PhDs EU-Rail

Deliverable 2.5

Data gathering and analysis of Fast Night Train operations contributing to the decarbonization of travel

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Executive Summary

Deliverable 2.5, entitled *Data gathering and analysis of Fast Night Train operations contributing to the decarbonisation of travel*, presents the findings of the PhDs EU-Rail project on the role of fast night train operation in supporting the transition towards more sustainable long-distance passenger transport in Europe. The report consolidates available data, policy developments, service examples, and scientific research in order to assess the current status of night train operations and their future potential within the European rail system. Deliverable 2.5, as such, is only a product of work conducted within the project lifetime; it can be classified as a systematic literature review scientific paper. For the project purpose, it was necessary to elaborate on the work a PhD student is conducting within the project time frame and explain which available literature will help finalise the work and support the statements.

The analysis confirms that night trains are a viable transport solution for medium- and long-distance travel, particularly on routes where aviation currently dominates, and passengers are seeking a practical alternative that combines travel efficiency with reduced environmental impact. Night trains offer the advantage of enabling passengers to travel overnight, thereby saving daytime hours while covering substantial distances. In environmental terms, they also provide a significantly lower greenhouse gas footprint than air transport, especially when operated on electrified rail networks with high occupancy rates.

The report identifies a renewed interest in night trains across Europe, driven by decarbonisation objectives, changing passenger preferences and increasing policy attention at both European and national levels. At the same time, it highlights a number of structural barriers that continue to limit the expansion of night train services. These include fragmented market structures, high infrastructure access charges, limited availability of suitable rolling stock, insufficient cross-border coordination, and complex ticketing and passenger rights arrangements. Such barriers reduce the competitiveness of night trains and constrain market entry for new operators.

In response to these challenges, the report systematically reviews stakeholders' current views on rolling stock for night services and their costs, timetable challenges, policy initiatives, and industry developments aimed at improving conditions for long-distance and cross-border passenger railway services. Particular attention is given to the European Commission’s Action Plan to boost long-distance and cross-border passenger rail, the work of the Back-on-Track network, and the expansion of services by operators such as ÖBB, SBB and European Sleeper. These developments indicate that night trains are increasingly recognised as an important component of the European mobility transition.

The report further provides an overview of existing European night train services and selected route examples, illustrating the diversity of current operational models and the geographical scope of the

night train network. In addition, three scientific case studies carried out within the PhD EU-Rail project are presented at scientific conferences: (1) TRANSCOM 2025, (2) HORIZONS OF RAILWAY TRANSPORT 2025, and (3) TRASNSPORT RESEARCH ARENA (TRA) 2026, and are at different stages of the publishing process. The first examines high-speed night trains in China as a reference case for integrating high-speed rail and overnight services and was published in Transportation Research Procedia. 2026;93:136-41, doi.org/10.1016/j.trpro.2025.11.021. The second analysis focuses on rolling stock characteristics, service quality, and modernisation needs of sleeping cars in Croatia and is still in the process of being published. The third one focuses on the passenger experience on night trains and is still being published. All together, these studies provide useful insights into the technical and operational dimensions of future night train development.

Overall, the report concludes that fast night trains have the potential to become a meaningful instrument for decarbonising long-distance travel in Europe. However, realising this potential will require coordinated action at the European and national levels, including targeted policy support, improved cross-border coordination, harmonised ticketing solutions, lower access charges, modernised rolling stock, and stronger integration within the wider rail network. With the appropriate enabling conditions, night trains can contribute significantly to the modal shift from air to rail and to achieving Europe's climate and mobility objectives.

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Abbreviation / Acronym	Description
AISBL	Association Internationale Sans But Lucratif (International non-profit association)
BEMUs	Battery-Electric Multiple Units
CEF	Connecting Europe Facility
CO2	Carbon dioxide
CO2e	Carbon dioxide equivalent
ČD	České dráhy / Czech Railways
DB	Deutsche Bahn / German Railway
DB FV	DB Fernverkehr / German Railway Passenger long distance Transport
EBT	Earnings Before Taxes
EC	European Commission
EIB	European Investment Bank
EMUs	Electric Multiple Units
ETCS	European Train Control System
EU	European Union
FTE	Forum Train Europe
GHG	Greenhouse gas
HS	High speed
HSR	High speed rail
HŽPP	HŽ Passenger Transport
ICE	Intercity-Express
IEA	International Energy Agency
ITF	International Transport Forum
MÁV / MÁV	START Magyar Államvasutak / Hungarian State Railways
NS	Nederlandse Spoorwegen / Dutch Railways
NJ	Nightjet
OSDM	Open Sales and Distribution Model
ÖBB	Österreichische Bundesbahnen / Austrian Federal Railways
PKP IC	Polskie Koleje Państwowe Intercity / Polish State Railways Intercity
PSO	Public Service Obligation

RNE	RailNetEurope
RJ/RJX	Railjet and Railjet Xpress
SBB	Schweizerische Bundesbahnen / Chemins de fer fédéraux suisses / Ferrovie federali svizzere / Swiss Federal Railways
SNCB	Société Nationale des Chemins de fer Belges / Belgian National Railway Company
SNCF	Société Nationale des Chemins de fer Français / French National Railway Company
TEN	Trans European Transport Network
TAC	Track Access Charges
TTR	Timetabling and Capacity Redesign
TSI	Technical Specifications for Interoperability
UIC	Union internationale des chemins de fer / International Union of Railways
VAT	Value added tax
UZ	Українська залізниця / Ukrainian Railways
ZSSK	Železničná spoločnosť Slovensko / Slovak Railways Passenger Transport

1 Introduction

Long-distance travel within the European Union relies on air transport, which poses environmental challenges and hinders decarbonisation goals. To help tackle these challenges, some railway companies have reintroduced night trains, a bold yet risky move given outdated organisational structures and equipment. There is an urgent need for academic research to be coupled with industry collaboration to develop and propose a new organisational model for fast, reliable night trains and to establish a sustainable business model for their operations. High-speed (HS) railways in Europe have proven their credentials and present a real opportunity to replace busy air routes. To help balance the CO_2 footprint, it is crucial to understand the importance of night train services in Europe and to identify the potential market and the most feasible routes for high-speed night trains based on customer preferences, demand, and revenue streams. In addition, it is critical to study the existing rolling stock that can be used for HS night train services and reveal areas for technical, operational, and logistical improvement that will enhance service quality, reliability, and passenger experience (Luketić H., Abramović B., Šipuš D., 2025).

Back-On-Track.eu is an independent European network and contains valuable documents and guidelines produced for all EU Railway operators. The idiom meaning is to return to a normal, desired state or to begin making good progress again after a period of interruption, difficulty, or delay, and the phrase originated in the railway industry, referring to the process of putting a derailed train back on the rails. According to (Back-on-Track Europe AISBL, 2025) trains are the most climate-friendly means of transport, and aeroplanes are the most unfriendly ones. More regarding Back-On-Track initiatives is attached in Annex I of this document. In the EU, the average in 2019, according to International Energy Agency (IEA) numbers, their actual emission of greenhouse gases (GHG) was 28 times higher than the emissions of long-distance passenger trains, including night trains. While the airline industry regularly refers to "green" flying, there is no clear pathway to achieving it. The capacity to produce "sustainable aviation fuels" is vanishingly low, and even if they were used on a larger scale, flying remains multiple times more climate-damaging than trains due to non-CO_2 effects. Battery-driven electric propulsion has made some limited progress, but even if one assumes a continuous increase in battery energy density, by 2050 it will only suffice for very short-distance flights (up to 500 km), the category in which fast day trains, if available, could easily compete with aviation. For the majority of short (500 – 1,500 km) and medium-haul (1,500 – 3,500 km) flights, night trains are the best alternative, as most people are unwilling to spend 6 hours or more of their daytime on a train. The advantage of night trains is the ability to sleep while travelling and to cover distances of up to 2,000 km, or even 3,000 km when combined with high-speed rail. If rolled out on a European scale as an alternative to flying, night trains could prevent 3% of the EU's gross climate-wrecking emissions.

Building new high-speed railway (HSR) lines (at speeds of 250 km/h and above) is costly, and has significant environmental impacts, so this cannot be the general solution for long-distance passenger transport. Where high-speed railway lines already exist, suitable night trains should be able to take advantage of them. But extending the night train network would not necessarily require expanding HSR beyond closing a few gaps. Upgrading all existing main lines to allow 160 to 200 km/h (or 230 km/h if possible) would be sufficient to achieve the range increase we are striving for with night trains. The EU Report (European Parliament, Steer Davies Gleave, 2017) does not see night trains as an integral part of the railway network, but rather as competitors to day trains. The basic idea behind long-distance night trains is:

- distances more than 700 km
- good connections, evening and morning, to "feeder railway lines" – the last mile concept
- a real chance to sleep undisturbed for 7 or more hours.

Night trains are experiencing a remarkable resurgence across Europe and beyond, driven by the urgent need to decarbonise long-distance travel and to reshape mobility patterns toward sustainability. Their unique value proposition, combining time efficiency, comfort, and reduced environmental impact, makes them a key enabler in the shift to low-carbon transport. This renewed momentum is not simply nostalgic. It is strategic. As policymakers and investors seek effective solutions to the climate crisis, night trains offer a concrete, scalable, and increasingly popular alternative to air travel for medium- and long-distance travel. In addition, they reconnect territories, offering cross-border links and overnight convenience that reimagine travel not just as transit but as an experience. Night trains are a vital part of the rail reform UIC is striving for. For that reason, the first edition of the Night Train Atlas was launched by UIC (Atlas Night Trains 2024, 2025). Arranging all necessary data, aligning infrastructure, and connecting several rail operations require vision and a strategic plan. With renewed public interest and political support, cooperation among railway undertakings is increasing, and the European Commission is providing funding opportunities for new strategies and projects.

Decarbonising the transport sector has taken a prominent role in the strategy to combat climate change (ITF, 2019). Research conducted by (Mandegari M., Ebadian M., & Saddler J., 2023) shows that the world's railway sector transports 7% of global freight and 8% of the world's motorised passenger movements, consumes only 2% of the energy used by the transport sector, and is responsible for just 0.3% of the direct CO2 emissions from fossil fuel combustion. On average, rail requires 12 times less energy and emits 7 - 11 times less GHGs per passenger-km than private vehicles and aeroplanes.

For that reason, numerous activities started among European service providers. For example, the European network to promote cross-border night trains, “Back-On-Track.eu,” campaigns for more, better, more affordable, long-distance, and cross-border night trains in Europe. They are convinced that night trains could not only be a modern, comfortable, and relaxed way to travel but also an important solution to reduce the EU's contributions to global warming by up to 3% overnight, particularly by substituting short- and medium-haul flights. This European non-profit organisation, with a volunteer-run headquarters in Brussels, has local groups in multiple countries (Back-On-Track.eu, 2025). The Back-on-Track network sees trains as:

- One of the most environmentally friendly ways of travelling long distances in Europe
- An important part of the transport system of the future, and not only a part of our history
- A convenient way of travel to both leisure and business, all year round

International trains, as well as night trains and auto-trains, are an integrated part of European railway traffic. Neglected night trains are a strong indicator of a disintegrated and deteriorated rail system. According to the European network opinion and General Position Paper issued in April 2024:

- Subsidies must be allowed, if trains suffer from unfair competition, for instance, compared to aeroplanes,
- Modern and reliable rail transport should be kept a public responsibility and kept as an integrated entity to the benefit of the passengers and not to shareholders. With good workplaces with a dedicated staff,
- Railways shall keep a good level of service – easy to buy international tickets, one system for all tickets, not too expensive, with improved trains (night trains are suffering from old stock)
- Good long-distance connections are needed – interconnected night trains and international day trains, with coordinated timetables,
- Night trains should connect a wide range of major cities and countries in Europe, AND
- Regional cross-border train connections should be developed

In the last few years, there have been interesting but numerically limited scientific papers about night train organisation. (Kantelaar, M. H., Molin, E., Cats, O., Donners, B., & van Wee, B., 2022) Investigate willingness to use night trains for long-distance travel. (Gunkel, T., Schnee, M., & Müller–Hannemann, M., 2011) Investigate how to find good night train connections. (Li, B., Qi, X. C., Li, Q., & Yang, X., 2018) analyse and predict the passenger flow of high-speed night trains. (Dömény I., & Dolinayová A., 2021) Investigate the feasibility of introducing a new night train connection in Central Europe. This study aims to analyse current night train services in Central Europe and find opportunities for their further development. Andrew Martin, in his book Night Trains – The Rise and Fall of the Sleeper, explains why night trains have been massively successful in Europe and what went wrong over the years. This book serves as a starting point for understanding travel expectations on night trains.

Considering the long tradition in Europe, night trains have been popular in the past; however, nowadays, long-distance night travel needs to be upgraded to accommodate passengers and their needs in the first place (Bulkova Z., Dedik M., & Gašparik J., 2022). According to research by (Martini F., & Pesci G., 2022) in recent history, it has been observed that night travel has returned to the transport scene despite years of neglect and insufficient investments. With the re-establishment of international train connections, the long-distance concept was restored as well. This was primarily a concept of "hotel on wheels" for businesspeople and tourists. The concept of people travelling for leisure is often impractical due to the disadvantages of accommodation and transport. Therefore, improving the harmonisation of timetables and direct connections is essential, as several studies have shown that train connections are unprofitable, uneconomical, and have no future.

It can be confirmed that there is a considerable research gap in the investigation of new organisational models for fast night-train operations across Europe.

2 Stakeholders' current and future standpoint regarding night trains

According to the European Union position paper, a passenger night train is any train that consists partly or wholly of rolling stock dedicated to or reconfigured for overnight travel. Travelling by night train has several advantages. One can relax and sleep during travelling, depart in the evening and arrive rested the next morning at the destination. Furthermore, taking the train at night allows you to cover long distances and significantly reduce emissions compared to travelling by aeroplane. Therefore, the night train might be a key step towards a more sustainable mobility.

An idealised overnight train would provide a non-stop journey of 8-10 hours between two stations, departing after 22:00 and arriving before 8:00. In practice, few night trains operate wholly within this period, and none that we have identified do so without stops en route, with the result that few offer an uninterrupted journey of more than six hours. In a climate-friendly Europe where we must reduce air travel, night trains are necessary. Without these trains, effective cross-border travel between all parts of Europe, including remote areas, is much more difficult.

The EU plays only a limited role in relation to night trains: setting the overall regulatory framework, including rail infrastructure charges, and investing in infrastructure. The Member States could require infrastructure managers to reduce infrastructure charges or could subsidise night trains in recognition of their benefits, as occurs in (at least) Austria, Sweden, the United Kingdom, and France. However, parliamentary debates in 1983 (in the United Kingdom) and 2016 (in Germany) rejected the idea of subsidising any long-distance services. The operators of night trains generally appear to manage them well. Cross-border operations and illogical changes of locomotives and crew are long-established. The past practice of allocating blocks of tickets to each railway for sale through stations is declining. Best practice appears to be: (1) to offer a range of accommodation and the opportunity to pay more for exclusive use of a compartment; (2) to use yield management to maximise revenue from the capacity available; and (3) to sell through a single (multilingual) website. However, some operators appear to offer only a narrow range of accommodation at fixed, low fares, likely to meet an inflexible national PSO.

The Trans-European Transport Network (TEN-T) core network corridors may be of some help to night trains, where they provide additional capacity, but major new international links appear not to have attracted night train services, and high-speed lines appear to have contributed to their decline. (Luketić H., Abramović B., Šipuš D., 2025).

The EU Commission has 14.12.2021. presented an Action Plan that covers the area of promoting night trains (Back-on-Track Europe AISBL, 2025). The phrase ‘night train’ is only mentioned four times in the 18-page document. But anyway, many elements go into improving conditions for night trains. “This

Action Plan aims at boosting long-distance and cross-border rail services. As night train services travel long distances and often cross borders, they will benefit from the measures foreseen in this Action Plan. The rules on public service obligations set out in Regulation 1370/2007 also apply to these services. In 2022, the Commission will adopt updated Interpretative Guidelines on Regulation 1370/2007 that will include cross-border services." (Back-on-Track Europe AISBL, 2025).

The introduction of new rail services requires substantial investments in rolling stock, either by railway undertakings, rolling stock leasing companies, or competent authorities when the service is provided under a PSO.

Although most long-distance cross-border services can be operated commercially, there is a need to kick-start the availability of rolling stock for these services. Public support for creating pools of long-distance cross-border rolling stock, or for mitigating commercial risks for leasing companies when acquiring and leasing it, could help generate the desired boost. Cross-border services often face a disadvantage vis-à-vis domestic services in the competition for scarce capacity. This also affects night trains entering major stations during the morning peak traffic. The Commission will support rail sector stakeholders and other interested parties in launching cross-border pilot services. As many key passenger lines will be on the TEN-T Transport Corridors, TEN-T Coordinators will have dedicated responsibilities to develop work plans supporting the development of cross-border rail services on these corridors, notably by proposing strategic investments and monitoring rail traffic performance through operational improvements such as integrated timetabling and capacity allocation. High and diverse track access charges across borders, notably in terms of mark-ups, are a decisive cost factor and can hinder the setting up of new services and the attraction of new entrants and private investment. The Commission will provide guidelines in 2023 for setting track access charges which support and encourage the development of long-distance and cross-border passenger services. It must become as easy and convenient for passengers to compare and buy rail tickets as it is for other transport modes, in a single transaction and using state-of-the-art technology. Passengers connecting between trains should be confident that they will arrive on time or, if not, that they will receive the necessary assistance to reach their destination. To make cross-border train travel attractive, passengers also need to be protected throughout the journey. The new Rail Passenger Rights Regulation, adopted in April 2021, introduced, for the first time, an obligation to offer through-tickets from 7 June 2023, but only on a rather limited basis. However, the limited obligation to offer them and the lack of an existing market for through tickets limit passenger protection and thus reduce the attractiveness of rail. Passengers combining several trains into a single journey must be assured they will not be stranded if one of the trains is late, regardless of whether the tickets were sold as a through ticket or as separate contracts. A solution could be to ensure that passengers travelling on combined separate tickets can continue their journey in the event of a missed connection under certain conditions. The Commission will therefore address the issue of journey continuation in case of delays as part of the initiative on multimodal digital mobility services. The Commission has already proposed measures to enable equal competition among different modes. With the Fit for 55 package presented on 14 July 2021, the Commission has put forward an ambitious set of proposals to align economic incentives with climate, social and environmental objectives, while recognising differences in the global and competitive contexts in which different modes of transport operate. This includes proposed changes to emission trading and to the energy taxation framework.

Action Plan complements the Commission's Sustainable and Smart Mobility Strategy, which sets ambitious milestones for rail transport. It builds on the experiences and findings of the 2021 European Year of Rail (ec.europa.eu, 2021).

It focuses on two main pillars:

- The full and correct implementation of the existing EU regulatory framework for railways, including the removal of any redundant national rules.
- The removal of obstacles to long-distance and cross-border passenger rail services.

The Action Plan is a roadmap for the coming years, with the goal of making long-distance cross-border rail travel more attractive to many more European passengers, notably by making rail journeys quicker, more frequent, and more affordable.

This action plan predates the 2022 multimodal legislative proposal to improve ticketing for long-distance, cross-border train travel in Europe. Planning and booking cross-border train trips must become easier and more user-friendly, enabling passengers to quickly find the best available ticket at the best price, with better protection when a journey is disrupted. The goal was to improve data exchange between mobility providers and facilitate the conclusion of commercial agreements between railway undertakings and third-party ticket sellers, thereby boosting the availability of train tickets. This would also allow passengers to buy tickets for journeys combining train travel with local public transport and other mobility options.

The Action Plan also includes measures to improve the rail network's operations, making rail travel more affordable. The Commission explored the possibilities for a European Union-wide VAT exemption for international train journeys. In 2023, the Commission issued guidelines on setting track access charges to boost affordable cross-border train travel. The European Commission (EC) boosts affordable energy in 2023/2024 through actions like the REPowerEU Plan, focusing on renewables, common gas purchasing, and grid upgrades (Grid Action Plan), alongside initiatives for energy efficiency (EED), consumer protection, and fast-tracking clean energy projects (Accele-RES) to lower costs, reduce fossil fuel dependence, and empower citizens with choices, all aimed at stabilizing prices and achieving climate goals. High and diverse charges can hinder the launch of new services, making the market less attractive to new players and reducing competition, which is likely to have a negative effect on ticket prices.

