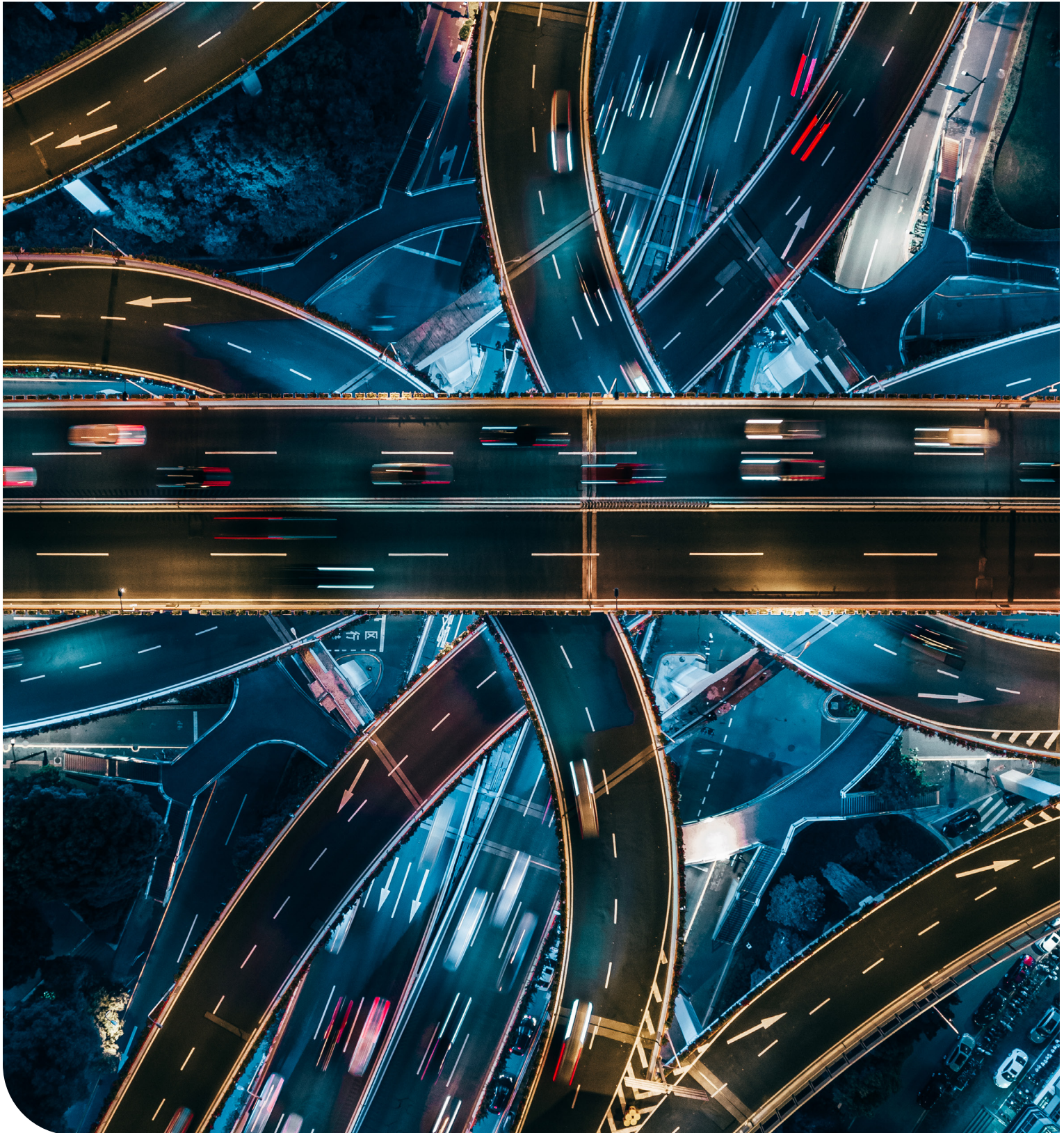


Charting the course:

The essential role of decarbonising transportation
in the transition to a regenerative economy

