CLIMATE ANALYTICS

Increasing uptake of public transportation

May 2023

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We would like to express our gratitude to the consortium members for their review and guidance in shaping this document.

CITATION AND ACKNOWLEDGMENTS

This document may be cited as:
Climate Analytics (2023). Increasing Uptake of Public Transportation

Cover image: Longxiang Qian

Supported by:

Federal Ministry for Economic Affairs and Climate Action

European Climate Initiative EUKI

on the basis of a decision by the German Bundestag

This project is part of the European Climate Initiative (EUKI) of the German Federal Ministry for Economic Affairs and Climate Action (BMWK). It is the overarching goal of the EUKI to foster climate cooperation within the European Union (EU) in order to mitigate greenhouse gas emissions. The opinions put forward in this publication are the sole responsibility of the author(s) and do not necessarily reflect the views of the Federal Ministry for Economic Affairs and Climate Action (BMWK).

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CLIMATE ANALYTICS

Supporting science based policy to prevent dangerous climate change enabling sustainable development

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Buses

Improving bus comfort

Bus transit is more flexible than rail and is critical to the connectivity and reliability of any transport network (Litman, 2021b). Buses often fill in the gaps between other forms of transportation and serve the most vulnerable members of society (Ibid.). Buses can attract greater total ridership than comparably resourced rail services, particularly in areas with dispersed development or lower income. However, in some cases, increased flexibility comes at the cost of convenience (İmre & Çelebi, 2017). Transportation systems design often neglects this trade-off.

Buses should be optimised for comfort and support passengers with diverse needs and circumstances. Improving bus comfort can encourage more passengers to travel with buses. In-vehicle time and load factor are useful indicators when analysing passengers' comfort perception. Investing in the fleet and optimising bus operations can enhance the comfort of the journey. Ways to optimise operations include:

- minimising waiting time;
- investing in comfortable waiting rooms for long-distance buses;
- journey-planning apps and mobile ticketing to increase ease of use and facilitate social distancing;
- comfortable and weather-resistant bus stops;
- dedicated bus lanes to improve punctuality, and
- reduction of overlapping bus routes to improve waiting time and fuel efficiency in specific areas (Hoonsiri et al., 2020; Pocard, 2021).

A survey done in Hamburg found that passengers prioritise punctuality (92%) and frequency of services (80%). Almost 95% of the interviewed passengers were very satisfied with riding an e-bus, compared to 52% for the conventional e-buses (*Sustainability and Practicability of Electric Buses*, 2020). Transit agencies must continuously monitor vehicle loads and consider changes to mitigate crowding and bring passengers back. Taking other steps, such as visible hygiene measures and mask-wearing, can also help reassure passengers. Transit agencies should also focus on improving the quality of the ride itself: a smoother, quieter bus ride can reduce stress and attract riders.

Bus lanes examples

Warsaw, Poland, added five dedicated bus lanes in 2020 to increase the punctuality of the buses (Polish News, 2022).

The United Kingdom announced a GBP 5 billion boost (5.8 billion EUR) for sustainable transport in 2020, focusing on improving bus services by introducing simpler fares, thousands of new buses, improved routes and higher frequencies. Additionally, London is going entirely cashless to speed up fare payments and reduce contact, while Covid-19 remains an issue (Transport for London, n.d.-a).

Railways

Developing railway infrastructure

Expanding railways provides the best way to increase rail use. However, investments in railway systems are very expensive and require a long lead-time to pay off. To assess the benefit of a rail investment, policymakers must correctly assess the existing and expected volume of rail demand. Both the existing, and especially the expected, demand should be high enough to compensate for negative externalities during construction, the barrier effect, and noise and visual intrusion. Presenting railway development as an alternative to motorway development could increase public acceptance for this measure. Since railway tracks often function for decades with some maintenance, policymakers must account for maintenance savings in a cost assessment. Below, the three main areas of action related to infrastructure, that can increase activity levels for this mode of transport and shift traffic from more carbon intensive modes of transport, are shortly described.

Improvement of local connections

Governments have abolished many local train lines, which daily commuters often used, due to the increasing popularity of car ownership. Revitalising and developing local rail lines can reverse that shift. However, these lines must be reliable, and wherever possible, save time and money for commuters. Parking spaces for bikes and cars, preferably with electric chargers, can significantly increase the impact of local train connections. This design would allow for using trains to cover a larger part of the distance that would otherwise be fully driven.