Along with the Action Plan, the Commission revised the Trans-European Transport Network (TEN-T) Regulation to ensure sufficient high-speed capacity and connections. It proposed, amongst other measures, a minimum speed of 160 km/h for the core network, as well as increased efforts to better connect airports to railways.

The Action Plan aims to make the best use of the Single European Railway Area to boost competition and the development of innovative, affordable train services, and to present a programme to remove the main obstacles that still impede the establishment and operation of long-distance cross-border passenger rail services.

2.1 Stakeholder ÖBB-Personenverkehr AG

Austrian Federal Railways Passenger Transport (ÖBB-Personenverkehr AG) is Austria's largest mobility service provider, handling over 1 million passengers daily across its rail and bus networks. Operating as a wholly owned subsidiary of ÖBB-Holding AG, it is renowned for maintaining a 94% punctuality rate (ÖBB, 2026). Its core services are Long-Distance, which connects major Austrian cities and regional capitals via the high-speed Railjet and Railjet Xpress (RJ/RJX) and Intercity-Express (ICE). Then there is the Nightjet (NJ) service, which provides extensive cross-border sleeper train services across Europe, featuring new-generation carriages with single Mini Cabins, as well as regional and local services operating on an extensive network of Cityjet trains and regional buses that integrate seamlessly with local transport associations. Timetable organisation difficulties at ÖBB Passenger Transport frequently stem from major infrastructure updates and extensive domestic construction, as planning for local and long-distance passenger rail services is updated incrementally throughout the year, and timetable details often change after tickets are initially issued. This causes noticeable disruptions for travellers. The ÖBB Nightjet and EuroNight timetables are heavily affected by ongoing organisational changes, network construction, and international coordination barriers. Because night trains cross multiple borders and share tracks with freight traffic, their schedules are much more sensitive to disruption than daytime routes. The planning data for the annual timetable is being continually adjusted. Due to ongoing consultations with international partner railways (such as DB in Germany or Trenitalia in Italy), many Nightjet routes are not open for purchase until shortly before the departure date. Many Nightjets are "compromise trains," meaning different halves of the train are physically uncoupled and re-attached to other trains at midnight stations. If one line experiences a track maintenance delay, it automatically triggers a cascading delay for the connecting night-train segments. Operating night-train rolling stock entails significant economic, technical, and manufacturing challenges. While ÖBB is Europe's market leader, the unique design requirements of sleeper trains make expanding and maintaining their fleets incredibly difficult (Tomeš Z., Paril V., 2026).

The primary rolling stock challenges facing night trains include high sunk costs and low capital efficiency (SCHIG, 2025)**,** (Dudgeon M., 2025)**,** (Booth H., 2024)**.** Standard daytime trains run continuously from dawn until late at night. In contrast, night-train rolling stock can generate revenue only once per 24-hour cycle. During the day, expensive sleeper carriages sit idle in shunting yards, earning nothing. (Jensen D., 2025). Because couchette and sleeper cabins take up significantly more space than standard rows of seats, night trains carry far fewer passengers per meter of train length. This structural limitation makes it very difficult to break even without massive public subsidies. Due to soaring daytime demand, ÖBB recently reduced its Siemens Mobility contract, capping its final new-generation Nightjet fleet at 24 units instead of the originally planned 33. The remaining funds were diverted to daytime Railjet 2 expansion (Railway Gazette, 2025).

Another challenge is intense maintenance and fast clean turnarounds (SCHIG, 2025)**.** Unlike day trains that require basic trash removal, night trains require complex hotel-style cleaning. Staff must strip beds, manage massive amounts of fresh linens, clean personal showers, and restock catering supplies within very tight morning turnaround windows (Agenda, 2025). Many night trains are "compromise trains." Throughout the night, portions of the train must be physically uncoupled and re-attached to other lines at major junctions to serve multiple destinations. This constant mechanical shunting increases wear and tear on the rolling stock (Traunmüller M., Michelberger F., Sauter-Serveas T., 2024)

Issues with night trains include fragmentation and cross-border bottlenecks due to technical incompatibility. Operating across Europe requires trainsets to navigate a patchwork of national rail rules. Rolling stock must support different overhead power voltages, distinct national signalling safety systems, and varying track geometry (RailEngineer, 2015), (Bradley S., 2026). While ÖBB has successfully rolled out its sleek, new-generation Nightjet trains on major routes (like Vienna-Hamburg or Amsterdam), a large portion of European overnight travel still relies on conventional carriages that are several decades old. Because the supply of new sleeper cars is globally scarce, replacing these ageing coaches is slow and expensive (Agenda, 2025) (Dudgeon M., 2025).

ÖBB is facing a complex fiscal squeeze, with consolidated Group Earnings Before Taxes (EBT) dropping 40% to €68.1 million (ÖBB Group, 2026)**.** While the passenger transport division remains highly profitable—buoyed by an 8% revenue jump to €4.09 billion—structural obstacles, massive capital expenditures, and an industrial recession in freight transit are straining the state railway's budget.

Project PhDs EU-Rail (Grant number: 101175856).

Night train carriages run for roughly 12 hours a day, sitting empty and unproductive in railyards during peak daylight hours. Standard daytime intercity trains stay in operation for up to 20 hours a day. Because sleeper and couchette cabins provide passenger privacy, they hold drastically fewer paying travellers per meter of train length compared to regular seating layouts. Routes like Vienna-Paris or Berlin-Paris required millions in state subsidies to run. High operating costs forced ÖBB to completely scrap those lines. Operating night trains requires premium "hotel-style" operations, including daily cabin deep-cleans, massive linen laundering logistics, and high mechanical wear from coupling and decoupling coaches at midnight stations. Squeezed by supply bottlenecks and changing network priorities, ÖBB altered its Siemens Mobility manufacturing deal. It capped its new-generation Nightjet order at 24 sets (down from 33) and funnelled those millions back into buying 13 new Railjet 2-day trainsets to capture high-density commuter revenue (Back-On-Track.eu, 2025). To stave off the extreme costs of purchasing completely new trains from an empty international second-hand market, ÖBB is pouring millions into retrofitting its legacy Railjet Fleet with new seat ergonomics and digital passenger info portals.

Table 1. The operational cost differences explain why ÖBB recently shifted capital from night to day transit (ÖBB Group, 2026)

Cost Metric	Nightjet Fleet (Sleeper)	Railjet Fleet (Daytime Intercity)
Daily Revenue Hours	12 hours per day (mostly idle during sunlight)	~20 hours per day (continuous utilization)
Passenger Capacity	Low (cabins take up heavy geometric space)	High (dense row/aisle seating configurations)
Onboard Service Costs	Premium (linens, bedding, individual shower plumbing)	Basic (standard trash collection, bistro car replenishment)
Financial Viability	Dependent on international state subsidies	Highly self-sustaining and profitable

2.2 Stakeholder Železničná spoločnosť Slovensko (ZSSK)

Železničná spoločnosť Slovensko (ZSSK) timetable issues are currently driven by extensive corridor modernizations, single-track bottlenecks, and technical glitches within the digital booking infrastructure. Passengers regularly navigate altered departure windows, cascading arrival delays, and synchronization errors on international routes (Kovacova M., 2025).

ZSSK is managing its timetable organization through structural revisions ordered by the Ministry of Transport alongside localized tactical adjustments to absorb massive corridor modernizations. The strategy focuses on accelerating core long-distance lines, implementing interval-based scheduling, and adjusting cross-border logistics to manage long-term infrastructure delays (ZSSK, 2026). ZSSK builds its annual timetables under the framework of the approved Transport Service Plan of Slovakia, coordinating directly with regional self-governments to synchronize regional routes. The carrier relies heavily on clock-face scheduling, establishing regular hourly expresses on backbone routes like Bratislava–Košice to create highly predictable transfer windows (UIC, 2025). On primary corridors, timetables split long-distance traffic into high-frequency "Tatran" express variants with 17 key stops and optimized "Kriváň" express variants making only 10 stops to preserve accelerated cross-country times (UIC, 2025).

In areas facing single-track limitations, such as the Poprad-Tatry–Vydrník link, ZSSK builds longer, adaptive padding intervals directly into the timetable to limit regional ripple delays (Ivina D. & Ma Z., 2024). When large engineering bottlenecks emerge, like the Trnava–Cífer or Bratislava–Košice renovations, ZSSK rolls out seasonal mid-term amendments rather than waiting for annual schedule resets (Ryník J., 2026). To maintain network punctuality during track work, timetables are occasionally written to short-turn selected regional services, terminating them early and substituting regional bus loops (Kovacova M., 2025). Timetables for non-Schengen cross-border routes, such as the Zakarpatia express lines connecting Košice to Mukachevo, include expanded standstill times specifically scheduled for customs and pre-departure screening (The Slovak Spectator, 2026). International connections like the new Čadca–Ostrava links are organized through co-scheduled timetables alongside partners like České dráhy and ÖBB to avoid platform conflicts (IDS BK, 2026). Seasonal surges are handled through temporary fleet adjustments, such as adding specialized sleeper car extensions to night services during peak summer cycles (The Slovak Spectator, 2026).

ZSSK faces major cost challenges tied to shrinking government subsidies and aging rolling stock, forcing the carrier to lean heavily on European Union funding for essential fleet upgrades. Concurrently, its service maintenance strategy relies on a multi-million-euro modernization plan to transition from outdated, fragmented repair shops to centralized high-tech hub (Simmons M., 2026). ZSSK operates under a strict Public Service Obligation (PSO) budget balanced by law. Pressures on Slovak public finances mean national subsidies are flattening out or actively contracting, capping the operator's ability to absorb unexpected operational cost overruns. National rail investment tracks far below the regional average of neighbouring countries, leaving ZSSK struggling to afford baseline vehicle renewals without external financial assistance (Simmons M., 2026). Operating routes across Slovakia's uneven network infrastructure is expensive. Over half of the network remains non-electrified, causing high diesel fuel costs and escalating the price of maintaining old diesel locomotives. High general inflation alongside rising component costs has driven up day-to-day operational outlays, while competitive labour market shortages put upward pressure on train mechanic and driver wages (Hlavatý J., Ližbetin J. & Fázik J., 2023).

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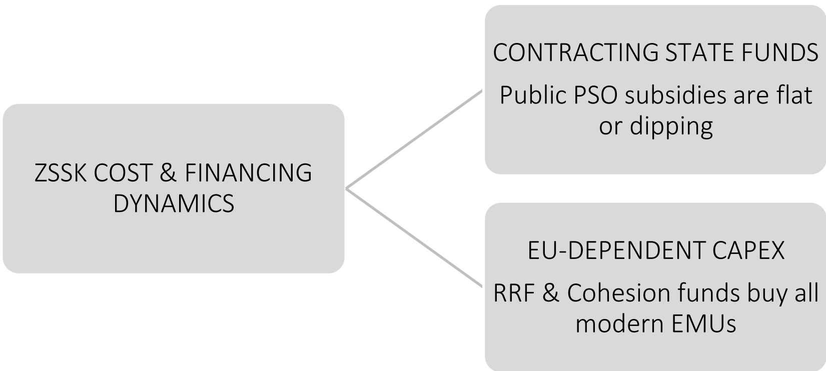
The operator is building modern, centralized maintenance hubs in key locations like Košice and Žilina to replace highly outdated facilities. These facilities bundle operational treatment halls, automated stable washing systems, and specialized tracks to safely clean modern closed-system vehicle toilets (Cech L., 2024). High rolling stock mileage across old carriages drastically increases repair labour and lowers fleet availability. The centralized maintenance strategy aims to minimize the volume of standby trains held in reserve by accelerating standard vehicle turnaround cycles. To combat internal maintenance budget shortages, new rolling stock procurements are structured as comprehensive 10-year service agreements. Recent procurement actions for long-distance Electric Multiple Units (EMUs) legally bundle spare parts supply and expert maintenance directly into the manufacturer's contract (RAILWAY PRO, 2026). ZSSK is shifting toward zero-emission alternative fleets to phase out high-maintenance combustion parts. This is highlighted by a major €144 million state contract financed by the EU Cohesion Fund to acquire 16 new Battery-Electric Multiple Units (BEMUs) to reduce maintenance outlays on non-electrified regional tracks (Simmons M., 2026)

Figure 1. Core Cost Challenges



2.3 Stakeholder Croatian railways Passenger Transport

Croatian Railways (HŽ Putnički prijevoz / HŽPP) timetable struggles are largely driven by a massive, multi-year infrastructure overhaul managed by HŽ Infrastruktura. While billions in EU funding are being poured into modernizing the network, the immediate consequence for passengers is a highly unstable schedule layout defined by cascading delays, unexpected cancellations, and a heavy reliance on replacement buses (Expat in Croatia, 2026). Primary operational bottlenecks are single-track network limitations, freight traffic prioritization and "slow driving" speed restrictions. Major arterial routes, such as the mountain corridor linking Zagreb to Split, operate on constrained single-track segments. If a single train incurs a delay, opposing trains must wait at passing loops, triggering network-wide schedule failures. Passenger trains frequently experience extended stationary delays at regional hubs because heavy international freight corridors are dynamically prioritized across single-track lines. Safety risks from aging tracks have forced dispatchers to implement sudden, temporary speed restrictions. These speed caps render the official annual timetable structurally inaccurate until formal amendments are published (HŽPP, 2026). Long-distance international night trains connecting Zagreb to major hubs like Stuttgart, Munich, Zurich, and Ljubljana are highly vulnerable to outside infrastructure issues. Engineering work across Germany, Austria, and Switzerland frequently forces HŽPP to announce last-minute route diversions or missed city stops (HŽPP, 2026). Seasonal international holiday trains arriving from Hungary, Austria, and the Czech Republic cause bottleneck delays during summer peak hours, upsetting local commuter train intervals around the coastal and Zagreb hubs. Because localized construction updates emerge rapidly, the annual baseline timetable undergoes multiple heavy revisions mid-year (such as major consecutive amendments rolled out in April and June). To get live delay tracking, travellers must use the updated HŽPP Mobile App, as the older *HŽPP Planer* app was officially retired due to syncing limitations. Croatia is currently executing an aggressive fleet overhaul to completely phase out its old, Yugoslav-era rolling stock by 2032. Backed by billions in European Union funds and massive European Investment Bank (EIB) loans, HŽ Putnički prijevoz (HŽPP) is rapidly deploying new trains built by the domestic manufacturer, Končar – Electric Vehicles (RCSEE, 2025). Končar is manufacturing 6 advanced electro-diesel hybrid trains explicitly designed to withstand the steep grades of the Split mountain route. Scheduled for rolling monthly deliveries, the first units enter commercial service, replacing unreliable 20-year-old tilting models (Railway Supply, 2026). To replace 45-year-old regional diesel trains, Croatia launched its first battery-electric multiple units (BEMUs**)**. For example, on the Zagreb–Bjelovar route, the train draws power from overhead lines for 44 kilometres and automatically switches to battery power for the remaining 30 kilometres (Končar, 2025). HŽPP has signed an €118 million contract for 13 additional alternative-propulsion trains, consisting of 5 electro-diesel, 4 electro-battery, and 4 pure-battery trains. Furthermore, a dedicated €53.6 million tender launched to procure 6 more regional BEMUs to service the non-electrified northern tracks of Varaždin and Međimurje (RCSEE, 2025). Every new low-floor train introduces modern accessibility standards. Passengers get ergonomic interiors, reliable air conditioning, onboard bicycle racks, electrical charging outlets, and free Wi-Fi connectivity (Končar, 2025).

The financing models for railway transport in Croatia and Slovakia are highly synchronized, as both countries rely on European Union structural funds as their primary capital expenditure engine while using European Investment Bank (EIB) framework loans to manage domestic co-financing gaps. Both nations face the same operational dilemma: balancing massive funding for international trans-

European corridors against the financial strains of non-electrified regional lines. The financing framework for Croatia's railway transport relies on a €6 billion national capital program spanning until 2030, structurally split between European Union grant pipelines for international freight corridors and multi-million-euro loan facilities for domestic lines. The deployment combines direct funding streams managed by the Ministry of the Sea, Transport and Infrastructure to aggressively divide the financial load between HŽ Infrastruktura and passenger carrier HŽPP.

Large-scale Trans-European Transport Network (TEN-T) priority corridors are directly subsidized via the Connecting Europe Facility (CEF) and the National Recovery and Resilience Plan. A major project includes the €898.9 million allocation of EU grants to fund the reconstruction and expansion of the 84-kilometer Dugo Selo–Novska corridor segment. For local networks and rolling stock assets ineligible for primary EU corridor grants, the state utilizes a massive €900 million framework loan from the European Investment Bank (EIB). An active €400 million tranche is currently drawing down to rehabilitate 500 kilometers of regional tracks and rebuild 30 suburban train stations (EIB, 2024). The Croatian national budget actively backs baseline infrastructure needs through co-financing limits. The state is committing €318 million in direct capital assistance out of a larger multi-year development package (Croatia Week, 2025).

HŽPP uses targeted EIB-backed tranches to fund cleaner passenger equipment. This includes a €57.3 million layout for 6 electro-diesel trains explicitly assigned to the Zagreb–Split connection and a €117.9 million rolling order to procure 13 hybrid, battery-electric multiple units (BEMUs) to phase out old diesel dependencies on secondary rural networks. The capital apparatus uses smaller, localized contracts to step-fix internal routes. A recent example is the €13 million contract formalized to execute a complete track and safety modernization along the local Hum-Lug–Gornja Stubica branch line. To supplement major infrastructure loans, secondary operations access niche funding sources, such as a €10 million loan agreement with Eurofima to pay for passenger carriage modernizations, alongside continuous project support via the EU's JASPERS advisory platform (Railway PRO, 2025).

The ticketing system and pricing structure of Croatian Railways uses a tiered channel structure designed to shift passengers away from physical counters and onboard purchases toward digital platforms. Ticket pricing varies primarily based on distance (kilometres travelled) and your chosen purchase method rather than airline-style dynamic scaling. The baseline costs for domestic rail transport in Croatia are distance-dependent and explicitly calibrated by HŽ Putnički prijevoz (HŽPP) based on fixed kilometre brackets. Rather than fluctuating via dynamic, airline-style supply scaling, prices remain fixed until regular tariff adjustments are published.

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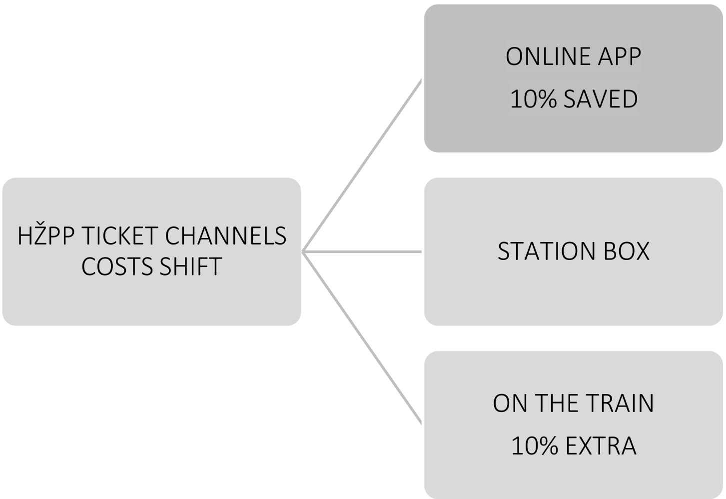
Figure 2. HŽPP ticketing channels



Service challenges for Croatian Railways stem directly from the friction between localized infrastructure decay and massive network rehabilitation projects. While billions are fuelling track overhauls, the short-term consequences include systemic network bottlenecks, dynamic operational delays, and major information gaps for daily passengers.

Systemic lag times affect both regional and long-distance trains. Regulatory agencies have penalized the railway infrastructure operators for failing to provide timely, real-time tracking data or clear, transparent status explanations to stranded passengers onboard delayed trains. Continuous, aggressive construction closures along arterial routes—such as the international [Koprivnica–Varaždin or Dugo Selo–Križevci [segments]—frequently require lines to close. HŽPP is forced to coordinate massive regional bus loops, which significantly increases total transit times. Key high-volume traffic markets, including suburban corridors surrounding the Zagreb Main Station hub, depend heavily on outdated single-track configurations. This lack of infrastructure layout leaves zero operational buffers for passing loops, causing minor hiccups to quickly snowball across regional networks. The physical infrastructure presents major barriers for passengers with reduced mobility (PRM). Only a small fraction of regional stations complies with modern European Technical Specifications for Interoperability (TSI), and even the critical Zagreb Main Station still lacks assistance-free boarding and elevated platform pathways.

