concerns on BEV

1. Battery production relies on material concentrated in specific geographical areas (lithium, cobalt, rare earth elements (REEs), etc.) which might create difficulties in the supply chain, especially with the increase in demand (90% of lithium in Australia, Argentina and Chile; >60% cobalt in Congo or > 70% of REEs in China)
2. The "green level" of the BEV depends on the energy mix of the country where it is used (how electricity is produced is key)
3. The smallest and lightest vehicles sufficient for the user's needs shall be used, and these shall be driven in an economical style.
4. As BEV ownership becomes more mainstream, this shall not lead to greater car use overall through a rebound effect.
5. The overall transport pattern needs to be tackled, including options such as car sharing and the modal shift to collective transport / soft mobility / micro-mobility etc.

So, even if cars can use electricity as well – they will have to use batteries (strategic dependency and waste management) while the use of electrified overhead lines in the railway sector avoids this strategic problems. BEV should be then seen more as a solution for those forms of mobility that cannot be substituted by public transport, cycling or walking, particularly in rural and remote areas.

The same concerns could be expressed for the development of battery electric flight engines. The technology is not yet mature, but it is expected that it will take up to 7 years to launch short-distance flights and for a maximum of 50 passengers.

➔ RAILWAY TRANSPORT: mode of transport with the lowest external costs

The total external costs of transport in the EU28 are estimated at € 987 billion[3]. This figure only includes congestion costs for road transport, as it was not possible to estimate congestion costs for other modes. In general, the most important cost category is accident costs equating to 29% of the total costs, followed by congestion costs (27%). Overall, environmental costs (climate

[3] https://ec.europa.eu/transport/sites/transport/files/studies/internalisation-study-exec-summary-isbn-978-92-76-03080-5.pdf

change, air pollution, noise, well-to-tank and habitat damage) make up the remaining 44% of the total costs. However, large differences exist between transport modes.

Road transport (and particularly passenger cars) is the largest contributor to external costs (83% of the total costs, € 820 billion), which is partly explained by the large share of road transport in the total EU28 transport performance. For aviation and maritime transport the external costs in the EU28 are estimated to be € 48 and € 98 billion. Finally, the total external costs for rail transport amount to € 18 billion. This large divergence between external costs of the different modes of transport demonstrates the necessity to ensure a level playing field among transport modes.

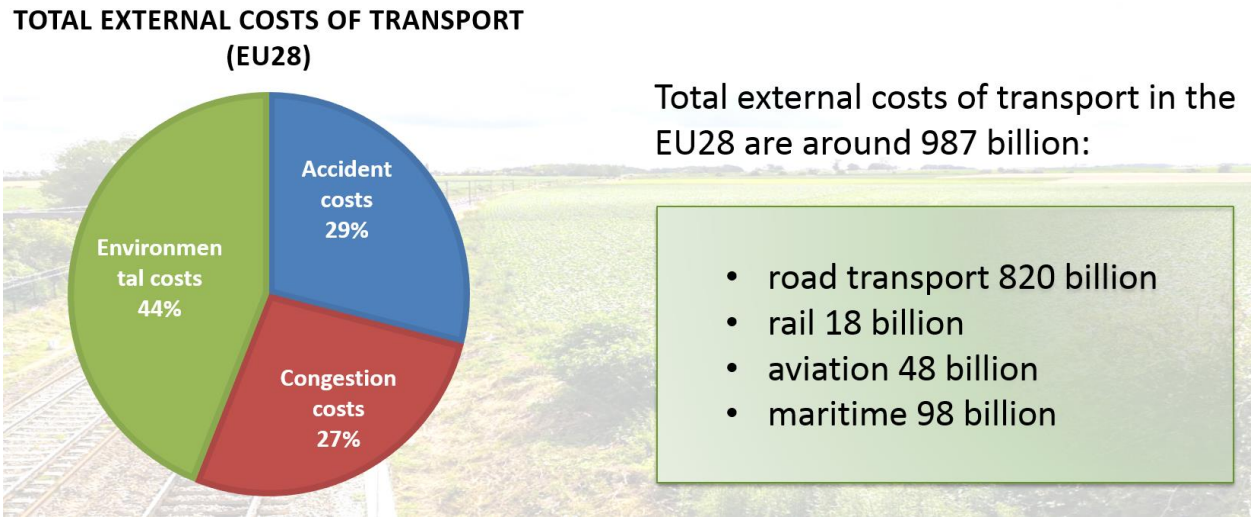

***Figure 5** – Total external costs of transport – Source: EC*

➔ RAILWAY ASSETS: long life expectancy

This must be put in perspective with the life expectancy of the different assets. Indeed, while the life expectancy of a car, a bus or a truck is estimated between 8 to 15 years and around 250.000km to 300.000km, the life expectancy of a railway vehicle is of 30+ years with a more intensive use and even up to 50 years for wagons. Although it might slow down the implementation of innovative solutions, the railway sector should emphasize the durability of railway assets and improve their modularity.

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➔ RAILWAY TRANSPORT: low impact on air quality

The importance given to air quality by EU citizens has raised in the last years. Poor air quality has a negative impact on quality of life. It causes many health issues, such as asthma and cardiovascular problems[4]. This in turn results in lost working days due to ill health, and higher costs for healthcare services, especially for children and the elderly. According to the European Environment Agency, poor air quality is also the number one cause of premature death across the EU. In addition to the damaging effects on human health, poor air quality also damages ecosystems. It should be emphasized that **the railway sector barely harms air quality**, especially in comparison to the other modes of transport.

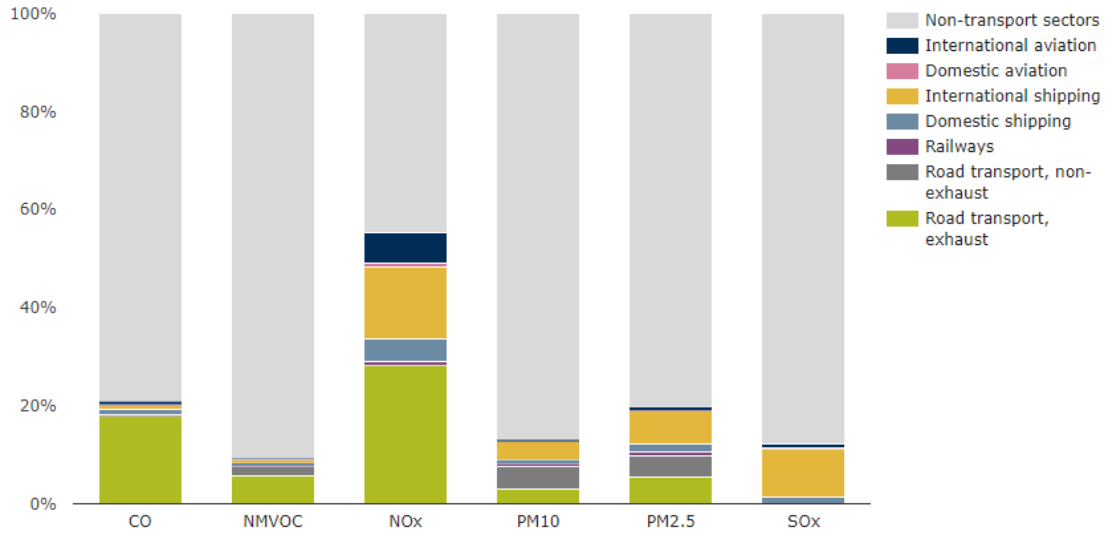


***Figure 6** – Contribution of the transport sector to total emissions of the main air pollutants - Source: EEA, 2019*

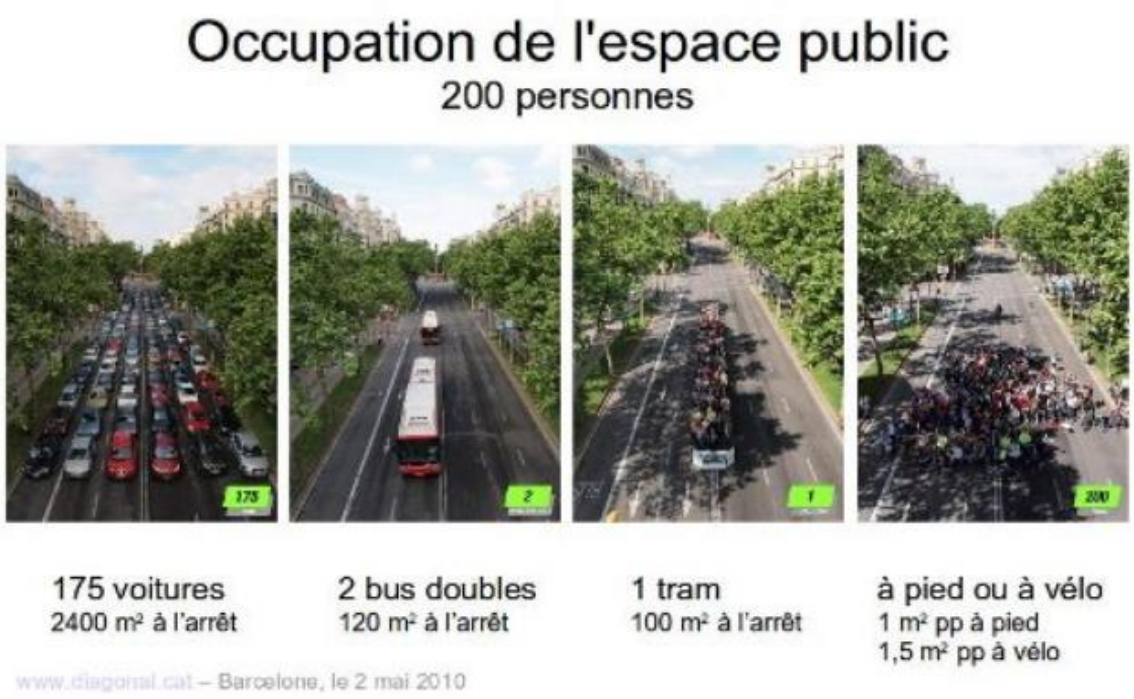
➔ ROAD TRANSPORT: source of congestion

One of the main emitting factors of GHG is car mobility with, in average, 102g CO_2/pkm, together with flight transportation that accounts for around 244g CO_2/pkm. For the train, it is less than 28g CO_2/pkm. This factor is reinforced by the fact that in Europe, the average occupancy of a car is slightly more than one. Increasing the number of car passengers proportionally reduce those emissions. With an average consumption of 0.12 kWh per passenger-km, urban rail is 7 times more energy efficient per passenger than car travel in cities. Low emission cars will still have a

