



HIGH-SPEED RAIL

The Right Speed For Our Planet

KEY MESSAGES

11TH UIC HIGH-SPEED CONGRESS

PALAIS DES CONGRES - MARRAKECH - MOROCCO

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Editorial from the UIC Chairman



High-speed trains are developing at a rapid pace. The pandemic did not stop the expansion of the high-speed rail network, as the length of operational lines increased by more than 40% between 2020 and 2022, going from 44,000 km to around 59,000 km. Additionally, the number of countries using high-speed trains is on the rise with the development of further projects, which is demonstrated by construction work across the world, in Europe, Asia, Africa, North and South America, and in the Middle East.

The challenges we face today are global, requiring new sustainable transport systems and a decarbonisation of the economy at a local, national, and international level. New economic situations and political challenges call for new transport operations and solutions to meet mass transport needs, while also combating climate change. It is possible to face this in both a positive and effective way.

More notice needs to be taken of the railways, and the 11th UIC High-Speed Congress was one of the ways that UIC was able to realise its purpose: to foster cooperation among the world's railways. The mobility of 2030 is taking shape today and we can find the best solutions for this, by working together and in solidarity. This requires a coordinated effort by all stakeholders in the transport chain, with the global railway community, united within UIC and driven by the values of unity, solidarity, and universality, working towards the same common goals.

Therefore, the new UIC work programme for the 2023-2025 period, which has just been published, forms a guideline for all of the action to be taken, so that rail can truly play a central role in decarbonising the transport sector on a global and regional scale.

Krzysztof Mamiński,
UIC Chairman

Editorial from the ONCF Director-General



The 11th edition of the UIC World Congress on High-Speed Rail took place on 7-10 March 2023 in Marrakech, the first time that it was held on the African continent, with a great wealth of information being shared and discussed. The theme of the congress was: *“High-speed rail: the right speed for our planet”*, and as part of this, we examined our relationship with speed, in light of this century’s primary challenge: to meet the necessary climate goals. We are all aware of the IPCC’s latest report¹ and that the experts are warning us that we have little time left to keep global warming below 1.5°C. We are being invited to participate in a real paradigm shift, and to implement this, we need to muster all the energy we can. The UIC World Congress on High-Speed Rail, which brought together operators, manufacturers, and political decision-makers, helped us to answer the question of high-speed rail’s place in this new world.

High-speed must be central in a new paradigm for a sustainable transport system, where rail forms the network’s backbone. In the next decade the world must drastically reduce emissions and as rail is by far the lowest greenhouse gas emissions of any mode of transport. Rail must grow by more than 40% by 2030 in close connection with all other forms of public and freight transport and active mobility, such as walking and cycling, which is too often hampered by unsuitable urban spaces.

High-speed rail is key to saving emissions through modal shift, as it can compete with aviation, one of the most polluting forms of transport. The International Energy Agency (IEA) state that by 2050, about 15% of flights should be moved to high-speed rail in order to meet the Paris Agreement objectives.

This important modal shift will need to be supported by significant investment in faster and more connects train networks. The discussions from the UIC World Congress on High-Speed Rail showed that defining this “right speed” on a local and regional scale will be one of the challenges for our sector but it is clear that the time to act is now!

Within the definition of the “right speed”, I want to mention a concept that UIC has been promoting since 2019, that the transport sector has to increasingly become a paragon of frugality, whether in terms of CO₂ emissions, energy consumption, speed, or even material life cycles. In each of these cases, railway has the advantage. It is up to us collectively, not only to demonstrate this, but above all to show how this new paradigm shift for transport can concretely be achieved.

Mohamed Rabie Khlie,
ONCF Director General, UIC Vice-Chairman

1. [AR6 Climate Change 2022: Impacts, Adaptation and Vulnerability](#) — IPCC

Key figures

1500

congress participants



250

speakers



48

countries



5

continents



25

CEOs and
senior managers



Ministers

and

high-ranking
officials



30

parallel sessions



45%

women



30

sponsors



50

exhibitors



1

unforgettable
gala dinner



4

days
including an exclusive
technical & cultural visit



Key outcomes

The main messages to be taken from the UIC World Congress on High-Speed Rail were that:

International cooperation must increase in order to provide long-term railway solutions, given that these would be highly beneficial for the planet, for each country and for each person.