2.4 Stakeholder Hungarian Railway Passenger Transport MÁV-START Co.

MÁV-START Co. is the primary operator of national and international rail passenger transport in Hungary. It manages a network spanning roughly 7,000 kilometers, providing domestic links and overnight connections to major neighboring European cities (MAV Cosport, 2025).

The overnight rolling stock of MÁV-START Co. consists of a blend of partially modernized 1990s international carriages, retro summer trains, and specialized catering units managed by the Utasellátó (passenger services) branch (Railway Gazette, 2024). The fleet operates across major EuroNight (EN) corridors connecting Budapest with cities like Berlin, Munich, Stuttgart, and Zurich, as well as seasonal routes to the Adriatic Sea (Railway PRO, 2026).

MÁV-START faces a severe systemic rolling stock crisis that impacts domestic travel reliability, summer capacity, and its international night train fleet. A combination of historical underinvestment, manufacturer bankruptcies, and aging infrastructure has resulted in notable operational challenges (Railway PRO, 2025) (Daily news Hungary, 2026).

Primary Rolling Stock Challenges is severe fleet aging and low availability. The average age of MÁV's passenger carriages is over 33 years. Only about 68% to 71% of the total 2,700-vehicle fleet is operationally available at any given time, creating acute shortages during seasonal summer spikes (MAC Cosport, 2015). The aging domestic locomotive fleet suffers frequent track-side breakdowns. During summer heatwaves, these failures often lead to complete air conditioning blackouts, forcing passengers to wait by the tracks. In late 2025, Hungary's strategically vital train repair and manufacturing plants (Ganz-Mávag International and the Dunakeszi Vehicle Repair Plant) went into court-ordered liquidation. While MÁV has stepped in to acquire the Dunakeszi facility, the financial turmoil severely delayed routine overhauls and halted the continuous domestic production of new "IC+" passenger cars (Railway PRO, 2026).The newly modernized Budapest–Belgrade railway line relies strictly on the European Train Control System (ETCS) with no legacy national backup system. Because only a small fraction of MÁV's fleet features onboard ETCS hardware, it bottlenecks both passenger and cross-border train dispatching. The international night train network is disproportionately vulnerable to these vehicle shortages. Because MÁV must prioritize its dwindling pool of modern, air-conditioned cars for daytime InterCity routes, the night fleet heavily relies on 1990s carriages. When this international couchette or sleeping cars require complex maintenance, MÁV is frequently forced to substitute them with standard daytime seating cars, causing unexpected downward tier-upgrades for passengers (Levente Koroes, 2026). To combat the rolling stock deficit, the Hungarian Ministry of Construction and Transport has initiated a series of aggressive stopgap and long-term procurement steps. MÁV has aggressively leased dozens of Siemens Eurosprinter, Alstom Astride, and Henschel diesel locomotives from European leasing firms to phase out decades-old machines. They also purchased 93 second-hand electric multiple units from Switzerland for regional transit (Railway PRO, 2026). Due to long manufacturing waitlists at European factories, Hungary began active negotiations to purchase 100 mid-to-long-distance trainsets from China to rapidly expand fleet numbers within a

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two-year delivery window. Following a €16.4 billion funding agreement with the European Union, Hungary has allocated roughly €2 billion specifically to rail upgrades.

MÁV-START operates its passenger ticketing through an intertwined infrastructure of physical station kiosks, an official website, and mobile apps. In recent years, passengers have frequently encountered systemic digital glitches, strict reservation blackouts, and application fragmentation. MÁV passengers face major confusion due to the simultaneous coexistence of two separate official smartphone applications. The older system that passengers generally use to purchase and display point-to-point tickets or view real-time train status delays and a newer application primarily optimized for regional travel passes like the Hungary24 and County24 passes. Users regularly report that the newer MÁV+ application frequently suffers from verification glitches where legally purchased multi-day passes or domestic tickets randomly fail to display during conductor checks. The older app is often plagued by interface errors, random crashes during payment verification, and difficulties processing specific family or age-group discount.

Company struggles with widespread, chronic timetable disruptions driven by failing infrastructure, severe heatwaves, and data integration errors. Punctuality across the network has deteriorated significantly, with cumulative system delays frequently reaching critical levels (Daily News Hungary, 2024). Over half of the Hungarian rail infrastructure operates under permanent or temporary slow zones. Due to degrading tracks, shifting track beds, and faulty switches, trains are legally forced to drop from standard speeds down to 20–40 km/h on major trunk routes. This structural issue renders printed timetables baseline-inaccurate even before physical breakdowns occur. During summer peak periods, high ambient temperatures trigger track distortion and overhead electric wire sagging. This forces sudden, unplanned route closures and widespread switch breakdowns. Key corridors—specifically the Budapest–Győr (Line 1) and Lake Balaton tourist lines—frequently collapse into multi-hour delays during seasonal temperature spikes. Because MÁV utilizes an interconnected, cyclic domestic schedule, a delay on an incoming cross-border EuroCity or major InterCity train instantly triggers a domino effect. Connecting regional branch trains are faced with the operational choice of either delaying their own departure to wait for passengers or leaving on time and abandoning transferring travellers. Passengers encounter major timetable data glitches during seasonal time shifts. In a prominent incident, a system-wide DST integration failure caused the official Vonatinfó digital live map to display fictional, virtual 60-minute delays for nearly every train operating nationwide. The GPS location tracking system feeding the mobile apps regularly suffers from data dropouts. Trains that are stationary due to engine failure or line blockages will occasionally show as "moving on time" on the passenger-facing app, leading to immense confusion at destination station platforms.

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Table 2. MÁV Rolling Stock Challenges

Technical Issue / Core Cause	Current Status & Details	Direct Passenger Impact
Critical Fleet Aging	•Average age of passenger carriages exceeds 33 years. • Heavy reliance on legacy 1970s–1990s technology.	• Frequent track-side mechanical breakdowns. • Sudden locomotive engine failures during transit.
Low Operational Availability	• Only 68% to 71% of the total fleet is operationally ready. • Backlog in basic replacement parts.	• Acute vehicle shortages, especially during summer peaks. • Unscheduled reductions in train lengths/capacities.
Air Conditioning Collapse	• Outdated cooling systems fail under extreme heatwaves. • Power supplies break under continuous heavy loads.	• Severe onboard overheating during summer travel. • Windows must be opened manually instead of climate control.
Manufacturing Bottlenecks	• Bankruptcy and liquidation at key domestic repair facilities. • Continuous funding delays for new "IC+" passenger cars.	• Extremely slow turnaround times for routine overhauls. • Halted rollout of freshly manufactured modern carriages.
ETCS Hardware Deficit	• Very low percentage of trains equipped with European Train Control System.	• Modernized lines (e.g., Belgrade route) bottleneck dispatch. • Trains cannot operate at maximum track speeds.
Night Train Vulnerability	• International EuroNight fleet heavily relies on older 1990s cars. • No modern operational backups available.	• Sudden downward tier-substitutions on overnight routes. • Sleeping or couchette cars replaced by day seating.

3 Rolling stock challenges - Key competitive areas of night trains

Night trains, defined as passenger trains equipped with couchette or sleeper carriages, are strategically essential for sustainable mobility, offering a carbon-efficient and user-friendly alternative to air travel over long distances (up to 2000 km). These services are currently experiencing a significant resurgence across Europe (Atlas Night Trains 2024, 2025). Overnight trains primarily compete with faster air travel and autonomous forms of overland transport, particularly automobiles and cruises in the leisure market (Mirvish J., 2023). Specific high-volume air routes, such as Berlin–Munich and corridors between Germany and Spain (e.g., Frankfurt–Madrid), are identified as key competitive areas where high-speed rail and overnight services aim to gain market share (ETR Railway Technology Review, 2018).

The competition faced by overnight trains stems from several modes of transport and specific high-volume routes that offer alternatives to long-distance rail travel. Based on the sources (ETR Railway Technology Review, 2018), the major competitive routes and transport modes are:

I. Competition from other transport modes. Overnight and luxury trains face direct competition from three primary transportation sectors in the passenger and leisure markets:

- Air travel (planes) is a critical competitor, especially for conventional overnight trains, due to its comparative speed and often relatively cheap ticket prices. High-speed rail already competes with inter-European flights on short routes (500–1000 km), and overnight trains are intended to provide an alternative for distances up to 2000 km. Planes are inherently faster (Mirvish J., 2023), completing trips in hours that might take the train several days. They focus on the destination, which appeals to guests less concerned with the journey itself. Policies promoting sustainable mobility often target the reduction of travel by car and plane by encouraging train use (ETR Railway Technology Review, 2018).
- Automobiles (cars, driving, RVs) allow travellers the most freedom to set their route and pace and decide where to eat and sleep (Mirvish J., 2023). The RV and camper van rental industry has grown and shares a customer base with overland travellers, posing problems for luxury rail. Competition also comes from driving in general, as exemplified by efforts to make high-speed rail competitive with both flights and driving on major routes (ETR Railway Technology Review, 2018).
- Cruises (boats) in the luxury leisure market pose a threat because they often surpass luxury rail in two key areas due to their sheer size (Mirvish J., 2023). They offer more route options within each company and greater personal space, along with amenities such as pools, theatres, and extensive dining options.

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II. Competition from High-Speed Rail Networks. The expansion of modern, high-speed rail (HSR) services presents internal competition to conventional overnight services:

- Shorter journey times with the construction of new high-speed lines and the use of modern trains have resulted in considerably shorter journey times between major European cities, which has contributed to a decline in conventional overnight rail travel (ETR Railway Technology Review, 2018).
- Daytime alternatives as HSR networks, already provide an alternative to flights on short to medium routes (500–1000 km) during the day (ETR Railway Technology Review, 2018).

III. Specific competitive routes. The potential for high-speed overnight rail is often assessed based on existing air routes that demonstrate high passenger volumes, indicating where direct competition is most viable:

- The route Berlin–Munich (Germany) is explicitly identified as the "most important domestic air route" where Deutsche Bahn (DB) aims to replace air travel as the market leader by leveraging competitive high-speed service (ETR Railway Technology Review, 2018).
- At a national level, the biggest passenger flows are between Germany and Spain. For instance, the Frankfurt–Madrid route accounts for significant daily passenger volume (around 2,600 passengers per day flying to the Spanish mainland from Frankfurt alone), making it a high-potential competitive corridor for rail (ETR Railway Technology Review, 2018).
- The route from the United Kingdom to Portugal is noted for high average passenger volumes (around 7,000 passengers per day flying in one direction) (ETR Railway Technology Review, 2018).
- Other High-volume European corridors with generally high passenger flow air routes used to estimate potential competition are between the United Kingdom, Spain, Germany, Italy, France, the Netherlands, and Belgium (ETR Railway Technology Review, 2018).

IV. Internal competition on the Rails. Luxury trains operating in countries like the US must also face competition for rail infrastructure. Rail infrastructure is typically built to handle both freight and passenger travel, and luxury rail services often face competition from freight rail over track priority, which can result in delays for high-paying travellers (Mirvish J., 2023).

4 Night trains timetable challenges

A night train is primarily defined by its provision of sleeping accommodations for overnight travel, but its operational context can influence its purpose and schedule. Based on the different sources, a comprehensive definition of a night train can be defined as: “A night train is a passenger train equipped with sleeping accommodation” (Atlas Night Trains 2024, 2025). To be qualified as such, part of or all of the rolling stock must be dedicated to overnight travel, specifically including a couchette or sleeper carriage. The resurgence and importance of night trains are driven by strategic goals related to sustainability and long-distance mobility:

- Sustainability and efficiency of night trains is a strategic complement to high-speed and conventional daytime services, providing a carbon-efficient and user-friendly alternative for medium and long-distance journeys, particularly those where air transport is currently dominant. Night trains combine time efficiency, comfort, and reduced environmental impact.
- Targeted use of overnight trains is seen as enabling rail to provide a genuine alternative to air travel for distances up to 2000 km (ETR Railway Technology Review, 2018). They contribute to the broader objective of moving toward environmentally friendly transport.
- Like other forms of luxury rail, night train journeys are often viewed as a journey-based form of leisure travel (Mirvish J., 2023).

Night trains, like daily trains, need to comply with a predefined timetable, and the structure of a night train's schedule varies depending on whether it is a long-distance service or part of an urban network optimisation. For that reason, several models were designed:

1. High-Speed overnight rail model (Idealised Long-Distance Service). A model for long-distance high-speed overnight trains differentiates the trip into three distinct operational sections (ETR Railway Technology Review, 2018):

   • Boarding section: the period when the train stops at one or more stations for passengers to board, typically lasting between zero and three hours, covering a travel distance of 0 to 400 km.

   • Night-time: the crucial segment where the train travels continuously with no stops while passengers are sleeping. This stage is intended to cover a long distance, specifically between 1100 to 2200 km in six to twelve hours.

   • De-boarding section: the final section where the train stops at selected stations to allow passengers to alight, again lasting between zero and three hours and covering 0 to 400 km.

   Historically, conventional overnight trains often used outdated rolling stock and operated at slower speeds than daytime services, frequently resulting in long journey times.

2. Urban subway network overnight train (Operational scheduling). In an urban subway network, an "overnight train" may be scheduled specifically to bridge the non-service hours and improve connectivity (Wang Y., Wei Y., Zhang Q., Shi H., Shang P., 2019). This operational definition dictates that the train:
   • Departs its depot after the last train at night.
   • Stays at a specific non-service station during non-service hours.
   • Continues to finish the remaining trip before the first train in the early morning.

The function of this specialised schedule is to minimise the number of passengers who fail to transfer for the last train service and the transfer waiting time for the first train service. Table 1 shows the routes of all European night trains.

Table 3. Night train routes (Atlas Night Trains 2024, 2025)

European Cross-border routes (Atlas Night Trains 2024, 2025)	**Operator**	**Max speed**	**Length of the route**	**Travel time**
NJ 40468 Vienna – Brussels Austria – Germany – Belgium	ÖBB, DB, SNCB	200 km/h	1.295 km	14:18 / 15:06
NJ 468-9 Vienna – Paris Austria – Germany – France	ÖBB, DB, SNCF	200 km/h	1.480 km	14:54
NJ 456 Graz – Berlin Austria – Czech Republic – Germany	ÖBB, ČD, DB	160 km/h	999 km	12:55 / 14:38
NJ 40420 Innsbruck – Hamburg Austria – Germany	ÖBB, DB	200 km/h	1.023 km	12:03 / 13:25
NJ 490 Vienna – Hamburg Austria – Germany	ÖBB, DB	200 km/h	1.162 km	12:37 / 13:28
NJ 233 Vienna-La Spezia Austria – Italy	ÖBB, Trenitalia	200 km/h	1.112 km	15:54
NJ 40233 Vienna-Rome Austria – Italy	ÖBB, Trenitalia	200 km/h	1.135 km	15:12 / 12:47
NJ 466 Vienna-Venice Austria – Italy	ÖBB	200 km/h	790	10:54
NJ 464 Graz-Zürich Austria-Liechtenstein-Switzerland	ÖBB, SBB	160 km/h	720	11:06
NJ 466 Vienna-Zürich Austria-Germany-Liechtenstein-Switzerland	ÖBB, SBB	200 km/h	787	10:41 / 11:18

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European Cross-border routes (Atlas Night Trains 2024, 2025)	**Operator**	**Max speed**	**Length of the route**	**Travel time**
NJ 420 Innsbruck-Amsterdam Austria-Germany-The Netherlands	ÖBB, DB, NS	200 km/h	1.081	14:14
NJ 40490 Vienna-Amsterdam Austria-Germany-The Netherlands	ÖBB, DB, NS	200 km/h	1.220	14:04
EN "Metropolitan" Prague-Budapest Czech Republic-Slovakia-Hungary	ČD, ZSSK, MAV-START	160 km/h	616	10:26
IC/EN "Chopin" Prague-Warsaw Czech Republic-Poland	ČD, PKP IC	160 km/h	789	11:23
EN 443 Prague-Michalovce Czech Republic-Slovakia	ČD, ZSSK	160 km/h	810	11:56
EC/EN "Jižní Express" Prague-Zurich Czech Republic – Austria – Germany - Liechtenstein-Switzerland	ČD, DB, SBB	160 km/h	887	14:00
NJ 424 Berlin-Brussels Germany-Belgium	ÖBB, DB, SBB	200 km/h	1.112	15:13 / 13:19
NJ 40424 Berlin-Paris Germany-France	ÖBB, DB, SNCF	200 km/h	1.297	14:56 / 13:14
NJ 40295 Munich-La Spezia Germany-Austria-Italy	ÖBB, DB, Trenitalia	200 km/h	1.075	15:00 / 16:15
NJ 295 Munich-Rome Germany-Austria-Italy	ÖBB, DB, Trenitalia	200 km/h	1.098	13:03
NJ 237 Stuttgart-Venice Germany-Austria-Italy	ÖBB, DB	200 km/h	1-109	12:05 / 11:33
IC "Adria" Budapest-Split Hungary-Croatia	MAV-START	120 km/h	772	15:00
IC "Istria" Budapest-Rijeka / Koper Hungary-Croatia-Slovenia	MAV-START	120 km/h	681/664	11:35 / 12:05
EN 40457-76 Budapest-Berlin Hungary-Slovakia-Czech Republic - Germany	MAV-START	160 km/h	1.023	13:00
EN 50237/462 Budapest-Stuttgart Hungary-Austria-Germany	MAV-START	200 km/h	969	12:00
IC/EN "Chopin" Budapest-Warsaw Hungary-Slovakia-Czech Republic-Poland	MAV-START, PKP IC	160 km/h	912	14:30
IC "Corona" Budapest-Brașov	MAV-START	120 km/h	803	15:00

European Cross-border routes (Atlas Night Trains 2024, 2025)	**Operator**	**Max speed**	**Length of the route**	**Travel time**
Hungary-Romania				
IC/EN "Chopin" Warsaw-Prague/ Budapest / Munich Poland-Czech Republic-Slovakia-Hungary-Austria-Germany	PKP IC, ČD, ÖBB, DB Fv, MAV, ZSSK	160 km/h	788/912/1.150	12:16 / 14:30 / 14:36
IC 346-7 "Dacia" Bucharest-Vienna Romania-Hungary-Austria	CFR Calatori	160 km/h	1.128	19:40
D 404-5 "Corvin" Cluj-Vienna Romania-Hungary-Austria	CFR Calatori	160 km/h	845	14:40
IC "Ister" Bucharest-Budapest Romania-Hungary	CFR Calatori	160 km/h	586	15:30
IC "Muntenia" Bucharest-Budapest Romania-Hungary	CFR Calatori	120 km/h	846	16:40
EN 1152-3 Bratislava-Split Slovakia-Austria-Slovenia-Croatia	ZSSK, ÖBB	120 km/h	957	17:31
EN 443 "Slovakia" Humenné-Prague Slovakia-Czech Republic	ZSSK, ČD	120 km/h	801	12:38
R/EC "Polana" Košice-Prague Slovakia-Czech Republic	ZSSK	160 km/h	848	12:47
SJ EN 345-6 Stockholm-Berlin Sweden-Denmark-Germany	SJ AB, Transdev	200 km/h	1.455	16:00
NT 93-4 Stockholm-Narvik Sweden-Norway	SJ AB	160 km/h	1.456	18:45
EN 40414-65 Zurich-Zagreb Switzerland-Liechtenstein-Austria-Germany-Slovenia-Croatia	SBB, ÖBB, HŽ	160 km/h	829	14:00
EN 40458-9 "Canopus" Zurich-Prague Switzerland-Germany-Czech Republic	SBB, ÖBB, ČD, DB	200 km/h	1.163	13:30
NJ 40409 Zurich-Berlin Switzerland-Germany	ÖBB, SBB, DB	200 km/h	997	11:21 / 12:04
NJ 40470 Zurich-Hamburg Switzerland-Germany	ÖBB, SBB, DB	200 km/h	1.0205	10:54 / 11:58
EN 40466-7 Zurich-Budapest Switzerland-Liechtenstein-Austria-Germany-Hungary	SBB, ÖBB, MAV START	200 km/h	1.060	11:40

European Cross-border routes (Atlas Night Trains 2024, 2025)	**Operator**	**Max speed**	**Length of the route**	**Travel time**
NJ 402 Zurich-Amsterdam Switzerland-Germany-The Netherlands	SBB, ÖBB, DB, NS	200 km/h	912	11:26
NJ 421 Amsterdam-Munich The Netherlands-Germany	NS, ÖBB	160 km/h	938	12:12
D 40149-749-EC 140 Kyiv-Vienna Ukraine-Hungary-Austria	UZ	160 km/h	1.438	22:00

Since 1991, there have been four so-called "railway packages" consisting of regulations and directives which regulate the European railway market. In 2007, the freight transport market opened, and in 2010, the cross-border passenger transport market opened. The fourth railway package provides for the complete opening of the European rail market and was launched in 2016. Important parts came into force in 2020. In addition to technical harmonisation, it obligates the member states to implement the following requirements:

1. Open network access: Access to the rail network must be open to all rail operators on equal terms, for both freight and passenger transport.
2. Separation of network and operations: The network must be managed separately from railway operations, however, bundling in holding companies (such as the DB or SNCF Groups) remains possible.
3. Public Service Obligations (PSOs) and tender obligation: If railway connections are subsidised by a member state, this must (in general) be done within the framework of an open tender.

