Sectoral Risk Briefings:
Insights for Financial Institutions

UN environment programme

finance initiative

Climate Risks in the Transportation Sector

This resource is part of the UNEP FI Risk Centre offering

May 2024

Disclaimers

The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Mention of a commercial company or product in this document does not imply endorsement by the United Nations Environment Programme or the authors. The use of information from this document for publicity or advertising is not permitted. Trademark names and symbols are used in an editorial fashion with no intention on infringement of trademark or copyright laws.

The views expressed in this publication are those of the authors and do not necessarily reflect the views of the United Nations Environment Programme. We regret any errors or omissions that may have been unwittingly made.

Suggested citation: United Nations Environment Programme (2024). Climate Risks in the Transportation Sector. Geneva.

Production: United Nations Environment Programme Finance Initiative.

Cover image: unsplash.com/@f_arns

Acknowledgements

Authors

UNEP FI

David Carlin
Head of Risk
david.carlin@un.org

Maheen Arshad
Climate Risk Manager
maheen.arshad@un.org

The authors would specifically like to acknowledge the contributions, inputs, and supporting research that have enabled the completion of this report:

Aoife Martin, UNEP FI
Zhongyi Hou, UNEP FI
Katy Baker, UNEP FI
Amina Naidjate, Williams College
Karthik Subbiah, Williams College

Project Management

The project was set up, managed, and coordinated by the UN Environment Programme Finance Initiative, specifically: Remco Fischer (kai.fischer@un.org) and David Carlin (david.carlin@un.org)

The project has been supported by the following financial institutions as members of the UNEP FI convened Climate Risk and Taskforce on Climate-related Financial Disclosures Programme:

ABN-AMRO
Access Bank
AIB
Bank of Ireland
Banorte
BBVA
Bradesco
CIBC
Citibanamex
Danske Bank
Desjardins
DNB
EBRD
Farm Credit Canada
Goldman Sachs
ING Intesa Sanpaolo
Itau
KBC
Lloyds
NAB
NIB
Scotia Bank
Sovcom Bank
Standard Bank
TSKB

Purpose of this document

This detailed briefing note explores relevant climate risks for the sector, supported by illustrative examples from firms in the form of case studies featured in the main text. These case studies showcase how firms in the sector are recognising and confronting climate risks through disclosure examples from their annual reports.

It is important to note that this brief specifically delves into the potential impacts of climate change on the sector. Therefore, exploring the reverse—how the sector impacts climate change—is not the primary purpose of this document. Additionally, the scope of this brief is narrowed to focus solely on climate risks, excluding a broader examination of potential environmental and social risks for the sector. A future series may incorporate these other important risks and considerations of double materiality.

This brief also provides guidance and recommendations aimed at assisting financial institutions in effectively managing both their own risks and those of their clients, with the aim of accelerating a sustainable financial and economic system.

Contents

List of figures and tables

Figures

Tables

Introduction

In the past few years, the global economy has been lashed by the COVID-19 pandemic, geopolitical conflict, supply chain disruptions, an energy crisis, and high inflation. These challenges are occurring against the backdrop of the mounting planetary emergency of climate change. Climate change can exacerbate all other challenges, increasing geopolitical conflicts over resources, crippling infrastructure and supply chains, extending the range of dangerous pathogens, and collapsing the natural systems upon which we depend. As the US Pentagon presciently stated: "climate change is a threat multiplier". While the transition to a sustainable, net-zero future is critical, it demands fundamental shifts in nearly all economic sectors. These shifts are not without risk for the companies and communities impacted by them.

Financial institutions face an array of risks from this rapidly changing, and often chaotic, world. Their clients are exposed to physical hazards as well as transition risks, which can have major credit, market, and operational implications. The prudent financial institution will explore these climate-related risks and prepare strategies to meet them. Future resiliency and success are contingent on thoughtful planning and good decisions today.

UNEP FI has been working at the intersection of sustainability and finance for over 30 years. Its programmes for financial institutions develop the tools and practices necessary to positively address the most pressing environmental challenges of our time. UNEP FI's Climate Risk and TCFD Programme has worked with over 100 financial institutions to explore physical and transition risks posed by climate change. Through this work, a need has been identified to provide financial institutions with a baseline understanding of climate-related risks and their manifestations across different sectors.

This brief is part of a series of notes that cover major economic sectors and their associated climate risks[1]. Each brief also provides specific guidance and recommendations for financial institutions to assist them in more effectively managing their risks and those of their clients. UNEP FI intends for the resources and perspectives included within these notes to empower financial colleagues to communicate these risks throughout their institutions and across the financial sector more generally. The hope is that the communication process will not only enhance awareness of climate risks, but also begin conversations that will lead to tangible changes in strategy and operations. It is the integration of the insights that will be the truest test of the effectiveness of this series. This particular brief covers the physical and transition risks facing the transportation sector.

1 Previously published climate risk sector briefs by UNEP FI cover Agriculture, Real Estate, Oil & Gas and Industrials.

Transportation sector overview

In 2021, the global transportation sector had the greatest reliance on fossil fuels from the end-use sectors, accounting for 37% of total carbon dioxide (CO_2) emissions. Transport emissions have grown at an annual average rate of nearly 1.7% from 1990 to 2021, faster than any other end-use sector (IEA, 2023a).

The transportation sector can be categorised into sub-sectors, including land transport and transport via pipelines, water transport, and air transport (Table 1) (NACE). In 2022, road vehicles were the most significant source of emissions of the transportation subsectors, accounting for 74% of global transportation CO_2 emissions. Shipping was the second-most carbon-intensive sub-sector, accounting for 11% of the transportation sector's global CO_2 emissions, followed by aviation (10%). Rail and pipeline transport were the least carbon-intensive sub-sectors, accounting for 1% and 4% of total CO_2 emissions from the sector in 2022, respectively (Figure 1) (IEA, 2023a).

Table 1: Transportation sub-sectors used in this report[2]

Sub-sector	Definition
Land Transport & Pipelines	Includes passenger & freight rail, transport via pipeline, etc.
Water Transport, referred in this brief as shipping	Sea, coastal, and inland freight and passenger transport
Air Transport, referred in this brief as aviation	Passenger and freight air transport, space transport

2 Passenger transportation is the movement of passengers using a specific transportation mode. Freight transportation is the movement of goods from one place to another.

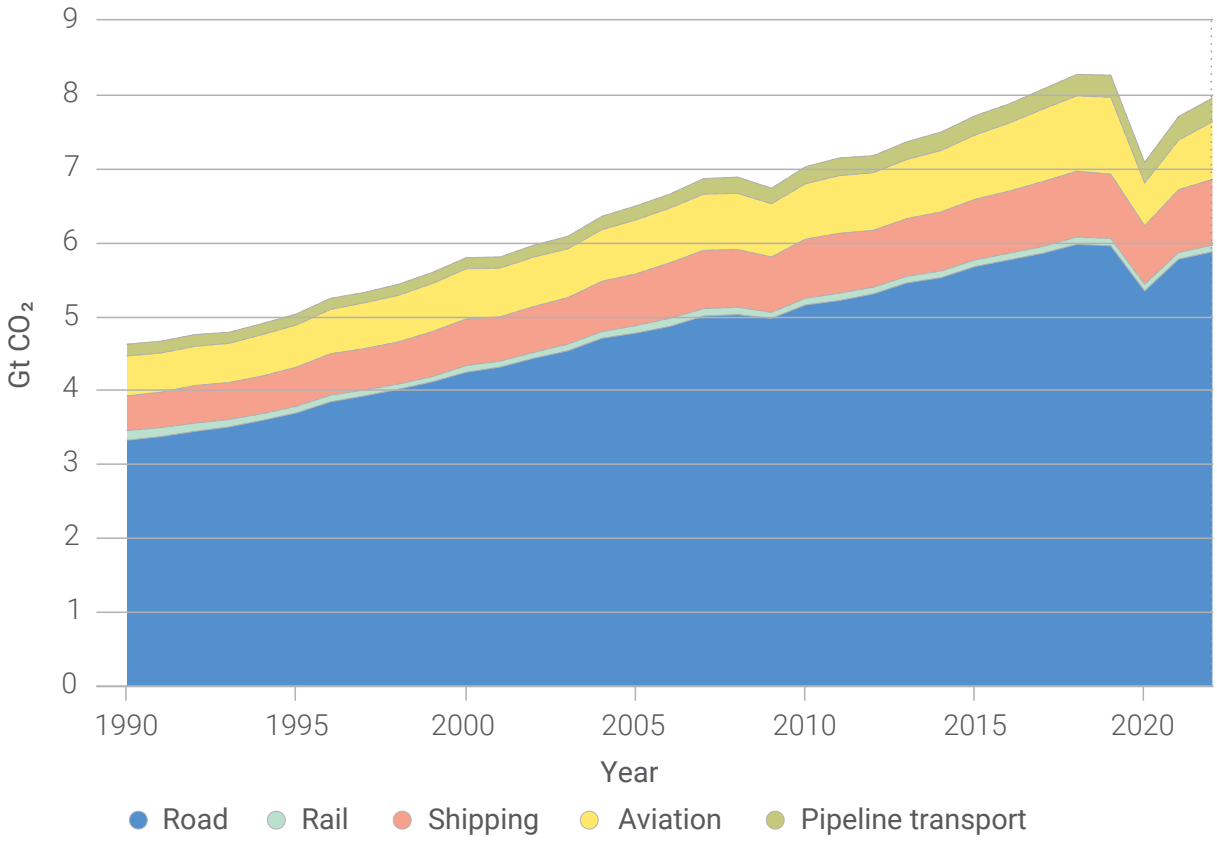


Figure 1: Distribution of CO_2 emissions by the transportation sector globally in 2022 by subsector (IEA, 2023a).

Between 2019 and 2050, demand for passenger transport is expected to nearly triple from nearly 44 trillion passenger-kilometres to 122 trillion passenger-kilometres globally. Demand for freight transport is also expected to increase to a similar level (ITF, 2019). For example, rail passenger traffic in India has increased by almost 200% since 2000, and freight traffic by 150% (IEA, 2019a). Rising incomes and growing populations in developing and emerging economies are becoming key drivers for growing demand. The anticipated growth in transport demand, coupled with an acceleration in the shift to a low-carbon economy, will create substantial challenges for the sector. For example, the Net Zero 2050 scenario of the International Energy Agency (IEA) shows a reduction of 20% in emissions from the transportation sector by 2030, even as demand rises, to align to a net zero pathway. Such a reduction will require rapid electrification of road vehicles, improved fuel efficiency of vehicles, scale-up of low-carbon fuels, and policies to encourage a modal shift to less carbon-intensive transport alternatives (IEA, 2023a).

However, at present, the sector remains highly reliant on high-carbon fuels, with 95% of the energy still sourced from oil (European Environment Agency, 2022). As economies transition to a low-carbon future, the transportation sector faces a wide range of transition risks. These range from rising policy pressures to the phase-out of traditional carbon-intensive vehicles through to the implementation of carbon prices and a shift in consumer preferences. Technological advancements in electric vehicles (EVs) and alternative fuels will also have a substantial impact on traditional firms in the sector. Along with transition risks, the transportation sector will also be exposed to physical

risks as the impacts of climate change intensify. These physical risks, which include severe storms and flooding, sea level rise, and droughts, can impact the supply chains and operations of the sector. Below we explore in depth the key physical and transition risks faced by the transportation sector (Table 2).

Table 2: Key climate risks for the transportation sector

Risk		Summary
Transition Risks	**Increasing carbon prices**	Carbon prices will increase the cost of emissions, which will have cost and price implications for traditional emissions-intensive sub-sectors from passenger vehicles to global shipping.
	Public policy restrictions	A growing number of governments are implementing a diverse range of decarbonisation policies, which are increasing pressure on carbon intensive production and operation activities in the transportation sector.
	Technological advancements in low-carbon alternatives	Technological advancements across sub-sectors, such as new low-carbon fuel and EVs, are creating market competition for carbon-intensive incumbent firms.
	Shifts in market preferences	Increased awareness by consumers of the emissions generated from various modes of transportation, such as flying and the use of internal combustion engines, is driving a shift in preferences towards low-carbon alternatives.
	Rising reputational risk	Companies linked to transport activities which emit large amounts of CO_2, such as airlines, vehicle manufacturers and shipping companies, face rising pressure to accelerate their decarbonization efforts from investors, non-profit organisations, and consumers.
	Growing investor action	Climate-conscious investors are shifting investments away from carbon-intensive practices and towards low-carbon alternatives, which poses challenges for carbon intensive transportation firms.
	Emerging legal risks	Recent lawsuits illustrate how environmental activists, citizens, and governments are increasingly using the courts to hold the transportation sector accountable for its emissions.

Risk		Summary
Physical Risks	**Intensifying storms and floods**	Increased frequency and severity of storms and floods due to climate change threatens transportation operations by damaging existing infrastructure, halting operations, and disrupting supply chains.
	Sea level rise	Rising sea levels can cause potential delays in supply chains or can directly damage expensive infrastructure.
	Rising temperatures and heat stress	Rising temperatures and more frequent heatwaves create issues for infrastructure and mechanical equipment used by companies in the sector as much of these were designed for lower temperatures.
	Droughts and water scarcity	Shifts in precipitation patterns also increase the risk of water scarcity, threatening the supply and production of vehicles and water-dependent transportation modes.
	Wildfires	Wildfires threaten to damage transport infrastructure and disrupt transport operations, as well as creating hazardous working conditions for employees.

SECTION A:

Transition risks

With a changing climate, emissions produced by the transportation sector have become a focus for governments, investors, and consumers in the transition to a low-carbon economy. The sector faces increasing exposure to the rise in carbon pricing initiatives globally. Policy pressures from governments are also creating operational barriers for the sector. Advancements in low-carbon technologies and shifting consumer preferences are creating stiff competition for traditional firms in the transportation sector. As economies accelerate their transition to a net-zero economy, the transportation sector will encounter significant transition risks.

These risks also pose a risk for workers and communities that rely on the sector for jobs and income. It is therefore important to align financing with a just transition approach that considers the impact of the transition on groups at risk to operations in the transportation sector, including workers, Indigenous Peoples, and local communities.

Case study 1: Transition risks

Ford TCFD Report 2022

An American multinational automobile manufacturer

Climate-Related Risks and their Impact on the Business Activity.
We divide climate-related risks into two categories:

- Transition risks—those that arise from actions associated with the transition to a low-carbon economy, including the introduction of new climate policies or low-carbon technologies, and
- Physical risks—those that arise from the physical impacts of climate change.

Both categories are examined through short term (<5 years), medium term (5–10 years), and long-term (> 10 years) timeframes.

Timing of the major risks for leading markets currently in the transition to electrification cover the three examined timeframes and are listed below. We expect technology, market, and workforce risks to lessen in the long-term timeframe in leading markets as electrification becomes more widespread. Other markets will reach the electrification inflection point later, extending technology and market risks. The table is not a complete listing of the risks we considered but is an overview of major risks in the most pertinent categories.

Major climate-related risks

Transition risks	
Regulation	Ford is subject to emissions, fuel economy, zero emissions, and other regulations that govern product characteristics, and these can differ locally, regionally, and nationally. New regulations are continuously being proposed to address environmental concerns and the regulatory landscape can change quickly. To comply, we may need to substantially modify product plans.
Technology	If cost-effective and timely hardware and software solutions are not available to meet our CO2 reduction goals, we are subject to technology risk. As we make further CO2 reductions, it becomes more challenging to make cost-effective improvements. Technology may not be available to make the improvements at the rate required, and the carbon neutral grid and charging infrastructure may not keep pace with vehicle electrification which could negatively impact sales.
Financial	There is a potential that our carbon neutrality plan would need to be accelerated which would require increased investments. Ford tied our Corporate and Supplemental Revolvers to three sustainability-linked KPIs such as reducing greenhouse gas emissions from the company's manufacturing plants and lowering Ford of Europe's CO2 tailpipe emissions per passenger vehicle. The applicable margin and facility fees may be adjusted if Ford fails to achieve, the specified targets.

Legal	Non-compliance with requirements can lead to fines or sales restrictions.
Market	Meeting our climate goals relies on wide market acceptance of electrified vehicles. There is a risk that our offerings do not meet sales volume expectations. Low market acceptance could be caused by low gas prices, changes required to fueling behavior, or by more product entries than are supported by demand. Excessive supply could lead to decreased revenue and profitability
Reputation	Reputation risk is tied to other risks such as meeting product emission targets or sales volumes for environmentally friendly vehicles. Our reputation can suffer if we do not reduce vehicle CO2 in line with expected progress for climate stabilization, which could result in lower sales.
Resource scarcity	As electrified products proliferate, there is a risk that scarce materials such as cobalt will increase in price slowing the growth of EV sales if an alternative to the material cannot be quickly found
Workforce	With the significant shift in capabilities needed to deliver the transition to electrification, there is a risk of lack of skilled workers and programs necessary to reskill the workforce.
Physical risks	
Extreme weather	Climate change can lead to increased extreme weather events such as storms or floods that can disrupt production or component supplies, while droughts can affect our access to water for our operations, especially in water-scarce areas.

1. Increasing carbon prices

In an effort to decarbonise the economy and meet net-zero pledges, governments are increasingly implementing carbon prices to artificially raise the price of carbon and encourage a shift away from carbon-intensive activities. As a carbon-intensive sector, transportation firms are the target of carbon prices that can significantly impact their costs and profits. For example, an average carbon price of just under USD 200/tCO_2 implemented starting in 2025 will be needed for the shipping sub-sector to reach net zero by 2050 (Global Maritime Forum, 2021). Research has estimated for every additional dollar added to a carbon tax, emissions from transportation will reduce by 0.2% in short-run and 0.9% in the long-run (Pretis, 2022).

In 2023, a total of 68 carbon-pricing initiatives have already been implemented worldwide, spanning 46 national jurisdictions and 36 subnational regions (World Bank, 2023a). Emissions trading schemes (ETSs) and carbon taxes cover 30% of global emissions, where, as of February 2023, the price of carbon in the European Union's (EU) ETS has exceeded EUR 100/tCO_2 (Carbon Brief, 2023).

A carbon tax—one of the two main types of carbon pricing mechanisms—directly sets a defined price on carbon. As of March 2023, there were 37 national and subnational jurisdictions with carbon taxes in place (World Bank, 2023a). Canada plans on increasing the stringency of its carbon tax federal benchmark, raising prices above CAD 170 (World Bank, 2023b). In 2022, EU legislators agreed to introduce a carbon price on road transport fuels. This will result in an estimated increase of prices at the pump of 10.5 cents for a litre of petrol and 12 cents for a litre of diesel (Euractiv, 2022). Similarly, in Baja California, Mexico, a carbon tax came into force in May 2020. It was set at MXN 0.17 for each litre or kilogramme of CO_2 linked to the sale of gasoline, diesel, natural gas, and liquefied petroleum gas (World Bank, 2021; EY, 2020). In July 2020, the Mexican state of Tamaulipas passed legislation enacting a carbon tax starting at about MXN 250 (USD 12.23)/tCO_2e to fixed sources and facilities that emit more than 25/tCO_2e of GHG monthly (World Bank, 2021). Sweden implemented a carbon tax implemented in 1991 at a rate of EUR 25 per ton of fossil fuel emitted, but has since risen to EUR 122 per ton (Government Offices of Sweden, 2023).

ETSs are the other main form of carbon pricing. These are cap-and-trade initiatives that typically put a cap on total emissions allowed in a regulated market. An ETS allows for the trading of contributions to those emissions. In 2022, there were 25 operational ETSs around the world, covering 17% of global GHG emissions and encompassing jurisdictions that comprised 55% of global gross domestic product (GDP) (International Carbon Action Partnership, 2022a). In 2022, Austria launched its national ETS focused on CO_2 emissions from transport, waste, building, and agriculture. The price attached to emissions in 2022 was EUR 30/tCO_2, but this figure is expected to rise to EUR 55/tCO_2 by 2025 (International Carbon Action Partnership, 2022b). In 2021, China announced its own ETS, which operates as the largest carbon market in the world. The system is estimated to cover more than 4 billion tons of CO_2, accounting for 40% of the country's carbon emissions. Currently, the Chinese ETS only covers power generation. However, proposed plans for the future include an expansion of the ETS to the domestic aviation subsector (International Carbon Action Partnership, 2022c).

The EU ETS is one of the world's first major carbon markets. It has covered CO_2 emissions from flights within the EU since 2012 (European Commission, n.d.), with plans to expand to also cover long-haul flights departing from the EU. In July 2022, the European Commission revised the system, leading to an increase from 45% to almost 80% of GHG emissions covered (European Roundtable on Climate Change and Sustainable Transition, 2023). In the revised version of the EU ETS released in May 2022, fuel suppliers will be regulated and required to abide by emission allowances. It is expected that fuel suppliers will pass the majority of the carbon price onto the final consumers (European Parliament, 2022a). Additionally, the proposal would extend the EU ETS to cover CO_2 emissions from maritime transport, especially from large ships above 5,000 gross tonnages (European Parliament, 2022b). The EU will also launch a separate ETS to cover road transport starting 2027 or 2028 (European Commission, 2023a).

Carbon pricing mechanisms implemented on the transportation sector can drive up operation costs for firms, making production and operating vehicles costlier. For example, a recent study assessed the impact of a global carbon tax by the International Maritime Organization (IMO) of USD 100–300/tCO_2 on China's bulk trade. The researchers

found that shipping freight rates could increase by 10–30% (Wu et al., 2022) as the shipping sub-sector is highly reliant on carbon-based fuels to operate at full capacity. As a carbon price can drive the price of fuel upwards, the overall cost of transporting goods by freight ship could rise. An average carbon price of EUR 7.55 could yield an increase of 4% in fuel costs (Fageda and Teixido, 2022). Such costs will have to be borne by either the manufacturers or consumers, if not both.

Similarly, a study has shown that carbon prices ranging from USD 6–10/tCO_2e in 2020 to USD 20–33/tCO_2e in 2030 could cause overall costs for international aviation—a sub-sector heavily reliant on fossil fuels—to range from USD 1.5–6.2 billion in 2025. A carbon price of USD 12-40t/CO_2e by 2035 could see costs increasing to USD 5.3–23.9 billion. The cost of carbon offsetting for airline operators could vary from 0.2-0.6% of total revenue in 2025 and 0.5–1.4% of total revenue from international aviation in 2035 (International Civil Aviation Organization, n.d). Following the implementation of the EU ETS, airlines reduced annual emissions between 2010 and 2016 by 4.7%. They did so chiefly by decreasing the number of flights offered by 4.9% (Fageda and Teixidó, 2022). As a result, the aviation sector is estimated to have experienced a substantial loss of EUR 150 million under the EU ETS (Carbon Market Watch, 2021). As carbon prices become more stringent, so will prices go up for consumers. This price hike will create a competitive disadvantage for firms subjected to a carbon price compared to those that are not.

The impact of a carbon price can vary depending on the model of vehicle and the distance travelled. Carbon prices have a more significant impact on the cost of shorter routes for airlines because these are less carbon-efficient and hence relatively more costly than longer routes in terms of per-kilometre allowances (Fageda and Teixido, 2022).

