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Breath of fresh air:

the risks of air pollution and the opportunity beyond toxic assets

ShareAction»

Contents

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About this paper

Air pollution is a critical global challenge. In response, ShareAction's 2024 briefing *Clearing the Air* explored the commercial risks that poor air quality poses to investors and companies.

This paper builds on that work by highlighting key and emerging air pollution linked risks and opportunities for companies and their shareholders to further demonstrate the need to integrate these considerations into investment decision making. It examines systemic and enterprise-level risks from ambient (outdoor) air pollution, outlines investment implications and offers targeted recommendations for effective investor action. The focus is on high-emitting sectors – including freight & logistics, construction, retail, and automotive – with emphasis on companies reliant on urban road transport.

Prepared by Chronos Sustainability (Dr Rebecca Drury, Dr Rory Sullivan, Nicky Amos, Fatima Husain and Tanya Cox) in consultation with ShareAction, the findings are based on a literature review, an expert survey, regulatory mapping, and interviews conducted with experts, investors and companies between July and November 2025.

Executive summary

Executive summary

Ambient (outdoor) air pollution is a systemic risk with profound societal, environmental and macroeconomic consequences.

Ambient air pollution is responsible for millions of premature deaths each year and is now recognised as the largest environmental threat to human health. The Institute for Health Metrics and Evaluation attributes 6.7 million premature deaths to ambient air pollution each year between 2021 and 2023.[1] These impacts fall disproportionately on vulnerable and marginalised communities, reinforcing existing health inequities.

The economic implications of adverse health effects are substantial. The World Bank estimates that the health impacts of ambient air pollution cost US$6 trillion a year, equivalent to 4.6 per cent of global gross domestic product (GDP).[2] In many countries, the economic burden exceeds 5 per cent of GDP, and global healthcare costs linked to air pollution are projected to rise eight-fold by 2060.[3,4]

Air pollution is also deeply interconnected with climate change, nature loss and human rights. Pollutants such as black carbon and ground-level ozone contribute to global warming, while climate change intensifies pollution through wildfires and extreme weather. Pollution-related ecosystem degradation reduces natural air filtration and carbon sequestration. These reinforcing feedback loops amplify risks for economies, societies and investors. Although yet to be quantified, current knowledge suggests that costs related to nature loss are likely to be substantial. For example, globally, soil degradation because of the deposition of air pollutants has been estimated to cost US$6.3–10.7 trillion annually.[6]

Regulatory tightening is accelerating globally, including in emerging markets.

Governments are responding to rising social, environmental and economic costs by strengthening air quality regulations. Legally binding emission ceilings, reduction targets and sector-specific controls are expanding across regions. While enforcement remains uneven, the overall trajectory is clear: more stringent standards, broader pollutant coverage and increased scrutiny of high-emitting sectors.

Transport remains a central focus, particularly in urban areas. European vehicle standards are increasingly shaping global regulatory norms, with adoption rising across Asia, Africa and Latin America.[8] Forthcoming regulations such as Euro 7 are expected to extend beyond tailpipe emissions to include non-exhaust emissions (NEEs) from tyres and brakes, an emerging area of material risk for companies reliant on road transport.

Ambient air pollution presents growing regulatory, legal and financial risks for companies.

Companies face rising exposure to regulatory penalties, enforcement actions and litigation as governments and courts respond to the mounting costs of pollution. High-profile cases such as Dieselgate demonstrate the scale of financial, operational and reputational consequences.

Litigation is expanding beyond regulatory breaches to include tort (civil wrongs), human rights and greenwashing claims, with courts increasingly recognising pollution-related harms under human rights law.

Sectors with high emissions profiles including automotive, transport, logistics, manufacturing, energy, chemicals and materials face heightened exposure. Pollution control technology providers also face both risks and opportunities as regulatory expectations evolve. Investors must prepare for a rapidly shifting risk landscape, where air pollution intersects with climate transition risk, nature-related risk and social and human rights risk.

Corporate action and regulatory readiness remains insufficient.

While some companies are beginning to acknowledge their contribution to air pollution and set reduction targets, most corporate strategies remain narrowly focused on greenhouse gas emissions. This leaves significant gaps in addressing harmful non-GHG pollutants such as $PM_{2.5}$, VOCs and NEEs. Disclosure frameworks such as the EU's Corporate Sustainability Reporting Directive (CSRD), Taskforce on Nature related Financial Disclosures (TNFD), Global Reporting Initiative (GRI) and Sustainability Accounting Standards Board (SASB) are beginning to drive improvements, but reporting remains inconsistent and incomplete across key sectors[10,11].

This paper concludes with recommendations for responsible investors.

Tightening regulation, more robust enforcement, and increasing litigation are making air pollution an increasing risk and opportunity for companies and those that invest in them.

1. Introduction

Impacts of ambient (outdoor) air pollution

Ambient air pollution has substantial impacts on human health.

Exposure to ambient air pollution is the second largest risk factor for death globally, surpassed only by cardiovascular disease.[2] It is now the largest environmental threat to human health, ahead of tobacco use.[12] Of the ~8 million premature deaths attributed to indoor and ambient air pollution annually:

- The Institute for Health Metrics and Evaluation estimates that 6.7 million (>80 per cent) of these deaths can be attributed to ambient air pollution each year between 2021 and 2023.[1]
- At least 2.5 million deaths (>30 per cent) annually can be ascribed to the combustion of fossil fuels.[13]

Fine particulate matter ($PM_{2.5}$) – tiny particles less than 2.5 micrometres in diameter that can penetrate deep into the lungs and enter the bloodstream – is the leading cause of health impacts from air pollution, responsible for over 90 per cent of the disease burden.[2] Other pollutants that have significant impacts on human health are listed in Table 1.

In 2022, the World Health Organisation (WHO) estimated that over 99 per cent of the global population lives in areas where ambient air pollution exceeds the WHO's air quality guidelines.[14] While air quality has improved in parts of the Global North, it continues to deteriorate in many regions of the Global South.[15] Without intervention, exposure to PM2.5 is predicted to increase by 50 per cent by 2030.[16]

Table 1. Ambient air pollutants that are harmful to health[17,18]

Pollutant	Description	Key Sources	Impacts on Human Health
Particulate Matter (PM)	Solid or liquid airborne particles defined by aerodynamic diameter: PM_{10} (≤10μ) and $PM_{2.5}$ (≤2.5μ) are particularly harmful to human health due to their ability to penetrate deep into lungs. PM originates from various sources, and its toxicity depends on chemical composition. Also contributes to ground-level ozone.	**Road transport** is a major source of PM, alongside **industrial, residential and agricultural activities**.[19,20] In the EU-27, transport was responsible for 29.3% of PM_{10} and $PM_{2.5}$ in 2022.[21] In Asia, 82% of urban ambient $PM_{2.5}$ is emitted by fossil fuel combustion for electricity generation and transport; agricultural burning; waste burning; and industrial operations.[22]	Heart disease, stroke, respiratory diseases, lung cancer, adverse perinatal outcomes. Studies estimate that there could have been as many as **10 million premature deaths from $PM_{2.5}$ emissions in 2012**.[23]
Nitrogen Dioxide (NO_2) and other Nitrogen Oxides (NO_x)	Highly reactive gases; soluble in water and strong oxidants. Contributes to ground-level ozone, acid rain and $PM_{2.5}$.	Combustion processes mainly linked to **transport and power generation**.[24] In the EU, >40 % of NOx is emitted by road traffic and 30% by industry.[24]	Asthma and other respiratory diseases. In 2021, 52,000 premature deaths were linked to chronic exposure to NO2 in the EU. Globally, in 2019, ~2 million new paediatric asthma cases were attributable to NO_2.[25] **In 2021, exposure to NO2 was linked to 177,000 healthy years of life lost for children and adolescents**.[26]
Sulphur Dioxide (SO_2)	Gas soluble in water. Contributes to development of particulate matter and acid rain.	Combustion of fuels linked to **industrial activities and power generation**. 60% of SO_2 emissions in Europe are from energy generation and heating.[24]	Asthma, respiratory diseases. The United States Environmental Protection Agency estimates that a 1 ton/year SO_2 **reduction would lead to reductions in mortality and years lost due to ill-health or disability, due to its role as a precursor to $PM_{2.5}$**.[27]
Volatile Organic Compounds (VOCs)	Variety of compounds. React with NO_x in the atmosphere to form Ozone (O_3).	In the UK, 50% is emitted by **transport (30% from road transport alone)**, 30% by **solvent use**, and 15% by **industrial processes**.[28] In the EU, in 2012, road transport accounted for ~90% of non-methane VOC emissions from the transport sector.[29]	Over time, exposure can damage the lungs, central nervous system, kidneys and liver.[30] **Linked to increased risk of cancer**[31] especially carcinogenic VOCs 1,3-butadiene and benzene.[28]