2023



CHARTING THE COURSE: THE ESSENTIAL ROLE OF DECARBONISING TRANSPORTATION IN THE TRANSITION TO A REGENERATIVE ECONOMY

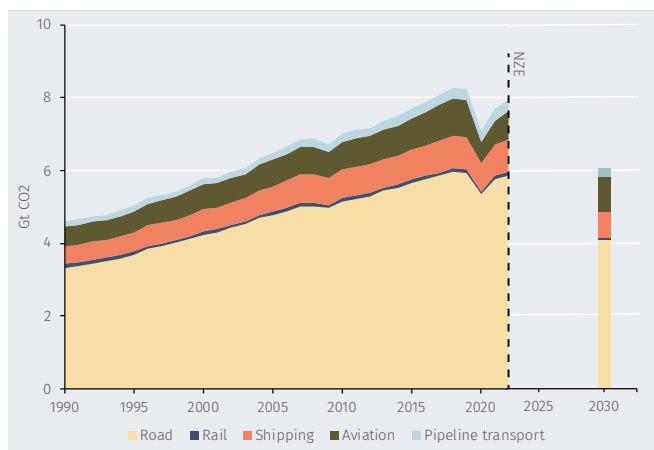
In this thought piece, Melanie Beyeler, Senior Portfolio Manager, details how the transportation industry, which is heavily reliant on fossil fuels, accounts for over 30% of CO₂ emissions from end-use sectors globally. To remain aligned with the Net Zero Emissions by 2050 Scenario, transport emissions will need to be reduced by approximately 25% by 2030. The realisation of this ambitious goal is dependent on three main lines of action: First, to ensure the swiftest possible transition to electric vehicles on our roads; second, to drive the commercialisation and widespread adoption of low-emission fuels – particularly in the maritime and aviation sectors; and third, to enact policies that promote a shift towards less carbon-intensive modes of travel.

Over 75% of transportation energy is driven by road transport

Land, sea, and air transportation predominantly relies on internal combustion engines that are powered by fossil fuels. Today, over 90% of the energy used in transportation comes from oil products, a mere 3.5 percentage point decrease compared to the early 1970s. As a result, the transport sector accounts for over one third of CO₂ emissions from end-use sectors globally.¹

Over three-quarters of the energy consumed in the transportation industry is driven by road transport, with shipping accounting for 10%, aviation for 8% and rail for 2% of total energy usage. Given that the demand for transportation services is expected to rise in the coming years, it is vital for the industry to transition towards a low-carbon future.² A significant uptick in the electrification of urban transportation is now expected, with hybrid and fully electric vehicles (EVs) becoming more common. In contrast, electrifying long-distance forms of transportation such as aviation, marine and road freight presents a more considerable challenge.³

Figure 1. Global CO₂ emissions from transport by sub-sector in the Net Zero Scenario, 2000-2030



Source: International Energy Agency (IEA), 2022

USD 5.7 trillion annual investment needed by 2030

To align with the Net Zero Emissions by 2050 Scenario⁴, the transportation industry will need to reduce its emissions by approximately 25% to around 6 gigatonnes by 2030 (see Figure 1). To realise this goal, there are four key areas that the sector must focus on: Achieving a swift transition to EVs on our roads, implementing operational and technical measures to increase energy efficiency, facilitating the commercialisation and widespread adoption of low-emission fuels – particularly in the maritime and aviation sectors – and enacting policies that promote a shift towards less carbon-intensive modes of travel.⁵ Annual investment of USD 5.7 trillion will be needed in the period to 2030 to realise these goals; this includes redirecting USD 0.7 trillion per year from fossil fuel investments towards technologies that facilitate the energy transition.⁶

Road: EV adoption is key to transport decarbonisation

Efforts to boost the adoption of electric vehicles for road use, coupled with the decarbonisation of the power supply, are the most crucial factors in the transportation industry's transition to net zero. Recent technological advances and, in particular, the latest breakthroughs in battery technology, have significantly enhanced the economic viability of EVs. Several G20 nations have set ambitious electrification goals to lower their reliance on fossil fuels. A notable example is Europe's strategy to ban CO₂-emitting cars from its roads with effect from 2035.⁷

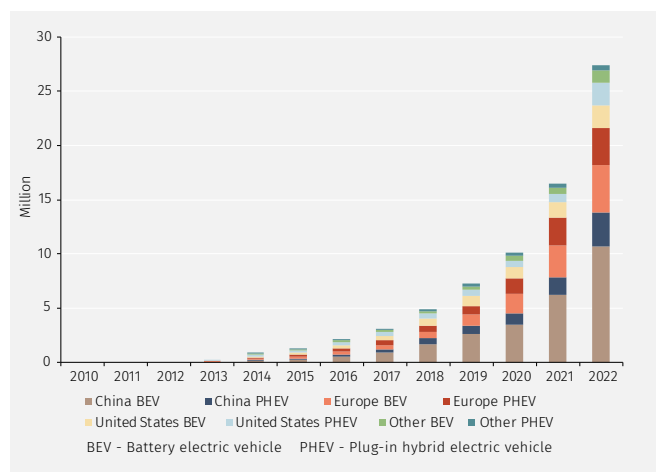
The electric car market is booming, with sales of EVs exceeding the 10 million mark in 2022, a 55% increase compared to 2021. In fact, EVs accounted for 14% of all new car sales in 2022, up from around 9% in 2021 and from less than 5% in 2020. Furthermore, global spending on EVs exceeded USD 425 billion in 2022, a 50% increase year-on-year.⁸