As carbon pricing mechanisms raise production and operating costs for firms in the transportation sector, these costs are likely to be passed on to consumers by firms (RFF, 2020). A study looking at a carbon tax and a value added tax implemented by the Swedish government since the 1990s analysed the impact of these taxes on gasoline demand. The cost of both was shown to be passed on to consumers in its entirety. In comparison to equivalent gas price changes, a carbon tax is able to induce a larger behavioural response from consumers. The same study found the impact of a carbon tax on the amount of gasoline demanded to be three times more significant than the impact of a change in the price of gasoline. As a result, the high elasticity of a carbon tax could have a strong impact in reducing gasoline use (LSE, 2017).

As less carbon-intensive vehicle alternatives enter the market on a massive scale, the costs of these vehicles will fall and the price for consumers will reduce. Consumers will have an additional incentive to switch to these alternatives in light of the increase in prices for conventional vehicles caused by carbon prices. Current evidence from analysis by the Bank of America already shows that EV customers use charging stations more often when fuel prices increase (Figure 2) (BofA, 2022). Such consumer behaviour is expected to increase under the implementation of a carbon price. For example, Norway instated additional taxes on consumers who continue to purchase ICE vehicles, including a VAT tax of 25% and a carbon tax of 20%, plus a slew of smaller taxes such as car scrapping fees and weight taxes. As a result, roughly 60% of the car sales in Norway are

now electric, far higher than other developed countries like the United States where EVs make up only 2% of car sales (Forbes, 2021a). This has spelled trouble for traditional ICE manufacturers in Norway as demand for their products have reached record lows as the country approaches its 2025 goal of a zero-emission automobile sector. Some conventional ICE automakers have adapted. Hyundai, for example, ended the sales of its petrol-only vehicles in Norway back in 2020 and then withdrew its ICE vehicles from the market at the start of 2023. Volvo has announced similar measures (Electrek, 2022).

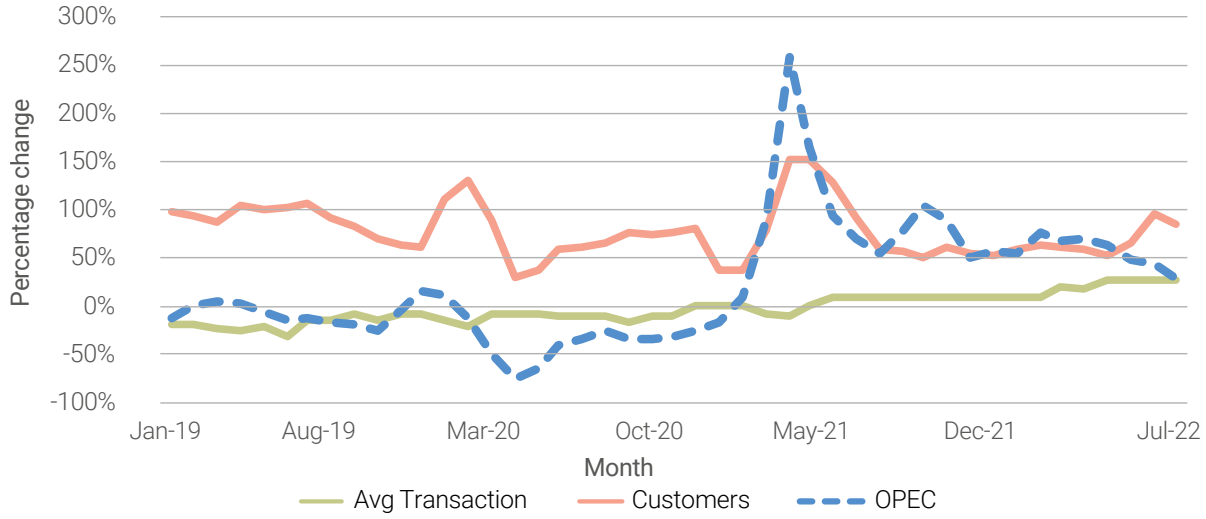


Figure 2: Percentage change in consumers paying for EV charging compared to the Organization of the Petroleum Exporting Countries (OPEC) oil price (BofA, 2022)

The results of Hong Kong Monetary Authority's (HKMA) 2021 Climate Risk Stress Test showed the impact for financial institutions of different carbon prices under two different transition scenarios—orderly[3] and disorderly[4]—on carbon-intensive sectors. Figure 3 illustrates the carbon price assumptions for both scenarios as part of the exercise. The disorderly transition scenario anticipates a carbon price being implemented in 2030 and then being abruptly increased thereafter. Such a scenario would initially present companies belonging to the transportation sector with major difficulties in changing their operating models and energy consumption behaviour, according to the climate stress test. This can significantly impact their financial position and impinge on their ability to repay loans. This can have negative knock-on effects for banks with portfolios consisting of firms from the transportation sector, affecting their profitability, capital positioning, loan provisioning, and credit risk-weighted assets (RWA). Under the disorderly transition scenario, the stress test concludes that the annual credit cost for participating banks of lending to the transportation sector could increase from their 2019 level of about 0.1% to more than 0.4% between 2031 and 2035 (Figure 4) (HKMA, 2021).

3 In the orderly scenario, governments take proactive and early steps to reduce emission levels in a gradual manner, such as steady increases in carbon prices.

4 In the disorderly transition scenario, governments do not legislate carbon-restrictive policies until 2030, at which point they take abrupt measures in order to meet the targets of the Paris Agreement.

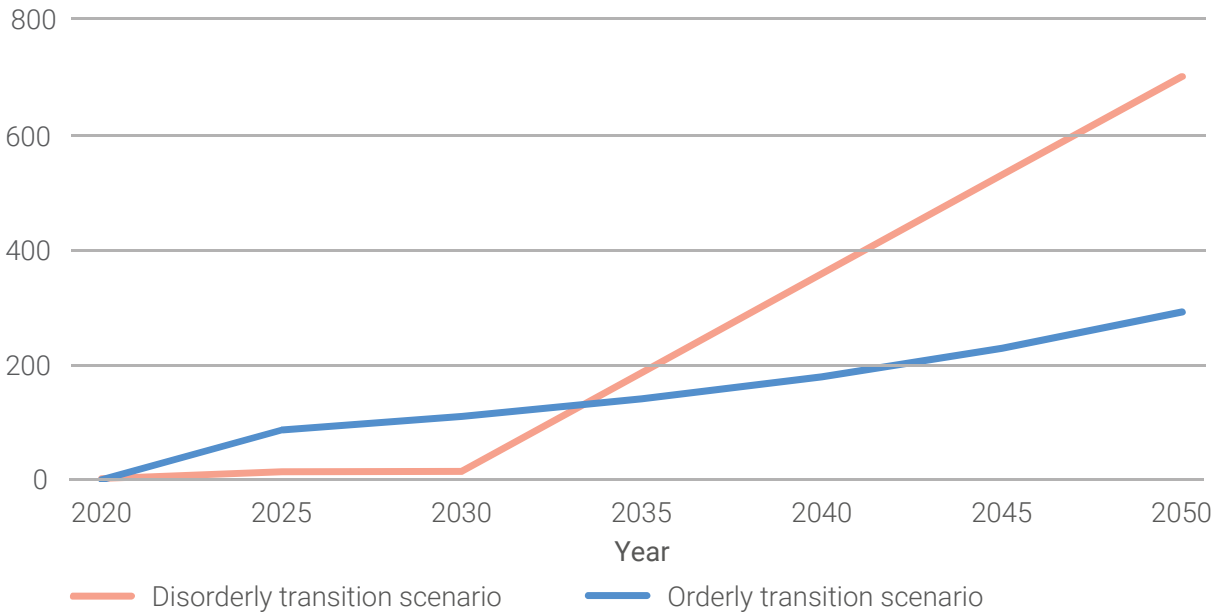


Figure 3: Carbon price under an orderly and disorderly scenario as part of HKMA's 2021 climate stress test exercise (HKMA, 2021)

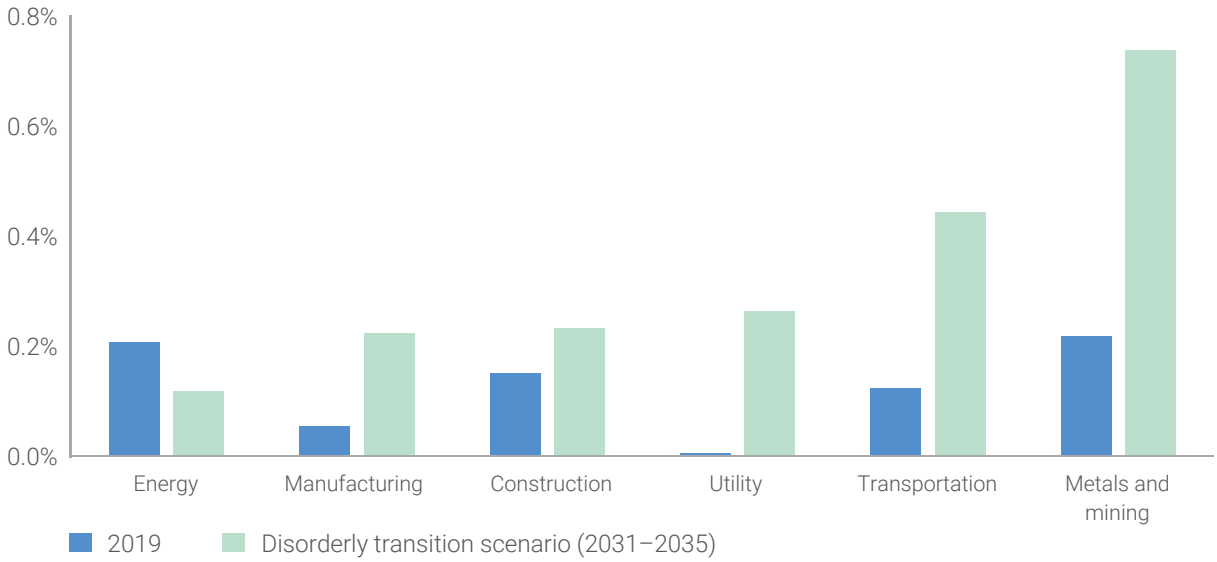


Figure 4: Annual credit cost[5] of lending to high-emitting sectors in 2019 compared to cost of lending under the disorderly transition scenario between 2031 and 2035 (HKMA, 2021)

5 Average annual change in expected credit losses/Average loan amount

Case study 2: carbon price risk

Wizz Air holding Annual Report 2022

Hungarian airline company

Transition risk mapping

Policy changes and new legislation by governments are and will be implemented in order to price and penalise GHG emissions. Adverse movements in the carbon pricing (including ETS) might have a negative impact on Wizz's portfolio. A reform in tax policies to incentivise carbon-efficient technologies would double the overall level of taxation in the mid term. For F23 these are considered as principal risks for the Company. In addition to carbon pricing policies, emission reduction regulations across global jurisdictions require organisations to adhere to reductions or face penalties. Carbon pricing risk has been identified by Wizz Air as one of the most relevant and impactful risks as a result of policy changes in the mid and long term in 2022.

Mitigation measures

Airbus Zero emission aircraft: due to the current cooperation with Airbus on their zero-emission aircraft project and the analysis of the impact of hydrogen aircraft on Wizz Air's fleet and business model, the company will be in a good position to quickly renew its fleet and transition to zero emissions aircraft faster than other airlines. Fleet leasing will allow us to deal better with technology obsolescence.

Potential pathways to net zero: A cross-functional team has analysed several scenarios for potentially reaching net zero by 2050 relying on technology solutions only and without air traffic management and other external economic mechanisms taken into account. The purpose was to evaluate the financial impact in light of WIZZ500 and to understand the financial impact of environmental legislation. The analysis has shown that while there will be an exponential cost increase on short and mid-term due to SAF mandate and carbon cost, if the company invests in zero emission technology and can secure SAF at lower than market cost (e.g. via offsetting agreements with fuel producers), then the overall cost structure will improve considerably, as opposed to not having acquired zero emissions aircraft.

2. Public policy restrictions

Given that it makes up more than one third (37%) of all global emissions, the transportation sector is increasingly at risk from different kinds of policy pressures as governments worldwide gear up efforts to decarbonise.

One of the most common examples of this trend globally is the implementation of tighter standards for ICE vehicles. In 2021, over 85% of car sales globally were subjected to such standards (IEA, 2021a). More than 20 countries have announced the complete phase-out of ICE car sales over the next 10 to 30 years, including Cabo Verde, Costa Rica, and Sri Lanka. Figure 5 illustrates government targets to phase out ICE vehicles. Many countries like Denmark, the Netherlands, and Singapore plan to completely phase out ICE vehicles by 2030, and Japan and China have announced phase-outs by 2035. In 2023, the European Council officially adopted the proposal to ban the sale of ICE passenger cars and vans from 2035 (European Parliament, 2023). Hong Kong also pledged to phase out carbon-intensive vehicles by ending the registration of new private ICE cars by 2035 or earlier (Hong Kong government, 2021). The move echoes a similar measure imposed by executive order in the US state of California back in 2020 (ICCT, 2020).

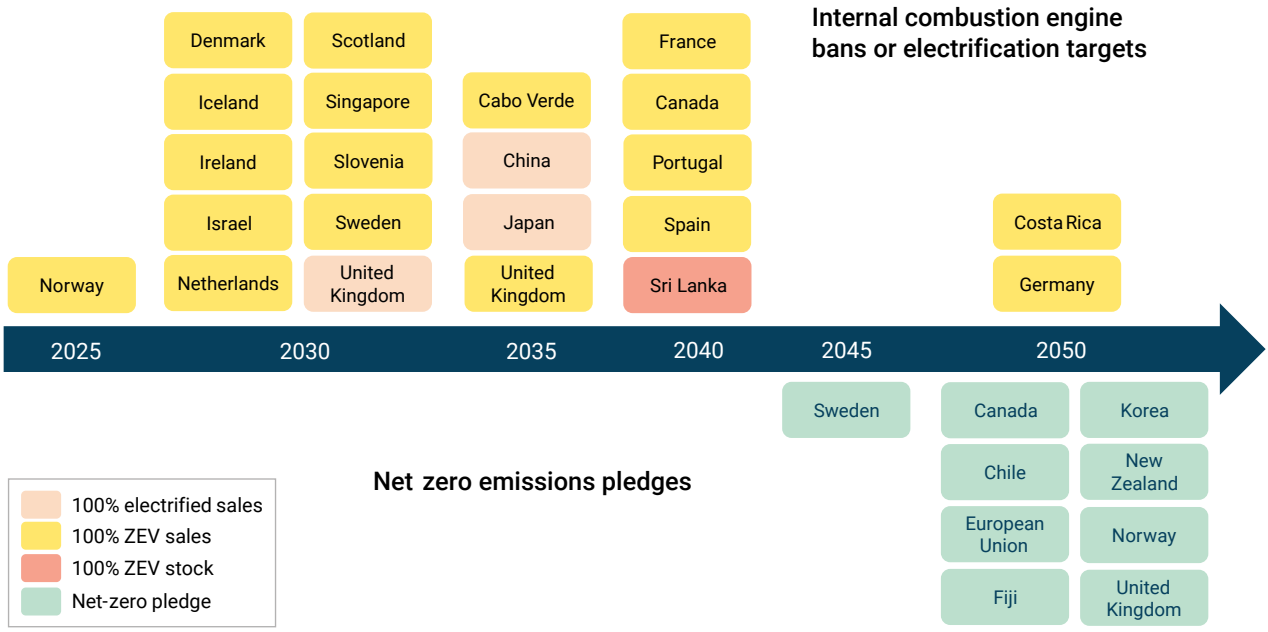


Figure 5: Displays commitments of countries to phasing out internal combustion engines and, additionally, turning to net-zero emissions. (IEA, 2021a)

In Norway, the government aims to phase out all ICE vehicles sales by 2025. Roughly 80% of new car sales sold in the country in 2022 were electric, with Tesla now supplanting all ICE automakers as the leading car manufacturer (New York Times, 2023). EVs in

the country have been exempted from registration and re-registration taxes, as well as VAT, for decades. Further, companies that buy EVs benefit from purchase subsidies. In addition, Norway has provided car owners with other incentives to go electric, including free parking, access to bus lanes, and toll exemptions. For instance, until 2019, EVs were exempted from paying regional road tolls; although this total exemption has since been lifted, EV owners currently pay a lower fee than owners of ICE vehicles (European Commission, n.d.). Many traditional car manufactures have had to rethink the products they sell in the country. For example, Norway became the first market where Hyundai announced that, as of January 2023, it would sell only all-electric cars (Hyundai, 2022). Volvo also committed to only selling battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs) (Volvo Car USA, 2022). Meanwhile, Volkswagen has said it will start selling BEV cars only from 2024 onwards (Electrek, 2022).

Similar to Norway, other governments have also introduced a number of schemes to incentivise consumers and investors to shift away from ICE vehicles towards cleaner cars. For example, Singapore created its Vehicular Emissions Scheme, which is a rebate system that reduces the consumers' Additional Registration Fee to encourage the purchase of cleaner cars with lower emissions (National Environment Agency, 2022). In 2021, New Zealand also announced a cash rebate scheme for electric and low-emission cars. The scheme also has an additional fee for ICE vehicles. The Clean Vehicle Rebate Project in California provided consumers with incentives of up to USD 7,000 for a new EV. In the United Kingdom, the government has offered discounts of USD 3,480 on new EVs which cost under USD 48,670 (World Economic Forum, 2021). Through such monetary incentives, EVs can become a compelling and affordable choice for consumers, potentially impacting the sales and profitability of ICE vehicle manufacturers significantly.

Jurisdictions have also enforced carbon caps on vehicle manufacturers. In 2022, the European Union revised a 2019 proposal that suggested that vehicle manufacturers be assigned annual emissions targets. Under the rules, fleets of newly registered vehicles must not exceed the targets by lowering the carbon caps set by the 2019 proposal. Failure to comply results in manufacturers having to pay a premium of EUR 95 per gramme of CO_2/km above the target per vehicle registered to sell their vehicle on the market (Council of the EU, 2022). For many carmakers, the hit to profits from the 2019 proposal was considerable. To comply, PSA Peugeot Citroën forecasted a 25% reduction to earnings per share in 2021. Similarly, UBS forecasted a drop in profits of 13% for Volkswagen, 10% for Renault, 9% for Daimler, and 7% for BMW (Financial Times, 2019).

Policy pressures have already begun impacting the aviation subsector with bans of short-haul flights and tighter regulation on aviation fuels. Most notably, in an effort to mitigate CO_2 emissions, France enacted a ban on all domestic flights that could be replaced with a train ride of less than 2.5 hours. Since coming into force in May 2023, three routes in France have been prohibited (République Française, 2023). Similarly, Austria bailed out Austrian Airlines during the COVID-19 pandemic on the condition that it eliminate all flights that could be replaced with a train ride of less than three hours, in addition to implementing a EUR 30 tax on flights less than 350km (CNN, 2023). In 2022, the Dutch government made headlines after limiting the number of flights arriving at its Schiphol Airport—the third largest airport in Europe—to 440,000 a year. Again, the move, which came into effect in 2023, was designed to reduce CO_2 emissions produced by the

country's aviation sub-sector. Flights have fallen by 11% since pre-pandemic levels as a result (Euronews, 2022). In response, KLM—the Netherlands flag carrier fleet—launched legal action with four other airlines (including Delta, one of the major US airlines) against the Dutch government, which the airline won in 2023 (Financial Times, 2023). In addition, the Dutch government also announced plans to phase out the use of private jets by 2025. Such flights account for up to half (30 to 50%) of all landings in the in the country (Forbes, 2023a).

Governments have also announced regulations for aviation fuels. In Norway, the government mandated that 0.5% of aviation fuel must be sustainable by 2020, growing to 30% by 2030. It has also mandated that all short-haul flights should become fully electric by 2040. In addition, the European Union announced a mandate that at least 2% of fuel offered at airports in the trading bloc should be sustainable aviation fuels (SAF) by 2025. Under the rules, minimum SAF content should rise to 6% in 2030, 20% in 2035, and 70% in 2050. Additionally, the rules hold that 1.2% of EU airport fuel should be synthetic by 2030, increasing to 35% by 2050 (European Commission, 2023b). However, the transition to SAFs will bring about cost challenges for airlines as they currently cost more than traditional jet fuel. SAFs are estimated to be twice as expensive as waste-based sources and six to ten times more expensive than synthetic fuels due to limited SAF production facilities (Aviation Benefits Beyond Borders, n.d.). This could result in higher up-front costs for aviation companies, as well as pricier air fares for consumers (CNBC, 2022). The International Air Transport Association (IATA) estimates that adopting sustainable fuels and decarbonising the aviation sub-sector globally will cost up to USD 1 trillion, the majority of which will have to be borne by consumers (Bloomberg, 2023). The International Council on Clean Transportation (ICCT) recently conducted a scenario analysis that included a Breakthrough scenario in which governments take early and sustained action to increase investments in zero-carbon airplanes and fuels causing fossil fuel use to reach zero by 2050.[6] The results of the analysis indicate that airfares for consumers would increase by 22% by 2050 due to the use of more expensive SAFs. This would lead to passenger traffic decreasing by an estimated 7% compared to the baseline scenario (ICCT, 2022).[7]

6 The breakthrough scenario shows early and stringent measures by governments to incentivise investments for decarbonising the aviation sub-sector. Fossil fuel use peaks in 2025 and falls to zero by 2050. Mitigation efforts include efficiency standards for new aircraft, global fuel tax, air traffic management, hydrogen-combustion aircraft, bans on fossil-fuelled aircraft, and the widespread adoption of SAFs (ICCT, 2022).

7 The baseline scenario represents the status quo of the aviation sub-sector. Actions to reduce CO_2 emissions, such as SAFs, technological improvements, and economic measures, do not take place (ICCT, 2022).

Case Study 3: Public policy pressures

Finnlines 2022 Annual Report

Finnish shipping company

Environmental restrictions set by international conventions
Stricter environmental regulations (e.g. NOx, SOx and CO_2 emission, wastewater and ballast water regulations) are the risk factors that could affect the Group's business.

Shipowners have had to report on ships' fuel consumption, subsequent CO_2 emissions and transport work to the European Commission as from 2018 in accordance with an EU directive. Globally, a similar system, IMO's Data Collection System, started in 2019. An accredited, impartial verifier validates the data in both systems. Finnlines operates in ecologically sensitive sea areas, mainly in the Emission Control Areas, i.e. the Baltic Sea, the North Sea and the English Channel, where the sulphur content limit for fuel oil has been 0.10% from 2015 in accordance with the MARPOL Convention, whereas globally, the sulphur limit decreased from 3.5% to 0.5% at the beginning of 2020. Finnlines has installed exhaust gas cleaning systems on 21 vessels since 2015 and will continue the project by installing equipment on the two remaining vessels.

The IMO has set the target to cut greenhouse gas emissions from shipping by 50% by 2050. Fuel consumption per cargo tons carried and nautical miles sailed should decrease by 40% by 2030 and by 70% by 2050. All target figures are compared with the 2008 level. The European Commission has raised the stakes even higher by setting the goal for Europe to become a climate-neutral continent by 2050.