Table 1. continued

Ozone (O_3)	Created by chemical interactions between NO_x and VOCs in the presence of sunlight.	*See NO_x and VOC_s.*	Increases risks of acute and chronic respiratory illnesses, for example, chronic obstructive pulmonary disease.[26] Exposure to ground-level ozone **causes an estimated 472,000 premature deaths every year**.[32]
Carbon Monoxide (CO)	Odourless gas produced by the incomplete combustion of carbon-based fuels.	Incomplete combustion of fuel linked to **transport and biomass burning**.	Difficulties breathing, exhaustion, dizziness, and other flu-like symptoms; exposure to high levels can be deadly. **CO poisoning caused 29,000 deaths in 2021**.[33]
Ammonia (NH3)	Colourless gas. Contributes to particulate matter.	85% of emissions come from **agriculture;**[34,35] ammonia is also emitted by **industrial processes, catalytic converters and waste utilities**.[35]	Acute inhalation can cause upper respiratory tract irritation; chronic inhalation is associated with increased respiratory symptoms and asthma.[36] **Secondary $PM_{2.5}$ formation** from NH_3 **caused an estimated ~61,000 premature deaths globally in 2012**.[37]
Black Carbon (BC)	Soot. Significant part of fine particulate matter ($PM_{2.5}$).	Incomplete combustion of fossil fuels, biomass and waste. Transport is a major commercial source with shipping representing a significant and growing contributor of black carbon.[38] In urban areas, diesel vehicles, buses, trucks, and residential heating (wood and coal) also contribute to local black carbon exposure.	Increases risk of cardiovascular disease; exposure during pregnancy is linked to adverse birth outcomes.[38] Assuming equal toxicity for all components of $PM_{2.5}$, **BC is linked to 150,000 excess deaths globally, but if toxicity is higher** (than other forms of $PM_{2.5}$) **its contribution may be much greater**.[38] Mitigation could prevent up to 400,000 premature deaths annually across the Indo-Gangetic Plain alone.[38]

Air pollution is a complex, multi-dimensional issue, that contributes to climate change, nature loss and violates human rights.

Air pollution is a complex, multi-dimensional issue which intersects not only with public health but also climate change, nature loss, and human rights (Figure 1).

Greenhouse gases – including carbon dioxide, methane and nitrous oxide – cause global warming. Combustion of fossil fuels is a major source of both greenhouse gas (GHG) and non-GHG air pollutants. Other pollutants, such as black carbon (BC) and ground-level ozone (O_3), are also significant drivers of climate change. BC and O_3 are however classified as short-lived climate pollutants rather than as traditional GHGs, and are typically excluded from conventional carbon accounting frameworks.

Pollution, including of air, water and soil, is the fourth largest driver of nature loss after land and sea use, resource extraction and climate change.[5] Air pollutants can cause environmental damage directly and also contribute to water and soil pollution via rainfall and depositing pollutants on the ground (see Box 1).[39] For example, in the Netherlands, the government has identified excessive nitrogen deposition (including from airborne pollution) as a critical issue due to its impacts on both nature and public health. It has introduced mitigation measures for industry, agriculture, transport and the construction sector.[40]

Box 1. How does air pollution affect nature?

Just like humans, wild animals can be harmed by inhalation of airborne pollutants, for example contributing to respiratory issues, reproductive problems and behavioural changes.

Air pollutants can also settle onto land, water and vegetation in a process known as deposition. This can be via ‘dry deposition’, where airborne pollutants settle onto surfaces or ‘wet deposition’, where pollutants are carried by rain, snow or fog (precipitation). Precipitation containing sulphur or nitrogen compounds is commonly known as ‘acid rain’.

Acid rain can alter soil chemistry, in turn harming plant health and productivity. It can also alter water chemistry, causing acidification and eutrophication of water bodies, which in turn depletes oxygen and harms aquatic life. At an ecosystem-level, this can alter species composition and reduce habitat quality, reducing provision of ecosystem services such as nutrient cycling.

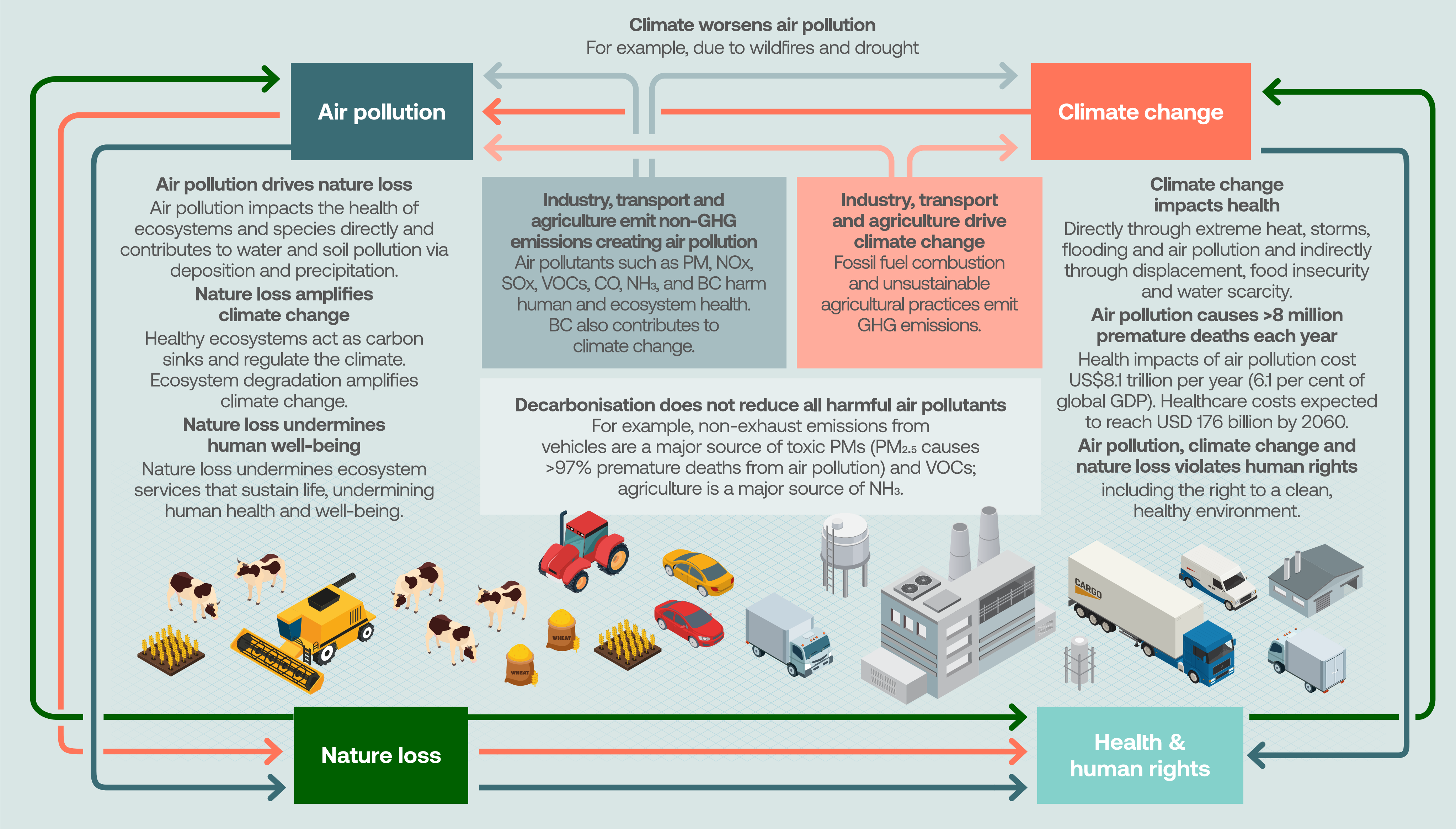
Particulate matter (PM) settling on to vegetation can block sunlight and hinder photosynthesis, affecting plants’ ability to generate energy, and in turn their health and growth. Ozone (O_3) can enter plants through pores in their leaves, causing stress and cell damage.

Heavy metals deposited by airborne pollution can accumulate in water, soil and food chains.

Climate change, air pollution and nature loss are inextricably linked, reinforcing each other through feedback loops (Figure 1) where pollution degrades ecosystems, weakened ecosystems reduce air quality regulation, and climate change intensifies pollution through wildfires and extreme weather, further harming nature and health. For example, clearing forests for wood fuel contributes to air pollution through biomass burning, while forest loss in turn reduces the planet’s capacity to regulate air quality, provide habitat and sequester carbon. Climate change also contributes to air pollution, for example by increasing the frequency of wildfires and droughts, which release smoke and raise dust levels in the atmosphere.

Access to a clean and healthy environment is recognised as a fundamental human right. For further information on how air pollution relates to human rights, see the section on litigation (page 27).[41]

Figure 1. Air pollution, climate change, nature, health and other human rights interact in many ways



Air pollution has substantial and far-reaching economic impacts – costs that are profound, cross-cutting and, potentially, undiversifiable.

The effects span multiple sectors and regions, influencing healthcare systems, productivity and economic growth worldwide.

