The CER Essay series

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LEVERAGING THE EU EMISSIONS TRADING SYSTEM TO FUND RAILWAY PROJECTS: AN ECONOMIC PERSPECTIVE

CER – Community of European Railway and Infrastructure Companies

CER
The Voice of European Railways

Università Bocconi
GREEN
Centre for Geography, Resources, Environment, Energy and Networks

CER Essays

The CER Essays initiative features a series of essays that show the rail sector as contributing not only to EU transport policy, but touching on different aspects of society at large. Topics covered by the initiative will range from modal shift, climate policy, infrastructure investment, high-speed rail, demography and more. Each essay will feature a different topic and be co-authored by a CER member CEO and a leading academic from the same country and will be used to spark debate among political stakeholders on the role of rail in the EU.

Follow the whole series

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Acronyms and definitions

CCP Core Carbon Principles
CDM Clean Development Mechanism
CEE Certificats d'Economies d'Energie
CMA Conference of the Parties serving as the meeting of the Parties to the Paris Agreement
DAC Digital Automatic Coupling
EC European Commission
EESC European Economic and Social Committee
EIB European Investment Bank
EPC Energy Performance Contract
ERA European Union Agency for Railways
ERTMS European rail traffic management system
EU European Union
EU ETS EU Emissions Trading System
ESCO Energy Service Company
GHG Greenhouse Gas
HSR High-Speed Rail
IPCC Intergovernmental Panel on Climate Change
ITMO Internationally transferred mitigation outcomes
MS Member State
NDC Nationally determined contributions
PACM Paris Agreement Crediting Mechanism
tCO2e Tonne carbon dioxide equivalent
Tkm Tonne-kilometre
TTW Tank-to-wheel

About the authors

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A Transport Economist (1971) who earned his degree in Economics at Bocconi University (Milan, Italy), and an MSc in Maritime Economics and Logistics (distinction) at the Rotterdam School of Management, Erasmus University.

He is the Director of the MEMIT Master program in Economics and Transport, Infrastructure and Supply Chain Management, and is responsible for the transport division at the Bocconi University GREEN Research Centre. He has been teaching four courses on Transport Economics since 2001. He is also member of the board of the SIET (the Italian Society of Transport Economy).

He has over twenty-five-years' experience in the fields of research, consultancy, and teaching. His consultancy and research activities mainly focus on the market scenario, economic assessments of transport projects, and feasibility studies at the national and international levels.

In 2015, he was appointed by the Italian Presidency of the Council of Ministers as an independent member of the board of directors of TELT (Tunnel Euralpin Lyon Turin). In 2017 and 2020, he was appointed by the Mayor of Milan as an independent member of the board of directors of ATM, a Public Limited Company owned by the City of Milan in charge of managing the public transport system within the Milan metropolitan area, as well as the Copenhagen metro. He is also a Senior Advisor at PTS, a consultancy and advisory firm based in Milan, Rome, Verona and Trieste.

Alberto Mazzola

CER Executive Director

Alberto Mazzola has been CER Executive Director since January 2021, representing its members towards EU policymakers and advocating rail as the backbone of a competitive and sustainable transport system in Europe.

Alberto Mazzola holds a Master's in Business Administration and a Doctorate cum Laude in Nuclear Engineering from the Politecnico of Milan. In 2002 he joined Ferrovie dello Stato Italiane (FS), where he held different positions. In his last role as Head of International Government Affairs, he was based in Brussels dealing with international affairs and European legislation, market regulation and technical standards. In his previous role of Head of International Affairs, he covered also business developments outside Italy. Before joining FS, he served as Member of the cabinet of Italy's State Holding Minister, Adviser to the Ministry of Industry in Romania, Mayor of Villa d'Adda and contributed to the worldwide business section of Leonardo Finmeccanica. Honours: Cavaliere della Repubblica Italiana.

Active in the European Economic and Social Committee (EESC) since 2015, Alberto Mazzola was Vice-President of the Transport, Energy and Service of General Interest Section and President of the International Trade Agreements Follow up Committee until September 2020. Since January 2021 he serves as Member of the EESC's Consultative Commission on Industrial Change, representing CER as well as Business Europe.

Executive Summary

Rail has extraordinary environmental credentials and plays an important role in the decarbonisation of the transport sector. Moreover, rail is the most energy-efficient mode of transport and contributes to Europe's energy security, but at present these clear socio-economic benefits cannot be rewarded as additional revenue for funding their projects.

This essay explains the economic rationale for rewarding the effects of carbon avoidance in railway projects to support the development of the railway sector through the EU Emissions Trading System (ETS).

The European Green Deal specifically mentions supporting a modal shift to rail, encouraging the use of effective tools to implement 'user pays' and 'polluter pays' principles, a proper funding for clean mobility and other supporting measures. Carbon pricing that can be applied either as carbon taxes or emissions trading systems is one of the most efficient solutions to facilitate the transition towards low carbon industries by providing an economic incentive.

The rail industry in particular, presents many advantages in terms of measurability and permanence of the emission reductions and sustainable development benefits. These are strong arguments for using EU Emissions Trading System (ETS) revenues to support rail investments dedicated to modal shift and energy efficiency.

Many rail investments are currently not profitable and too risky for private investors, due to their high upfront costs. Nonetheless, most rail investments have a very high benefit/cost ratio if, in the economic analysis, we include the role of externalities. These types of projects have the potential to become self-sustainable with the appropriate policy framework and investment conditions. Hence, regarding investments in more sustainable transport solutions, particularly railways, better internalization of external economies would enhance their cost-competitiveness.

For this reason, EU policies should support rail transport development through carbon markets by:

1. Increasing the awareness of rail's contribution in decarbonising transport emissions through carbon avoidance;
2. Implementing specific guidelines for Member States to use a minimum share of revenues from the EU ETS, Innovation Fund, Modernisation Fund, Social Climate Fund, Recovery and Resilience Facility in order to support rail investments dedicated to modal shift and energy efficiency solutions;

3. Leveraging carbon markets to boost financing for decarbonisation of transport, including railways, while reinforcing the role of the European Investment Bank (EIB) and of private long term investors.

The primary reasons for committing a percentage of ETS revenues to rail investments in a coordinated manner among EU Member States fall into four main categories:

1. to accelerate sectoral decarbonization in the EU through modal shift and energy efficiency;
2. to support interoperability, through harmonization and standardization, which help products reach sufficient volume to benefit from economies of scale, thereby driving production costs down, like Digital Automatic Coupling (DAC);
3. to mitigate the adverse welfare impacts of the ETS on affected transport industries or communities by offering a lower cost of alternatives;
4. to mobilize additional sources of climate finance by also offering more opportunities for long term private investors in the sector.

The analysis of potential instruments to enable creditworthy railway infrastructure managers and railway undertakings to access sustainable commercial financing is based on three specific case studies: a) a case of new high-speed railway (HSR) network[1], b) a case related to the introduction of new technology such as DAC in the freight sector[2] c) an energy project related to the electrification of a rail line in the port of Antwerp[3].

The first case presents the main findings in terms of CO_2 reduction supporting the establishment of a European HSR network connecting the main European cities and regions. This involves investments in constructing new HSR lines, upgrading existing ones, and enhancing digitalization and automation, such as ERTMS. If realized, the two different HSR network scenarios (2030 and 2050, with varying levels of ambition) will result in significant CO_2 emission savings. The displacement of more GHG intensive transport modes (airplanes, buses, and personal cars) by a less GHG-intensive one (high-speed rail) generates energy efficiency for the transport system. The 2030 scenario will save a total of 1,5 billion tonnes CO_2 by 2070 while the more ambitious 2050 scenario will save a total of 5 billion tonnes CO_2 by 2070, even after accounting for the embedded CO_2 emissions of constructing the HSR network. The relevance of the carbon avoidance of these scenarios is a strong argument for using EU ETS to support them. In this case, the traffic shifted to HSR will result in a substantial amount of: €157,6 billion in 2030 scenario and €525,5 billion in the 2050 scenario. The study assumes construction costs to be €16,5 million per km, therefore, we estimate in the 2030 scenario that up to 9.555km of HSR lines could be financed thanks to rewarding the effect of carbon avoidance[4]. In the 2050 scenario 31.849 km[5] of HSR lines could be financed.

The assessment of the potential effects of DAC carried out in the study DACcelerate-European Freight DAC Delivery Programme[6] shows that the introduction of DAC has a clear potential to

1 *Using as source the Technical Report "Smart and Affordable Rail Service in the EU: a socio-economic and environmental study for High Speed in 2030 and 2050" published in 2023.*
2 *Using as source the study "DACcelerate-European Freight DAC Delivery Programme", particularly in the section 4.5 "Modal shift potential" and section 7.1 "Report on capacity/productivity gains, modal shift potential, market opportunities and quantification of external effects"*
3 *Using as source the "Social Cost Benefit Analysis (SCBA) for the electrification of 9,5 km long railway line 11".*
4 *The result will be an investing capacity equal to 120,8% of the km included in 2030 scenario (9.550 km compared to 5.300km)*
5 *The result will be an investing capacity equal to 95,3% of the km included in 2050 scenario (31.849 km compared to 34.200km)*
6 *https://projects.shift2rail.org/s2r_ip5_n.aspx?p=DACCELERATE*

contribute to an increase in the modal share of rail in the freight sector, primarily due to the ability to operate faster and heavier freight trains, as well as the additional functions enabled by DAC. Focusing on CO_2 emissions, the study estimates that DAC could save approximately 140 million tonnes of CO_2 per year at the EU level over 30 years. These savings are €16,8 billion, which is more than the investment costs of the European DAC Delivery Programme. While the electrification of rail lines in the Port of Antwerp may not attract significant funds from ETS allowances, it adds considerable value to intermodal transport by reducing travel time and enhancing operational efficiency.

The EIB is well positioned to support the EC, the Member States, and private long-term investors in enhancing their ability to combine funds using carbon market revenues. This support will contribute to reinforcing EU priorities in the rail sector, particularly for cross-border projects and interoperability.

Alberto Mazzola

CER Executive Director

Introduction by CER

Climate change is a market failure because the costs and impacts of GHG emissions are not borne by those causing them. To overcome these externalities, global stakeholders are engaging in carbon pricing and implementing market-based initiatives to expose the social and environmental costs of GHG emissions and provide financial incentives to address these costs.