But what does high-speed rail actually offer?

- ▶ Employment - through the construction and operation of train lines.
Recently, the California High Speed Rail Authority reported that the construction of their high-speed line created over 10,000 jobs, which feeds directly into the economy and generates tens of billions of dollars.
- ▶ Energy Efficiency - there is there is clearly a positive impact on the environment, because of this mode of transport's energy efficiency.

The potential impact on local areas is another crucial factor and must be sufficiently prepared for by local stakeholders, including impacts on:

- ▶ The image of the area served: modernisation, accessibility, etc.
- ▶ How the cities served are categorised: is the line rural to urban or from a regional city to one nearby?
- ▶ Urban development, in particular around the stations.
- ▶ Residential areas, particularly with the emergence of remote working as people can now live in medium-sized towns which are connected to cities by high-speed trains.
- ▶ Tertiary education with more cooperation between universities.
- ▶ Tourism, especially for tourist sites with high potential.
- ▶ The general economic impact, by moving headquarters closer to operational sites, or with how time is valued evolving.





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Rail will continue to be a champion of the fight against climate change, and we have the responsibility to make this known.

Additionally, rail maintains an advantage over electric cars due to 2 specific strengths:

- ▶ The impact of a train in terms of emissions is 12 times less than an electric car², with the latter also not being a form of mass transport. Therefore, electric vehicles are (almost) like any other car, just as likely to be caught in the same traffic jam.
- ▶ Being a mode of mass transport, trains are simply more efficient as they also reduce congestion. In France, for example, a train composed of two two-level trainsets can transport between 1,000 and 1,200 people, within a 400 m long space.

In contrast, these 1,000 to 1,200 people would need more than 1090 cars (with an occupancy rate of 1.1) and would form a 4 km long queue. At the same time, for a short-haul A320 type aeroplane, the maximum capacity is 200, with an A350-900 having 324 seats.

2. The methodology is based on a study by Carbone 4 aimed at comparing the emissions of a long-distance train journey with those of competing modes of transport over a distance of 400 to 1,000 km in mainland France (low-carbon electricity), on the most complete perimeter possible.
medias.sncf.com/sncfcom/pdf/DESTE/Methodologie-generale-InfoGES_2022.pdf / ADEME's Base Carbone® / Carbone 4

Currently, travelling by high-speed train means emitting approximately 12 times less CO₂ (per km travelled in France) than an electric car and 26 times less than a combustion-powered car.

Additionally, if the share of rail travel doubles (which is SNCF's aim by 2030), this would contribute to the 30% reduction in greenhouse gas emissions planned in France.

In contrast to road and air travel, railways do not require a major technological overhaul to offer zero emissions transport, it is already the most electrified mode of motorised transport. However, there is still a need to continue to improve rail to phase out fossil fuels and to make infrastructure and rolling stock more weather resilient and adapted to climate change.

What is the right speed for our planet?

High-speed rail is not only within the purview of more economically developed nations. Morocco is a middle-income country which has had great success with its high-speed project, with numerous CEOs of UIC member railway companies commending the work during the congress.

Today Asia predominates in the size of its high-speed network, having three quarters of the world's lines. Moreover, there is considerable potential for development in Southeast Asia and India, as well as in other continents such as Africa, North America, and Central Europe.

The congress participants were asked was the “right speed” was according to them. The results of this questions are as follows:

- ▶ <200 km/h 1%
- ▶ 200 to 249 km/h 10-15%
- ▶ 250 to 299 km/h 30%
- ▶ 300 to 349 km/h 40%
- ▶ 350 km/h and + 10-15%

Therefore, there was no consensus during the UIC World Congress on High-Speed Rail about what the “right speed” might be. It effectively depends on the different regions, the distances between cities, the size of a country, and so on. In other words, it depends on geography.

Nevertheless, some practical answers were provided by the speakers at the UIC World Congress on High-Speed Rail.