[4] https://theicct.org/sites/default/files/publications/Global_health_impacts_transport_emissions_2010-2015_20190226.pdf

higher environmental impact than public transports or soft mobility. Furthermore, the space occupancy of the cars and, more particularly, the congested traffic is harming the competitiveness of the European enterprises. In France, the congestion cost has been estimated at 17bn Euros in 2013 and could reach 22bn Euros in 2030[5]. **A dense urban network of public transport, including rail, together with incentives to walking and cycling, compose the smart urban mobility triptych with reduced congestion costs.**

The pictures below, taken in Barcelona and largely spread on social networks, are a striking examples of the car space occupancy in comparison to other modes of transport.



It must finally be noted that, in an urban context, it takes 27min to make 4km by car, 18min by bus and 12min by bike. In Paris, the average speed of a car is 13km/h, 15km/h for a bike and 18km/h for an electric bike. With an average journey of 6.1km and more than half of the journeys being less than 3 km, it seems essential to focus the investments in alternative modes of transport than the car i.e. public transport and cycling infrastructure mainly.

[5] https://cebr.com/reports/the-future-economic-and-environmental-costs-of-gridlock/

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As a conclusion, rail is the mass transportation mode with the lowest greenhouse gas emission and the highest degree of energy independence, with the most durable assets. As such, rail must be considered the greenest mode of mass transportation and should play a central role in the future of mobility in Europe and in reaching the environmental goals of the European Union. The central role of the railway sector for reaching climate objectives has been recognised on the 2nd of June 2020 in a political statement signed by 22 Member States, Norway and Switzerland[6]. In this political statement, a strong political commitment has been expressed to develop further international rail passenger transport.

B)Strategy for a rail renaissance

In order to make the shift to rail, we must abandon the car-centric approach for mobility. A paradigm shift must be initiated, and the Agency wants to be in the forefront of this change, and already formulated this ambition by developing a compelling vision for the target railway system[7]. It appears clear now considering the climate impact of the different modes of transport that the most effective lever of action is to shift traffic from road and aviation to rail.

In order to foster the railway sector and make it the backbone of mobility over the next 30 years, it is necessary to:

- ➔ Connect major urban areas in Europe by rail
- ➔ Connect top 30 airports to the railway network
- ➔ Develop a European network of night trains
- ➔ Eliminate the bottlenecks
- ➔ Foster an industrial railway policy
- ➔ Create a 'Eurocontrol' for rail
- ➔ Finance railway projects

[6] https://www.permanentrepresentations.nl/permanent-representations/pr-eu-brussels/documents/publications/2020/06/04/political-statement-for-coalition-of-the-willing-development-international-rail-passenger-transport

[7] https://www.era.europa.eu/sites/default/files/agency/docs/target_railway_system_en.pdf

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➔ Connect major urban areas by rail

In the last 30 years, the EU's high-speed network has massively increased and, by the end of 2017, extended to over 8400 line-km while the initial objectives was to reach 30.000km by 2030. An objective which may seem now to be difficult to achieve. However, shifting long-distance trips from aviation (primarily short-distance flights) and cars to conventional and high-speed rail is energy efficient and can deliver significant environmental gains. High-speed rail offers the only established low-carbon and less fragmented alternative to aviation, a sector that is one of the most challenging to decarbonise, for the transport of large volumes of passengers over distances of up to 1.000 kilometres. Some Member States, like France, are already considering removing internal flights when there is a rail alternative doing the same journey in less than 2h30min.

About 60-80% of present high-speed rail activity can be shown to derive from shifts away from conventional rail and planes, with the remainder from avoided road traffic (10-20%) and induced demand (10-20%). There is some evidence of substantial (even nearly total) high-speed rail substitution for air traffic. More broadly, countries with existing high-speed rail lines tend to have proportionately fewer short-haul flights than countries without high-speed rail.

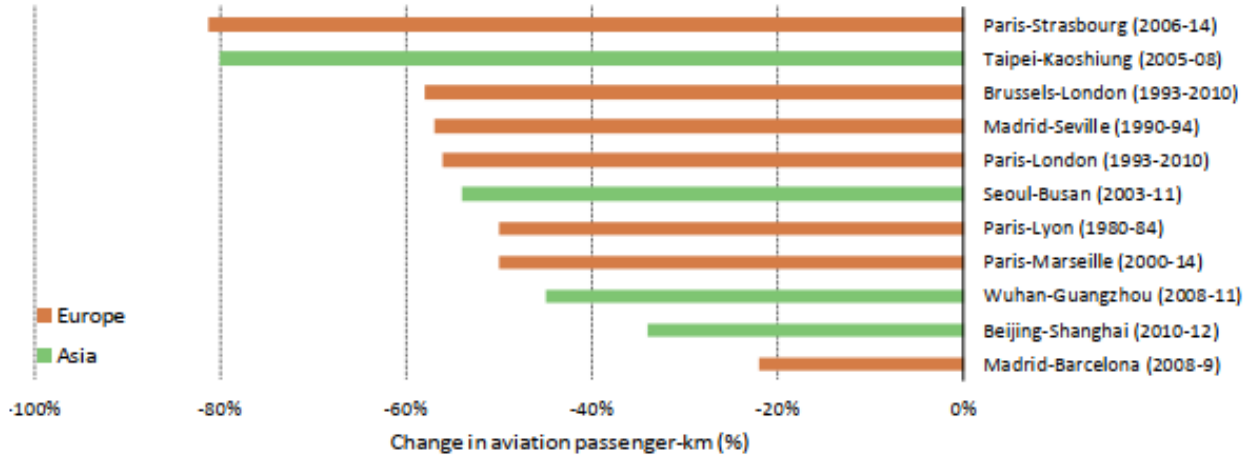

Figure 7 *– Average change in passenger activity on selected air routes after high-speed rail implementation – Source: Xia (2016); Borjesson (2014); Givoni (2013); Chen (2017); Commissariat Général au Développement Durable (2016)*

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Examples of High Speed lines' impact on air routes	
PARIS - STRASBOURG	In 2007, SNCF launched a new high speed service between Paris and Strasbourg. One year after the placing in service of this new line, the air connections dropped from around 2 million passengers/year to a bit less than 1 million. In 2012, the air connection between Strasbourg and Roissy was abandoned. In 2016, the second phase of this line has been completed putting Paris at around 1h50 from Strasbourg. The air connections between Strasbourg and Orly was then abandoned in spring 2016.
PARIS – LONDON	For a long time, the flight connection between Paris and London (first commercial connection in 1919) has been the most important worldwide. In 1994, there were more than 4 million passengers/year on this route. In 2007, it was a bit more than 2 million and today this connection is not even in the top 20 busiest connections in Europe. Additionally, a research by HS1 Ltd has found that high-speed train travel between the UK and Europe has enabled a yearly emission reduction of 750,000 tons of carbon, the equivalent of 60.000 flights.
ROMA - MILANO	In Italy, between 2008 and 2018, the number of high-speed passengers has increased from 6.5M to 40M with the development of the HS network. On the line between Roma and Milano, the share of passengers travelling by train have increased from 38% in 2009 to more than 70% in 2017 with a long lasting positive trend for the train.
BERLIN - MÜNCHEN	Finally, a more recent example is the Berlin-Munich line. After this line opened in December 2017, the journey time between the two German cities decreased from six to four hours, leading to a 200 per cent increase in the number of passengers on the rail connection.

When we look at the major urban areas in Europe, it is noticeable that there are big gaps in the rail network between major European cities. Our focus is on the top 50 most populated European urban areas at a distance of less than 1.000km and for which the train journey is more than five hours. The worst 20 EU connections between these cities have been recorded in the following table:

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Link	Time/distance	Estimated passengers/year 2019[8]
Madrid (3)[9] – Lisboa (19)	9h45 / 625km	1.5M
Paris (2) – Milano (8)	7h20 / 850km	1.75M
Marseille (14) – Milano (8)	7h15 / 520km	No data
Amsterdam (12) – Hamburg (11)	5h15 / 460km	455k
Amsterdam (12) – Berlin (5)	6h05 / 650km	840k
Hamburg (11) – Stockholm (28)	10h40 / 980km	220k
København (33) – Stockholm (28)	5h15 / 650km	1.5M
Stuttgart (20) – Milano (8)	7h / 500km	165k
München (17) – Milano (8)	7h10 / 500km	510k
Berlin (5) – Warszawa (15)	5h45 / 575km	200k
Berlin (5) – Wien (18)	8h30 / 680km	1M
Wien (18) – Warszawa (15)	7h / 670km	405k
Berlin (5) – Budapest (16)	11h30 / 875km	330k
Warszawa (15) – Budapest (16)	10h / 850km	365k
München (17) – Budapest (16)	6h50 / 650km	375k
Wien (18) – Milano (8)	10h / 850km	510k
Milano (8) – Budapest (16)	13h / 970km	200k
Budapest (16) – Bucureşti (29)	14h40 / 840km	125k
Bucureşti (29) – Sofia (41)	9h / 350km	110k
Sofia (41) – Athens (10)	11h50 / 795km	220k

Based on past experience related to investments on high speed lines, the number of flight passengers per year connecting the two main cities and the potential intermediary stops, the 4 connections which have the highest potential of modal shift would be:

New high Speed lines with highest potential	
MADRID - LISBOA	The Commission granted 265M Euros from the cohesion fund in March 2020 to improve the high speed connection between Madrid and Lisboa. The work should start from December 2022 mainly in

[8] ERA figures based on Eurocontrol data.
[9] The number next to a city is its rank in the top 50 most populated urban areas classification.