The World Bank estimates that **ambient air pollution costs US$6 trillion a year, equivalent to 4.6 per cent of global gross domestic product (GDP),** with the highest toll in middle-income countries.[2] In the UK, air pollution is estimated to cost the economy £20 billion each year due to premature death, inability to work and resulting health impacts.[42] In China, economic losses due to hospitalisation and premature death were estimated to be 2.5 per cent of the country's GDP (2,065 billion Yuan) in 2017.[43] In the EU, the health impacts attributed to exposure to air pollution are estimated to cost €600 billion per year, equivalent to 2 to 10 per cent of GDP (based on data from 2005 to 2020).[3] Global healthcare costs related to air pollution are projected to grow eight-fold from US$21 billion in 2015 to US$176 billion in 2060.[4]

Poor air quality places a burden on healthcare systems, and has been shown to reduce labour supply[44,45] and worker productivity,[46–49] increase absenteeism,[50] lower educational attainment,[51] and disrupt supply chains. The Organisation for Economic Co-operation and Development (OECD) estimates that ambient air pollution results in 1.2 billion workdays lost globally each year, which could reach 3.8 billion days by 2060.[52] It has also, in some instances, been found to raise the incidence of violent crime[53] and road traffic accidents.[54]

In China, air pollution has been linked to negative impacts on stock market performance, with analysis of more than 1,000 listed companies between 2012 and 2019 revealing significant declines in returns during high-pollution episodes.[55] Air pollution has also been associated with reduced entrepreneurial activity, evidenced by lower rates of new firm registrations[56] and diminished levels of venture capital investment, as investors perceive heightened operational and regulatory risks in polluted regions.[57]

The economic impacts of damage to ecosystems have not yet been fully quantified due to a lack of reliable global data,[52] but they are likely to be substantial:[58]

- A 2025 report by the European Commission estimates that the economic cost of environmental damage from air pollution in 2030 will range from €3.7–11 billion, and additional crop and forest damage are each estimated at €13–18 billion.[59]
- Ground-level ozone is projected to cause an average loss of 8 per cent of wheat yields in the northern hemisphere by 2050.[60]
- A UN Economic Commission for Europe assessment in 2016 found that ground-level ozone concentrations are reducing the production of crops and wood in Europe by up to 15 per cent each year.[58]
- In France, current annual economic losses from air pollution affecting crop and timber production are approximately €2.4 billion, with damage expected to increase by around 10 per cent over the next decade.[56]
- A UN Environment Programme Finance Initiative report estimated that, in 2015, the loss of ecosystem services (the essential benefits nature provides including food, clean water, climate

regulation, and support for life processes like soil formation and pollination) due to soil degradation from air pollution alone cost between US$6.3 and 10.7 trillion annually.[6]

- A UK study found that the combined costs of ammonia pollution on health and biodiversity range from £580 million to £16.5 billion per year.[61]

In 2022, the combined cost of ambient air pollution to health, ecosystems and the economy was estimated to exceed 5 per cent of GDP in nearly half (26) of the 56 countries in the pan-European region and North America, reaching as high as 10 per cent of GDP in at least six countries.[62]

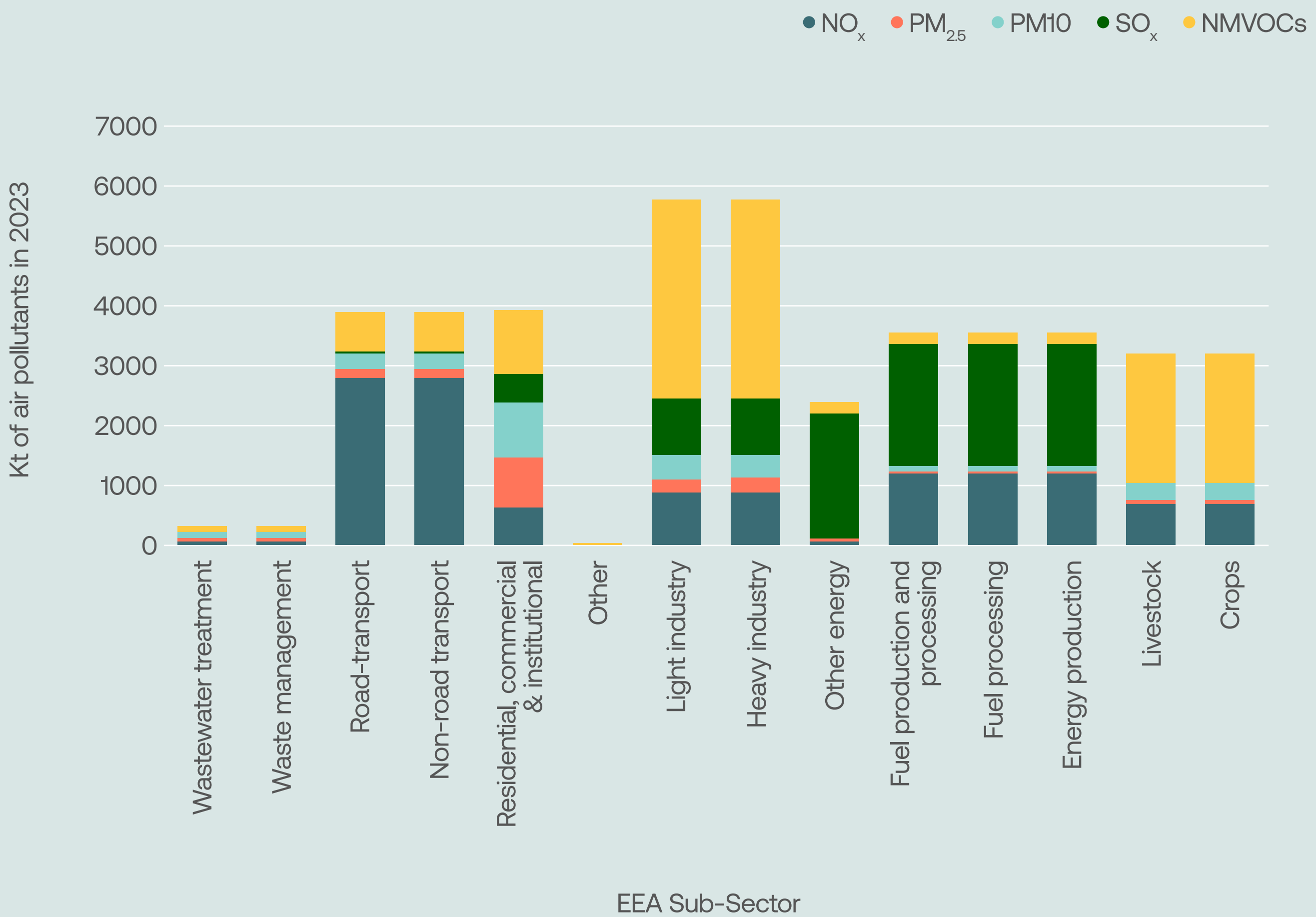
Sources of ambient air pollution

The primary sources of ambient air pollution (see Table 1 and Figures 2 and 3) include:

- fossil fuel combustion in transport, manufacturing (for example, of cement, steel, chemicals) and energy generation;
- agricultural activities;
- industrial activities such as construction, mining and waste incineration; and
- natural sources including wildfires and dust.[26]