- ▶ As the mobility market starts to span longer distances, the right speed will be the maximum that technology can achieve. Regardless of environmental or external socio-economic factors, the niche that railways occupy is determined by technology.
- ▶ Especially in terms of the environment, energy may be saved by going a slower speed, yet the trains would experience lower volumes in favour of air and road traffic, due to an increase in travel time, meaning that technological capability remains the decisive factor for limiting speed.
- ▶ Equally, reducing speed to reduce production costs is cancelled out by the subsequent positive externalities being curtailed, meaning that again, the commercial speed is fixed by what is technically feasible.

These observations were witnessed at different junctures as the commercial speed of railways doubled from 160 to 320 km/h. Therefore, these are no projections or estimates, but facts that have been measured and proven with virtually no exceptions, which is encouraging for countries who are currently without high-speed rail but wish to embark on this adventure.









Is there alternative technology which could unseat the high-speed train?



One of the sessions at the UIC World Congress on High-Speed Rail was dedicated to new modes of transport, and partially responded to this question by looking at current trials of alternative high-speed terrestrial travel.

MAGLEV

The upper limits of land-borne speed may come from magnetic levitation at between 400 and 600 km/h.

To reach this speed threshold, maglev vehicles will have to remain a terrestrial (in the sense that they are based on land and operate in an unmodified environment) and guided mode of transport. The only different parameter is adhesion, which is effectively reduced to zero.

Therefore, maglev may be considered to be the pinnacle of the railway, where the latter has evolved from concentrated to distributed traction and maglev would follow this trend by transferring the power from the vehicle to the track and making it linear. This change is what enables levitation and therefore a reduction in adhesion.

While Japan (with a line under construction), China and South Korea are actively developing magnetic levitation, Germany has taken a step back, in comparison to a time when it was investing in the Transrapid.

Currently, Deutsche Bahn is following the development of magnetic levitation in Japan, although it has been clearly announced that no contract has yet been signed between these two parties.

The United States also has a project for a magnetic levitation line that would use infrastructure where there are no alignment restrictions.

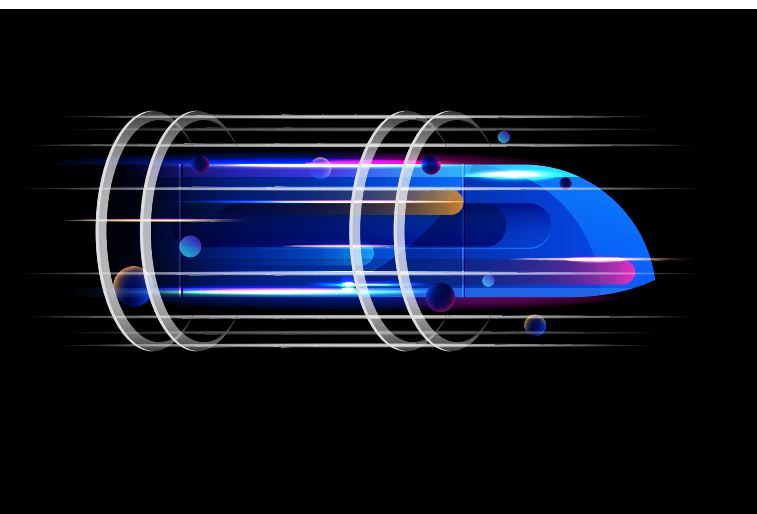
HYPERLOOP

The highest level of speed, at up to 1,000 km/h, is theoretically achievable with the hyperloop.

As a comparison, medium and long-haul aeroplane flights have commercial speeds ranging from between 700 to 1,000 km/h, as they fly at high altitudes to reduce running resistance. On the ground, comparable speeds would be impossible to achieve naturally, which is why the hyperloop would use a tube in which near-vacuum conditions are reached. In this respect, the hyperloop is similar to aviation in that, although it is on land, it needs a special environment.

However, it is currently in a much earlier phase of development than magnetic levitation, meaning that the capacity for hyperloop to become a medium and long-distance mode of mass transport remains to be seen.

There is therefore a spectrum between road (with personal cars as a private mode of transport, carpooling which is semi-private, and coaches which are public) and air transport, with the railway, maglev, and hyperloop in the middle, not only in terms of commercial speed, but also of the technology used.