The state of the railways differs greatly from member state to member state – there is no direct connection between privatisation and the state of the rail system as a whole:

- Rail systems in good condition: UK (fully privatised), Austria (privatised to a lesser extent), Portugal (privatised to a lesser extent), Netherlands (partly privatised), Czech Republic (partly privatised), Sweden (mostly privatised), Finland (privatised to a lesser extent).
- Rail systems in mediocre condition: Germany (partly privatised), Italy (partly privatised), Belgium (privatised to a lesser extent), Poland (partly privatised), Spain (privatised to a lesser extent), Denmark (partly privatised).
- Rail systems in poor condition: France (privatised to a lesser extent), Greece (fully privatised).

The decisive factor for the state of a member state's rail system is, above all, the level of public spending on rail infrastructure. There is no magic privatisation concept that makes good rail transport cheap.

Incidentally, when compared to emerging and other developed economies, the share of goods transported by rail is particularly low in Europe. The main cause is the transport policies pursued by the EU and its member states in the past.

Rail passenger transport is growing at about the same rate as the total passenger transport market. This means the share of rail transport neither increases nor decreases. However, there have been major shifts, generally away from (nighttime) long-distance traffic towards (daytime) medium-distance traffic, especially in favour of air travel. The night train network and conventional intercity network outside high-speed lines are shrinking continuously, especially in Southern and Western Europe. This has made air travel the only attractive alternative on many routes. The railway network is also shrinking in almost all member states, especially in structurally weak rural regions. In France, the Macron government briefly considered closing about 30% of the network. These plans were quickly softened, yet numerous rural routes are acutely endangered. After the financial crisis, Greece permanently shut down about 50% of its rail lines from 2010 onwards but continues to upgrade its main axes. For reasons of cost and comfort, high-speed rail is not a serious competitor to air travel for distances greater than 500 km (or 700 km with ultra-high speed).

The situation is quite different for night trains, which can cover distances in the range between 500 and 1,500 km, such as Stockholm-Narvik (1,400 km), Vienna-Rome (1,100 km), Paris-Venice (1,100 km) or Turin-Palermo (1,500 km) and which are very popular on these routes. Figure 4 explains the competitive advantage of night trains: exchanging travel time for sleep.

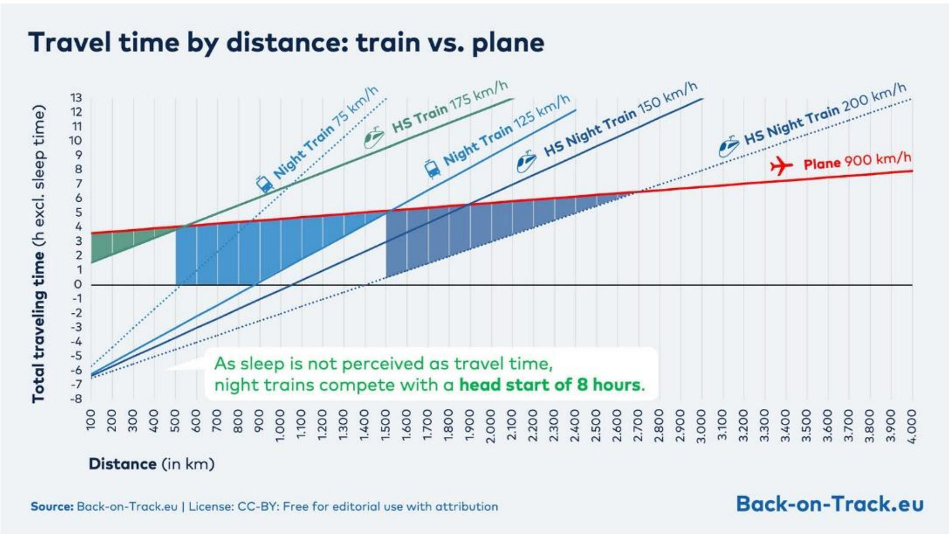


Figure 3. Travel time by distance: train vs. plane.

However, daytime high-speed long-distance transport can supplement a night train network and allow even longer distances at attractive conditions. Furthermore, opening the high-speed network to a new generation of compatible night trains could help even cover distances of 1,500 to 3,000 km with a competitive total travelling time. Many night trains and intercity connections are abandoned despite experiencing high demand. ÖBB's new night train service in Germany is recording a strong increase in passenger numbers. However, budget airlines generally exert downward pressure on railway ticket prices. The basic problem, however, is that the separation of network and operation prescribed by the EU has changed the basic cost structure for long-distance train operators. Before the separation of network and operation prescribed by the EU, there was an incentive for railway companies to achieve optimal network utilisation. The railway network causes essentially fixed costs, the variable costs of additional trains on the network are low (approx. 10%). The economic separation of network and operations required by the EU significantly increases the variable costs of network access from the train operators' perspective. This creates an incentive to run as few trains as possible. Night trains were traditional "gap fillers" that used the network during periods of low demand. Night trains travel slower than day trains but cover larger distances and therefore have a lower energy consumption per kilometre. With the separation of network and operation and the introduction of network access charges, these economic advantages of night trains were lost. The stagnation of rail freight traffic in Europe can also be partly attributed to this effect.

Unfortunately, on occasion, it has been observed that railway companies deliberately undermine conventional long-distance traffic to increase ridership on high-speed services.

The European transport system has been shaped by state investment policy for hundreds of years. Many European railway lines and canals were built in the 19th century in cooperation between states and private investors (today this would be called "public-private partnership"). The transfer of traffic from rail to road in the 1950s and 1960s was also the result of deliberate state road construction and subsidy policies. In the 1970s, there were plans in West Germany, France and Great Britain to reduce the railway network to a core network, but these policies were abandoned in the wake of the oil crisis. Since then, most EU member states have tried to operate a publicly subsidised railway network at minimal cost. Mobility ensures the social and economic coherence of societies, which is why it is politically promoted and made more affordable. All modes of transport, including air and road transport, are subsidised in various ways, and no one has to pay the real costs of mobility for society as a whole. A transport sector operating according to the strict principles of a market economy is neither practicable nor desirable, especially from an environmental and socio-political point of view. Market mechanisms can occasionally be used as steering instruments, but this should not hide the fact that the entire mobility market is massively distorted, which is also what is generally politically desired.

Even after the European elections, the EU Commission, in its new composition, will certainly not move away from the policy of liberalising the railway market, including the separation of network and operation. It remains to be seen to what extent the promised increases in railway sector efficiency will be achieved by this policy. At the political level, it is particularly important to draw the attention of EU institutions to the unintended negative side effects of the liberalisation policy on conventional long-distance traffic and to persuade them to take appropriate countermeasures. In particular, the EU could:

- Aim to reduce investment risks and costs for new night train operators by acquiring its own fleet of sleeper and couchette coaches (either new or second-hand) and leasing them to new market entrants. An EU second-hand rail vehicle fleet for daytime passenger and freight transport is also conceivable and could improve market dynamics.
- Tender night train connections between major European cities itself, possibly in cooperation with member states, cities, and regions.
- Implement passenger rights rules in such a way that the European rail system remains a network that is useful beyond individual point-to-point connections offered by a particular operator.
- Pass on the environmental and social costs of aviation to airlines and combat social dumping and low-price policies in the aviation industry.
- Reduce direct and indirect subsidies to air and private motorised transport wherever possible.

In this context, it is particularly important to strengthen the territorial and social cohesion of Europe; high-quality, climate-friendly mobility must be available to all Europeans. To achieve climate protection in the transport sector purely through market mechanisms is difficult to reconcile with this goal. Therefore, the EU must, in coordination with the member states, intervene more actively in the transport market. Offers that have the character of a partial decommodification of the transport system, such as Interrail, are very helpful in this context and should be strengthened. It would be conceivable, for example, to introduce a European long-distance social ticket with annual free kilometres to strengthen internal tourism and support internal migrant workers. Currently, no political entity feels responsible for the functioning of the trans-European long-distance and night train network. This must change.

To effectively promote European rail transport, the EU would have to step out of its role as a pure market regulator and actively shape the transport system, not only at the infrastructure level but also at the service level. It remains to be seen whether a sustainable consensus to this effect can be reached among the member states and political party families. In some cases, however, this role can also be fulfilled by member states, regions, and cities, especially to create and promote pilot projects.

5 Global warming – reduction potential by night trains

From the (Maier J., 2022) paper and according to opinion polls, 7 out of 10 Europeans would be willing to take the night train instead of the plane if the offer seemed reasonable. Back-on-Track, a European network of night train initiatives, has used this as a basis to examine air passenger numbers in the EU in 2019 to identify which air connections could be replaced by night trains. Distances up to 1500 km and up to 3000 km were considered under different scenarios. Overall, up to 32 % of passengers could switch to night trains if there were an attractive offer. This would reduce emissions from air traffic by 26 %. To create such an offer, up to 2500 additional night trains would be required, as well as a considerable improvement in the framework conditions, in particular, a reduction in track access charges.

The potential of night trains has recently been examined in a couple of studies, but these either examined a predefined target network or estimated passenger numbers based on given constraints, and if climate effects were calculated, non-CO2 effects were ignored.

This paper is a follow-up to the 2021 study on EU air passenger volumes that could be shifted to night trains and examines possible climate effects under optimal conditions.

The paper assumes a capable rail infrastructure on TEN-T routes, prepared for a maximum speed of 160 km/h, modern rolling stock with substantial improvements of privacy, security and comfort, an average occupancy rate of 80%, like for other means of transport that require booking and a level playing field that allows for reasonable ticket prices.

Related to reasonable ticket prices and an article by (Maier J., 2023), Member States can easily reduce the price of a cross-border night train ticket and push for the creation of new lines. Setting a 0% rate of value-added tax (VAT) on cross-border routes and reducing the track access charges imposed by the owners of the infrastructure (TAC) can lower ticket prices by 3%-48%, depending on the passenger profile scenario. On average, the ticket price reduction across all user types on the European lines studied is 15%. The article concludes that European countries should also temporarily or permanently exempt night train operators from TAC (Track Access Charges) to incentivise railway operators to create new lines. This exemption would be particularly welcome, allowing rail operators to acquire or refurbish night train rolling stock. Back-on-Track Europe and Transport & Environment are calling on Member States and the EU to set up the relevant binding measures to achieve this price reduction and kick-off the market of European cross-border night trains. European night trains are slowly making a comeback. They are one of the solutions to shift passengers from air to rail. Nevertheless, the night train business model suffers from structural and regulatory disadvantages compared to planes. As a result, it is often more expensive for passengers to travel by rail for the same distance, despite the low-carbon impact of this transport mode. Night train travel has, on average, a 28-times slower climate impact than air travel (Back-on-Track, 2023). Since 2020, a few new night train connections have been launched, partly to address the growing urgency to shift to low-carbon transport modes. For example, Brussels and Berlin are now finally connected again with a night-train operated by the new rail company, European Sleeper. The contribution of night trains to reducing GHG emissions and climate-related impacts is greater at longer distances (beyond 1,500 km) than at shorter ones, reinforcing the case for developing long-distance European night trains.

At the EU level, the Commission published an Action Plan in December 2021 to boost long-distance and cross-border passenger transport. Unfortunately, the EC has not tabled binding legislation to reduce train costs. It has put forward several initiatives including publication of “Guidelines in 2023 for setting track access charges which support and encourage the development of long-distance and cross-border passenger services” and assessment of “the need for an EU-wide exemption of international rail tickets from VAT to significantly reduce the cost to rail passengers” and administrative support to 10 cross-border rail pilot projects including two new night train services between Paris and Venice and Amsterdam and Barcelona. At the Member States levels, several countries have set up or are in the process of setting up national policies that would reduce the cost of international night trains. France has reduced track access charges for non-high-speed night trains to the direct cost. In Austria, VAT has been removed on international train tickets since 2023. In Germany, the night tariff will generally apply to genuine night trains from 2024. In Belgium, night trains will be exempt from TAC and traction energy payments for 2 years to kick off the market for European night trains. The federal government has earmarked a budget of 2 million euros for this support to European cross-border night trains. Therefore, considering the agendas at the EU and Member State levels, the decision is to focus on two components of the cost structure of night trains: track access charges (TAC) and value-added tax (VAT). VAT is charged on the ticket price sold by the rail operator, while TAC is part of the night train's overall cost structure. TAC are tolls paid by rail operators to use the rail infrastructure.

According to study, it is possible reduction or a (temporary) exemption of TAC, as well as setting a 0% rate of VAT for European train tickets, will bring additional benefits to the EU and the Member States because:

- It would only be indirect subsidies, completely in line with the EU directives and not requiring direct subsidy (public service obligations) to long-distance passenger transport (which some member states would be reluctant to use).
- It will not significantly reduce the amount of revenues for the States and the infrastructure managers, as the reduction will apply to services that hardly exist today.

- Some rail infrastructure, sometimes funded with EU money, such as the high-speed link between Perpignan in France and Figueras in Spain, has spare capacity. Night trains could improve their utilisation.

Moreover, reducing TAC and VAT for European cross-border night trains would create a more level playing field with air travel, which enjoys a 0% VAT rate for international journeys under international agreements and benefits from a cost structure that does not cover the full environmental cost of its emissions. If the 0% VAT rate for international air travel is not limited, rail travel should benefit from the same advantage. Night trains are a new market with allow profitability. They need help to kick-start the market.

Back-on-Track Europe and Transport & Environment are specifically calling on the Commission of the European Union to:

1. Define night trains as a market segment (in addition to freight services, passenger services within the framework of a public service contract and other passenger services) for which infrastructure managers must evaluate their relevance for mark-ups.
2. Make a TAC reduction on direct costs mandatory for the night train segment until its relevance for mark-ups is proven.
3. Recommend an EU-wide VAT rate of 0 % for European night trains.

While the EU has the power to harmonise TAC and VAT rules, Member States can also act directly at the national level to reduce the price of European night trains. Back-on-Track Europe and Transport & Environment are specifically calling on Member States to:

1. Reduce TAC on night trains to the direct cost.
2. Set at their national level a 0 % rate of VAT for all European night trains.
3. Explore a (temporary) exemption from TAC for European night trains to kick off the market. The study recommends, at a minimum, a temporary suspension and gradual reintroduction of TAC at a standardised direct cost level over a 7-year period, 2026-2032, which would be sufficient for existing and new operators to order new or refurbished rolling stock to take advantage of the introduction period.
4. Do not exclude the night train segment from using existing high-speed lines (like in France) to anticipate further developments in night train technology.

Back-on-Track Europe and Transport & Environment are calling on both Member States and the European Union to reduce the financial burden on European night trains to stimulate the offer and make them more price-competitive.

6 Night trains renaissance

Trains are the most climate-friendly means of transport, planes the most unfriendly one. In the EU, the average in 2019, according to International Energy Agency (IEA) numbers, their actual emission of greenhouse gases (GHG) was 28 times higher than the emissions of long-distance passenger trains, including night trains (Back-on-Track.eu, 2024). While the airline industry regularly refers to "green" flying, there is no clear pathway to achieving it. The capacity to produce "sustainable aviation fuels" is vanishingly low, and even if they were used on a larger scale, flying remains multiple times more climate-damaging than trains due to non-CO2 effects. Hydrogen faces significant unsolved storage and transportation challenges. Finally, battery-driven electric propulsion has made some limited progress, but even if one assumes a continuous increase in the energy density of batteries, by 2050, this will only suffice for very short-distance flights (up to 500 km), the category in which fast day trains, if available, could easily compete with aviation. Building new HSR lines (for speeds of 250 km/h or more) is costly and has a significant environmental impact, so this cannot be the general solution for long-distance passenger transport. Where high-speed lines already exist, suitable night trains should be able to use them. But extending the night train network would not necessarily require expanding HSR beyond closing a few gaps. Upgrading all existing main lines to allow 160-200 km/h (or 230 km/h if possible) would be sufficient to achieve the range increase we are striving for with night trains. Without countermeasures, European aviation emissions will continue to rise by 3% annually. Even with a lower growth rate, by 2040, aviation alone is expected to emit more greenhouse gases than any other sector, including the energy industry. When we demand immediate action to improve market and finance conditions for night trains, this will hardly endanger Europe's aviation industry. It might just help to stop its emissions from growing. Trains should be cheaper than planes. While trains must generate energy and sales tax revenue and must partly refinance their infrastructure, air transport is exempted from most levies. This subsidy structure in favour of the most climate-damaging means of transport must be reversed. This can be achieved by making planes less attractive or by making trains more attractive. We demand both. We aim for a network of modern, attractive, and quiet night trains that covers the whole of Europe and connects neighbouring countries. It should be able to accommodate the potential of more than 360 million passengers per year who would consider night trains under reasonable conditions. For this, we need new, innovative vehicles that improve privacy and safety without sacrificing the space for encounters with people that night trains used to offer. The necessary backbone for this is around 20,000 locomotive-hauled carriages (or groups of carriages) built for distances of up to 1,500 kilometres or more and speeds of up to 250 km/h. To use existing high-speed lines and to cover some interchangeable routes in the 1,500 and 3,000 km distance range, these would be supplemented by around 500 special high-speed trains, each capable of carrying up to 800 sleeping passengers. Currently we have approximately 150 inner-European night train routes (excluding the Ukrainian, Belarusian and Russian night train networks, which are already quite dense). With a coordinated EU-level approach that doubles the number of inner-European night train routes to 300 and addresses critical missing links in the current patchwork of services, it is possible to triple the current number of night train passengers within just seven years. Such a network would ensure regular connections between all major European cities, creating an integrated network that allows people, by combining night and high-speed day services, to get from any station in Europe to another within 36 hours. And we are convinced that once this is achieved, we will find out that tripling the passenger numbers will not be sufficient.

EU Action has 10 improvements plan to boost long-distance and cross-border passenger rail (Back-on-Track.eu, 2022):

1) INTRODUCTION - The plan correctly identifies issues and points in a positive direction, but it is not ambitious enough. For example, 11 new international night train routes to carry 2.5 million passengers per year are not enough when the French government is proposing 15 new routes in France to carry at least 5 million passengers. A more ambitious study by the independent network 'Oui au train de nuit' has shown that night trains throughout Europe could transport 100 million passengers a year along 350 routes.

2) CHARGES AND TAXES - Welcome the suggestion for both harmonised and lower track access charges and EU-wide VAT exemption for cross-border travel. It is understandable that such an exemption already applies to exports and imports between Member States. Disappointed by the fact that the document does not give a very clear figure of what could be a fair access charge, which should not exceed the marginal costs.

3) REMOVING OBSTACLES - There must be a clear timetable for removing such obstacles and improving infrastructure, ticketing, and information systems so that more ambitious day and night services can be introduced. In this context, there are some concerns that some companies and some governments are reluctant to share data or answer questions. Political pressure must be used if necessary to require them to do so. Of course, political pressure is easier to exercise when the railway operators are publicly owned. On the other hand, franchisees and open access operators can bring innovation to the benefit of all users. Consideration must be given to the conditions under which new operators enter the market.