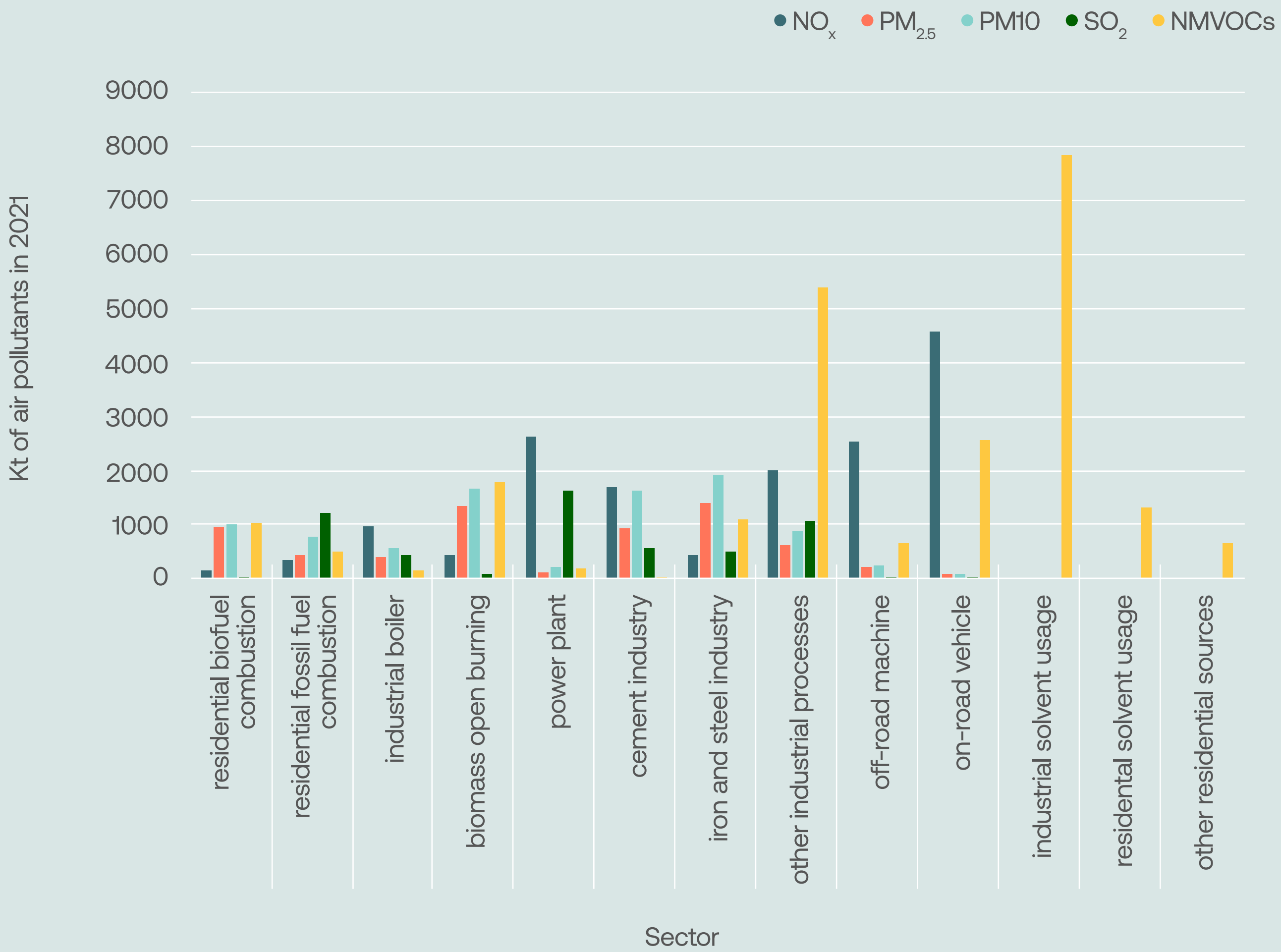
The Exploring Natural Capital Opportunities, Risks and Exposure (ENCORE) database identifies sectors including agriculture, mining and quarrying, manufacturing, transport and power generation as having high or very high materiality for air pollutants.[1]

Figure 2. Heavy and light industry, energy production and transport were the main causes of NO_x, $PM_{2.5}$, PM10, SO_x and non-methane VOCs emissions in Europe in 2023



Source: European Environment Agency. (2025). National emissions reported to the Convention on Long-range Transboundary Air Pollution (LRTAP Convention), v1.0, 2025. doi:10.2909/D94EDBD6-C426-4AAE-85AF-56C77D7257E7.

Figure 3. Fuel combustion and industrial processes were the main sources of NOx, PM2.5, PM10, SOx and VOCs emissions in mainland China in 2021



Source: Li S, Wang S, Wu Q, Zhang Y, Ouyang D, Zheng H, Han L, Qiu X, et al. (2023). Emission trends of air pollutants and CO2 in China from 2005 to 2021. Available at: https://figshare.com/articles/dataset/Emission_trends_of_air_pollutants_and_CO2_in_China_from_2005_to_2021/21777005/1 [Accessed 11 September 2025].

Urban Pollution and Road Transport

Road transport is a major source of urban ambient air pollution globally[20] and of health damage costs from air pollution as reported in OECD countries.[58] The key pollutants of concern in urban areas are NO_2 and $PM_{2.5}$ which harm health both directly and as precursors of harmful ground-level ozone. Though there are geographical variations, **the primary source of NO_2 and $PM_{2.5}$ is road transport** followed by combustion for commercial, industrial, residential and agricultural activities.[19,20]

While levels of some pollutants have decreased in high-income regions due to stricter regulations and cleaner technologies, emissions continue to rise across much of the Global South. **Vehicle emissions are projected to rise rapidly in Asia, Africa, and Latin America**, driven by demographic and economic trends, despite an increasing number of countries in these regions committing to net-zero targets.[8] Transport remains one of the few sectors with growing emissions, largely due to heavy-duty vehicles, which contribute disproportionately to air pollution.[8]

Moreover, although air pollution has been significantly reduced in higher-income countries, $PM_{2.5}$ levels in most European countries and the US remain at least twice the WHO guidelines.[63]

Beyond Carbon: why air pollution demands more than climate action

Action to address climate change brings health co-benefits for many air pollutants.

Efforts to reduce greenhouse gas (GHG) emissions – particularly through decarbonisation and electrification – also lower non-GHG emissions, delivering significant benefits for both air quality and climate. For example, it is estimated that eliminating fossil fuel combustion in 2017 would have reduced the global $PM_{2.5}$ burden by 27.3 per cent, prevented over a million premature deaths[64] and could additionally lower rates of childhood asthma and premature birth in cities worldwide.[65]

There are efficiency gains in implementing policies and technologies that simultaneously address GHG and non-GHG emissions, maximising co-benefits for climate and air quality. This gives rise to the 'Integration dividend' whereby investment needs can be ~40 per cent lower when climate and air quality are planned together.[2]

There can also be trade-offs between air quality and climate change. For example:

- A shift from electrification to hydrogen as a means of reducing GHGs would reduce cuts to NO_x by 40 per cent by 2050.[66]
- Increasing use of biofuels as a renewable energy source may exacerbate air pollution.[15]
- Some technologies used to reduce air pollution can increase energy demand.[15]

By reporting on air pollution, companies and investors can ensure their pollution abatement and climate strategies are aligned and any trade-offs fully considered.

Decarbonisation does not address all sources of ambient air pollution.

While company strategies focused solely on decarbonisation do reduce air pollution, they fail to address a range of other harmful air pollutants, with serious consequences for public health, climate change, nature loss and potential human rights violations.

For example, as vehicle exhaust emissions decline in many regions, **non-exhaust sources of pollution from road transport and associated sectors – such as brake wear, tyre wear, and road dust resuspension (where dust and particles on the road surface are thrown back into the air by vehicle tyres) – have become major contributors to $PM_{2.5}$ and PM_{10}**, particularly in urban areas (see Box 2). Non-exhaust emissions (NEEs) arising from tyre and brake wear are also expected to be responsible for the vast majority of PM emissions from road transport in the future.[8]

Box 2. Particulate matter, microplastics, and tyre, brake and bitumen wear particles

Airborne particulate matter (PM) consists of solid particles (including microplastics) and liquid droplets suspended in the air. PM_{10} (≤10μm) and $PM_{2.5}$ (≤2.5μm) are particularly harmful to human health due to their ability to penetrate deep into lungs. PM also adversely affects ecosystems (Table 1). PM can deposit in soils, vegetation and surface water run-off, and may contain chemical compounds, microplastics and micro-metallic particles.

Microplastics are plastic particles smaller than 5 mm, typically generated from the breakdown of larger plastics (for example, from plastic waste, synthetic textiles and personal care products, from vehicle use (tyre and brake wear), or manufactured as microbeads. They can disperse through **air, water and soil**, affecting human and ecosystem health via inhalation, ingestion and the **leaching of toxic chemicals**. Finer and more aged microplastics are the most toxic due to increased surface area and surface modifications.

Particles from tyre and brake wear and **bitumen** from road surfaces are major sources of both particulate matter and microplastic pollution.[67,68] Tyre abrasion is considered the main contributor (>35 per cent) to microplastic emissions into the environment (Box 3).[69] Approximately 34 per cent of coarse-mode tyre wear particles and 30 per cent of brake wear particles have been found in the ocean.[70] PM emitted from tyre abrasion is a key source of toxic metals,[71] contributing disproportionately to $PM_{2.5}$ toxicity due to high oxidative potential.[72] Toxic chemicals leached from tyre wear particles have also been implicated in the sudden deaths of up to 90 per cent of salmon in urban streams in the northwestern United States.[73]

In 2018, the UK's emissions inventory attributed 67 per cent and 79 per cent of $PM_{2.5}$ to brake, tyre and road surface wear.[74] A 2024 review found that non-exhaust PMs accounted for 66 per cent by weight of particles in the 2.5 to 10μm range and 29 per cent of particles in the 0.2 to 2.5μm range in urban areas.[71]

Though this requires further research,[75] the anticipated increase in electric vehicles (EVs) on the road may further raise total microplastic emissions from vehicle tyres, partly because current EVs are typically 20–30 per cent heavier than their internal combustion engine equivalents.[76] These sources of PM are not mitigated by electrification or decarbonisation, making them a persistent and growing concern. Reducing these emissions requires companies to develop and adopt lower-emission technologies and less toxic materials, alongside wider efforts related to research and development, transport planning, and regulation (see Box 3).