Improving cross-border connections

Driving or flying across EU borders is still smoother than international rail. In many cases passengers must change trains or wait at national borders. One solution is the Single European Railway Area. The Commission proposed fostering research in Europe's railway sector through a European Partnership on Rail Research and Innovation, building upon the Shift2Rail initiative. Implementing the ERTMS system, including

different track charges, will address current difficulties in international rail travel (Ouferroukh, 2018; *S2R Mission and Objectives*, 2020).

High-speed rail

Although high-speed rail accounts for only 2% of the global rail network, it transports one-quarter of all rail passengers. For distances up to 1,200 kilometres, high-speed rail competes with air transport (IEA, 2019). IEA's most ambitious rail scenario for 2,050 projects that China could decrease its transport emissions 12% by continuing to massively expand rail (Pike, 2019). By 2050, China could reach over 100,000 kilometres of high-speed track in IEA's most ambitious scenario (Pike, 2019).

Turkey is developing 16 new lines to connect major cities in a 1652-kilometre network by 2023. It is planning more than 30 new high-speed rail lines, for a total of 7419 kilometres, and completed tests in 2020 on the 393-kilometre Ankara-Sivas line. The Ankara-Sivas line should be operational by late 2021.

Night trains

According to European Passenger Federation data, the number of night trains (long-distance cross-border trains) in Europe decreased significantly, from 1,257 in 2001 to 445 pairs of trains per week in 2019. After a significant decrease in popularity, some night train connections reopened recently. The first night train in Austria since 2003 commenced operation in 2020, travelling from Vienna to Brussels. Sweden launched night train services to Belgium and Germany to reduce dependence on aviation and minimise travel impacts.

Smaller railway operators, such as the Austrian ÖBB, have focused on developing night trains (ÖBB, n.d.). They are developing a network of international connections by utilising their location. As part of an emergency report on strategies to decrease global oil demand, IEA estimates suggest replacing air travel with night trains would reduce global oil demand by around 40 thousand barrels per day (IEA, 2022).

Night trains have a steady, almost linear increase in costs. Different cost structures for night trains make it more difficult for night trains to achieve the economies of scale seen on daytime trains. Buying and operating night trains is also expensive compared to daytime trains. Some groups recommend that the EU buy a massive night train fleet and lease trains to operators. Policy makers must address the EU-wide shortage in all forms of cross-border trains (Steer Davies Gleave, 2017). Policy makers can use strategic investments, preferential loans, and even create a European stock pool, given night trains' higher costs and more sophisticated technology (Steer Davies Gleave, 2017). National and international governments will need high political will and collaboration for these policies to succeed. These measures are necessary to address scheduling and the price competition between other modes of transport which benefit from high subsidies or lack internalisation of external costs (Marcellin, 2021).

Night trains may play a significant role in moving away from intra-EU aviation. However, to become a viable alternative, night trains must improve in:

- comfort;
- affordability;
- frequency;
- price parity (through a reduction of subsidies for airlines);
- ticketing – major national rail operators should sell tickets online for trips that involve different operators;
- interoperability (implementation of ERTMS);
- reducing track access charges;
- improved infrastructure, and
- helping operators buy rolling stock through European funding.

Reducing taxes on train tickets

The high cost of rail tickets, compared to flying, is one of the most frequently cited hurdles in reducing transport emissions. Part of this disparity comes from relatively heavy taxes on tickets, which far outpace the undertaxed aviation sector (Dornier, 2019). To be competitive with rate-cut plane tickets, train tickets taxes need to fall, and rail service providers must pass reductions to customers.

Lower VAT rates have shown some progress in this area, as lower VAT rates have correlated with lower train fares. For example, Germany cut the rate of value-added tax (VAT) on rail travel from 19% to 7%. The national rail operator, Deutsche Bahn (DB), passed this reduction on to passengers, with some fares of 50km or over declining by around 10% (A. Murphy, 2020a). Switzerland saw a 0.3% general decrease in train prices in June 2018 as a direct consequence of VAT reductions (*Train Travel to Become Cheaper in Switzerland*, 2017). This decrease contrasted with generally increasing train fares across Europe (*Train Travel to Become Cheaper in Switzerland*, 2017). The United Kingdom has zero-rated VAT for train tickets (in addition to bus fares and taxi rides) (HM Revenue & Customs, 2020). While not a VAT exemption, the 0% VAT has reduced fares on train tickets, as rail companies can still claim VAT credits on input, and ticket holders do not pay the additional VAT tax.