4) INFORMATION AND RIGHTS - Better information is even more important now that open access operators are starting to provide international services. The European Commission should encourage innovative solutions to make booking night train journeys as easy as booking any other train or plane journey. Passenger rights concerning information, booking and compensation if something goes

wrong, must also be observed, and the most basic passenger right of all is to have a train service that fulfils the customer's needs.

5) REPLACING AIR BY RAIL - Corridors where flights can be replaced by trains must be identified and ambitions set. The proposal is for the European Commission to list the 500 most-used intra-EU routes of up to 2000 km and to estimate how and when they can be replaced by trains. The European Investment Bank should finance the construction of a pool of rolling stock for both day and night trains on such routes.

6) LENGTH OF JOURNEY - On some routes, a night train journey time of 8-10 hours should encourage modal shift, but on others, 12 hours will be more acceptable (to avoid very late departures or very early arrivals). On longer routes, such as Denmark to Switzerland, 15 hours is acceptable. Night trains should use high-speed lines when appropriate.

7) ARRIVAL TIMES - It should be a priority to develop TEN-T corridors into major stations at times in the morning convenient for travellers. The Commission highlights "Pilot Projects", and it should be clarified that TEN-T corridors for long-distance night trains must be developed as a whole, so that these can enter major cities at the right times in the morning, that capacity must always be present and that these trains must have higher priority than local, regional and national trains at the same places and times.

8) STAFF, CONTROLS AND LANGUAGE - The question of border controls on night trains must be addressed. Night sleep should not be disturbed by any border control. In aviation, many passport controls are left to airport staff. Night train staff can deal with this and should receive relevant training in addition to the training required for all on-board staff. The outdated language requirements also need to be addressed.

9) TOURISM AND REGIONS - The European Commission should support the night train concept through co-funding to promote eco-friendly tourism and accessibility to authorities in popular tourist areas. International visitors to an area like northern Italy should appreciate being able to sleep on a night train, thereby having more time to enjoy their holiday.

10) MONITORING MODAL SHIFT - There must be measurable ambitions for modal shift, such as a matrix showing percentage shares of traffic, by both day and night trains, over particular distances at 5-yearly intervals. At present, it is not clear what political targets for modal shift are presented, nor are any tools presented to evaluate ongoing development. The overall efforts to increase rail's share of EU passenger transport must be juxtaposed by an overview of this type.

7 Night train service examples

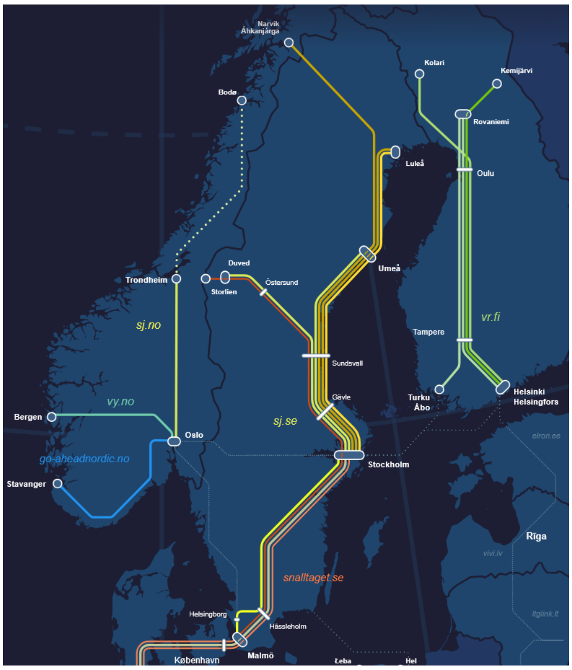
Night trains offer a comfortable way to travel. From reclining seats to private sleeping cabins, there's a travel option for every wish and budget. Save precious travel time by moving from one destination to the next while you sleep. High-speed trains in Europe require a seat reservation, most commonly in France, Italy, and Spain. Reservation fees are charged by the railway carriers and are not included in your Eurail Pass.

Night trains in Europe (eurail, 2025):

1. Night Riviera Sleeper runs from London Paddington all the way to Penzance, the most westerly major town in Cornwall. Travel time is around 8 hours and 10 minutes, and the train runs Monday to Friday and on Sunday.
2. European Sleeper. Travel from Belgium and the Netherlands to Berlin and Prague with routes – Brussels, Antwerp, Rosendaal, Rotterdam, The Hague, Amsterdam, Amersfoort, Deventer, Bad Bentheim, Berlin, Dresden, Bad Schandau, Děčín, Ústí nad Labem and Prague.
3. Swedish night train. SJ operates night trains to travel directly to Sweden's major cities such as Gothenburg, Östersund, Luleå, Stockholm, and Malmö. Connections are available upon arrival to smaller popular towns such as Are, Kiruna, Narvik (Norway), and Sundsvall. All these domestic night trains have refreshment facilities offering hearty hot and cold meals, drinks, snacks, and a full breakfast.
4. EuroNight. EuroNight (EN) trains are operated by various European railway carriers and offer an extensive overnight network throughout Europe. Sleep comfortably aboard a EuroNight train as you make your way to cities like Warsaw, Budapest, Zagreb, and Berlin, and arrive at your destination well-rested, with a whole day of exploring ahead of you! Since the vast network of EuroNight trains is a collaboration among various carriers, they offer different products on every route. The same train usually includes multiple destinations to cover as many direct routes as possible in the most comfortable way. This is why certain trains are typically split up or combined at centrally located stations in Europe, such as Breclav, Bohumin, and Salzburg. With many routes to choose from, the EuroNight is a great way to travel to many destinations in Central Europe, including Austria, Hungary, Slovenia, Croatia, Poland, Slovakia, Romania, Czechia, and Switzerland. It has accommodation options to suit everyone and takes you to some of Europe's greatest cities while you sleep. EuroNight trains are often a collage of colours – they consist of carriages from multiple carriers. On some key routes, trains are branded with their own names. In the overview below, EuroNight trains are sorted by these names: EN Metropol routes, EN Chopin routes, EN Carpatia routes, EN Kalman Imre routes, and EN Lisinski routes.

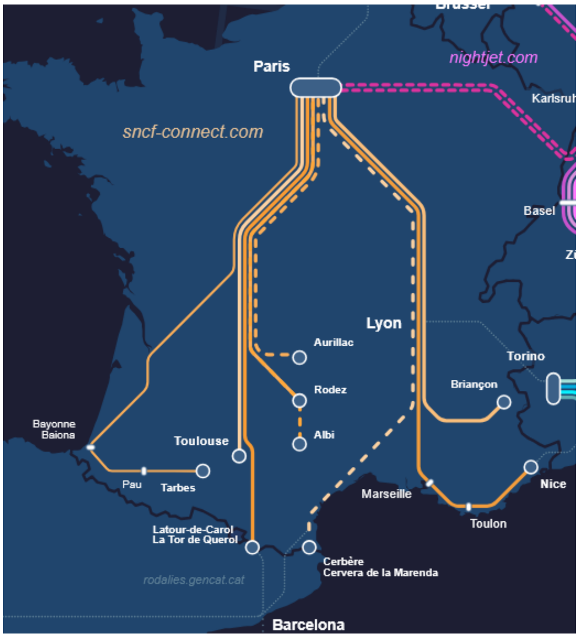
5. InterCity Notte routes. From metropolises such as Milan and Rome to Sicily and Puglia, the InterCity Notte is a great way to cover vast distances in Italy. An extensive network of services reaches all corners of Italy, and trains are even transported by ferry across the Strait of Messina towards Sicily. Furthermore, the accommodations on the train are modern and comfortable, and offer good value for money when you want to save on hotel costs and daytime hours.
6. ÖBB Nightjet. ÖBB Nightjet trains are operated by the Austrian railways (ÖBB) and offer an extensive overnight network throughout Europe. Travel from city to city comfortably during the night with ÖBB Nightjet and save the daytime for sightseeing. Travel to famous cities like Vienna, Munich, Rome, and Berlin and arrive there well-rested. In December 2023, ÖBB introduced its 'Nightjet of the new generation'. In addition to the most modern seats, couchettes, and sleeping cars, it has a new concept called 'Mini Cabin'. Passengers will now be able to sleep in private pods with the same comfort as modern couchettes. With so many routes to choose from, the ÖBB Nightjet is a great way to travel to destinations in Austria, Belgium, France, Germany, Italy, the Netherlands, and Switzerland. It has accommodation options to suit everyone and takes you to Europe's greatest cities while you sleep.
7. Bosphorus Express route. The Bosphorus Express night train runs daily between Bucharest (Bucuresti Nord station) and Istanbul (Halkali station) until October 9th. Halkali station is situated on the Western outskirts of Istanbul, from here you can take a metro/Marmaray train to the city centre and under the Bosphorus to the Asian side.
8. Calendonian Sleeper route. The train runs from London Euston station to 5 destinations in Scotland: Edinburgh, Glasgow, Fort William, Aberdeen and Inverness. Travel time varies from 7,5 hours to almost 13 hours.
9. Snälltåget night train routes. Snälltaget has different domestic and international night train routes available for passholders. The international route takes you from Stockholm, via Malmö and Copenhagen (Ørestad), to Hamburg and Berlin. On selected dates, this train also continues to Dresden. During winter sports season, the Snälltåget night train from Malmö and Stockholm to Östersund, Åre, and Storlienis a great way to travel over 1200km through the Swedish countryside. You can relax in the comfort of your cabin as you travel north, and when you awake the next morning, you will be in the mountains, ready to hit the slopes at the popular Åre ski resort, for instance. This train has a restaurant serving hot and cold food, and drinks. A sleeping bag, blanket, and pillow are also provided - so you don't have to worry about a thing - just relax and enjoy the journey.

10. Intercités de Nuit routes. With the Intercités de Nuit you can sleep your way from Paris to Toulouse and continue to Latour de Carol on the Spanish border. You can also travel to Briancon in the Alps, near the Italian border. The Intercités de Nuit is a comfortable night train, connecting Paris with the rest of France.
11. Budapest – Bucharest route. Between Budapest in Hungary and Bucharest in Romania there are several night trains. Travel by night from one cultural capital to another and uncover the many differences between these two cities with similar names. Several trains run daily between Budapest and Bucharest. The larger part of the journey goes through Romania, crossing the country from west to south-east. When taking the Ister or the Dacia, the most interesting stops along the way are Sibiu, Sigisoara, Brașov, and Sinaia in the Transylvania region. Here you can visit Bran Castle, more commonly known as Dracula's castle, or embark on a hike in the mountains. From Brașov, you can reach Bucharest in less than 3 hours. The entire journey should take you approximately 17 hours. When waking up, you will see the scenic landscapes of Transylvania from your bed or seat. The highlight of this journey is the Carpathian Mountains after Brasov. The Dacia also has a direct carriage that takes the route via Timisoara and Craiova to Bucharest and one that ends in Cluj Napoca. The third train on this route, the Muntenia, connects Budapest and Bucharest via Timisoara and Craiova, taking the (by daylight) less scenic Southern route.
12. Sofia-Istanbul Express route. The Sofia-Istanbul Express night train runs daily between Sofia and Istanbul. The train's final stop is Halkali, on the outskirts of Istanbul. Halkali station is situated on the Western outskirts of Istanbul, from here you can take a metro/Marmaray train to the city centre and under the Bosphorus to the Asian side.



Snälltaget

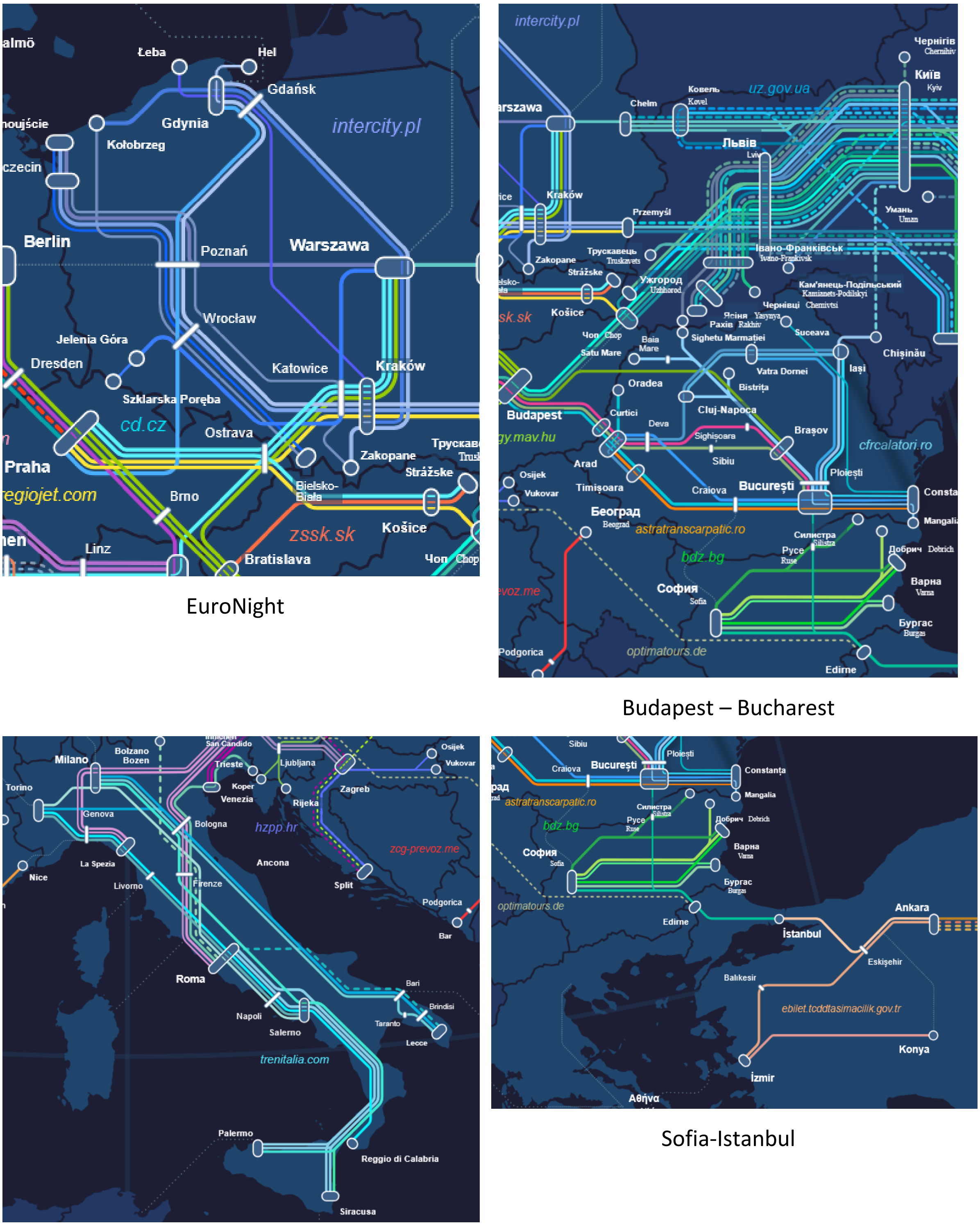
Calendonian



Intercités

EuroNight

Project PhDs EU-Rail (Grant number: 101175856).



EuroNight

Budapest – Bucharest

InterCity Notte

Sofia-Istanbul

Figure 4. Back-On-Track night trains route maps (Back-on-Track Europe AISBL, 2025)

Europe’s best Night trains (Discovery Trains, 2025):

1. Caledonian Sleeper: London – Inverness. It features modern cabins and impeccable service. The journey begins with optimal comfort: cosy beds, quality sheets, and warm hospitality. The highlight is watching the sun set over the Scottish Highlands from the bar car while enjoying a

traditional Scottish dinner. Priority access to the bar car is given to Club Car and Double cabin passengers.

2. Santa Claus Express: Helsinki – Rovaniemi. The name itself is magical, and the journey lives up to it. Each evening, the Santa Claus Express departs from Helsinki to Rovaniemi, the official hometown of Santa Claus. This modern and ultra-comfortable train runs year-round with cosy sleeping cabins (with private or shared bathrooms), making it the easiest way to reach the Arctic Circle while you sleep.
3. SJ/Norrlandståget: Stockholm – Narvik. The Norrlandståget takes you deep into the heart of the Scandinavian north, with breathtaking views of Swedish Lapland. Though the journey is long (18 hours), it is perfect for nature lovers and adventurers. Expect untouched landscapes, snowy forests, and majestic Norwegian mountains.
4. Intercity Notte: Milan – Lecce. The train is modern and well-equipped, with pleasantly soft bedding. Breakfast is served directly to your compartment. No showers on board, but restrooms are clean and well-maintained. Staff are attentive and discreet.
5. Nightjet: Vienna – Krakow. This overnight route operated by Polish Railways (PKP) offers clean, relatively new 3-berth compartments (women-only available). Small sink and clever storage make it practical, though space is tight for taller travellers. The basic breakfast (juice, coffee, pastry or waffle) is enough to start the day, and arrival is early (around 6 AM).
6. Zurich – Ljubljana. The ride is calm and pleasant, with scenic views and very affordable fare, with no service on board.
7. Nightjet ÖBB: Paris – Vienna. This night train offers a smooth ride between Paris and Vienna with spacious cabins, comfy bunks, and reclining seats. Private bathrooms are available in Double cabins. No dining car, but a light breakfast is included and served in your compartment.
8. Intercity Notte: Rome – Palermo. One unique feature of this journey is the ferry crossing over the Strait of Messina. While the train is older, it still works fine and offers the special magic of watching the sun rise over Sicily.
9. Brussels – Prague (European Sleeper). A breath of fresh air for night trains in Europe, this route, launched by the European Sleeper cooperative, connects two very different capitals in one smooth ride. The cabins are not luxurious but have that retro railway charm. Clean sheets, a warm welcome, and breakfast in bed make it all very pleasant.
10. Hamburg – Stockholm (Snälltåget). With a charming name (Snälltåget means "kind train" in Swedish), this scenic Scandinavian journey crosses the iconic Øresund Bridge between Denmark and Sweden. Simple but clean couchettes, a peaceful atmosphere, and helpful staff make this a serene ride. No dining car, but a snack bar offers the essentials.

(NOX, 2025) offer overnight trains across Europe with 100% personal rooms. With full onboard privacy and hotel partners for early check-ins at desired destination NOX wants to become the best option for business travel across Europe. They plan to connect over 100 European cities by 2035. To them, night trains only make sense at scale, and their aim is to always have a great night train alternative to every short-haul flight, everywhere in Europe. Nox is a newly designed night train which will offer fully private rooms across Europe from 2027. Travellers will get on in the evening hours, relax onboard, sleep in their rooms, and arrive well-rested at their destination in the morning. Nox will focus on privacy, good sleep, and affordable prices. You will not need to share your room with strangers, and you can lock it from the inside and the outside. On top of that, Nox aims to offer ticket prices as low as air fares. The spacious design allows you to take all your luggage and personal items with you and still have enough room to relax on comfy armchairs, work at large tables, and enjoy the scenery passing by through your large personal window. Nox is committed to becoming a premium experience as affordable as a flight. Single rooms will start at 79€, and double rooms from 149€, with prices flexible depending on demand. Nox will be a European brand, aiming to offer an alternative to short-haul flights across the continent. They will start with a single line and expand the product and route network from there on.

Nox offers three room categories:

I. Single and Double Loft rooms have upper beds, reachable by ladder and feature separate seating and table areas with lots of space for you and your items.
II. Loft rooms have wide single and double beds where you will sleep vertically to the travel direction and enjoy a loft-like view over your room and window.
III. Double Vista rooms offer a low-floor and a chest-height bed for easy access, with plenty of space to relax by converting the bed into two seats. In Double Vista Rooms, you will sleep parallel to the travel direction, with stunning views of the outside directly from your bed.