Box 3. Addressing Non-Exhaust Emissions

Key areas and opportunities to address NEEs include:[77]

- Using existing lower-emission abrasive materials, and abrasive materials with less toxic chemical composition, and particle filtration technologies.
- Developing and promoting technologies that reduce or remove NEE sources, for example, regenerative braking (see Case Study 2).
- Road planning, particularly in urban areas, for example to reduce braking, cornering, and acceleration.
- Regulations that set and enforce baseline and progressive NEE standards, such as requirements for low-emission and less toxic abrasive materials.
- Investing in research and development that fast-tracks understanding of NEEs and advances solutions to reduce health and ecosystem impacts.

VOCs are primarily emitted by transport and industrial activities. Chronic exposure to VOCs further threatens health, damaging vital organs, increasing cancer risk, and causing a range of environmental impacts (see Table 1). Nearly all non-exhaust VOCs arise regardless of the type of vehicle and its mode of power.[74] In the UK, transport accounts for half of all VOC emissions, with road transport responsible for 30 per cent.[30] In the EU, road transport contributes approximately 90 per cent of non-methane VOC emissions from the transport sector.[75] These emissions arise from both exhaust and non-exhaust sources, and **may increase as total vehicle kilometres grow in a future electrified fleet**.[79]

Black carbon (or soot) is an important cause of global warming and also a primary component of $PM_{2.5}$.[80] As a short-lived climate pollutant rather than a traditional GHG, it is typically excluded from carbon accounting models and frameworks. BC also degrades sensitive cryosphere ecosystems (for example, the Arctic), contributes to unpredictable monsoons patterns and flooding, exacerbates heatwaves, and reduces agricultural productivity.[38] Transport is a major commercial source with shipping representing a significant and growing contributor of black carbon,[38] while in urban areas, diesel vehicles, buses, trucks, and residential heating (wood and coal) also contribute to local black carbon exposure.

2. Ambient air pollution risks and opportunities

Although the substantial societal and macro-economic risks of air pollution are now well understood, there remains a lack of definitive evidence linking air pollution to company financial performance. Nevertheless, regulatory and litigation risks are growing, and companies and investors should be proactively managing them.

ShareAction's *Clearing the Air* report (2024)[63] summarised the enterprise and operational-level risks arising from air pollution, and the evolution of industrial emissions standards and sustainability disclosure standards. Building on this work, this section focuses on the increasing regulatory and litigation risks related to air pollutants globally, with an emphasis on road transport.

Regulatory risks

Appendix 1 summarises past, current and emerging policy and regulatory instruments regulating air pollution) for seven key geographies (China, EU, India, Indonesia, Thailand, UK and US), with a particular focus on road transport. A three-pillar framework was used as a conceptual tool to organise the research and make sense of diverse regulatory landscapes:

- Pillar 1: National ambient air quality standards (AAQS), that is, concentration-based standards that define 'acceptable' air quality.
- Pillar 2: Emission limits or reduction strategies, that is, emissions ceilings or action plans focused on reducing emissions of specific pollutants.
- Pillar 3: Source-specific transport controls, that is, regulations targeting road transport such as vehicle emission or fuel quality standards.

Most jurisdictions begin with ambient air quality standards (Pillar 1) and subsequently develop more complex measures, such as emission ceilings (Pillar 2) or transport controls (Pillar 3). While these pillars are not strictly sequential, they generally reflect the typical evolution of air pollution regulation, though exceptions exist. For example, in the US, source-specific controls (Pillar 3) were implemented before broader emissions limits (Pillar 2).

A growing number of countries, including those in the Global South, are introducing air quality regulations

Countries are increasingly introducing regulations governing ambient air quality (Pillar 1), emissions limits or reduction strategies (Pillar 2) and source-specific controls for emissions from road transport (Pillar 3) (Figure 4).

Figure 4. The US and EU were the first in our sample to introduce regulations governing air quality

An increasing number of countries are setting legally binding emission ceilings and reduction targets.

While legally binding emission ceilings are not new (for example, the 1979 Convention on Long-range Transboundary Air Pollution established binding emissions limits for its ratifying parties in Europe and North America),[81] they represent a novel and potentially influential development in emerging markets.

In 2021, the UN Environment Programme's first Global Assessment of Air Pollution Legislation reviewed air quality laws across 194 countries and the EU.[82] It found that most countries (64 per cent) had embedded AAQS in legislation, including 100 per cent of EU countries and 96 per cent within the United Nations Economic Commission for Europe. However, only 40 per cent of Commonwealth nations and 67 per cent of Association of Southeast Asian Nations (ASEAN) members had done so. The assessment also noted that 21 per cent of countries were revising their air quality legislation, while 16 per cent were planning to introduce or revise standards in the near future. In 2025 the WHO reported a 17 per cent increase in countries implementing AAQS for key air pollutants since it published its Air Quality Guidelines in 2021.[83]

Of the countries selected for this briefing (Table 2), all have established AAQS (Pillar 1), while all except Indonesia have also set binding emission reduction targets (or equivalent measures) for at least one pollutant (Pillar 2). Thailand's draft Clean Air Act, once enacted, is expected to include legally binding reduction targets for additional harmful pollutants.[84]

Rather than relying on national emission targets, China employs target-based action plans that assign responsibility across sectors and regions. Under the Air Pollution Prevention and Control Law, national and local authorities have statutory powers to set targets and mandate public disclosure.

Table 2. Regulation of key pollutants in six countries and the EU

■ AAQS or equivalent (for example, concentration limits) which set maximum allowable pollutant levels in the air.

● Legally binding national emission ceiling (absolute cap) which sets a mandatory limit on the total quantity of a pollutant the country can emit by a certain date (EU/UK model).

△ Mandatory reduction plan/target based on non-compliance: legally binding, enforceable emission reductions are triggered if ambient standards are exceeded, for example the US SIPs or India's NCAP city-level reduction mandates.

Country	SO_2	NO_2	NO_x	PM_{10}	$PM_{2.5}$	O_3	CO	Pb	NMVOCs	NH_3
China	■ ●	■ ●	■ ●	■ ●	■ ●	■ ●	■	■	■ ●	■
EU	■ ●	■ ●	■ ●	■	■ ●	■	■	■	●	●
India	■	■	■	■ △	■ △	■	■	■	■	/
Indonesia	■	■	■	■	■	■	■	■	/	/
Thailand	■	■	■ △	■	■ △	■	■ △	■	/	/
UK	■ ●	■ ●	■ ●	■	■ ●	■	■	■	●	●
US	■ △	■ △	△	■ △	■ △	■ △	■ △	■ △	△	/

There is a clear trend toward tightening vehicle and fuel emission standards aligned with European standards for road transport.

The EU operates a comprehensive vehicle emission standards regime through progressive Euro regulations (Pillar 3). Light-duty vehicles (cars and vans) are governed by Euro 5/6 standards, while heavy-duty vehicles follow Euro VI requirements targeting NO_x, PM, HC, and CO through mandatory type approval and market surveillance. The forthcoming Euro 7 proposal aims to introduce enhanced real-world emissions testing, alongside brake and tyre particle limits and extended durability requirements.

All the countries except the US reference EU standards for road transport.

- **United Kingdom:** Euro standards have been domesticated with tailpipe limits for NO_x, PM, CO, and hydrocarbons (HC). Euro 6 applies to new (light-duty) diesel vehicles and gasoline vehicles, while Euro VI governs heavy-duty vehicles. These standards underpin urban air quality measures like London's Ultra Low Emission Zone (ULEZ), which requires Euro 6 diesel and Euro 4 petrol compliance. A consultation on Euro 7 is planned for 2026.
- **China:** Vehicle emission standards (China I–VI) are combined with urban transport measures initially modelled on EU norms but increasingly adapted to the national context. China VI was implemented in two stages: Stage A in 2020 and Stage B in 2023. Stage B introduced some of the world's strictest criteria, including real-world emissions testing, particulate number limits, and mandatory diesel particulate filters for heavy-duty vehicles.
- **India:** Pillar 3 regulations are based on the Bharat Stage (BS) emission standards, the functional equivalent of EU vehicle standards, setting nationwide tailpipe limits for PM, NO_x, CO and HC. In 2020, India introduced BS-VI, aligning directly with Euro 6. This reduced the fuel sulphur limit to 10 ppm, tightened PM and NO_x limits, and added new provisions such as particulate number standards, extended emission warranties, and real-world emissions testing. BS-VI applies nationwide to both light- and heavy-duty vehicles, with enforcement supported by fuel quality upgrades and expanded testing protocols.
- **Thailand:** Vehicle emission regulations draw directly from European standards. Euro 5 applies to new diesel vehicles from January 2024, and Euro 6 for petrol vehicles from January 2025. Euro 6 for heavy-duty vehicles is expected in 2032. Fuel standards have been upgraded in parallel, with sulphur content reduced to 10 ppm to support compliance.
- **Indonesia:** Adopted Euro 4 standards for gasoline vehicles in 2017, aligning tailpipe limits for NO_x, PM, CO, and HC.