Mitigation actions
Finnlines has optimised its schedules and routes to achieve the highest possible capacity utilisation, which minimises the environmental stress per transported cargo unit. Ships run on optimal speed, load, and trim. The underwater hull is brushed regularly during the open-water season to remove micro-organisms, which have attached to the ship's hull, increasing fuel consumption.

All ships have a Ship Energy Efficiency Management Plan, the purpose of which is to identify energy-saving measures and to establish practices to improve energy efficiency.

3. Technological advancements in low-carbon alternatives

Continuing technological advancements in low-carbon transportation and sustainable fuels are threatening the dominance of firms focused on traditional carbon-intensive vehicles in the sector. According to the OECD Green Recovery Database, more than half of identified green spending (accounting to USD 611 billion) is directed towards the energy and transportation sectors (OECD, 2022a). Private investors and governments are funnelling increasing amounts of money into EVs and alternative fuel types. With greater investments, technological advancements are making less carbon-intensive alternatives economical viable, thereby increasing competition for traditional businesses.

EVs are one of the most widely utilised alternatives to carbon-intensive passenger vehicles and thus pose a significant threat to traditional ICE vehicles. In 2021, market shares for EVs reached nearly four times their 2019 levels and accounted for around 10% of global car sales (IEA, 2022a). This highlights the growing threat to traditional companies in the sector focused on manufacturing and selling ICE vehicles. The massive expansion of EVs on the market can be attributed to advancements in EV technology, driven by significant investments from governments and the private sector. This has allowed EVs to become increasingly competitive with ICE vehicles in regards to distances covered, costs incurred, and car models available. An illustrative example of such investment comes from the United States, where the federal government has an average allocated research and design budget for sustainable transportation of almost USD 700 million annually (Institute for Energy Research, 2019; Harvard, 2022). In recent years, EV manufacturers in the country have been able to expand their catalogues to include popular vehicle models that were previously only available in ICE formats.

Concerns regarding EV battery capacity for long-distance driving have long deterred customers from switching from ICE vehicles to EVs. An extensive network of petrol stations exists in most countries around the world that permits drivers of ICE vehicles to refuel with comparative ease. In contrast, EV recharging stations remain comparatively small in number. This increases the possibility of running out of EV battery power while out of range of a charger. Such 'range anxiety' represents a pressing concern for consumers. However, technological advancements in battery capacity has improved the distance of a single-charge battery from an average of 68 miles in 2011 to 234 miles in 2021. This is projected to extend to 1,200 miles by 2024, increasing market competitiveness of EVs (IEA, n.d.).

The improving economics of EVs will make these vehicles more affordable for consumers in the coming years, thus threatening the sales and revenues of businesses that are dependent on ICE vehicles. Rechargeable lithium-ion batteries, commonly used in EVs,

have long contributed to high EV costs. This is because the raw materials required to produce them—such as nickel, cobalt, and manganese— are costly. However, manufacturers have recently been experimenting with cheaper materials and simplifying battery design to bring down battery costs (Kelley Blue Book, 2023). As a result, lithium-ion battery prices plummeted from USD 1,191 per kilowatt-hour (kWh) in 2010 to USD 137 per kWh in 2020 (Transport Environment, 2021). BloombergNEF, Bloomberg's primary research service for energy, estimates that the cost of battery packs will continue to decline, reaching USD 62 per kWh by 2030 (BloombergNEF, 2019). Decreases in battery cost have brought the cost of EVs even closer to conventional ICE vehicles. In addition, EV maintenance costs fall below those for ICE vehicles as EVs have far fewer moving parts. Other advantages for EVs include lower brake wear due to regenerative braking, the absence of fluids such as engine oil, and the low maintenance requirements of their electronic components (US Department of Energy, n.d.-a).

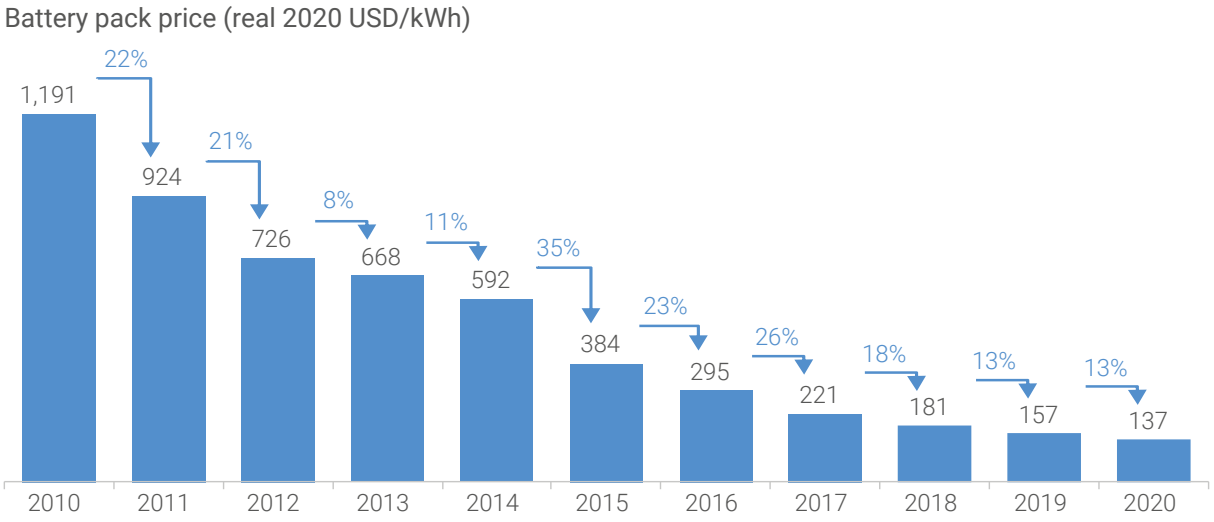


Figure 6: Lithium-ion battery price from 2010 to 2020 (Transport Environment, 2021)

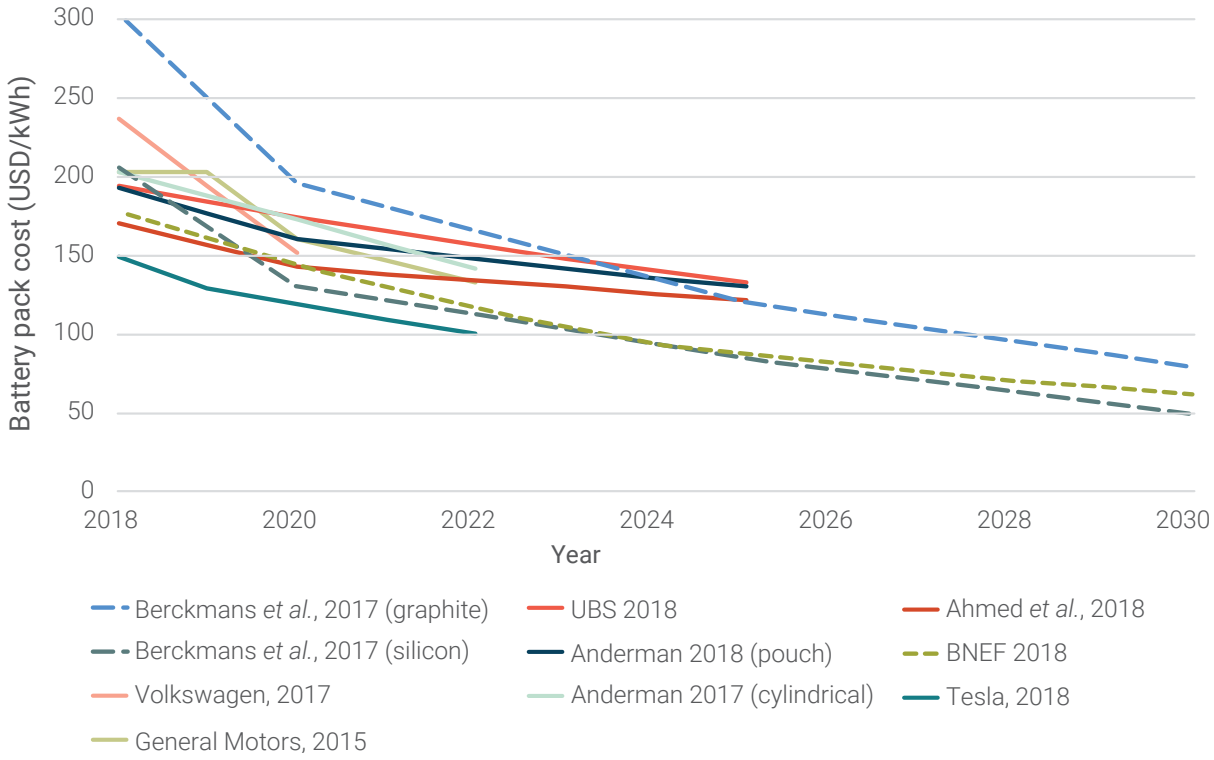


Figure 7: Estimated costs of electric vehicle battery packs from 2018 to 2030 (ICCT, 2019)

As a result of decreasing production costs and increasing demand, EV production has increased dramatically in recent years (Figure 8 and 9). As of June 2023, car dealers in the United States had over 92,000 EVs in their inventories, which is over three times more than the 21,000 in stock a year before. EVs have now outpaced the average days' supply of ICE vehicles at dealerships, reaching a critical mass. Average EV supply at dealerships jumped from 36 days' worth in the second quarter of 2022 to 92 days' worth in the second quarter of 2023 (Cox Automotive, 2023).

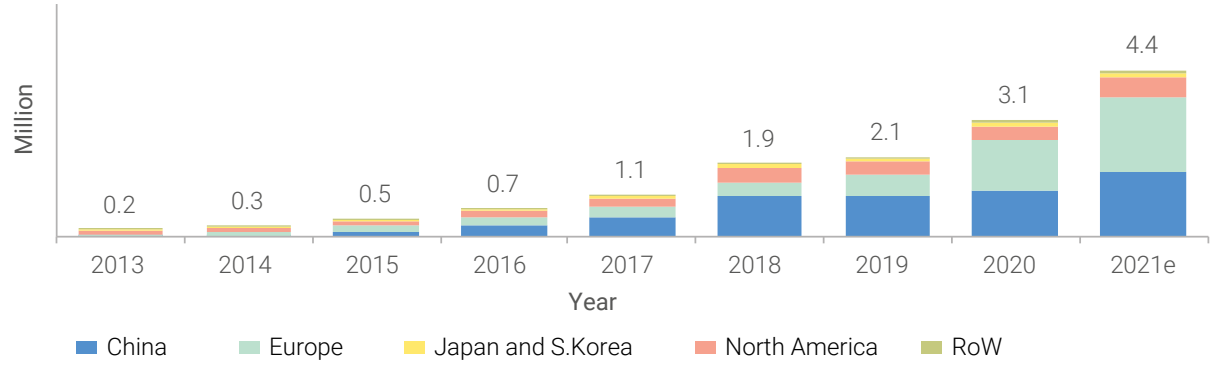


Figure 8: Global passenger EV sales by region from 2013 to 2021 (Transport Environment, 2021)

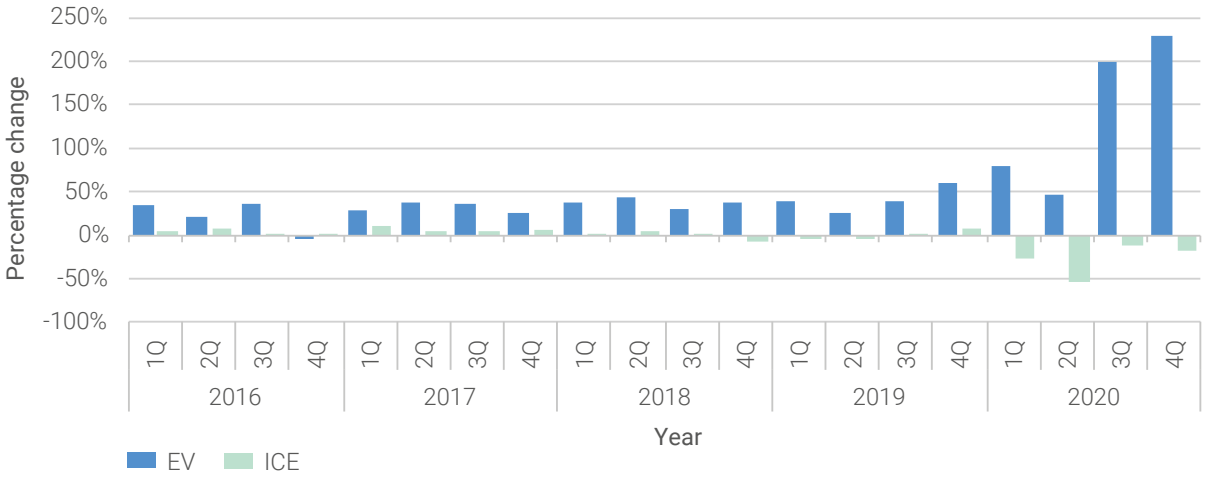


Figure 9: Change in European passenger sales of EVs and ICE from 2016 to 2020 (Transport Environment, 2021)

Transportation sub-sectors such as aviation and shipping are hard to electrify. The shift from traditional fossil fuels to SAFs is therefore crucial for their decarbonisation. SAFs are biofuels that serve the same function of carbon-intensive jet fuels but are less carbon-intensive (US Department Of Energy, n.d.-b). Compared with fossil kerosene, SAFs could reduce the aviation sub-sector's CO_2 emissions by anywhere from 70% to nearly 100%. Demand for shipping and air travel is expected to increase in the coming years and government restrictions are projected to tighten so as to limit the global temperature rise. As such, the demand for SAFs is also expected to rise. For example, the global demand for biofuels is projected to increase by an estimated 28% between 2021 to 2026 (IEA, 2021b).

To meet growing demand, the size of the global SAF market is expected to increase by USD 14.84 billion by 2032, representing a compound annual growth rate (CAGR) of 42.39% (Precedence Research, 2023). An estimated USD 1.45 trillion in investment is needed to scale up SAFs by 2050 in order to replace the current demand for jet fuel (SimpleFlying, 2022). Given the limited production of SAFs to date, their availability has been low and their cost has been far higher than traditional jet fuels. However, due to policy pressures such as the EU's 2023 SAF mandate,[8] as well as advancements in SAF production, the SAF industry is projected to have 3,815 megatons (Mt) per year of biomass feedstock available by 2030. This should yield approximately 120% of the projected 2030 global jet fuel demand of 108 billion gallons per year (EY, 2023a). As a result of economies of scale, production costs are expected to drop significantly over the coming decades as availability increases, causing prices to dip below traditional jet fuel by 2050 (ING, 2023). As SAF costs decrease, aviation firms that do not pursue early investment in SAFs and a near-future transition plan could face high operation costs from pricey traditional fuels. In contrast, their more proactive competitors will be in a strong position to take advantage of lowering SAF prices.

8 The 2023 European Union Sustainable Aviation Fuel Mandate was a political agreement reached in April 2023 with the aim of decarbonising the European aviation sector by requiring fuel suppliers to blend SAFs with kerosene starting in 2025 (European Commission, 2023b).

4. Shifts in market preferences

As the adverse effects of climate change continue to gain publicity and carbon pricing mechanisms drive traditional fuel costs upwards, many consumers have begun to value climate-conscious travel alternatives over traditional, carbon-intensive options. The People's Climate Vote, led by the United Nations Development Programme, comprises the largest global survey of public opinion on climate change ever conducted. The results reveal that 38% of respondents support the proposal that goods on planes, ships, trains, and trucks should be transported using clean energy (UNDP, 2021). Additionally, nine out of ten of those surveyed in the world's most urbanised countries are in favour of clean transport (UNDP, 2021).

According to the latest Mobility Consumer Index survey, more than 50% of respondents across 18 countries planning to buy a car would choose either a fully electric, plug-in hybrid, or hybrid vehicle (EY, 2022b). This shift in consumer preferences is partially responsible for why spending on EV purchases grew to USD 82 billion in 2018, an increase of 70% on the previous year (IEA, 2019b). It also helps explain how consumer and government spending on EVs reached USD 277 billion in 2021 (IEA, 2022b). A 2018 report study from the University of Michigan looking specifically at fuel costs found the average annual cost of driving an EV was less than half of that of gasoline vehicles (The University of Michigan, 2018). As costs associated with EVs decrease, global sales are expected to increase. Historic patterns back this up, with EV sales already increasing from 120,000 vehicles in 2012 to 6.6 million vehicles in 2021 (IEA, 2022).

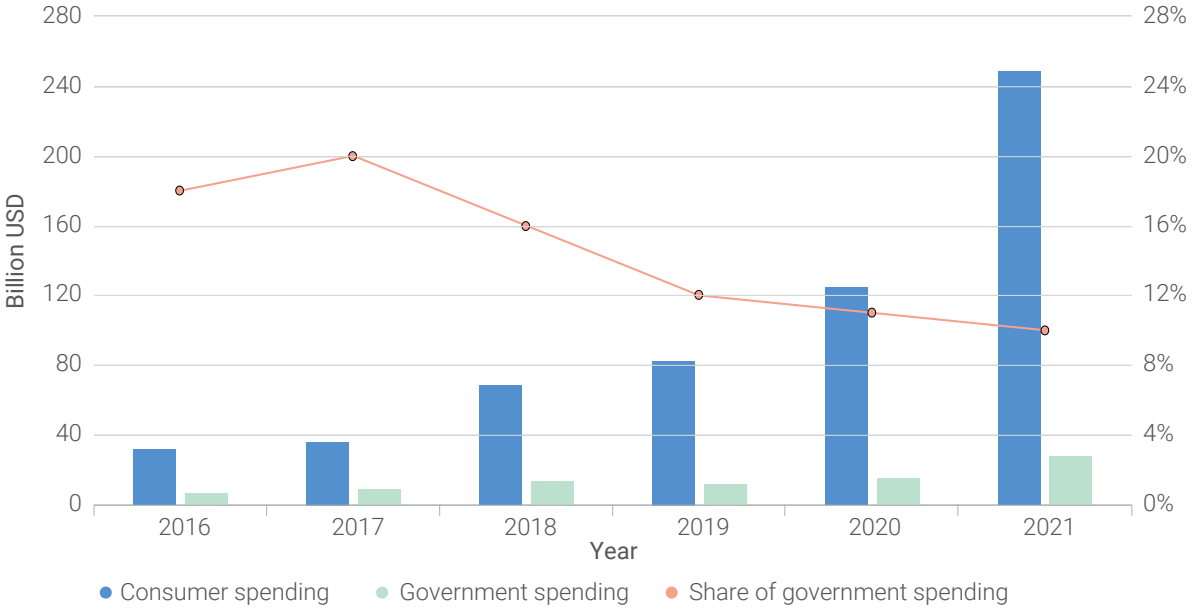
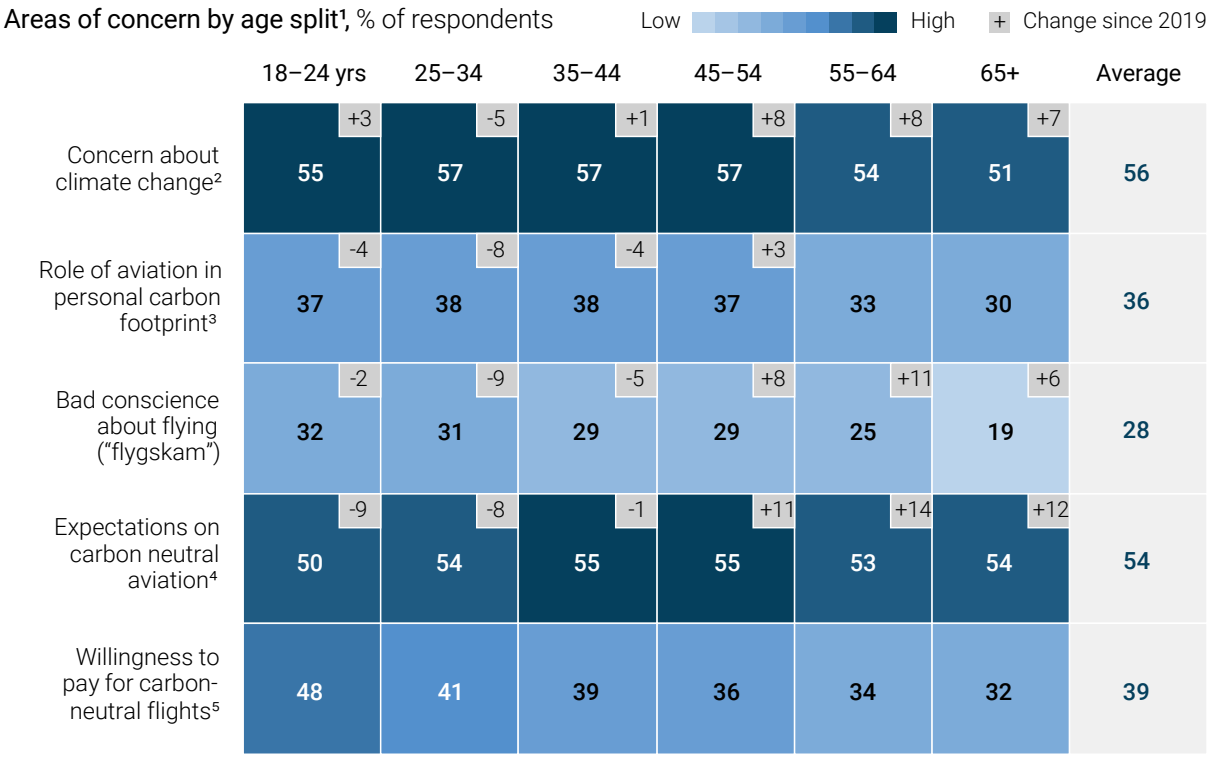


Figure 10: Consumer and government spending on electric cars from 2016 to 2021 (IEA, 2022b)

EVs are rapidly taking over the market share from ICE vehicles. In 2021, EV sales accounted for 8.6% of the global car market but they are projected to reach 15% by 2025 and 23% by 2030 (IEA, 2023c). By 2030, EVs are expected to outperform ICE vehicles in global sales (EY, 2023a). With rising EV sales, this naturally means that companies selling ICE vehicles will witness a drop in their sales. The growth of ICE manufacturing is expected to experience double-digit declines in the coming decades, and suppliers of ICE components are expected to see a shrinkage of their markets. For example, the market size for ICE transmission suppliers—which was once USD 95 billion in 2019—is expected to dip to USD 25 billion in 2035. ICE engine system suppliers are expected to see a similar trend, with their market size shrinking from USD 73 billion to USD 17 billion between 2019 and 2035 (McKinsey, 2022). As firms witness their businesses shrink, they will be forced to close down divisions and reduce their workforce. Ford Motor Company already plans to cut as many as 8,000 jobs, mostly positions in its ICE division, for instance. The move is designed to help the US automaker repurpose capital for investment in EV production (Electrek, 2022).