Towards a new transport paradigm

Another widely discussed idea during the UIC World Congress on High-Speed Rail was that it was less about speed, and more about the transport system itself. All of the participants agreed on the need to implement a system in which public transport, the train, active mobility, and buses form the core, or more precisely the backbone, of mobility, which is all made possible by high-speed rail.

For example, Morocco has a master plan which includes the development of high-speed rail along a north-south and then an east-west axis. On the north-south axis, renovations of the conventional rail network were carried out leading to an increase in traffic. At the same time, the high-speed project enabled the network of stations to be further developed, on top of interlinking all public transport.

The participants also discussed urban development. The world will continue to urbanise over the next three decades, rising from 56% in 2021 to 68% in 2050³.

If these cities are to continue to be liveable in at all, meaning that walking, cycling, crossing the road, and children being able to play, is still being an option, then mobility must become more straightforward. This simpler mobility will need to take up less space, pollute less, and consume less energy.

Again, high-speed rail, as the backbone of the transport system, is part of the solution.

The round tables at the UIC World Congress on High-Speed Rail focused more on cars than aeroplanes, as they are by far the high-speed train's biggest competition.

While the plane has increased its commercial speed to a lesser extent, it does not have a "higher" competitor. It dominates the long-distance market and when natural barriers (such as stretches of water and mountain ranges) need to be crossed.

The rail and air market shares are well established, predictable, and effectively stable depending on the length of the train journey:

- ▶ Under 2 hours, the train has the market,
- ▶ Between 2 and 6 hours, the market is split between the two,
- ▶ Above 6 hours, the aeroplane supplants the train.

This rule is more or less universal. When the market deviates from this, rail or air operators adapt their service frequencies and/or prices and, very typically, the market returns to its normal split.

When the journey time by rail is below 2 hours door-to-door, the train is as fast, if not faster than the plane. Therefore, society should have an interest in guiding travellers towards the most environmentally friendly mode of transport, also knowing that the train and plane could better complement each other.



3. World Cities Report 2022, UN HABITAT, [Key Findings and Messages](#), chapter 1, page 1.



The most problematic issue seems to be road transport, as the private car is currently less safe, more polluting, and responsible for the majority of the land-based transport sector's CO₂ emissions, leaving significant room for improvement.

Effectively, it can evolve towards more or less complicated types of self-driving vehicles which would improve safety and transform its economic model, as the driver would no longer systematically need to be the vehicle's owner.

This change is already underway and vehicle manufacturers are integrating it into their service strategies, therefore, ignoring this development would be suicide for the railways.

However, although the panellists at the congress acknowledged that the car effectively has a more open future than the train, they were not concerned, for the following three reasons:

- ▶ Any progress that the car makes can be useful to improve the train's door-to-door service.
- ▶ Even if cars and coaches were to become as environmentally "clean" as a train, they would use more energy than trains for the same amount of traffic.
- ▶ A train with 1,000 seats is the equivalent of a 4 km long line of cars, meaning that a vehicle will never have the same capacity as a train, unless there is significant investment in infrastructure, which is often impossible in dense urban areas.