Beyond the countries studied, **there is a clear global trend toward tightening vehicle and fuel emission standards aligned with Euro norms, particularly in Southeast Asia, and increasingly in sub-regions of Africa and Latin America**. For example:

- **East Africa:** Low-sulphur fuel standards were first adopted in 2015 and revised to 10 ppm in 2025 (aligned with Euro 6), alongside harmonised vehicle emission standards of at least Euro 4 introduced in 2022.[8]
- **West Africa:** Low-sulphur fuels at 50 ppm and stricter vehicle emissions standards at Euro 4 were adopted in 2020.[8]

- **Latin America:** UNEP is working with Central America sub-region governments to harmonise vehicle and fuel emissions regulations across the sub-region, aligned with Euro 6.[8]
- **Southeast Asia:** Thailand and Vietnam have adopted Euro 5 fuel and vehicle standards, while Cambodia plans to implement Euro 5 by 2027.[8]

Emissions standards for road transport are tightening and are being extended to cover non-exhaust emissions and non-road mobile machinery.

The Euro 7[i] emissions standards (replacing Euro 5/6) will:[86]

- **Introduce brake and tyre abrasion regulations for the first time**, introducing performance requirements for abrasion with limits anticipated to be phased in from 2028 by vehicle class.
- **Introduce a step change in limits for NOx** (reducing from 80 mg/km to ~60 mg/km) (1,000 mg/km to 500 mg/km).
- Double durability requirements to 10 years or 200,000 km; and
- Require more robust real-driving emissions testing (to address Dieselgate-exposed lab manipulation – see Case Study 1).

The California Air Resources Board is currently researching PM emissions from tyre and brake abrasion and road resuspension with a view to introducing regulations. Under the Clean Air Act, California has a waiver allowing it to set its own vehicle emissions standards that are stricter than federal rules. California's example has led to other states implementing more stringent regulations: 17 states and Washington D.C. (covering 40 per cent of the country's light vehicle market)[87] have all adopted California's Low-Emission Vehicle (LEV) standards, Zero-Emission Vehicle (ZEV) mandates and Advanced Clean Trucks (ACT) regulations.[88] Whether this leads to regulations of NEEs in the US remains to be seen in the context of proposals to roll back emissions regulations.[7]

Non-road mobile machinery emission standards are now being implemented in many regions to reduce pollution from off-road construction, agricultural and other mobile equipment, including in the EU, UK, US, China, India, Thailand and Indonesia.[89]

Uneven enforcement is a challenge.

Regarding Pillar 1, most EU member states have struggled to comply with air quality standards set by the Ambient Air Quality Directives. As of October 2019, 32 infringement procedures were pending against 20 member states.[90] In the same year, 33 of the 43 reporting zones in the UK exceeded NO_2 limits.[91] In the US, persistent compliance gaps remain for $PM_{2.5}$ and ground-level ozone, particularly in urban and industrial regions such as in California and the Midwest.[92] In India, cities including Delhi, Mumbai and Kolkata have consistently exceeded NAAQS limits, particularly for particulate matter.[93]

In China, compliance is pursued through phased and region-specific deadlines, often tied to major city clusters. Despite progress – especially reductions in $PM_{2.5}$ – many northern and industrial cities continue to exceed limits, especially during winter heating seasons, while local enforcement capacity and data transparency remain uneven.

[i] The Euro 7 emission standards for new mass-produced cars in the EU and UK are expected to come into effect in November 2026, with a mandatory compliance date for all new cars to meet the standard set for November 2027. For heavy-duty vehicles like trucks and buses, the enforcement dates are May 2028 (new type approvals) and May 2029 (new vehicles).[86]

Under Pillar 2, 11 of 27 EU member states had failed to meet 2020–2029 commitments for at least one pollutant by 2022,[94] resulting in 14 formal notice letters.[95] The UK has been more successful, meeting its 2020–2029 targets for all pollutants (NO_x emissions were 578 kilotonnes (kt), below the 765 kt ceiling);[96] however, projections indicate potential shortfalls for several 2030 targets, including NO_x, SO_2, $PM_{2.5}$, and NH_3, without stronger policy interventions.

In the US, federal enforcement has been robust, with substantial penalties for non-compliance (see below). However, recent legislative changes have weakened fuel economy enforcement by eliminating Corporate Average Fuel Economy (CAFE) penalties, while EPA emissions standards remain in place.

The evolving regulatory landscape for vehicle emissions is reshaping the automotive industry.

For instance, the Stellantis merger, which combined Fiat Chrysler Automobiles and Groupe PSA, was partly driven by the need to share the financial and operational burden of complying with increasingly stringent EU emissions for passenger vehicles.[9] This regulatory pressure has also fostered strategic partnerships between Tesla and traditional automotive companies such as Stellantis, Toyota, Ford and Mazda.[97] Meanwhile, London's ULEZ has driven a nearly 40 per cent decline in diesel fuel sales over four years – double the rate of decline observed across the rest of the UK – highlighting significant shifts in consumer behaviour and declining demand for older diesel vehicles.[98]

Litigation risks

Litigation related to air pollution is expected to increase, driven by stronger regulations, growing consumer and citizen awareness, and advances in technologies that can attribute violations to specific sources.

Air pollution lawsuits for regulatory breaches have imposed substantial penalties on companies and forced costly product recalls and compensation payments.

Examples of costs associated with recent regulatory violations include:

- Hino Motors (US, 2025): Fined US$1.6 billion in the US for fraudulent emissions testing under the Clean Air Act.[99]
- Manitowoc Company (US, 2025): Fined US$42.6 million for selling cranes with non-certified diesel engines under the Clean Air Act.[99]
- Marathon Oil Company (US, 2024): Fined US$64.5 million in the US for stationary source violations under the Clean Air Act, and required to invest an additional US$177 million in compliance measures.[100]
- Cummins Inc (US, 2023): Fined US$1.675 billion for installing 'defeat devices' on nearly one million RAM pickup trucks to bypass emissions controls, in addition to vehicle recalls under the Clean Air Act. The litigation led to an estimated US$2 billion in resolution costs.[101,102]

- Hyundai (India, 2023): Fined over US$3 million for exceeding mandated fleet emission levels.[103] Other companies penalised the same year included Honda, Renault, Skoda, Nissan and Force Motors.
- Toyota (US, 2021): Fined US$180 million in the US for Clean Air Act violations and an additional US$50 million in Australia for misleading emissions claims.[104]
- Volkswagen (2015): Facing costs exceeding US$30 billion for the emissions scandal known as 'Dieselgate', including fines across the US, EU and Australia, as well as recall costs and compensation payments (Case Study 1).[104]

Litigation is pushing governments to take stricter action.

State failures have led to numerous successful legal challenges for failing to uphold air pollution regulations. For example:

- **Germany:** Environmental Action Germany and ClientEarth have brought 40 cases to court, most of them successful, resulting in significant regional rulings on air quality.[105] Notably, Germany's top court clarified in 2017 that local authorities are not only permitted but required to implement diesel bans where pollution exceeds legal limits.[105]
- **India:** The National Green Tribunal has played a pivotal role in policy-level changes for air pollution controls. Earlier landmark Supreme Court cases, such as MC Mehta v. Union of India, established judicial precedent for enforcement when executive agencies fail to act and empowered citizens to litigate for environmental protections.
- **Indonesia:** In 2021, citizens successfully sued the government over Jakarta's air pollution, leading the court to mandate improvements in air quality monitoring and enforcement.[106]
- **Belgium:** ClientEarth's successful litigation (Belgium Case C-723/17) strengthened public rights to challenge the adequacy of monitoring and government compliance with EU regulations.

Courts are increasingly tying pollution-related harms to wider environmental and public health obligations and to human rights law, opening new legal avenues.

Courts are increasingly factoring public health harms (for example, disease, mortality) into climate-related litigation, with case numbers trending upwards, most notably in high-income countries.[107,108] Cases are increasingly relying on advancing scientific and medical evidence, while economic forces and pricing of health are also playing a key role, as courts are challenged by litigants to adjudicate on the responsibility for health impacts.[107,109] For example, in a series of civil liability cases in France, medical evidence was used to prove causal links between short-term peaks in air pollution and aggravation of respiratory symptoms in children.[109]

Scientific evidence demonstrating the human health consequences of climate change is likely to assume greater importance in lawsuits following recent advisory opinions by the Inter-American Court of Human Rights and International Court of Justice saying that states have specific duties to protect the health of individuals from life-threatening effects of climate change.[109] Advances in attribution science are strengthening these claims further, paving the way for more claims against high-emitting companies, and significantly heightening risks arising from litigation.[109]

Courts are also increasingly recognising pollution-related harms under human rights law. Examples drawing on Articles 2 and 8 of the European Convention on Human Rights include:

- In 2025, *Cannavacciuolo and Others v. Italy* the European Court of Human Rights found a violation of Article 2 concerning pollution of soil and water resulting from state inaction.[110]
- In 2025, a Spanish court ruled that authorities violated residents' human rights by failing to address severe air and water pollution from industrial pig farms, setting a precedent for treating livestock-related environmental harm as a fundamental rights issue across Europe.[111]
- In 2024, *Verein KlimaSeniorinnen Schweiz v. Switzerland* successfully challenged the government for failing to protect citizens from climate-related health risks, largely under Article 8, making it the first international court ruling that state inaction on climate change violates human rights.

