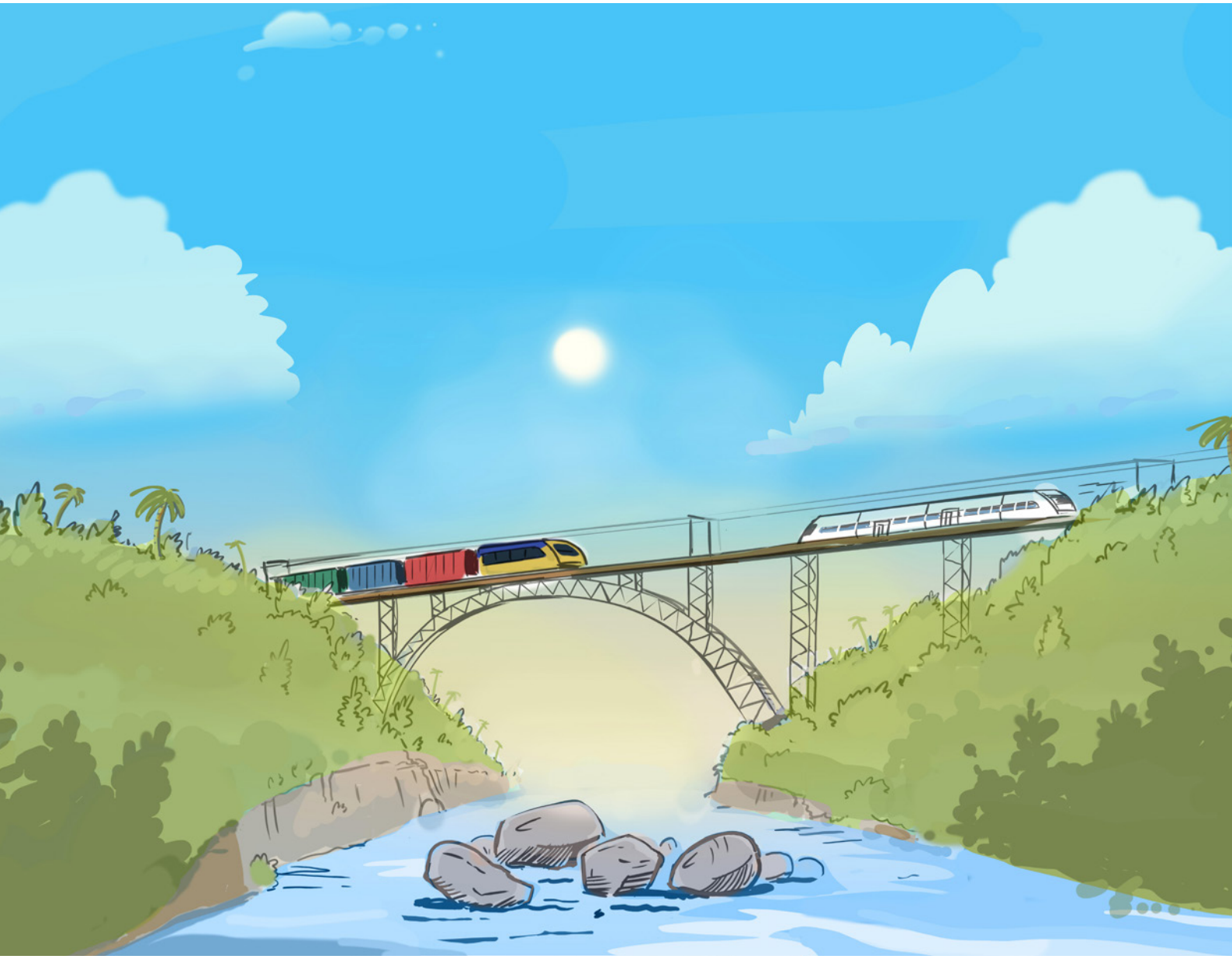
BRIDGING THE RAIL FINANCE GAP

CHALLENGES AND OPPORTUNITIES FOR LOW- AND LOWER MIDDLE-INCOME COUNTRIES

White paper



UNIVERSITY OF BIRMINGHAM

Roland Berger

ALSTOM

UIC

Foreword

In the collaborative spirit that brings about transformation, the International Union of Railways (UIC) and ALSTOM are proud to work together with the University of Birmingham and Roland Berger, on this important new report in the lead up to COP28. As we navigate the complex challenges of the 21st century, it is our shared conviction that unlocking investment in rail infrastructure in low-and lower middle-income countries (LICs and LMICs) is vital to avoiding strong transport emission growth, while bringing connectivity and economic benefits that will allow economies to flourish.

We call upon governments, international financial institutions, and the global community to recognize this opportunity and deliver the transformations needed to ensure funding and financing of rail in LICs and LMICs is greatly expanded, including through access to climate finance. This study lays out the challenges faced by the rail sector in these countries and provides recommendations for collective efforts that will take advantage of a short window of opportunity to set countries on a sustainable development path, before further carbon is embedded into their transport systems. Let us work together to accelerate investment in rail and embark on a journey towards a greener, more resilient world.

Francois Davenne, Director General of UIC
Natalie Bouvier, Chief Strategy Officer, ALSTOM

The lead up to COP28 highlights the need for even stronger action to tackle the current climate emergency, where the transport sector continues to be one of the main emitters of greenhouse gases. The potential for rail infrastructure in LICs and LMICs is considerable, which can lead to equally considerable savings in carbon emissions. We were delighted to work with Alstom and UIC to produce this important contribution to the debate, which shows that major changes are needed to enable rail to fulfil its potential role in reducing CO_2 emissions. We are enormously grateful for contributions from our partners and from experts across the world and look forward to the debate and to seeing much needed change. The Birmingham Centre for Railway Research and Education (BCRRE) is Europe's largest academic-based group that provides world-class research, education, and innovation to the global rail industry. Similarly, Roland Berger is looking to use its implementing power to unlock climate action and help ensure future-proof business models.

Professor Paul Plummer, University of Birmingham
Didier Brechemier, Roland Berger

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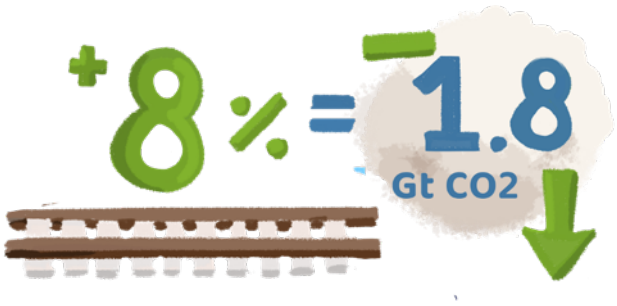
Executive Summary

Increasing the amount of rail infrastructure with a strong focus on low-income countries (LICs) and lower middle-income countries (LMICs) can help avoid substantial carbon emissions through decoupling economic development from transport emissions growth, which will also benefit the entire global community.

LICs and LMICs are home to more than half of the world's population, yet they only account for 17% of transport-related emissions. Investing in railways, which are more energy efficient and less carbon intensive than other transport modes, can help LICs and LMICs achieve climate goals. Additionally, other economic benefits from rail projects, such as growth in trade and formal jobs, increased accessibility and connectivity, densification of urban spatial growth and much lower negative external costs in comparison to other modes support the promotion of sustainable development goals.



LICs and LMICs have substantially less rail infrastructure than High Income Countries (HICs) with an average network density of 4.95 km of rail infrastructure per 1,000 km of surface area, versus an average of 50 km for HICs. Analysis undertaken for this study shows that if LICs and LMICs were able to expand their rail infrastructure to the level of the best-in-class countries among them (95th percentile), they could quadruple rail modal share to 8% and avoid a total of 1.8 Gt of carbon emissions by 2050. This would see the additionof 180,000 km of new interurban lines and 12,000 km of new urban lines. Closing this rail infrastructure gap would require annual investment in rail in LICs and LMICs of USD 80 billion per year through 2050. Annual investment of USD 25 billion would still allow the addition of 50,000 km of interurban lines and 4,000 km of urban lines and the avoidance of 1 Gt of emissions by 2050. Expanding rail investment to these levels would require a substantial build-up of technical, legal and financial capacity in LICs and LMICs.

The main challenge to expanding rail infrastructure in LICs and LMICs is securing adequate financing and attracting foreign investors. These countries generally have limited tax revenues, which limits their ability to self-fund the upfront infrastructure investment costs of rail projects. Additionally, countries may already have high debt levels, limiting access to commercial borrowing, with rail projects difficult to be fully covered by private finance in any case. International Financial Institutions (IFIs) are important sources of development funding for LICs and LMICs yet they have historically directed far more funding to road projects than rail, partly because standard models of cost-benefit analysis used to assess projects do not account for benefits that may last for the entire life of rail infrastructure of 100 years. Some bilateral government funding for rail does also come through Export Credit Agencies (ECAs) who play a crucial and decisive role in supporting exporters in LICs and LMICs, making their projects bankable and allowing access to the private banking market under competitive terms. Currently available climate financing schemes based on carbon crediting can be a source of funds, however the amounts on offer from those based on carbon crediting have not been material for rail projects.. A further difficulty in funding rail is that many economic benefits of rail projects accrue to broader society and are difficult to capture to the project developer as a financial return.

Closing the financing gap for rail investment in LICs and LMICs is an issue of global significance, that, if resolved will deliver global public goods. It therefore justifies interconnected action from governments, IFIs, the international community and the finance sector to support these countries in realising the potential for avoiding substantial carbon emissions and delivering broad economic benefits.

