Maximising air to rail journeys

Reducing intra-EU aviation emissions through modal shift to rail: limits and opportunities

July 2020

Summary

A study commissioned by T&E and conducted by Koios Strategy finds that ambitious modal shift from air to rail would see limited, though important, potential for emissions savings. T&E recommends that, as part of the EU's long term decarbonisation strategy, improvements are made to develop a European wide connected rail system combined with tax policies targeting aviation to deliver a fair ticket prices that reflect the environmental impacts.

This study makes use of the T&E aviation CO2 database which is based on Eurostat, Planefinder and ICAO CO2 database to calculate a theoretical maximum of the potential to shift to rail. The results demonstrate that even with ambitious scenarios for rail improvement, such as connecting all major cities with high speed rail, this could deliver only a small reduction in the overall emissions of EU aviation (2-4% reduction). Distance and travelling time were the main factors explored. This study did not consider the potential impact of changing price signals and therefore the modal shift and resulting emission reductions could be higher if fair taxation was introduced.

T&E recommends that this potential should be unlocked by focusing EU train network developments on boosting passenger rights and service, industry wide data sharing, acceleration of traffic management systems and providing strategic investments to develop cross border connections. These developments alone are not a silver bullet to solve European aviation's emissions problem. This requires fair taxation of flying, alternative fuels, and embedding some of the changes to travel demand resulting from Covid (i.e. increased video conferencing, flying less for work) if the bulk of aviation emissions are going to be tackled.

1. Current state

The European Green Deal aims to set European transport on a path to full decarbonisation by 2050 and specifically mentions as part of the deal to support modal shift to rail, implement effective tools to implement 'user pays' and 'polluter pays' principles, proper funding for clean mobility and other supporting measures. Additionally the European commission declared 2021 the Year of European Rail to support the delivery of these European Green Deal objectives. In this context it's a priority to understand what proportion of travel can be shifted and where the priorities for modal shift are.

Flights departing from Europe are currently responsible for 184 million tonnes of CO2 emissions and as a result 4.2% of total EU emissions[1]. Within that, intra-EU (within Europe) emissions account for 62 Million tonnes CO2 (32% of the total)[2]. A frequently proposed solution for the emissions growth of aviation is to substitute these intra-EU journeys by rail. The study accompanying this briefing estimates the potential reduction in CO2 from such an approach, by a modal shift to rail, and the potential emissions if improvements in quality, speed and services of rail would be implemented.

1.1. Overview of European passenger market

When it comes to rail journeys in Europe, the report finds that most journeys are short (below 200km) and within member states (not cross border journeys). Around a fifth of journeys (passenger-kilometres) are for longer distances and these are considered the most relevant for competition between the air and rail market. This results in an estimated rail volume of 200 billion passenger-kilometres in the intra-European air/rail market and is divided between journeys of 200km up to 1000 km. On short journeys of below 250km with the best rail connections, all journeys are made by train. However as the distance increases, so too does the share of aviation, with almost all journeys above 1000km taken by airplane.

[1] UNFCCC, National Inventory Submissions GHG 2018
https://ec.europa.eu/transport/sites/transport/files/2019-aviation-environmental-report.pdf

[2] T&E's European Aviation model - See Annex A of the report. Note that the database uses statistics which only covers 'main airports', 8.3% of the passengers and 9.9% of the CO2 are not included in the analyses with the database in this report.