Transport decarbonisation and its impact on the environment remains the biggest obstacle to achieving the goals set by the EU Green Deal and the EU Zero Pollution Action Plan. These environmental challenges also play a strategic role in reducing reliance on fossil fuels. Surface transport produces one-quarter of EU GHG emissions across all sectors and its emissions are still increasing[7]. Fully compliant with the EU Taxonomy Regulation, electrified rail remains the most environmentally friendly mode of mass transport and will have an important role to play in achieving European environmental goals.

Railways significantly minimize GHG emissions due to their energy efficiency compared to other transport modes and extensive use of electric traction. In Europe, 81,6% of rail train-kilometres in 2020 were powered by electric propulsion. This reduction is further enhanced by the decarbonization of the European energy mix. For instance, in the Netherlands, the railway sector already uses 100% renewable sources. According to the PRIME Benchmark Report, the share of renewable energy in the rail sector among the 15 most relevant infrastructure managers is already 52%.

CER aims to support the completion of a modern European railway network that aligns with smart and sustainable European policies. Rail is a crucial part of the solution to some of the most pressing mobility challenges in Europe.

The CER Essay demonstrates that rewarding the effect of carbon avoidance in railway projects provides a significant complementary tool for securing funding for rail investments, such as the completion of the European High-Speed Rail (HSR) Masterplan and the deployment of Digital Automatic Coupling (DAC) in freight. According to the HSR case, more than €525 billion (95,3% of the projected total investment costs) in the 2050 scenario could be utilized to build 31.849 km of HSR lines. GHG savings in the DAC case could amount to €16,8 billion between 2026 and 2055.

This paper provides the rationale for further extending the ETS mechanism to support carbon avoidance in transport through railway investments. Such action would also lead to a reduction in imported fossil fuels, resulting in significant macroeconomic benefits, including improvements to the EU balance of payments.

CER hopes that European decision-makers, while considering this study, will direct ETS revenues into rail investments and amend ETS legislation to make this compulsory in the first revision. Such actions would benefit society economically, financially, and environmentally.

7 *According to European Environment Agency (2023), the transport sector is a major contributor to greenhouse gas (GHG) emissions in the EU-27 because of its strong dependence on fossil fuels. The exhaust emissions of transport (including aviation bunkers) were responsible for 25.9% of total GHG emissions in the EU-27 in 2019. Since 1990, overall GHG emissions have fallen by 24%, however those of transport have risen by 33%. Consequently, transport's share of GHG emissions has grown.*

1. The research context and the main goals

The European Green Deal outlines the European Union (EU)'s long-term climate objectives up to 2050: achieving climate neutrality by 2050 (zero net emissions of GHG) and reducing transport emissions by 90% by 2050.

European railways will strive towards carbon-free train operation and provide society with a climate-neutral transport alternative by taking the following actions: a) Electrification of the rail network; b) Modernisation of the vehicle fleet; c) Deployment of renewable energy sources, d) Utilisation of alternative "powertrains" and fuels such as batteries, hydrogen and biofuels, as a transition and e) Energy efficiency improvements such as regenerative braking and energy-efficient driving[8].

The European Green Deal specifically mentions supporting a modal shift to rail, encouraging the use of effective tools to implement 'user pays' and 'polluter pays' principles, a proper funding for clean mobility and other supporting measures.

Carbon pricing that can be applied either as carbon taxes or emissions trading systems is one of the

8 *CER (2023), Railway contribution to the EU climate target for 2040"*

most efficient solutions to facilitate the transition towards low carbon industries by providing an economic incentive.

Emissions trading systems, also known as cap and trade, involve the regulator allocating a limited number of carbon permits. According to this system, carbon emitting companies must hold permits to cover their emissions. Thus, through a market-based system, polluters are allowed to match their carbon emissions by trading carbon allowances. As the cost of carbon increases, carbon-releasing companies are forced to shift their operations to greener applications.

Established emissions trading systems are accompanied by exchange-listed futures, which enhance market efficiency through price formation and liquidity, attracting investors to actively trade.

Besides carbon pricing mechanisms, a variety of climate-specific financing instruments and incentive mechanisms have already been developed to support investments in the railway sector (e.g. green bonds, sustainability-linked bonds and loans, Green Rail Investment Platform offered by European Investment Bank, etc)[9].

Carbon markets could contribute to promoting carbon avoidance in the transport sector by allocating part of their revenues to railway investments, thus encouraging a modal shift to rail from more polluting means of transport.

Figure 1: Definitions used in carbon markets

Carbon reduction
Projects decreasing the amount of GHG emissions, compared to prior practices.
For example, switch from diesel to electricty in engines.

Carbon removal
Projects directly decreasing the amount of GHG already in the atmosphere.
Particularly challenging in the transportation sector because of the variety of emission sources and the space limitations in vehicles - buses that have been developed to run on natural gas are now being fitted with carbon capture devices.

Carbon avoidance
Projects preventing additional GHG emissions.
For example, railway infrastructure by enabling transportation of more passengers and freight prevent GHG emissions in transport.

Source: GREEN

9 *As an example, SNCF Group has its Green Bond program certified each year by the best market standards, "Green Bond Principles", "Climate Bond Initiative", and publishes an annual Green Bond impact report (SNCF -Green securities Framework 2023-2024, 23 May 2024). Other railways undertakings have the same financial approach.*

In compliance carbon markets (e.g., EU ETS), regulations are designed to decrease the cap on the total amount of GHG emissions that operators can produce, ensuring the achievement of climate targets and overall emissions reduction over time. Allowances, which represent the right to emit a certain amount of CO_2, can be traded. Entities that have reduced their emissions can sell their spare allowances.

In voluntary carbon markets, entities that take action to permanently reduce GHG emissions can sell the 'rights' related to these reductions to entities seeking to lower their emissions. Carbon credits are purchased to offset an equivalent amount of carbon emissions created elsewhere and are typically used to make carbon-neutral claims.

Trading: when emissions exceed pre-defined allowances (cap), the implementing party needs to purchase allowances in the carbon market. When emissions are below pre-defined allowances, the implementing party can sell the remaining allowances in the carbon market. In our example (Figure 2), company 1 can sell the saved allowances to company 2 in the carbon market.

Crediting: when actual emissions of an entity, such as a company, are below the pre-defined crediting threshold (that can be set equal to the original emission level, as in the example in Figure 3), the implementing party can sell the credits in the carbon market. Since it is a voluntary market, no penalty is charged if the emissions exceed the crediting threshold.

Figure 2: Trading allowances in compliance markets

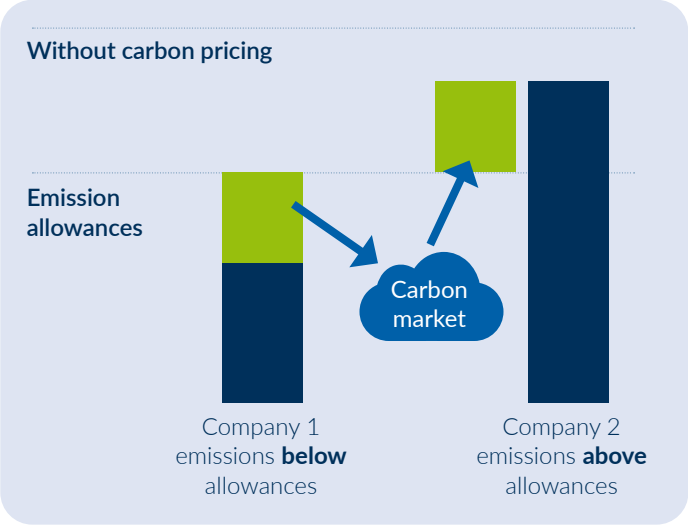
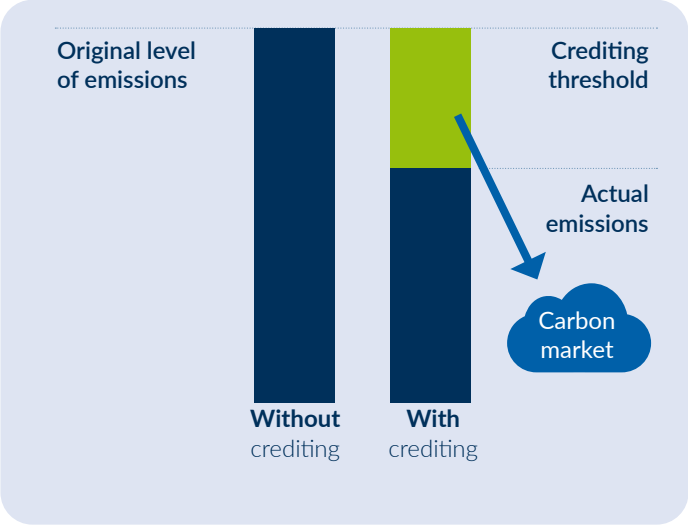


Figure 3: Crediting in voluntary markets



This essay explains the economic rationale for rewarding the effects of carbon avoidance in railway projects to support the development of the railway sector through the EU Emissions Trading System (ETS).

The researchers used a multidisciplinary approach and reviewed an extensive list of documents and reports on this topic, including studies conducted by the European Commission (EC), European Investment Bank (EIB), World Bank (WB), and International Union of Railways (UIC), as indicated in the bibliography.

The research is divided into four phases:

1. Analysis of the role of carbon markets applicable to transport;
2. Analysis of the role of voluntary carbon markets for green investment in the transport sector in developing countries;
3. Analysis of the potential instruments to allow creditworthy railway infrastructure managers and railway undertakings to access sustainable commercial financing and drafting of three specific case studies based on parametric estimation on quantification of the carbon avoidance;
4. Policy recommendations to support rail infrastructure projects financing through the EU ETS revenues and funds.

This essay explains the economic rationale for rewarding the effects of carbon avoidance in railway projects to support the development of the railway sector through the EU Emissions Trading System (ETS).