1. High income countries should provide grants to fund rail projects in LICs and LMICs

Recognising the importance of decoupling transport emissions growth from economic growth in LICs and LMICs through increased rail investment, and the global public goods that will result, high income countries should provide substantial funding for rail through grants - or loans with a significant grant element. Even partial grant funding of rail projects would greatly increase their financial viability, and help leverage accompanying concessional financing by funding the interest and deferral of loan payback, ensuring that far more can be completed. Grants should come as part of the annual $100bn of climate finance that developed countries committed to provide to developing countries, including LICs and LMICs, at COP15 in 2009, as well as, when applicable, as part of the Loss and Damage funds approved at COP27 in 2022.

2. Governments should allow rail projects in LICs and LMICs to be funded under Article 6 of the Paris Agreement and support the development of carbon finance market regulations for rail

Due to the large scale emissions that would be avoided from new rail projects in LICs and LMICs, governments should consider rail as climate mitigation projects under Article 6 of the Paris Agreement, generating carbon credits that would in turn be allowed to be sold to richer countries. Governments should also support the development of carbon finance market regulations specifically for land transport, that would standardize the calculations of avoided emissions from a modal shift to rail, which would expand climate funding sources for rail.

3. IFIs should adapt their methods of cost-benefit analysis of rail projects and greatly increase the funding they direct to rail

With long lifetimes of 30-35 years for rolling stock and up to 100 years for infrastructure, rail projects are discriminated against with standard methods of cost-benefit analysis used by IFIs. Such approaches must be updated, allowing rail projects to use lower depreciation rates so that their substantial future benefits can be better captured by financial models. Additionally, the wider socio-economic benefits of rail, though difficult to monetise, must be incorporated in appraisal processes. IFIs should also prioritise low carbon, efficient and resilient modes in future expansion of their lending pools, increasing funds allocated to rail projects, as well as support LICs and LMICs in making their railways more creditworthy.

4. LICs and LMICs should lead implementation of policies to spur private investment in rail, and modal shift

Governments in LICs and LMICs can increase the attractiveness of private investment in rail projects by providing stronger rights over rolling stock to creditors. Similarly, aligning to standardise rail technical standards across countries will increase investor confidence and can also allow multi-country rail corridors to be developed. Governments should also accompany rail projects with policies that incentivise modal shift, with both push and pull measures, to ensure the full utilisation of infrastructure and the success of projects and delivery of the climate and economic benefits they promise. This will also be aided by closely integrating rail with other transport modes, by taking action to improve first and last mile connectivity for people and goods
in conjunction with rail projects.

5. The international finance sector should work to make financing rail projects more attractive to the public and private sectors and to build capacity in LICs and LMICs

Important forms of public and private sector finance for rail projects in LICs and LMICs should be expanded. The international finance sector should work to support the development of capacity in LICs and LMICs for the delivery of rail projects as Public Private Partnerships. Countries should also be supported by the sector to help build institutional and technical capability through strengthening fiscal and regulatory frameworks.

6. LICs and LMICs should collaborate with the rail industry to structure rail projects to maximise broader economic benefits

Private companies can bring significant operational and technical expertise to rail projects in LICs and LMICs where there may be a lack of local capacity; they can also help develop the industrial capacity of countries through facilitating participation in supply chains during construction and operations phases LICs and LMICs should work with the rail industry to structure projects in this way, which will broaden economic benefits, increase countries' economic complexity and create high value formal jobs.

7. The rail industry should continue to leverage digitalisation and advances in rail technologies to improve the attractiveness of rail

De-risking cost-effective technologies can help reduce required project investments and improve project bankability. The railway sector should continue to progress in developing new solutions that lower operation and maintenance costs, which are particular challenges of the mode. Newe forms of traction, or digital train-based control systems, can also reduce the need for line-side infrastructure and with that lower overall infrastructure costs and make projects more attractive for financing.

List Of Abbreviations

ADB
Asian Development Bank

AfDB
African Development Bank

CDM
Clean Development Mechanism

CER
Certified Emission Reduction

ECA
Export Credit Agency

GCF
Green Climate Fund

HIC
High-Income Country

LIC
Low-Income Country

LMIC
Lower Middle-Income Country

IADB
Inter-American Development Bank

NDC
Nationally Determined Contributions

OECD
Organisation for Economic Co-operation and Development

TOD
Transit Oriented Development

UMIC
Upper Middle-Income Country

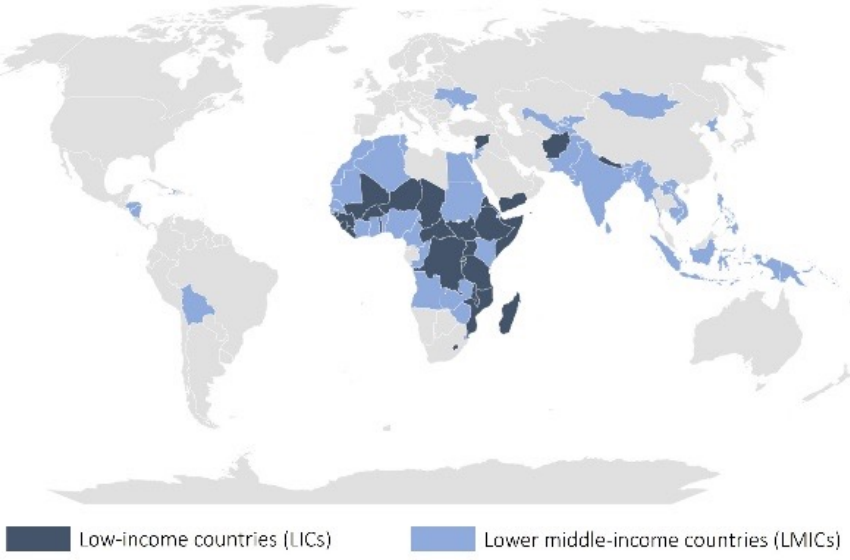
UNFCCC
United Nations Framework Convention on Climate Change

What are LICs and LMICs?

Low-income countries (LICs) and lower middle-income countries (LMICs), are definitions used since 1983 by the World Bank to classify countries based on their Gross National Income (GNI) per capita, using its Atlas Method.

Low-income countries (LICs) are those with a GNI per capita of USD1,135 or less in 2022, and lower middle-income countries (LMICs) are those with a GNI per capita between USD1,136 and USD4,465.

Other countries are labelled either upper middle-income countries (UMICs), with a GNI per capita between USD4,466 and USD13,845; or high-income countries (HICs) where the GNI per capita is USD13,486 and above.



1 WHY DO RAILWAYS IN LOW-INCOME AND LOWER MIDDLE-INCOME COUNTRIES MATTER?

Railways as contributors to sustainable development

The transport sector continues to be one of the biggest contributors to global emissions, despiteworldwide commitment to reduce emissions in all sectors following the Paris Agreement signed in 2015. Transport emissions mostly arise from the world's heavy dependence on fossil-fuel transport modes. Road transport emits 75% of total transport carbon emissions and uses more than 40% of global oil consumption [1, 2]. Pathways to avoid irreversible environmental damage must include a drastic shift to low carbon modes to move people and goods.

Railways are known for their relatively low emissions, yet more needs to be done to consolidate its inclusion within the plans for climate action outlined in Nationally Determined Contributions (NDCs) in response to the Paris Agreement. In a recent analysis by the International Union of Railways (UIC), findings show that only 54 out of 195 parties mention rail in their NDCs, with 32 countries being LICs and LMICs. Furthermore, only 19 parties have specific targets stated in their NDCs, among which 12 are LICs and LMICs[1]. This shows that despite limited financial capacity, these countries have a clear ambition for rail potential in climate action and are clearly seeking support from the international community to deliver on that potential.

Direct impact - In a pressing time for climate action, a low-carbon mode of transport like rail is losing market share. While railways carry 8% of the world's passengers and 7% of global freight transport, they only consume 1% of the total energy demand [3].

Compared to other modes, rail has one of the smallest carbon footprints, with an average emission of 22g of CO_2 per passenger-km. In comparison, buses emit an average of 63g of CO_2 per passenger-km, commercial aeroplanes emit an average of 123g per passenger-km, and medium cars emit an average of 148g per passenger-km [4].

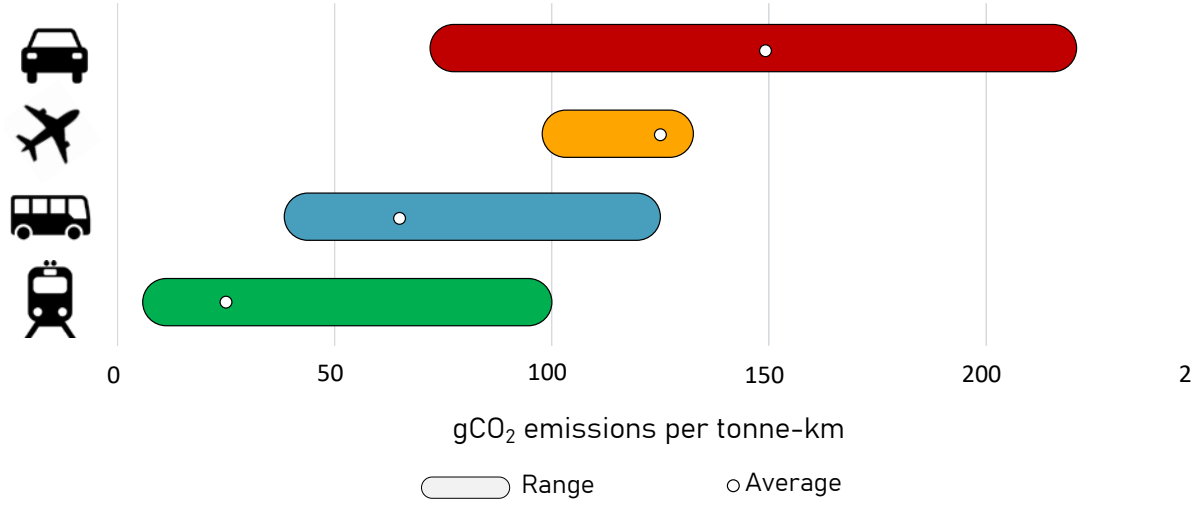


Figure 1. Average emissions per passenger-km for different transport modes

Indirect impact - Rail also has fewer negative externalities than road transport. Studies estimate that external costs from road modes can be 9 times larger than those of electric trains (and 6 times larger than diesel trains) when converted to monetary values (EUR-cents/passenger-km or EUR-cents/tonne-km)[2] .