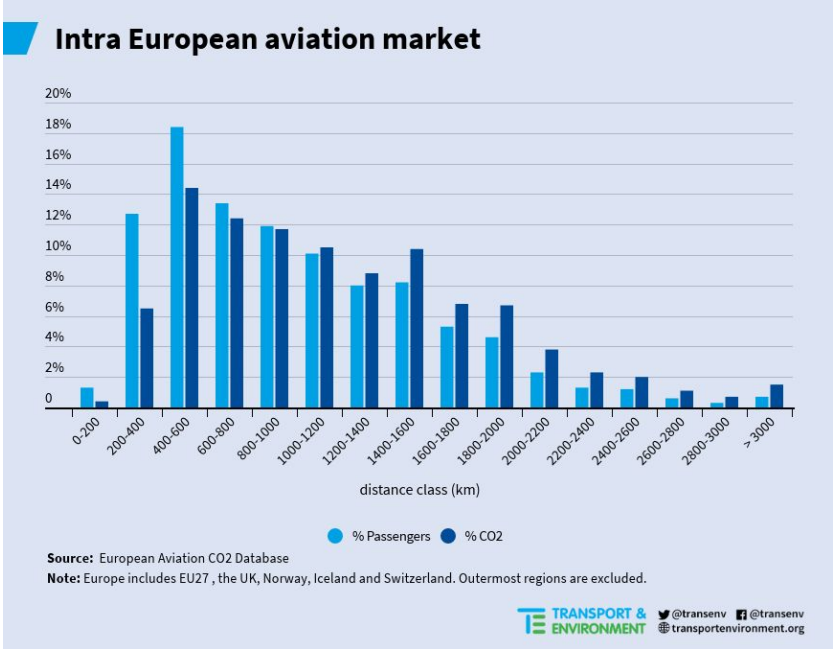

Figure 1 - Breakdown of the % passengers and CO2 per journey distance class for Intra EU Aviation Market .

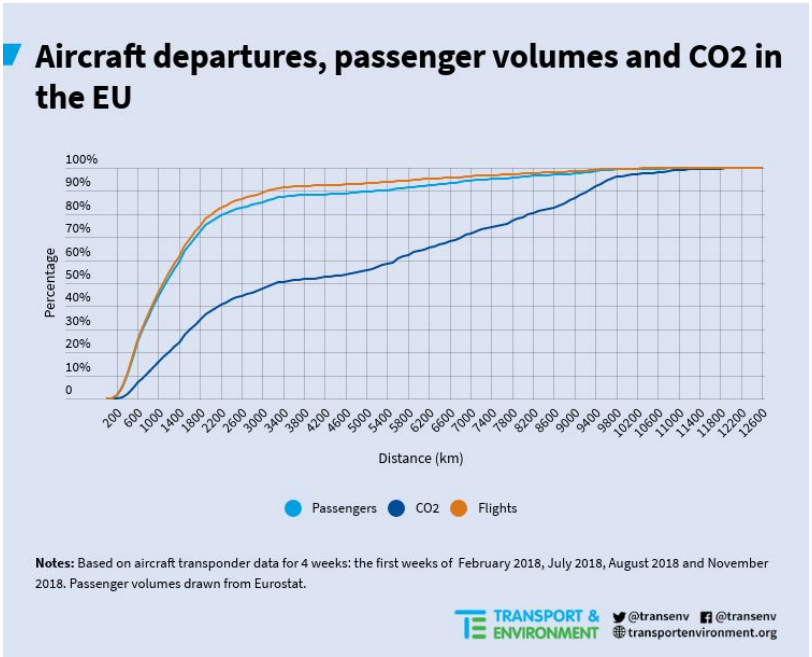

Figure 2 - Cumulative graph to show Passenger numbers and CO2 for intra EU air travel. This graph shows that in theory ending all flights less than 1000km (including to Islands) could result in a maximum of 15% reduction in emissions as an example.

1.2. Factors that determine mode of travel

There are two key factors that determine the choice between air or rail; travel time and price. By using the T&E Aviation CO2 database to study 72 city pairs of journeys within the EU, it was found that up to a distance of 700 km, for the busiest city travel pairs[3], the train offers a comparable travel time when calculating travel time between city centres. In total 14 city pairs are faster by train than by air, with those routes predominantly connected by high speed rail connections. Therefore for rail to compete with aviation on time travelled, high speed rail connections are required. As travel distance increases so does the time advantage for air. The travel time for aviation is clearly linked to the distance travelled, however for train travel the travel time is much more variable with less correlation to distance. Even with high speed rail connections there can be high variation in the speed of travel and time it takes to reach the destination. It should be noted that this study only calculates shifting potential based on travel time, not on other factors, which could potentially raise that number.

1.3. Challenges in improving EU rail network

One of the challenges in developing an EU rail network has been that when it comes to priorities for member states, domestic rail improvement (which across EU is 98% of rail passengers) often end up favoured over developing international connections, because ultimately the decision making regarding funding for rail improvements lies with national governments who historically have opted to support their own priorities over their neighbours or the wider European community.

[3] See Annex B of the study which ranks 72 aviation and railway city pairs in terms of passenger numbers and CO2 emissions.