Rail Delivery Group (RDG), a British industry group, recently warned that aeroplane fuel is tax-exempt (Ames, 2020). By contrast, rail operators must pay levies on electricity. These levies have recently doubled, increasing pushing costs and ticket prices. RDG argues that taxes now account for up to 40% of electricity costs for rail providers. To RDG, the 'polluter pays' concept only applies to non-air travel. Other countries have similar disparities and have struggled to close the gap between air and rail travel taxation.

Making booking international trips easier

It is much easier to book an international flight than an international train trip. If one travels cross-border in Europe involving more than one operator, there is no "one-stop-shop" for booking a train ticket. While websites like Rome2Rio allow customers to plan connections in advance, this service does not allow for booking the tickets, nor does it provide any live data on connections (*Rome2rio*, 2022). Train operators do not share data or ticket selling rights. Rail operators tend to sell tickets only for segments of a journey instead of combined or through tickets, bypassing obligations relating to compensation, re-routing and assistance (Brillaud et al., 2021; Melchior et al., 2021). Rail operators' websites do not provide interfaces to other operators' systems, complicating customers trying to travel internationally via rail.

European law obliges rail transport operators to share only basic data with other rail carriers or independent ticket vendors. The regulation does not cover fare data and leaves member states to require dynamic travel and traffic data (e.g. information on platform numbers and changes, accurate seat plans, real-time delays and cancellations, and predicted arrival time). These data are critical for a seamless journey and for passengers to find alternative connections in case of disruptions.

Independent ticket vendors need to enter into bilateral agreements with every rail operator and can only sell tickets to which the rail operator gives them access. Therefore, these vendors can only get access to, for example, standard fares, but not to reduced fares or railcards. These restrictions hinder independent vendors from assembling their own products.

Policymakers must significantly simplify the booking process (A. Murphy, 2020b). A rail ticketing regulation could enable passengers to search and book rail tickets across Europe with one click, up to 9-12 months in advance, under the protection of passenger rights for the entire trip. This system would facilitate a necessary aspect of improved rail travel.

Improving the quality of railway services

For rail services to compete with other forms of transportation, the train must be an appealing option and fulfil the passengers' requirements for a comfortable journey. Train services should be easy to navigate – signage should be conspicuous, timetables should be accurate and easy to read, ticketing should be straightforward and simple, and connections between major cities should be as direct as possible. Cross-border journeys require information sharing and navigable ticketing systems. Journeys across multiple borders provide extra challenges for passengers finding routes and tickets. Additionally, train services should improve multimodal ticketing so that passengers can easily complete their entire journey (Europe on Rail, 2020).

Journeys with a transfer, particularly between rail services, currently force passengers to bear the risk of missing a departure. If policymakers required rail services to provide

"through tickets", passengers would have guaranteed punctual arrival when using services of different operators.

Timeliness also contributes to journey satisfaction. Studies have found that delays sway customer satisfaction and opinion significantly. Rail services must ensure high-quality service with minimal delays. Train frequency and length can address other complaints, such as crowding and lack of luggage space (Monsuur et al., 2017).

Railway amenities are also essential for customer appeal. This customer appeal can encourage rail travel. Rail services can maximise customer comfort by offering food and drink, increasing power socket availability, and providing entertainment opportunities through free Wi-Fi and onboard streaming. Since people increasingly work during rail travel, quiet areas in cars and other comfort-oriented measures can also increase railway appeal (Ghazanfar, 2019).

Rail service improvement examples

National Rail, a service in the United Kingdom, announced a series of service-improvement projects beginning in 2022, such as a new line across London and improvements to rolling stock (better lighting and air conditioning, more wheelchair-accessible spaces, and improved CCTV for customer safety and comfort). Other projects include renovating Gatwick airport to alleviate congestion and crowding (National Rail, 2022). This congestion and crowding had consistently been the chief complaint of both commuters and leisure travellers (National Rail, 2022).

London Northwestern Railway is revitalising its rail stations to improve the customer experience by improving accessibility options, re-engineering stations to avoid bottleneck points, and improving restrooms for customer comfort.

In Summer 2021, German Railways started operating XXL-ICE trains on selected lines and increased train frequency on others. The XXL trains have a length of 374 metres, can carry up to 900 passengers, and travel at 265 km/h (*Sommerfahrplan*, 2021).