	Extremadura with a 180km section of line in this project of 715km. However, at the moment, the Portuguese government indicated that there would be no budget available for this project until 2027.
PARIS - MILANO	In June 2020, Thello a daughter company of Trenitalia is planning to launch a high speed service on this line which would connect Paris to Milano in 6h.
KØBENHAVN - STOCKHOLM	There are projects to increase the commercial speed on this line and to link the two cities in 2h40 with the EuropaBanan built.
BERLIN – PRAHA - WIEN	This project would also be a possibility to connect Dresden and Brno and could also be extended to Bratislava and Budapest. A high speed development programme has been launched by the Czech Republic in 2017 incorporating this project. The planning and project works are underway. The first sections are expected to start to be constructed around 2025. The most advanced is the section between Praha and Dresden with a tunnel under the mountain range on the Czech/German border. There is a common Czech-German group working on it. Then some sections between Praha and Brno and between Brno and Ostrava are advanced as well.

In the decision-making process to invest in a project, the carbon footprint measuring GHG emissions should be taken into consideration. Indeed, with the environmental objectives, **it is now imperative when evaluating the merit of a project to compare not only the economic costs with benefits but also the costs and benefits in terms of incremental GHG emissions** as well as consideration to other environmental impacts. In this respect, the Taxonomy Regulation, agreed at political level in December 2019 and which will establish in future delegated acts criteria determining when an economic activity can be considered sustainable will be an important step forward.

Although important, it is extremely difficult to calculate the carbon footprint ex ante and due to uncertainty on secondary effect and many variables, GHG estimates are in principle approximate. In its methodology[10], the EIB decided to set minimum project thresholds for inclusion in the GHG footprint at 100,000 tons CO_2e per year for absolute emissions and 20,000 tons CO_2e per year (positive or negative) for relative emissions. Taking into account the direct emissions (fuel combustion) and the indirect emissions (electricity used by the operators), it shows that,

[10] EIB project carbon footprint methodologies – Methodologies for the assessment of project emissions and emissions variations

according to the figures of the European Environmental Agency, a plane will emit around 244g CO_2/pkm while it is less than 28g CO_2/pkm for a train, it was possible to calculate the emissions for these specific air routes and the potential emissions for the routes with a train journey.

For the connection Madrid-Lisboa, with 1.5M passengers/year and, based on Eurocontrol data, an average flight distance of 625km, the direct emissions produced by operating this flight connection are 212,280 tons CO_2 per year. With the same number of passengers on rail and the same distance, it would be 24,360 tons CO_2 per year. For the connection Paris-Milano, this would be 298,900 tons CO_2 per year for the flight connection and 34,300 tons CO_2 per year for the rail connection. For the connection København –Stockholm, this would be 219,600 tons CO_2 per year for the flight connection and 25,200 tons CO_2 per year for the rail connection. Finally, for the connection Berlin-Wien, this would be 152,500 tons CO_2 per year for the flight connection and 17,500 tons CO_2 per year for the rail connection.

Route	Flight passengers/year	Air CO_2 direct emissions/year	Rail CO_2 direct emissions/year
Madrid-Lisboa	1.5M	212,280 tons CO_2	24,360 tons CO_2
Paris-Milano	1.75M	298,900 tons CO_2	34,300 tons CO_2
København–Stockholm	1.5M	219,600 tons CO_2	25,200 tons CO_2
Berlin-Wien	1M	152,500 tons CO_2	17,500 tons CO_2

If there was a full modal shift from air to rail as it happened in the Paris-Strasbourg scenario for these four high speed connections, a **reduction of 781,920 tons CO_2 direct emissions** on a yearly basis could be expected. The full modal shift being an optimistic scenario and considering the past experiences, a modal shift of 60% of the passengers would still represent a reduction of 469,152 tons CO_2 direct emissions per year. Without considering the emissions due to the construction of the lines, these figures are still very conservative for three main reasons. Firstly, a modal shift from other modes of transport, mainly private cars and growth in demand would have to be expected. Secondly, the intermediate stops (e.g. Praha and Dresden in the Berlin-Wien scenario) would also contribute to the reductions in CO_2 emissions. Thirdly, short distance flights (<700km) emit more CO_2 per passenger/km than long distance flights so that the average of 244g CO_2/pkm is underestimated for the flights considered. Indeed, 25% of airplane's fuel is used during landing and take-off making flight relatively inefficient energetically on short distances.

In addition, most of the busiest air routes (***annex 1***) are connecting two cities from the same country. Where the railway connection is performing well (e.g. Madrid-Barcelona), the green advantage of the railway transportation should be valued more and the use of the airlines should

be disincentivised (e.g. through internalization of external costs). From these busiest domestic air routes, two specific routes have an important high speed rail potential:

- **München-Hamburg**: today 5h35 for 612 km with 1.75M flight passengers/year;
- **Athens-Thessaloniki**: today 5h25 for 501km with 1.5M flight passengers/year. It is also noticeable that one of the missing link identified (see below "eliminate bottlenecks") is ID 304: Sofia [BG] - Kulata [BG] - Promachon [EL] - Thessaloniki [EL]. An HS line from Athens to Thessaloniki could be prolonged to Sofia.

Finally, despite the outmost importance to continue investing in the development of the European high speed network, maintenance and reinvestment in the existing infrastructure to reinforce existing routes is at least as important as construction of new infrastructure. It is also necessary to better manage the existing rail capacity.

➔ Connect top 30 airports to a railway network

Most of the largest airports in the European Union are already connected to a railway network. However, the following airports are not connected to any railway network, whether light rail or railway line (see opposite box). Two important airports not connected to a railway network have not been included in this list:

- Palma de Mallorca due to its geographical position;
- Berlin Tegel due to the construction of the new Berlin Airport and its connection to the central station of Berlin.

The key targets

Dublin airport: 31M pass./year

Budapest airport: 15M pass./year

Alicante airport: 14M pass./year

Bucharest airport: 14M pass./year

The interconnection between the railway network and the main airports would be an important factor of success of initiative such as "Night and flight" developed in Switzerland which could change medium to long-distance travel behaviour. The night trains in the past decades have rarely been oriented towards the business travellers. The "Night and flight" initiative made it possible to flexibly link a night train journey with a one-way flight as a round trip at a package price. However, the combination between night train and plane can only be a success if it was

offered through an integrated rail-air ticketing service. This would also require a European network of night trains.

➔ **Develop a European network of night trains**

Most of the night trains connections in many of the European countries (**annex 2**), particularly in the West, are at risk of closure or have already closed mainly due to the strong competition with low-cost airlines but also due to the lack of investment in these services. However, at the end of the 1980s, night trains were an efficient alternative to travel in Europe and there are today opportunities to revitalize this type of service.

Indeed, there is a contrary trend in Austria with the development of Nightjet services *(***annex 3***)*. Flights between Vienna and many of the cities served by these night trains are infrequent or inconvenient and, in Austria, domestic competition from coach operators is tightly regulated. This may improve the commercial viability of night trains in Austria.

Considering the current trends, night trains seem to be competitive against aviation, but require affordable tickets, which in turn require reduced track access charges. In the longer term, the use of private cars, and eventually aviation, are likely to be reduced to the benefit of other, more environmentally friendly modes of transport, which provide a competitive advantage to this type of service. It could also play an important role in tourism and it facilitates the travel of people with reduced mobility due the accessibility requirements.

It must be noted that, in general, night passengers are rather not taking their decision based on price or shortest possible travel time but more on the level of comfort according to the Research study for TRAN Committee – "Passenger night trains in Europe: the end of the line?". However, in the absence of night trains, travellers will choose the fastest service. In addition, an important factor in the development of such service is to consider a minimum sleeping time. Over the past years, best practices for night train services have been established:

- To offer a range of accommodation and the opportunity to pay more for exclusive use of a compartment;
- To use yield management to maximise revenue from the capacity available; and
- To offer all types of accommodation for sale through a single (multilingual) website.

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Two key measures to revitalize night trains

REDUCTION OF TRACK ACCESS CHARGES

- There would be a need to agree at EU level on a common definition of “night trains” and then classify them as a specific segment of traffic so as to allow for the reduction of track access charges. For instance, **Directive 2012/34/EU should be modified** to specify that night trains should be considered as a market segment, and to ensure that their viability is not undermined by excessive mark-ups to infrastructure charges. Adding an element of “day trains versus night trains” in this Directive would be a good step.

SUPPORT THE OPERATORS IN BUYING NEW NIGHT TRAINS

- There should be a mechanism to support the operators in buying new night trains or modernizing Rolling stock. Indeed, a major element of the cost of providing night trains is the cost of rolling stock. Relative to day stock, there may be both a higher cost per vehicle, because of higher unit manufacturing costs for the typically small night stock fleets, and a higher cost per passenger space, because night stock typically has fewer spaces per vehicle. The importance of incentives to buy new Rolling stock is even more important considering the average age of the night trains, considerably higher than the conventional fleet so that to invest operators need to have certainty on the sustainability of their financial investments.