2. Modal shift

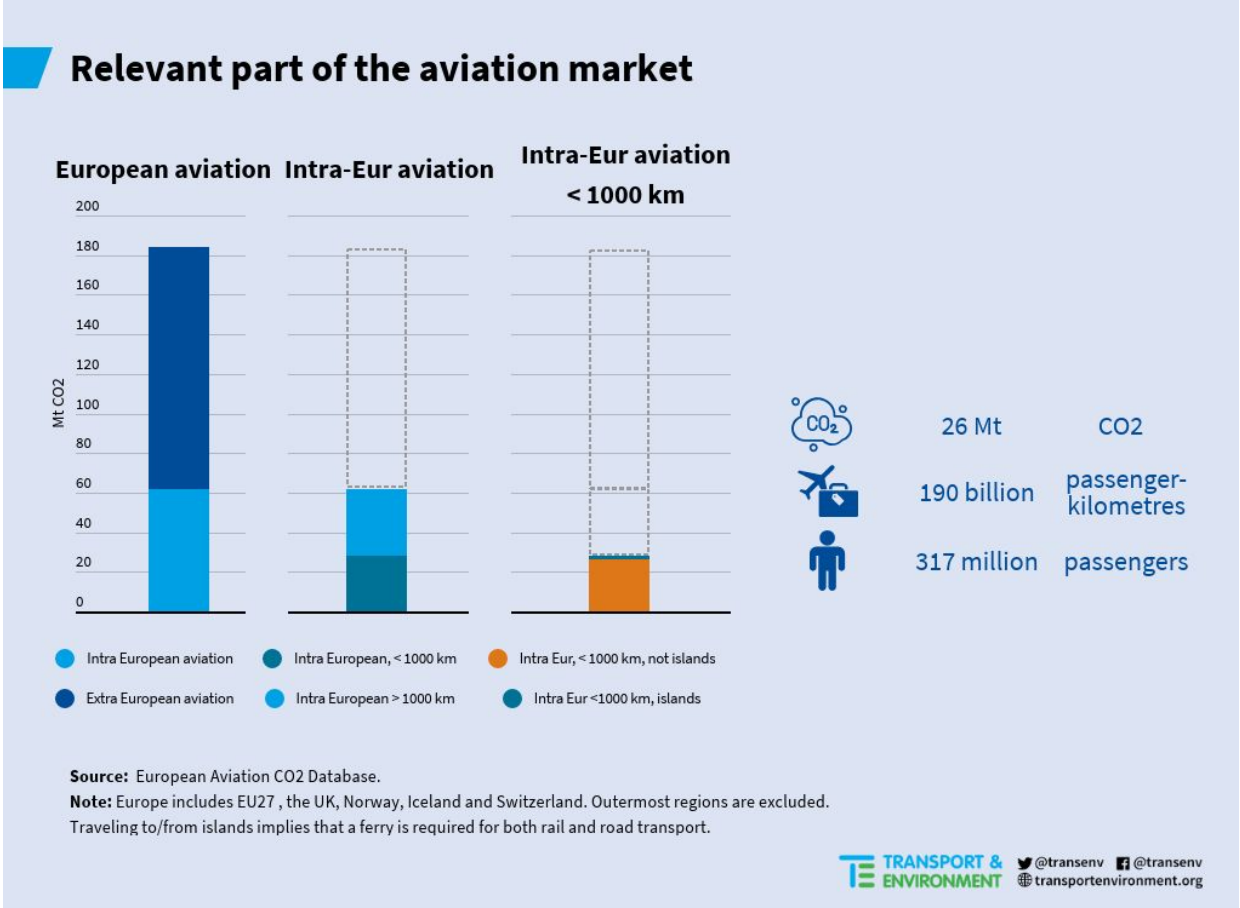

Figure 3: The orange block (furthest right bar) represents the proportion of intra EU aviation that could realistically be shifted to rail (journeys below 1000km, and not including islands).

2.1. Focus of the study

Subtracting the emissions from flights longer than 1000 km, as well as island connections, brings the focus of this study down to a target 26 Mt CO2. This corresponds with 42% of the emissions from all intra-EUR-31 flights (EEA, including the UK) and 14% of total CO2 from European aviation.

2.2. Assessment of improvements in rail services

In assessing the impact of potential improvements in rail services, 3 scenarios were compared to current services; Best practice, Speed increase and Night Trains. For more details, please refer to the study accompanying this briefing.