Energy: making the network an energy producer and/or a partner for green energy

A generally favourable situation

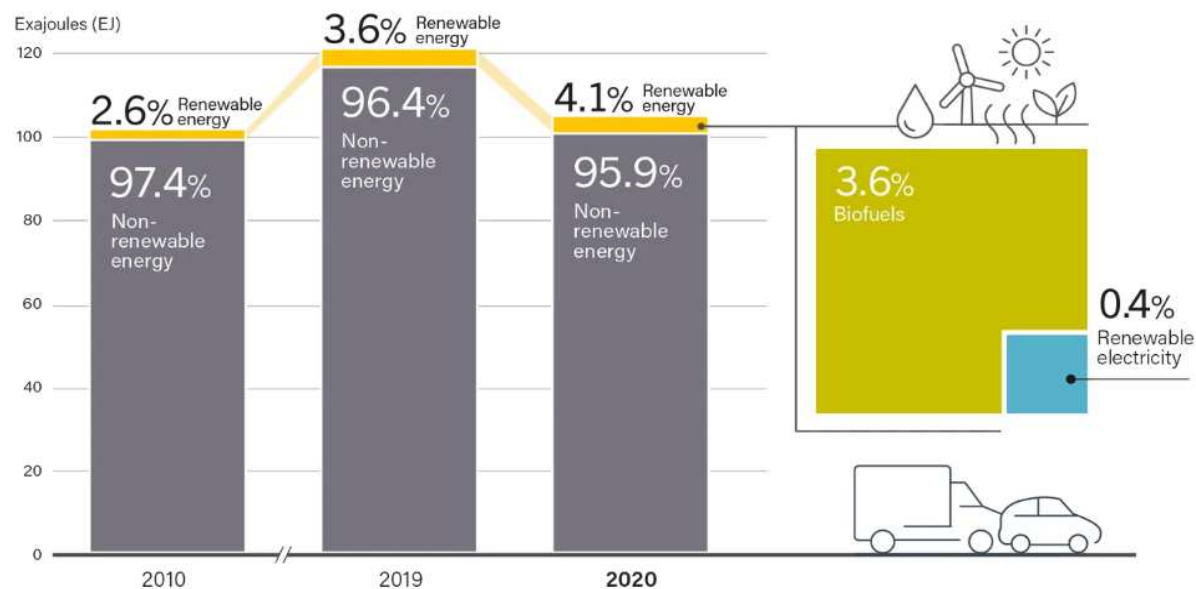
Renewable energy is drawing considerable attention worldwide, according to the Renewable Energy Policy Network (REN21) and their annual “Renewables Global Status Report” published in March 2023.

Although the transport sector has the fastest growing energy consumption, it also has the lowest share of renewable energy use, at a modest 4%. This demonstrates that the sector will need more than a mere continuation of its electrification in order to become more sustainable and efficient and to move sector-wide towards green energy. “Electrifying vehicles will not reduce traffic jams, will not improve road safety, and will not make transport more accessible. We need zero-emissions public transport with dedicated infrastructure, including rail, to reduce the number of vehicles and increase the volume of journeys made by foot or bicycle.” Mohamed Mezghani, Secretary General of the International Association of Public Transport (UITP), emphasises.

The REN21 report also states that the transport sector consumed 113.4 exajoules (EJ) of energy in 2021, representing around a third of the total energy demand for end-uses. Transport energy demand increased by 7.8% during the 2021 period but was still 6.6% below pre-pandemic levels. This was mainly due to a 7.7% reduction in transport-related oil consumption between 2019 and 2021, even as demand rose for electricity, biofuels and fossil gas.

Road transport consumed the vast majority of transport-related energy (nearly 78%) in 2021, followed by marine transport (11%) and aviation (8%), whereas rail transport consumed far less (3%).

Renewable Share of Total Final Energy Consumption in Transport, 2010, 2019 and 2020



Estimates based on the IEA, “[Energy Consumption in Transport by Fuel in the Net Zero Scenario, 2000-2030](#)”, 26 octobre 2022, and on the REN21 policy database. See the reference table R3a in the GSR 2023 data pack, www.ren21.net/gsr2023-data-pack



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A common lens for addressing efficiency in transport is the “avoid-shift-improve” framework, which focuses on 3 points:

1. For the transport sector as a whole, “avoid” travel (where possible).
2. For individual travel, encourage a strong modal shift towards modes of transport with low emissions.
3. Improve vehicles (by “improving” technology).

For example, as the demand for energy grows, public policy and land management strategies can help reduce the need for motorised transport, especially in urban areas.

In addition, incentives and investments can shift users towards less energy-intensive modes such as cycling, walking and rail. Finally, improving vehicle technologies and increasing the share of renewables is critical to reducing both energy use and emissions, thus enabling large efficiency gains⁴.

4. Source: [REN21 Renewables 2023 Global Status Report](#)

However, for 2022, no new national targets for renewable energy shares at a global level were adopted for the transport sector. Nevertheless, some countries did revise their goals.