Regular interval timetables

Easy travel planning significantly increases railway attractiveness. For example, if trains arrive at the same minute every hour, and transfer waiting times are short, rail travel becomes more attractive for passengers. Rail passenger transport services with integrated regular interval timetables (IRIT) offer passengers a regular interval timetable for services on the railway network. IRIT has the potential to increase the quality and attractiveness of railway passenger services in comparison to other transport modes (Finger et al., 2014).

The taxonomy developed by Finger *et al.* (2014) for Swiss Economics identifies four general levels of regular timetables:

- **Level 0:** Trains run at irregular intervals (e.g. rush hour or when other trains are completely booked) in a system without regular timetables.
- **Level 1:** Simple regular timetables, in their most reduced form, introduce timetables and refer to schedules with frequent trains.
- **Level 2:** Introducing regular symmetrical timetables. Train connections cross some network nodes at a specified time, but the timetables do not coordinate the crossing time at all network nodes.
- **Level 3:** "Integrated regular timetables": Symmetric timetables with train connections at all network nodes at a specific time (e.g. at the full hour). The timetables define a symmetric frequency well in advance. Integrated regular timetables also account for the tariff system (one tariff system coordinating national and regional rail networks, promote intermodality, and account for the frequency of daily connections. These considerations make integrated regular timetables attractive for customers.
- **Level 4:** Trains run at a very high frequency, e.g., every five or ten minutes. The train frequency is so high that time schedules become irrelevant.

Integrated timetable example

Switzerland organises timetables symmetrically around the hour ('minute .00') with a basic timetable structure repeating every 60 or 30 minutes depending on demand. A particular service may depart from the station daily in an understandable and predictable pattern (08:00, 08:30, 09:00, 09:30, etc.). To coordinate this schedule, trains running on the same route in opposite directions need to mirror one another. If train A arrives 'x' minutes before the hour, its counterpart travelling in the opposite direction must depart 'x' minutes after the hour, with the two crossing in the middle. Some lines do not operate on a strict clock-face schedule due to asymmetric lines or other physical constraints.

Subway & Tram

Improving public transportation infrastructure

Improving public transport infrastructure is essential to increase utilisation and shift from passenger car transport. Public transport systems must extend beyond urban areas to suburbs and exurbs. German, Austrian, and Swiss municipal public transport systems provide an excellent model. Public transport in Munich, Hamburg, Berlin, Vienna and Zurich span areas ten to thirty times larger than the respective urban area. This system, however, risks compromising public transport's frequency and reliability. At the same time, infrastructure costs often prevent public transportation infrastructure improvements. Government grants or local taxes explicitly earmarked for public transport provide funding options. In France, businesses with 11 or more employees pay a public transport payroll levy called Versement Transport, or VT (Versement Transport, VT). Companies support the levy because good public transport benefits employees and the local economy. VT funded much of the recent boom in French urban tram system construction.

Public transport infrastructure examples

In 2019 Berlin, Germany, announced that it would spend 28 billion EUR improving public transport between 2019 and 2035 (Loy, 2019). Market analysts predict that BVG will increase its revenue by around 3.4% per year. This increased revenue will originate partially from ticket price hikes (1.4%) and improved passenger numbers (expected to grow by 1.8%). BVG also plans to expand tram tracks, a major component of Berlin passenger transport, by 70 kilometres in the next 15 years (Hernández-Morales & Posaner, 2021).

Madrid, Spain, has one of the best public transport integration practices (Vassallo & Bueno, 2019). An integrated fare system and extensive coverage defined Madrid's success. Most people live within 500 metres of a station, 89% live within one kilometre of a station, and one ticket covers all public transport. This accessibility, combined with the fact that 97% of jobs are within one kilometre of a station, ensured high use. Public private partnerships made building the infrastructure of this vast project possible.

Ticket integration between urban and regional rail services

One of the challenges to decarbonising passenger transport is the "last mile problem". If individuals find public transport too complicated, obscure, or challenging for the last leg of their journey (i.e., from the airport/central station to their destination) they may use more carbon-intensive transport, such as a taxi or personal vehicle, for the whole trip.

“City tickets”, like the Madrid example, provide one potential solution. “City Tickets” combine services to and from a main station, as well as transport between stations. These tickets incentivise travelling with public transport for different riders, cities and trips. “City Tickets” thus facilitate multimodal journeys and reduce emissions.