➔ Foster the industrial railway policy

Digitalisation has the potential to increase infrastructure capacity, between 20% and 50% depending on the traffic type and signalling used. Among the induced benefits, aside the higher share of railways and the avoided greenhouse gas emissions, savings from avoided infrastructure investments shall also be considered and quantified. Modern signalling systems can really improve the performance of the railway sector. In addition, the national legacy control systems are incompatible (the patchwork effect due to the lack of coordinated strategy) and it constitutes a significant barrier for having a seamless traffic. **ERTMS ("European Rail Traffic Management System")** is a major industrial project being implemented by the European Union, a core industrial project which will serve to make rail transport safer, more competitive and increase the level of integration of the European railway system. This common European standard and its deployment will provide the backbone for a digital railway system and the main factor to achieve the Single European Rail Area.

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The following table summarises the main areas for future digitalisation.

Area	Topics
Data management	▪ Traffic data management solutions (including ERTMS/ETCS) ▪ Asset data management solutions ▪ Energy data management solutions
Big data	▪ Maintenance prediction ▪ Network usage
Cybersecurity	▪ Risk understanding by the staff ▪ Security-by-design
Artificial intelligence	▪ Train operations ▪ Autonomous driving (certified AI technologies for safety-critical applications) ▪ "Intelligent" maintenance concepts
New mobility services	▪ Seamless door-to-door mobility based on integrated multimodal transport systems
Digitalisation of freight logistics services	▪ Rail freight as part of a global digital logistics system (greater efficiency and lower costs)

Figure 8 – Main areas for future digitalisation - Source: final report on the contribution of the rail sector to delivering EU policy priorities at local and regional level – Committee of the Regions

ERTMS should also foster the innovation in the rail sector. On the 5th of January 2017, the European Commission adopted an Implementing Regulation setting the new ERTMS European Deployment Plan (EDP)[11]. The EDP provides for about 40% of the Core Network Corridors to be equipped by ETCS by 2023 (15 672 km). However, this objective will be difficult to achieve. Indeed, although ERTMS is vital for an efficient European railway system as it **can increase capacity by 30 to 40%**, only 9.5% of track was equipped in 2015. It is important to notice that track-side equipment can be reduced by up to 70% with the latest version of ERTMS, with important savings on renewal, maintenance and fostered reliability. **The deployment of ERTMS shall be firmly accelerated together with the specifications, development and demonstration of ERTMS game changers.** Finally, the Agency shall act as a strong system authority for ERTMS, also with the aim of protecting investments through **improved modularity.**

[11] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32017R0006

This capacity increase can be further improved together with energy savings with **Automatic Train Operation (ATO)**. Coupled with lighter trains and higher loading factor, ATO can lead to energy savings between 20% and 50%. Also, ATO coupled with ERTMS/ETCS deployment, will reduce operating costs for railway undertakings and maintenance costs for infrastructure managers, while further improving punctuality. Investing in this technology is fundamental to make the rail renaissance a success.

The **imminent emergence of 5G**, with its extremely good latency and throughput close to 1 Gigabyte per second, should enable the development of critical and operational railway applications. ERA, the International Railway Union (UIC) and the sector are currently cooperating with the European Telecommunication Standards Institute (ETSI) and the 3rd Generation Partnership Project (3GPP) to standardise the 5G-based Future Rail Mobile Communication System (FRMCS) as the successor to GSM-R. The first specifications should be available in 2022 and this new communication system should enhance voice and data applications and could be a facilitator for intelligent sensors and smart metering. While the development of 5G would necessitate new equipment (on-board and trackside) at a major cost impact, it is a key enabler for the digitalization of the railways. It will allow to create more predictive maintenance models and tele-maintenance cutting thus the costs of maintenance, to facilitate the development of business applications such as a multimodal ticketing and, together with higher grade of automation, to better manage traffic operation with an increase of the capacity. It would be essential to fund testing on the adaptability of 5G to railways in order to determine if some fine-tuning will be necessary. It is also extremely important to secure the spectrum capacity for rail main lines and urban radio communication system, enabling to ensure the right level of quality of service for rail transport systems.

However, digitalisation of the railway system offers at the same time an inherent risk regarding cybersecurity, as the cyber-threats surface increases with the technology penetration. Careful considerations on awareness, training and technical remediation (e.g. security by design) to achieve a cyber resilience of the railway systems are the corollary of digitalisation.

Other important aspects to be considered in the next years are the development of **interchangeable components**, a **fair ticketing system** and **interoperability of data** between various platforms within rail and between modes. Indeed, improving connectivity with other transport modes (car share, buses, public transport) including scheduling information are crucial for the increase of the rail market share for passenger transport.

Finally, the COVID-19 crisis has put the light on the necessity to increase the capacity at train level. The double-module with a capacity of up to 1300 passengers/train can ensure the physical distance in case of sanitary crisis while being fully used in normal period. 740m long freight trains, on the other hand, can increase the capacity by up to 25-30% on most of the networks. Supporting the investment in new rolling stock or in their refurbishment is essential to achieve the modal shift. It could also participate in the development on new innovative services like the one developed by Mercitalia in the last 3 years.

Mercitalia Fast experience

A team composed of Mercitalia and Ferrovie dello Stato staff members started an internal analysis on the e-commerce and express delivery sector in October 2017. From this market analysis, a decision has been made to create a new "innovative and disruptive" service called Mercitalia Fast for a growing logistic market segment, e-commerce, by adapted high speed passenger trains into freight trains. In order to decrease the time for authorizing the vehicles, the closest configuration to the passengers' trains has been adopted:

- ETR 500 with a maximum speed of 300 Km/h has been used with 2 locomotives at the extremities and 12 wagons allowing for a maximum speed of 250 Km/h with this composition;
- Internal furnitures, toilettes, drains and other components for the passengers service have been removed to enable the cargo capacity without exceeding the maximum and minimum weight of passengers wagons;
- No modification of the doors;
- The fire prevention system has been maintained as of a passenger train;
- Some specific ballasts have been developed for empty wagons.

In addition, an algorithm to distribute the load coherently and to avoid overload has been developed. Some load simulations for different balancing situation have also been conducted to guarantee safety against derailment.

With this Mercitalia Fast service, new types of goods are transported such as mobile phones, clothes, wines and food, glasses. In addition, Mercitalia Fast started a partnership with Nextive for the e-commerce sector. The goods are transported on a North-South of Italy during night hours. Mercitalia Fast trains operate as the last train in the night and the first in the morning with the objective of delivering the goods at the most convenient time for the last miles delivery. Reduced track access charges could also be beneficial for this kind of services, especially as this is a growing market trend and in favour of intermodality. Finally, the A1

highway connecting North and South of Italy is congested due to heavy traffic of trucks and, in the first year of service, Mercitalia Fast service was able to shift about 8000 trucks from the road to rail.

➔ Eliminate bottlenecks

Following the work started by the former Member of the European Parliament (MEP) Michael Cramer on the railway missing links in the European Union, the European Commission elaborated a study on the missing links on the internal EU borders in March 2018. 365 cross-border rail connections were identified in total of which 149 are non-operational today (41%). It is also striking that most "missing" or "promising links" are outside of TEN-T corridors or the Comprehensive Network.

Shortlist of missing and promising links

ID 7: Hazebrouck [FR] - Poperinge [BE]	ID 216: Ilirska Bistrica [SI] - Šapjane [HR] (- Rijeka [HR])
ID 8: Armentières [FR] - Comines/Komen [BE] (- Kortrijk [BE])	ID 219: Imeno [SI] - Harmica [HR] - Savski Marof [HR]
ID 9: (Lille Flandres [FR] -) Comines(France) - Comines/Komen [BE]	ID 220: (Stranje [SI] -) Sveti Rok ob Sotli [SI] - Đurmanec [HR] (- Zabok [HR])

ID 16: (Valenciennes [FR] -) St-Amand-les-Eaux [FR] - Antoing [BE] (- Tournai [BE])	ID 237: Priekule [LV] - Skuodas [LT] - Kretinga [LT] (- Klaipeda [LT])
ID 19: (Le Quesnoy [FR] -) Bettrechies-Bellignies [FR] St. Ghislain [BE] (- Mons [BE])	ID 238: (Liepaja [LV] - Priekule [LV] -) Vainode [LV] - Ritine [LT] - Bugeniai/Ruzgai [LT] - Mažeikiai [LT]
ID 20: Maubeuge [FR] - Quévy [BE] (- Mons [BE])	ID 239: (Riga [LV] -) Reņģe/Ruba [LV] - Mažeikiai [LT]
ID 39: (Gent [BE] -) Wondelgem [BE] - Terneuzen [NL]	ID 240: (Riga [LV] -) Meitene [LV] - Joniškis [LT] (- Šiauliai [LT])
ID 40: Sint-Niklaas [BE] - Terneuzen [NL]	ID 242: (Daugavpils [LV] -) Eglaine [LV] - Obeliai [LV] - Panėvežys [LT]
ID 43: (Antwerpen [BE] -) Turnhout [BE] - Tilburg [NL]	ID 243: (Daugavpils [LV] -) Kurcums [LV] - Turmantas [LT]
ID 44: (Hasselt [BE] -) Heerpelt [BE] - Achel [BE] - Borkel en Schaft [NL] - Eindhoven [NL]	ID 277: Komárno [SK] - Komárom [HU]
ID 45: Mol [BE] - Roermond [NL]	ID 304: Sofia [BG] - Kulata [BG] - Promachon [EL] - Thessaloniki [EL]
ID 57: (Mönchengladbach [DE] -) Dalheim [DE] - Roermond [NL]	ID 306: (Varazdin [HR] -) Kotoriba [HR] - Murakeresztúr [HU]