Nox is a new player entering the European mobility space. A Berlin-based startup is on a mission to offer a real alternative to short-haul flights. From 2027, Nox plans to operate Europe-wide overnight trains with fully personal rooms for one or two people at the price of a flight. “Sleeping while a train gets you across Europe is a great concept. But today, people must share their cabins with strangers, beds are tight, and it is often more expensive than air travel. We want to change that and make night trains an essential part of European travel,” says Thibault Constant, Co-Founder of Nox. On YouTube and Instagram, he is known as “Simply Railway”, with over half a million followers and over 400-night train trips worldwide under his belt. His experience influenced Nox a lot: all three-room types will have 2-meter-long beds, separate seating with tables, and enough space to stand up and store your luggage. Nox also plans to offer double beds and beds with panoramic window views. “Our room design allows us to fit more people into our trains than traditional operators can. This, paired with a strict focus on standardisation and operational excellence, will allow us to offer affordable fares on over 35 European routes”, says the founder, Janek Smalla, who has co-launched Flix Train and, until 2024, led the German ridesharing market for Bolt. The company has already reserved train coaches, is finalising the approval of its interior design and is now preparing the next large financing round for autumn. Interested passengers can already explore planned timetables, and detailed views of the rooms and prices are available on the company’s webpage. Users can also join the free Nox “Early Bird Club” to stay updated, enjoy discounted rates, and gain early access to bookings.

Another possibility to travel by night train offers LunaTrain company (LunaTrain, 2025). Night trains in Europe are struggling to survive – expensive, uncomfortable, and infrequent. The Berlin-based startup Luna Rail, founded by Anton Dubrau, aims to change that with modern cabins and fair prices, hoping to make overnight travel attractive again. Connections are being discontinued, comfort and prices are often disappointing – but a glimmer of hope comes from Berlin: The startup Luna Rail has been developing a new concept for day and night trains with private cabins, pull-out beds, and affordable tickets since 2023.

LunaTrain is an online booking website where customers can book train tickets for a wide range of night trains in Europe. This booking platform brings together the night train offerings of many railroads in one place. This website aims to provide travellers with clear information so they can get a transparent picture of what to expect from this unique way of travelling within Europe. Booking overnight train tickets online should be as easy and simple as booking a hotel or airline ticket. With LunaTrain they want to create a platform where you can find all information about every night train in Europe and where you can also book tickets in a user-friendly way. LunaTrain is offering sustainable travel by making it easy to book night train tickets online. Night trains are not only a sustainable way to travel. At the same time, they offer a special travel experience, a form of “slow travel” where you travel in a different, more conscious way.

From December 2025, SBB and Austrian Federal Railways (ÖBB) will gradually be introducing the new generation of Nightjets on night train routes. The first new trains will operate on the Zürich HB–Hamburg route from 4 December 2025 onwards. The new generation of Nightjet trains offers a comfortable, climate-friendly night-time travel experience with a modern design, more privacy, bicycle spaces, accessible compartments, and many other amenities. Fixed beds, mini cabins for solo travellers and private showers and toilets in the sleeping cars make for a relaxed journey across Europe (SBB, 2025). You can purchase tickets for your desired connection via the SBB Mobile app, online at SBB.ch using the timetable, or you can seek advice at the ticket counter of your nearest SBB station.

The largest and growing night train network is Austria's national rail operator, ÖBB, which operates Nightjet night trains. Many Nightjet routes operate under PSOs in Austria, Switzerland, Hungary, and Poland, but others are former City Night Line routes closed by DB in December 2016, which ÖBB has decided to operate on a commercial basis, or have been opened more recently. This means that many Nightjet routes are the result of a recent, active decision to retain or open them. We noted that the majority of routes are over 500-800 kilometres and terminate in cities or conurbations with airports that serve more than 500,000 airline seats per year.

The Koralm Railway (Carinthia Regionmarketing, 2025) is set to transform travel and trade across Austria and beyond. As a key part of Austria's new southern rail line, it stands among Europe's most important infrastructure projects, providing a faster, safer, and more efficient connection between the provinces of Styria and Carinthia. Cutting directly through the heart of the Koralpe mountain range, the new line will reduce travel time between Graz and Klagenfurt from 3 hours to just 45 minutes, thanks to a maximum speed of 250 km/h, making journeys more comfortable and accessible. The route leads through the mountain massif of the Koralpe, which is also responsible for the second name of the Koralmbahn – Koralpenbahn. This route through the mountain range separating Styria and Carinthia is the core element of the high-speed railway link, spanning 126 kilometres. In addition, it also improves Slovakia's connection with western Styria, southern Carinthia, and Italy. The Koralm Railway (ÖBB Infra, 2025)strengthens the Baltic–Adriatic Corridor, making rail freight more attractive and cost-effective, helping Austrian companies stay internationally competitive. Environmentally, rail freight produces around 30 times fewer CO_2 emissions than road transport, supporting a more sustainable future. With 50 kilometres of tunnels and more than 100 bridges, the project showcases Austria's world-class rail engineering. Leading Austrian companies Rhomberg Sersa Rail Group, PORR Group, voestalpine Railway Systems, Siemens Mobility and Sprecher Automation are playing key roles in its construction. The Koralm Railway is fully operational from 14th December 2025, ushering in a new era of connectivity for Austria and Europe. The Koralm Railway (Advantage Austria, 2025) forms part of the Baltic–Adriatic TEN-T corridor that will eventually connect Polish and Italian seaports. EU transport officials at the inauguration described the route as a "game-changer" for north–south freight and passenger flows, complementing the Brenner Base Tunnel and the future Semmering Base Tunnel to create a high-speed spine through the Alps. Practical implications for business travellers: The initial passenger timetable offers 29 daily Graz–Klagenfurt services, with Railjet Xpress trains running at up to 250 km/h. Vienna–Klagenfurt journey times fall by 45 minutes to 3 h 10 min, while Vienna–Graz drops below 2 hours for the first time. Corporate travel managers with operations in Austria's southern industrial belt (automotive, timber and green-tech clusters) can now schedule same-day meetings that previously required overnight stays. Early-morning Railjet Xpress departures also connect neatly with long-haul flights out of Vienna Airport, reducing the need for short-haul positioning flights and supporting corporate sustainability targets. For international passengers keen to capitalise on these quicker connections, VisaHQ can simplify the paperwork by handling Austrian (and wider Schengen) visa applications entirely online, ideal for business travellers on tight schedules. Dedicated account managers, real-time tracking, and expedited processing options mean teams can secure travel documents without derailing project timelines. It took three gigantic tunnelling machines with 10,000 hp to drill a tunnel through the Koralpe in what a veritable tour was de force. On the Styrian side, drilling commenced in early 2013 in Leibenfeld. Carinthia followed suit in 2015, starting in the Lavanttal valley. The construction also set the world record for the longest forward thrusts, with six million cubic metres of excavated rock. From engineers to machine technicians and blasthole drillers, this project required the expertise of a range of skilled professionals, each bringing their knowledge, creativity and experience. It thus made an invaluable contribution to the economic future of the participating regions. Travelling on the Koralmbahn will become routine. Even today, passengers are benefiting from the existing track sections. In specific areas, for instance in south-western Styria, this has already considerably shortened journey times. Thanks to the Koralmbahn, access to the high-tech land of Carinthia is now within reach for many people. Short journey times and 23 modern train stations and stops create an infrastructure that supports economic growth and attracts jobs in Carinthia, Austria's much-loved southernmost province, with all its scenic and cultural treasures.

8 Passenger behaviour and willingness to use night trains

Understanding passenger behaviour is a key element in evaluating the future potential of night train services in Europe. While infrastructure, rolling stock availability, and policy frameworks represent important prerequisites for the development of long-distance rail services, the success of night train operations ultimately depends on travellers' willingness to choose rail over competing modes of transport. In recent decades, aviation has become the dominant mode for long-distance travel within Europe, largely due to the expansion of low-cost airlines, increased airport connectivity, and the perception of flying as the fastest and most convenient form of travel. However, growing environmental concerns, the need to reduce greenhouse gas emissions, and the increasing political support for sustainable mobility have renewed interest in rail transport as a viable alternative for medium- and long-distance journeys.

Night trains represent a unique transport concept that differs significantly from conventional daytime travel. Unlike standard rail services, where passengers spend several hours travelling during the day, overnight trains allow travellers to sleep while covering long distances. These characteristics transform travel time into rest time and potentially reduce the perceived burden of long journeys. In practice, this means that distances of approximately 1,000 to 1,500 kilometres can be travelled overnight without requiring passengers to sacrifice daytime hours. Such distances correspond to many existing air travel corridors in Europe, making night trains particularly relevant in the context of modal shift strategies. For example, journeys between major European cities such as Amsterdam and Vienna or Amsterdam and Milan fall within this distance range and are currently dominated by aviation traffic. Studies have shown that these routes carry hundreds of thousands of passengers annually, suggesting substantial potential for alternative transport modes.

Despite the theoretical advantages of overnight rail travel, passengers' willingness to use night trains depends on a complex combination of behavioural, economic, and service-related factors. Travellers evaluate different transport options based on a range of attributes, including travel time, ticket price, comfort level, reliability, and convenience. In addition, socio-demographic characteristics such as age, income, travel purpose, and travel experience influence individual preferences and decision-making processes. To better understand these behavioural dynamics, researchers have conducted empirical studies examining travellers' willingness to use night trains as a substitute for air travel on long-distance European journeys. One such study analysed the potential demand for night train services using a combination of qualitative and quantitative methods, focusing on travellers' preferences and the trade-offs they make when selecting between different transport alternatives (Kantelaar, 2019).

Behavioural research in the transport sector typically assumes that travellers seek to minimise the disutility of travel. According to this perspective, individuals evaluate each available transport option

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by considering its advantages and disadvantages and ultimately choose the option that provides the highest perceived utility. This theoretical framework is widely used in transport economics and is commonly referred to as the random utility model. Within this framework, travel attributes such as cost and travel time play a central role in determining modal choice. However, additional factors such as comfort, flexibility, and convenience can also significantly influence travellers' decisions. In the case of night trains, these qualitative attributes become particularly important because passengers spend considerable time on board and rely on the onboard environment for sleep and rest.

To analyse passenger preferences for night train travel, researchers often use stated-preference survey methods. This approach is particularly useful in situations where new transport services are not yet widely available and therefore cannot be analysed using real-world behavioural data. Stated-preference surveys present respondents with hypothetical travel scenarios and ask them to choose between different transport alternatives under varying conditions. By systematically changing attributes such as travel time, ticket price, comfort level, and arrival time, it becomes possible to estimate how travellers value these attributes and how they influence modal choice decisions. The collected survey data can then be analysed using discrete choice modelling techniques, which allow researchers to estimate the probability that a traveller will choose a particular transport mode under specific conditions.

In studies on night train travel, respondents are typically asked to choose among several realistic alternatives for long-distance journeys. These alternatives often include travelling by night train, flying early in the morning, or flying in the evening and staying overnight in a hotel before continuing the journey the following day. By comparing these options, researchers can analyse how travellers evaluate the advantages and disadvantages of overnight rail travel relative to air transport. One of the key advantages of the stated-preference approach is that it allows researchers to analyse hypothetical service configurations that do not yet exist in practice. This enables evaluation of potential future night train services and estimates of how improvements in comfort, pricing, or scheduling might influence passenger demand.

A critical factor influencing travellers' willingness to use night trains is the perceived comfort of the journey. Unlike daytime transport modes, where passengers typically remain seated for a limited period of time, night train passengers rely on the train environment for sleeping and relaxation. Consequently, the quality of sleeping facilities, the level of privacy in compartments, and the availability of additional services such as showers or catering facilities play an important role in shaping passenger perceptions. Traditional night trains typically offer three main accommodation categories: standard seats, couchette compartments with multiple beds, and sleeper cabins providing greater privacy and comfort. Each accommodation type represents a different balance between price and comfort, allowing operators to serve multiple passenger segments with varying preferences and budgets.

Research findings indicate that travellers attach significant importance to the level of comfort offered by night train services. In particular, the availability of private compartments and improved sleeping facilities can significantly increase the attractiveness of overnight rail travel. This is especially relevant for business travellers and older passengers, who may be less willing to share sleeping spaces with strangers and who place greater emphasis on privacy and convenience. On the other hand, younger travellers and tourists may be more willing to accept shared accommodation if it allows them to travel at a lower cost. This variation in passenger preferences highlights the importance of offering multiple service classes in night train operations, enabling operators to simultaneously address the needs of different market segments.

Travel time is another important determinant of passenger choice. Although night trains generally take longer than flights, their overnight operation can mitigate this disadvantage by allowing passengers to sleep during the journey. From a behavioural perspective, time spent sleeping is often perceived as less burdensome than time spent travelling during the day. As a result, travellers may be willing to accept longer total journey times if they can arrive at their destination rested and ready to begin their activities. Nevertheless, excessively long travel times can still reduce the attractiveness of night trains, particularly if departure or arrival times are inconvenient. For most passengers, an overnight journey of approximately ten to fourteen hours appears to represent a reasonable compromise between travel distance and comfort.

Ticket price also plays a crucial role in determining whether passengers choose night trains or air travel. The rapid expansion of low-cost airlines has significantly reduced air travel prices within Europe, creating strong competition for rail operators. As a result, night train services must be priced competitively in order to attract passengers who would otherwise choose to fly. However, direct comparisons between flight prices and train tickets do not always capture the full economic cost of travel. Air travel often involves additional expenses such as airport transfers, baggage fees, and accommodation costs if the flight schedule requires an overnight stay. When these factors are taken into account, night train travel can become more competitive, particularly for travellers who value arriving directly in city centres.

Arrival time represents another key attribute influencing travellers' decisions. One of the main advantages of night train travel is the ability to arrive in the morning, allowing passengers to begin their activities at the destination immediately. This is particularly attractive for business travellers who wish to maximise the productive use of their time. However, if arrival times are too early in the morning or too late in the day, the attractiveness of night train services may decrease. Ideally, overnight trains should arrive at their destination between early morning and mid-morning, allowing passengers to access local transport and have sufficient time to reach their final destinations.

In addition to these operational factors, socio-demographic characteristics can also influence travellers' preferences for night train travel. Studies have shown that factors such as age, education level, income, and travel purpose can significantly affect modal choice behaviour. Younger travellers and students are often more open to alternative travel experiences and may be more willing to try night trains, particularly if they offer cost advantages. In contrast, business travellers typically prioritise reliability, punctuality, and comfort, so high-quality sleeper accommodations and efficient booking systems are essential to attract this segment of the market.

Another important factor influencing passenger behaviour is environmental awareness. As public concern about climate change continues to grow, an increasing number of travellers are considering the environmental impact of their transport choices. Rail transport is widely recognised as one of the most environmentally friendly modes of travel, producing significantly lower greenhouse gas emissions per passenger-kilometre compared to aviation. This environmental advantage may encourage some travellers to choose night trains even if the journey is slightly longer or more expensive than flying. In this context, night train services can play an important role in supporting the broader transition toward sustainable mobility.

Behavioural modelling studies often reveal distinct traveller segments with different preferences and priorities. Some passengers are primarily motivated by price and are willing to sacrifice comfort in exchange for lower ticket costs. Others place greater emphasis on comfort, privacy, and service quality, and may be willing to pay higher prices for premium accommodations. Environmental motivations can also influence traveller behaviour, particularly among younger generations who may prioritise sustainability when choosing transport modes. Identifying these segments allows railway operators to design services that appeal to multiple passenger groups simultaneously.

The results of behavioural studies can also be used to simulate different future scenarios for night train services. By adjusting key attributes such as ticket price, comfort level, and travel time, researchers can estimate how these changes might influence modal shares between rail and air transport. Scenario analyses typically show that improvements in comfort and reductions in ticket prices can significantly increase the probability that travellers will choose night trains. Similarly, investments in modern rolling stock and improved on-board facilities can enhance the attractiveness of overnight rail travel and help attract passengers who would otherwise prefer flying.

From a policy perspective, understanding passenger behaviour is essential for designing effective strategies to promote rail transport. If policymakers wish to encourage a modal shift from aviation to rail, they must ensure that night train services offer competitive travel conditions. This may involve reducing infrastructure charges, supporting investments in new rolling stock, and improving cross-border coordination between railway operators. In addition, integrated ticketing systems and digital booking platforms can make international rail travel more convenient and accessible for passengers.

In conclusion, passenger behaviour plays a decisive role in the future development of night train services in Europe. While infrastructure investments and technological innovations are important components of transport policy, the ultimate success of night trains depends on whether travellers perceive them as a convenient, comfortable, and economically attractive alternative to air travel. Behavioural studies demonstrate significant market potential for overnight rail services, particularly on routes of approximately 1,000 to 1,500 kilometres. By improving comfort levels, ensuring competitive pricing, and offering convenient schedules, railway operators can increase the attractiveness of night train travel and contribute to a broader shift toward sustainable transport systems.

9 Cross-border rail passenger market potential

The European Green Deal includes a commitment to make Europe the first climate-neutral continent by 2050. In December 2020, the Commission published its Sustainable and Smart Mobility Strategy, which identified the need for decisive action to shift activity towards more sustainable transport modes, notably by increasing the number of passengers travelling by rail. The European Parliament has requested that the Commission assess how cross-border night train services may be promoted. The Commission therefore commissioned this study to provide further insight into long-distance cross-border rail services, the obstacles to their establishment, operation, and greater use, and potential measures to address these obstacles (European Commission, 2021).

The Commission requires a wide-ranging but rapid study of possible improvements to cross-border rail services, the obstacles to the establishment, operation, and greater use of such services, and proposals to remove them.

Since 2001, railway undertakings have developed a range of new commercial models. Many operate under competitive pressure to reduce costs, and some have incorporated elements associated with low-cost airline business models. However, the scope for introducing low-cost rail services appears limited, particularly given the importance of en-route infrastructure charges in rail operations, especially on high-speed lines. National railways, competent transport authorities, and commercial operators have proposed new commercial and public service obligation (PSO) cross-border night trains on several routes, although not all routes announced in 2021 have yet commenced operations. For long-distance cross-border night trains, limited information is available on passenger numbers, revenues, or profitability. By contrast, valuable information exists on cross-border air connections, which rail could, in principle, compete with successfully. Additional potential routes for night trains may emerge if demand increases, for example as a result of changing passenger preferences. However, the introduction of a larger number of new night train services may be constrained by the need for additional or reallocated capacity at many city-centre stations.

Infrastructure charges vary considerably and, in many cases, are significantly higher than the "cost that is directly incurred as a result of operating the train service". The legislative framework permits charges above this level only where they do not "exclude the use of infrastructure by market segments which can pay" for it. Nevertheless, many stakeholders reported that services that could otherwise be operated commercially are excluded because charges exceed the level operators are able to bear. At present, infrastructure managers are permitted to set higher charges for cross-border services than for domestic services. Such charges may constitute a barrier to market entry and may leave costly infrastructure capacity underutilised. Lower infrastructure charges would not necessarily lead to lower fares, but they could encourage new entry and price competition, at least where regulatory bodies do not determine that this would compromise the economic equilibrium of one or more PSO services. Infrastructure capacity depends on network configuration, the speed and stopping patterns of each rail service, whether services operate at regular intervals, how they are timetabled relative to one another, and whether interchange between them is required. Planned changes by 2030 may increase rail connections, speeds, or capacity, but this does not imply that suitable capacity will be available for any specific proposed long-distance cross-border service.

Rolling stock will also be required to operate additional cross-border services, and the lack of suitable rolling stock constitutes an obstacle to their introduction. Raising finance for the purchase of new rolling stock to support services in a new market can be difficult. By contrast, airlines and coach operators can lease aircraft or coaches to test new routes for limited periods and, if these prove unsuccessful, return them or redeploy them elsewhere.

Ticketing systems are necessary for passengers to search for journeys, purchase tickets, make reservations, and provide evidence to railway undertakings that they are entitled to travel on their services. However, railway undertakings and ticket vendors cannot always sell end-to-end long-distance cross-border journeys or enable passengers to book successive rail services operated by one or more railway undertakings. In some cases, a passenger may purchase a single ticket valid on any combination of trains, operated by any mix of railway undertakings, between any two stations. In other cases, booking successive railway services operated by undertakings within the same group requires two transactions. This partly reflects the tension between integration and competition. In principle, a long-distance cross-border journey involving two or more operators can be offered at an end-to-end market fare that is lower than the sum of the separate fares. In practice, however, the end-to-end fare is sometimes higher than the cheapest combination of separate fares. Moreover, for many long-distance cross-border markets, demand may be too limited to justify one or more operators establishing and sharing a specific end-to-end fare.