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If the recent surge in EV sales can be maintained, this has the potential to align car-related CO₂ emissions with the Net Zero Scenario. Importantly, however, rates of EV adoption vary significantly from region to region: While there has been a significant increase in EV sales in China, for example, as well as in certain European countries and some US states, this is far from becoming a global phenomenon (see Figure 2). Sales in developing and emerging countries in particular have so far lagged behind other nations as consumers are deterred by higher upfront costs and an inadequate charging infrastructure.⁹

Figure 2. Global electric car stock in selected regions, 2010-2022

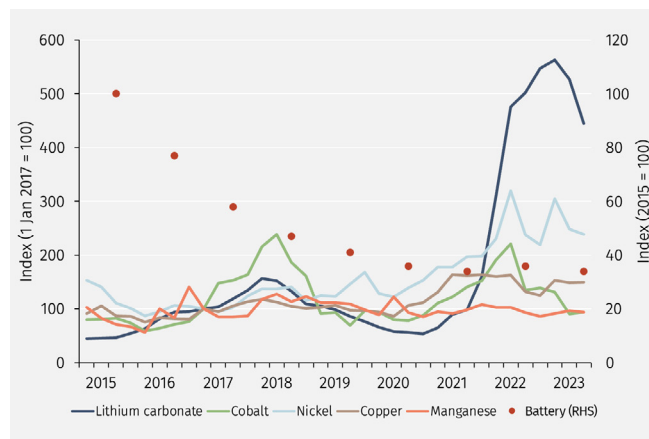


Source: IEA - Global EV Outlook 2023

The way forward for battery technology and recycling

Further research and innovation in battery technology – from the development of advanced cathode and anode materials to scalable manufacturing processes for next-generation batteries – are essential to support progress in the EV space. At the same time, improvements in end-of-life battery management and recycling are vital. Progress continues to be made in enhancing the energy density of batteries and in increasing safety while reducing costs. However, priority should now be assigned to minimising the use of critical metals such as nickel and lithium in batteries, given existing supply challenges.¹⁰

Figure 3. Price of selected battery materials and lithium-ion batteries, 2015-2023



Source: IEA - Global EV Outlook 2023

Lithium-ion batteries currently dominate the EV battery market, with the majority of common battery chemistries relying on essential minerals such as lithium, cobalt and nickel. In 2022, lithium iron phosphate (LFP) batteries – the only lithium-ion battery chemistry that does not use nickel or cobalt – accounted for almost 30% of the battery market, the highest share in the past decade. This surge is partly attributable to the price volatility of battery metals, which rendered LFP batteries more attractive despite their lower energy density (see Figure 3).¹¹

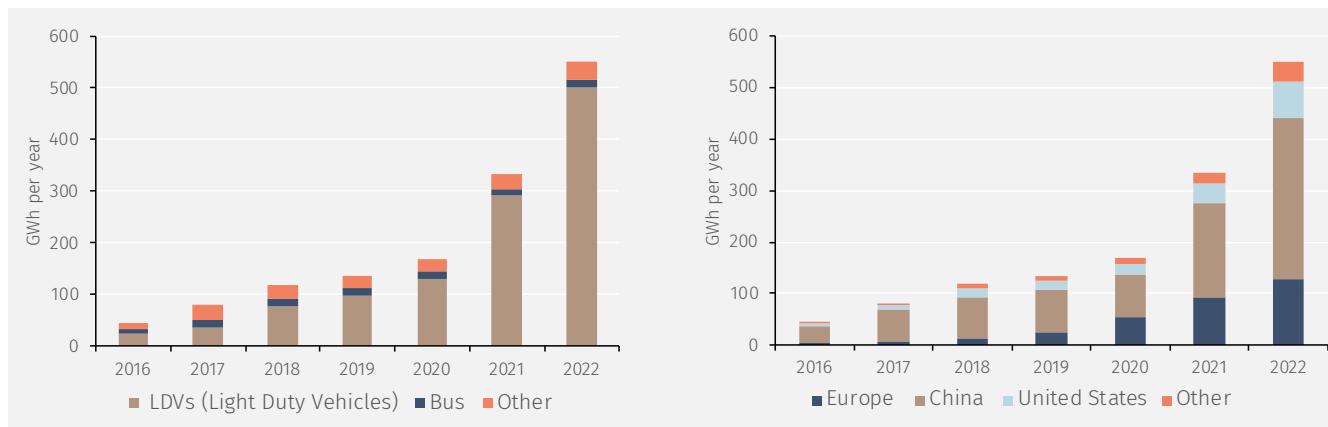
Supply chains for sodium-ion (Na-ion) batteries – currently the sole feasible alternative to lithium-based batteries – are now already being established, with over 100 GWh of manufacturing capacity either in operation or in the pipeline. China's CATL, a global leader in lithium-ion battery manufacturing, has developed a Na-ion battery that is estimated to cost 30% less than a LFP battery. However, it is important to note that the energy density of these Na-ion batteries is lower than even the least energy-dense lithium-ion batteries currently available.¹²