[1] LICs and LMICs that have specific targets for rail in NDCs: Burkina Faso, Chad, Democratic Republic of Congo, Eritrea, Ethiopia, Malawi, Myanmar, Sierra Leone, South Sudan, Sudan, Tajikistan, Uganda – UNFCCC registry

[2] Calculations based on a study conducted by the European Commission that compares the external costs of private cars against conventional passenger trains (electric or diesel), and HGVs against freight trains (electric or diesel). External costs calculated include accidents, air pollution, climate change, noise, congestion, emissions, habitat damage, and social marginal congestion costs (trunk roads at near capacity) [52]

Investment in railways also bring broader socioeconomic benefits in the form of formal jobs and economic development [5]. In intercity corridors, railways have been found to promote greater economic activity and social opportunities, especially for women and other marginalized groups. Rail projects can also be structured such that they build industrial capacity to improve the economic output and complexity of countries, through transfer of technologies to allow local participation in supply chains.

When planned appropriately, railways can serve as the backbone of Transit Oriented Development (TOD), promoting strong economic development from rising real incomes and land value appreciation within proximity of transit stations or corridors [6]. Rail systems also use less land to transport the same amount of goods or people than road, an important benefit particularly in densely populated countries like in Asia, and also positive for the impacts on biodiversity from expanding transport systems.

Although rail has widely known and accepted positive externalities, these are not well quantified and understood in monetary value.

Railways continued path towards Net Zero

Even with lower emissions than other land transport modes, the railway sector continues to make considerable technological advancements towards full decarbonisation. Electrified systems can be powered by renewable energy sources, and replacing higher-emission diesel systems offers a range of alternatives, including alternative zero-emission traction systems for non-electrified rail networks. After deployment on commercially operated lines in Germany, Alstom's hydrogen trains will also be deployed in Italy, and are being tested across continents, in Canada and Saudi Arabia [9, 10, 11]. Trains with batteries to allow operation on sections of unelectrified lines will also be deployed in multiple countries in coming years.

Decoupling development from emissions in LICs and LMICs with rail infrastructure

LICs and LMICs have much smaller historical contribution to greenhouse gas emissions (GHG), but are much more vulnerable to the adverse impacts of climate change [10]. These countries **are home to half of the world's population, but responsible for only 17% of global transport CO_2 emissions** [11]. The contribution to transport emissions from LICs is remarkably small: less than 1% of total emissions [11]. In contrast, **a sixth of the world's population lives in high-income countries but are responsible for more than half of the global emissions from transport activities.**

In absolute values, transport emissions per capita in high-income countries are an order of magnitude larger than those in LICs and LMICs. High-income per capita emissions are approximately 3 tonnes of CO_2 each year, in comparison to 0.3 tonnes in LMICs and 0.1 tonnes in LICs [11]. Overall transport emissions per capita are not only smaller in LICs and LMICs compared to other country groups, but they also represent a smaller proportion of total emissions. In HICs, transport emissions represent approximately 25% of total CO_2 emissions, whereas they represent 10% of total emissions in LMICs and only 5% in LICs.

The inequality is also reflected in access to public transport. UN Habitat estimates that about 52% of the world's population have access to public transport but this comes with wide regional variations; in Sub-Saharan Africa the figure is 31% compared to 90% in North America and Europe - indicating relative mobility poverty that is limiting opportunities for jobs, business and other social needs for mobility [12].

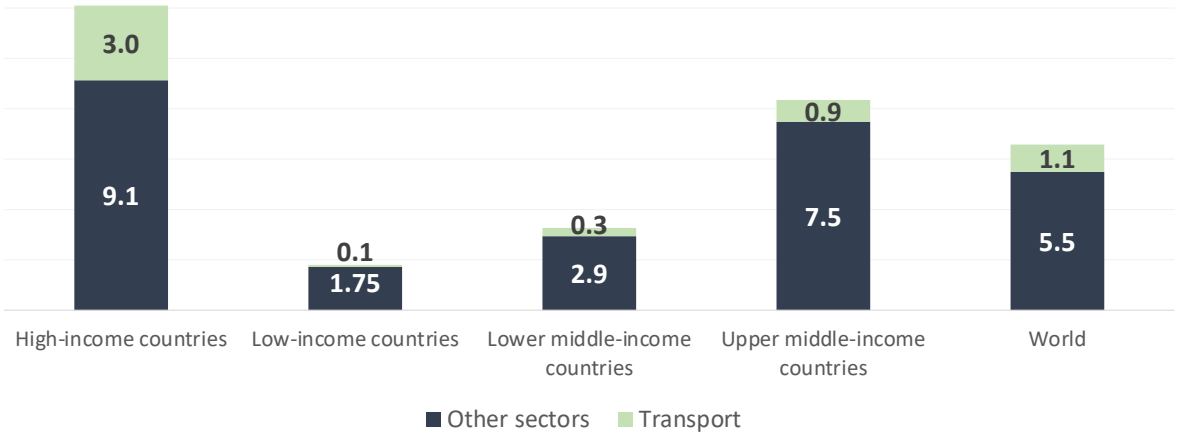


Figure 2. CO_2 emissions per capita per lending group for transport and other sectors [12]

LICs and LMICs as critical part of climate solution

Studies have found that a 1% increase in economic development has been linked to a 0.4% growth in CO_2 emissions, due to a focus on modes that are intensive in both resource consumption and land use [13]. Investments in low-carbon transport infrastructure can reduce that proportion and contribute to a more sustainable development in the long run. This is particularly important as transport demand in LICs and LMICs is expected to grow significantly. For example, it is estimated that by 2050 passenger and freight demand will triple in Sub-Saharan Africa and that in South and Southwest Asia passenger demand will almost double and freight demand will grow by a factor of 4.9 [14].

LICs and LMICs are less capable of dedicating sufficient public funded investment to climate mitigation and adaptation, and therefore face the greatest challenges in terms of both development and climate. These countries require accelerated economic development to meet the UN's Sustainable Development Goals.

Decoupling growth from carbon emissions in LICs and LMICs is therefore a matter of global significance. If the transport sector in these countries emitted the same amount of CO_2 per capita as high-income ones, global transport emissions would more than double. This would mean an additional 8.5 billion tonnes of CO_2 being emitted annually, increasing overall global emissions by 16% [11].

If this amount was monetised under most recent estimates of Social Costs of Carbon (at USD185/ tonne CO_2) [15], avoiding those emissions in LICs and LMICs carries the monetary equivalent value of over USD 1.5 trillion each year. It is therefore imperative to support economic growth in LICs and LMICs that is sustainable, and that does not entail growth of transport emissions. Substantial investment in rail infrastructure can fulfil this goal through its simultaneous contribution to economic development and reduction in carbon emissions per unit of traffic.

However, rail investment in LICs and LMICs lags HICs and both LICs and LMICs are currently constrained in their ability to either directly invest, or to secure the external investment required to achieve this goal. **These countries therefore face an important challenge: on the one hand, they hold a substantial sustainable capital in avoided carbon emissions with appropriate decoupling investments. On the other hand, they are unable to fund the investment in rail required to capitalise on this opportunity.**

The transformational power of rail infrastructure in LICs and LMICs

The Dakar Regional Express Train (TER) opened at the end of 2021, linking Senegal's capital to Diamniadio. The 36km long commuter link has 13 stations and now carries an average of 50,000 passengers per day, operating with 15 Alstom Coradia trainsets at maximum speeds of up to 150km/h, using cutting edge European Rail Traffic Management System for signalling. The line is double track, uses UIC standard gauge and is electrified. The second phase, currently under construction, will extend the line a further 19km to Blaise Diagne international airport. The project also envisages an increase in its daily capacity.

The Dakar TER project was financed by loans from Development Finance Institutions, namely the African Development Bank (AfDB), the Islamic Development Bank (IsDB), and the French Development Agency (AFD) as well as public funds from the Senegal government. It also benefited from a direct loan from French Treasury, and a national budget contribution. This is a perfect example of a successful combination of export and development finance tools.

The project is a cornerstone of the Plan Emergence Senegal. It allows Dakar to address growing urban congestion that causes estimated economic losses of USD200 million per year [16]. It has already carried 36 million passengers between January 2022 and October 2023 with a punctuality of 98%. Coupled with the creation of an Integrated Special Economic Area, it will spur sustainable economic growth, and create 75,000 jobs, not to mention the wider social equity impacts: more women recruited, affordable tickets, and ticket availability at all stations. Finally, it is estimated that the project will save around 340 thousand tonnes of CO_2 over a 40-year lifespan [17].