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ID 59: Geldern [DE] - Straelen (DE) - Venlo [NL]	ID 307: (Zagreb [HR]-) Koprivnica [HR] - Botovo [HR] - Gyékényes [HU] (-Budapest [HU])
ID 60: Goch [DE] - Gennep [NL] (- Nijmegen [NL])	ID 308: Virovitica [HR] - Barcs [HU]
ID 61: (Krefeld [DE] -) Kleve [DE] - Kranenburg [DE] - Groesbeck [NL] - Nijmegen [NL]	ID 312: (Osijek [HR] -) Beli Manastir [HR] - Magyarbóly [HU] (- Villány [HU] - Pécs [HU])
ID 66: (Wesel [DE] -) Bocholt [DE] - Winterswijk [NL]	ID 313: (Entroncamento [PT] -) Elvas [PT] - Badajoz [ES]
ID 68: Ahaus [DE] - Alstätte [DE] - Broekheurne [NL] - Enschede [NL]	ID 316: (Pocinho [PT] -) Barca de Alva [PT] - Fregeneda [ES] (- Salamanca [ES])
ID 178: Rosenbach bei Villach [AT] - Jesenice [SI]	ID 317: Porto [PT] - Vigo [ES]
ID 212: Trieste [IT] - Hrpelje-Kozina [SI]	ID 360: (Faro [PT] -) Vila Real de Santo António [PT] - Ayamonte [ES] (- Sevilla [ES])

Figure 9 *– Shortlist of missing and promising links– Source: European Commission*

Out of these 38 missing and promising links, the infrastructure investments necessary for 22 of these links were estimated at around 4.5bn Euros and around 15mEuros annual subsidy for 28 links. However, many of these missing links face problems of different natures (lack of interest from competent authorities, offer not adequate due to infrastructure and/or rolling stock constraints, administrative obstacles). One of the conclusions of this study was that funding for cross-border connections not on the core and comprehensive TEN-T network should also be available, especially for buying rolling stock. In addition, the technical pillar of the Fourth Railway Package grants ERA sufficient powers to assist cross-border service promoters at the levels of infrastructure or rolling stock for safety and interoperability matters. The list of the potential most beneficial projects is available in ***annex 4***. **Dedicated resources should therefore be earmarked for cross-border projects.**

➔ Create a Eurocontrol for rail

At the moment, the European rail network consists primarily of interlinked national systems which are optimised to meet domestic needs (patchwork effect) even though big improvements have been brought with the work on interoperability made over the last decades. The lack of integrated traffic and capacity management is detrimental to traffic predictability and an efficient use of this network. In addition, the lack of international cooperation persists because public authorities, railway undertakings and infrastructure managers are primarily held to account for their performance in providing domestic services and to a lesser degree for international services. What is needed is a European mindset for rail passenger and freight services, based on a

supportive regulatory framework, and the right incentives to operators for offering cross-border passenger rail services.

Rail needs to be able to offer **the capacity needed for the anticipated modal shift from road and air** and **an effective and fair cost-recovery system for the track access**. An **EU-wide control authority** to allocate tracks to operators (similar to Eurocontrol in civil aviation) could be created. This would facilitate cross-border path allocation to find alternative routes in times of need, increase efficiency and decrease costs of rail freight. Indeed, the strong European dimension of the freight sector – more than 50% of the railway freight transport is international - means that rail freight is particularly suffering from the lack of a truly Single European Rail Area, in particular from the lack of interoperability between the different networks and of coordination of operations, at the borders or in terms of rail capacity and traffic management. This organisation would also reinforce the clean-up national rules which often create obstacles. Finally, it would be the catalyser for the further development of the Rail Freight Corridors.

The governance of such a new body could consist of a mixed representation of high-level Member States representatives and EU representatives (general policy, budget and programme), a management board consisting of infrastructure managers and capacity allocation bodies (implementation) and an Agency in charge of executing. The role of this Agency could be:

- Ensuring a rail traffic supervision and monitoring at European level. Infrastructure managers and capacity allocation bodies need a structured and standardised way of coordinating traffic across borders. A European traffic control system could ease national traffic management centres to work together in a defined standard approach for a smooth transfer of international trains from one part of the network to the other.
- This Agency should furthermore assume the role of coordinating and planning role between parties to ensure, among other things, better connections between train paths and services.

➔ Finance the railway projects

- **Connecting Europe Facility (CEF)**

Negotiations are currently on-going for the multiannual financial framework 2021-2027 and the budget for Connecting Europe Facility (CEF) budget is to be determined. The European Commission is proposing:

• Greater emphasis on rail and waterborne transport, digitalization, and the use of alternative fuels;

• Total proposed allocation to be over **30bn Euros.** It could even go up to **40bn Euros** (to be compared to the 60-80bn Euros potentially allocated to the car industry);
• 60% of CEF climate expenditure.

However, the investment needed for the realisation of the TransEuropean Transport (TEN-T) core network is estimated to create EUR 4.5 trillion cumulated GDP and 13 million job years EU-wide. For the completion of the TEN-T core network alone, **750 bn Euros**[12] are still needed until 2030 (it would be up to 1.5 trillion for the comprehensive network).

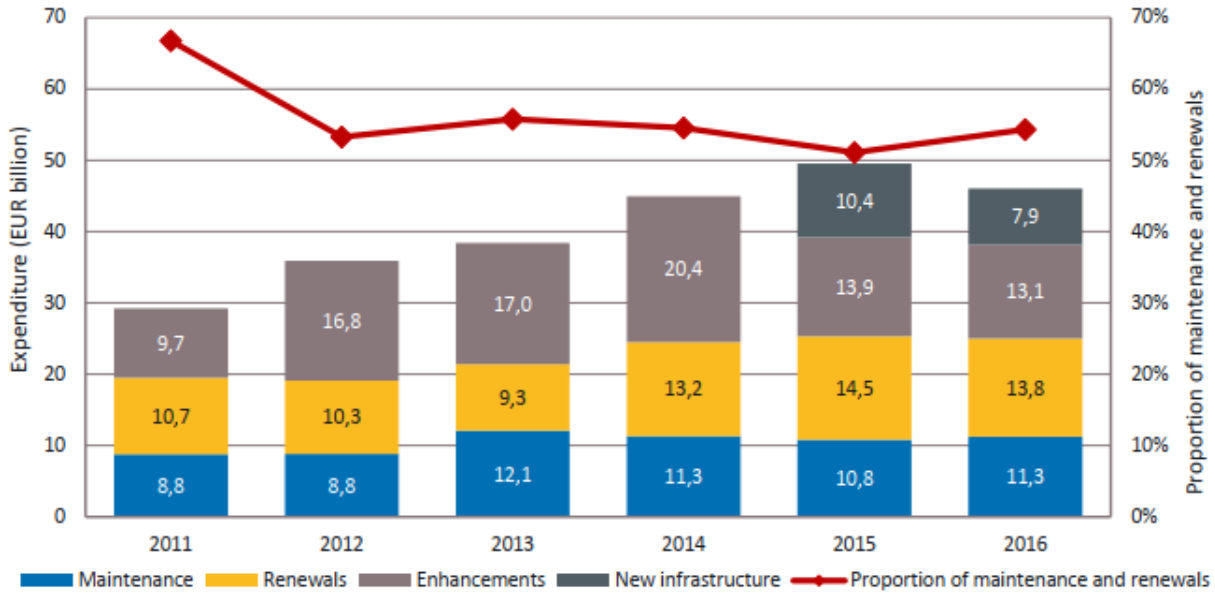


***Figure 10**: Total EU infrastructure expenditure – Source: European Commission*

In a report from 2018, the European Court of Auditors pointed out that since 2000, the EU has been investing €23.7 billion into high speed rail infrastructure without a realistic long term EU plan for high speed rail. This is resulting in 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. The CEF funds should be assigned in relation to strategic priority projects, commitments to complete the core high speed rail network. With a strategic plan, the co-funding could be increased to more than the 40% foreseen on the most strategic projects.

[12] Sixth report on monitoring development of the rail market, European Commission

- **European Investments Bank (EIB)**

Since 2000, the EIB has provided loans to the value of 29.7 billion euro to support the construction of high speed rail lines.

Examples of projects currently approved by the EIB

ADIF suburban railway framework project consists of several railway infrastructure renewal and upgrading schemes in five metropolitan areas in Spain (Asturias, Barcelona, Madrid, Santander and Valencia). The schemes comprise the renewal and modernisation of civil works, tracks, electrification and signalling, improvements of safety (e.g. removal of level crossings) and accessibility of stations for a total cost of 1.5bn Euros for 600M Euros will be a loan from EIB.

Netz Elbe Spree Rolling Stock project consists of the acquisition of new rolling stock (electric passenger vehicles) and associated equipment for a public service contracts to operate the rail passenger services in the wider Berlin area for a total cost of 1.3bn Euros of which 186M Euros will be a loan from EIB.

Divaca-Koper second rail track is a construction project of 27 km of rail track on a new alignment to increase rail capacity between the port of Koper in Slovenia and the rail junction in Divaca for a total cost of 1.2bn Euros of which 250M Euros will be a loan from EIB.

The railway Vinkovci-Vukovar upgrade project comprises the modernisation and electrification of the single track, non-electrified railway line connecting Vinkovci and Vukovar, in Vukovar-Srijem County. Total length of the reconstruction is 18.7 km. After the reconstruction, the line will allow a maximum speed of 120 km/h except in urban areas. The total project cost is 77M Euros for which 10M will be a loan from EIB.

Estonian railway project consists of several schemes of renewal and modernisation of the existing Estonian railway network, including the modernisation of the tracks, signaling and traffic control systems.The project will cost 205 M Euros for which 95M Euros will be a loan from EIB.