As the demand for batteries surges, another environmental concern is emerging: How to safely dispose of EV batteries at the end of their lifecycle and avoid the generation of significant volumes of waste. The solution lies in recycling, and this is fuelling the development of a new industry with significant growth potential. Countries around the globe are already implementing policies and regulations to address this waste challenge and protect the environment – and further rules are set to follow. We need simply look to the automotive industry to see how this can be done: Lead-acid batteries represented around 95% of the global battery market back in 2016. These batteries today have a recycling rate of over 90% in developed markets thanks to strict regulatory measures.¹³

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Figure 4. Battery demand by mode and region, 2016-2022



Source: IEA - Global EV Outlook 2023

The need for speed when expanding EV charging infrastructure

A large and easily accessible charging infrastructure is vital for the sustained growth of the EV market. Surveys consistently show that the availability of charging options is one of the primary concerns of existing and potential EV owners alike – often ranking higher on their list of priorities than driving range, battery lifespan or even the price of the vehicle.¹⁴ At end-2022, the number of public EV charging stations available worldwide reached 2.7 million, with over 900,000 new installations added during the year, up by 55% versus 2021 (see Figure 5).¹⁵ Under the Net Zero Scenario, there will be a significant expansion of the public charging infrastructure with the installation of 17 million more charging stations by 2030.¹⁶

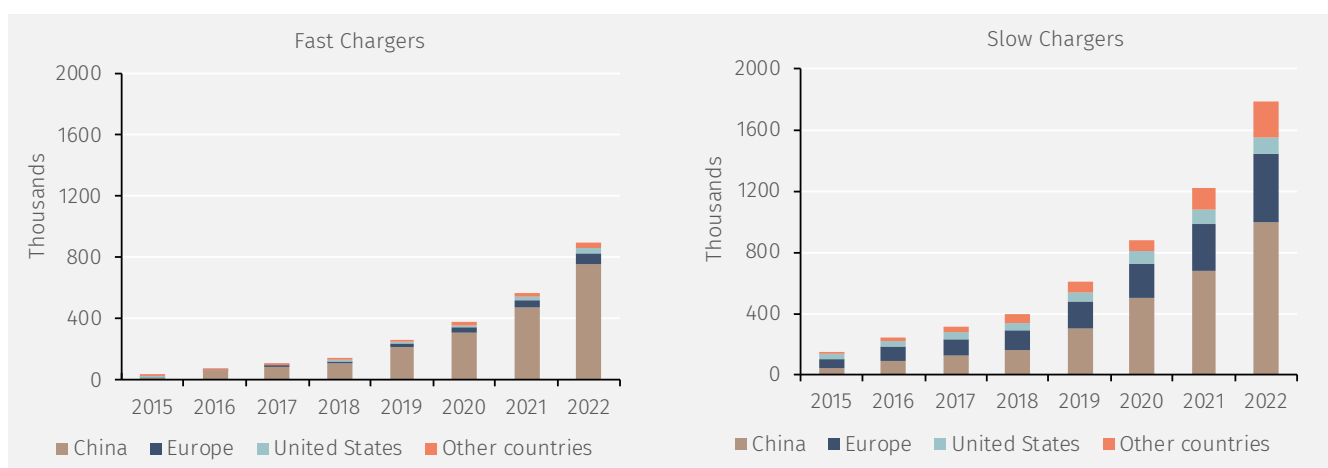
Rail: The most energy-efficient mode of mass transportation

No other form of mass transportation has more potential when it comes to climate action than rail travel, given

its high level of energy efficiency. It handles 9% of global motorised passenger traffic and 7% of freight shipments, while accounting for only 3% accounting for 3% of transportation energy consumption, according to the International Energy Agency. Despite its significant contribution to achieving the targets set out in the Paris Agreement, rail has unfortunately recently been losing market share to higher-polluting forms of transport in most major markets across the globe (see Figure 6 overleaf).¹⁷