Passenger rights in relation to successive railway services operated by one or more railway undertakings are technically complex. Regulation (EU) 2021/782 on rail passenger rights introduces obligations to offer through-tickets and establishes rights for passengers who hold them. However, some stakeholders have observed that through-tickets may be more expensive than a combination of tickets sold at special fares, which reduces their attractiveness to passengers. In 2018, fewer than 80% of EU27 long-distance and high-speed passenger services arrived with a delay of less than five minutes. Passengers undertaking journeys that require changes of train are often concerned about what will happen if, for any reason, they fail to make the connection to one or more of the trains on which they intended or were booked to travel. Railway systems often do not enable undertakings to identify passengers holding tickets for connecting journeys or to hold connections for delayed services. Delaying departures can disrupt operations and cause other passengers to miss connections. Significant investment has been made in rail infrastructure and rolling stock to reduce journey times, but these gains may not be realised by connecting passengers who fail to complete a connection and consequently arrive later than expected, sometimes incurring additional expense and inconvenience. Railway undertakings cannot realistically operate a service in which no trains ever arrive late. Nevertheless, the inconvenience and risk associated with changing trains could be reduced through clearer information on minimum connecting times within and between stations, as well as broader provision for passengers to specify longer connection times. Unless punctuality and reliability improve substantially, the most effective way to enhance passengers' experience of, and confidence in, rail connections may be clearer information on minimum connecting times and greater functionality in journey planners and ticketing and reservation systems to allow passengers to select longer connection times.

Technical, operational, and safety obstacles to cross-border operations remain. Differences in electrification systems can be accommodated through multi-system locomotives and trains, although there are limits to the number of systems that can be incorporated within a locomotive or fixed-formation train set. Differences in track and structure gauge can be addressed by stock equipped with gauge-changing technology and smaller dimensions, and standard-gauge high-speed lines are extending into Spain, which uses the Iberian gauge, and into the Baltic states, which use the Russian gauge. Many other technical differences are being addressed through Technical Specifications for Interoperability (TSIs), but in some cases existing assets, systems, and procedures can only be brought into compliance when they are due for renewal. The European Train Control System (ETCS), intended to serve as a common system, can in the short term function as an additional system required only for a limited part of a journey. A trend towards fixed-formation trains, combined with a wide range of incompatible couplers and other systems, together with differing technical requirements across networks, may make it increasingly difficult for a single train to be split into portions serving different destinations.

The Commission's study on High-Speed Rail, carried out by EBP, identified potential reductions in rail journey times between metropolitan areas resulting from new connections and increased speeds planned between 2020 and 2030. High-speed lines from Belgium to France and the Netherlands, the Channel Tunnel between France and the United Kingdom, the Perpignan-Figueres link between France and Spain, and the Öresund link between Denmark and Sweden were all planned and developed specifically to support new cross-border services, whether under public service obligation or commercial operation. The same is true of the Fehmarn Belt link between Denmark and Germany and

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Rail Baltica, linking Estonia, Latvia, Lithuania, and Poland. Information on cross-border rail passenger numbers remains limited, but useful evidence is available from cross-border air services, which could, in principle, be replaced by long-distance cross-border trains. Efforts to facilitate cross-border travel began in the nineteenth century and continue through harmonisation measures, including a common signalling system, ETCS, and regulatory harmonisation through the four railway packages. However, the liberalisation of cross-border services in 2010 has generated little market entry on long-distance cross-border routes. Legislation explicitly permits cross-border services to be charged at higher rates than domestic services and allows domestic PSO services to be prioritised when infrastructure is congested. The Open Sales and Distribution Model (OSDM) may facilitate the sale of cross-border tickets as a single transaction, but it remains untested in practice and will need to be monitored accordingly. Some additional long-distance cross-border services may be commercially viable, whereas others are likely to require subsidy. Higher market prices for fossil fuels, or higher taxation at the global, European, or national level, would increase the relative cost of competing modes compared with rail. Conversely, rail may be subsidised in recognition of its potential environmental advantages over alternative modes.

The coordination of timetables across borders requires bilateral or multilateral processes involving the relevant infrastructure managers. In 2014, RailNetEurope (RNE) and Forum Train Europe (FTE) jointly initiated the Redesign of the International Timetabling Process (TTR), which is intended to be implemented by 2025 and to enable capacity allocation for both short-term and long-term needs. Pilot projects have indicated that TTR required extensive IT development, with costs of €675 million, in order to achieve a high degree of pre-planning, automation, and integration between legacy systems adapted for the purpose. IRG-Rail has noted that there appears to be broad stakeholder agreement that Directive 2012/34/EU requires revision. Other stakeholder comments have focused on the manner in which infrastructure managers establish and apply the priority rules that the Directive permits them to use on congested and specialised infrastructure.

The Commission has already proposed measures to promote competition on a more equal footing across different transport modes. In the Fit for 55 package presented on 14 July 2021, the Commission put forward an ambitious set of proposals aimed at aligning economic incentives with climate, social, and environmental objectives, while recognising the differences in the global and competitive context within which different transport modes operate. This includes proposed amendments to emissions trading and to the energy taxation framework (Back-on-Track.eu, 2022).

10 Scientific Research within the PhDs EU-Rail project

Within the framework of the PhDs EU-Rail project, several scientific studies have been conducted in order to analyse different aspects of night train systems and their potential role in the future development of long-distance passenger transport in Europe. These research activities contribute to a deeper understanding of technical, operational, and organisational challenges related to the revival and further development of night train services. In addition to the policy analysis and data collection presented in the previous sections of this deliverable, the project also aims to support scientific research exploring new concepts to improve the competitiveness and sustainability of overnight rail transport.

The results of this research have been disseminated through international scientific conferences and publications addressing various aspects of night train operations, including infrastructure utilisation, rolling stock characteristics and passenger service quality. In particular, three recent studies focus on the development of high-speed night train concepts and on the analysis of sleeping cars used in night train services. These studies provide valuable insights into the technological and operational dimensions of night train systems and support the broader objective of identifying innovative solutions for fast, sustainable long-distance passenger transport.

The first study examines the concept of high-speed night trains, using China as an example, where high-speed railway infrastructure has enabled the introduction of overnight services operating at significantly higher speeds than conventional night trains. The second study focuses on sleeping cars used in Croatian railway operations, analysing their technical characteristics, operational role, and future development potential within the context of modern night train services. Third study was also conference paper tittle Passenger Experience in Night Trains with reference to how sleeping cars and couchette cars shape passenger satisfaction, comfort, perceived safety, privacy, and the motivation to choose overnight rail travel.

Together, these studies provide complementary perspectives on the future development of night train systems and highlight the importance of both infrastructure and rolling stock innovations for improving the attractiveness of overnight rail travel.

10.1 High-speed night trains: case study China

Within the framework of the PhDs EU-Rail project, recent scientific research has also addressed the concept of high-speed night trains and their potential role in the future development of long-distance passenger rail transport. One of the relevant studies examines the case of China, where high-speed railway has developed into the most extensive and technologically advanced system in the world, while at the same time new forms of night operations have emerged in response to the growing need for efficient, comfortable, and sustainable long-distance travel. The paper High-Speed Night Trains:

Case study China was presented at the 16th International Scientific Conference on Sustainable, Modern and Safe Transport (TRANSCOM 2025), and it provides a useful scientific contribution to the understanding of how high-speed infrastructure can be combined with the traditional logic of overnight travel (Luketić, Šipuš, & Abramović, High-Speed Night Trains: Case study China, 2026).

The relevance of this paper for the present deliverable is substantial. The overall objective of Deliverable 2.5 is to gather and analyse data on fast night train operations contributing to the decarbonisation of travel, with a strong focus on new organisational models, market potential, operational requirements, and passenger service quality. The introduction of the deliverable itself already stresses the importance of studying existing rolling stock, high-speed rail opportunities and possible technical and operational improvements that could support future fast night train services. In that sense, the Chinese case is not merely an external example, but a highly relevant empirical benchmark that demonstrates how high-speed rail and overnight operations can be merged into a practical, functioning passenger service.

The paper starts from the premise that high-speed rail has transformed long-distance transport by combining speed, reliability, safety, and affordability. In the Chinese context, high-speed rail is presented as a dominant, continuously expanding system that has already changed the structure of intercity mobility. The paper emphasises that recent advances in this field include the introduction of high-speed night trains, extending the functionality of the high-speed rail system beyond daytime operation and aligning it with the “sleep and arrive” logic traditionally associated with conventional sleeper trains. According to the abstract, China’s high-speed railway system has become a global leader in long-distance travel, and the emergence of night services further increases its versatility by responding to modern passenger expectations regarding time efficiency, comfort and continuity of travel (Luketić, Šipuš, & Abramović, High-Speed Night Trains: Case study China, 2026).

A particularly important case described in the paper is the launch of new high-speed night train services connecting Hong Kong West Kowloon with Beijing and Shanghai. These services began on 15 June 2024 and were designed around the principle that passengers can board in the evening, use nighttime hours for rest, and arrive the following morning prepared to continue their activities. The paper highlights this as a flexible and convenient form of travel that enhances the attractiveness of rail in competition with aviation. It also notes the subsequent extension of the Shanghai route to Ningbo, increasing the number of directly connected destinations and showing that such services can be scaled and expanded within a larger rail network. The fact that the train operates on multiple nights per week also indicates that this is not an isolated pilot but a structured and recurring service concept (Luketić, Šipuš, & Abramović, High-Speed Night Trains: Case study China, 2026).

This Chinese example is particularly valuable for European discussion because it demonstrates that high-speed night trains are not only a theoretical idea but an operational reality. In Europe, night trains have historically been organised according to a nineteenth-century logic based on conventional rolling stock, sleeper cars, and relatively modest commercial speeds. The paper explicitly notes that, despite increased policy discourse on decarbonisation and the Green Deal, there has been little concrete action in Europe to organise high-speed night trains. This observation is directly relevant to the scope of the PhDs EU-Rail project, because it confirms the research gap already recognised in the deliverable: there is strong policy ambition and growing market interest, but a limited number of concrete organisational and technical models for implementing fast night train systems at scale.

The scientific value of the Chinese case lies not only in the existence of the service, but also in the broader system context in which it operates. The paper explains that high-speed railway is generally defined by the International Union of Railways through a commercial speed threshold of 250 km/h, which already indicates a substantial leap compared with conventional railway services. The Chinese system is then presented as a mature high-speed environment supported by specialised infrastructure, advanced rolling stock, and a very large network. The article notes that China has the largest high-speed rail infrastructure in the world and that this network has undergone intensive expansion and modernisation, making it an appropriate case study for examining how nighttime high-speed services can be integrated into a broader transport system.

Another important contribution of the paper is that it places high-speed night trains within a wider technological and operational logic. The text explains that high-speed trains differ from conventional trains not only in terms of speed but also through specialised design and infrastructure. Features such as advanced aerodynamics, distributed traction, specific bogie systems, and lightweight construction are described as key enablers of high-speed performance. For the purposes of this deliverable, this is important because it underlines that fast night trains cannot simply be understood as conventional sleepers running faster. Instead, they require a dedicated systems perspective that includes infrastructure capability, rolling stock performance, timetable design, operational reliability, and passenger service integration.

The paper also points to the scale and intensity of railway operations in China, noting that railway travel has become the dominant form of long-distance transport and that the system records very high numbers of daily train departures. This matters because the success of high-speed night trains depends not only on train technology but also on network maturity, capacity management, and station functionality. The article stresses that robust infrastructure alone is insufficient; the performance of hinterland hub stations and the network's resilience are also essential. This insight is highly relevant to European implementation. A future fast night train model for Europe would need to consider not only high-speed corridors themselves, but also the role of major terminals, intermediate hubs, maintenance windows, and cross-border operational interfaces. In other words, the service concept must be embedded in a network logic rather than treated as a standalone route innovation.

From the passenger's perspective, the article reinforces the importance of the “sleep and arrive” concept as a core value proposition. In the context of long-distance travel, one of the central weaknesses of daytime rail is that passengers spend a large part of the day in transit, which can make rail less attractive than aviation. Night trains reduce this disadvantage by turning travel time into sleeping time. When combined with high-speed infrastructure, this principle can potentially be extended to much longer distances than are currently feasible with conventional overnight trains. This makes high-speed night trains especially relevant for corridors where daytime rail is too slow but where aviation still dominates despite growing climate concerns. The Chinese case, therefore, illustrates how speed and overnight travel can be merged into a single service logic that improves both passenger convenience and environmental performance.

For the present deliverable, the Chinese case supports several broader conclusions. First, it demonstrates that high-speed night trains can be treated as a distinct development path within long-distance passenger rail rather than as a marginal variation of conventional night trains. Second, it shows that the successful implementation of such services depends on the existence of a sufficiently developed high-speed rail ecosystem, including dedicated lines, suitable trainsets, strong operational planning, and high levels of service integration. Third, it suggests that the concept is particularly well suited to the needs of modern passengers, who increasingly value both travel-time efficiency and service comfort. In this respect, the paper supports the argument developed elsewhere in this deliverable that future fast night train systems must combine infrastructure, rolling stock, business model, and passenger service into a coherent organisational concept.

The Chinese experience also offers a comparative perspective for Europe. Although the institutional, regulatory, and geographic conditions differ significantly, Europe already possesses a substantial high-speed rail base, especially in countries such as France, Spain, Germany, and Italy. However, these networks are still predominantly configured for daytime services. The paper suggests, indirectly but convincingly, that underused nighttime capacity on high-speed infrastructure could be mobilised for overnight services if supported by appropriate organisational and technical models. For Europe, this raises important questions about rolling stock compatibility, access charges, international scheduling, station access in the early morning and the overall business case for such services. These are precisely the kinds of issues that the PhDs EU-Rail project seeks to explore.

In addition, the paper contributes to the sustainability narrative of the deliverable. One of the main motivations behind the renewed interest in fast night trains is the decarbonisation of long-distance travel. High-speed night trains offer a potentially powerful instrument in this regard because they target the same market segment that is currently strongly dependent on aviation: medium- to long-distance intercity travel where time matters and where passengers are reluctant to spend long daytime hours on board conventional rail services. By enabling passengers to rest overnight while covering long distances on electrified rail infrastructure, high-speed night trains can help reduce dependence on short- and medium-haul flights and thus support broader climate goals. The Chinese example demonstrates that such services are not only compatible with a modern transport system but can in fact become a visible symbol of innovation in sustainable mobility.

Overall, the TRANSCOM 2025 paper provides an important scientific contribution to this deliverable by offering an international case study of high-speed night rail in practice. It helps move the discussion beyond general policy support for night trains and toward a more concrete understanding of what fast overnight rail could look like in operational terms. The value of the paper lies in showing that the combination of high-speed infrastructure and overnight service logic is both feasible and relevant to modern passenger demand. For the purposes of the PhDs EU-Rail project, the Chinese case should therefore be understood as a reference model that can inform future European research on route design, timetable concepts, rolling stock requirements, passenger service quality, and the overall organisation of fast night train systems.

10.2 Sleeping cars in night train operations: case study Croatia

Another scientific study conducted within the framework of the PhDs EU-Rail project focuses on the analysis of sleeping cars used in night train operations, with particular attention to the Croatian railway system and its role within the wider European night train network. The paper Sleeping Cars in Croatia was presented at the international scientific conference on transport and railway operations and provides a technical and operational analysis of sleeping car rolling stock, as well as an overview of its historical development and future potential in the context of modern night train services.

Sleeping cars are among the most important elements of overnight rail transport because they directly determine passenger comfort and the overall attractiveness of night train travel. Unlike daytime trains, where passengers usually remain seated during the journey, night trains must provide facilities that enable passengers to sleep and rest during long-distance travel. The quality of sleeping accommodations, the level of privacy in compartments, and the availability of additional services therefore play a decisive role in shaping passenger perception of night train services. As a result, the design and modernisation of sleeping cars has become a key topic in the discussion about the revival of night trains across Europe (Luketić, Šipuš, & Abramović, Operation of sleeping wagons in Croatia, 2025).

The development of sleeping cars has a long history in European railway systems. Historically, sleeping cars were introduced in the late nineteenth century as part of the development of long-distance railway services. These vehicles allowed passengers to travel overnight between distant cities while maintaining a reasonable level of comfort. Over time, sleeping car designs evolved to include different types of accommodation, such as single compartments, double compartments, couchettes, and luxury cabins. Despite this long tradition, many sleeping cars still in operation today were built several decades ago and often no longer meet the expectations of modern passengers (Luketić, Šipuš, & Abramović, Operation of sleeping wagons in Croatia, 2025).

The Croatian railway system provides an illustrative case study of these challenges. Night train services in Croatia have traditionally relied on sleeping cars produced in earlier generations of railway vehicle manufacturing. These vehicles typically feature compartment-based layouts that accommodate several passengers in shared spaces. Although such designs were once standard across Europe, changing passenger expectations have gradually increased the demand for greater privacy, improved sleeping conditions, and higher levels of on-board comfort. In addition, many older vehicles require technical upgrades to comply with modern safety standards and operational requirements (Luketić, Šipuš, & Abramović, Operation of sleeping wagons in Croatia, 2025).

The study analyses the technical characteristics of sleeping cars currently used in Croatian night train services. These vehicles are typically designed as compartment coaches containing multiple cabins arranged along a central corridor. Each compartment contains several berths that can be converted from seating positions during daytime use into sleeping beds for overnight travel. The configuration usually allows different accommodation capacities depending on the service category, ranging from single occupancy compartments to shared couchette arrangements. While this configuration allows efficient use of space, it may also limit the level of privacy and comfort expected by contemporary passengers.

Another important aspect analysed in the study concerns the operational role of sleeping cars within the wider railway system. Sleeping cars are not simply passenger accommodation units; they also represent specialised rolling stock that must be integrated into train operations, maintenance procedures, and scheduling frameworks. For example, sleeping cars require specific servicing procedures for bedding preparation, cleaning, and passenger assistance. In addition, their interior design must accommodate luggage storage, sanitary facilities, and other passenger services necessary for overnight travel.

Project PhDs EU-Rail (Grant number: 101175856).

The paper also discusses the operational limitations associated with older sleeping car fleets. Many existing vehicles were designed according to standards that differ from modern interoperability requirements, which may limit their ability to operate freely across international railway networks. In Europe, the growing emphasis on cross-border rail passenger transport means that rolling stock must comply with various technical standards and regulatory frameworks, including those defined by the European Union Agency for Railways and the Technical Specifications for Interoperability (TSI). Upgrading or replacing ageing sleeping car fleets is therefore an important step in ensuring that night train services remain viable within an increasingly integrated European railway market.

Passenger expectations represent another critical factor influencing the future development of sleeping cars. Modern travellers increasingly expect higher levels of comfort, privacy, and convenience during overnight journeys. This includes features such as private sleeping cabins, improved noise insulation, climate control systems, onboard Wi-Fi connectivity, and accessible sanitary facilities. These expectations have already influenced the design of new-generation night train rolling stock introduced by several European railway operators. For example, recent projects such as the new Nightjet trainsets introduced by the Austrian Federal Railways demonstrate how innovative interior layouts can provide greater flexibility and improved passenger experience.

The Croatian case study highlights the importance of considering both technological and organisational aspects when modernising sleeping car fleets. While introducing new vehicles is an obvious solution, the study also emphasises the potential to upgrade existing vehicles through targeted refurbishment programmes. Such upgrades may include improvements to interior fittings, modernisation of electrical systems, installation of improved climate control equipment and integration of modern passenger information systems. These interventions can significantly extend the operational life of existing rolling stock while improving the quality of service offered to passengers.

In addition to technical considerations, the study also examines the broader strategic role of sleeping cars within the future development of night train services. As discussed earlier in this deliverable, the revival of night trains in Europe is closely linked to the objective of reducing greenhouse gas emissions and promoting sustainable mobility. Night trains have the potential to replace a significant share of short- and medium-haul air travel, particularly on routes between major European cities spanning approximately 800 to 1500 kilometres. However, for this potential to be realised, night train services must offer a level of comfort and reliability comparable to alternative modes of transport (Luketić, Šipuš, & Abramović, Operation of sleeping wagons in Croatia, 2025).

Sleeping cars, therefore, play a central role in the competitiveness of night train services. If passengers perceive overnight rail travel as uncomfortable or outdated, they are unlikely to choose it over air travel. Conversely, modern, and well-designed sleeping accommodations can transform the night train experience into a comfortable and attractive form of travel. In this sense, sleeping car design should not be viewed merely as a technical issue but as a key component of the overall business model for night train services.