Best practice scenario which would mean applying the standard of today's best performing rail services across the entire rail network, which in practice would mean high speed rail connections between major cities. In addition to HSR expansion, this scenario assumes that all flights shorter than 300 km shift to rail (except to and from islands) where a rail connection exists. For trips between 300 and 1050 km, it is assumed that the longer the distance the lower the potential to shift to rail. For trips above 1050 km, no shift would take place.

Speed increases by 10% and assumes that the net-speed between city pairs increases by 10% on all connections competing with aviation. This scenario assumes faster train services between city pairs with higher cruising speed, less or shorter stops, faster border crossings and better train paths.

Night Train scenario assumes an addition of 30 night train services between cities on routes of 800-1250km (this equates to an approximate 40% increase in night train services).

	Reference (BAU)	Best practice		Trains 10% faster		Night train +50%
Air passengers	317 Mpax	207 Mpax	-35%	270 Mpax	-15%	-2.4 Mpax
Rail passenger	500 Mpax	613 Mpax	+23%	547 Mpax	+9%	+2.4 Mpax
Air pkm	190 Bpkm	142 Bpkm	25%	163 Bpkm	-14%	-2.4 Bpkm
Rail pkm	200 Bpkm	248 Bpkm	+24%	227 Bpkm	+13%	+2.4 Bpkm
Air CO2	25.7 Mt	18.3 Mt	-7.4 Mt	22.0 Mt	-3.7 Mt	-0.24 Mt
Rail CO2	5.0 Mt	6.2 Mt	+1.2 Mt	5.7 Mt	+0.7 Mt	+0.06 Mt

Table 1. Overview of the estimated impact of three assumed railway improvements on the air/rail market between 200 and 1250 km for intra-European (excluding islands)

The night train scenario of a 40% increase in night train services is a conservative scenario and could be considered less than reopening previous operating night train routes that have been cancelled over the last 10 years. As an example, between 2009 and 2019 over 60% of the French night train network

was removed[4]. The European Commission has commissioned a pilot study at the request of the European Parliament to scope night trains, in order to revitalise cross-border night train services[5].

All these scenarios are also conservative as in reality a greater potential is possible through switches in destination. This includes people choosing to travel to different places based on new rail services or a wider movement to travel closer to home or to avoid over tourism.

The costs of implementing any of these scenarios has not been considered in the study. This is important as, for example, high speed rail is significantly more expensive to build than conventional lines due to the need for straighter tracks and more distance between tracks for safety. In the case of a short section of track between Milan - Trieste, it was found to be 4 times more expensive to build HSR and in practice would deliver little in terms of reducing journey time[6]. Analysis of actual operating speeds on high speed lines found that on average only 45% of the design speed was achieved in practice and those actual speeds achieved could be delivered with upgrades to conventional rail for a fraction of the costs.

The results demonstrate that improving high-speed connections between major EU cities on distances up to 1000km would reduce intra-EU aviation emissions by 6-11% (2-4% of overall EU aviation emissions). This figure of 2-4% is calculated in the study based on applying best practice from top performing routes to the entire rail network. However ending all flights less than 1000km (including to Islands which would present significant challenges) would result in a maximum 15% reduction in emissions (see Figure 2).

The study doesn't consider the modal shift potential from changing price signals through application of a kerosene tax, for example. The shifting potential - and resulting emission reductions - may be higher if fair taxation for flights was introduced, and cheap price dumping on flight routes was prohibited. For example there are still flights operating on high-speed rail routes that are already competitive in travel time (e.g. Paris-Marseille, 638km).

There are several key city pairs that, if improvements to rail services take place, it would deliver the most emissions savings (See Annex 1 for recommendations to improve rail in Europe). A European plan is required to develop those routes with the most potential for emissions savings and to improve modal shift on the rail routes that are already competitive (e.g. currently 8 times more passengers fly

[4] https://ouiautraindenuit.files.wordpress.com/2018/01/2019-02-28-investigation-oui-au-train-de-nuit.pdf
[5] Pilot Project on the Revitalisation of Cross-border Night Trains - https://etendering.ted.europa.eu/cft/cft-display.html?cftId=6170
[6] Special Report - A European high-speed rail network: not a reality but an ineffective patchwork (2018) https://op.europa.eu/webpub/eca/special-reports/high-speed-rail-19-2018/en

London - Amsterdam than travel by rail despite the fact that rail is faster on this route). However this study does not calculate what the cost of the practicality of achieving this theoretical maximum would be. These costs should be weighed up in terms of costs of other measures to reduce aviation emissions. There are several co-benefits of a shift to rail: noise, connection of regions, increase the "European" feeling especially if cross-border regions are connected, rail is a service of general interest to all European citizens (and not mainly of benefit to high/middle-income groups) and there is significant public support for improving rail services.