Many ICE manufacturers have recognised the risk of not adapting their business models to the growing EV market. For example, in 2022, Vietnamese automaker VinFast, which rolled out its first automobile model less than five years ago, announced that it would completely switch production to EVs. Its goal going forward is to ramp up sales of its battery-powered sports utility vehicles (SUVs) in German and American markets (CNBC, 2023). Meanwhile, Audi has announced its intention to phase out combustion engines from majority markets by 2033 (Audi, 2023), as has General Motors by 2035 (Murray and Sesia, 2023). For its part, Volvo has pledged to make half its sales fully electric by 2025, with the other half being hybrid vehicles (Volvo, 2018). In a similar move, mega-group Stellaris (which consists of Chrysler, Fiat, Peugeot, and Citreön) says BEVs will account for 100% of its sales in Europe and 50% of its sales in the United States by 2030 (Stellantis, n.d.). Therefore, traditional automakers that do not update their business models to meet the rapid rise in demand for EVs could face losing their current market share.

Growing evidence shows that consumers are showing an increasing preference for "greener" air travel. A global survey by McKinsey finds that 40% of travellers would pay at least 2% more for carbon-neutral tickets. Further, to reduce their climate impact, about 36% of respondents plan to fly less frequently (McKinsey, 2022). Notably, younger consumers are shown to be more concerned about the environmental impact of flying and are willing to pay more for carbon-neutral flights compared to older age groups. This is particularly relevant given that the younger generation constituted 32% of the global population back in 2018 (Bloomberg, 2018) and will represent 27% of the world's income by 2030 (Business Insider, 2020). As a difficult-to-decarbonise sub-sector, the aviation industry faces a growing risk of consumer shifts towards less carbon-intensive practices.



[1] Counting responses 5 and 6 on the scale (1=strongly disagree, 6=strongly agree).
[2] % "really worried" about climate change.
[3] % for whom aviation plays a "major role" in their footprint.
[4] % agreeing aviation should "definitely become carbon neutral."
[5] % willing to pay $20+ more for a $1,000 flight.

Figure 11: Summary of survey results by McKinsey on sustainable aviation preferences by consumers (McKinsey, 2022)

Additionally, growing consumer preference towards public transportation as a low-carbon alternative is becoming increasingly evident. Public transportation offerings are highly concentrated in urban areas. As the world becomes increasingly urbanised by 2050, 70% of the world's population will live in such areas and will have access to public transportation (United Nations, 2018). In an IBM Sustainable Mobility Consumer Survey that surveyed 5,000 adults across Munich, London, Chicago, San Francisco, and Rome, half of public transport-users chose this option for reasons of sustainability (IBM, 2021). Cities are also incentivising commuters to use public transport through projects like expansions in service options and transport pricing schemes. A prime example is Germany's introduction of a steeply discounted monthly transportation pass (priced at EUR 9) between the months of May and August of 2022. The measure aimed to mitigate the effects of rising automobile fuel costs, while also helping the country reach its CO_2 targets (Reuters, 2022). The results of this policy highlighted areas of improvement for public transportation in the country. Interest was so high that over 21 million passes were purchased between May and July alone. This yielded an average increase of 10% in the number of people taking regional trains, with usage of certain route jumping by up to 25% (DW, 2022).

Case Study 4: China's Automobile Market vs Legacy Automakers

China has the largest automobile market in the world in terms of both supply and demand. As such, it holds great influence over the global automobile industry. In recent years, EV costs in the country plummeted due to innovations in battery capacity and scaled production, piquing the interest of the general public. In the first quarter of 2023, EV deliveries constituted 31% of all car sales, a rise from the previous year's figure of 28% (South China Morning Post, 2023). Figure 12 illustrates the market share of new-energy vehicles, such as EVs, in comparison to traditional fuel type cars in China. Interest in new-energy vehicles has steadily grown over the last decade, catapulting the EV company Tesla into becoming China's automobile seller with the highest brand value. In second place is Toyota, which is the largest automobile manufacturer in the world (Statista, 2023).

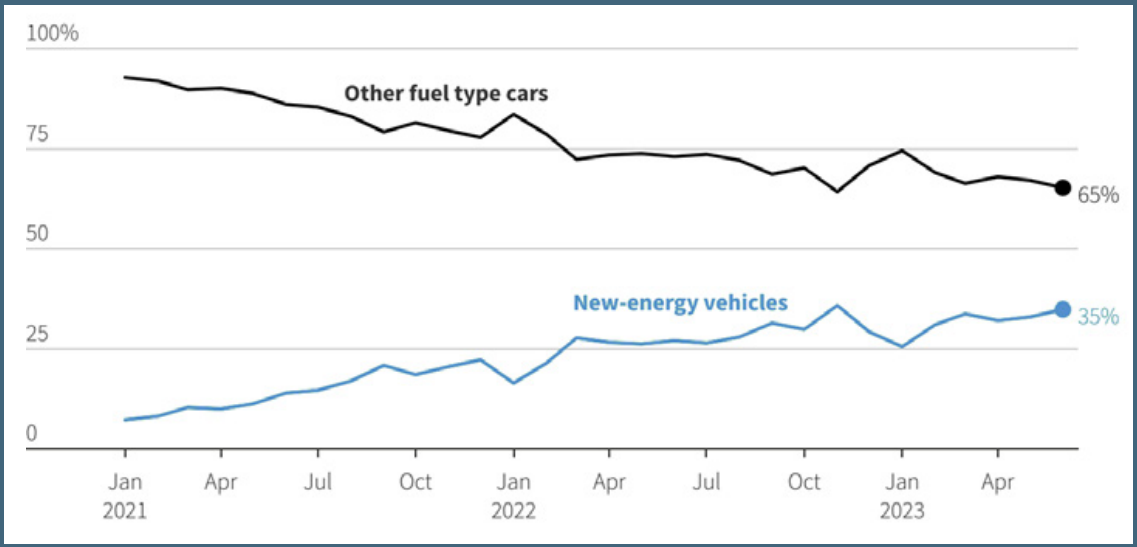


Figure 12: The market share of new-energy vehicles (such as EVs) in comparison to traditional fuel type cars (such as ICE vehicles) in China (Reuters, 2023)

Toyota, along with fellow legacy automakers such as Volkswagen, Honda, and General Motors, is at a risk of losing a significant portion of its Chinese market share to international and domestic EV manufacturers (South China Morning Post, 2023). Volkswagen, which had previously been the most popular automobile brand in China for 15 years, watched its market share dwindle by 3.6% in 2022, with BYD—the country's leading EV manufacturer—surpassing Volkswagen to become China's bestselling auto brand in the first quarter of 2023.

To compensate, Volkswagen unveiled a plan known as project “100%TechCo” that aimed to establish an EV development centre in the region with a view to reducing EV development times by 30% (Volkswagen, 2023). Similarly, Toyota’s chief executive, Koji Sato, replied to the market hits by describing the “need to increase our speed and efforts to firmly meet the customer expectations in the Chinese market”. He followed this up by confirming the company’s intention to develop an EV-dedicated platform by 2026. Recent research reports indicate that companies that have been slow to adopt EV technology, such as Toyota and Volkswagen, are projected to face further losses in the Chinese market, even in the most conservative estimates (Greenpeace, 2023; Electrek, 2023).

5. Rising reputational risk

With an increasing shift in consumer sentiment towards climate-conscious solutions comes the higher probability of reputational risk for firms that do not prioritise climate action. Reputational risks can materialise through external pressure on transport companies from campaign groups, governments, and consumers. Rising public concern over climate change is resulting in attention being brought to governments, companies, and financial institutions that continue to contribute to CO_2 emissions. If a firm is deemed untrustworthy or unethical in its climate practices, it can bring about serious damage to its public image, thus driving down sales and profits.

The aviation sub-sector is growing increasingly vulnerable to reputation risks as climate activists draw attention to the excessive carbon emissions produced by private jet travel. In November 2022, dozens of protestors blocked air travel at 13 private airports across 12 countries for a day (New York Times, 2022). Many of those protesting were scientists belonging to Science Rebellion, an organisation of academics advocating for direct environmental action (Science Rebellion, n.d.). Similarly, a report spotlighting the celebrities emitting the most greenhouse gasses through private jet flight garnered public attention and outrage via social media and news outlets (Yard, 2022). A similar report tracked the private jet spending of companies represented in the S&P 500. It found that private jet spending hit a 10-year high in 2021, with the average bill hitting USD 170,000 (Financial Times, 2022). A 2022 report by the campaign group Greenpeace found that the seven largest European airlines—including names such as Air France and Lufthansa—have made little to no effort to keep their emissions in line with the Paris Agreement. Under the guise of sustainable commitments, these companies have not set annual reduction goals in their flight offerings. This is despite the obligation on them to reduce their flights by 2% annually until 2040 so as to be in line with the 1.5°C climate target. As a result, Greenpeace and 30 other organisations are campaigning to end fossil advertising and sponsorship in the European Union (Greenpeace, 2022).

Automakers that are unwilling to adjust their operating model and embrace EVs are vulnerable to reputational damage. For example, in 2021, Greenpeace released a study on global automakers' recent decarbonisation action and transition plans. The organisation ranked Toyota, Stellantis, and Ford the lowest out of the 10 companies it analysed. Its assessment was based on the percentage of company sales that came from zero-emission vehicles and on the progress they had made in decarbonising their supply chains (Figure 13) (Greenpeace, 2021a). The same year, more than a dozen environmental, scientific, and auto industry groups published an open letter criticising Toyota's business practices after the company had been fined USD 180 million for knowingly breaching Federal standards on clean air emissions for a decade (Forbes, 2021b). Additionally, it was pointed out that Toyota had supported plans by the administration of

President Donald Trump to repeal an ambitious clean car emissions programme established by his predecessor, President Barrack Obama. As a result, environmentalists called for a boycott of the company, with "#BoycottToyota" trending on social media (The Dallas Morning News, 2021). Another Greenpeace study released in 2022 subsequently ranked Toyota as one of the most negative companies on climate policy (Greenpeace, 2021b). Although large corporations may be able to withstand the decline in support from such boycotts, smaller firms stand less of a chance.

	Overall grades	Phase-out of ICE vehicles full marks: 10, weight: 60%	PSupply chain decarbonisation full marks: 10, weight: 20%	Resource sustainability	Deductions
Toyota	F--	1.88	4.45		-
Stellantis	F--	2.88	3.05		-
Ford	F-	1.13	5.30		
Daimler	F-	3.13	2.30	+	-
Honda	F+	3.50	1.70	+	
Nissan	F+	3.31	5.40	+	-
Hyundai-Kia	F+	4.81	3.10		-
Renault	D-	4.31	6.75		-
Volkswagen	D	5.19	4.35		-
General Motors	C-	6.69	5.60		-

Figure 13: Ranking of global automakers based on their decarbonisation plans by Greenpeace (Greenpeace, 2021a)

Case Study 5: Rising reputational risk

COSCO SHIPPING International Annual Report 2022

Chinese shipping corporation

Transition risk identification

The Group continue to assess its effects on our operations and strengthen our internal capacity to adapt the escalating climate-related risks. The Group identified the reputational risk as a main risk driver if the public policy regulations haven't been fully complied with. By considering its potential climate-related risks in respect of the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD), the Group considers that its s reputation may be affected by customer actions or perceptions regarding its contributions to the transition to a low-carbon economy. It is essential that the Group's business model aligns with the low-carbon economy, or it may be perceived negatively by customers. In light of stricter environmental regulations and the impact of carbon taxes on businesses, the Group needs to be fully aware of these issues in order to avoid violating laws and triggering reputation risk.

Risk mitigation measures

When it comes to transition risks, the Group keeps abreast of the latest regulatory developments in terms of our production standards and other applicable laws and regulations to avoid any non-compliance. In an effort to contribute to a greener production environment and comply with relevant regulations, COSCO Kansai Companies and Jotun COSCO are working towards low-emission production.

6. Shift in investor sentiment

Investors are increasingly considering growing climate risks and opportunities by incorporating ESG factors into their decision-making. A prime example is the shift in investment towards the development and expansion of EVs. As auto companies announce new ventures into EVs and new start-ups get formed, the rise in competition in the global EV market is increasing investor confidence. One strong piece of evidence supporting the rise in EV investments is the boom in funding by venture capitals (VCs) for start-ups in the EV sector. Investors such as banks, private equity funds and VCs see EV start-ups as an opportunity for high financial returns. Figure 14 illustrates the recent trend in VC investment in electromobility start-ups. It shows how VC investments in start-ups producing EVs and charging technologies rose by 50% between 2021 to 2022, reaching an estimated USD 1.2 billion (IEA, 2023b). This rise in EV investment is a threat to ICE vehicle producers as the increase in investment comes at the expense of a decrease in investments available for ICE vehicles (Bloomberg, 2022).

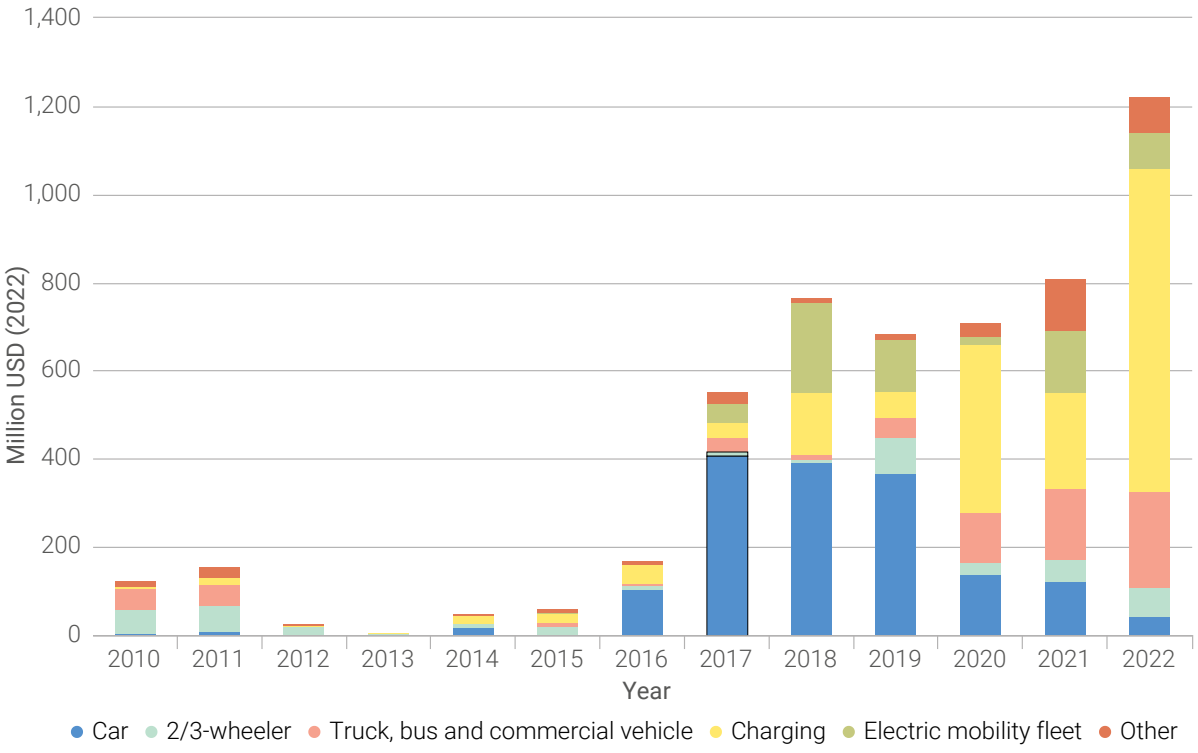


Figure 14a: Early-stage electric mobility start-ups b) growth-stage electric mobility start-ups (IEA, 2023b)

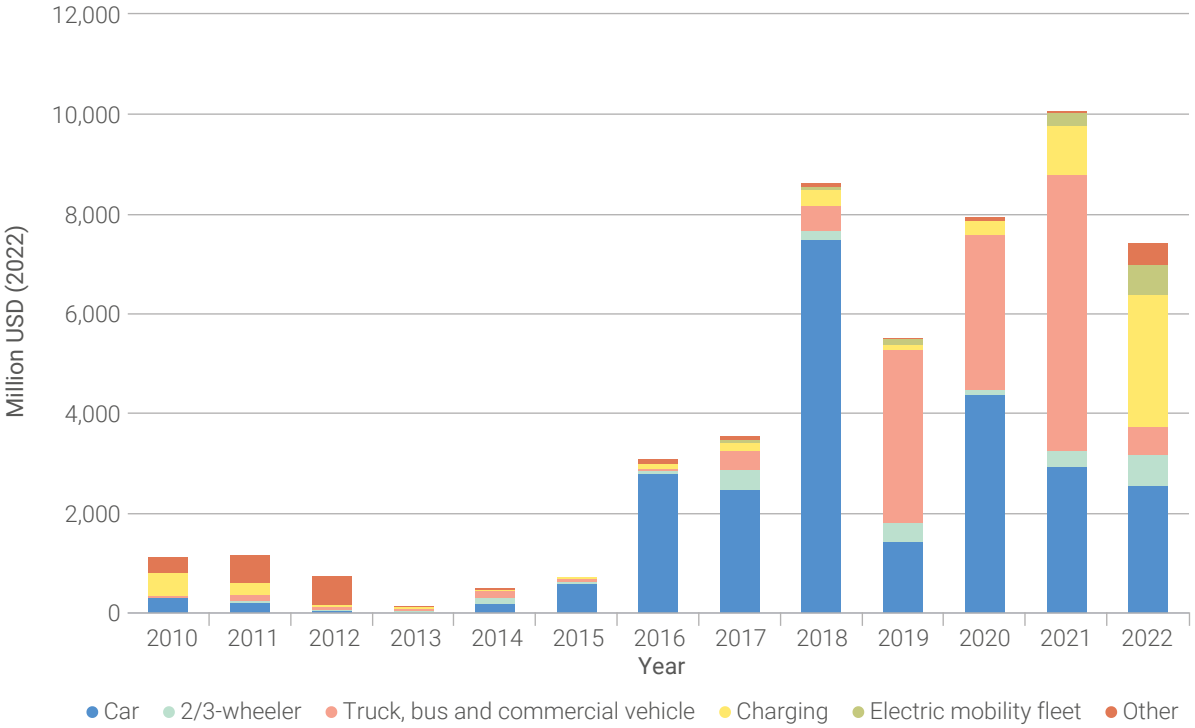


Figure 14b: Growth-stage electric mobility start-ups (IEA, 2023b)

7. Legal risks

Climate activists and governments have begun pursuing legal action to hold to account transportation companies for the contribution that their high emissions make towards climate change. As a result, the transportation sector faces increasing climate-related legal risks.

In Europe, the European Commission (EC) charged four major automobile companies—Audi, BMW, Porsche, and Volkswagen—USD 944,467,021 (EUR 875,189,000) in fines for colluding to restrict competition on emission-cleaning for diesel engines. BMW was judged to have had limited technical development, in breach of its Article 101(1)(b) of the Treaty and Article 53(1)(b) of the European Economic Area (EEA)-Agreement, in its actions taken between 25 June 2009 and 1 October 2014 (Forbes, 2021c). The US automaker Daimler also admitted guilt in collusion; however, as it blew the whistle to the EC, Daimler avoided a USD 784,858,295 (EUR 727,000,000) fine. In the United States, as part of a multi-state coalition, the US Attorney General filed a suit against the US Postal Service (USPS), arguing that its plans to replace 90% of its fleet with traditional fossil fuel-based vehicles violated the National Environmental Policy Act's requirements (US Office of Attorney General, 2022). In response to the lawsuit, USPS retracted its initial plan and has since committed USD 9.6 billion to electrify its delivery fleet by 2026, including 66,000 vehicles and charging stations at hundreds of facilities (White House, 2022). In 2021, the US Department of Justice and the Environment Protection Agency (EPA) announced that Toyota would be subjected to a USD 180 million fine for a decade's worth of non-compliance with the Clean Air Act emission-related defect reporting requirements, which required firms to report instances of recalls or defects in equipment responsible for vehicle emissions. Between 2005 and 2015, the company failed to file over 69 reports to the EPA. Some of the reports it did submit, on the other hand, it did so up to eight years late (USDOJ, 2021).

In 2022, environmental groups launched a lawsuit against Dutch airline, KLM, claiming that its Fly Responsibly campaign mislead consumers to how environmentally friendly flying actually is (BBC, 2022). The case remains in the courts with more hearings expected this year (The Guardian, 2023). In 2023, US airline Delta Airlines faced a USD 1 billion lawsuit over its 2020 carbon neutrality claims, which were deemed to be misleading and demonstrably false. The company had pledged USD 1 billion in 2020 to mitigate its carbon footprint over the subsequent decade, but the class-action lawsuit maintains that Delta's efforts largely target "junk" offsets that do little to counteract their carbon emissions. It also claims that the firm misled climate-conscious consumers by operating under the guise of carbon neutrality (The Guardian, 2023).

8. Transition risk guidance

This section offers guidance on how financial institutions can address transition risks within the sector and support their clients in the process.

Key transition risk questions for financial institutions to consider include:

1. **Gathering information**

- Are there any new governmental standards (e.g. on fuel efficiency, on fossil fuel use, on pollution) that impact assets within our portfolio's footprint?
- How rapidly is the low-carbon transition progressing across our portfolio footprint? What do energy costs, demand, and efficiency look like across our portfolio footprint?
- What have our clients disclosed in their financial, sustainability, and climate reports regarding their transition risks?
- Are any of our clients facing legal action related to industrial activities, pollution, or other environmental issues?
- How many of our clients have transition plans? Do they incorporate just transition considerations into these plans?
- Do we have emissions data for our clients?
- What are the obstacles for transitioning to less-carbon intensive alternatives in the areas the client operates in (e.g. infrastructure availability)?

2. Assessing the risks

- Have we looked at transition scenarios to see how these risks will evolve over time across the portfolio? Have we considered short-term, medium-term, and long-term risks?
- What does our exposure to higher-risk clients look like? What are the terms of our financial relationship (e.g. debt/equity, tenor)?
- How does the emissions intensity of our clients compare to industry and regional averages?
- What is the cost of production for our clients? How does that compare to industry and regional averages?
- How much are clients investing in low-carbon operations and in research and development?
- Have we considered the potential environmental and social risks that might emerge from shifts in the value chain or changes in demand resulting from transition risks?

3. Engaging with clients and updating strategy

- Do our senior leaders understand the transition risks of our clients?
- How are we helping our clients to transition to a low-carbon future? How are we supporting their efforts to advance a just transition?
- How will the transition risks identified and assessed influence our strategy in the transportation sector?
- What specific updates to risk management practices or business activities will be needed to appropriately consider these transition risks in our operations?

Recommendations for risk management

1. Understand the energy demands of transportation types

The energy use and emissions intensity of a transportation asset can provide financial institutions with valuable information about the transition risk for firms in the sector. Technological advancements, shifts in market preferences, and government policies can have strong negative implications for firms producing carbon-intensive assets, with fuel prices being a crucial factor in determining the affordability and desirability of assets sold by transportation firms. These growing risks make it vital for financial institutions to gather data on an asset's fuel use and emissions intensity. The types of data that can be collected can include the amount of fuel consumption across fuel types, portion of passenger and freight, number of vehicles and distance travelled. For the shipping sub-sector, hours underway and technical characteristics of the ship (e.g. deadweight tonnage) can also be useful metrics for assessing emissions intensity (Poseidon Principles, 2023). Such data can be used to compare clients to one another and determine which are the most vulnerable to the climate transition.