Ticket integration examples

Austrian rail service ÖBB provides a combined train, bus, and tram ticket. Regional transportation services sell their tickets through the ÖBB central ticket service. Passengers can also purchase these tickets through the ÖBB mobile app. This app further eases the transition between national and regional services. ÖBB combines tickets automatically based on the user's starting and final location. ÖBB include other offers, (specific city tickets, etc.) whenever and wherever possible (Region and City Tickets, n.d.).

Belgium also offers limited options for a single, multimodal ticket. Belgium targets travellers between cities (business commuters, students, etc.). These tickets enable all-in-one travel along a particular route and within cooperating towns (Combined Train + STIB, TEC or De Lijn Season Ticket, n.d.).

In Germany, Deutsche Bahn offers multiple possibilities to combine public transport to a train station with train tickets between destinations. Deutsche Bahn’s automatically includes a “City Ticket” for journeys over 100km to and from applicable areas. The “City Ticket” is valid in over 120 towns and cities across Germany. Deutsche Bahn’s “City Mobil” ticket provides single trips or day-cards in areas not covered by the City Ticket (City-Ticket and City Mobil, n.d.). These systems facilitate multimodal trips (City-Ticket and City Mobil, n.d.).

An additional development in Germany was the introduction of the ‘9-euro ticket’, a discounted nation-wide local and regional public transport travel pass for June, July and August 2022. The cheap monthly pass increased rail travel, according to the Federal Statistical Office (Destatis), which noted that travels of 30 kilometres or more were up by 42% in July 2022, compared to pre-pandemic levels (Destatis, 2022). Between May and August of 2022, more than 38 million tickets were sold, with most users noting that they used the ticket for everyday journeys, and a third indicating they used the ticket for special excursions as well (Levy, 2022). Traffic data firm TomTom found that during the period the 9-euro ticket was valid, 23 out of 26 cities studied saw a reduction in vehicle congestion (Ibid.). The 9-euro ticket was wildly popular, and residents have continued to push for the introduction of cheap tickets for regional and urban rail. A similar 49-euro ticket has been made available as of May 2023 (NDR, 2023).

Free public transportation

Accessible transport is essential for everyone. Without accessible transport, people who cannot walk or cycle would resort to a personal car. Free public transport could, along with multimodality, reduce global oil demand by about 330 thousand barrels of oil a

day. Free public transport is a robust measure to reduce transport emissions, improve social equity, and improve society's quality of life (Choi, 2021; IEA, 2022).

However, free public transport has two significant drawbacks. Firstly, it would lose revenue for transport operators and thus require higher public subsidies. Simultaneously, however, the policy would eliminate the costs of the ticketing infrastructure. In smaller cities, this cost can consume up to a quarter of ticketing proceeds. Secondly, free public transport may result in the misuse of public transport. Misuse includes examples like partying or overstaying. Policymakers should consider the advantages and disadvantages of free public transport on a case-by-case basis.

Free public transport examples

Amid skyrocketing fuel prices in the first quarter of 2022, several jurisdictions implemented temporary free public transit. For example, Tasmania, Australia, implemented five weeks of free bus access to alleviate pressure on consumers ('Free Buses', 2022). California, USA, introduced a bill that would implement three months of free public transit to respond to high fuel prices (Archie, 2022).

Dangjin, South Korea, instituted a free public transit system in 2019 for all 200,000 citizens. Dangjin's system had three phases:

- Phase one: The elderly, physically disabled individuals, and veterans received free transport tickets.
- Phase two: Dangjin included children and students.
- Phase three: Dangjin included all other citizens.

Ridership among eligible groups on the extensive bus system rose 30% annually. The program also alleviated an average annual economic burden of 1,120,000 KRW (825 EUR) per household (Choi, 2021).

In 2020, Luxembourg made all public transport free. Passengers only require tickets for cross-border trips and first-class cabins (*Free Transport*, n.d.). The government estimates the loss of ticket revenue was less than 10% of the total operating cost (Kirby, 2020). The relatively small loss was part of the motivation to phase out fares within the country. The increased usage of buses and trams within the city centre reduced vehicle traffic overall. Due to the timing of the rollout and the ongoing Covid-19 pandemic, Luxembourg has not yet published official ridership numbers.

Estonia introduced free public transport to reduce car traffic in 2018. Estonia began with an experiment in the capital, Tallinn (Gray, 2018). Registered residents paid EUR 2 for a "green card", which made all public transport trips free (Gray, 2018). The government supported this measure by expanding the bus network and increasing the share of public transport trips (Köllinger, 2021). However, the percentage of trips by car remained stubbornly high.

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