Two countries raised their targets for the share of renewables in transport by 2030: Portugal from 20% to 29%, and the Netherlands from 14% to 28%⁵. In contrast, Italy revised its target downward from 22% to 16%⁶. At the city level, Curitiba (Brazil) set a target to power 100% of passenger transport with renewables by 2050⁷. In the United States, King County (Washington state) committed to achieving a zero-emission public transport fleet by 2040⁸.

Similarly, very few countries have set a modal shift target in their legislative framework, with Austria being an exception.

On a regional level, Europe is still alone with its target to double the modal share of high-speed and freight traffic by 2050. Our sector therefore needs to showcase its biggest achievements.

5. Source: M. Vitorino, “[Portugal sets new goals for renewable energy consumption](#)”, Lexology, 12 December 2022; Dutch Emissions Authority, “[Renewable Energy for Transport 2022-2030](#)”, accessed 7 February 2023.

6. Source: European Renewable Ethanol, “[Overview of Biofuels Policies and Markets Across the EU](#)”, October 2022.

7. Source: TUMI, “[Curitiba](#)”, 6 April 2022.

8. Source: King County, “[Transitioning to a Zero-Emissions Fleet](#)”.

Concrete action within the railway sector

In 2019, the French National Railway (SNCF) signed a 25-year power purchasing agreement (PPA) to provide enough solar power to cover 3.6% of its annual energy consumption and is the seventh solar PPA that the company has signed in recent years. The railway undertaking aims to have 40% to 50% of its energy stemming from renewable sources by 2026.

Investment in renewable energy is for the most part concentrated around electrical systems. In 2022, the Austrian Federal Railway (ÖBB) announced a EUR 1 billion (USD 1.07 billion) investment in hydropower, wind power and solar PV projects to supplement its existing renewable energy systems.⁹

To name a success story in this domain, for more than a year now, all of the Al Boraq trains (high-speed trains in Morocco) run entirely with green energy. This is part of the Moroccan National Railway's (ONCF's) plan to gradually begin its energy transformation, with 25% of its total energy consumption coming from green sources in 2022. In 2023, this will increase to 50%, with the entirety of train energy consumption becoming green in 2024.

ONCF's principal aim is to reduce their carbon footprint in the short term. With this plan, Morocco will avoid emitting 120,000 tonnes of CO₂ (carbon dioxide) which is the equivalent of planting 4 million trees.

At the UIC World Congress on High-Speed Rail, the Director-General of the Moroccan Agency for Energy Efficiency (AMEE), Saïd Mouline, highlighted how crucial green hydrogen would be for decarbonising the railway sector. In particular, he emphasised that it is possible to use green electricity and that now, with ONCF's work, a system is in place to bring all of Al Boraq's electricity from a wind farm, following a completely emission-free virtuous model.

Finally, he underlined that hydrogen-fuelled trains are already a reality. They are already operational in Europe and could also run in Morocco in the near future by replacing non-electrified fuel-using trains.

The hydrogen needed for this could be produced in Morocco, from renewable resources, as these economic models already exist. Mouline also explained that Morocco's more than 10 years of experience with public-private partnerships (PPP) means that the country is part of a model where the potential for renewables is extraordinary, and this economic model of partnership with the private sector also makes it possible to attract green financing to accompany these projects.

Moreover, the UIC World Congress on High-Speed Rail served to confirm that this new system could become a real means of decarbonising the industry.

Some UIC members presented their action plans during the High-Speed Congress, with notable examples including:

- ▶ Reducing energy consumption,
- ▶ Improving measures and monitoring,
- ▶ Implementing actions to end fossil fuel use (notably through bioenergy, hybrid rolling stock, hydrogen trains, replacing oil-fired boilers, etc.) or even through purchasing electricity (through commitments to long-term renewable electricity purchase agreements such as Energy Power Purchase Agreements).

Finally, certain railway undertakings are already producing their own renewable energy, especially via solar power plants and rooftop units on buildings or car parks.

The railway sector therefore has all of the assets necessary for achieving carbon neutrality in a credible way and with a strong lead over other modes of transport.