2. White certificates as an incentive for energy saving actions in the railway sector

Interesting examples of incentives for energy-saving actions in the railway sector come from the French and Italian energy-saving certificates. Both cases successfully promoted and stimulated new investments in energy efficiency through a market-based mechanism. Energy providers encourage clients to save energy (expressed in tons of oil equivalent saved in Italy and kilowatt-hours in France) through investments eligible for certificates credited by governmental agencies. Obligated parties can also purchase certificates from other actors who have carried out energy-saving actions, particularly eligible non-obligated ones. Additionally, they can obtain certificates by contributing to supporting programs.

For instance, in 2022, Ferrovie dello Stato Italiane generated €55 million in revenues from Energy Efficiency Certificates ('White certificates'), which increased to €90 million in 2023. The €35 million increase compared to the previous year is due to the recognition of white certificates accrued during the year (+€63 million), net of their sale (-€28 million). The item 'White certificates' represents energy efficiency certificates accrued by group companies as of the balance sheet date, reflecting energy savings achieved through the application of efficient technologies and systems[10].

One of the key tools of the French energy demand-side management policy within the context of European Energy Efficiency Directive is the Energy Savings Certificate mechanism or Certificats d'Economies d'Energie (CEE) created in 2005. Similar to the Italian system, it promotes and stimulates investments in energy efficiency through a market mechanism. The government determines a pluri-annual global energy savings goal (usually 3 or 4 years) in MWh cumulated actualised (Cumac[11]). This goal is then borne by all energy suppliers, also called 'Obligés,' according to their share of the total supply. To fulfill their obligation, they must promote energy-saving projects to consumers or face financial penalties. The energy providers ('Obligés') encourage final clients to save energy through incentives for energy-saving actions in the residential, tertiary, industrial, and transport sectors. These projects are eligible to receive certificates credited by governmental agencies on a registry. Other actors (local collectives, brokers, etc.) may also participate in the process, request certificates (and then sell them to energy suppliers), or engage in brokerage activities, depending on their status. CEEs are tradable assets whose unit of account is the kilowatt-hour of final energy saved. The registry on the Registre National des Certificats d'Économies d'Énergie[12] facilitates the matching of buyers and sellers by enabling holders of CEE volumes to buy or sell. As the registry does not act as an organized market, transactions are negotiated by mutual agreement between holders outside the registry. The volumes and transfer prices are then recorded, and the CEE transferred. By recording transfers, a representative index of the price of CEE exchanges is calculated and made available to the public.

Examples of incentives for energy-saving actions in the railway sector come from the French and Italian energy-saving certificates.

10 *White Certificates (also known as TEEs - Energy Efficiency Certificates) recognized by the Gestore dei Energy Services (GSE) against the achievement of energy savings through the application of efficient technologies and systems. In the period of time that elapses between the moment when the right is acquired to the title by providing the service and the time when the TEEs are actually disbursed as a result of the process of certification by the GSE, revenues from TEEs are recognized on an accrual basis - and recognized in inventories until the next sale - based on the best estimate of the number of TEEs expected, in proportion to the savings of Tonnes Oil Equivalents ("TEP") achieved or estimated to be achieved. The valuation of the same is made at the weighted average market value of the energy year (as defined by the operator of the energy services) available on the reference date. When the sale is then actually realized, any adjustment from the best estimate is made. FS Group does not provide specific details on the projects that get the TEEs, but according to Italian GSE the following interventions carried out in the transport sector in order to achieve savings in energy end-use are eligible for the incentive mechanism: a) purchase/replacement of vehicular fleets and public transport fleets powered by electricity, natural gas, LNG, LPG, hybrid or hydrogen; b) purchase of fleets of non-electric-powered transportation vehicles powered by one or more fuels including other than natural gas, LNG, LPG or hydrogen; c) purchase of fleets of electric vehicles powered by renewable energy; d) energy efficiency of fossil-fueled transportation vehicles; e) adoption of behavioral measures (e.g, efficient reporting and management systems, data analysis systems on consumption of individual facilities, utilities and vehicles); f) purchase of more efficient fleets of trains for domestic passenger and/or freight rail transport, trains for regional passenger transport, and rail vehicles for LPT.*

11 *The term "cumac" comes from the contraction of "cumulated" and "discounted" because the kWh saved are cumulated over the life of the product and actualised*

12 *https://www.emmy.fr/public/accueil*

As part of the energy savings certificates (CEE) scheme, in 2022, the French Ministry of Energy Transition published an order creating a standardized operation sheet for rail freight services. This sheet bears the reference "TRA-SE-116 - Rail freight" and it is valid until July 2028. It establishes a contract for the provision of rail freight services for goods previously transported by road. Tonne-kilometres transported by conventional freight and tonne-kilometres transported by sea container are eligible. The order creates a fourfold bonus for energy-saving operations covered by this form. The CEE amount is around 14% of the average selling price per tonne/km, i.e. €4,80 for 1.000 t/km.

Recent developments in the energy efficiency market offer new and innovative solutions to finance energy efficiency business models implemented by Energy Services Companies (ESCOs). These models focus on renovating existing infrastructure, with repayment coming entirely or partially from energy savings. Most agreements between customers and ESCOs are underpinned by energy performance contracts (EPCs). The EPC obligates the ESCO to install the required equipment, guarantees performance, and outlines the terms for any upfront or ongoing payments. These payments are designed to be less than the financial savings generated by the project.

The two most common types of EPCs are referred to as a (1) guaranteed savings or (2) shared savings model. In the first case, the ESCO guarantees a certain savings on the client's energy bill. The ESCO takes on the technical risk. In the second case, the ESCO can provide financing, as well as project development and implementation costs, with the energy savings shared between the ESCO and the client over the contract period.

The EPC provides the customer with a guaranteed level of energy savings and the ESCO with a reliable source of revenue. EPCs typically last from 2 to 20 years, depending on the measures implemented. Depending on the customer's preference and access to capital, the customer, the ESCO, or a combination of the two can be responsible for securing the finance for the project. A direct loan agreement with a third-party lender is an option for both parties.

Depending on project sizes and clients, different financing mechanisms and schemes can be used: working capital loans, leasing, sales of receivables, special-purpose vehicles or dedicated financial instruments.

At present, we have not found a specific example of EPC in the railway sector, but pilot projects could be proposed to introduce interoperable innovations, European Rail Traffic Management System (ERTMS) signalling system, or energy efficient system like Digital Automatic Coupling (DAC) that is a powerful lever for boosting the performance, safety, and reliability of operations, because it will enable operations to be automated[13]. Other pilot projects could be proposed to update rolling stocks, to raise energy efficiency and to integrate renewables.

13 *The introduction of DAC will make it possible to shorten the time taken to assemble goods trains and to digitise the braking and control processes: wagons can be handled more quickly and efficiently in marshalling yards; trains can be built longer and heavier and run faster. Up to 15% more capacity could be gained with like-for-like infrastructure. The implementation of DAC will be particularly beneficial for single-wagon load trains, which are very time-consuming to manoeuvre and hook up.*

3. An overview of carbon markets

As previously stated, climate change represents a market failure because the costs and impact of carbon emissions are not borne by those causing them. Carbon markets are considered a tool for accelerating mitigation action and they consist of the trading in GHG units that represent one metric tonne of carbon dioxide equivalent (tCO_2e) and have a unit price that is (typically) determined by supply and demand.

Carbon markets play a crucial role in achieving the net-zero goals of various governmental and private entities. Trading can reduce compliance obligations under carbon pricing instruments, as mentioned above, or address hard- or impossible-to-abate GHG emissions in sectors not covered by them. They also serve as financial incentives for mitigation activities outside the scope of compliance markets, particularly in the developing world. The market for credits is where buyers and sellers trade credits issued by domestic, international, or independent crediting mechanisms. These credits are generated in projects that meet certain requirements imposed by the governments or the crediting mechanisms.

The following paragraphs will present the main characteristics of different schemes of carbon pricing and trading that could offer recommendations for potential financial tools for railway development.

3.1 The role of the EU Emissions Trading System (EU ETS)

The EU ETS is a cornerstone of the EU's policy to combat climate change and its key tool for reducing GHG emission costs-effectively. The EU ETS is now an important source of funding for the green transition and is expected to become even more important in the future. It is the world's first major carbon market, and its main scopes are the following:

- makes polluters pay for their GHG emissions, helps bring emissions down and generates revenues to finance the EU's green transition,
- operates in all EU Member States plus Iceland, Liechtenstein, and Norway (EEA-EFTA states),
- covers emissions from around 10.000 installations in the energy sector and manufacturing industry, as well as aircraft operators flying within the EU and departing to Switzerland and the United Kingdom – or around 40% of the EU's emissions and it also covers emissions from maritime transport.

The EU ETS was introduced in 2005, and it consists of four phases. The present phase (the fourth) is related to the period from 2021 to 2028. During this period, the number of emission allowances will be reduced by 2.2% each year, starting from 2021.

The EU ETS started covering emissions from maritime transport as of 2024 and a new emissions trading system, called ETS2, has been created to cover emissions from buildings, road transport and additional sectors. The new system will become operational in 2027. To achieve the latest reform of ETS, the number of emission allowances will be reduced by 4.3% per year over the period 2024-2027 and by 4.4% per year for 2028-2030.

The revenues from the EU ETS feed mostly into national budgets[14]. Starting from mid-2023 Member States must use these revenues to support investments in renewable energy, energy efficiency improvements and low-carbon technologies that help reduce emissions further. The sale of allowances also supplies the EU ETS funds for low-carbon innovation and energy transition, the Innovation Fund[15] and the Modernisation Fund[16].