Examples of strategic projects under assessment by the EIB

AVE Extremadura Madrid: Upgrading of the Navalmoral de la Mata-Plasencia-Cáceres-Mérida-Badajoz railway corridor (about 287 km) to high speed technical standards, including increase in line

speed, electrification and doubling of the existing single track sections. The project is part of the high speed rail line Madrid-Extremadura and will improve cross-border connections with Portugal in the Atlantic TEN-T corridor.

The **Project "Modernization of the Sofia - Plovdiv railway line**: railway section Elin Pelin - Kostenets" concerns the rehabilitation of railway infrastructure on the TEN-T core corridor. The implementation of the project will contribute to eliminate the current bottleneck on the corridor through Bulgaria and support the development of the Orient/East Med corridor for a total cost of 555M Euros.

In addition, it must be emphasized that the EIB is currently preparing a Climate Bank Roadmap for its activities on climate actions and environmental sustainability from 2021 to 2025. For vehicles, the EIB is considering prioritising the finance of zero tailpipe transport vehicles, i.e. light rail, metro, tram, electrified rail rolling stock, as well as electric, hydrogen or fuel cell passenger vehicles. While for infrastructure, the EIB is considering deeming all electrified public transport infrastructure (rail, metros, trams and bus rapid transit systems) as consistent with a low-carbon pathway, alongside investment in waterborne transport infrastructure.

- **Shift2Rail**

Shift2Rail is the rail joint undertaking under Horizon 2020. Shift2Rail (S2R) was formally established in 2014 with Council Regulation (EU) N° 642/2014 and 920 million Euros have been allocated for research, development and innovation (R&D&I) until 2024 to develop the necessary solutions to help completing the Single European Railway Area. It is a public-private partnership, which manages a multiannual work programme of targeted research and innovation to increase capacity and reliability and reduce life-cycle costs of rail services in Europe. Structuring rail research in the form of a Joint Undertaking has been key in overcoming the fragmentation and the lack of continuity of research in the rail sector, by developing a long-term strategy, in close cooperation with all stakeholders.

Rail stakeholders are calling for continuing joint R&D&I activities under “Horizon Europe” in an institutional partnership. The Commission presented its important EU R&I programme for 2021-2027 in June 2018 and the Council and Parliament reached a provisional agreement in March 2019. The Commission’s proposal for the budget allocated to the “climate, energy and mobility” cluster within pillar 2 for Horizon Europe is EUR 15 billion, the same as the budget for the proposed cluster on “digital and industry”. In order to increase the research effort for the rail

industry, extending the Shift2Rail programme under Horizon Europe 2021-2027 with a significantly larger budget is fundamental.

European Union funding is very important for railway infrastructure investments. European Union funding through Cohesion Fund (CF), the European Regional Development Fund (ERDF), the Connecting Europe Facility (CEF), and the European Investment Bank (EIB) contribute an average of 12% of the total funding for investment in rail infrastructure in Europe.

EUR billion	All transport projects	Railway projects	Proportion of total invested in rail
ERDF and Cohesion Fund	70.1	18.7	27%
CEF	19.7	14.6	74%
Total	**89.8**	**33.3**	**37%**

Figure 11: *Allocation of EU funds to transport and rail projects for the EU funding cycle 2014-2020 – Source: INEA, DG Regio*

However, in order to ensure an equal level playing field for all modes of transport, it is also necessary to look at other financial tools or mechanisms.

- **Kerosene taxation**

One resource to finance the railway projects could be to redirect some of the resources from the taxation of civil aviation. In some Member States such as France or Sweden, the absence of kerosene taxation appeared as a fiscal injustice in the political debate. The taxation in the civil aviation sector is relatively low and has been considered for decades as a situation of unfair competition between modes of transport. Although the international Law of ICAO limits the possibility for taxing kerosene, some solutions could be envisaged to tax directly or indirectly the emissions of the civil aviation.

Until the COVID-19 crisis, the civil aviation sector had a 4% growth leading to more emissions which could be multiplied by 4 in 2050. Such a growth in the emissions of the civil aviation sector would not be compatible with the environmental objectives of the Paris agreement and the agreement at international level for this sector is not enough to reverse the trend (Carbon Offsetting and Reduction Scheme for International Aviation - CORSIA).

In order to lower these emissions, two levers can be activated: on one hand, improving the energy efficiency with biofuels and, on the other hand, modal report to the railway by

internalizing some external costs in the price of the plane tickets. Developing a climate taxation would allow to act on these two levers.

The exemption of the taxation on kerosene for international flights is foreseen in the Convention of Chicago. However, despite this Convention, some mechanisms exist:

- EU ETS: since 2012, the aviation sector has been included in the carbon market for the intra-EU flights.
- CORSIA: Since 2016, ICAO has adopted CORSIA that will oblige airlines companies from 2021 to buy carbon credits to compensate their emissions which are above the level of 2020.
- Kerosene taxation on domestic flights as it is the case in Sweden.

CO_2 taxation on flight tickets in place in 7 EU Member States (Germany, France, Italy, Finland, Austria, Netherlands and Ireland).

***Figure 12** – Comparison in kerosene taxation – Source: Transport & Environment*

However, none of the above has had an impact on civil aviation negative emission trends. In addition, the exemption of taxation for kerosene is also considered as an indirect subsidy to fossil fuels.

Some measures could be put in place in order to limit the future emissions of this sector:

- Kerosene taxation on specific intra-EU flights following bilateral agreements between Member States. The EU Directive on taxation for energy products allows for such bilateral agreements.
- Increasing the number of Member States applying a taxation on flight tickets and applying different levels depending on geographical areas.
- All Intra-EU flights could be subject to such a tax but the ones connecting isolated territories for which the flights are subject to territorial continuity measures.

Depending on the measures taken and considering the minimum taxation foreseen in the Directive on taxation of energy products of 0,33 Euros/liter, a study of the European Commission (***annex 5***) has indicated that such taxation would add around **13,2 bn Euros (16,9 if the United Kingdom is included) to the current 6.3 bn Euros already gathered (10bn with the UK) on an annual basis**.

However, these figures have been calculated before the COVID-19 crisis with a sector that was growing very fast. While before the COVID-19, there were between 25.000 to 35.000 flights depending on the month of the year in the 44 members of the ECAC, this has been reduced by more than 80% to around 5000 in May 2020.

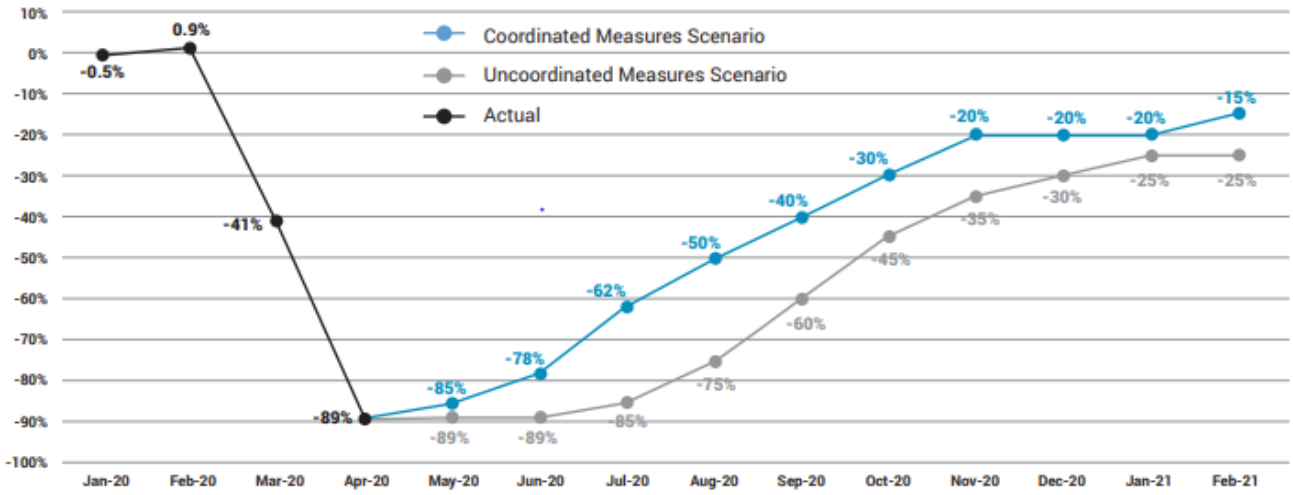


***Figure 13** – Air traffic scenarii post-COVID crisis – Source: Eurocontrol (April 2020)*

The situation of the airlines companies and the air traffic should not get back to its 2019 level before at least mid-2021. In conclusion, depending on the recovery scenario of the air traffic and

considering that the air traffic will not come back to its 2019 level before some years (flight shaming, sustainable tourism and less business trip with videoconference tools), a taxation on kerosene could generate between **10 to 11 bn Euros per year in the current context for which a part of it could be allocated for the modal shift to railways.**

- **Eurovignette**

Similarly to the tax-exempted fuel for aviation, in competition with road, rail is at a serious disadvantage since it covers the major part of cost it causes, whereas road profits from large external cost unpaid-for by it (see paragraph above on externalities). “User-pays” and “polluter-pays” principles are an approach towards creating a level playing field between the transport modes but is currently applied inconsistently. There is an urgent need of environmentally differentiated infrastructure charges for all transport modes which would be a policy favorising rail transport as this mode of transport is already paying for its external costs.

A well-known example is the Swiss LSVA (Leistungsabhängige Schwerverkehrsabgabe or redevance poids lourds liée aux prestations - RPLP). It is a road toll system for heavy-duty vehicles covering all types of roads introduced in 2001. This system is compliant with EU regulations since it is non-discriminatory. Two-thirds of the revenues go to the national level with the major part of it used for funding the large Alps-crossing rail tunnel projects. With a rail modal split of 60% in the Alps-crossing freight traffic, the Swiss approach is much more successful than any other EU Member State.