2 HOW CAN RAIL INFRASTRUCTURE SUPPORT A GREENER FUTURE WITH THRIVING ECONOMIC GROWTH?

The potential for railway infrastructure in LICs and LMICs

There is generally a strong requirement for the expansion of railway infrastructure networks in LICs and LMICs to levels that can allow appropriate modal shifts and support local and regional economic development. Denser rail networks broaden connectivity and offer greater utilisation potential to lower the overall costs of transport on tracks. Most LICs and LMICs have very little rail infrastructure available and what is existing may not meet safety standards for operations. Even including outlying countries with dense networks (Bangladesh, India, Moldova, and Ukraine), the average railway network density across LICs and LMICs is 4.95 km of rail infrastructure per 1,000 km2 of surface area[3]. By contrast, many high-income countries have networks that may be orders of magnitude denser, such as the USA (15.1), France (41.8), Japan (72.5), and Germany (93.6).

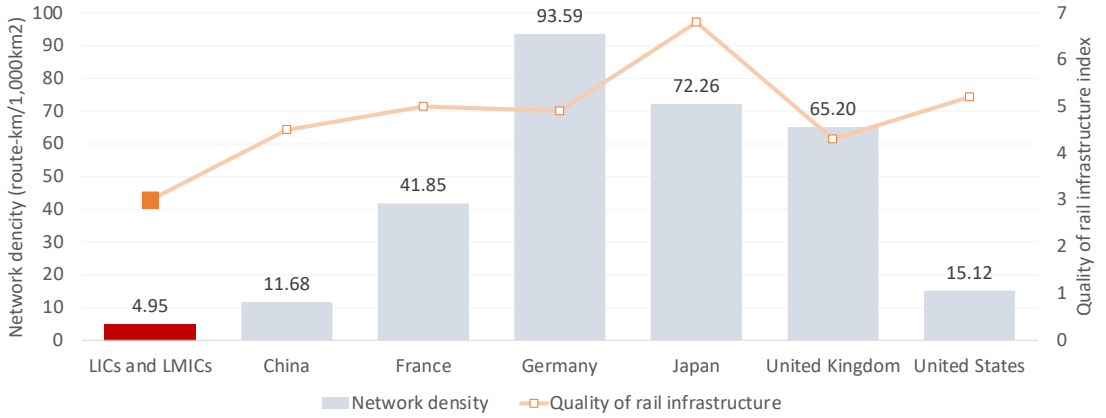


Figure 3. Average rail network density and infrastructure quality of LICs and LMICs compared to world-leading countries

In terms of quality of rail infrastructure, LICs and LMICs also lag behind the global average. Of all 82 LICs and LMICs, only 34 are included in the World Economic Forum Index for quality of rail infrastructure. Their average rail infrastructure quality is 3.0 out of 7.0, which is below the global average of 3.6 [18]. If these countries expanded and improved their railway networks, rail transport could play a greater part in the local and regional transport and contribute to decouple their economic development from emissions.

How much rail infrastructure could LICs and LMICs have?

To estimate the potential increase in rail infrastructure in LICs and LMICs, the relationships between the need in railway infrastructure and key economic, geographic, and political indicators in each country has been analysed[4]. Due to the different metrics, interurban and urban railways were calculated separately. Two scenarios were developed to estimate the potential growth in both urban and interurban railway networks (details can be found in the Methodology section). Scenarios take into consideration the different contexts of LICs and LMICs, avoiding comparisons to the maturity of infrastructure seen in high-income countries that may lead to unrealistic estimates. The analyses conducted here adopt the premise of levelling LICs and LMICs to the best cases among the group.

- A **base case** assuming that countries expand their railway infrastructure to the average levels of the 75th percentile among LICs and LMICs.
- A **best case** where the growth follows the average performance of the “best in class” (95th percentile)

Results show that there is a significant potential to expand railway infrastructure in LICs and LMICs that would support sustainable development. This potential for new railway lines amount to **between approximately 50,000km (base case scenario) and 180,000km (best case scenario) of new interurban lines** between now and 2050. Africa currently holds the greatest potential for growth, which in the best-case scenario could see 135,000km of railway lines added to its current network.

[3] Information collated from national statistics, the CIA Factbook, and the International Union of Railways (UIC) database.

[4] The analyses presented in the report are the result of a high-level estimation of the general need for rail infrastructure. Specific investments should be undertaken only when economic analysis demonstrates positive economic returns on the investments.

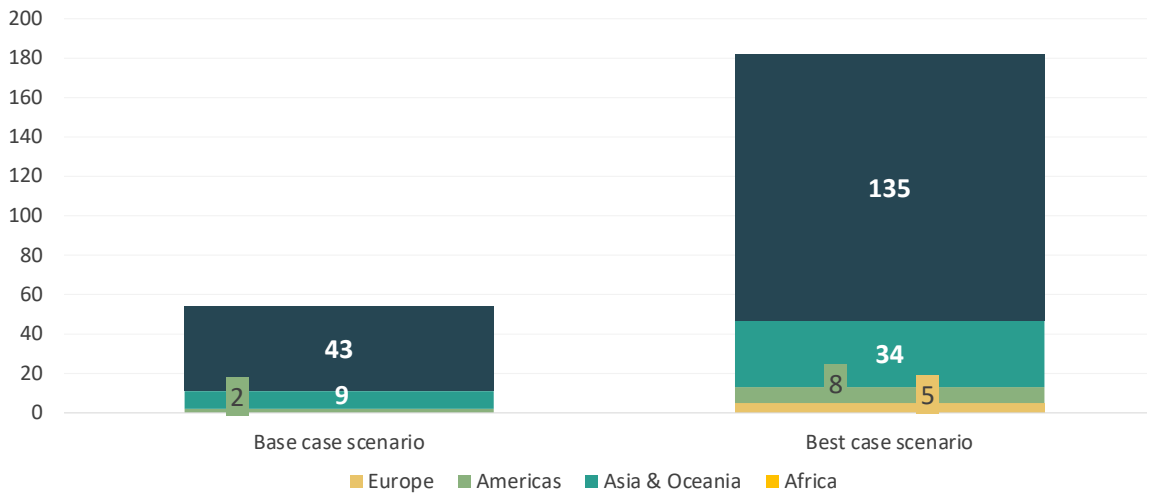


Figure 4. Potential growth in interurban railways in LICs and LMICs (in '000 km)

Cities in LICs and LMICs also demonstrate significant potential for railway infrastructure. The number and size of urban areas in developing countries continues to grow rapidly. Almost 50 cities that will have more than 5 million inhabitants by 2035 are located in LICs and LMICs [19]. This level of urban agglomeration creates ideal environments of economic density where improving railway infrastructure can provide substantial benefits.

The potential growth or urban railways between now and 2050 ranges between **4,000km (base-case scenario) and 12,000km (best-case scenario)**. The greatest development potential observed is in Asian and African cities, which aligns with observed global demographic trends.

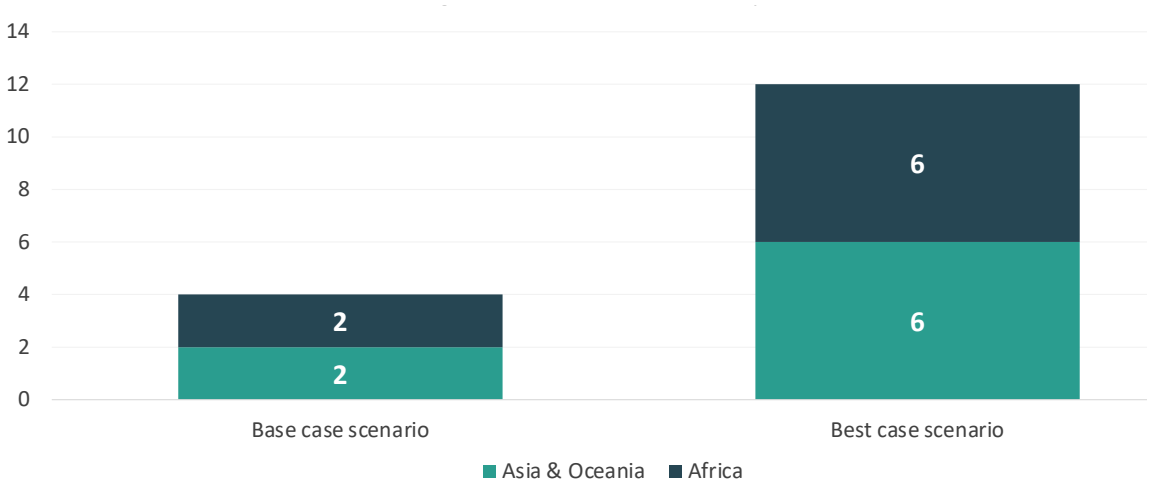


Figure 5. Potential growth in urban railways in LICs and LMICs (in '000 km)

The impact on global carbon emissions

A large increase in rail infrastructure in LICs and LMICs, as per these scenarios, would result in the avoidance of substantial carbon emissions. For both scenarios (base-case and best-case) an estimate of the potential carbon savings has been made, in comparison with a business-as-usual forecast. To calculate these potential savings, the potential growth in railway infrastructure was used to estimate respective increases in the modal share of passenger rail. Underlying assumptions can be found in the Methodology section.