According to the 2022 Ecologic report "The use of auctioning revenues from the EU ETS for climate action (2013-2020)" on eight EU countries, it emerged that only two countries (Italy and Poland) have allocated a minority part of their ETS budget to the railways sector, but without a clear

14 *Total auctioning revenues generated under the ETS system amounted to €43,6 bn in 2023, of which €33 bn went directly to EU Member States. Of the remaining revenue, €7,4 bn supplied the Innovation Fund and the Modernisation Fund and €2,8 bn supplied the Resilience and Recovery Facility, which Member States use to advance the clean energy transition and boost energy security.*

15 *The Innovation Fund was established by Article 10a(8) of Directive 2003/87/EC to support across all Member States innovation in low-carbon technologies and processes and it is one of the world's largest funding programmes for innovative low-carbon technologies. The Fund focuses on highly innovative clean technologies and big flagship projects with European added value that can bring significant emission and greenhouse gas reductions. Innovation Fund projects cover a wide range of innovative technologies in areas such as energy-intensive industries, renewables, energy storage, net-zero mobility and buildings, hydrogen, and carbon capture, use and storage. They are located in the EU, Liechtenstein, Iceland, and Norway. The Innovation Fund's total funding depends on the carbon price, and it may amount to about €40 billion from 2020 to 2030, calculated by using a carbon price of €75/tCO_2.*

16 *The Modernization Fund supports the modernization of energy systems and the improvement of energy efficiency in 13 lower-income EU Member States and it operates under the responsibility of the beneficiary Member States, who work in close cooperation with the European Investment Bank (EIB) and the Commission. The Modernisation Fund is financed by revenues from the auctioning of 2,5% of the total quantity of the EU ETS allowances auctioned between 2024 and 2030. The Modernisation Fund primarily supports investments in 6 priority areas and one o this is the reduction of overall energy use through energy efficiency, including transport. The total revenues of the Modernisation Fund amount to €57 billion from 2021 to 2030, assuming a carbon price of €75/tCO_2. In the period from January 2021 to June 2024 the total spending of Modernization Fund was equal to €12,65 billion.*

programme and consistency. For instance, in the case of Italy, a total of €100 million was allocated between 2016 and 2018 for the reconstruction of cities to incorporate sustainable means of transport. The carried-out projects resulted in the improvement of public transport lines, such as new subway lines, and the fortification of railway lines and road links. The resources were not consistent over the years, from the ETS revenues the amounts devolved were: €40,5 million in 2016, 38,5 million in 2017 and 18,5 million in 2018. In the case of Poland, in 2017, 43,4% of ETS budget was allocated for preferential VAT rate by rail transport companies, in 2018, 21,2% for support for rail enterprises, in 2020, 28,3% for support for rail enterprises, including the expansion of interregional railway system. In summary, the Ecologic report highlighted that the railway sector received a very limited amount of the Member States revenues from the EU ETS in 2013-2020 period.

There is an ongoing debate about whether the EU should recognise international credits for the future of the EU ETS, as they are not currently allowed for compliance. EU ETS participants cannot currently use international credits for compliance and the EU has insisted that it will not use Article 6 of PACM to reach its NDCs.

In order to address potential social impacts arising from the ETS2, the Social Climate Fund (SCF) was established in 2023[17]. The SCF will provide dedicated funding to Member States (about €87 billion from 2026-2032) to support the most affected vulnerable groups, especially households in energy or transport poverty. The SCF will promote fairness and solidarity between and within Member States while mitigating the risk of energy and transport poverty during the transition.

Member States may use the SCF to support structural measures and investments in energy efficiency and renovation of buildings, clean heating and cooling and integration of renewable energy, as well as in zero- and low-emission mobility solutions. Addressing the root causes of transport poverty means focusing on accessibility, affordability, and the spatial layout of communities. Strategies may include investing in affordable and accessible public transport options and improving green infrastructure. This holistic approach ensures that the investments and measures have a meaningful and sustainable impact.

The "Note on good practices for cost-effective measures and investments to support for implementation of the SCF" published by the EC in June 2024 briefly addresses public transport but fail to underline potential of railways.

The railway sector received a very limited amount of the Member States revenues from the EU ETS in 2013-2020 period.

17 *Regulation (EU) 2023/955 of the European Parliament and of the Council.*

Between 2021 and 2024, only three projects from the Modernisation Fund have been allocated to the railway sector. The first two are projects in Romania with a budget of € 475 million assigned in 2023 and 61 million assigned in 2024. The first investment[18] supports the reduction of energy consumption through energy efficiency in the transport sector and it concerns a project for the purchase of 62 new EMUs (Electrical Multiple Units) trains to replace 77 old electric trains in 11 routes. The second investment concerns a large-scale project for the period 2024-2027 relating to the replacement of 14 old electric trains by 9 new EMUs (Electrical Multiple Units) trains and of the replacement of 22 old electric locomotives by 23 new ones for long distance services[19]. The third is a project in the Czech Republic that covers the purchase of electric, battery electric and hydrogen multiple units to replace diesel and old electric trains in the Czech Republic with a budget of €5 million[20].

The Innovation Fund financed in 2022 an Italian pluriannual project in the railway sector with €4,4 million named H2 Valcamonica.

The EESC recommends establishing a new, separate, well-designed, high-integrity and robust credit scheme for carbon avoidance with sound methodologies which have yet to be developed.

It is interesting to note that the European Economic and Social Committee[21] (EESC) believes that carbon reduction projects should involve both carbon removal and carbon avoidance. However, it believes that carbon avoidance is currently insufficiently supported at the EU level, whereas investments in carbon avoidance solutions have already yielded successful results in utilities, transport, and heating. Therefore, the EESC recommends establishing a new, separate, well-designed, high-integrity and robust credit scheme for carbon avoidance with sound methodologies which have yet to be developed. The EESC considers that the credits from carbon avoidance would offer incentives to decarbonise and provide funding for zero-emission projects. For instance, the EESC recommendations could be effectively implemented through programmes similar to the French energy savings mechanism dedicated to rail freight services for goods previously transported by road, as described in Chapter 2. Additionally, the Swiss Federal Office of Energy's program, which focuses on offsetting CO_2 emissions by improving the efficiency of passenger and freight transport, could serve as a model. This programme promotes switching from high CO_2 emission transport modes to those that achieve significant and lasting reductions in CO_2 emissions, such as shifting from road to rail. At the same time, the EESC calls attention to the fact that EU ETS allowances must not be used as 'credits', as this could undermine the current market-based nature of the EU's carbon trading system.

18 *Modernisation Fund reference number MF 2023-2 RO 0-008*
19 *Supporting the reduction of energy consumption through energy efficiency in the transport sector- sustainable rolling stock for long-distance train services" (Modernisation Fund reference number MF 2024-1 RO 0-005)*
20 *Modernisation of public transport – electric and H2 passenger trains priority investments of the Programme "TRANSGov" (Modernization of public transport)" for which it envisages a contribution from the Modernisation Fund (Modernisation Fund reference number MF 2024-1 CZ 0-003)*
21 *Opinion of the European Economic and Social Committee (EESC) on the Communication on Industrial Management COM(2024) 62 final dated 30th of May 2024*

3.2. The context of the Paris Agreement

The adoption of the Paris Agreement by Parties to the United Nations Framework Convention on Climate Change (UNFCCC) in December 2015 was a pivotal moment in international climate diplomacy[22]. All Parties, united by a legally binding treaty, agreed to contribute to addressing climate change under a long-term and dynamic regime.

Article 6 of the Paris Agreement recognizes that some Parties may choose to pursue voluntary cooperation with other Parties in implementing their Nationally Determined Contributions (NDCs) to allow for higher ambition in their mitigation and adaptation activities and to promote sustainable development and environmental integrity.

Article 6 sets out how countries can pursue voluntary cooperation to reach their climate targets. It enables international cooperation to tackle climate change and unlock financial support for developing countries. This means that, under this article, countries are able to transfer carbon credits earned from the reduction of GHG emissions to help one or more countries meet their climate targets. There are three tools that countries can draw upon under Article 6, one of which is the Paris Agreement Crediting Mechanism (PACM) - the UN's new high-integrity carbon crediting mechanism[23]:

1. Article 6.2: According to voluntary approaches that involve the use of internationally transferred mitigation outcomes, countries can authorize carbon credits as internationally transferred mitigation outcome (ITMO) and are responsible for ensuring that ITMOs meet relevant international and national criteria;
2. Article 6. 4: Use of a mechanism to contribute to the mitigation of GHG emissions and support sustainable development, Emission reductions, usually defined as PACM;
3. Article 6.8: Non-market approaches[24].

Article 6.2 creates a decentralized governance system for ITMOs. Countries can make bilateral or multilateral agreements with each other regarding how ITMOs will be used to achieve NDCs. Each country will be responsible for authorizing the issuance, transfer, and retirement of credits as well as monitoring, reporting, and verifying (MRV) the quality of the credits. This means that each country should maintain a registry of credits.

The A6.4 mechanism is a centralized governance system with a registry administered by the Supervisory Body, a group created at COP26.

22 *The Agreement entered into force on 4 November 2016 once it had been ratified by at least 55 Parties, accounting for at least 55% of global greenhouse gas (GHG) emissions.*

23 *Decision 3/CMA.3, annex, available at: https://unfccc.int/sites/default/files/resource/cma2021_10_add1_adv.pdf#page=25 and Decision 7/CMA.4, annex I, chapters III–VI, available at :https://unfccc.int/sites/default/files/resource/cma2022_10a02_adv.pdf#page=33*

24 *These approaches cover all ways to contribute to mitigation that don't involve a carbon market, such as nature-based solutions, ecosystem solutions, reforestation, and community projects, or implementing taxes to discourage emissions. This article provides a formal framework for international climate cooperation outside of carbon markets, enhancing public and private sector participation in NDC implementation, and enabling coordination across instruments and relevant institutional arrangements.*

Figure 4: Article 6.2 and Article 6.4 of the Paris Agreement Credit Mechanism (PACM)

	Article 6.2[25] (Bottom-up Approach and decentralized system)	Article 6.4[26] (Top-down Approach and centralized system)
Governance	Under bi - or plurilateral approach	Under the Authority or supervision of UNFCCC
Metrics	Internationally transferred mitigation outcome (ITMO) from any Mechanism/procedure/protocol	Emission reductions (ER) calculated in accordance with the methodologies and metrics assessed by the Intergovernmental Panel on Climate Change
Approach	Arrangement in place for authorizing and tracking the use of ITMO towards the achievement of NDCs.	A mechanism to contribute to GHG emission reductions and support sustainable development is established under the authority and guidance of the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement (CMA) for use by Parties on a voluntary basis.

Source: GREEN elaboration on United Nations Development Programme and United Nations Framework Convention on Climate Change reports

Projects supported through Article 6 of the Paris Agreement inject new funding into various project categories, encompassing energy efficiency, solar, hydro, agriculture, and transportation. In general, carbon markets have significant potential for attracting investments in Circular Carbon Economy solutions[27].