2. Support the development of new product designs

Businesses in the transportation sector will face challenges to their current business models as many firms in the sector rely on revenue from selling carbon-intensive vehicles or providing a transportation service using carbon-intensive vehicles. The combination of growing government restrictions and policies, couple with changes in consumer preferences and increasing competition, may lead to some of these firms acquiring losses. Many firms in the sector have recognised the reality of growing risks associated with their current operations and are developing (or have developed) plans to transition from carbon-intensive practices to less carbon-intensive practices. For example, many automakers have set targets to phase out the production of ICE vehicles. Similarly, airlines are considering advancements in aircraft design and propulsion technologies to decarbonise. Many of these plans require significant investments to diversify the product design of vehicles. Financial institutions should assess their clients' transition plans with industry-specific targets and metrics to ensure they are credible. A number of frameworks exist to help perform this assessment. Examples include the Assessing Carbon Transitions framework by CDP, as well as the guidance issued by the Task Force on Climate-related Financial Disclosures (TCFD) on effective transition plans. These transition plans can help ensure financing provided is climate resilient.

Adaptive and mitigating actions of clients

1. Diversification of operations

Firms in the transportation sector are significant contributors to global CO_2 emissions. However, firms are taking steps to diversify their business model. Diversifying operations for the road sub-sector includes changing their production to producing a wider range of models of fuel-efficient vehicles and EVs. Firms are also looking to reduce the carbon intensity of production processes by improving energy efficiency and using low-carbon energy sources. For example, for the aviation sub-sector, firms are considering SAF, optimizing flight pathways and improving the efficiency of aircrafts and ground equipment. As firms reprioritise their focus on reducing their emissions intensity, they should develop transition plans to set out a journey to achieve targets.

2. Environmental and social stewardship

Strong environmental and social practices are essential across all economic sectors. However, the transportation sector faces a number of historic and ongoing environmental issues. These range from shipping and freight transport causing fuel spills that endanger ecosystems through to vehicle emissions that degrade air quality through road transport and aviation. Similarly, the expansion of EV manufacturing raises growing concerns about the social implications associated with mining critical minerals required for EVs. Integration of environmental and social practices will require the involvement of actors across supply chains. As such, environmental and social stewardship needs to be a top priority for firms in the sector. Products and services provided by the sector should be designed and operated in a manner that improves the quality of life for all communities. Firms should consider the electrification of vehicles produced or used to reduce air pollution and should implement protocols to reduce fuel spills that can damage natural areas. Additionally, firms should take into account the affordability and accessibility of transportation for communities. It is important to address the disparity between the availability of transit services and the specific transportation needs of the population in a given area. Companies in the sector should meet transportation needs without releasing CO_2 emissions that negatively impact health, the climate, and biodiversity. The following box offers examples of social factors that financial institutions and their clients should take into account during the transition to a low-carbon economy.

Examples of sector-specific social considerations (UNEP FI, 2023)

Employment impacts: The structural shift in urban transportation away from fossil fuels-dependent mobility towards electrification and the increased use of public transport services is expected to lead to net employment gains. However, the positive prognosis masks considerable reallocation, involving the creation of new jobs in public transport services; rail infrastructure construction; and electric vehicles manufacturing production and maintenance of electric vehicles accompanied by job losses in the conventional automobile industry; changes to the fuel supply chain; and a decline in commuting due to remote working and learning. There are additional impacts on the livelihoods of workers in the formal and informal economy involved in small scale and informal transport services and dependent on fossil fuel-based public transport.

Skills development needs to be considered since new technical skills will be required in emerging sectors, such as public transport operations and services, and repairing electric vehicles.

Social dialogue and stakeholder engagement: solid transition plans are required to support the transformation of the transportation sector and should be based on social dialogue and include informal, platform and app-based workers.

Rights: Transition plans should recognize the rights to freedom of association and collective bargaining within the transportation sector.

Gendered impacts: Female public transport workers face additional challenges compared to their male colleagues, most significantly as a result of gender-based discrimination, harassment and violence; and routinely poor access to sanitary facilities which are clean, safe and dignified.

Equitable access to transportation ensuring people's access to employment opportunities and contributing to economic productivity and reduced inequality; and affordability of sustainable technologies and vehicles. Higher vehicle costs may disproportionately impact lower-income customers who tend to drive less efficient vehicles.

Aligning to net zero

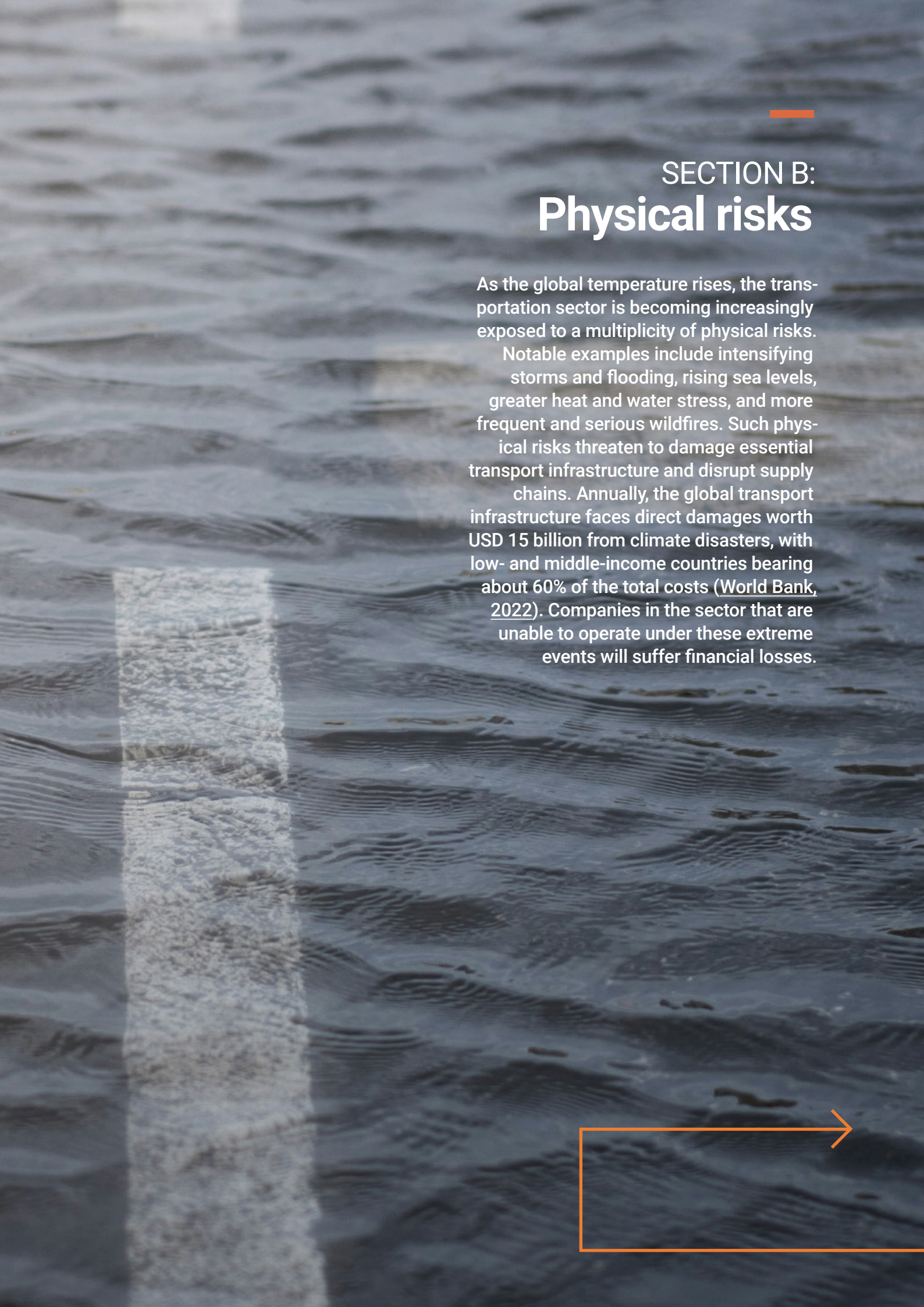
Financial institutions looking to manage their transition risks in the transportation sector should engage directly with clients and support their respective transition plans. Necessary as these steps are, however, a client-level approach must also complement a more strategic approach to reducing the firm's financed emissions. Over the past few years, hundreds of major financial institutions have committed to net zero by 2050 across their portfolios. Most of these institutions have joined one of the industry-specific decarbonisation alliances (e.g. Net-Zero Banking Alliance, Net-Zero Asset Owner Alliance) to support them in fulfilling their climate goals. Beyond the financial

sector, net-zero alignment has also gone mainstream in government policies worldwide, with nearly 90% of global emissions now covered by a net-zero commitment.

Amid growing pressures on high-carbon sectors and the decarbonisation ambitions of financial and government actors, financial institutions can consider a credible and actionable net-zero commitment as a means of mitigating both the systemic and idiosyncratic risks of the transition. The process of operationalising a net-zero commitment begins by assessing baseline financed emissions. Institutions then set targets for their portfolios and specific sectors, such as the transportation sector using science-based scenarios. After the targets are set, financial institutions develop holistic strategies to reduce their financed emissions. These processes can be explained to stakeholders in a transparent transition plan that demonstrates not only their net-zero commitment but also spell out how the firm is mitigating its transition risks.

Additional guidance

- The Equator Principle's guidance note on Climate Change Risk Assessment provides detailed information on transition risk assessment.
- The European Central Bank has published good practices for climate-related and environmental risk management for financial institutions.
- Methodology by the Transition Pathway Initiative is available on emission intensity and carbon performance assessment of automakers.
- Additional guidance by the Transition Plan Taskforce is available on disclosing credible transition plans for firms.
- University of Oxford's publication Assessing the Credibility of Climate Transition Plans in the Aviation Sector can be used by financial institutions to understand the areas of improvements needed in clients' transition plans for the aviation sub-sector.
- UNEP FI and the International Labour Organization's report on Just transition Finance includes guidance for banks and insurers on adopting a just transition lens in their banking and underwriting activities.
- UNEP FI and the Cambridge Institute for Sustainability Leadership's report on Leadership Strategies for Client Engagement: Advancing climate-related assessments provides guidance on advancing climate-related assessments and assessing client transitions for effective use in client engagement.



SECTION B:

Physical risks

As the global temperature rises, the transportation sector is becoming increasingly exposed to a multiplicity of physical risks. Notable examples include intensifying storms and flooding, rising sea levels, greater heat and water stress, and more frequent and serious wildfires. Such physical risks threaten to damage essential transport infrastructure and disrupt supply chains. Annually, the global transport infrastructure faces direct damages worth USD 15 billion from climate disasters, with low- and middle-income countries bearing about 60% of the total costs (World Bank, 2022). Companies in the sector that are unable to operate under these extreme events will suffer financial losses.

1. Intensifying storms and floods

Assets in the transportation sector have a high exposure to the risk of extreme storms, such as hurricanes. This is due to the fact that many transportation hubs, such as airports and ports, are located near coasts. Water, air, and ground passenger transportation are particularly vulnerable to hurricane risk, with 10–25% of their assets being currently exposed (Moody's, 2021a). As extreme storms increase in severity and frequency, the portion of exposed assets in these sub-sectors is expected to rise.

Production facilities and vehicle manufacturing are especially vulnerable to severe storms and flooding. These climate-related physical impacts can decrease profitability for firms in the sector from higher energy costs, operational shutdowns, and delivery disruptions to production plants. This vulnerability to flooding and extreme storms has already been witnessed in practice. An illustrative example occurred in 2019, when extensive flooding led to large-scale disruption of Thailand's automobile industry. Original Equipment Manufacturers (OEMs) had to pause manufacturing operations in factories, which accounted for 10% of Thailand's automobile parts production (Supply Chain, 2020). Similarly, Toyota South Africa Motors (TSAM) had to close its Durban plant in South Africa for three months after a severe flood in 2022. The financial losses due to this shutdown amounted to roughly R28 billion (USD 1.48 billion), with a production shortfall of about 70,000 cars at an average of R400,000 (USD 21,000) per car. Such events also have a substantial impact on employees. The shutdown of TSAM, for example, led to a drop of 30% in incomes for the firm's 7,500 employees over the three-month period (Citizen, 2022). Another notable climate-linked disruption occurred in Mexico in June 2018 when a localised flood compelled Honda to suspend operations in its auto plant in Celaya, in the state of Guanajuato. Auto and engine production at the plant resumed in November, while Honda was forced to shift a proportion of production to a plant in another area. The flooding had knock-on effects for production elsewhere. Following the 2018 incident, for example, Honda had to suspend production for a month at its plant in Indiana, United States, because critical engine parts produced in its Mexico plant had run out (Honda, 2018). In total, the event cost the automaker a reported USD 450 million in losses (Expansion, 2018).

As countries transition to decarbonise the transport sector, demand for EVs is expected to grow rapidly. In 2021, 10% of global car sales were electric, four times greater than in 2019. Two million EVs were sold in the first quarter of 2022 alone, 75% higher compared to 2021 (IEA, 2022). In the United States, EV manufacturing is expected to reach 4.5 million vehicles annually by 2030, supported by the Inflation Reduction Act (CleanTechnica, 2023). As the demand for EVs grows, 90% of counties in Tennessee—a US auto manufacturing hub where General Motors (GM) is developing a multi-billion-dollar EV battery plant—are expected to be exposed to high flood risk. Severe floods in Davidson

County, which will be home to GM's battery plant, led to multiple deaths and a Federal Disaster Declaration in 2021 (Moody's, 2021a). Extensive costs are also associated with harms to employee safety, particularly for plants in flood-prone areas. It is therefore concerning that key US auto manufacturing hubs are located in areas at risk of flooding. One notable example is that of Wayne County, Michigan, which is home to both GM and Ford. The flood-prone county accounts for 23% of all US automotive production and 76% of its overall automotive research and development (Wayne County, 2023).

Increases in the severity and frequency of extreme storms and flooding can also cause extensive damage to critical road, rail, port, and other transportation infrastructure. Such damage can lead to closures and can make it impossible for transportation firms and consumers to operate cars, trucks, trains, and airplanes. As a result, such incidences may force them to suspend or drastically reduce their activities. In 2021, for instance, a study estimates that 127 million vehicle hours were lost in just one week in the wake of a fierce storm across the south on the United States. The cost from the trucking industry was put at about USD 8.3 billion (Weather, 2021). Storms and flooding can also significantly impact global supply chains by causing delays in transportation. These delays impact each point on the supply chain, from raw material producers right the way through to OEMs and their distributors. This can lead to redirected capacity, such as freight being rerouted and backup in other areas. For example, ports in the United States' state of New Jersey experienced flood damages amounting to USD 147 million as a result of Hurricane Sandy (EDF, 2022). Similarly, the aftermath of Hurricane Maria in Puerto Rico caused huge supply-chain disruptions downstream. The country's fuel distribution system, for example, operated at only 30% of its usual capacity in the two weeks following the storm (CNA, 2018). During the first five days of the storm, transportation was made almost impossible due to the loss of critical infrastructure, shortages of fuel shortages, and lack of electricity, among other challenges. Extreme storms and flooding pose a growing risk for the sector as they threaten infrastructure, routes, and operations that companies in the sector are dependent on for profits.

The rise in storm severity and frequency is also disrupting global aviation through delays, cancellations and the rerouting of planes. In 2018, for example, Typhoon Jebi wreaked havoc on Japan's aviation sub-sector. The typhoon submerged several aircrafts at Kansai International Airport in Osaka up to their engines and caused over 700 flight cancellations (Business Insider, 2018; CNBC, 2018). Similarly, in 2022, Typhoon Hinnamnor blasted South Korea and the surrounding area, grounded 270 domestic flights and 66 ferry services (LA Times, 2022). In the summer of 2023, over 1,300 flights in the United States were cancelled and more than 5,700 flights were delayed due to severe weather on the East Coast (USA Today, 2023). Similarly, tropical storm Hurricane Ida in August 2023 caused over 700 flights to be cancelled before the storm made landfall in Florida (Forbes, 2023b). Cancellations due to extreme storms can cost airlines millions of dollars. For example, in 2017, following hurricanes Harvey, Irma, and Maria, American Airlines reported losses of USD 475 million in its third quarter. Similarly, Spirit Airlines reported losses of USD 40 million due to the hurricanes. Meanwhile, hurricanes Harvey and Irma caused Southwest to lose an estimated USD 100 million in revenue, while the latter event resulted in Delta Airlines losing USD 120 million in revenues (Travel Agent Central, 2017).

Of all road and railway infrastructure assets globally, 7.5% are exposed to a one-in-100-year flood event (UN, 2021). The annual direct cost of damage to road and railway assets from extreme weather events is estimated to vary between USD 3.1 billion and USD 22 billion, with flooding accounting for 73% of the costs (UN, 2021). In 2019, Storm Eberhard swept across Belgium, the Netherlands, and Germany, forcing major railway companies like German Rail and Austrian Federal Rail to cancel services due to safety concerns (DW, 2019). At the time, insured losses due to extreme wind from the storm was estimated at between EUR 900 million and EUR 1.5 billion (Verisk, 2019). Severe weather events, particularly heavy bouts of rainfall, can cause landslides and can threaten to destroy trains and tracks. A case in point was a storm in 2020 in Kentucky, United States, which directly struck a 96-car freight train (Two Degrees, 2020). With every locomotive costing around EUR 3 million, damages from extreme storms and flooding can be extremely costly to companies belonging to the sector (Two Degrees, 2020). Extreme storms can also cause underground railways to flood. Just such an incident occurred in 2012 when Hurricane Sandy flooded the New York subway system, resulting in USD 5 billion in repairs (Bloomberg, 2021a). In Zhengzhou, China, meanwhile, the sudden falling of 200 millimetres of rain during a storm in 2021 caused subways to flood. Several commuters drowned as a direct result (Climate Change News, 2021).

The shipping sub-sector is particularly vulnerable to extreme storms and flooding due to the location of ports. A global survey ranked the main extreme weather incidents affecting ports worldwide where there were significant or critical effects in terms of port closure or downtime. The 53 ports involved in the research cited wind as the most problematic factor for port activities, followed by extreme waves and rainfall (UN, 2021). In 2019, approximately 38% of global container port activity was situated in regions vulnerable to high hurricane risk, including coastal areas of China, South Korea, Japan, and the American Eastern Seaboard (Port Economics, Management and Policy, 2019). According to the Environment Defense Fund, impacts from climate change could cost the shipping industry up to USD 25 billion by 2100 in a business-as-usual warming situation. Excluding the costs to infrastructure, storm-related disruptions could cost USD 7.5 billion annually (EDF, 2022). Rerouting ships as a result of storms can be costly as each additional day at sea for a container ship consumes 150 tons of fuel, costing approximately USD 75,000. Extreme weather events can force closure of ports. For example, Hurricane Harvey in 2017 caused the closure of the Port of Houston in Texas for a week. According to estimates, the closing of a major port such as the one in Houston can cause financial losses of up to USD 2.5 billion from delayed or cancelled business transactions (Transport Topics, 2017). Additionally, intense storms can cause cargo to be lost overboard due to extreme weather. An estimated USD 54.4 million was lost due to containers falling overboard in the first four months of 2021 alone (Bloomberg, 2021b). Adapting to the rising threat of extreme storms will also be costly for the transportation sector. Research has found that the cost of adapting 53 ports in the Asia-Pacific region could range from USD 31 to USD 49 billion (UN, 2021).

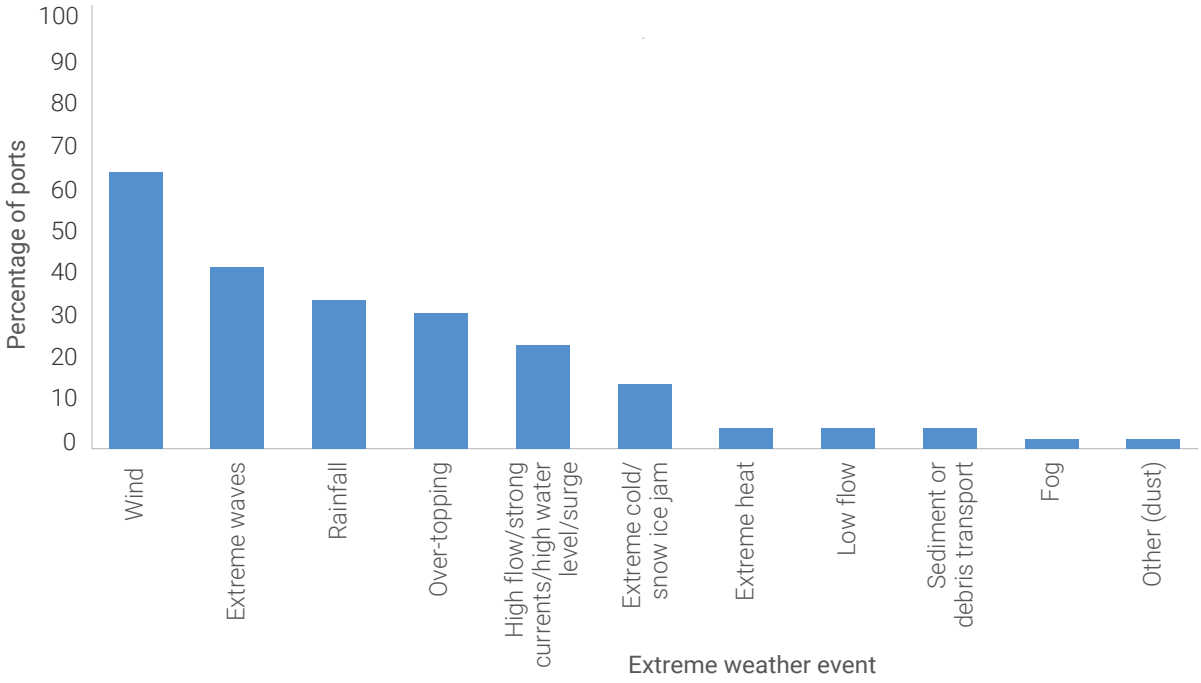


Figure 15: Portion of ports reporting extreme weather events, such as those intensified by climate change (UN, 2021)

Severe flooding can also cause increasing damage to vehicles, resulting in an increase in the number flood-related vehicle insurance claims. For example, flooding in Auckland in early 2023 saw insurance claims for damaged vehicles skyrocket. Overall, the insurance industry estimated that the floods would cost more than USD 620 million. Over 7,500 claims were made for damaged vehicles, worth an estimated USD 65 million (Floodlist, 2023), with one insurer alone facing a record breaking 1,500 claims (Autocar, 2023). As a result, insurance premiums were expected to rise (RNZ, 2023). Similarly, flooding in Delhi in 2023 after the Yamuna River overflowed saw a spike in insurance claims. Acko General Insurance, an Indian private insurance firm, reported a rise of 5–10% in such claims due to the floods (CNBC, 2023a). Insurers in Australia have also observed an increase in the number of customers renewing their car insurance. This is despite insurance premiums increasing by more than 10% and inflation levels rising. Companies are also observing high retention rates for motor insurance (SMH, 2023). As flooding risk worsen, the rising cost both of damage and of vehicle repair can cause insurance premiums to go up. In turn, this impacts affordability of insurance for many consumers.