In the current negotiations on the different programmes, the Commission has a potential lever to direct the attention of Member States to rail transport. Considering the urgent environmental objectives, it should be difficult for Member States to argue a continuation of a dominance of funding for conventional road transport.

EUROPEAN UNION AGENCY FOR RAILWAYS

Making the railway system work better for society.

CONCLUSIONS

Rail is by far the most energy-efficient transport mode for suburban and urban mobility which, in combination with walking and cycling, compose the **smart urban mobility triptych**. However, in many situations, the car is still an essential component of the mobility. The different modes of transport must be thus integrated in order to put the **mobility-as-a-service** (MaaS) concept in practice with the:

- identification of an optimum transport mix for efficient and sustainable transport of people and goods;
- setting up of a set of integrated requirements for multi-modality, together with a multi-modal approach to path allocation and a holistic view of transport safety at EU level;
- An EU-wide responsible organisation, such as a **Land Transport Agency,** should be entrusted with this role.

This would lead to the establishment of a **new sustainable hierarchy of transport modes**. In urban context, this new hierarchy will privilege the active modes of transport (walking, cycling), then the public transport, then the car sharing and, finally, the private car. **Rail will become the backbone that supports an environmentally sustainable multimodal transport system and will be favoured as a transport mode by the new generations.**

In this new hierarchy, the railway sector should be highly ranked for both transport of goods and passengers due to its low impact on the environment. This would be lead to a rail renaissance through:

➔ The development of the European high speed network and investment in maintenance of the existing infrastructure;
➔The interconnection between the railway network and the main airports;
➔The development of a European network of night trains;
➔The elimination of inefficiencies on the railway network which create bottlenecks;
➔A strategy for the future of the industrial railway policy;
➔The creation of an organization centrally managing part of the capacity and the traffic of the railway network;
➔Important investments in railway projects.

2021 will be the European year of rail and this year would be a good opportunity to put the focus on the contribution of this mode of transport to the climate objectives and its key contribution to the future of mobility. The role of the European Union Agency for Railways will be essential in

this context and its budget must be preserved and increased in the years to come in order to ensure its ability to perform its duty to make the railway system work better for society.

In this period of economic crisis, it must be noted that the European rail sector employs ca. 2.3 million people and represents approximately 1.1% of the GDP of the Member States[13]. A growth in rail-related employment might help to offset the job losses in the automotive industry expected from electrification and from the aviation sector. Rail industries from rails over track equipment to rolling stock are important technology clusters spread across almost all EU Member States, creating jobs which are spread throughout the EU territories including less favoured areas. Furthermore, railways are important in regards to the training of skilled staff and play a key role in avoiding youth unemployment and in securing skills supply for the industry as a whole. With the constant absolute growth of rail transport in the EU, it is to be expected that **employment in the sector will continue to grow**.

Finally, during the COVID-19 crisis, the estimated decrease in daily fossil CO_2 emissions from the confinement of world populations and economic crisis is of –17% at its peak in April. The annual decrease is estimated by several organisations (Nature Climate change, International Monetary Fund, International Energy Agency) to be around –4.2 to –7.5%. This is an order of magnitude comparable to the rates of decrease needed year-on-year over the next decades to limit climate change to a 1.5 °C warming. These figures show **how big the challenge to limit climate change according to the Paris Climate Agreement is**.

Furthermore, most changes observed during the crisis will be temporary without a fundamental transformation of our production and consumption systems as they do not reflect structural changes in the economic, transport or energy systems. Surface transport accounts for nearly half the decrease in emissions during confinement. While the European Union is willing to achieve climate neutrality through the long-term establishment of net-carbon and resilient economy, the extent to which imperatives of climate change are considered when planning the economic response to the crisis will largely influence the CO_2 emissions trend in the next decades.

[13] The European Rail Research Advisory Council – Rail 2050 vision

ANNEXES

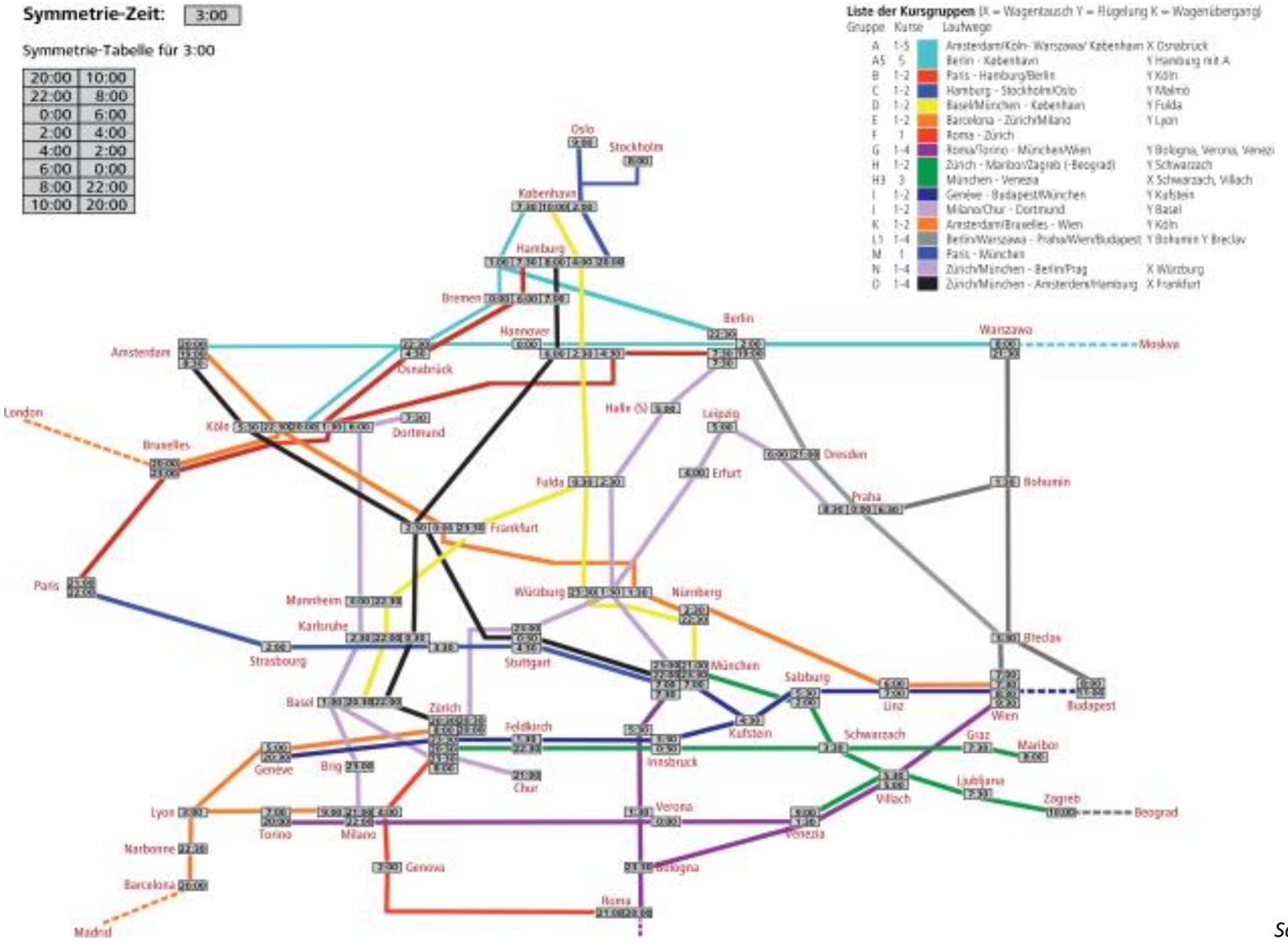
Annex 1
Top 20 busiest European air routes

Rank	Airport 1	Airport 2	Passengers (2018)	Distance (km)	Train connection
1	Madrid/Barajas	Barcelona/El Prat	2,466,968	505	3h00
2	Frankfurt	Berlin/Tegel	2,292,098	424	3h45
3	Toulouse/Blagnac	Paris/Orly	2,282,407	588	4h10
4	Nice/Côte d'Azur	Paris/Orly	2,135,634	686	5h47
5	Barcelona/El Prat	Palma de Mallorca	2,035,602	N/A	N/A
6	Berlin/Tegel	Munich	1,988,248	505	3h55
7	Catania/Fontanarossa	Rome/Fiumicino	1,976,230	539	8h56
8	Madrid/Barajas	Palma de Mallorca	1,967,136	N/A	N/A
9	London/Heathrow	Dublin	1,809,140	N/A	N/A
10	Munich	Hamburg	1,749,616	612	5h37
11	Amsterdam/Schiphol	London/Heathrow	1,746,940	539	4h44
12	Rome/Fiumicino	Palermo	1,663,463	923	N/A
13	Madrid/Barajas	Gran Canaria	1,616,540	N/A	N/A
14	London/Gatwick	Barcelona	1,556,045	1489	13h23
15	London/Heathrow	Frankfurt	1,552,249	769	5h15
16	Athens	Thessaloniki	1,543,931	501	5h23
17	Stockholm	Copenhagen	1,520,873	629	5h07
18	Madrid/Barajas	Lisbon	1,517,620	629	8h36
19	Copenhagen	Oslo	1,509,030	603	No train!
20	Palma de Mallorca	Düsseldorf	1,495,826	N/A	N/A