25 *For all the details: https://unfccc.int/sites/default/files/resource/cma3_auv_12a_PA_6.2.pdf*
26 *For all the details: https://unfccc.int/sites/default/files/resource/cma3_auv_12b_PA_6.4.pdf*
27 *https://www.cceguide.org/guide/*

One of the first applications of Article 6.2 in the transport sector is the registered compensation project agreement between Switzerland and Thailand on an "Operation of e-buses on privately owned, scheduled public bus routes in the Bangkok Metropolitan area by Energy Absolute" signed in February 2023. Switzerland wants to reach its GHG reduction target for 2030 in part with reductions achieved abroad[28]. The activity will replace the use of conventional (diesel & natural gas) buses with e-buses on more than 100 (existing and new) privately operated bus routes that provide a regular, scheduled service within the Bangkok Metropolitan area[29]. The carbon finance from the purchase of up to 500.000 mitigation outcome units (in 2022-2030 period) that are authorised as ITMOs within Thailand's first NDC period (including the 2030 vintage) shall be used to level the total cost of ownership differential between baseline buses and the project e-buses. The mitigation outcomes from this project are generated inside sectors covered by Thailand's NDC and represent a surplus beyond the policies and measures planned by the government of Thailand. The program activity of privately-operated public transport buses is not within the scope of measures planned under Thailand's NDC or accompanying domestic legislation of implementation. The mitigation outcomes will be used in the NDC implementation period until 2030[30]. The cooperative approach ensures environmental integrity by demonstrating that ITMO revenues close the existing total cost of ownership (TCO) gap for the initial batch of 154 e-buses that are to be put into operation. The carbon finance will allow to adhere to existing bus ticket prices, thus ensuring a viable, commercial operation of this initial fleet.

In order to reach the decarbonization target, in Switzerland among the eligible projects for offsetting CO_2 emissions there is one for improving the efficiency of passenger and freight transport, thanks to switching from a type of passenger or freight transport with high CO_2 emissions to one that generates relevant and lasting reductions in CO_2 emissions (e.g. shift from road to rail, traffic avoidance and vehicle fleet management)[31].

28 *Switzerland wanted to work out and test concrete solutions together with interested states and the private sector. To this end, the Federal Department of the Environment, Transport, Energy and Communications has concluded an agreement with the Climate Cent Foundation on the use of the Foundation's remaining assets, which come from a surcharge on gasoline and diesel imports in the years 2005 to 2012. At least 20 million Swiss francs will be made available to finance pilot projects, which will be decided on by mutual agreement between the Federal Government and the Foundation.*

29 *Refer to Annex 1 of the MADD for further details: Operation of e-buses on privately owned, scheduled public bus routes in the Bangkok Metropolitan area by Energy Absolute" (project ID number 5002).*

30 *The Calculation of mitigation outcomes is based on the following T-VER methodologies, while some modifications have been applied: 1. T-VER-METH-TM-05 Version 03 – Use of Electric Vehicles in Public Transportation System (TM-05); and 2. T-VER-METH-TM-06 Version 03 – Modal Shift from Private Vehicles to Public Passenger Transportation with Electric Vehicles (TM-06). The monitoring is based on data of measured fuel consumption of comparable buses or electricity consumption of electric buses. For modal shift, annual surveys via a ticket sales app are the primary basis for calculating emission reductions. The verification body is the Bureau Veritas Certification (Thailand) Limited.*

31 *Swiss Federal Office of Energy SFOE Energy Economy Division, Offsetting CO_2 emissions: projects and programmes Eligible and ineligible project and programme types (Category 5.1) Annex L to the communication 'Offsetting CO_2 emissions: projects and programmes', 08 January 2024.*

4. The role of relevant methodologies for funding rail projects in emerging economies and developing countries

The use of carbon credits as part of wider emission strategies is expected to increase due to greater regulation and ambitious company targets. In many cases, after exhausting all options for avoiding and reducing emissions, companies are exploring ways to compensate for hard-to-abate emissions, bridge the gap until new emissions reduction technologies are available, and voluntarily reduce emissions from historic activities.

Carbon credits can impact companies' business strategy in four key ways:

- Meeting regulatory requirements in hard-to-abate areas/sectors;
- Temporarily reducing current footprint until real abatement projects are implemented;
- Compensating for residual carbon footprint after emissions-reduction programs have been developed;
- Compensating for historic emissions since the organization was founded.

There is a wide selection of available carbon credits, including those for nature-based abatement solutions (e.g. reforestation projects), protecting ecosystems (e.g. preventing deforestation), and industrial removal (e.g. CCUS) or avoidance. Solutions based on technology tend to be more expensive. There are carbon credits with co-benefits that go beyond GHG removal and avoidance (e.g., meeting other United Nations Sustainable Development Goals). Local carbon credits are gaining popularity, but the volume potential in many countries is limited.

The positive aspect of voluntary markets is that projects can receive additional revenue for free use. However, the critical points include the complexity and high transaction costs associated with project registration and certificate issuance. Additionally, these costs must be paid upfront, while payments are results-based and only released after satisfactory monitoring. Low prices and market volatility are also negative aspects. Voluntary market projects can be clustered over various clients and countries to reduce the unitary transaction costs of project formulation, validation, registry, and verification. A rail project needs to achieve at least 100.000 tonnes of emission reductions per annum to be financially attractive at current voluntary market prices.

A rail project needs to achieve at least 100.000 tonnes of emission reductions per annum to be financially attractive at current voluntary market prices

Pricing carbon credits in voluntary carbon markets is different than in compliance markets. According to S&P Global, pricing in voluntary carbon markets is "opaque"[32] . Prices in voluntary carbon markets may register a high variability due to differences in project cost (mainly explained by the type of activity and location), buyer preferences, the number of credits traded per transaction, and the credit's vintage[33].

For the voluntary carbon market to maintain the integrity of the credits generated, issued, and used, it is essential that it aligns with the new context under the Paris Agreement and its relevant new rules. Core and long-held principles underpinning the quality of carbon credits, such as additionality, conservative baseline-setting, and the avoidance of double counting, are all affected in some way by the new rules and model of the Paris Agreement. By aligning with the framework and rules of the Paris Agreement, the expertise, ingenuity and rigour of independent project development, standard-setting and market infrastructure can be applied to serve new compliance uses that are already emerging. Finally, aligning with the framework and rules of the Paris Agreement mitigates the risk of inadvertently undermining or rendering inefficient government efforts, which could, in turn, cast doubt on the efficacy and appropriateness of voluntary efforts.

As previously described, the ITMOs are a new set of market-based provisions defined in Article 6 of the Paris Agreement and replace the former Clean Development Mechanism[34] (CDM) system managed by the United Nations Framework Convention on Climate Change (UNFCCC).

Among the detailed methodologies that can be applied to railway and infrastructure companies in developing countries, the most relevant ones have been approved by CDM.

32 *S&P Global Platts, Platts CEC Price Assessment (link)*

33 *As project methodologies continue to evolve, also in response to experts and market scrutiny, buyers prefer credits from more recent vintages, which may reduce the risk that they buy credits from a project that will have its additionality called into question in the future.*

34 *The CDM is part of the United Nations Framework Convention on Climate Change (UNFCCC). As the largest regulatory project-based mechanism, the CDM offers the public and private sector in high-income nations the opportunity to purchase carbon credits from projects in low or middle-income nations (non-Annex 1). CDM is involved in setting standards and verifying projects. Carbon credits are verified and certified by authorized third parties (Designated Operational Entities).*

Figure 5: Definitions of existing carbon crediting methodologies for the rail sector

METHODOLOGY	DESCRIPTION
AM0090: Modal shift in transportation of cargo from road transportation to water or rail transportation[35]	This methodology applies to project activities that result in a modal shift in the transportation of a specific cargo (excluding passengers) from road transportation using trucks to water transportation using barges, ships, or rail. In Jul 2024, there is only one example of project of this type in the CDM database that is eligible for the transition from CDM to Article 6.4: the Transport Programme of Activities in the Cement Industry in Chile
AM0101: High-speed passenger rail systems[36]	The methodology includes establishing and operating a high-speed rail passenger transport system between urban areas. At the end of July 2024 there are no examples of this type of project in the CDM registry
ACM0016: Mass Rapid Transit Projects[37.]	This methodology applies to project activities for establishing and operating new rail-based or bus-based mass rapid transit systems (MRTS) in urban or suburban regions for passenger transport by replacing a traditional urban public transport system. For trains, typical projects involve the extension of existing rail lines or expansion of existing rail infrastructure (e.g. new rail lines). In July 2024, there are only four examples of projects of this type that are eligible for the transition from CDM to Article 6.4: the Mumbai Metro One, the Metro Delhi in India or the LRT System in Tunis or the Guiyang MRTS Line I Project in China
AMS-III.C.: Emission reductions by electric and hybrid vehicles[38].	This methodology applies to project activities introducing new electric and/or hybrid vehicles that replace fossil fuel vehicles in passenger and freight transportation. In July 2024, the only five examples of projects of this type that are eligible for the transition from CDM to Article 6.4 are all in India except one, and they are the following: Lohia Auto Industries Electric Vehicles, Hero Electric Vehicles, Electrotherm Electric Vehicles, EKO electric vehicles in India and Sustainable Climate transformation by e-mobility in Cambodia

Source: GREEN

35 *https://cdm.unfccc.int/methodologies/DB/4DOIK2WYP8P3AGAVJKT0CHY1NXJ4QP. Emission reductions associated with difference in carbon content between a non-renewable fuel and a less carbon intensive non-renewable fuel used for substitution measure shall not be eligible for Gold Standard registration.*

36 *https://cdm.unfccc.int/methodologies/DB/0U42CLZRFTEERYLAB4SZ87ERW84ZUT. In this specific case in order to be considered eligible for Gold Standard registration the emission reductions associated with difference in carbon content between a non-renewable fuel and a less carbon intensive non-renewable fuel used for substitution measure shall not be eligible.*

37 *https://cdm.unfccc.int/methodologies/DB/PPZC6A7B2DFBT0MC46OK0AROF64FKE. Emission reduction associated with end use energy efficiency improvements measure and also substitution of fossil-driven by renewable energy driven (batteries charged by PV, RECs, or RE fraction in grid) will be eligible for Gold Standard registration*

38 *https://cdm.unfccc.int/methodologies/DB/HLOH5R7J6M96A23TFECTQ1BVIE24CK*

Transport comprises only a very small component (10 out of 3.495, therefore less than 0,3%) of all registered CDM projects eligible for Art 6.4 transition and all of them are in developing countries like India, Chile, Cambodia and China. The main reason for this is the complex and time-consuming procedures required for the quantification of emission reductions and for fulfilling UNFCCC requirements. Nevertheless, there is a slow and increasing trend in the participation of transport projects, particularly those involving fleets of vehicles such as MRT, BRT, metro, and monorail, where the large scale of the project makes it worthwhile for PACM participation.