Over the past decade, urban and high-speed rail infrastructure has developed rapidly, laying the groundwork for convenient low-emission transportation within and between cities.¹⁸ To align with the Net Zero Scenario, emissions need to decrease by 5% annually in the period to 2030. This will involve converting diesel operations to electric, using biodiesel blends, and implementing various efficiency measures. All new high-throughput rail corridors must be electric, while hydrogen or battery-electric trains with strategic charging stations will need to replace diesel trains on less busy lines.¹⁹

Figure 5. Installed publicly accessible light-duty vehicle charging points by power rating and region, 2015-2022

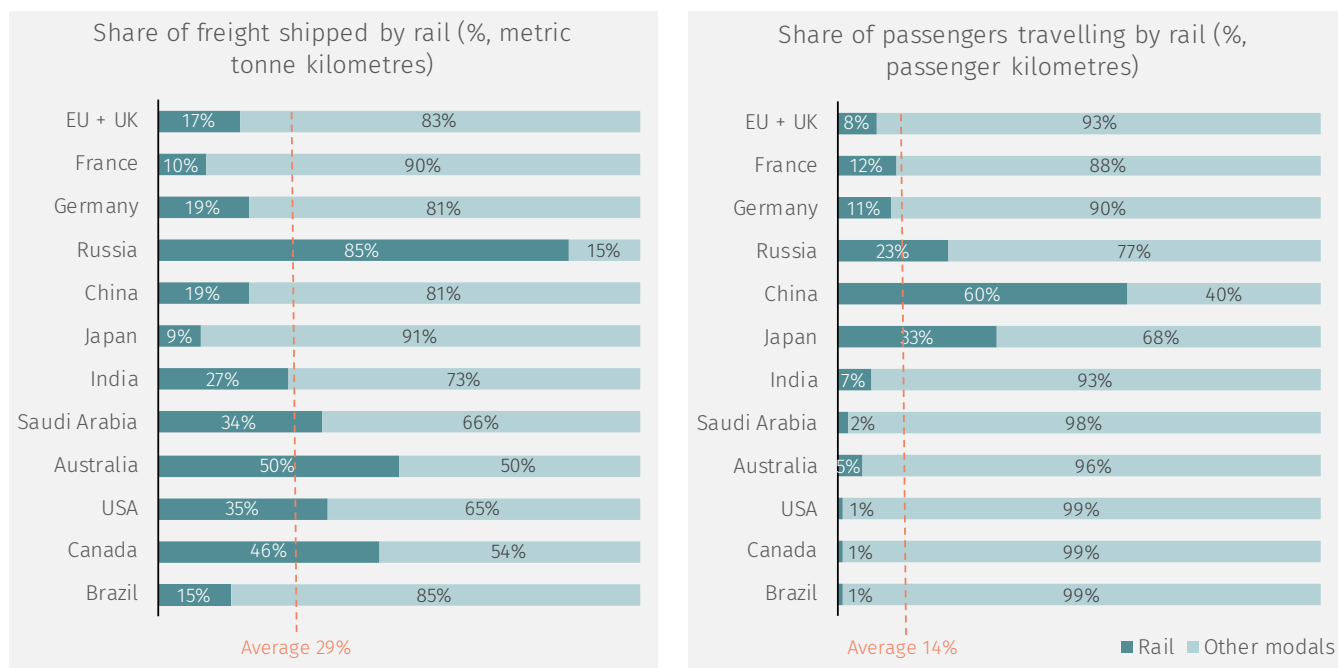


Source: IEA - Global EV Outlook 2023

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Figure 6. Rail's share of transport is underrepresented in most countries and regions



Source: BCG, Riding the rails to sustainability 2022

Hydrogen trains gain momentum

Hydrogen-powered trains are gradually gaining traction globally as a sustainable means of transport. Germany began operating its first hydrogen trains in 2022, for example, with more on the way. Japan and Spain are now trialling hydrogen trains, with France soon set to follow, while Italy has allocated significant funding for the purchase of hydrogen-powered trains. Meanwhile, India is expected to start test-runs later this year and Chile is planning to introduce hydrogen trains in 2024. Together, these countries are demonstrating the global commitment to this green technology.²⁰

Hydrogen fuel cell trains can cover long distances of up to 1,000 km at speeds of up to 140 km/h without needing to refuel. Unlike electric trains, they do not require investment in overhead catenary lines, making them a cost-effective alternative for long-distance routes with low usage. Additionally, fuel cell trains offer the advantage of potentially rapid refuelling times.²¹

Shipping: Fossil fuels still power 99% of energy needs

Maritime shipping facilitates 80-90% of worldwide trade and contributes approximately 3% to annual global greenhouse gas (GHG) emissions. While this may seem like a small percentage, the long lifespan of vessels and the projected growth in this sector underscore how important the next decade will be for the decarbonisation of this

industry.²² The International Maritime Organization (IMO) estimates that by 2050, maritime trade could increase between 40% and a staggering 115% compared to 2020 levels. The IMO has warned that if no action is taken, GHG emissions associated with the shipping sector could grow by between 50% and 250% by 2050 compared to 2008 levels.²³