9. Source: [REN21 Renewables 2023 Global Status Report](#)





Carbon offsetting to fund a third of railway investment

Investing in high-speed rail is not a luxury, particularly for middle-income countries in the southern hemisphere. It must be seen as a way to develop the mobility system and land management, in particular by freeing up capacity for conventional traffic and especially for everyday trains.

During the UIC World Congress on High-Speed Rail, there was considerable discussion surrounding funding. It was, above all, highlighted that one of the best characteristics in Morocco's case was its simplicity, the way in which the whole sector was organised and developed, while being very economical in terms of resources.

This makes it repeatable, and this type of investment should increase as high-speed demonstrates its positive effect on the development of a truly sustainable transport paradigm that has the support of the general population.

The only issue may be regarding financing. From the discussions it became clear that the notion of only using private funding to finance major land transport infrastructure can no longer be sustained: the return on investment is simply not sufficient for private capital. Therefore, other sources of funding need to be found.

One of the principal reasons to invest in railway infrastructure is that it offers a concrete method of reducing emissions within the transport sector. A modern and electrified railway system, as exists in Europe, emits a mere 0.5% of emissions for a market share of 9%. In other words, investment in railway capacity should be eligible for carbon financing, provided that there are sound methods in place to avoid a rebound effect.

The right combination, especially for Africa and middle-income countries, could be the following:

- ▶ Around a third of the resources to finance investments must come from operating revenue.
- ▶ The second third must come from governments investing in public funding.
- ▶ The final third should come from carbon financing, in line with the modal shift enabled by the investment.

In concrete terms, it is the railway that enables this decarbonisation, as the backbone of the mobility system. Funding should therefore be obtained in the form of subsidies. None of this exists at present.

However, following the UIC World Congress on High-Speed Rail, it is vital that the relevant stakeholders work together on a common narrative, in order to be able to convince international financiers of this fact.

The signatory countries of the Paris Climate Agreement have not managed to reduce their emissions sufficiently to achieve these targets.

The strategies currently used by governments, which mostly rely on more renewable energy and lower consumption of carbon, are not sufficient. According to the Net Zero Stocktake 2022, more than a third of the world's largest publicly traded companies now have net zero emissions targets, up from a fifth in December 2020, creating a growing need to expand carbon credit.

Funding should therefore be freely available in the mid-term for railway infrastructure, provided that it is possible to work together to create the necessary national and international regulatory mechanisms.

Next steps

According to the International Energy Agency, rail's market share needs to increase by more than 40% by 2030 for the transport sector to reach its 2050 "net zero" target. Although steps are being made in the right direction, especially in the high-speed domain, the railway sector only transports around 8% of passengers and 7% of freight globally, meaning that not only are more trains needed, but that they are needed now.

This will require substantial investment from the public and private sectors in order to create suitable and convenient public transport for residents, as well as policies to encourage this transition.

As outlined during the UIC World Congress on High-Speed Rail, the development of high-speed rail is also dependent on a number of different variables, such as the economic situation, the availability of sources of funding, the geopolitical situation, the willingness of decision-makers, and an understanding that rail has an edge over other modes of transport.

Safety, low emissions, the high quality, and security of travel are just some of these advantages.

It is difficult to predict what the situation will be in 2040. Many continents are currently developing this type of line. Europe plans on doubling its high-speed network by 2030 and even tripling it by 2050. North America has plans for ambitious investment in this area, and Morocco's example shows that the African countries can, and wish to, construct high-speed trains.

The Asian and Middle Eastern countries are heavily investing in high-speed rail, while other regions are also considering the merits of this type of investment.

The UIC World Congress on High-Speed Rail is a further turning point in the awareness that we must all continue to work together. The current state of knowledge shared during the three days must be succeeded by strong, notably financial, commitment.

So that rail is an entirely inclusive and connected mode of transport, there is need for:

- ▶ Cohesion and consistency in relevant policy decisions.
- ▶ Permanent support from donors.

This UIC World Congress on High-Speed Rails was a milestone, but cooperation is still of the essence, especially in view of the upcoming United Nations Climate Change Conference, COP28. This is crucial, so that rail and general public transport has a wider reach and, thanks to pre-existing and readily available solutions, is seen as the solution for decarbonised transport.





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