Case Study 6: Intensifying storms and abnormal precipitations

COSCO SHIPPING International Annual Report 2022

Chinese shipping corporation

Climate-related risk mapping

The threats of climate change is imminent, especially in the face of extreme weather conditions such as frequent typhoons, seasonal storms and abnormal precipitations. The Group identified the risks of extreme weather conditions (e.g. typhoons, flooding) as an acute physical risks that are relevant to our operations. The increasingly frequent extreme weather may damage the assets and facilities of the production plants, while putting the safety of employees at risk.

Climate-related risk adaptation

To mitigate the identified climate-related risks, COSCO Kansai Companies and Jotun COSCO have devised a set of emergency management plans and a natural catastrophe contingency plan.

Conducting yearly emergency exercises, we also aim to heighten the awareness of our employees in the production facilities and encourage efficient internal communication in the event of various natural catastrophes. Our Tianjin plant, for instance, has formulated flood prevention and severe cold weather reaction plan, while our Zhuhai plant has developed storm and flood response plans. Furthermore, COSCO Kansai Companies have also established emergency response teams to ensure successful execution of strategies and constant monitoring of climate conditions.

2. Sea-level rise

Transportation infrastructure located in coastal areas are substantially exposed to the risk of sea levels rising. Globally, a quarter of the 100 busiest airports are located less than ten metres above sea level (New York Times, 2018). In the United States, meanwhile, more than 60,000 miles of roads and bridges are located in coastal areas that are at risk of flooding and damage from sea-level rise (EPA, 2022). A sea-level rise of 1.2 metres could cause severe damage to transportation infrastructure, including 27% of major roads, 9% of rail lines, and 72% of ports along the coastline of the Mexican Gulf (Shen et al., 2018). In South America, meanwhile, a sea-level rise of 50cm could destroy more than 7,000km of roads. As for England, a 2°C warming scenario could see an estimated 1,600km of major roads, 650km of railway lines and 92 stations under water by 2080 (Earth.org, 2019). The risk of sea-level rise threatens transportation companies due to an increased likelihood of coastal flooding and storms surges, which can potentially lead to disruptions in operations and material damages. Without any additional climate action, under a worst-case climate scenario (RCP8.5), sea-level rise and stronger storms could cause annual damages and port disruption costs to increase to up to USD 25 billion. At present, global annual costs to port damage amount to USD 3 billion (Environmental Defense Fund, 2022).

Of all the transportation sub-sectors, the aviation and shipping sub-sectors are the most vulnerable to sea-level rise, with between 5–10% of assets exposed due to the proximity of transportation hubs to the coast. Analysis by Moody's has shown that exposure to sea-level rise for the sector is mainly concentrated in Asia, Europe and North America (Moody's, 2021b). A number of airports and airlines are especially exposed, according to the assessment. These include Japan Airlines and EVA Airways, with 18–21% and 14–19% of their assets exposed to sea-level rise, respectively. Shipping firm A.P. Moller-Maersk is similarly vulnerable, with around 13–18% of its assets highly exposed (Figure 16).

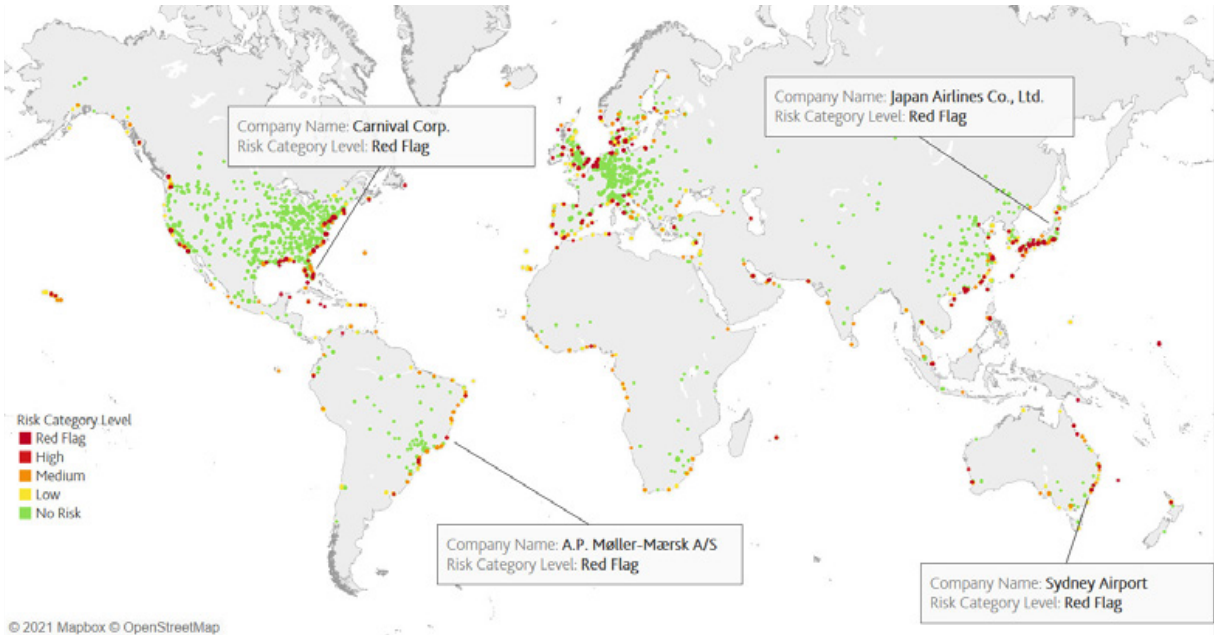


Figure 16: Exposure of companies from the aviation and shipping sub-sectors to sea-level rise (Moody's, 2021b)

As global warming worsens, ports globally will witness extreme sea levels. It is estimated that even under a 1.5°C temperature rise, extreme sea levels previously observed once a century could occur once every 10 years by 2030 at ports in South America, Africa, Southeast Asia and the Pacific (Figure 17) (UNCTAD, 2021). Coastal infrastructure will be especially vulnerable as sea levels rise. It is estimated that from 2010 to 2100, the amount of cargo handled at ports exposed to extreme high sea levels (i.e. above 4.5 metres) could increase by 200 million tons along the European coastline. According to the projected global mean sea levels and effects of tides, waves, and storm surges, 64% of all seaports are expected to be overrun under the RCP8.5 scenario. Across Europe, meanwhile, more than 60% of port traffic is dependent on connections with ports that have a high sea-level risk (Christodoulou et al., 2019). This poses a risk to shipping companies because they rely on the operability and availability of these ports.

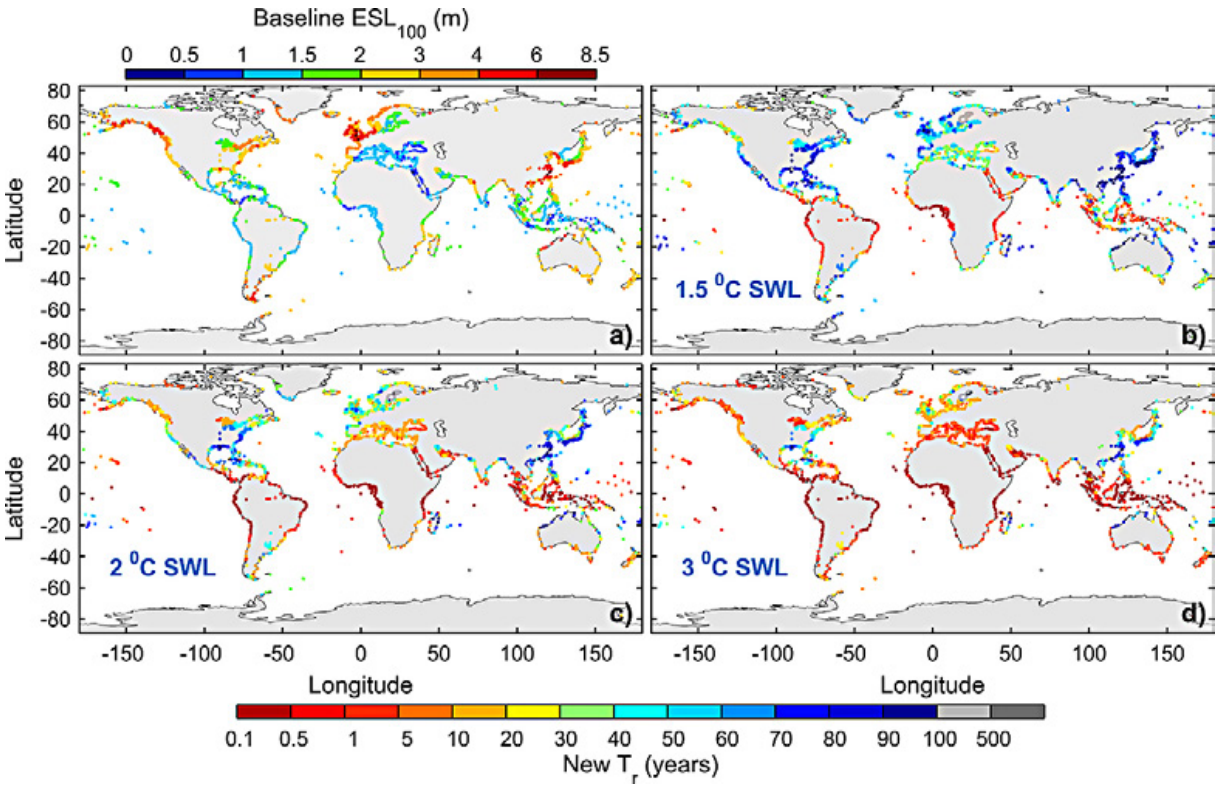


Figure 17: Extreme sea level projections for global ports under different warming levels (SWL: Specific Warming Levels) (UNCTAD, 2021)

A global temperature rise of 2°C could put 100 airports below the main sea level, further increasing their exposure to coastal flooding. By 2100, 10–20% of all global airline routes could be at risk of disruption. Moreover, adapting current transportation infrastructure to rising sea levels could be extremely costly for cities. Adapting airports to limit the risk of sea-level rise could cost up to USD 57 billion globally by 2100 (Yesudian & Dawson, 2021).

Similar to airports, railways are also vulnerable to sea-level rise. According to a study from the Committee on Climate Change, in 2018 about 520km of railway lines were under 0.1% or higher risk from coastal flooding caused by sea-level rise. However, the likelihood of climate change-related accidents will continue to grow. It is projected that by 2080, 650 km of railway lines and 92 railway stations in the United Kingdom will be exposed to significant coastal flooding and erosion (Railway Technology, 2019).

3. Rising temperatures and heat stress

Higher temperatures and heat stress will increasingly manifest themselves in the coming decades, presenting a significant risk to the transport sector. Rising temperatures and severe heat stress can affect factors crucial to the operation of the sector. Infrastructure and mechanics used in the transportation sector at present have been built for the current climate and are not suited for a world with warming temperatures. Heat stress can affect both the operation of vehicles and road conditions. For example, in the trucking sub-sector, truck engines need to be kept cool in order to function. If not, they shut down. Additionally, hot temperatures impact tires and may lead to decreased fuel mileage, worn out tires, and poor handling (Freight Waves, 2019). Should the global temperature continue to rise, firms belonging to the sector may well be compelled to cease operations due to the resulting heat stress.

High temperatures can also be detrimental for the operations of the aviation sub-sector as airplanes cannot operate above a certain temperature level. For example, in July 2017, temperatures in Phoenix, Arizona, skyrocketed to 48°C, causing 50 flights to be grounded (McKinsey, 2020). The US airline American Airlines cited 48°C as the maximum operating temperature for flight operations, leading it to cancel flights due to the heatwave (Atlantic, 2017). Without any climate action under a business-as-usual scenario (RCP 8.5), the frequency of temperatures exceeding 48°C will increase. The number of regional flights in the United States expected to be grounded annually will consequently go up to anywhere between 200–900 by 2030 and between 500–2,200 by 2050 . This would mean about 185,000 passengers could be impacted from heat stress annually, a 23-fold increase on 2020 levels (Figure 18) (McKinsey, 2020). As airlines are forced to cancel flights due to extreme heat stress, they could face lost profits from flights they can no longer operate.

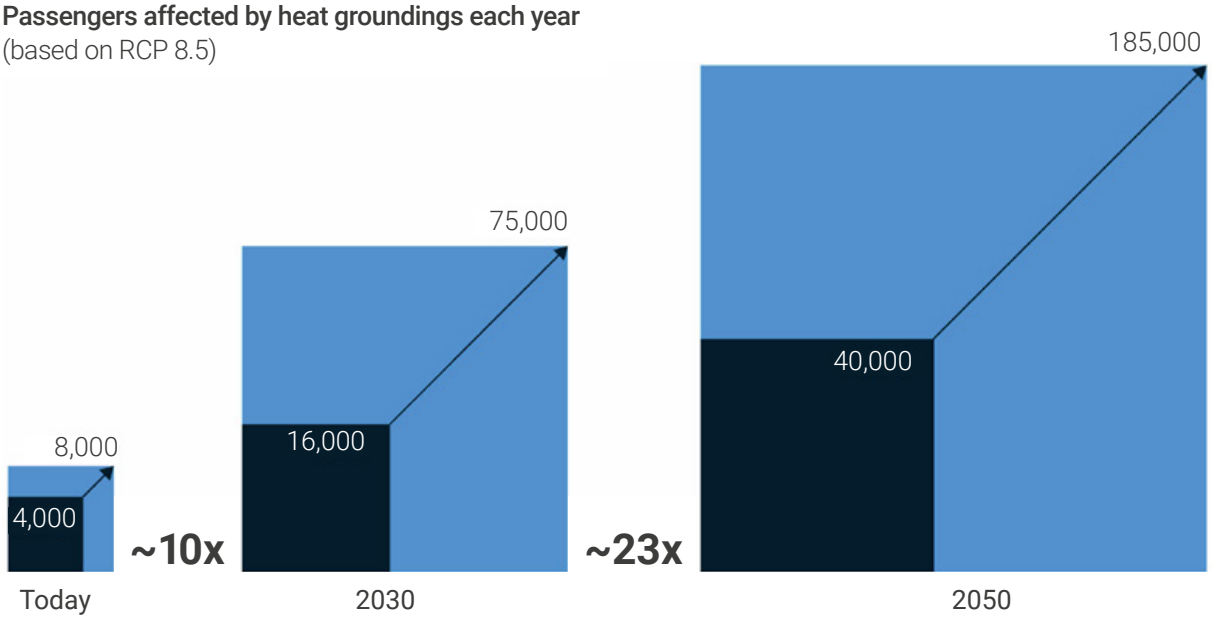


Figure 18: Passengers affected from airplanes grounding due to extreme heat from 2020 to 2050 (McKinsey 2020)

The rail sub-sector is especially vulnerable to extreme heat. As rail tracks are made of steel, they can buckle under extreme temperatures as already witnessed in various countries (Network Rail, 2023). Buckling of rail tracks is an extreme concern for railway companies as it forces them to suspend operations. In addition, overhead electric lines are highly vulnerable to heat waves. For example, the 2022 UK heatwave extensively disrupted both intra- and inter-city railway lines, spurring Network Rail to create a "resilience taskforce" to develop long-term solutions to heatwave-related disruptions (Guardian, 2022). Under high temperatures, companies are also forced to impose speed limits as a safety precaution, which can also cause financial loss due to the slowing of operations (Network Rail, 2023). In the United States alone, the cumulative impacts of costs from delays due to rising global warming can range from USD 25–45 billion under a low emission scenario (RCP 4.5) to USD 35–60 billion under a high emission scenario (RCP 8.5) by 2100 (Chinowsky et al., 2017).

High temperatures and heat stress can significantly impact the productivity of workers in vehicle manufacturing and transportation. For example, car manufacturing facilities experience an 8% reduction in output during weeks with six days of temperatures exceeding 32°C in the United States. High temperatures can also lead to a decrease in working hours and lower wages. Extreme heat can create hazardous working conditions, resulting in fatigue, dehydration and other heat-related illnesses for those spending prolonged periods in elevated temperatures (World Bank, 2023c). At present, it is common for workers in automotive workshops to face overheating during the summer, a trend that is likely to increase in frequency as global temperatures continue to rise (Rahman and Adnan, 2023).

4. Droughts and water scarcity

Climate change-induced droughts and water scarcity pose threats to the transportation sector, impacting both vehicle manufacturing and modes of transportation that depend on waterways.

Automakers may be forced to shut down operations due to power scarcity and shortages of crucial raw materials that need large amounts of water for supply. For example, in 2022, reservoirs dried up in mainland China after the country experienced the worst recorded heatwave in 60 years. This reduced the amount of energy produced by hydropower, which led to power shortages. As a result, the government in Sichuan province ordered the closure of all factories for six days. The shutdown impacted automotive companies and battery manufacturers, with knock-on effects for EV supply chains. The effects were particularly acute because of Sichuan's position as a manufacturing hub for lithium batteries (the province plays host to two of the world's largest lithium providers)—a crucial component of EVs. The automakers Tesla and SAIC Motors complained to authorities that the power shortages had impacted their suppliers for key parts and components in Sichuan, causing a slowdown to their manufacturing. Some companies, such as Volkswagen and Toyota, were able to make up for the six days of production losses by expanding capacity in other plants. However, as droughts like these become more common and more intense, firms in the sector could face significant production losses, impacting their profitability. The effect on battery manufacturing is especially threatening for EV supply chains, which play a vital role in decarbonising the transportation sector and reaching net zero (Fitch Solutions, 2022). Currently, waiting times for some EVs can range from five to 15 months, and these wait periods may extend further as water stress intensify (Electrifying.com, 2023).

The decline in water levels due to droughts can have profound implications for the shipping sub-sector and, as a result, global trade. In 2023, the Panama Canal faced its worst drought in 143 years, resulting in a mid-August backlog of 264 ships. The Panama Canal is responsible for 3% of global trade by volume and 29% of container trade through the Pacific. Countries like the United States, China, and Japan heavily rely on the canal for trade. The drought has led to a 15 million-tonne decrease in the volume of goods transported through the canal, and has caused ships to extend their transit time by an additional six days (IMF, 2023; Baker Institute for Public Policy, 2023). To cope, containers were offloaded and shipped by rail; for instance, the Taiwanese-owned vessel Ever Max had to unload 700 containers. Due to decreased water levels in the Panama Canal, the cost of shipping a container from Asia to the East Coast of the United States increased by more than 30%. It is estimated that a decrease in ships crossing the canal due to low water levels could result in USD 200 million in losses for the Government of Panama in 2023 (Baker Institute for Public Policy, 2023). Severe droughts can also isolate inland

ports, as seen in the 2022 drought in Germany, where low water levels in the Rhine River led to reduced load capacities for ships transporting petrochemicals and oil products, resulting in increased costs for companies (OECD, 2022b; Independent Commodity Intelligent Services, 2022). As droughts intensify, shipping companies can become exposed to more frequent delays and higher operational costs.

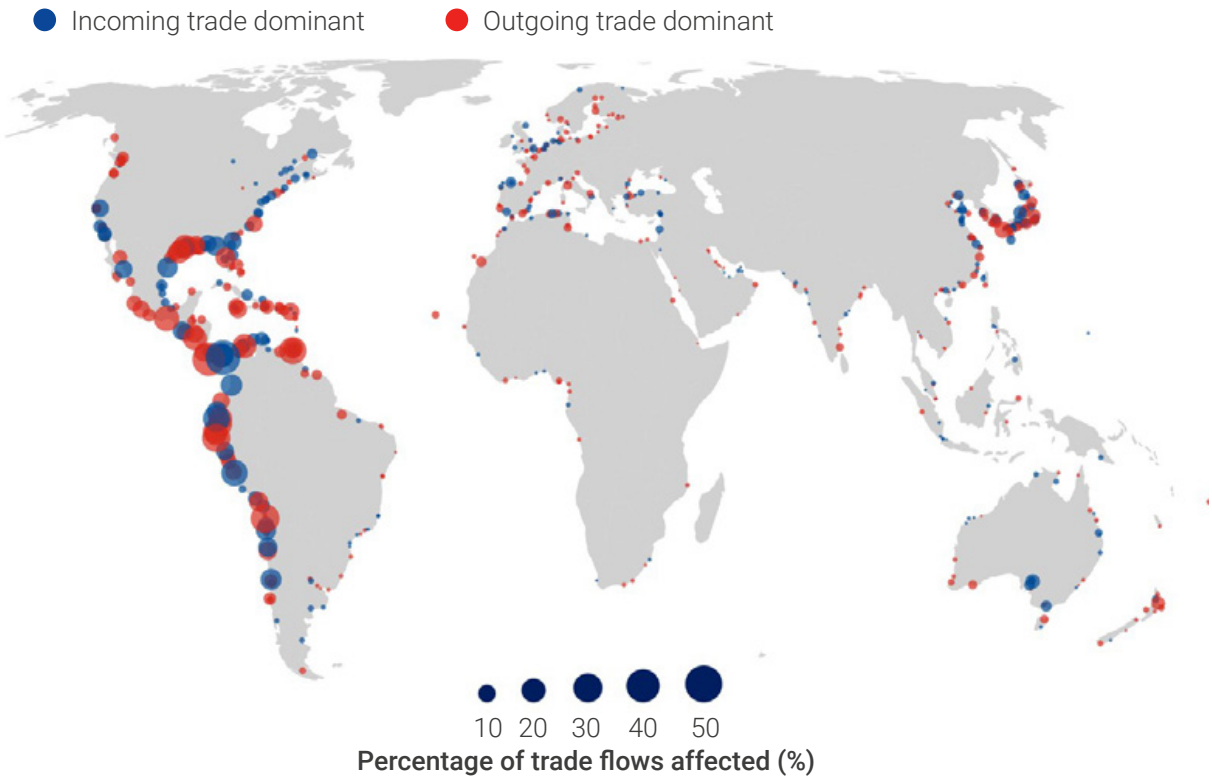


Figure 19: Impact of the drought in Panama on port-level trade flows from March to October 2023 (IMF, 2023)

Case study 7: EV manufacturing and water stress in Thailand

Transitioning the transportation sector to net zero is highly dependent on uptake of EVs continuing to expand in a way that sees them replace ICE vehicles. Yet production of EVs encounters numerous challenges due to supply chain constraints, with shortages of vital raw materials necessary for manufacturing representing a particular problem. The International Energy Agency (IEA) reported that in 2021, the price of raw materials such as steel increased by 100% and aluminium by 70%. The price of lithium, a crucial component of batteries, increased by 15% (IEA, 2022). Another key concern for EV supply chains is the growing risk presented by water scarcity.

EV manufacturers are beginning to set up production facilities in Thailand. BYD, a Chinese EV manufacturer, announced that it will invest USD 865 million to produce EVs in the South-East Asian. Production is expected to start in 2024, with projected volumes initially set at around 150,000 vehicles for export annually. Thailand's Board of Investment has already approved the company's USD 516 million plan to manufacture both battery-powered and plug-in hybrid vehicles. However, the establishment of EV production in the country is expected to worsen the water stress already being faced by businesses in Thailand (China Dialogue, 2022).