At present, fossil fuels cover around 99% of the energy used in international shipping, with fuel oil and marine gas oil (MGO) accounting for up to 95% of total consumption.²⁴ By 2030, alternative fuels will have to make up 15% of the total energy mix to align with the Net Zero Scenario – a massive increase from the current figure of less than 0.5%. It is projected that approximately half of low-carbon fuel consumption in 2030 will consist of biofuels, which are suitable for use in existing vessels. However, the adoption of other fuels, particularly ammonia and hydrogen, will require substantial developments in both policy and technology.²⁵

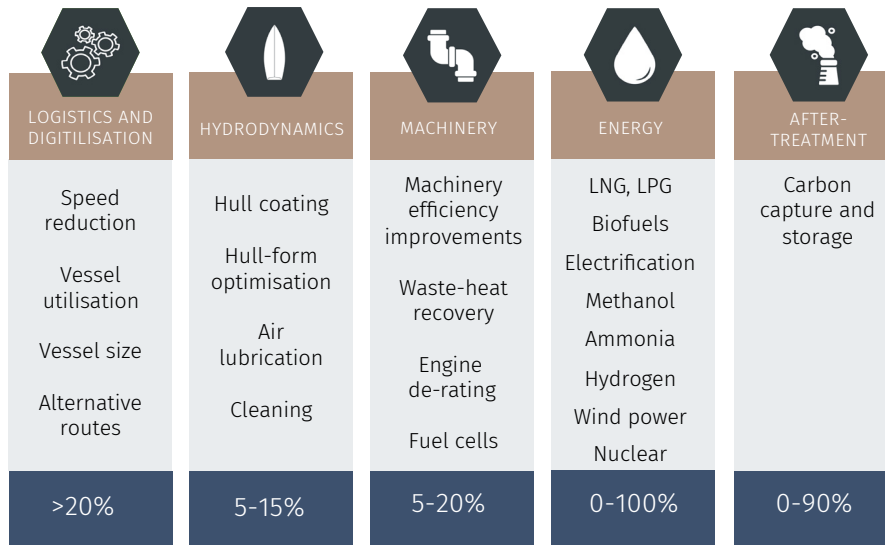
Not all plain sailing: Challenges and progress in the transition to alternative fuels

The primary focus of emissions reduction efforts in the shipping sector is on replacing existing fossil fuel sources with alternative fuels. However, this transition to alternative fuels is in its infancy, with only 1.2% of vessels currently utilising alternatives such as liquefied natural gas (LNG), and to a lesser extent, battery/hybrid, liquefied petroleum gas (LPG), or methanol.²⁶

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Figure 7. Solutions that can contribute to decarbonise shipping, and their GHG reduction potential



Source: DNV, Maritime Forecast 2050

There are currently several obstacles that are preventing the swift transition and decarbonisation of the shipping industry. They comprise the availability and cost of alternative fuels, the level of maturity of fuel technologies, technical feasibility, safety considerations, infrastructure needs for bunkering and onboard fuel storage, and the potential impact on ship and engine design, not to mention the skills and capabilities of the crew. The decarbonisation of the shipping sector cannot be achieved in isolation and will require concerted efforts across the entire ecosystem.²⁷

Despite the challenges faced by shipowners, there are nevertheless signs of progress, with 6.5% of ships that are currently operational and 51% of those on order (measured by gross tonnage) capable of using alternative

fuels, including LNG carriers. These figures represent an improvement on the previous year, when the numbers were 5.5% and 33%, respectively. In terms of gross tonnage, LNG fuel dominates, with battery/hybrid solutions deployed mostly on smaller vessels. It is nevertheless important to acknowledge that while LNG has a lower carbon footprint than heavy fuel oils, it still falls within the category of fossil fuels, and is exposed to issues such as methane slip and to emissions associated with the entire production-to-tank process.²⁸

Aviation: CO₂ emissions grow faster than rail, road or shipping

In 2022, the aviation sector contributed 2% of global energy-related CO₂ emissions, signalling a more rapid

Figure 8. Alternate fuel uptake in the world fleet in number of ships (upper) and gross tonnage (lower), as of July 2023