The findings of this research highlight several important implications for the future development of night train systems in Europe. First, the renewal and modernisation of sleeping car fleets is essential for improving the attractiveness of night train services. Second, railway operators should consider innovative interior layouts that balance passenger comfort with operational efficiency. Third, cross-border interoperability requirements must be taken into account when designing new rolling stock in order to ensure that night trains can operate seamlessly across international railway networks (Luketić, Šipuš, & Abramović, Operation of sleeping wagons in Croatia, 2025).

From the perspective of the PhDs EU-Rail project, the Croatian case study provides valuable insights into the practical challenges associated with maintaining and modernising sleeping car fleets within smaller railway systems. While large railway operators may have greater financial capacity to invest in new rolling stock, smaller operators often rely on gradual modernisation strategies and refurbishment programmes. Understanding these constraints is important when developing realistic strategies to revive night train services across Europe.

Together with the previously discussed research on high-speed night train concepts, the analysis of sleeping cars contributes to a comprehensive understanding of the technical and operational requirements for future night train systems. High-speed infrastructure can enable overnight services over longer distances, while modern sleeping cars ensure that these journeys are comfortable and attractive travel options. The combination of these elements represents an important step toward developing a new generation of night train services capable of supporting sustainable long-distance mobility in Europe.

10.3 Passenger Experience in Night Trains

The renewed interest in night trains across Europe reflects a broader shift toward more sustainable and passenger-friendly long-distance travel. While environmental and economic factors drive this resurgence, the long-term success of night train services depends significantly on the quality of the passenger experience. This paper investigates the two principal categories of night-train rolling stock. It assesses how sleeping cars and couchette cars shape passenger satisfaction, comfort, perceived safety, privacy, and the influence on choosing overnight rail travel. Through a comparative analysis based on publicly available data, user reviews, and service descriptions from European operators such as ÖBB, SNCF, and RegioJet, the paper identifies the strengths and limitations of each wagon type from the passenger's point of view.

Sleeping cars offer a higher level of privacy and comfort, often with individual beds and en-suite facilities, while couchette cars provide a more economical, shared sleeping arrangement. These differences shape traveler expectations, preferences, and overall satisfaction.

By highlighting the role of comfort, service level, and travel atmosphere in user experience, this research contributes to discussions on how night train design and service models can better align with passenger needs and support rail's modal shift potential.

Intermodal aspects, particularly bicycle transport in the context of Regulation (EU) 2021/782 (European Union, 2021.), are also considered. Despite the growing body of literature on the environmental and economic benefits of night trains, thorough comparative analyses linking carriage design to concrete passenger experience: comfort, privacy, safety, and operational reliability remain scarce. This paper seeks to fill that gap by combining operators' data, scientific research findings, and real user experiences.

It is necessary to understand how sleeping cars and couchette cars affect passengers' perceptions of comfort, privacy, safety, and service level, and how these factors shape the intention to use night trains again. The working hypothesis is that standardizing service quality and improving comfort, especially in couchette cars, can significantly increase the attractiveness of night rail transport. A comparative case-study design with mixed-method elements was applied. The quantitative component includes the collection and analysis of numerical indicators, for example, the number of available berths by carriage type and the frequency and duration of delays while the qualitative component involves thematic coding of user reviews and descriptive evaluation of operator services. This combination enhances the robustness and credibility of the findings. The results of a comparative analysis of the two main categories of night-train rolling stock sleeping cars and couchette cars, operated by three leading European providers: ÖBB Nightjet, SNCF Intercités de Nuit, and RegioJet are presented by the analysis that follows the dimensions defined in the methodology: comfort, privacy, perceived safety, service level, and operational reliability. This study confirms that the couchette cars, despite substantial upgrades such as mini-cabins and improved ventilation, remain a more economical but less comfortable alternative. Operational reliability emerged as the weakest link in the system: delays of several hours seriously undermine the fundamental promise of night trains arriving well-rested and on time. Intermodal accessibility, particularly bicycle capacity, is becoming an increasingly important element of the overall travel experience and strongly influences mode choice.

Based on these findings, railway operators are advised to continuously improve carriage design from mattress quality and sound insulation to introducing modular mini-suite options in couchette cars and to standardize service levels by ensuring consistent availability of Wi-Fi, power outlets, and breakfast. Systematic investment in operational reliability is essential, including timetable optimization, reduction of technically complex coupling and uncoupling operations, and better cross-border coordination. It is also recommended to increase bicycle capacity to at least eight spaces per train, to meet rising passenger needs and exceed the minimum requirements of Regulation (EU) 2021/782.

Transport policymakers should provide funding and favorable credit lines for fleet renewal, consider raising minimum standards for bicycle capacity, and simplify technical and administrative coordination in cross-border operations. For the scientific community, it is particularly important to conduct longitudinal studies tracking changes in perceived service quality after carriage modernization and develop integrated demand models that incorporate intermodal factors and diverse passenger profiles.

In conclusion, night trains can make a substantial contribution to reducing greenhouse-gas emissions and decarbonising transport in Europe. Realizing this potential, however, depends on the ongoing enhancement of the passenger experience from comfortable sleep and reliable operations to seamless intermodal connectivity making night trains a genuinely competitive and sustainable alternative to air travel.

Project PhDs EU-Rail (Grant number: 101175856).

11 Limitations

This deliverable is based on a combination of literature review, policy analysis, available service data, secondary statistics, and selected scientific case studies. While this approach allows for a broad assessment of the current state and future potential of fast night train operations in Europe, several limitations should be acknowledged.

First, the availability of harmonised and up-to-date data on night train operations remains limited. Information on passenger volumes, load factors, revenue, operating costs, and profitability is often incomplete, inconsistent across operators, or not publicly available. As a result, comparisons between routes and services must be interpreted with caution.

Second, the night train market is evolving rapidly. New services are being introduced, modified, or discontinued on a frequent basis, while policy measures, infrastructure upgrades, and rolling stock investments continue to reshape the market environment. Consequently, some of the findings presented in this report reflect a moving landscape and may require updating as new data become available.

Third, the analysis relies in part on secondary sources, including reports, industry publications, campaign material, and scientific papers. Although these sources provide valuable insights, they may differ in methodology, assumptions, and scope. In particular, estimates relating to environmental benefits, market potential, and modal shift are highly sensitive to assumptions regarding occupancy rates, energy mix, infrastructure access charges, ticket prices, and passenger behaviour.

Fourth, the case studies included in the report are illustrative rather than exhaustive. The examples from China and Croatia provide useful reference points for high-speed night train concepts and sleeping car operations, but they cannot be directly generalised to all European contexts due to differences in network structure, regulatory frameworks, technical standards, and market conditions.

Finally, passenger preferences and willingness to use night trains are influenced by a wide range of factors, including travel purpose, comfort expectations, price sensitivity, reliability, and environmental awareness. These factors vary significantly across countries and market segments, which means that the results presented in this deliverable should be seen as indicative of broader trends rather than as definitive conclusions applicable to all routes or user groups.

Overall, the limitations of this study reflect the early stage of development of the European night train market and the fragmented nature of the available evidence base. Further research, supported by more detailed operational data and continued monitoring of emerging services, would be beneficial to strengthen future assessments.

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Annex I - Back on Track project

Back on Track is a European initiative for cross-border rail transport, in particular the night train network. The initiative gathers around 60 active members from more than 10 European countries, including railway and tourism workers, both active and former, representatives of national passenger associations, scientists, and private individuals. What distinguishes Initiative from the national passenger associations is its explicitly pan-European perspective. Initiative regards the European railway system as a coherent network and is in regular contact with national passenger associations, the railway industry, European and national politicians, environmental associations, trade unions and scientists who study the European transport system (Back-On-Track.eu, 2025).

For example, during the timetable change in December 2018, new night train connections were introduced for the first time in several years, such as Berlin-Vienna and Berlin-Budapest. For the first time, there were no cutbacks of important connections in Western and Central Europe. In response to a public petition and political persuasion by Initiative and others, the coalition agreement of the new Swedish government provides for the reintroduction of night train services to other European countries. In France, the government has committed itself to maintaining the remaining night train connections after Initiative and others campaigned for their retention for years. In Spain, the relaunch of the Barcelona-Granada direct link was planned. In Germany, the EU network accompanied the successful partial takeover of DB's night train network by the Austrian Federal Railways (ÖBB), which preserved important connections. EU network member Joachim Holstein informed the transport committee of the Bundestag about the situation of night trains in Germany in January 2015 and February 2017.

The project, Open Night Train Database, started in June 2023, with the coordinators Howard Osbourne and ERC UK (Back-On-Track.eu, 2025). The lack of information about night trains, let alone a single platform to book a train from one place in Europe to another, is obviously one of the major obstacles to promoting the use of night trains. Various projects have tried to fill the gap, but maintaining complete and up-to-date information is a task no single project has yet achieved. As bad information can be worse than no information, the idea of this project was to invite different, partially competing actors across Europe to join forces based on the principles of open data and open source in order to achieve our common goal of better information services on night trains, better and quicker than each for themselves.

There was a common interest in joining forces to enable a better information service for night train passengers (day trains were beyond scope). Though some participants wanted to keep their interfaces, possibly for commercial purposes, there was a common interest in contributing to a joint open-source database that would allow commercial use. The software used for gathering data had to be open source to cover as many operators as possible, and the maintainer had to be a charitable organisation. The idea was to have Back-on-Track Germany electric vehicles for the time being. The Open Rail Association which creates an open, autonomous and collaborative innovation space and whose mission is to promote the development of Open Source software projects in the railway sector, as it already exists in numerous other industrial sectors like telecommunication, automotive, or energy, was asked to step in, as this would be even better, however, their focus is on sharing software, not data, so they did not take care for infrastructure. To allow for different editors to contribute and to correct parts of the data, the project uses Google Sheets, and for managing versions of the static data files, scrapers, assigning tasks and discussing solutions, the project uses a GitHub Account and other tools such as Slack workspace.

Back-on-Track Germany has created a map of the European night train network (Back-On-Track.eu, 2025) whose online version is always up to date, includes all regularly served destinations and important railway stations, and covers almost all European timetables. However, the system does not specifically search for night trains. Deutsche Bahn completely abolished its night trains in 2016. ÖBB took over the business and sent the Austrian Nightjets to Germany, Italy, Switzerland, Amsterdam, Brussels and Paris. New-generation Nightjets have been running between Hamburg and Vienna/Innsbruck since December 2023. They have also been running between Vienna and Bregenz since March 2024, and between Munich and Rome since 9 September 2024. Travelling by night train in Central Europe is often a little trip back in time because the last carriages were built 30 years ago, but have of course been renovated in the meantime, and you can even still open the window. The Back-on-Track initiative is campaigning for night trains to cover more than 1,500 kilometres in the future. Even today, long distances can be combined, for example from Munich or Vienna to Milan, Venice, or Rome – and on to Sicily the following night (including a ferry journey). Or from the south to Hamburg, and after a day on the Elbe & Alster to Stockholm, and from there again to the Arctic Circle. European night trains are always more climate-friendly than aircraft. The difference is most pronounced where fully booked trains run on electrified routes and are powered by a low-carbon energy source, like in Sweden or France.

Based on IEA global values for 2019 shown in Figure 1 for night trains, emissions are on the same level as for long-distance trains; their lower seating capacity is typically outweighed by higher occupancy rates.

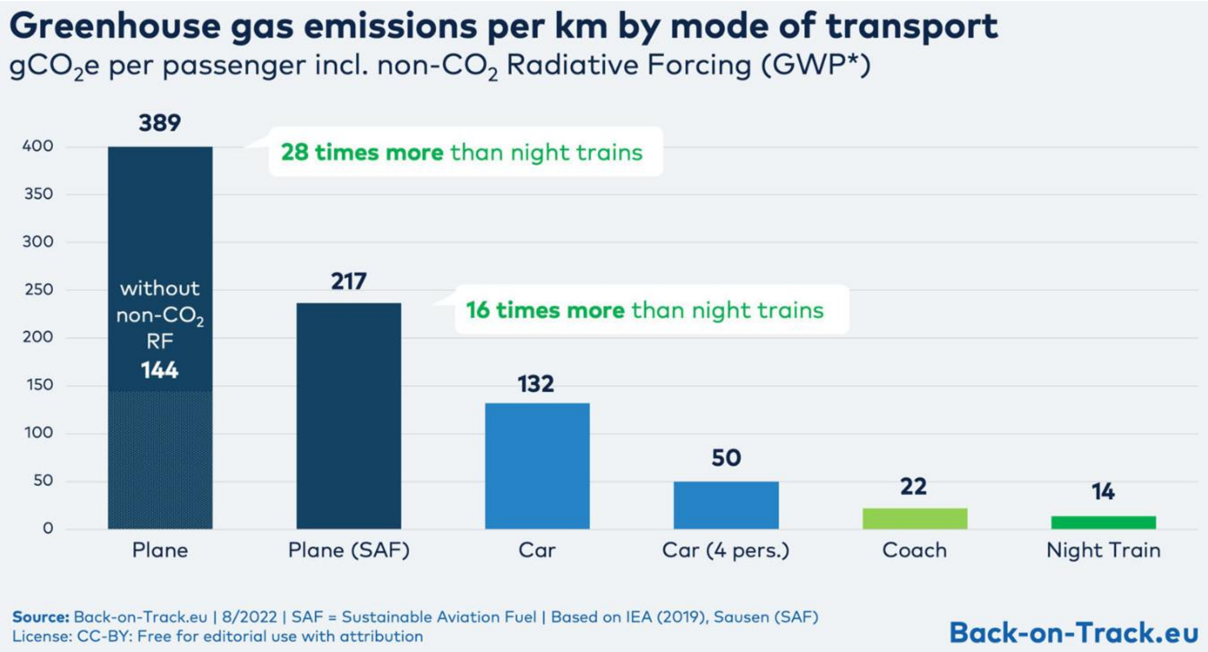

Figure 5. Greenhouse gas emissions per km by mode of transport in gCO2e per passenger (gCO2e/pkm)

Greenhouse gas emissions per km by mode of transport are shown in Figure 2, with average emissions per person and km. According to these averages, the relation is 1:28, meaning using a plane is roughly 30 times as bad for the climate as taking the night train. You can examine the emissions of single-night trains in comparison to car and plane emissions using the UIC EcoPassenger Tool. The results may vary between 0,28 gCO_2/pkm (SJ 94 Stockholm-Narvik) and 28 gCO_2/pkm (IC 273Helsinki-Oulu).

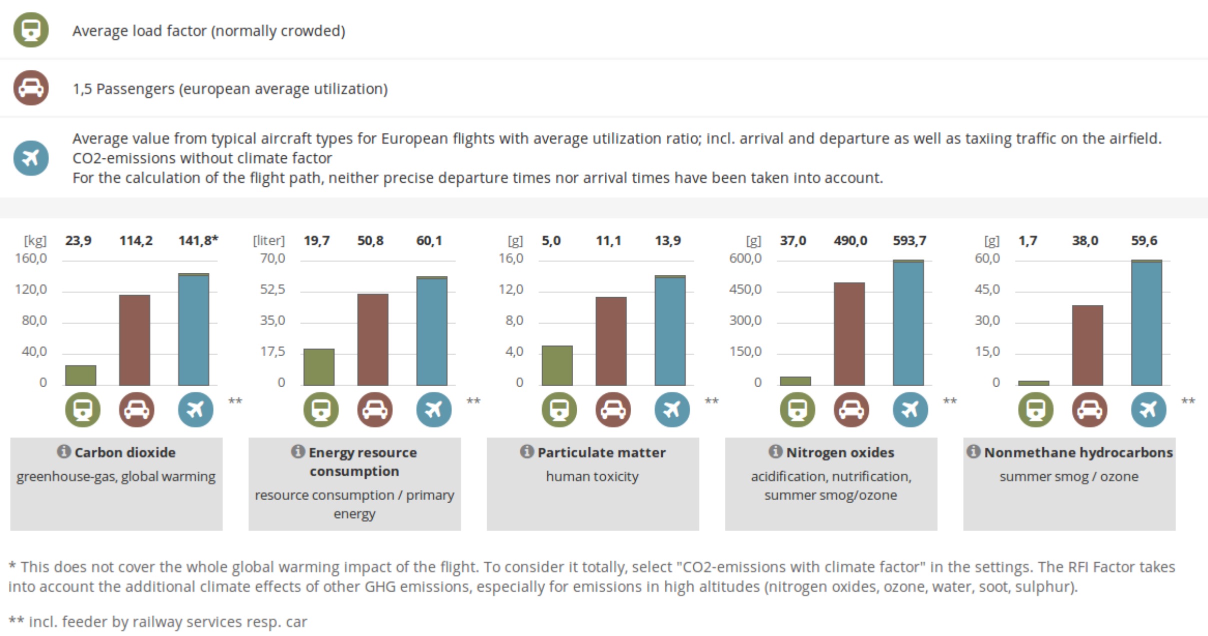

Figure 6. UIC Eco Passenger Tool – Environmental comparison between modes of transport for a trip from Berlin to Paris.

Night trains could replace a large share of medium-distance intra-European flights up to 3000 km. Opinion polls repeatedly showed that 7 in 10 Europeans would likely use a night train instead of a plane if the conditions were reasonable. Based on this data, shown in Figure 3, we estimated that a quarter of aviation emissions could be reduced by shifting to night trains. That equals a 3% share of the total EU emissions in 2019. Of course, this is only possible if there are trains and tracks available, and the total journey price is not significantly higher than that of taking the aeroplane.

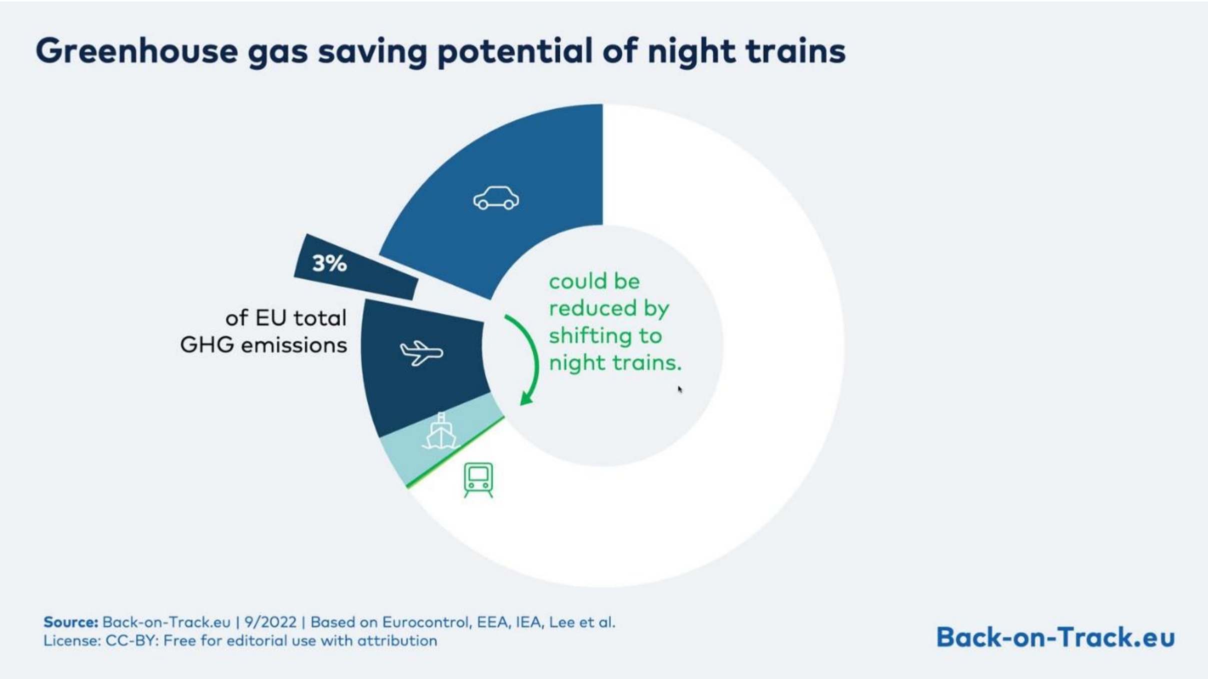

Figure 7. Greenhouse gas saving potential of night trains – 3% of total EU greenhouse gas emissions could be avoided with the help of a comprehensive night train network.