3. Conclusions

Between 4 to 7 Mt CO2 from intra-European aviation may be avoided by a modal shift from air to rail which is the equivalent of taking 2.2 to 3.8 million combustion cars off the road[7]. This corresponds with 6% to 11% of the CO2 emissions from intra-EUR-31 aviation and with 2% to 4% of CO2 from all aviation emissions in EUR-31, thus there is limited potential for modal shift from air to rail in Europe. However in achieving net zero emissions in Europe, it is important that these emissions savings are pursued.

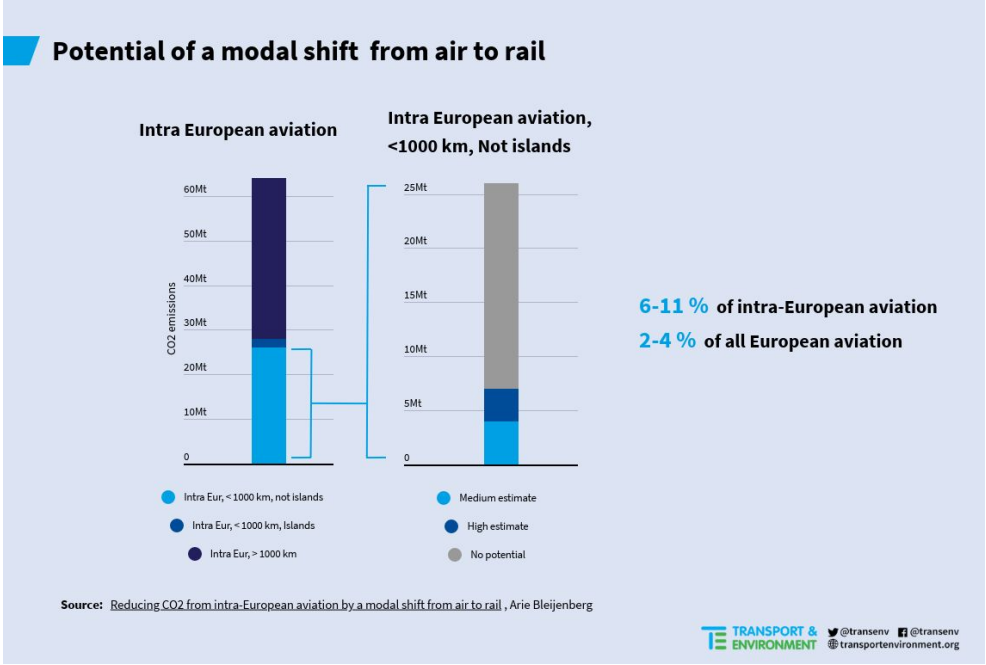

Figure 4: Potential of a modal shift from air to rail

[7] 4-7 million tonnes CO2 is equivalent to 2.2 - 3.8 Million average cars. See https://www.transportenvironment.org/publications/co2-emissions-cars-facts

However, modal shift from aviation to rail is not a silver bullet for tackling intra-EU aviation emissions. Additional policies and modified behaviours will be required to deliver emissions savings for aviation such as traveling differently, flying less and switching to lower greenhouse gas emitting fuels and aircraft.

4. Recommendations

1) A strategy to address those limited aviation emissions which can be reduced through a shift to rail should be pursued, based on the recommendations in Annex I
2) For the remainder of aviation emissions, which constitute the vast majority, an ambitious aviation decarbonisation strategy is needed which would include pricing aviation emissions, investing in new fuels, and locking in some of the changes to travel consumption resulting from the Covid crisis.