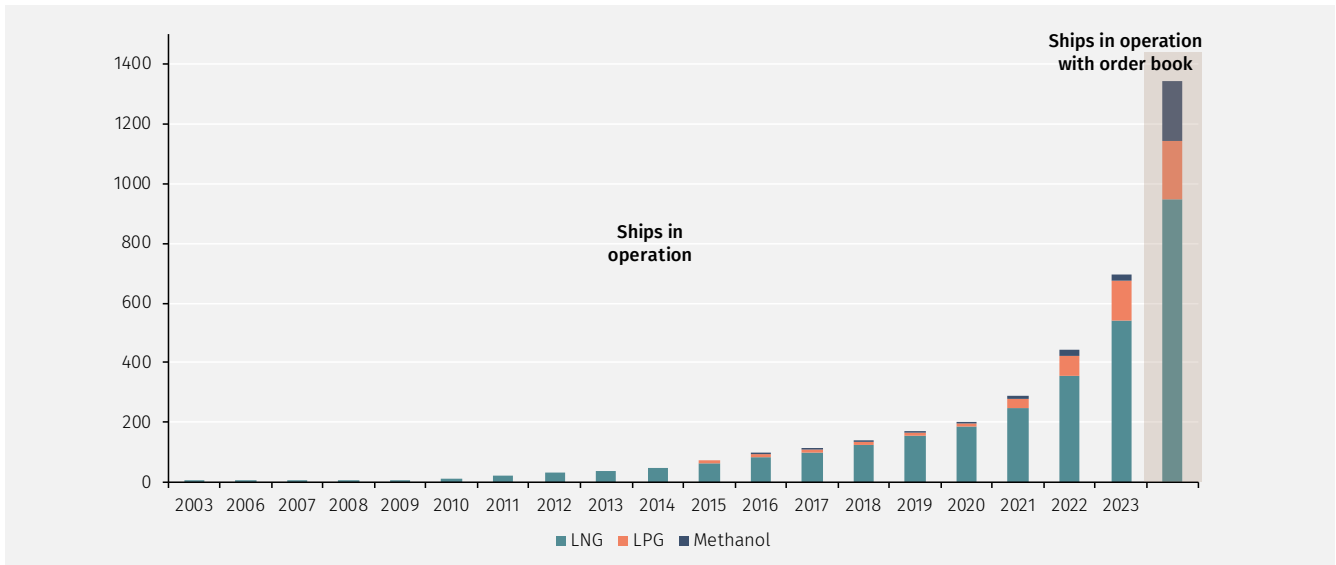


Source: DNV, Maritime Forecast 2050

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Figure 9. Development of LNG, LPG and methanol fuel technology uptake by number of ships, excluding gas carriers



Source: DNV, Maritime Forecast 2050

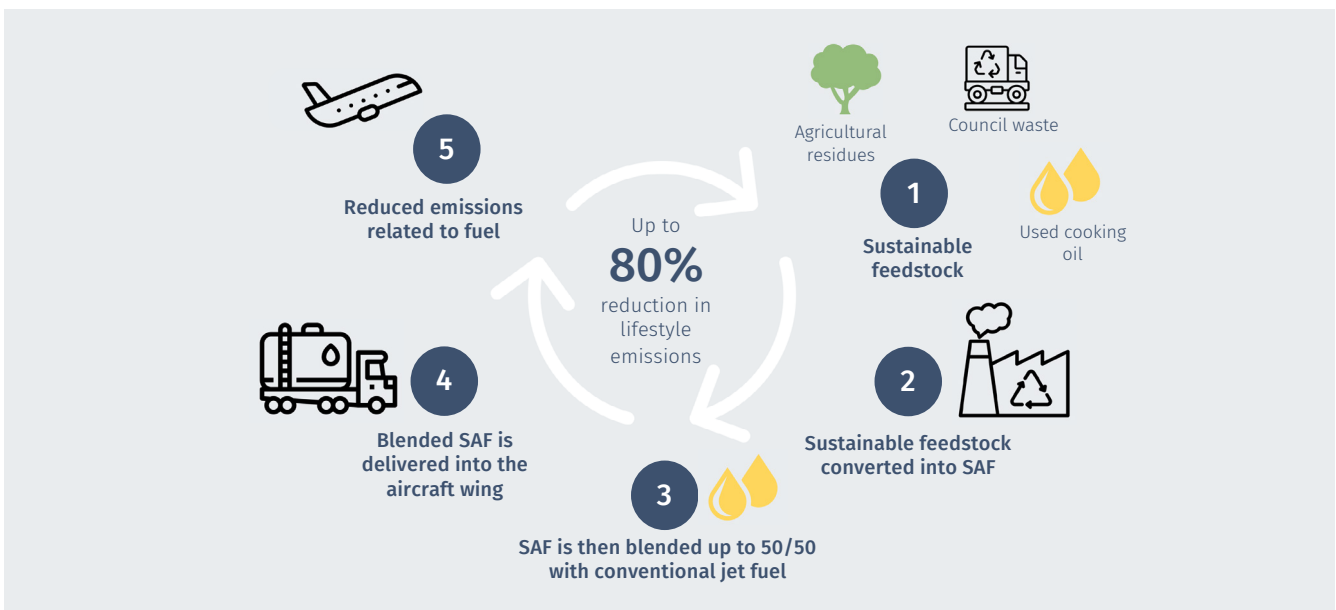
growth rate in recent decades than rail, road or shipping. Similar to shipping, the extended operational lifespan of aircraft, combined with the expected expansion of this sector, shows why it is critically important to achieve decarbonisation within the aviation industry over the next decade.²⁹