In the voluntary carbon market, the credits, in CO_2 e, created by projects in transportation and energy efficiency/fuel switching were respectively 1,6% and 3,4% from 2019 to 2023[39]. The volume for these two categories is relatively low considering the GHG generated by transportation relative to other sectors.

The Assessment Framework is the rulebook that outlines the detailed criteria used by the Integrity Council for Voluntary Carbon Markets to evaluate whether carbon-crediting programs and categories of carbon credits meet the ten principles established in the Core Carbon Principles (CCPs). Carbon-crediting programs that are CCP-Eligible will be able to use the CCP label on carbon credits from approved Categories[40].

The ten principles are related to:

1) Effective governance,
2) Tracking,
3) Transparency,
4) Robust independent third-party validation and verification,
5) Additionality,
6) Permanence,
7) Robust quantification of emission reductions and removals,
8) No double counting,
9) Sustainable development benefits and safeguards and
10) Contribution to net zero transition.

39 *The "State of the Voluntary Carbon Market in 2024" by Ecosystem Marketplace. https://www.ecosystemmarketplace.com/publications/2024-state-of-the-voluntary-carbon-markets-sovcm*

40 *The CCPs and Assessment Framework define a threshold standard focused on the integrity of the VCM. The CCPs and the Assessment Framework have been developed through an open dialogue with carbon-crediting programs and other stakeholders and draw from multiple sources, including: the Taskforce on Scaling Voluntary Carbon Markets (TSVCM), the Intergovernmental Panel on Climate Change (IPCC), the United Nations Framework Convention on Climate Change's Paris Agreement and Cancun Safeguards, Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) of the International Civil Aviation Organization (ICAO), and the work of Calyx Global and the Carbon Credit Quality Initiative.*

5. Leveraging the EU Emissions Trading System to Fund Railway Projects: case studies

5.1 The case of a new high-speed railway network connecting main European cities

The EU and the Intergovernmental Panel on Climate Change (IPCC) consider the modal shift from air to rail and from road to rail as one of the most important solutions for decarbonizing the transport sector. Moreover, the continuous evolution of HSR technology will contribute to reducing the CO_2 emissions of HSR services[41].

The EU's Smart and Sustainable Mobility Strategy[42] calls for doubling HSR rail traffic by 2030, and tripling it by 2050, relative to 2015 levels. Reaching these targets will require raising ambitions across the board in the rail sector.

Millions of tons of carbon dioxide have already been saved through the modal shift from air and road to HSR services. This number is expected to grow exponentially as new lines are completed and new services are launched by both incumbents and new operators within the European Single Market. Many countries are expressing increasingly ambitious plans for railways networks and services to meet agreed-upon net zero climate targets.

The EU ETS, based on the scale of carbon avoidance of the project, can contribute to meeting maintenance costs and, in the most promising cases, also cover investment costs. Moreover, it can introduce a significant inflow of money in the long run, making a project more sustainable, financially attractive, and less prone to stalling due to funding deficits. On the other hand, access to carbon finance requires time, up-front investment, and a long-term horizon. Therefore, aggregating projects with similar characteristics and using the same methodologies could reduce initial certification costs and increase their aggregate annual GHG savings. This approach could generate more interest from results-based climate finance investors and institutions.

41 *As an example, Eurostar ordered a robust and consistent monitoring study in each of its markets to highlight the environmental benefits of taking the train. This study based on 2022 data compared Eurostar's carbon emissions with other modes of transport on equivalent journeys completed by car, plane, or bus. The results show that its trains emit an average of 5,5g of CO_2 per passenger per kilometer, which is on average 90% less CO_2 than travelling by car and 95% less than going by plane.*

42 *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions (2020). Sustainable and Smart Mobility Strategy – putting European transport on track for the future {SWD(2020) 331 final}. Retrieved from EUR-Lex - 52020DC0789 - EN - EUR-Lex (europa.eu). The strategy and importance of HSR have been backed further in the Council of the EU's general approach to the TEN-T Network*

The report "Smart and affordable rail services in the EU: a socio-economic and environmental study for High-Speed in 2030 and 2050 – Executive Report[43]" presents the main findings[44] underpinning the establishment of a European HSR network connecting the main European cities and regions, combining investments in constructing creating/upgrading new HSR lines and upgrading the digitalization and automation of existing ones, i.e. ERTMS. The study confirms that investing in a comprehensive European HSR network will deliver added value to European society and massively reduce the environmental footprint of European passenger transport. The report proposes a Masterplan for the HSR network connecting all EU capitals and major cities and calls for the Commission and Member States for a coordinated implementation with sufficient funding in the next decades. Such a comprehensive network, tripling the existing high-speed rail (HSR) network, will require substantial investment costs averaging €550 billion. However, it is expected to deliver a net positive benefit of approximately €750 billion to society.

The results of both the market and the impact assessments were highly positive and supportive of an expansion of the European HSR network. According to the more ambitious 2050 scenario, approximately 49.000 km of HSR lines will be in operation in Europe already by 2040. This, in conjunction with the demand "shocks", such as increased HSR competition and investments in railway technologies, would result in HSR accounting for 54% of passenger transport by 2070. Conversely, the less ambitious 2030 scenario would limit the HSR share to only 32%. Expanding HSR would significantly contribute to combating climate change.

The impact assessment of the Master Plan presents the impact of the network, policies and

technological developments and the resulting traffic demand in various scenarios. By applying a Cost-Benefit Analysis (CBA) to the investment in constructing the networks, the technical report concludes that expanding the HSR network and introducing other measures, such as innovative railway technologies and competition in the HSR market, are likely to be highly beneficial to European society. The HSR network is expected to yield a financial benefit of € 400-447 billion for the 2030 scenario and € 561-836 billion for the 2050 scenario to European society. The benefits would, hereby, outweigh the costs 5-10 times in the 2030 scenario and 2-4 times in the 2050 scenario.

The assumptions regarding CO_2 emissions from different transport modes have been based on the CE Delft study on the external costs of

43 The report is based among other elements on information and conversations with CER/ALLRAIL//UNIFE on the basis of a common MoU and it was prepared by EY in collaboration with the Bocconi University (Green centre) and Blue Arches for the Europe's-Rail JU

44 The study is presented in greater detail in the two Technical Reports (1 & 2), covering the market and impact assessments respectively.

transport[45]. The study includes emissions from both the production of energy (well-to-tank) and the operation of the modes (climate change, CO_2 emissions). This approach accounts for emissions related to the energy mix and the emissions from powering electric transport. The energy mix (well-to-tank) is assumed to gradually decarbonize over time, based on the forecast from the International Energy Agency in their World Energy Outlook 2021[46].

The energy mix needed to power electric vehicles is thereby assumed to be net zero by 2050. Based on recent trends in partnerships between energy providers and infrastructure managers, it is assumed that the energy mix for rail will be CO_2 net-zero by 2030[47]. The study includes estimations on the future CO_2 emissions from constructing both rail and other infrastructure such as airports and highways. According to the study, the increased shift to HSR in the 2030 and 2050 scenarios, coupled with a rapid decarbonization of the power supply for rail, will be key to decarbonizing the European transport system. By 2070, compared to the baseline scenario, a total of 1,5 and 5 billion tonnes CO_2 will be saved in the 2030 and 2050 scenarios, respectively.

The first estimates of the results of the project HSR network are based on the economic principle that the rail project will benefit from the ETS revenues collected in the transport sector in proportion to the carbon avoidance generated specifically by the project. The general economic principle is that the GHG intensive transport modes should cross-finance the most sustainable transport mode.

The following table presents the estimated results in terms of the total value of carbon avoidance in 2025-2070 period, with no economic or financial discount, considering two scenarios (scenario 2030 and scenario 2050[48]) and two different values of the carbon price during the 45 years period of analysis (2025-2070), with the following assumption:

1. Equal distribution of CO_2 saved per year;
2. Carbon price per tonne CO_2e: €95 from 2025 to 2034 and €120 from 2035 to 2070;
3. Scenario 2030 assumes to invest in 5.200 km of new HSR line by 2040 while scenario 2050 assumes to invest in 34.200 km of new HSR by 2040.