Further information

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Annex 1: Rail recommendations

1.1 Recovery package

The COVID-19 crisis will change European mobility and the aviation sector will undergo restructuring which could lead to reductions of short-haul flights and a shift to high speed train connections. Investments and recovery funds should focus on upgrading existing rail services, furthering the electrification of the system and strategic cross border connections that can support modal shift. Make transport finance provided to member states conditional on having a modal shift target. Develop a COVID-19 green recovery fast-funding facility for rail infrastructure (for instance for rail stations with bicycle stations or providing facilities to improve comfort of travellers).

Any recovery and/or EU budget funds should provide more favourable rates of co-financing for improvements for international connections and work with member states to develop public service obligations (PSOs) for key connections. An EU regional development (Interreg funding) programme for reinstalling or developing new cross border connections and networks could be developed for implementation.

1.2 Passenger rights and ticketing

Current problem for passengers is that Operators' websites mostly do not allow booking of cross-border tickets; passengers need to buy tickets from different operators for the different sections of one journey and have no guarantee to arrive at their final destination.

Key to improving passengers rights, tickets and services is rail operators sharing data (on services, real time, tickets, all fares). Development of a multimodal through / single ticket booking service to rival the ‘skyscanner’ style services that exist for booking air travel. Regulatory changes are required to support passenger rights, especially for bookings for the entire journey including when travelling across several different providers and amend the rail passenger rights legislation which currently exempts national rail operators to ensure passengers are covered in cases of travel disruption.

To achieve a "One journey - one ticket" (multimodal, and accessible through one app)
- operators need to share data
- passenger rights need to apply along the entire travel chain (minimum as long as no through-tickets are provided: 'hop on the next train', irrespective of the operator
- passengers need to have access to the passenger rights (e.g. in case of delays) and should not need to struggle with finding the right addressee.

The Passenger Rights Regulation is currently in Trialogue and will likely be finalised during the current German presidency (before the end of 2020).

1.3 Data

Operators need to share data on passenger numbers, capacity loads, real-time data and coordination of connections to support the strategic development of European rail network. The sharing of data and ticketing services is also essential to the creation of a through ticket multimodal booking system as described above.

1.4 Infrastructure and procurement

Electrification and cross border connectivity (Signalling, track gauge etc) should be prioritised. Currently only roughly 80% of the core TEN-T network is electrified, only 60% of the general rail network. And rail must switch to consuming 100% renewable energy. Cross Border connections and missing links in the network also need to be improved.

Digitalization and modernisation of rail track management. The European Rail Traffic Management System (ERTMS) is vital for interoperability and establishing a single network. Full roll out of the ERTMS system could increase capacity by 30%. The target is to deploy ERTMS on 50% of core network by 2023 however by 2015 only 9.5% was implemented. It is therefore vital that this rollout is accelerated.

An EU wide authority to allocate tracks to operators (like eurocontrol for airways) could be formed to oversee cross-border path allocation, to find alternative routes in times of need, increase efficiency and avoid major disruptions. Cross-border infrastructure projects are often delayed because of administrative hurdles, with no single contact point (for permitting etc) in each country. As a solution, each member state should determine one single contact point and a stronger role for the EC Coordinators. This can be achieved through the policy process in TEN-T Streamlining Directive.

1.5 Rolling stock

Investment in new rolling stock and creation of smart subsidies, loans or rental services for new entrants to enter the market eg. for leasing of second hand wagons to support new night-train services in Europe.

1.6 Opening access for new entrants

Best practice examples exist in Sweden and eastern europe, where new entrants were responsible for new lines, including night trains. Can also boost railway services with reduced track access charges, especially for night train services which could make use of capacity at less busy times. Challenges for new entrants that currently exist are: access to services on stations, possibility to pick-up passengers

at stations, high entry costs (due to unrealistic standards and requirements that protect the positions of established parties) and long term contracts are barriers.

1.7 Fair Fares with a level play field

Currently there is an unfair playing field of competition between air and rail travel where the polluter pays principle does not apply:

- rail pays energy/electricity tax, while planes do not.
- in some member states VAT is charged on international/national rail tickets; aviation only pays VAT on national tickets but not on international tickets.
- rail pays for ETS allowances on electricity, aviation gets 85% for free.
- rail pays for infrastructure use, cars mostly do not (depending on member state). EU legislation requires member states to charge rail at least for marginal costs of infrastructure use, some member states even charge full costs.
- most member states have for decades invested much more in road infrastructure then in rail,