The options for delivering deep decarbonisation are rather limited in the aviation sector. Aviation relies heavily on high-energy-density fuels, primarily due to the weight and volume restrictions of aircraft. Given the existing aircraft configurations, the range of alternative fuels that can effectively replace traditional jet fuel is restricted

to advanced biofuels and synthetic drop-in fuels, often referred to as e-fuels.³⁰

Driving the development of innovative technologies across the sector – from the production of low-emission fuels to enhancements in aircraft and engine design and operational optimisation – will be essential to reduce emissions from aviation. Additionally, measures to curb consumer demand will be key to limit emissions growth and to then ultimately lower emissions in the course of the decade in alignment with the Net Zero Scenario.³¹ The primary strategy for reducing the aviation industry’s carbon footprint is to establish objectives for the utilisation of Sustainable Aviation Fuels (SAFs).³²

Figure 10. Sustainable aviation fuel creation



Source: Action Renewables

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Targeting 10% SAF usage by 2030

SAFs are liquid aviation fuels that have the potential to cut CO₂ emissions by 80%. Made from various sources (feedstock), including synthetic production that captures carbon from the air, SAFs are sustainable because they do not compete with food crops or use additional resources such as water or land, and they do not contribute to environmental problems like deforestation or biodiversity loss. Unlike fossil fuels, which release locked-away carbon, SAFs recycle the CO₂ absorbed by biomass in their feedstock's lifecycle. They are a "drop-in fuel" that has to be combined with fossil (petroleum-based) jet fuel and can then be used in existing aircraft engines without any need for modifications to existing propulsion systems.³³

At present, jet kerosene is the dominant choice for aviation fuel, with SAF accounting for less than 0.1% of total aviation fuel consumption. Anticipated production capacity is expected to cover only 1-2% of the demand for jet fuel by 2027. To meet the goal of increasing SAF usage in aviation to 10% by 2030, in alignment with the Net Zero Emissions by 2050 Scenario, substantial investments in SAF production capacity will be essential, together with the implementation of accompanying measures such as the introduction of targeted fuel levies and low-carbon fuel standards.³⁴

Conclusion

The urgent need to decarbonise the transportation industry is beyond question, especially as the demand for transportation services is expected to rise in the coming years. Given that road transportation accounts for 75% of transportation energy globally, the accelerated adoption of EVs is particularly important to ensure alignment with the Net Zero Emissions by 2050 Scenario. Further, with rail representing the most energy-efficient form of mass transport, focused efforts are needed to reverse the decline in its market share versus higher-polluting forms of transport. Additionally, the shipping and aviation sectors must focus on overcoming substantial challenges in the transition from fossil fuels to alternative fuel sources. We have a pressing collective responsibility to call for and contribute to the policy developments, investments and technological advances, as well as the change in consumer behaviour, needed to drive the decarbonisation of the transportation industry and to support its successful transition to a regenerative economy.

Footnotes

^{1, 5, 9, 10, 11, 12, 16, 18, 19, 20, 21, 23, 25, 29, 31, 34} IEA

^{2, 7} IRENA, World Energy Transitions Outlook 2023

^{3, 30} IRENA, Reaching Zero Biojet Fuels

⁴ The Net Zero Emissions by 2050 Scenario (NZE Scenario) is a normative scenario that shows a pathway for the global energy sector to achieve net zero CO₂ emissions by 2050

⁶ IRENA, World Energy Transitions Outlook 2022

^{8, 15} IEA, Global EV Outlook 2023

¹³ <https://batteryCouncil.org/>

¹⁴ McKinsey, Scaling EV infrastructure to meet net-zero targets

¹⁷ BCG, Riding the rails to sustainability, 2022

^{22, 24} IRENA, Decarbonising Shipping

^{26, 27} UN, Review of maritime transport, Oct 2023

²⁸ DNV, Maritime Forecast 2050

³² IRENA, World Energy Transitions Outlook 2023

³³ IATA, Net zero 2050: sustainable aviation fuels, 2023

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