In 2022, the UN formally recognised the human right to a clean, healthy and sustainable environment.[41] German citizens are now invoking this right to sue the government, citing health impacts.[112] Litigation related to the right to a clean, healthy and sustainable environment is likely to follow the trajectory of climate-related litigation, which has seen over 3,000 court cases brought against governments and companies globally since 2015.[113]

Air quality regulations are also evolving to better enable litigation. For instance, the revised EU Ambient Air Quality Directive (2024) grants individuals the right to seek compensation for harms related to air pollution.

Litigation claims are increasingly directed at companies.

As outlined above, recent case law shows that public health and human rights arguments are increasingly being deployed in climate litigation. These cases are moving beyond challenges to government policy and are now directed squarely at corporate actors, particularly in high-emitting sectors, including 'polluter pays', greenwashing and civil wrong claims (for example, for personal injury, private nuisance and even negligence). A 2025 report by the London School of Economics showed:[114]

- Over 80 'polluter pays' cases were filed between 2015 and 2024, including 11 in 2024.
- 20 per cent of climate cases filed in 2024 targeted companies, or their directors and officers.
- Cases involving 'climate-washing' (a form of greenwashing in which an entity misrepresents its progress towards climate goals) have been one of the most widely used strategies in corporate litigation in 2024, a growing number targeting the use of carbon credits to offset emissions.
- Though dismissed on evidentiary grounds, a recent ruling by the German court in Lliuya v RWE set a precedent by confirming that companies can be held liable for their historic global emissions.

The consequences of these claims can include significant damages or settlement costs. For example:

- In *Honolulu v. Sunoco and District of Columbia v. ExxonMobil*, the claimants sought damages and injunctive relief for the fossil fuel companies' alleged misrepresentation of their products' climate change effects and public nuisance. Financial awards are still pending.[114,116]

- In 2024, the Australian Investments and Securities Commission fined Mercer Super AU$11.3 million for misleading sustainability claims which falsely claimed they exclude fossil fuels from some investment options[117] and Vanguard Investments AU$20 million for false and misleading statements about ESG exclusions.[118] In 2025 they fined Active Super AU$10.5 million for misleading conduct by promoting fossil fuel exclusions while maintaining holdings in companies involved in oil extraction and coal mining.[119]
- In July 2023, the City of Vancouver announced a class-action suit against major oil companies for misleading the public about climate impact – one of Canada's first municipal deceptions claims.[120]
- In the US, at least a dozen states are actively suing or planning lawsuits against fossil fuel companies for negligence and public nuisance related to climate-related harms, aiming to recover billions in adaptation and infrastructure costs.[121]

This convergence of public-health framing, air-quality harms and climate-related duties heightens air pollution-related litigation risk for companies. Investors should be aware that these interconnected legal trends increase exposure across both environmental and human rights forums.

Case Study 1. Impacts of Diesel-gate

In 2015, it was revealed that Volkswagen (VW) had installed 'defeat devices' in diesel engines designed to detect when a vehicle was undergoing emissions testing and temporarily reduce NO_x emissions to meet regulatory standards. In real-world driving, however, emissions were found to be up to 35 times higher than legal thresholds.[122]

The scandal cost the VW group more than US$30 billion in legal settlements, fines and compensation,[104] caused its share price to drop by nearly 40 per cent,[122] and severely damaged trust among regulators, consumers and investors.

The case triggered the widespread introduction of stricter vehicle emissions regulations, including real-driving emissions (RDE) testing to ensure compliance throughout a vehicle's lifetime.[123] It also placed the entire automotive sector under increased regulatory and public scrutiny,[124] leading to higher research and compliance costs. The scandal accelerated the decline in diesel vehicle values, pressured commercial diesel fleets to shift to alternative fuels and electrification, and prompted investigations into other manufacturers' emissions practices.

Investor losses were substantial, resulting in over 1,400 lawsuits in Germany alone.[125]

Opportunities

While air pollution emissions pose risks, effective mitigation of these emissions opens up a range of opportunities and operational efficiencies.

A range of technologies are emerging to reduce air pollutant emissions, including low-emission technologies, smart transport systems, non-GHG emissions capture and utilisation, chemistry in manufacturing, and low-emission farming practices.[126] For example, technologies like regenerative braking systems, particulate capture devices (see Case Study 2), and low-abrasion materials can reduce tyre wear emissions, while use of less toxic chemicals in tyre manufacturing can lower the toxicity of unavoidable particulate matter.[127] This is creating new product markets, particularly in transport freight and logistics, and sustainable manufacturing.

By advancing and adopting these innovations, companies can both proactively address emissions while also differentiating themselves for competitive advantage. In the context of increasing regulation, this will enable companies to access public procurement contracts, access urban delivery zones, and secure financing.

Proactively mitigating emissions also promotes cost-saving operational efficiencies, for example through streamlining deliveries (in turn reducing fuel costs and vehicle wear), and enhancing worker health and productivity. Companies leading on air pollution mitigation may also be better positioned to attract talent, customers and community support, especially in urban areas where air quality is a visible concern. While upfront investment can be significant, these measures often deliver long-term financial benefits through reduced compliance risk, avoidance of litigation costs, and improved access to sustainability-linked financing and procurement opportunities.

For investors, supporting companies that lead on air pollution mitigation offers competitive advantage, operational efficiencies, and access to new markets, while ensuring regulatory readiness and business resilience. These actions also align with emerging disclosure frameworks such as the Taskforce for Nature-related Financial Disclosures (TNFD), EU Corporate Sustainability Reporting Directive (CSRD) and International Sustainability Disclosure Standards (ISSB) (see Box 4), helping investors meet ESG requirements and manage systemic risks. Moreover, investing in air pollution solutions supports multiple UN Sustainable Development Goals, strengthening ESG credentials and unlocking opportunities for sustainability-linked financing, impact funds and public procurement tied to SDG compliance.

Case Study 2. Technologies to reduce non-exhaust emissions at source

The Tyre Collective, a UK-based clean-tech startup, has developed a patented on-vehicle device that captures tyre particles at source using electrostatics and airflow. Laboratory tests indicate the technology can capture up to 80 per cent of airborne particles. The company is partnering with a range of companies, including Rivian, HIVED and Ringway, to pilot the device, including on electric delivery vans and road maintenance vehicles, aiming to quantify and reduce PM emissions from tyre wear in urban areas and assess integration into fleet operations.[128]

Combined with the wider adoption of lower-abrasion and less toxic tyre materials, this technology has significant potential to reduce NEEs from road transport, contributing to improve urban air quality and sustainable logistics practices.

3. Corporate and investor action on ambient air pollution

Globally, corporate disclosure on non-greenhouse gas emissions remains limited, but is beginning to grow, driven largely by regulatory and stakeholder pressure.

Historically, corporate accountability for non-GHG emissions (which has remained voluntary for many sectors) has been weak, with few companies disclosing data or setting measurable reduction targets. However, disclosure is gradually increasing as regulatory scrutiny and sustainability frameworks expand their scope beyond greenhouse gases:

- The World Benchmarking Alliance (WBA) found that while 43 per cent of energy companies and 27 per cent of water utilities disclose air pollution data,[11] overall reporting remains low. In its 2022–2024 Nature Benchmark,[129] only 33 per cent of 816 companies disclosed relevant information – most notably in highly regulated sectors like mining and chemicals – suggesting disclosure is often driven by compliance rather than voluntary transparency.
- A 2024 assessment by First Sentier MFUG Sustainable Investment Institute on the state of nature-related disclosures found that early corporate reporting on air pollution remains qualitative and incomplete. Among a sample of 16 companies disclosing against the Taskforce on Nature-related Financial Disclosures (TNFD) framework, air pollution was acknowledged as a material risk, but described as "otherwise underreported."[130]

- A 2025 analysis of 100 companies' sustainability disclosures in the first year of EU Corporate Sustainability Reporting Directive (CSRD) implementation (companies are required to report on air pollutants including NO_x, SO_2, PM, VOCs and other hazardous substances), found that, though 47 companies flagged pollution as material in their impact assessments, most disclosures were high level and lacked quantitative data; while a few companies provided detailed metrics on non-GHG air emissions, most focused on GHGs only. Where reported, pollutants were linked to industrial processes, energy generation and transport. Pollution-related financial impacts were rarely quantified.[131]
- Research from the Global Reporting Initiative (GRI) found that reporting on non-GHG emissions is lagging behind reporting on CO2 emissions. Chemicals, construction materials and mining are the sectors that most often disclose information on non-GHG emissions, while pharmaceuticals, construction, metals processing and transport are lagging behind. NO_x and SOx are the most often reported pollutants. Reporting on other non-GHG emissions is more sector specific. For example, PM emissions are reported more frequently by the mining and construction materials sectors, while reporting on VOCs is done more frequently by companies in the chemicals sector.[10]

Despite being a leading contributor to air pollution, companies in the transport sector continue to lag behind other industry sectors on disclosure.