If realized, the two scenarios will result in a significant amount of saved CO_2 emissions. The displacement of more GHG-intensive transport modes (airplanes, buses, conventional rail, motorcycles, and personal cars) by less GHG one (HSR) generates energy efficiency for the transport system. The 2030 scenario will save a total of 1,5 billion tonnes CO_2 by 2070 while the 2050 scenario will save a total of five billion tonnes CO_2 by 2070, still accounting for the embedded CO_2 emissions of constructing the HSR network. The

45 *European Commission (2019). EU Handbook on the external costs of transport. Version 1.1. Retrieved from Handbook on the external costs of transport - Publications Office of the EU*

46 *International Energy Agency (2021). World Energy Outlook 2021.*

47 *According to PRIME Benchmark Report the share of renewable energy in rail is already 52% in 2022 for the 15 most important infrastructure managers. Network Rail (10 August 2022). Network Rail signs solar power agreement with EDF Renewables UK in milestone step towards a cleaner and greener railway and Boulouchos, K. & Ducrot, V. (2022) "The Swiss experience to support modal shift Performance-based road-charging and efficient rail infrastructure". The CER Essay Series.*

48 *The complete impact assessment was carried out for the four network scenarios: a baseline where the current HSR network would not be extended; a 2030 scenario of the lines currently under construction estimated to be complete by 2030, a 2050 scenario connecting all European Functional urban Area -FUAs and an extended 2050 scenario which connects the EU accession candidate and potential candidate countries. The analysis presented here are limited to the 2030 and 2050 scenario. 2030 scenario includes the Network comprised of lines in operation and lines to be completed as part of the Core TEN-T Network for a total of 20.500 km (compared to existing 15.200km), while the 2050 scenario includes Network comprised of lines connecting all Functional Urban Areas (FUAs) (above 250.000 inhabitants) in Europe, in addition to the HSR lines forming part of the Extended Core TEN-T Network (2040) and the Comprehensive Ten-T Network (2050) for a total of 49.400 km*

Figure 8: The results of the first hypothesis of rewarding the effect of carbon avoidance of the project HSR network (Hypothetical)

	2030 Scenario	2050 scenario
Total CO_2 Saved (2022–2070):	**1,5** billions of tonnes	**5** billions of tonnes
Annual CO_2 Savings (2025–2070):	**30,61** millions of tonnes	**102,04** millions of tonnes
Value of CO_2 per Tonne (2025–2034 and 2035–2070):	**€95** per Tonne (2025–2034) **€120** per Tonne (2035–2070)	
Total Value of carbon avoidance (2025–2070):	**€157,65** Billion	**€525,51** Billion
Construction of new HSR lines	**9.555 km**	**31.849 km**

Data based on baseline hypothesis values from EU projections

Source: GREEN elaboration

traffic shifted to HSR will result in a substantial amount of: €157,6 billion in the 2030 scenario and €525,5 billion in 2050 scenario.

The study assumes construction costs of €16,5 million per km. Based on our estimates, in the 2030 scenario, up to 9.555 km of HSR lines could be financed due to the benefits of carbon avoidance. This is more than double the 5.300 km of investments assumed in the 2030 scenario. In the 2050 scenario, 31.849 km of HSR lines could be financed, which is equivalent to 95,3% of the investments assumed for that year.

5.2 The case of a technological innovation in the freight sector: the implementation of DAC

Rail freight is the backbone of a sustainable transport system, but innovations are essential to enhance its competitiveness. Rail freight transport faces significant challenges like asset utilization, poor data quality or complex processes. To cope with these challenges, changes are required. Automatization and digitalization play a crucial role in enhancing the competitiveness of rail freight. One groundbreaking innovation to enable these developments is Digital Automatic Coupling (DAC), which has the potential to significantly accelerate the transformation of rail freight transport. The vision of future freight transport involves an intelligent system that interconnects various stakeholders, processes, and technologies.

The tasks involved in preparing a freight train, such as brake testing, coupling, uncoupling, and recording the wagon order, are still done manually in Europe. The introduction of Digital Automatic Coupling (DAC) aims to enhance the attractiveness of rail freight and modernize the system, bringing numerous benefits[49].

The most important benefit of DAC for European rail freight is the increase in capacity, productivity, and quality.

The assessment of the potential effects of DAC carried out in the study DACcelerate-European Freight DAC Delivery Programme[50], particularly in the section 4.5 “Modal shift potential” and section 7.1 “Report on capacity/productivity gains, modal shift potential, market opportunities and quantification of external effects”, shows that the introduction of DAC has a significant potential to increase the modal share of rail in the freight sector. This is primarily due to the enhanced functions DAC enables, including faster and heavier freight trains. However, it is crucial to focus on intermodal and single wagonload rail products. The introduction of DAC will greatly enhance rail transport's environmental sustainability, particularly by reducing greenhouse gas emissions by 55% by 2030.

The European DAC Delivery Programme (EDDP) enabled by Europe’s Rail executed a specific study to analyse the socio-economic and environmental benefits of the implementation of the DAC Core system and DAC applications (Full Digital Freight Train Operations). According to the study's focus on CO2 emissions, the total annual savings at

49 *The Digital Automatic Coupler (DAC): An Effective Way to Sustainably Increase the Efficiency of Freight Transport in Europe - by Luciano Cantone et. al. – Nov. 2022 and Scientific Poster for Transport Research Arena 2024 Dublin presented by DB Cargo*

50 *https://projects.shift2rail.org/s2r_ip5_n.aspx?p=DACCELERATE*

the EU level due to the introduction of DAC is approximately 5 million tonnes/ year, equal to 140 million tonnes over 30 years.

The first estimates of the results of the EDDP project are based on the economic principle that the rail project will benefit of the ETS revenues collected in the transport sector in proportion of the carbon avoidance generated specifically by the project. The following table presents the estimated results for the total value of carbon avoidance over the 2026-2055 period, without any economic or financial discounting, and considers two different carbon price values over the 30-year analysis period, based on the following assumption: 1) Equal distribution of CO_2 saved per year; 2) Carbon price value per Tonne CO_2eq: 95 Euro from 2025 to 2034 and 120 Euro from 2035 to 2055.

If realized, the scenarios will result in a significant amount of saved CO_2 emissions. The modal shift environmental benefits related to faster and heavier trains generates energy efficiency for the transport system. The reference scenario will save a total of 140 million tonnes CO_2 in 2026-2055. The freight traffic shifted from road to rail will result in a substantial amount of potential carbon avoidance: €16,8 billion in 2026-2055 scenario, equal to €588,3 million per year.

The EDDP study assumes an investment cost, related to CAPEX (Coupler costs, additional components and Infrastructure & IT systems) and OPEX (recurring costs and one-off costs), is around €20.000 for each of the 460.000 wagons in the market and for each of the 17.000 locos, for a total investment cost of approximately €10 billion.

Figure 9: The results of the first hypothesis of rewarding the effect of carbon avoidance of the project European DAC Delivery Programme (Hypothetical)

	Reference Scenario
Total CO_2 Saved (2026–2055):	**140** millions of tonnes
Annual CO_2 Savings (2026–2055):	**5** millions of tonnes
Value of CO_2 per Tonne (2025–2034 and 2035–2055):	**€95** per Tonne (2025–2034) **€120** per Tonne (2035-2055)
Total Value of carbon avoidance (2026–2055):	**€16,75** Billion
Available funding for DAC deployment:	**460.000** wagons + **17.000** locos

Source: GREEN elaboration

5.3 The case of the electrification of a port rail line

In March 2021, a collaboration between the Port of Antwerp, Railport, and Infrabel announced their "Sustainable Rail Vision for the port of Antwerp". This vision outlines a significant commitment to doubling the modal share of freight transport at the port, increasing it from 7% in 2019 to 15% by 2030.

Increasing the modal share of freight traffic at the port of Antwerp will create important spill-over effects for the rest of the Belgian transport network. The port of Antwerp is one of the most important logistics hubs in the country, with many connections to the rest of Europe.

Freight transport to and from the port of Antwerp accounts for nearly half of all freight transport by rail in Belgium. The Antwerp road network suffers from severe congestion, imposing an important constraint on the further growth of freight transport. This makes a modal shift towards rail even more indispensable. In addition, the persistent shortage in truck drivers makes a modal shift towards rail even more desirable. The Sustainable Rail Vision for the Port of Antwerp aligns with the broader goals of greening freight transport and achieving carbon neutrality by 2050[51].

It is within this context of the Sustainable Rail Vision that Transport & Mobility Leuven developed a Social Cost Benefit Analysis (SCBA) for the electrification of 9,5 km long railway line 11 connecting BASF, a huge chemical industry company, and Combinant, operator of an intermodal open terminal. In this SCBA the baseline scenario corresponds to the existing situation of the rail network.

The expected results of this project are the following:

- Reduction in emissions from diesel locomotives in the port on line 11. Nearly all diesel locomotives going to BASF and Combinant will be replaced by electric locomotives.

- Reduced travel time for the goods transported via line 11. Today, most freight trains entering the port have electric traction. To reach the destination via line 11, today each electric locomotive arriving at Antwerp North (=entering point to the port) needs to be replaced by a diesel locomotive. This takes on average 1,76 hours per locomotive change.

There will be a reduction in greenhouse gas (GHG) emissions of 15,2 grams per tonne-kilometer as most polluting diesel locomotives are replaced by

51 ERA (2022)

electric locomotives, which have a marginal climate cost of zero.

The SCBA does provide a focus on CO_2 emissions: the total savings / year thanks to the electrification of line 11 is approx. 158,7 tonnes per year in 2025 and 396,7 in 2050 for a total of 5.272 tonnes in the 26-year period.

The first estimates of the results of the line 11 electrification project are based on the economic principle that the rail project will benefit of the ETS revenues collected in the transport sector in proportion of the carbon avoidance generated specifically by the project. The following table presents the estimated results for the total value of carbon avoidance over the 2026-2050 period, without any economic or financial discounting, and considers two different carbon price values over the 30-year analysis period.

If realized, the scenario will result in a non-significant amount of saved CO_2 emissions. The environmental benefits related to a substitution of diesel loco with electric ones for 9,5km in the port of Antwerp will generate operational efficiency, but limited energy efficiency for the transport system. The scenario will save a total of 5.272 tonnes CO_2 in 2026-2050 and will equal to €0,59 million.

The electrification of line 11 in the port of Antwerp assumes an investment costs of approximately €30 million and €0,162 million per year in terms of operational costs. Therefore, according to these estimates, in the 2026-2050 scenario only a small amount of the yearly operational costs could be financed through the benefits of carbon avoidance. By the way, the project has a positive social benefit/cost ratio thanks to the reduction of travel times and increase of operational efficency of the intermodal transport services to and from the port.

Figure 10: The results of the first hypothesis of rewarding the effect of carbon avoidance of the project electrification of line 11 in the port of Antwerp (Hypothetical)

	Scenario
Total CO_2 Saved (2026–2050):	**5.272** tonnes
Annual CO_2 Savings (2026–2050):	**158,7 to 396,7** tonnes
Value of CO_2 per Tonne (2025–2034 and 2035–2050):	**€95** per Tonne (2025–2034) **€120** per Tonne (2035-2050)
Total Value of carbon avoidance (2026–2050):	**€590.599**
Funding to cover annual operational costs: 15%	**15%**

Revenues obtained from auctoning ETS allowances should be considered for cross-financing, supporting, more sustainable transport modes, such as rail.