The business-as-usual scenario assumed a constant rail modal share of 2% between now and 2050, whereas the base case scenario produced an estimated modal shift of 5% and the best-case scenario a modal shift of 8%. Using these values, carbon savings were calculated as the difference between scenarios using estimated CO_2 emissions per mode from global energy mix.

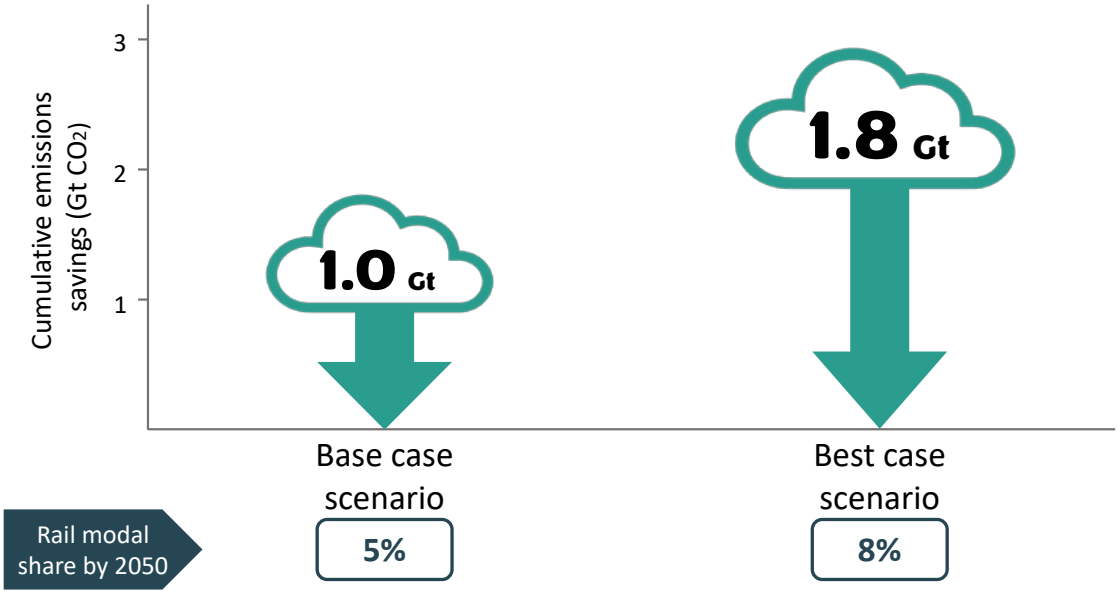


Figure 6. Potential cumulative savings for scenarios analysed

It stands therefore that, if a sustainable growth in rail infrastructure were achieved in LICs and LMICs with an adequate uptake in occupancy, the total cumulative savings from the expanded use of rail could reach between 1,000 and 1,800 million tonnes of CO_2 by 2050. These represent yearly savings of between 37 and 67 million tonnes of CO_2 emissions. These calculations did not take the emissions associated with construction of transport infrastructure. Whilst rail infrastructure is notably resource intensive, recent studies have found that road and railway infrastructure have a similar carbon footprint when considering the traffic volumes and overall lifecycle[5]. This also builds on the logical assumption that if rail infrastructure were not implemented, it would be necessary to build roads of similar capacity to fulfil the economic flows of the corridor.

[5] Based on the studies by Lokesh et al. [50, 51]. Their models estimate the whole life carbon of 1 km of rail track, with a service life of 60 years, is 2,024.3 tCO_2eq for ballasted track and 1,662.2 tCO_2eq for ballastless track. In comparison, the whole life carbon of 1 km of road, with a service life of 40 years, is 2,658.9 tCO_2eq for dual-3 lane and 2,014.1 tCO_2eq for dual-2 lane.

3 THE FINANCE GAP FOR RAIL PROJECTS IN LOW AND LOWER MIDDLE-INCOME COUNTRIES

Fulfilling the rail infrastructure potential of LICs and LMICs

With an intensifying climate emergency, there needs to be a substantial increase in investments in sustainable transport infrastructure that can lead to both mitigation and adaptation to climate change. Within the rail sector, estimated investments required to contribute to the achievement of global climate targets amount to hundreds of billions annually. The International Energy Agency (IEA) estimates that between USD 315 billion and USD 640 billion annually will be needed globally for rail to achieve climate mitigation targets [3].

The proportion of this investment that would be required by LICs and LMICs to transform their railway networks and see the socio-economic benefits that would accompany that growth is not large. To achieve the projected infrastructure growth of the two scenarios developed until 2050, total investments required would range from **USD740 billion (base case scenario) to USD 2,310 billion (best case scenario)**. This would mean a requirement of **annual investments of between USD 25 billion and USD80 billion**. In contrast, **annual explicit fossil fuel subsidies amount to over USD500 billion globally** [20].

These values derive from general assumptions of interurban railway infrastructure costs of USD 8.5 million/km, and USD 61.8 million/km for urban railway infrastructure, based on a study that analysed approximately 1,500 global rail projects [21].

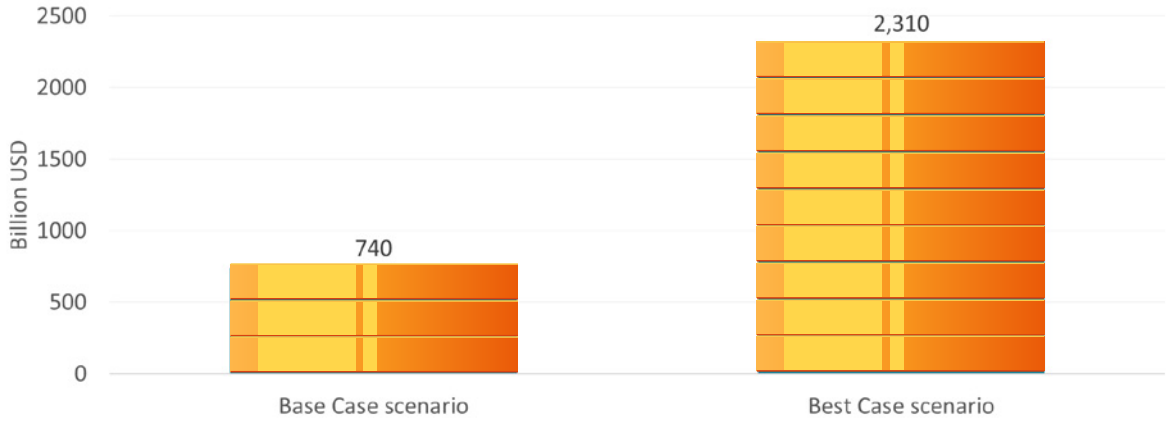


Figure 7. Total investment required to fulfil infrastructure potentials in billion USD

Current barriers for rail finance in LICs and LMICs

The necessary investments to fulfil the rail infrastructure potential in LICs and LMICs may be relatively small in a global context, yet they are still challenging relative to the financial situation of these countries, due to their financial capacity. A finance gap undoubtedly exists for rail projects in LICs and LMICs, but it is important to understand the underlying factors behind this reality from a holistic perspective.

These countries have limited tax revenues compared to higher-income economies, which limits self-funding potential for new railway lines or upgrades to existing infrastructure. They rely on securing external sources of funding or financing, however they generally already navigate high levels of public and private debt which restricts further borrowing. Concessional grants for projects such as rail infrastructure are generally limited to relatively small amounts of up to USD 5 million and are usually made in expectation that larger amounts will subsequently be financed. Concessional loans from International Finance Institutions (IFIs) are an attractive source of finance, as well as bilateral funding through institutions like Export Credit Agencies (ECAs). Sources of private finance for rail projects can be difficult to secure due to some of the inherent features of the projects; this is particularly the case in LICs and LMICs. Additionally, economic benefits that result from projects, like uplifts in the value of land located close to new rail lines, can be difficult to capture and direct to the projects.

The very nature of large rail projects can also add to difficulties in securing financing. The lifecycle of rail infrastructure is very long, at 100 years or more. Although shorter, the lifecycle of rolling stock is also relatively long at 30 – 35 years. Rail projects deliver socioeconomic benefits on these long timescales, but they exceed the length of normal financing models. IFIs generally offer loan tenors of around 30 years, while private loans generally have tenors up to 10 years. Particularly for passenger rail projects, fares must generally be set at affordable levels, not sufficient to cover costs of operation and maintenance.For this reason, rail projects generally have required primarily government investment, as private sector entities will not make standalone investments in projects that only partially recovers costs. Freight rail projects are an exception, with specific cases that can guarantee commercial returns to project developers (e.g. mining industry).

Current standard approaches to assess the benefits of rail projects also create barriers for rail investment. Standard depreciation rates used in cost-benefit analysis lead to limited or no financial benefits for projects extending longer than 30 years. Cost-benefit analysis is particularly difficult for greenfield projects, where there is limited existing evidence available to be used in the analysis.

Furthermore, economic benefits created by rail projects are not only rarely incorporated at full scale in financial models, but also do not conform with expected return on investment to the funding partner(s). Avoided carbon emissions can be estimated, but past prices set for avoided carbon are generally low, well below estimates of the social cost of carbon. Other benefits of projects such as the creation of formal jobs, densification of urban areas due to development patterns that can be influenced by rail, or spurring broader economic opportunities and development are difficult to quantify and monetise. Rail projects also reduce externalities that impose significant societal costs such as air pollution, congestion, traffic accidents, noise emissions and overall health. These benefits although widely recognized as public goods are not incorporated in financial models. The same goes for the direct or indirect positive effects of rail projects on accessibility and equality. For all these reasons, current financial models fail to capture the positive economic returns of rail projects, focusing solely on a financial return on investment, which hinders further investments on rail and strongly contribute to the “finance gap” for rail in LICs and LMICs.