In recent decades, Thailand has undergone an economic transformation and has expanded its industries. However, as the impacts of climate change worsen, the country is becoming increasingly susceptible to droughts due to changes in rainfall patterns. Severe droughts have resulted in decreased water flow into dams (The Water Project, n.d.). It was estimated that major droughts in 2020 cost the country USD 1.5 billion, about 0.27% of the GDP. The problem of limited water availability has also created competition between industries to obtain water supplies. The government's promotion of industrial investments has exacerbated the problem by increasing water demand from industries. This has led to water supplies being diverted away from framers and local communities, and to the creation of an unequal distribution of water resources (East Asia Forum, 2020).

As BYD's investment helps EV manufacturing take off in the country, increasing water demand for production will further worsen the country's water shortages and add tension between sectors on gaining access to water supplies.

Case Study 8: Heat and drought risk

SNCF Annual Report 2022

France's railway company

Climate physical risks

Due to weather extremes of heatwaves and droughts, SNCF is already having to deal with the consequences of climate change on its activities. This is illustrated by the damage caused to infrastructures (asset impairment, track deterioration, etc.), equipment (breakdowns, accelerated obsolescence, etc.), and results in a decline in service quality (delays, temporary cessation of activity). Based on historical database, extreme heat accounts for around 20% of train cancellations and 16% of lost minutes during 2022 and 2021. The impacts of climate change on property are already noticeable:

- On rolling stock: embedded electronics and defective air conditioning in cases of extreme heat.
- On real estate and stations: degradations due to drought and flooding.
- On infrastructure: distortions, untimely deteriorations.

These events have financial impacts, affect customer satisfaction, and frustrate the strategic goal of doubling the number of passengers on trains within 10 years. Beyond the impact on SNCF's operations, these events could have a knock-on effect on the regions, with significant socio-economic and ecological impacts. The damaging climate events could disrupt production (hydraulic stock levels at their lowest in the summer of 2022 due to drought) and the potential consequences for SNCF are varied: decline in rail production performance and service quality, financial impacts reducing investment opportunities necessary for the company's low-carbon transition and the development of low-carbon mobility offerings, etc.

Climate-related control systems

To reduce infrastructure, station and rolling stock vulnerability—and boost their resilience to external pressures—the inclusion of climate risk in technical choices is now decisive for the company's future performance, as the commitment is for several decades due to the lifespan of the investments. Studies were conducted to better understand the climate change mechanisms and the impact on railway operations and incorporate this knowledge into the operating frameworks and processes of the company, as well as into its action plans.

To secure service continuity in the summer of 2023, SNCF Voyageurs drew up a resilience plan faced with risks of heatwaves, drought and flooding. The aim is to anticipate the impact of these weather hazards:

- For traffic: cancellation of trains, impacts on regularity, on-line incident management, increased maintenance.
- For the customer service: on-board comfort, passenger information and management, compliance with contracts entered into the transport organising authorities in regions, etc.
- For employee working and safety conditions: extreme heat protection equipment testing and adaptation of outfits, change in work schedules, shades to protect employees and prevent train overheating, state-of-the-art reflective coating on buildings and trains.

5. Wildfires

Wildfires can badly affect a wide range of transportation infrastructure, from roads, runways and ports through to the manufacturing facilities of automakers and other transportation-related manufacturers. Such infrastructure can either be forced to shut down or, worse, be exposed to costly damage. As global warming worsens, the frequency and severity of wildfires is expected to rise. Transportation facilities and infrastructure located in areas most at risk to wildfires will encounter damage and disruptions of operations that can increase costs and generate financial losses for firms in the sector.

In early July 2021, for example, wildfires raged across Western Canada (Figure 20). In British Columbia alone 297 such fires burned, including a large blaze in the small town of Lytton (Reuters, 2021). The fire in Lytton burned 90% of the village as temperatures reached a record of 49.6°C (Reuters, 2021b). Over the course of 2021, more than 1,600 fires burned nearly 8,700 square kilometres in British Columbia, making it the third worst year on record in terms of area burned (CBC, 2021b).

Figure 20: Wildfire in Prince Albert, Saskatchewan, Canada in 2021 (Reuters, 2021a)

Canada's wildfires caused damages to the country's rail networks and to the downstream supply chain. One fire destroyed tracks operated by the Canadian Pacific Railway and Canadian National Railway, which account for the majority of transportation to the Vancouver port (Financial Post, 2021). Damages like these caused major disruptions to transportation networks in the area. In July 2021, for example, more than 4,000 Canadian Pacific and Canadian National cars loaded with grains remained stuck for two full days (Financial Post, 2021). The shutdown of rail networks also meant that as many as 30,000 barrels a day of crude that are normally shipped through Vancouver for refineries in the Pacific Northwest could no longer be shipped (Financial Post, 2021).

These dangers also caused the Canadian government to introduce a variety of transportation-related restrictions in order to prevent further damage. For instance, the Transport Ministry ordered Canadian National Railway and Canadian Pacific Railway to reduce train speeds. At one point, the Transport Minister even went as far as to order a 48-hour stop to all rail travel in parts of British Columbia (Insurance Journal, 2021).

Not only were these delays and disruptions extremely costly to the two rail companies, but lawsuits were filed against the companies over the possibility that sparks from their tracks started some of the fires (CBC, 2021).

6. Physical risk guidance

This section offers guidance on how financial institutions can address physical risks within the sector and support their clients in the process.

Key physical risk questions for financial institutions to consider:

1. Gathering information

- What are the most prevalent physical risks across our portfolio footprint?
- What have our clients disclosed in their financial, sustainability, and climate reports regarding their physical risks?
- How many of our clients have business resiliency plans or a climate change risk assessment in place?
- Do we have locational data on the major assets of our clients?

2. Assessing the risks

- How much of our portfolio operates in areas of high physical risk?
- What does our exposure to higher-risk clients look like? What are the terms of our financial relationship (e.g. debt/equity, tenor)?
- Have we looked at physical risk scenarios to see how these risks will evolve over time across the portfolio? Have we considered short-term, medium-term, and long-term risks?
- How would physical hazards disrupt our clients' production and distribution activities?
- How long might disruption last for the client? What might be the potential loss in revenue?
- What indirect damages[9] might result from physical hazards (e.g. business disruption, changes in value of assets) for individual clients?
- How might insurance markets (and insurability) change in the face of worsening physical risks? What proportion of our clients are covered? Which hazards are covered? Is uninsurability a risk in areas of more frequent physical hazards?
- Have we explored if local adaptation measures are being taken by individual clients and, if so, how they will increase the resilience of assets to climate change?

9 Indirect damages can result from tangible damages caused by a physical risk. An example of this is business disruption caused by the physical damage to a business's property or facilities.

- How much are clients investing in adaptation and resiliency measures?
- Have we considered the potential environmental and social risks that might emerge from changes in the value chain as a result of physical hazards?

3. Engaging with clients and updating strategy

- Do our senior leaders understand the physical risks of our clients?
- How are we helping our clients to transition to more resilient infrastructure, equipment, and other assets?
- How will the physical risks identified and assessed influence our strategy in the transportation sector?
- What specific updates to risk management practices or business activities will be needed to appropriately consider these physical risks in our operations?

Recommendations for risk management

1. Use highly granular location data to identify key physical hazards

Financial institutions should take advantage of the asset-level datasets (both open source and commercially managed) that they have access to in order to gain information on asset types, asset prices, capacity, geographical and hyper-local data, and resiliency of the assets. They should then incorporate the key findings from these datasets into their risk management practices. Data can be used to identify key physical hazards of a particular area where their clients from the transportation sector operate. Insights can also be gleaned as to how these hazards are likely to evolve in the coming decades. These findings should be combined with asset-specific information on mitigating and adapting to these risks. Financial institutions should also conduct climate scenario analyses to assess the exposure and resiliency of their portfolio under different scenarios. The use of local data can enable a firm to assess its exposure across a broad set of potential climate impacts.

2. Consider global supply chains

The manufacturing of automobiles is highly dependent on the availability of crucial components and raw materials upstream in the supply chain, including lithium batteries and steel parts. For this reason, financial institutions should not only explore the direct impact of physical risks on their transportation clients. They should also be aware of the potential impacts of climate-related events on other sectors linked to the production of these components, such as industrials and metals and mining. Doing so will help them to identify and understand potential supply chain vulnerabilities. Hundreds of companies can be involved in producing different components of a vehicle that need to be transported to a production facility for assembling. An evaluation of these supply chain vulnerabilities can help build resiliency for both clients and financial portfolios.

Adaptive and mitigation actions clients can take

1. Resiliency planning

As global temperatures rise and the impacts of climate change worsen, the infrastructure and supply chains of the transportation sector face increasing risk from physical hazards. Firms can develop resiliency and adaptation plans for their most important sites and supply chains. These plans can begin with an assessment of current climate risks and asset vulnerabilities. They should also explore different climate scenarios that focus on how the frequency and severity of climate risks may change over time. Resiliency planning should also create procedures for business units to respond to potential disruptions in upstream supply and downstream consumption. Clients of the transportation sector can focus on strengthening adaptation measures through synergies with other environmental issues, such as floods, water stress, air quality, and biodiversity conservation, at the same time they should make sure that such measures do not increase in aggregate climate risks of neighboring communities.

2. Climate-ready infrastructure

Infrastructure such as ports and production facilities are vital for the transportation sector to function. Therefore, firms in the sector should invest in climate-ready assets that will withstand extreme climate events. To enhance resiliency, relevant physical risks identified through vulnerability assessments should be incorporated into the development plans for road networks, ports and terminals. Investments will be required in physical infrastructure and technologies to strengthen resilience. Clients and financial institutions should use screening tools to evaluate climate risks and consider alternative transport networks. Retrofitting and deploying climate defenses, such as sea walls and on-site backup power generators, may be explored for current infrastructure like ports, terminals, and buildings utilised by clients. Additionally, investments with environmental co-benefits hold the potential for increased effectiveness. Similarly, engagement with local stakeholders will be crucial to implement resiliency practices.

Additional guidance

- The Equator Principle's guidance note on Climate Change Risk Assessment provides detailed information on physical risk assessment.
- The note by the Network for Greening the Financial System, titled 'Physical Climate Risk Assessment: Practical Lessons for the Development of Climate Scenarios with Extreme Weather Events from Emerging Markets and Developing Economies', offers a framework to complement existing climate risk assessment practices.
- The European Central Bank has published good practices for climate-related and environmental risk management for financial institutions.
- UNEP FI and the Cambridge Institute for Sustainability Leadership's report on Leadership Strategies for Client Engagement: Advancing climate-related assessments includes guidance on advancing climate-related assessments for effective use in client engagement.

Bibliography

Atlantic (2017). Did climate Change Ground Flights in Phoenix. theatlantic.com/science/archive/2017/06/did-climate-change-ground-flights-in-phoenix/530976/

Autocar (2023). AA Insurance says Auckland floods could cause largest car claims event ever. autocar.co.nz/aa-insurance-says-auckland-floods-could-cause-largest-car-claims-event-ever/

Aviation Benefits Beyond Borders (n.d.). What is sustainable aviation fuel? autocar.co.nz/aa-insurance-says-auckland-floods-could-cause-largest-car-claims-event-ever/

Baker Institute for Public Policy (2023). Supply Chain Alternatives for Ocean Shipping if Climate Change-driven Water Shortages Persist at the Panama Canal. bakerinstitute.org/research/supply-chain-alternatives-ocean-shipping-if-climate-change-driven-water-shortages-persist

BBC (2022). Environmentalists sue Dutch airline KLM for 'greenwashing'. bbc.com/news/science-environment-61556984

Bloomberg (2018). Gen Z is Set to Outnumber Millennials Within a Year. bloomberg.com/news/articles/2018-08-20/gen-z-to-outnumber-millennials-within-a-year-demographic-trends?leadSource=uverify%20wall#xj4y7vzkg

Bloomberg (2021a). Why New York's Subway Keeps Flooding. bloomberg.com/news/articles/2021-09-02/this-is-why-hurricane-ida-flooded-the-nyc-subway

Bloomberg (2021b). Shipping Containers Fall Overboard at Fastest Rate in Seven Years. bloomberg.com/news/articles/2021-04-26/shipping-containers-plunge-overboard-as-supply-race-raises-risks#xj4y7vzkg

Bloomberg (2022). Carmakers Start to Starve Combustion Models Out of Existence. bloomberg.com/news/articles/2022-07-08/carmakers-start-to-starve-combustion-models-out-of-existence#xj4y7vzkg

Bloomberg (2023). Airlines Will Hike Ticket Prices to Pay for Costly Sustainable Fuel. bloomberg.com/news/articles/2022-07-08/carmakers-start-to-starve-combustion-models-out-of-existence#xj4y7vzkg

BloombergNEF (2019). A Behind the Scenes Take on Lithium-ion Battery Prices. about.bnef.com/blog/behind-scenes-take-lithium-ion-battery-prices/

BOFA (2022). Electric Vehicles, EVs on the Charge. business.bofa.com/content/dam/flagship/bank-of-america-institute/esg/EVs-on-the-charge-november-2022.pdf

Business Insider (2018). Thousands of people are stranded at one of the most important airports in Asia as it gets pounded by Typhoon Jebi's floodwaters. businessinsider.com/kansai-airport-flooded-by-typhoon-jebi-thousands-stranded-report-2018-9?r=US&IR=T

Business Insider (2020). Gen Z is set to take over the economy in a decade, despite potentially losing USD 10 trillion in earnings because of the pandemic. businessinsider.com/gen-z-will-take-over-economy-2030-33-trillion-income-2020-11?r=US&IR=T#:~:text=Gen%20Z%20is%20set%20to,earnings%20because%20of%20the%20pandemic&text=By%202030%2C%20Gen%20Z's,Z%20due%20to%20the%20pandemic

Carbon Brief (2023). EU carbon price tops EUR 100 a ton for first time. carbonbrief.org/daily-brief/45524/

Carbon Market Watch (2021). Additional profits of sector and firms from the EU ETS 2008–2019. Additional profits of sectors and firms from the EU ETS 2008–2019. carbonmarketwatch.org/publications/additional-profits-of-sectors-and-firms-from-the-eu-ets-2008-2019/tch

CBC (2021a). Lytton, B.C., resident files lawsuit alleging CP, CN rail caused the fire that destroyed her village. cbc.ca/news/canada/british-columbia/lytton-fire-lawsuit-1.6145197

CBC (2021b). A look back at the 2021 B.C wildfire season. cbc.ca/news/canada/british-columbia/bc-wildfires-2021-timeline-1.6197751

China Dialogue (2022). Thailand's EV push may worsen water shortages in the east. chinadialogue.net/en/transport/thailands-ev-push-worsen-water-shortages-east/

Chinowsky *et al.* (2017). Impacts of climate change on operation of the US rail network. Impacts of climate change on operation of the US rail network—ScienceDirect

Christodoulou *et al.* (2019). Sea-level rise in ports: a wider focus on impacts. link.springer.com/article/10.1057/s41278-018-0114-z

Citizen (2022). Toyota Prospection Plant back in gear after flood damage. citizen.co.za/motoring/toyota-prospecton-plant-returns-to-full-working-roder/

CleanTechnica (2023). Projected US EV Manufacturing Capacity by 2030 (based on announced. Projects). cleantechnica.com/2023/02/21/tracking-the-post-ira-boom-in-the-us-ev-supply-chain/

Climate Change News (2021). New York floods show subway systems must be prepared for climate change. climatechangenews.com/2021/09/02/new-york-floods-show-subway-systems-must-prepared-climate-change/

CNA (2018). Supply Chain Resilience and the 2017 Hurricane Season. cna.org/archive/CNA_Files/pdf/irm-2018-u-018098-final.pdf

CNBC (2018). Powerful typhoon hits western Japan, killing at least six. cnbc.com/2018/09/04/typhoon-jebi-japan-issues-evacuation-advisories-cancels-flights.html

CNBC (2022). Sustainable aviation fuel costs more but consumers will be willing to pay, IATA chief says. cnbc.com/2022/02/11/sustainable-aviation-fuel-costs-more-but-consumers-willing-to-pay-iata.html

CNBC (2023). Vietnamese EV maker VinFast says job cuts won't derail plans to start U.S. production. cnbc.com/2023/02/10/vietnams-ev-maker-vinfast-is-on-track-to-start-production-in-the-us-in-2024.html

CNBC (2023a). Delhi car insurance claims surge amid rising floodwaters—steps to raise yours. cnbctv18.com/personal-finance/delhi-flood-monsoon-heavy-rains-car-insurance-motor-rise-in-claims-steps-to-raise-policy-17242931.htm

CNN (2023). Europe is trying to ditch planes for trains. Here's how that's going. edition.cnn.com/travel/article/planes-to-trains-europe-climate/index.html

COSCO Shipping (2022). COSCO Shipping International Annual Report 2022. coscointl.com/media/2155/e00517_ar2022_61315_0417_1338.pdf

Cox Automotive (2023). EV Inventor Reaches Critical Mass in U.S. coxautoinc.com/news/ev-inventory-reaches-critical-mass-in-u-s/

DW (2019). Storms over Europe disrupt German trains, traffic, aviation. dw.com/en/germany-storms-halt-trains-disrupt-motorways-aviation/a-47844905

DW (2022). Germany's 9-euro travel pass; Success or failure? dw.com/en/germanys-9-euro-travel-ticket-success-or-failure/a-62329405

East Asia Forum (2020). Thailand's water shortage and inequality crisis. coxautoinc.com/news/ev-inventory-reaches-critical-mass-in-u-s/

Earth.org (2019). How Climate Change will impact Global Transport Sector. earth.org/how-climate-change-will-impact-global-transport-sector/

EDF (2022) Act now or Pay Later: The costs of climate inaction for ports and shopping. edf.org/sites/default/files/press-releases/RTI-EDF Act Now or Pay Later Climate Impact Shipping.pdf

Electrek (2022a). Tomorrow's the last day Hyundai will sell any ICE cars in Norway. electrek.co/2022/12/30/tomorrows-the-last-day-hyundai-will-sell-any-ice-cars-in-norway//

Electrek (2022b). EV reckoning comes to Ford as it cuts 8,000 ICE jobs to focus on electrification. https://electrek.co/2022/07/20/ev-reckoning-comes-to-ford-as-it-cuts-8000-ice-jobs-to-focus-on-electrification/n (electrek.co)

Electrek (2023). China's EV surge threatens legacy automakers market dominance from GM to VW. electrek.co/2023/05/11/chinas-ev-surge-threatens-legacy-automakers-market-dominance/#:~:text=China%2C%20the%20world's%20largest%20automaker,up%20from%2028%25%20last%20year

Electrifying.com (2023). Waiting times for new electric car deliveries down by 39% since October peak. electrifying.com/blog/article/waiting-times-for-new-electric-car-deliveries-down-by-42-since-october-peak

EPA (2022). Climate change Impacts on Transportation. epa.gov/climateimpacts/climate-change-impacts-transportation

EY (2020). Mexico: Baja California's Congress approves new tax legislation, including an emissions tax. ey.com/en_gl/tax-alerts/mexico--baja-california-s-congress-approves-new-tax-legislation-including-an-emissions-tax

EY (2023a). Sustainable Aviation Fuel on the rise. eysafrise.com

EY (2023b). Electric vehicles continue charge toward sales dominance—EY analysis. ey.com/en_gl/news/2023/01/electric-vehicles-continue-charge-toward-sales-dominance-ey-analysis#:~:text=The%20latest%20predictions%20show%20that,the%20US%20four%20years%20faster

Euractiv (2022). EU approves CO_2 tax on heating and transport, softened by new social climate fund euractiv.com/section/emissions-trading-scheme/news/eu-agrees-co2-tax-on-heating-and-transport-fuels-softened-by-new-social-climate-fund/

European Environment Agency (2023). Transport: increasing oil consumption and greenhouse gas emissions hamper EU progress towards environment and climate objectives eea.europa.eu/publications/transport-increasing-oil-consumption-and

European Commission (.n.d.) Aviation and the EU ETS. climate.ec.europa.eu/eu-action/aviation-and-eu-ets_en

European Commission (2023a). ETS 2: Buildings, road transport and additional sectors. ETS 2: buildings, road transport and additional sectors (europa.eu)

European Commission (2023b). European Green Deal: new law agreed to cut aviation emissions by promoting sustainable aviation fuels. ec.europa.eu/commission/presscorner/detail/en/ip_23_2389

European Parliament (2022a). Revision of the EU Emission Trading System (ETS)—Q2 2021 europarl.europa.eu/legislative-train/carriage/revision-of-the-eu-emission-trading-system-(ets)/report?sid=6901

European Parliament (2022b). Pricing instruments on transport emissions europarl.europa.eu/RegData/etudes/STUD/2022/699641/IPOL_STU(2022)699641_EN.pdf

European Parliament (2023). EU ban on the sale of new petrol and diesel cars from 2035 explained europarl.europa.eu/news/en/headlines/economy/20221019STO44572/eu-ban-on-sale-of-new-petrol-and-diesel-cars-from-2035-explained

European Roundtable on Climate Change and Sustainable Transition (2023). 2022 State of the EU ETS Report. ercst.org/state-of-the-eu-ets-report-2022/

Expansion (2018). Honda prevé una pérdida de 450 mdd por inundación en Celaya. expansion.mx/empresas/2018/08/31/honda-preve-una-perdida-de-450-mdd-por-inundacion-en-celaya

EY (2022). Why consumers are charging toward electric vehicles. ey.com/en_it/automotive-transportation/mobility-consumer-index-wave-3

Fageda, X. & J. Teixido (2022). 'Pricing carbon in the aviation sector: Evidence from the European emissions trading system,' Journal of Environmental Economics and Management. Vol. 111, No: 102591 sciencedirect.com/science/article/pii/S0095069621001352

Financial Post (2021). Supply chain crunch as B.C. wildfires halt hundreds of rail cars, slowing exports. financialpost.com/news/economy/western-fires-halt-hundreds-of-canada-rail-cars-slowing-exports

Financial Times (2019). Europe car groups face huge profit hit to cut CO_2. ft.com/content/74c04dc2-5b9c-11e9-9dde-7aedca0a081a

Financial Times (2022). US company spending on private jets for personal use hits 10-year high. ft.com/content/acc17817-e14c-443c-91f4-b1e611de2dbf

Fitch Solutions (2022). Quick View: Mainland China Drought Highlights Climate-Related Risks in Global EV Supply Chain. fitchsolutions.com/autos/quick-view-mainland-china-drought-highlights-climate-related-risks-global-ev-supply-chain-23-08-2022?fSWebArticleValidation=true&mkt_tok=NzMyLUNLSC03NjcAAAGNxoI8s053L7FoR_BXI6EpYtYP_16hGTRNfg-0MeuAgXBZM8MDcD_Do0YR8OsbFT18LPxJ8XMg1xdUtYfBlR5z2BcCFD638QWkvmbhgayA7wbdWk9abQ

Floodlist (2023). New Zealand—Insurers Expect Auckland Flood Claims to Exceed USD 1 billion NZ. floodlist.com/australia/new-zealand-auckland-flood-insurance-claims

Forbes (2021). Why Norway Leads In EVs—And the role played by cheap electricity. forbes.com/sites/ianpalmer/2021/06/19/why-norway-leads-in-EVs-and-the-role-played-by-cheap-renewable-electricity/?sh=25abf76f275f