Source: Eurostat

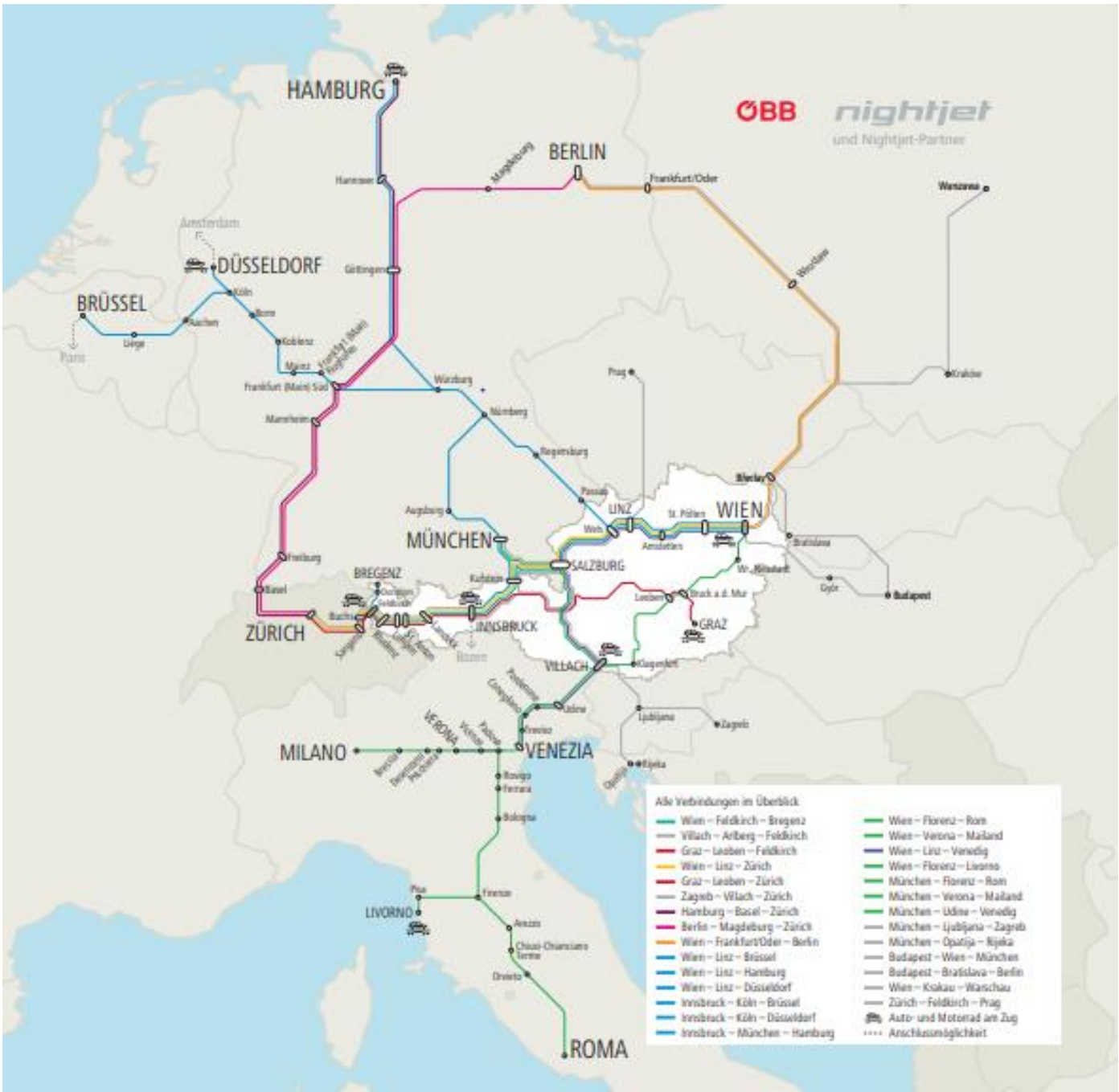
Annex 2

Map of European night trains network



Source: LUNALINER

Annex 3
Map of Nightjet network



Source: Nighjet

Annex 4

List of potentially most beneficial projects

ID	Name of the rail connection	TEN-T: Corridor/ Core Network or Comprehensive Network	Classification according to 2017 timetable	Importance for the border region	Importance for the countries concerned	Importance on TEN-T level	NUTS3 in country A	NUTS3 in country B	The connection could improve TEN-T connectivity between…	The connection could alleviate the following structural spatial effects	Stakeholders' assessment
6	Dunkerque [FR] - De Panne [BE]	-	Elements missing	Medium	Low	No	FR301	BE258	-	Connection would be an additional link north of Lille the, along the French-Belgian coast	Rather positive
18	Valenciennes [FR] - Mons [BE]	Comprehensive Network	Entirely missing: dismantled	Medium	Low	Low	FR301	BE323	-	Connection would be an additional link south of the Lille area where no rail connection with passenger services between FR and BE exist today (gap of approx. 230 km)	Rather positive
21	Maubeuge [FR] - Charleroi [BE]	Comprehensive Network	Freight only	Low	Medium	Low	FR301	BE326	-	Connection would be an additional link south of the Lille area where no rail connection with passenger services between FR and BE exist today (gap of approx. 230 km)	Rather positive
25	Charleville-Mézières [FR] - Givet [FR] - Dinant [BE]	-	Entirely missing: dismantled	Medium	Low	No	FR211	BE353	Comprehensive Network/North Sea-Mediterranean	Connection would be an additional link south of the Lille area where no rail connection with passenger services between FR and BE exist today (gap of approx. 230 km)	Rather positive
45	Mol [BE] - Roermond [NL]	Comprehensive Network	Freight only	Medium	High	Low	BE222	NL414	-	Connection would be an additional link in the border area between Breda and Maastricht where no rail connection with passenger services between BE and NL exist today (gap of approx. 100 km)	Rather positive
55	Aachen [DE] - Maastricht [NL]	-	Proposed link	Medium	Low	No	DEA2D	NL423	North Sea-Baltic/Rhine Alpine/Comprehensive Network	-	Rather positive
78	Ducherow [DE] - Świnoujście Centrum [PL]	-	Entirely missing: dismantled	High	Medium	No	DE80N	PL428	-	Connection would ease the access from Berlin to the Polish and also the German part of the Island Usedom	Rather positive
88	Guben [DE] - Czerwieńsk [PL] - Zielona Góra [PL]	-	Freight only	Medium	Low	No	DE40G	PL432	Comprehensive Network	-	Rather positive
137	Freiburg [DE] - Colmar [FR]	-	Entirely missing: dismantled	High	Low	No	DE132	FR422	Rhine-Alpine/North Sea-Mediterranean	-	Rather positive
139	Rastatt [DE] - Rœschwoog [FR] - Haguenau [FR]	-	Elements missing	High	Low	No	DE124	FR421	Rhine-Danube/Rhine Alpine/Comprehensive Network	-	Rather positive
148	Trier [DE] - Thionville [FR] - Metz [FR]	Comprehensive Network	not fully exploited	High	Medium	Low	DEC02	FR413	-	Improved direct connection would ease rail transport between Trier and Metz. Today detour via Luxembourg or Saarbrücken necessary.	Rather positive
162	St-Maurice [CH] - Évian-les-Bains [FR]	-	Neglected	High	Low	No	CH012	FR718	-	Connection would improve public transport on the southbanks of Lake Geneva where no passenger rail services exist today	Rather positive
178	Rosenbach bei Villach [AT] - Jesenice [SI]	Comprehensive Network	not fully exploited	High	Medium	High	AT211	SI042	-	-	Rather positive
179	Klagenfurt [AT] - Bleiburg [AT] - Maribor [SI]	-	not fully exploited	Medium	Low	No	AT213	SI033	-	-	Rather positive
185	Oberwart [AT] - Szombathely [HU]	-	Entirely missing: dismantled	Medium	Low	No	AT111	HU222	-	Connection would be an additional link in the border area between Sopron and Szentgotthard where no rail connection with passenger services between AT and HU exist today	Rather positive
188	Deutschkreutz [AT] - Sopron [HU]	Comprehensive Network	not fully exploited	High	Medium	Low	AT112	HU221	-	-	Rather positive
250	Wałbrzych [PL] - Meziměstí [CZ]	-	Freight only	Medium	Low	No	PL517	CZ052	-	-	Rather positive
267	Muszyna [PL] - Plaveč [SK]	Comprehensive Network	Freight only	Medium	Low	No	PL218	SK041	-	Connection would be an additional link in the border area of Poland and the Slovak Republic where only few railway connection with passenger services exist at all	Rather positive
320	Zaragoza [ES] - Canfranc [ES] - Pau [FR]	Comprehensive Network	Entirely missing: dismantled	Medium	Medium	Low	ES241	FR615	-	Connection would be an additional link in the border area of Spain and France where only few railway connection with passenger services exist at all	Rather positive

Source: European Commission

Annex 5

Impacts per taxation scenario and change relative to the current situation for the EU 28

	Current situation	Abolition of ticket tax		Introducing VAT on all tickets (19%)		Introducing fuel excise duty	
Impacts **Aviation sector**	*Value*	*Value*	*Change*	*Value*	*Change*	*Value*	*Change*
Passenger demand (million)	691.5	718.5	4%	570.4	-18%	616.0	-11%
Average ticket price (€)	304	293	-4%	358	17%	333	10%
Number of flights and connectivity			4%		-18%		-11%
Employment (1,000 FTE)	362	376	4%	296	-18%	321	-11%
Value added (€ billion)	43.4	45.1	4%	35.6	-18%	38.5	-11%
CO_2 emissions (Mton)	149.5	155.3	4%	123.3	-18%	133.1	-11%
People affected by noise (1,000)	2,851.5	2,919.8	2%	2,495.9	-12%	2,637.1	-8%
Aviation-related fiscal revenue (€ billion)	10.0	2.6	-74%	39.9	297%	26.9	168%

Source: European Commission, CE Delft (June 2019)