Rail projects in LICs and LMICs also face greater risks in terms of project implementation compared to HICs, which can also be reflected in their borrowing capacity and cost. Many LICs and LMICs lack the institutional and technical capacity that are crucial to conduct appropriate feasibility studies and environment and social impact assessments and to successfully implement projects. In many of these countries, the rail sector may consist of only one government organisation.

Current financing mechanisms for rail

An alternative and competitive financing mechanism available to finance rail projects in LICs and LMICs are through the involvement of Export Credit Agencies (ECAs). In that respect the mandate of ECAs from OECD countries is to support private businesses to export to low-income and lower middle-income countries, according to standardised rules governing the cost of the financings administered by the OECD. This is an important mechanism with regards to financing rail projects that incorporate rolling stock and/or signalling equipment that is generally manufactured in OECD countries. This arrangement has mobilised more than 650 billion Euros in financial support for exports between 2011 and 2021 [22]. Of the total support since 2005, approximately 20% has been for rail exports to LICs and LMICs. However, a vast majority of that amount (62%) was used for a single destination country – India. The reform package released by the OECD (Climate Change Sector Understanding (CCSU) or commonly known as “the Arrangement” or “the Consensus”) which came into effect mid July 2023 can be seen as a positive milestone to help increase the impact of trade and finance flows on securing climate objectives. Specifically, the OECD participants agreed in principle on the expansion of the scope of green or climate friendly projects (by the inclusion of rail which before was ruled by a specific sector understanding). From the OECD’s standpoint, “The aim of the agreement in principle is to make arrangement financing flexible enough to better face challenges posed by the economic and financial needs of projects as well as the increasingly competitive landscape and to create further incentives for supporting a wider range of climate friendly and green transactions.” In a nutshell the main benefit of the CSSU are threefold (i) increasing the maximum repayment terms up to 22 years for CCSU-eligible projects and 15 years for most other projects (ii)

introducing further repayment flexibilities, and; adjusting the minimum premium rates for credit risk for longer repayment terms and obligors with a higher credit risk rating.

This being acknowledged, building on this positive momentum (with the modernization of the OECD consensus, important milestones have been reached to reduce its complexity and to regain the attractiveness of the Arrangement), the Consensus should be adapted for a more flexible set of rules. Indeed, besides the relevance of global value chains and the widely acknowledged increased competition outside the OECD Arrangement, that also propose better financing conditions, there is a continuous need to ensure the OECD Consensus remains attractive for the reestablishment of a real global level playing field. Additionally, there is a need to align the rules for development and export finance on debt products more coherently. .

Another source of financing for rail in LICs and LMICs are development agencies from high-income countries. These may provide concessional loans targeted to promote sustainable development and economic growth. China offers an alternative to OECD countries for the financing of rail projects in some LICs and LMICs, including as part of its “Belt and Road Initiative” This has seen Chinese financial institutions (mainly the China Exim Bank and the China Development Bank) fund projects to develop railway infrastructure with loans that may be concessional. Implemented projects to date include Standard Gauge Railway Lines in Ethiopia (USD2.5 billion loan), Nigeria (USD500 million concessionary loan), Kenya (USD4.7 billion loans), and Laos (USD3.6 billion). However, many Belt and Road projects, including rail, have been criticised for unsustainably increasing the debt levels of LICs and LMICs [23]. Some projects have also not met original forecasts for traffic and usage levels.

A particular form of private financing that has been promoted as suitable for rail projects are Public Private Partnerships (PPPs). PPPs are generally designed such that a consortium of private companies designs, finances and builds a rail system, before operating and maintaining it for a concession period that may be 25 years. Some project risks are held by the consortium, such as for those related to construction, financing and operation, the idea being that private companies may be able to better reduce these risks through their design and structuring of the project, and therefore reducing overall project costs. Governments generally provide upfront funding and ongoing subsidies or funding to the private companies and may retain risks related to commercial revenues. PPPs have been successfully used to fund rail projects in many high-income countries, but less so in LICs and LMICs. The structuring of the projects, and their ongoing regulation and oversight require complex commercial and regulatory frameworks and knowledge, that may challenge the institutional capacity of LICs and LMICs [24].

Concessional financing from IFIs have been crucial for LICs and LMICs to date, as a development mechanism despite their relatively low tax bases. [24]. IFIs have limited access to funds that can be administered as grants, instead they are able to borrow at competitive rates due to their generally investment grade credit ratings. These organisations have consistently provided important loans to foster all sectors in developing countries, including transport.

In absolute values, IFIs have helped finance tens of thousands of projects for the transport sector in LICs and LMICs across all continents. However, there has been a visible predominance of finance for road projects over time, leaving rail infrastructure somewhat overlooked despite its clear green credentials. Using data set from a sample of three multilateral development banks[6] (Asian Development Bank - ADB, African Development Bank - AfDB, and Interamerican Development Bank - IADB), the gap between road and rail finance is visibly large. **Road transport has received cumulatively almost six times more investments than rail transport in the total periods reported[7].** Moreover, LICs have been particularly overlooked in terms of finance for transport projects, even more so in rail, receiving only USD 320 million in the periods concerned.

[6] These three multilateral development banks were selected because their publicly available data offered the same granularity and resolution.

[7] ADB (1968-2023); AfDB (1967-2022); IDB (1961-2023) – values adjusted for inflation.

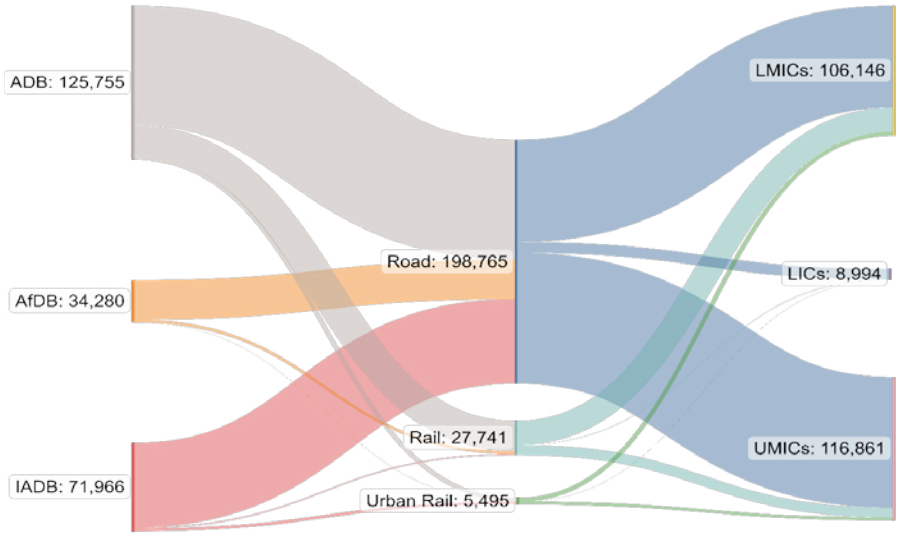


Figure 8. Analysis of historical investments per mode by three multilateral development banks (in USD millions adjusted for inflation)

IFIs are undergoing changes concerning the scale and the prioritisation of investments, that will see more of the finance they deploy directed towards projects with positive climate benefits. Many IFIs are progressively moving towards only financing projects that have outcomes that are Paris Agreement-aligned, which will see funding allocations for transport projects flow away from road and airports towards rail and ports [25]. This must be accompanied by an increase in internal technical capacity and an increase in the number of projects designed in LICs – which so far have been lagging.

What about Climate Finance[8]?

What is climate finance?

Climate finance is financing provided by public or private entities for activities that, in whole or in part, mitigate carbon emissions or support adaptation and resilience to climate change. Climate finance is defined by its *purpose*, not its source or its instrument. Because railways are a green mode, most financing of railway investments would be considered climate finance, even if the investment is undertaken for development or other productive purposes rather than primarily for climate benefits.

Worldwide climate finance flows across all sectors were estimated to average $653 billion over 2019 and 2020.[9] About 90 percent of climate finance has been invested in mitigation measures and only two-fifths flowed to non–Organization for Economic Cooperation and Development (OECD) countries. About 25 percent (USD 169 billion) was invested in the transport sector, with railways and public transport representing 2 – 3 percent of the total. The transport financing (data are not available for railways separately) comes from a variety of sources including:

- **Public Sector:** This includes financing provided by public funds, State Owned Enterprises (SOEs), governments and public development financial institutions at both national and international levels.
- **Private Sector:** This includes financing from corporations, commercial banks, institutional investors, and households.
- **Multilateral Climate Funds:** Several international mechanisms and funds facilitate climate finance. Two include the Green Climate Fund (GCF), and the Global Environment Facility (GEF), both established under the United Nations Framework Convention on Climate Change.
- **Multilateral Development Banks:** Organizations like the World Bank and regional development banks provide financing on concessional terms to support climate-related projects in developing countries.
- **Bilateral Development Agencies:** Some countries provide financing directly to other countries through bilateral agreements, budgetary aid or project funding allocated to specific projects that align with their climate goals.

[8] This section draws from a study conducted by Jyoti Bisbey, Martha Lawrence, and Matthias Plavec for the World Bank on "Mobilizing Climate Finance for Railways"

[9] Preliminary estimates from Climate Policy Initiative (CPI) stand at $608 billion–622 billion in 2019.