Forbes (2021b). Here's How Toyota Can Regain Its Lost Green Brand Image. forbes.com/sites/margooge/2021/12/09/heres-how-toyota-can-regain-its-lost-green-brand-image/?sh=35125a1beacc

Forbes (2021c). Germany's biggest automakers fined 875EUR for emissions collusions. forbes.com/sites/michaeltaylor/2021/07/08/germanys-biggest-automakers-fined-875-million-for-emissions-collusion/?sh=3539b56b77f9

Forbes (2023a). Amsterdam's Schiphol Airport To Reduce Emissions with Private Jet Ban Cancelling New Runway. forbes.com/sites/carltonreid/2023/04/05/amsterdams-schiphol-airport-to-reduce-emissions-with-private-jet-ban-cancelling-new-runway/?sh=21da6ff1631f

Forbes (2023b). Airlines are ancelling hundreds of flights as hurricane Idalia heads for Florida. forbes.com/sites/suzannerowankelleher/2023/08/29/airlines-flight-cancellations-hurricane-idalia/?sh=1df969546470

Freight Waves (2019). Baking temperatures put Australia's trucks ad drivers at risk. freightwaves.com/news/australian-summer-heat-dangers

Global Maritime Forum (2021). Policy options for closing the competitiveness gap between fossil and zero-emission fuels in shipping. globalmaritimeforum.org/news/policy-options-for-closing-the-competitiveness-gap-between-fossil-and-zero-emission-fuels-in-shipping

Government Offices of Sweden (2023). Sweden's Carbon Tax. government.se/government-policy/swedens-carbon-tax/swedens-carbon-tax/#:~:text=Swedish%20carbon%20tax%20rates&text=The%20carbon%20tax%20was%20introduced,of%20SEK%2010.87%20per%20EUR)

Greenpeace (2021a). Auto Environmental Guide 2021—A comparative analysis of global automakers' decarbonization: recent actions and future plans. greenpeace.org/static/planet4-eastasia-stateless/2021/11/47de8bb4-gpea_auto_environmental_guide_2021.pdf

Greenpeace (2021b). Toyota ranked worst among global carmakers for decarbonization: Greenpeace report. greenpeace.org/eastasia/press/7006/toyota-ranks-last-among-global-carmakers-for-decarbonization-greenpeace-report/

Greenpeace (2022). New Greenpeace report finds Europe's biggest airlines failing over climate claims. greenpeace.org/eastasia/press/7006/toyota-ranks-last-among-global-carmakers-for-decarbonization-greenpeace-report/

Greenpeace (2023). Foreign automakers on track to lose market share in China due to slow shift to EVs: study. greenpeace.org/eastasia/press/7968/foreign-automakers-on-track-to-lose-market-share-in-china-due-to-slow-shift-to-EVs-study/

Guardian (2022). Britain's rail services severely disrupted as heatwave damage is repaired. theguardian.com/business/2022/jul/20/britains-rail-services-severely-disrupted-as-heatwave-damage-is-repaired

Harvard (2022). Current electric vehicles subsidies fail to reduce overall emissions, says Harvard Law study. hls.harvard.edu/today/current-electric-vehicles-subsidies-fail-to-reduce-overall-emissions-says-harvard-law-study/

HKMA (2021). Pilot Banking Sector Climate Risk Stress Test. hkma.gov.hk/media/eng/doc/key-functions/banking-stability/Pilot_banking_sector_climate_risk_stress_test.pdf

Honda (2018). Update: Celaya Plant Flooding and Recovery. hondanews.com/en-US/releases/update-celaya-plant-flooding-and-recovery

Hong Kong government (2021). Government announces Hong Kong Roadmap on Popularisation of Electric Vehicles. info.gov.hk/gia/general/202103/17/P2021031700597.htm

Hyundai (2022). Major milestone for Hyundai in the Norwegian market—where from 1 January 2023, the brand will sell only electric cars. hyundai.news/eu/articles/press-releases/major-milestone-for-hyundai-in-the-norwegian-market.html

IBM (2021). IBM Survey: Consumers Care about Sustainability, But Speed and Convenience Prevail in Daily Transit Choices. newsroom.ibm.com/IBM-Survey-Consumers-Care-about-Sustainability-But-Speed-and-Convenience-Prevail-in-Daily-Transit-Choices

ICCT (2019). Update on electric vehicle costs in the United States through 2030. theicct.org/sites/default/files/publications/EV_cost_2020_2030_20190401.pdf

ICCT (2020). Growing Momentum: Global overview of government targets for phasing out sales of new internal combustion engine vehicles. theicct.org/growing-momentum-global-overview-of-government-targets-for-phasing-out-sales-of-new-internal-combustion-engine-vehicles/

ICCT (2022). Vision 2050: Aligning aviation with the Paris agreement. theicct.org/wp-content/uploads/2022/06/Aviation-2050-Report-A4-v6.pdf

IEA (2019a). The Future of Rail. iea.org/reports/the-future-of-rail

IEA (2019b). Is government support for EVs contributing to a low-emissions? iea.org/commentaries/is-government-support-for-EVs-contributing-to-a-low-emissions-future

IEA (2021a). Policies to promote electric vehicle deployment. iea.org/reports/global-ev-outlook-2021/policies-to-promote-electric-vehicle-deployment

IEA (2021b). Biofuels. iea.org/reports/renewables-2021/biofuels?mode=transport&region=World&publication=2021&flow=Consumption&product=Ethanol

IEA (2022a). Global EV Outlook 2022—Securing supplies for an electric future. iea.blob.core.windows.net/assets/ad8fb04c-4f75-42fc-973a-6e54c8a4449a/GlobalElectricVehicleOutlook2022.pdf

IEA (2022b). Consumer and government spending on electric cars, 2016–2021. iea.org/data-and-statistics/charts/consumer-and-government-spending-on-electric-cars-2016-2021

IEA (2022c). Electric cars fend off supply challenges to more than double global sales. iea.org/commentaries/electric-cars-fend-off-supply-challenges-to-more-than-double-global-sales

IEA (2023a). Transport. iea.org/energy-system/transport

IEA (2023b). Global EV Outlook 2023: Corporate Strategy. iea.org/reports/global-ev-outlook-2023/corporate-strategy

IEA (2023). Global EV Data Explorer. iea.org/data-and-statistics/data-tools/global-ev-data-explorer

IEA (n.d.). Electric Vehicles. iea.org/energy-system/transport/electric-vehicles

IMF (2023). Climate Change is Disrupting Global Trade. imf.org/en/Blogs/Articles/2023/11/15/climate-change-is-disrupting-global-trade

Independent Commodity Intelligent Services (2022). Low Rhine to hinder barge traffic, could affect production—BASF. icis.com/explore/cn/resources/news/2022/08/11/10794689/low-rhine-to-hinder-barge-traffic-could-affect-production-basf

Institute for Energy Research (2019). Electric Vehicle Subsidies: On the Road to Nowhere. instituteforenergyresearch.org/regulation/electric-vehicle-subsidies-on-the-road-to-nowhere/

Insurance Journal (2021). Canada orders rail transport restrictions in areas with high wildfire risk. insurancejournal.com/news/international/2021/07/12/622212.htm

International Carbon Action Partnership (2022a). Emissions Trading Worldwide: 2022 ICAP Status Report. icapcarbonaction.com/en/publications/emissions-trading-worldwide-2022-icap-status-report

International Carbon Action Partnership (2022b). Austria's national ETS enters into force. icapcarbonaction.com/en/news/austrias-national-ets-enters-force

International Carbon Action Partnership (2022c). China National ETS. icapcarbonaction.com/en/ets/china-national-ets

International Civil Aviation Organization (n.d). What would be the impact of a global MBM scheme for international aviation? icao.int/Meetings/HLM-MBM/Pages/FAQ3.aspx

ITF (2019). Transport demand set to triple, but sector faces potential disruptions. itf-oecd.org/transport-demand-set-triple-sector-faces-potential-disruptions

Journal of Marine Science and Engineering (2022). Impacts of shipping carbon tax on dry bulk shipping costs and maritime trades—the case of China. mdpi.com/2077-1312/10/8/1105

Kelley Blue Book (2023). Why are electric car batteries so expensive? kbb.com/car-advice/why-ev-batteries-expensive/

LA Times (2022). Flights grounded in South Korea as typhoon nears with winds of up to 105 mph. latimes.com/world-nation/story/2022-09-05/flights-grounded-typhoon-hinnamnor

LSE (2017). Cars, carbon taxes and CO_2 emissions. lse.ac.uk/granthaminstitute/wp-content/uploads/2017/03/Working-paper-212-Andersson_update_March2017.pdf

McKinsey (2020). Will infrastructure bend or break under climate stress? mckinsey.com/capabilities/sustainability/our-insights/will-infrastructure-bend-or-break-under-climate-stress

McKinsey (2022). Opportunities for industry leaders as new travelers take to the skies mckinsey.com/industries/travel-logistics-and-infrastructure/our-insights/opportunities-for-industry-leaders-as-new-travelers-take-to-the-skies

Moody's (2021a). US automotive manufacturing hubs exposed to climate risk. us-automotive-manufacturing-hubs-exposed-to-climate-risk

Moody's (2021b). Critical industries have substantial exposure to physical climate risks. assets.website-files.com/5df9172583d7eec04960799a/618872a58d35f2643cbcaef2_BX9770_ESG_Critical%20industries%20have%20substantial%20exposure_7Nov2021.pdf

Murray, M. & A. Sesia (2023). General Motors Commits to 100% Electric Vehicles by 2035. Darden Case No. UVA-BC-0284. ssrn.com/abstract=4346918

National Environment Agency (2022). Enhanced Vehicular Emissions Scheme to be extended with Tightened Pollutant Thresholds. nea.gov.sg/media/news/news/index/enhanced-vehicular-emissions-scheme-to-be-extended-with-tightened-pollutant-thresholds

Network Rail (2023). Running the railway. networkrail.co.uk/running-the-railway/looking-after-the-railway/delays-explained/buckled-rail-and-summer-heat/#:~:text=Because%20rails%20are%20made%20from,high%20as%2051%C2%B0C

New York Times (2018). Many Major Airports are near sea level. A disaster in Japan shows what can go wrong. nytimes.com/2018/09/07/climate/airport-global-warming-kansai.html#:~:text=A%20quarter%20of%20the%20world's,5%20meters%20above%20sea%20level

New York Times (2022). Climate Activists, Including scientists, are arrested in protests at private airports. nytimes.com/2022/11/10/us/private-jets-climate-protests-airport.html

New York Times (2023). In Norway, the electric vehicle future has finally arrived. nytimes.com/2023/05/08/business/energy-environment/norway-electric-vehicles.html#:~:text=The%20country%20will%20end%20the,during%20periods%20of%20high%20demand

OECD (2022a). Assessing environmental impact of measures in the OECD Green Recovery Database. oecd.org/coronavirus/policy-responses/assessing-environmental-impact-of-measures-in-the-oecd-green-recovery-database-3f7e2670/

OECD (2022b). Supply Chain Disruption: An underestimated climate impact? oecd-forum.org/posts/title-of-article#:~:text=At%20first%2C%20when%20droughts%20occur,intensity%20and%20potential%20for%20congestion

Port Economics, Management and Policy (2019). Risk of Hurricanes for Global container ports, 2019. porteconomicsmanagement.org/pemp/contents/part6/port-resilience/hurricanes-global-container-ports/

Precedence Research (2023). Sustainable Aviation Fuel Market Size is expanding at USD 14.84 Bn by 2032. globenewswire.com/en/news-release/2023/02/22/2613204/0/en/Sustainable-Aviation-Fuel-Market-Size-is-Expanding-at-USD-14-84-Bn-by-2032.html

Pretis, F. (2022). Does a Carbon Tax Reduce CO_2 Emissions? Evidence from British Columbia. Environ Resource Econ 83, 115–144 (2022). doi.org/10.1007/s10640-022-00679-w

Rahman M.N.A. and Adnan A.A. (2023). A Review on Heat Stress Issues Among Workers at Automotive Service Centre. Journal of Advanced Research in Applied Sciences and Engineering Technology, 32(3), 334–341. doi.org/10.37934/araset.32.3.334341

Railway Technology (2019. Sea change: protecting coastal railways from rising sea levels.railway-technology.com/features/sea-level-impact-on-railways/

Republique Francaise (2023). Décret n° 2023-385 du 22 mai 2023 précisant les conditions d'application de l'interdiction des services réguliers de transport aérien public de passagers intérieurs dont le trajet est également assuré par voie ferrée en moins de deux heures trente. legifrance.gouv.fr/jorf/id/JORFTEXT000047571222

Reuters (2021a). Canada orders rail restrictions to reduce wildfire risk. reuters.com/world/americas/canada-orders-rail-restrictions-reduce-wildfire-risk-2021-07-11/

Reuters (2021b). New evacuation orders issued in western Canada as fire guts town after record heat. reuters.com/business/environment/wildfire-forces-evacuation-residents-small-western-canada-town-2021-07-01/

Reuters (2022). Germany bets on cheap tickets to help transport sector meet CO_2 targets. reuters.com/business/cop/germany-bets-cheap-tickets-help-transport-sector-meet-co2-targets-2022-11-03/ers

Reuters (2023). China's car sales shrink 2.9% in June as big-ticket spending falters. reuters.com/markets/asia/chinas-car-sales-shrink-29-june-big-ticket-spending-falters-2023-07-10/#:~:text=Asian%20Markets-,China's%20car%20sales%20shrink%202.9%25%20in,as%20big%2Dticket%20spending%20falters&text=BEIJING%2FSHANGHAI%2C%20July%2010%20(,caution%20on%20big%2Dticket%20spending

RFF (2020). Carbon pricing 202: Pricing carbon in the transportation sector. rff.org/publications/explainers/carbon-pricing-202-pricing-carbon-transportation-sector/

RNZ (2023). Auckland floods, Cyclone Gabrielle to cost insurance industry more than USD 1b. rnz.co.nz/news/national/485394/auckland-floods-cyclone-gabrielle-to-cost-insurance-industry-more-than-1b

Science Rebellion (n.d.). Scientist rebellion. scientistrebellion.org/

SimpleFlying (2022). USD 1.45 trillion investment needed to scale SAF by 2050. simpleflying.com/145-trillion-investment-needed-scale-saf-2050/

SMH (2023). Steep jump in premiums, more to come for home and car insurance simpleflying.com/145-trillion-investment-needed-scale-saf-2050/

SNCF (2022). SNCF Annual Report 2022. sncf.com/en/finance/financial-publications-sncf?document_type=3434&entity=3433&form-type=1&keywords=annual&language=All&year=All

South China Morning Post (2023). Foreign car brands from Volkswagen to Toyota to lose share in China, the world's largest automotive market as era of gas and diesel vehicles nears end. scmp.com/business/china-business/article/3220148/foreign-car-brands-volkswagen-toyota-lose-share-china-worlds-largest-automotive-market-era-gas-and

Statista (2023). Largest automobile markets worldwide in 2022, based on new car registrations. statista.com/statistics/269872/largest-automobile-markets-worldwide-based-on-new-car-registrations/

Stellantis (n.d.). Electrification—Accelerating the drive to electrification. stellantis.com/en/technology/electrification?adobe_mc_ref=

Supply Chain (2020). Thailand flooding impacts automobile supply chain. supplychain-digital.com/logistics/thailand-flooding-impacts-automobile-supply-chain

The Guardian (2023). Delta Air Lines faces lawsuit over USD 1bn carbon neutrality claim. theguardian.com/environment/2023/may/30/delta-air-lines-lawsuit-carbon-neutrality-aoe

The Dallas Morning News (2021). Toyota faces backlash as the top donor to gop objectors to presidential vote. dallasnews.com/business/autos/2021/06/28/toyota-faces-backlash-as-the-top-donor-to-gop-objectors-to-presidential-vote/

The University of Michigan (2018). Relative Costs of driving electric and gasoline vehicles in the individual U.S. states. websites.umich.edu/~umtriswt/PDF/SWT-2018-1_Abstract_English.pdf

The Water Project (n.d.). Water in Thailand—Crisis. thewaterproject.org/water-crisis/water-in-crisis-thailand

Transport Topics (2017). Houston Port ready to ease shipping backlog after hurricane Harvey. ttnews.com/articles/houston-port-ready-ease-shipping-backlog-after-hurricane-harvey

Travel Agent Central (2017). Find out how much money airlines serving the Caribbean lost due to hurricanes. travelagentcentral.com/transportation/find-out-how-much-money-airlines-serving-caribbean-lost-due-to-hurricanes

Two Degrees (2020). USD 80 billion a risk: the climate threat to rail transport. twodegreesadapt.com/blog/80-billion-at-risk-the-climate-threat-to-rail-transport

Transport Environment (2021). Hitting the EV infliction point. transportenvironment.org/wp-content/uploads/2021/08/2021_05_05_Electric_vehicle_price_parity_and_adoption_in_Europe_Final.pdf

US Office of Attorney General (2022). AG Shapiro files suit against UPS, argues vehicle acquisition plan fails to comply with environmental standards. attorneygeneral.gov/taking-action/ag-shapiro-files-suit-against-usps-argues-vehicle-acquisition-plan-fails-to-comply-with-environmental-standards/

UN (2018). 68% of the world population projected to live in urban areas by 2050 , says UN un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html

UN (2021). Interagency report for second Global Sustainable Transport Conference. sdgs.un.org/publications/interagency-report-second-global-sustainable-transport-conference

UNCTAD (2021). Climate change impacts on seaports: A growing threat to sustainable trade and development. unctad.org/news/climate-change-impacts-seaports-growing-threat-sustainable-trade-and-development

UNDP (2021). The Peoples' Climate Vote. undp.org/publications/peoples-climate-vote

UNEP FI (2023). Just Transition Finance: Pathways for Banking and Insurance. unepfi.org/publications/just-transition-finance-pathways-for-banking-and-insurance/

USA Today (2023). 1,300 flights canceled, thousands more delayed due to stormy East Coast weather. eu.usatoday.com/story/travel/airline-news/2023/08/07/flights-canceled-delayed-Wednesday/70546363007/

US Department of Energy (n.d.-a). Maintenance and Safety of Electric Vehicles. afdc.energy.gov/vehicles/electric_maintenance.html

US Department Of Energy (n.d.-b). Sustainable Aviation Fuels—Bioenergy Technologies Office. energy.gov/eere/bioenergy/sustainable-aviation-fuels#:~:text=Sustainable%20Aviation%20Fuel%3A%20Safe%2C%20Reliable,with%20a%20smaller%20carbon%20footprint.

USDOJ (2021). Toyota Motor Company to Pay USD 180 Million in Settlement for Decade-Long Noncompliance with Clean Air Act Reporting Requirements. justice.gov/opa/pr/toyota-motor-company-pay-180-million-settlement-decade-long-noncompliance-clean-air-act

Verisk (2019). AIR Worldwide Estimates Industry Insured Losses for Winter Storm Eberhard. air-worldwide.com/news-and-events/press-releases/AIR-Worldwide-Estimates-Industry-Insured-Losses-for-Winter-Storm-Eberhard/

Volkswagen (2023). Volkswagen Group brings products to market faster in China—development time reduced by around 30%. volkswagen-newsroom.com/en/press-releases/volkswagen-group-brings-products-to-market-faster-in-china-development-time-reduced-by-around-30-percent-15749

Volvo (2018). Volvo cars aims for 50% of sales to be electric by 2025. media.volvocars.com/global/en-gb/media/pressreleases/227602/volvo-cars-aims-for-50-per-cent-of-sales-to-be-electric-by-2025

Volvo Car USA (2022). Volvo Car USA announces 2023 lineup will be only hybrid or electric, and Google-equipped. media.volvocars.com/us/en-us/media/pressreleases/298780/volvo-car-usa-announces-2023-lineup-will-be-only-hybrid-or-electric-and-google-equipped#:~:text=The%20effort%20reflects%20another%20step,to%20fit%20their%20daily%20routines

Wayne County (2023). waynecounty.com/departments/econdev/home.aspx

Weather optics (2021). Supply chain losses likely exceeded USD 10 billion during deep south winter storm. weatheroptics.co/post/supply-chain-delays-likely-exceeded-10-billion-during-deep-south-winter-storm

White House (2022). Biden-Harris Administration Announces Historic Investment to Electrify U.S. Postal Service Fleet. whitehouse.gov/briefing-room/statements-releases/2022/12/20/biden-%E2%81%A0harris-administration-announces-historic-investment-to-electrify-u-s-postal-service-fleet/

Wizz Air Holdings PLC (2022). Wizz Air Holdings PLC Annual Report and Accounts 2022. wizzair.com/static/docs/default-source/downloadable-documents/corporate-website-transfer-documents/annual-reports/wizz_air-annual-report-and-accounts-f22_final--pwc-confirmed_061d7bd2.pdf

World Bank (2021). State and Trends of Carbon Pricing 2021. openknowledge.worldbank.org/entities/publication/7d8bfbd4-ee50-51d7-ac80-f3e28623311d

World Bank (2022). Weathering the storm: 3 priorities to enhance resilience in transport. blogs.worldbank.org/transport/weathering-storm-3-priorities-enhance-resilience-transport

World Bank (2023a). Carbon pricing dashboard. carbonpricingdashboard.worldbank.org/map_data

World Bank Group (2023b). State and Trends of Carbon Pricing 2023. openknowledge.worldbank.org/entities/publication/58f2a409-9bb7-4ee6-899d-be47835c838f

World Bank (2023c). The heat is on: How high temperatures are impacting workers and the global economy. blogs.worldbank.org/developmenttalk/heat-how-high-temperatures-are-impacting-workers-and-global-economy

World Economic Forum (2021). These countries offer the best electric car incentives to boost sales. weforum.org/agenda/2021/06/electric-vehicles-financial-incentives/

Yard (2022). Just Plane Wrong: Celebs with the worst private jet CO_2 emissions. weareyard.com/insights/worst-celebrity-private-jet-co2-emission-offenders

Yesudian, A & J. Dawson (2021). 'Global analysis of sea level rise risk to airports', Climate Risk Management, Vol, 31, No. 100266. sciencedirect.com/science/article/pii/S2212096320300565?via%3Dihub

UN environment programme

finance initiative

UNEP Finance Initiative brings together a large network of banks, insurers and investors that collectively catalyses action across the financial system to deliver more sustainable global economies. For more than 30 years the initiative has been connecting the UN with financial institutions from around the world to shape the sustainable finance agenda. It has established the world's foremost sustainability frameworks that help the finance industry address global environmental, social and governance (ESG) challenges. Convened by a Geneva, Switzerland-based secretariat, more than 500 banks and insurers with assets exceeding US$100 trillion work together to facilitate the implementation of UNEP FI's Principles for Responsible Banking and Principles for Sustainable Insurance. Financial institutions work with UNEP FI on a voluntary basis and the initiative helps them to apply the industry frameworks and develop practical guidance and tools to position their businesses for the transition to a sustainable and inclusive economy.

unepfi.org

unepfi.org

info@unepfi.org

/UNEPFinanceInitiative

UN Environment Programme Finance Initiative

@UNEP_FI