6. Recommendations to support the EU's rail transport financing through the EU carbon market

EU policies should support development of the rail transport in three steps:

1. Increasing awareness of rail's contribution to decarbonising transport emissions through carbon avoidance;
2. Implementing specific guidelines for Member States to allocate a share of revenues from the EU ETS, Innovation Fund, Modernisation Fund, and Social Climate Fund to support rail investments focused on modal shift and energy efficiency solutions;
3. Exploring further possibilities to use ETS revenues to boost financing for decarbonisation of transport, including railways, reinforcing the role of the EIB and of private long term investors.

Accelerating the sustainable finance framework for railways could help bridge the gap between required investments and existing funding in this sector. This would support essential transport activities needed for the transition, aligning with

the European Green Deal and Paris Agreement objectives.

Revenues obtained from auctioning ETS allowances in the transport sector should be considered for cross-financing, supporting more sustainable transport modes, such as rail, extending for instance the role of the Innovation Fund and Social Climate Fund to specific transport priorities that could guarantee a relevant role for modal shift and energy efficiency solutions in the rail sector, such as TEN-T cross-border projects or European widespread diffusion of technological improvements such as DAC.

Establishing a new funding instrument is essential to deal with the new challenges that Europe will increasingly face in the coming years, among which ensuring the resilience of infrastructures at high risk due to climate change, expanding rail infrastructure, implementing the EU HSR masterplan also proposed by Enrico Letta[52], and sustaining interoperability technologies for supporting the Single Market while favoring alliances among stakeholders to push down the costs of automation and digitalization.

The main reasons for allocating a percentage of transport ETS revenues to rail investments in a coordinate manner among EU Member States fall into four main categories:

1. to accelerate sectoral decarbonization in the EU through modal shift and energy efficiency;
2. to support interoperability, through harmonization and standardization, which help products reach sufficient volume to benefit from economies of scale, thereby driving production costs down (e.g. DAC);
3. to mitigate the adverse welfare impacts of the ETS on affected transport industries or communities offering a lower cost of alternatives;
4. to mobilize additional sources of climate finance offering also more opportunities for long-term private investors in the sector.

The regulatory landscape related to carbon markets is dynamically evolving and the EU ETS will be revised in 2026[53].

As the EU's climate bank, the EIB could support railway projects through a Rail Carbon Platform with co-funding. The EIB's extensive experience in the railway sector is already highlighted by the Green Rail Investment Platform, which focuses on financing investments to address decarbonisation challenges by expanding electrification and introducing new technologies. Therefore, the Rail Carbon Platform could be seen as an evolution of an existing financial instrument. Additionally, the EIB's supporting role will be crucial in fostering synergies and complementarities with the Innovation Fund and Modernisation Fund and long-term private investors.

The role of the EIB in the sector could be strengthened by the EC launch of "Action plan to boost long distance and cross-border passenger rail" on 14 December 2021, which contains its clear commitment to the Luxembourg Rail

52 *Letta, E. (2024) "Much more than a market - speed, security, solidarity, empowering the Single Market to deliver a sustainable future and prosperity for all EU Citizens, high-level report on the future of the Single Market, commissioned by the European Council.*

53 *Delbeke J., Dombrowicki P., Iozzelli L., Marro E. (2024) "International and European Action on international carbon credits", Policy Brief, Florence School of Transnational Governance, EUI.*

Protocol[54]. "The Luxembourg Protocol" has entered into force formally on 8 March 2024. The EIB will also be crucial in building trust, encouraging ambition, and providing predictability and legal certainty. Additionally, the EIB could offer capacity-building and advisory services to rail stakeholders.

EIB could support the presentation of railway projects by clustering interventions across railways to increase their aggregate annual GHG savings for results-based climate finance (e.g. DAC, hydrogen locos, etc). An example could be a Special Purpose Vehicle for Energy Performance Contract for DAC. The potential role of Energy Services Companies (ESCO) could be indirectly supported through a credit mechanism based on a mix of revenues deriving from blended financing plans linked to certificated energy savings and GHGs reductions. This system should be fit for the long-term. While it must be sufficiently flexible to cater for a diverse range of commitment types, national capabilities and circumstances, this flexibility should not undermine transparency, accountability, and ambition. Independent expert review teams should conduct regular reviews.

The EIB is well-positioned to support the European Commission, Member States, and private long-term investors in enhancing their ability to combine funds using carbon market revenues. This support will help reinforce EU priorities in the rail sector, particularly for cross-border projects and interoperability.

EC should implement specific guidelines for Member States to use a specific quota of Innovation Fund, Modernisation Fund, and Social Climate Funds in order to support cost-effective rail investments dedicated to modal shift and energy efficiency solutions

54 *The Luxembourg Protocol to the Convention on International Interests in Mobile Equipment on Matters specific to Rail Rolling Stock signed (hereinafter referred to as the Rail Protocol), was adopted by a diplomatic Conference, held in Luxembourg, on 23 February, 2007. The Rail Protocol provides a mechanism for recognizing and registering international security interests in railway rolling stock to facilitate cross-border and domestic financing of such assets. The rail sector was chosen as one of the sectors to be covered by the Cape Town Convention on International Interests in Mobile Equipment (hereinafter referred to as the Convention) to facilitate risk management for international financiers in relation to assets which, by their nature, can cross borders. In addition, even in relation to rolling stock which does not cross borders, the Convention, together with the Rail Protocol, creates an additional security for lenders financing rolling stock. The Rail Protocol is aimed at being an international legal framework which provides security to private investors and encourages private investment in the railway sector.*

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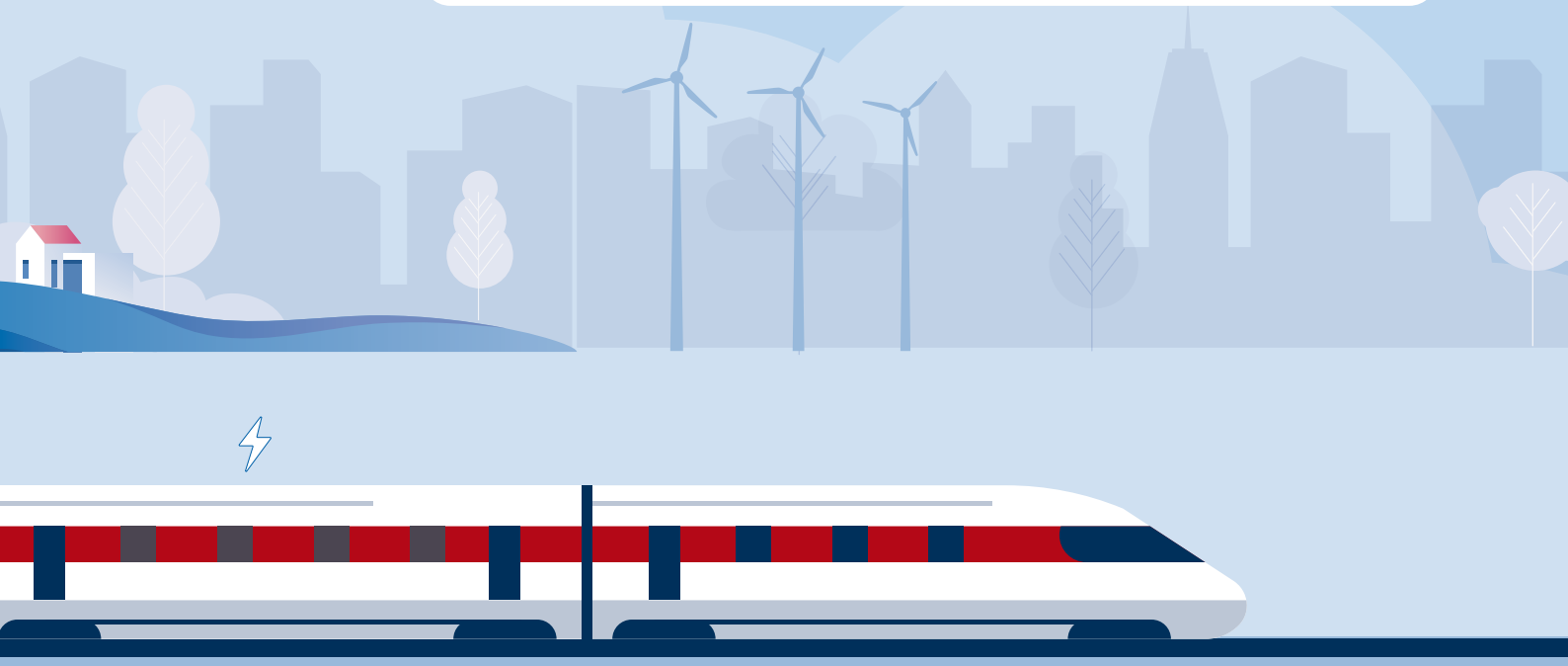
Key facts

Rewarding the effect of carbon avoidance in railway projects through the EU Emissions Trading System (ETS)

provides a significant complementary tool to gather funding for rail investments such as the **completion of the European High-Speed rail (HSR) Masterplan and the deployment of Digital Automatic Coupling (DAC) in freight.**



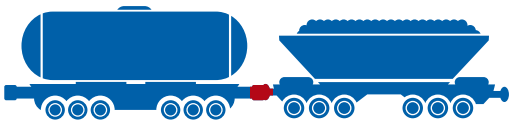
More than

€525 billion

(**95,3%** of the projected total investment costs)
in 2050 scenario could be utilized to **build**

31.849 km
of HSR.

€16,8 billion
through carbon savings and avoidance
of the European DAC delivery programme



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CER

The Community of European Railway and Infrastructure Companies (CER) brings together railway undertakings, their national associations as well as infrastructure managers and vehicle leasing companies. The membership is made up of long-established bodies, new entrants and both private and public enterprises, representing 71% of the rail network length, 76% of the rail freight business and about 92% of rail passenger operations in EU, EFTA and EU accession countries. CER represents the interests of its members towards EU policy makers and transport stakeholders, advocating rail as the backbone of a competitive and sustainable transport system in Europe.

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