Climate funds

Several multilateral climate funds have been established to promote investment in climate change mitigation and adaptation measures, but transport has been only a small beneficiary of climate funds, receiving USD 141 million in 2020. The GCF and the GEF have emerged in recent years as the most active funds in the transport sector. Both originated with the United Nations Framework Convention on Climate Change (UNFCCC), have the World Bank acting as the trustee, and receive most of their funding from developed country donors.

As of July 2023, GCF had a total of 15 active transport projects in its portfolio, with a combined value of USD 952 million. GCF's financing in transport is focused on climate change mitigation. Examples of rail projects financed by GCF indicate a focus on urban systems, but none of the rail projects implemented to date have been in LICs or LMICs.

It shows that, to date, climate funds are not scaled to address the substantial financing needs in the railway sector, and therefore may be considered as a potential co-financier for such projects. This can be attributed to the fact that the scale of financing available from climate funds is quite limited compared to the size of many railway projects. In addition, the process for rail projects to determine if they can qualify and the subsequent process to access the financing is uncertain and takes usually considerable effort and time. In the limited availability of climate finance to the transport sector, urban rail would appear to be the rail investment most likely to qualify for financing.

Green Bonds

To access green bond financing, the investment financed must be 'green' and the bond issuer must be creditworthy. The green bonds issued in 2022 reached a size of USD 487 billion, with the use of green bonds in the transport sector trending up to around 20% of that. Accessing commercial capital markets, including Green Bonds, requires the rail project to be creditworthy, which is a challenge to LICs and LMICs where the financial viability of projects is limited. For instance, most of the World Bank green bonds for rail projects went to upper middle-income countries (UMICs) such as Brazil, China, and Colombia, while only a small fraction went to LMICs such as India and the Philippines, mostly due to UMICs having more creditworthy railways. A fruitful exception is Morocco's national railway operator ONCF which is issuing green bonds to finance or refinance eligible projects linked to electrified and low-carbon rail infrastructure for passenger and freight transport.

Railways that provide loss making public services, such as urban passenger services, can access commercial financing, provided they have support from governments to make them creditworthy. Given the reality of borrowing limitations of LICs and LMICs, development finance institutions can support the reforms needed to improve the creditworthiness of railways and provide credit enhancement instruments to support such commercial financing.

Carbon Finance Markets

Many voluntary markets adhere to recognized standards and methodologies for measuring, reporting, and verifying emissions reductions. The price of carbon credits in voluntary markets can vary widely depending on supply and demand, project type, and the market's specific characteristics. It is often influenced by market dynamics and the perceived value of the projects being funded. The voluntary carbon market had a total annual value in the order of USD 2 billion and transport related credits accounted for less than 1% of the total credits issued between 2015 and 2021.

While direct decarbonization measures such as transitioning from fossil fuel-powered engines to electrified or alternative fuels are easier to quantify, many railways are already run on electricity making the carbon market from fuel shift smaller than for other modes of transport. But rail projects that produce GHG reduction through modal shift, diverting traffic from carbon-intensive transport modes like trucks, could tap into a bigger carbon finance market.

To promote rail carbon finance, whether it is a compliance or voluntary market, carbon market regulations specifically for land transport are necessary. These would limit emissions from land transport and qualify GHG reductions from modal shift, including active transport (cycling and walking), public transport and ridesharing instead of single occupied private cars, as well as substituting rail for air travel and for freight.

What Role for Climate-Specific Instruments?

Railways, as a green mode of transport, have potential to access climate specific financing, if constraints are addressed.

- **Climate funds could help leverage commercial financing.** Because their resources are small compared to the size of typical railway investments, climate funds, by themselves, are not scaled to address the substantial financing needs in the railway sector. Rather they could be used together with commercial finance in blended finance package to reduce cost or reduce risk, such as the case for a light rail projectin Costa Rica.
- **Sustainable commercial finance has significant potential.** The pool of investors is large and growing. Green bonds and loans could finance a wide range of adaptation as well as mitigation investments, while sustainably-linked finance could finance an even broader range of investment. To access this financing, governments and railways need to work together to make their railways creditworthy. The World Bank and other Development Finance Institutions can support the reforms needed to improve the creditworthiness of railways and support the transition to commercial financing through credit enhancement instruments.
- **Carbon finance markets have potential, with changes in regulations.** Regulations and standards would be needed to quantify the emissions of land transport operators and quantify emissions reductions, including from modal shift to rail. The monitoring, reporting, verification (MRV) standards would need to be agreed with international agencies. Facilitation would be needed as the process is expensive; and projects owners face both lack of resources and capacity to undertake the process.

Stronger engagement from governments and MDBs—the traditional sources of financing for railways—is also needed. Climate funds often rely on MDBs and governments to originate and lead on financing railways in lower- and middle-income countries. Carbon finance market regulations need to be developed to cover land transportation and include railways. This would support financial regulators and railways with their green finance frameworks and methodologies; and provide financial assistance with market MRV services. Finally, support for governments and railways to address the creditworthiness of SOE railways could unlock sustainable commercial financing for railways.

The Partnership for Global Infrastructure and Investment [26]

The Partnership for Global Infrastructure and Investment (PGII) is a collaboration between the G7, IFIs and the private sector to advance public and private investments in sustainable, inclusive, resilient and quality infrastructure. Through this partnership, the G7 aims to mobilize up to USD 600 billion by 2027 in order to narrow the infrastructure investment gap in partner countries.

In Sub-Saharan Africa, the United States is supporting the development of the Lobito Corridor, with an initial investment in a rail expansion that may become the primary open access transportation infrastructure connecting the Democratic Republic of the Congo (DRC) and Zambia with global markets through Angola. Initial investments under consideration include USD 250 million in potential financing from the U.S. International Development Finance Corporation for the rail line and an initial USD 900 million in financing from the U.S. Export Import Bank for two solar projects that will generate over 500 megawatts of renewable power in Angola.

Recently, the Japan International Cooperation Agency (JICA) financed or co-financed a number of railway projects in Asia. Examples include the North-South Commuter Railway in Metro Manila, the Philippines (USD 2.8 billion) and the mass rapid transit (MRT) Line 5 in Dhaka (USD 974 million) in collaboration with ADB; a high-speed railway between Mumbai and Ahmedabad (USD 2.2 billion), and a metro railway in Patna (USD 720 million).

Looking forward – from Clean Development Mechanism (CDM) to Article 6

Initiated under the Kyoto Protocol, the Clean Development Mechanism (CDM) was the first carbon finance scheme. Managed by the UNFCCC, projects that could demonstrate savings in carbonemissions would be allowed to issue credits for their Carbon Emissions Reduction (CER). The CDM scheme was broadly utilised by various sectors but not much by transport, even less so by rail. Of the more than 12,000 successfully validated projects, only 32 were dedicated to transport, and only 9 of those were in the rail sector. Even at the highest historical rates, CERs issued for rail transport were nowhere near sufficient to cover capital costs of projects – and were mostly used to support operations of existing systems.

During COP26 in Glasgow, Article 6 of the Paris Agreement was approved, and established a new platform for the international carbon market that can substantially improve the finance potential for LICs and LMICs. Under Article 6, emission reductions that have been authorised for transfer by the selling country's government may be sold to another country, but only one country may count the emission reduction toward its Nationally Determined Contributions (NDCs), and the trading in these carbon credits could help reduce the cost of implementing countries' NDCs by as much as $250 billion in 2030 [27].

There have been propositions to expand the understanding of mitigation to include carbon avoidance. Should that be the case, then LICs and LMICs would potentially find in Article 6 a mechanism to finance rail projects under the premise of decoupling economic growth from carbon emissions. This would adopt calculations of the CO_2 that they would prevent from the equivalent investment in road modes to generate similar or greater traffic volumes.

Sharm el-Sheikh Implementation Plan and the Loss and Damage Fund

COP27 in Sharm El Sheikh saw the breakthrough to provide "loss and damage" funding for vulnerable countries hit hard by climate disasters. The cover decision, known as the Sharm el-Sheikh Implementation Plan, highlights that a global transformation to a low-carbon economy is expected to require investments of at least USD 4-6 trillion a year. Delivering such funding will require a swift and comprehensive transformation of the financial system and its structures and processes, engaging governments, central banks, commercial banks, institutional investors and other financial actors. Once up and running, the fund will provide particularly vulnerable countries with funding to support recovery from the impacts of climate-related disasters such as floods and droughts. Although negotiations are still ongoing developing nations call for wealthy countries that have contributed the most to climate change to provide most of the funding, and in grant form. Pakistan, which saw heavy infrastructure loss due to the floods in late 2022, had damages to 3,127 kilometres of railway track [28] (around 40 percent of in-service railway). In support of the reconstruction plan for the country, UN Secretary General calls for "the Loss and Damage Fund must be operationalized, so that it can provide grant-based finance without increasing debt".

4 BRIDGING THE GAPS FOR RAIL PROJECTS IN LOW- AND LOWER-MIDDLE INCOME COUNTRIES

Investing in rail infrastructure to decarbonise future transport volumes in LICs and LMICs will create global public goods, specifically benefits at the global scale in avoiding carbon emissions that can help limit climate change and associated adverse impacts, as well as bringing broad socioeconomic benefits to these countries.

LICs and LMICs hold a relatively high power in carbon avoidance due to their low historical and current emissions, but limited power in realising the investment in rail infrastructure that can avoid potential future emissions from growth of unsustainable transport provision. The analysis undertaken as part of this study shows that between 1.0 – 1.8 Gt of future carbon emissions from LICs and LMICs can be avoided by 2050 if there is a large increase in their rail provision. It is therefore of global significance for climate action that means to fund and finance investment in rail infrastructure in LICs and LMICs is secured. This will require action and coordination by governments in both rich countries and LICs and LMICs, IFIs and the international finance sector and the rail industry. To that end, this study makes the following recommendations:

1. High Income countries should provide grants to fund rail projects in LICs and LMICs

a. In order to facilitate a substantial increase in rail infrastructure in LICs and LMICs richer countries should provide grants that either fully or partially fund projects. Making such grants available, when allied with concessional financing, should greatly improve the financial viability of projects.

b. Grants should come from the annual USD 100 billion climate finance that developed countries committed to providing developing countries at COP15 in Copenhagen.

c. Grants could also come from the “loss and damage” fund agreed at COP27 in Sharm el-Sheik, if rail infrastructure is damaged due to climate change impacts.

2. Governments should allow rail projects in LICs and LMICs to be funded under Article 6 of the Paris Agreement and support the development of carbon finance market regulations for rail

a. The emissions that can be avoided by rail projects in LICs and LMICs should be considered by governments as climate mitigation under Article 6 of the Paris Agreement. This would allow the carbon savings of these projects to be sold to become savings under the NDCs of richer countries, providing an important new source of climate financing and lowering the overall cost of emission reduction.

b. Governments should also work to define carbon finance market regulations specifically for land transport. These would qualify emission reductions from modal shift to rail (and active transport – walking and cycling) from more polluting modes like road and air travel. This would support projects by allowing a financial value to be established on compliance or voluntary markets, increasing their financial viability.

3. IFIs should adapt their methods of cost-benefit analysis of rail projects and greatly increase the funding they direct to rail

a. As current methods of cost-benefit analysis used by IFIs do not recognise the up to 100 year benefits from rail projects these institutions should develop an approach that allows lower discount rates to be used for rail projects, therefore increasing the number of projects they fund.

b. IFIs should also seek to increase the value they ascribe to the broader socioeconomic benefits that rail projects in LICs and LMICs can bring in their appraisals of projects.

c. As IFIs move towards larger lending pools to increase climate action they should allocate more of their funding of transport projects to rail projects in LICs and LMICs, projects that by their nature are Paris Agreement-aligned.

d. Additionally, IFIs should continue working with governments in LICs and LMICs through their advisory divisions, to help them structure bankable and sustainable railway/mobility projects.

4. **LICs and LMICs should lead implementation of policies to spur private investment in rail, and modal shift**
   a. Governments in LICs and LMICs should make their rail projects more attractive to private investors by providing more security over moveable rolling stock assets to creditors.
   b. They should also work together to adopt aligned rail technical standards across countries, which will increase investor confidence and allow multi-country rail corridors to be developed.
   c. Governments should accompany rail projects with policies that encourage modal shift in order to ensure full utilisation of infrastructure and success of outcomes. These can be through both push and pull measures.
   d. To further encourage modal shift LICs and LMICs should accompany rail projects with investment to facilitate seamless last and first mile connections for both passengers and freight.

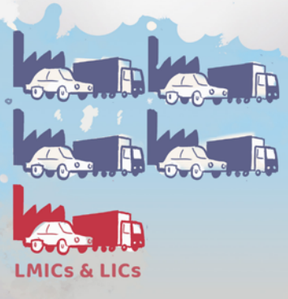
5. **The international financial sector should work to make financing rail projects more attractive to the public and private sectors and to build capacity in LICs and LMICs**
   a. Building on the significant progress of the CCSU (the OECD consensus) it should be adapted for a more flexible set of rules and to ensure it remains attractive for the reestablishment of a real global level playing field. Additionally, there is a need to align the rules for development and export finance on debt products more coherently.
   b. he international financial sector should collaborate with LICs and LMICs to make private financing of rail projects more attractive by building capacity such that some projects can be delivered under the PPP model.
   c. The international finance sector should also support LICs and LMICs to build the institutional and technical capacity to deliver rail projects. This would come through support to strengthen fiscal and regulatory frameworks.

6. **LICs and LMICs collaborate with the rail industry to structure rail projects to maximise broader economic benefits**
   a. Private companies can bring significant operational and technical expertise to rail projects in LICs and LMICs where there may be a lack of local capacity; they can also help develop the industrial capacity of countries through facilitating participation in supply chains during construction and operations phases. LICs and LMICs should work with the rail industry to structure projects in this way, which will broaden economic benefits, increase countries' economic complexity and create high value formal jobs.

7. **The railway industry should continue to leverage digitalisation and advances in rail technologies to improve the attractiveness of rail**
   a. The railway industry has made strong advances in digitalization, delivering benefits that can lower the upfront investment cost of projects as well as operation and maintenance costs. The industry should continue to invest in such technology, as well as in alternative green traction modes that can also reduce infrastructure costs.

Bridging the finance gaps
for rail in LICs and LMICs

Emissions per capita in LMICs and LICs are almost 4 times fewer than those in High Income Countries.



But economic development can cause transport emissions to grow

So rail must grow as a mode of transport

An 8% rail modal share can avoid 1.8 Gt CO2eq emissions by 2050 while delivering socioeconomic benefits

BARRIERS

RECOMMENDATIONS

INTERNATIONAL COMMUNITY

High Income countries should provide grants to fund rail projects in LICs and LMICs

INTERNATIONAL FINANCE SECTOR

The international financial sector should work to make financing rail projects more attractive to the public and private sectors and to build capacity in LICs and LMICs

IFIs should adapt their methods of cost-benefit analysis of rail projects and greatly increase the funding they direct to rail

GOVERNMENT

Governments should allow rail projects in LICs and LMICs to be funded under Article 6 of the Paris Agreement and support the development of carbon finance market regulations for rail

LICs and LMICs

LICs and LMICs should implement policies to spur private investment in rail, and modal shift

LICs and LMICs should work with the rail industry to structure rail projects to maximise broader economic benefits

RAILWAY INDUSTRY

The railway industry should continue to leverage digitalisation and advances in rail technologies to improve the attractiveness of rail

5 METHODOLOGY

Estimates for railway infrastructure potential

Target railway infrastructure density were based on **benchmarks with best-in-class cities or countries** within Low Income Countries (LICs) and Lower-Middle Income Countries (LMICs) sample.

Country in scope – Low Income Countries (LICs): Afghanistan, Burkina Faso, Burundi, Central African Republic, Chad, Democratic Republic of Congo, Eritrea, Ethiopia, the Gambia, Guinea-Bissau, Lesotho, Liberia, Madagascar, Malawi, Mali, Mozambique, Myanmar, Niger, Rwanda, Sierra Leone, Somalia, South Sudan, Sudan, Tajikistan, Togo, Uganda.

Lower Middle Income Countries (LMICs): Angola, Bangladesh, Benin, Bhutan, Bolivia, Cambodia, Cameroon, Cape Verde, Comoros, Republic of Congo, Djibouti, Timor Leste, Egypt, Eswatini, Ghana, Guinea,Haiti, Honduras, India, Iraq, Cote D'Ivoire, Jordan, Kenya, Kiribati, Kyrgyzstan, Lao PDR, Mauritania, Moldova, Morocco, Nepal, Nicaragua, Nigeria, Pakistan, Papua New Guinea, Philippines, Samoa, Sao Tome & Principe, Senegal, Solomon Island, Sri Lanka, Tanzania, Tunisia, Uzbekistan, Vanuatu, Vietnam, Yemen, Zambia, Zimbabwe.

a. Inter-urban railway infrastructure potential

The inter-urban additional railway infrastructure potential was calculated thanks to a score based on **interurban railway density compared to a rail development index**. This index is based on 4 criteria: economics (i.e., includes exportation, importation, GDP per km2, and mining export), geographics (i.e., includes land area, altitude index, population density), governance and institution efficiency (i.e., includes risk of conflict, government effectivness), and infrastructure level (i.e., road density).

Targets have been set to 75th percentile for the base case scenario and to 95th percentile for the best case scenario.

b. Urban railway infrastructure potential

The urban additional railway infrastructure potential was calculated thanks to a score based on **urban railway density compared to population density**. The targets have been set for two clusters: high populated urban areas, and low populated urban areas (with a threshold of 5 million people).

Similarly to the analysis on inter urban railway potential, targets have been set to 75th percentile for the base case scenario and to 95th percentile for the best case scenario.

Evaluation of necessary investments

The assumptions taken to estimate the cost of railway building were **USD 8.5m** per rail km for **interurban railway**, and **USD 61.8m** per rail km for urban railway.

Costs of new rail infrastructure have been based on a c. 1500 projects UIC analysis in LICs and LMICs. Generally, costs indicated in the database include all infrastructure-related expenses, including track-building, signaling, stations, bridges & tunnels etc. Some projects seem to factor in rolling stock, although these projects are probably the exception.

Evolution of modal share of rail

As an input, the increase of railway network has been used (based on the previous analysis made to estimate railway infrastructure potential).

The assumptions taken is to double **network utilization rate** (i.e., number of seats offered for a given network) by 2050, **occupancy rate** is to improve by 50% (i.e., number of seats filled) by 2050, traffic forecast is based on demography (assumptions taken country by country) with an **average journey** considered constant.

Estimates for CO_2 savings

Assumptions were made on CO_2 **emission per mode** (using global energetic mix). Savings of both scenarios are calculated as the difference between a "business as usual" scenario with a constant rail modal share.

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