Under WBA's Urban Benchmark, the transport sector stands out as the weakest performer on air pollutant disclosures, with only one of 55 assessed companies reporting relevant emissions data;[11] the 10 freight and logistics companies evaluated in the Nature Benchmark[129] also received low scores for air pollution reporting.

Disclosure of air pollutants such as NO_x, SO_2, and PM is gradually shifting from a largely voluntary or compliance-based activity to a mainstream ESG reporting expectation, particularly in the EU (see Box 4). Companies are increasingly responding to regulatory disclosure requirements, while voluntary frameworks are encouraging greater transparency where air pollution is material to environmental or financial performance.

In recent years, freight and logistics companies have begun to acknowledge air pollution as both a business and societal risk, and some have started to improve transparency around their contributions. For example, PostNL,[132] FedEx[133] and DHL[134] all identify air pollution as an issue of concern (although they do not explicitly recognise it as a material risk): FedEx and DHL monitor and disclose NOx, SO2 and PM_{10} albeit with varying levels of coverage, and PostNL reports on the proportion of its fleet compliant with EU emission norms (see Case Study 3). Leading operators such as PostNL are also piloting innovations to address NEEs, signalling early efforts to tackle a persistent gap in corporate air pollution management.

Case Study 3. PostNL proactively manages financial risks from tightening air quality regulations and sustainability goals

PostNL, the national postal and logistics provider of the Netherlands, is taking a leading role in addressing air pollution within the transport and logistics sector. The company explicitly identifies air pollution as a risk, acknowledging its impact on air quality in urban air quality, human health, and overall "liveability."[132]

PostNL conducts systematic assessments to identify pollution-related impacts, risks and opportunities across both its direct operations and upstream value chain. Informed by these assessments, its environmental strategy prioritises reductions in NO_x, $PM_{2.5}$ and PM_{10}, alongside its decarbonisation goals. This proactive approach mitigates financial risks associated with tightening air quality regulations, such as higher investment costs and potential vehicle supply constraints.[132]

To operationalise this strategy, PostNL is rapidly transitioning its fleet to electric vehicles and expanding the use of bicycles for last-mile delivery, while consolidating deliveries through urban hubs. It aims to achieve emission-free deliveries in 25 Dutch city centres by 2025, expanding this goal to cover the Netherlands and Belgium by 2030.[132]

PostNL also discloses its NO_x, $PM_{2.5}$ and PM_{10} emissions and, as of 2024, has begun reporting emissions from tyre and brake wear – a rare practice in the logistics sector – though a formal reduction strategy for these sources has yet to be developed.[132]

Reflecting its leadership, PostNL holds a top-three ranking in the Dow Jones Sustainability Index for the transport and logistics sector, and a gold rating from Ecovadis for its overall sustainability performance.[135]

The primary driver of corporate action on air pollution remains regulatory compliance, followed by reputational risks.

The primary driver of corporate action on air pollution is regulatory compliance, with increasingly stringent standards for non-GHG emissions creating tangible risks, including litigation, fines and operational constraints. Reputational considerations is also a significant driver, particularly where air pollution affects local communities near high-impact sites such as factories, transport hubs or construction zones.

At the same time, a growing number of companies are beginning to recognise the opportunities associated with improved air quality – from operational efficiencies and innovation in cleaner technologies to strengthened stakeholder trust and licence to operate.

However, beyond a small number of leading companies (see Case Studies 3, 4 and 5) and proactive investors, human rights considerations and the broader health impacts of poor air quality on local stakeholders remain secondary, despite the substantial public health consequences of air pollution exposure.

Case Study 4. Multiplex prioritises stakeholder materiality in managing air pollution

Multiplex, a global construction company, has identified air pollution as a material issue within its environmental strategy. Air pollution is embedded in the company's Sustainable Ecosystems pillar, alongside biodiversity and water, allowing Multiplex to align air pollution with its climate and nature agendas and leverage shared solutions such as electrification and decarbonisation.

The company's approach is shaped by its urban operational footprint, particularly in London. Materiality assessments are informed primarily by location-specific regulatory drivers including Net Zero Building Standards, Low Emission Zones and Non-Road Mobile Machinery standards. Reputational risks associated with operations in densely populated areas are considered alongside social responsibility toward workers and local communities. While air pollution did not meet the financial thresholds under IFRS 1 & 2, it was deemed material due to its localised impact and stakeholder relevance.

Multiplex's strategy focuses on transport and logistics, including delivery consolidation, transition to electric vehicles and use of alternative fuels. Air pollution criteria around Non-Road Mobile Machinery compliance are embedded in sub-contractor contracts, and the company works closely with suppliers to support compliance and fleet transformation.

Although no formal targets for non-GHG pollutants have yet been set, Multiplex is actively monitoring air pollution and preparing for future disclosure requirements related to air pollutants.

Air pollution is a multi-dimensional issue, framed through health, climate and nature-related risk lenses.

Some companies explicitly recognise air pollution as a material health risk. For example, Maersk (a major shipping company) identifies air pollution as a material risk to both the environment and human health, while IKEA (a major retailer) frames its actions on air pollution as addressing both health and climate impacts. Investors addressing air pollution often situate air quality within a broader health and climate agenda, with a few taking a holistic approach by integrating air pollution considerations across relevant themes within their ESG frameworks.

Companies are increasingly recognising air pollution, alongside climate change, as a nature-related risk (see Case Study 4). Several companies have flagged air pollution as a risk in their TNFD reporting and are tracking metrics for pollutants including PM, NO_x, VOCs, NH_3 and BC. Examples include maritime shipping and logistics companies NYK Group,[136] Wallenius Wilhelmsen[137] and Mitsui O.S.K. Lines;[138] industrial firms including Tata Steel,[139] Hindalco Industries Limited[140] and US Steel;[141] and petrochemical and logistics company GC Group.[142]

While some investors frame air pollution within a health lens – for example, Achmea Investment Management prioritises health as a key issue in its engagement strategy and considers air emissions within this[143] – investors are also increasingly framing air pollution within a natural capital context. For example, in 2024, the Norges Bank Investment Fund obtained a dataset estimating the societal costs generated by companies' direct environmental impacts. The Fund's approach assumes that higher societal costs increase the likelihood of regulatory interventions, requiring companies to internalise some of these costs. In this assessment, air pollution ranked fourth, after GHG emissions, waste and land use, representing approximately 20 per cent of the total weighted natural capital impact.[144]

While climate change remains the primary focus for most customers and shareholders, attention is increasingly shifting toward nature-related risks. This shift is largely driven by frameworks such as CSRD and TNFD, which encourage companies to report pollution, including non-GHG emissions, as part of their nature-related impacts. As a result, air pollution is increasingly recognised as a risk in high-risk sectors and is being incorporated into nature-related disclosures.[145]

Whether viewed through the lens of public health, human rights or environmental stewardship, high-risk companies should proactively identify and assess air pollution risks, and their interconnections with nature, climate and human rights, informing comprehensive action that mitigates these inter-related risks effectively. For example, Nest's Responsible Investment strategy links air pollution to climate change, biodiversity loss and public health, emphasising integrated risk management, cross-sector engagement, and stewardship to address these overlapping impacts.[146]

Case Study 5. Norsk Hydro frames air pollution as a nature-related risk

Norsk Hydro ASA, a Norwegian aluminium and renewable energy company and one of the world's largest aluminium producers, recognises air pollution as a material risk. The company has set targets for key air pollutants, including a 50 per cent reduction in SO_x, NO_x and PM by 2030. Target-setting goes beyond legal compliance and is based on technical and economical feasibility, requiring both CAPEX and OPEX commitments.

Air pollution is managed under the company's global nature strategy framework, alongside biodiversity, water, resource extraction and waste. Materiality assessments leverage tools such as the ENCORE dataset and the SBTN Materiality Screening Tool.

Beyond the physical risks to the environment, Norsk Hydro also considered transition risks related to regulation, market and reputation when assessing the materiality of air pollution. Norsk Hydro has a long-standing reputation in Norway, and aluminium customers are increasingly concerned about embedded emissions.

More recently, frameworks such as TNFD and CSRD have reframed air pollution within a broader nature-related context, strengthening the business case for proactive management and reporting.

Box 4. Disclosure Regulations

Disclosure of air pollution is shifting from voluntary and compliance-based reporting to mainstream ESG frameworks, particularly in the EU. Examples include:

- EU Corporate Sustainability Reporting Directive (CSRD): Though this has yet to be finalised, it is anticipated that European Sustainability Reporting Standards (ESRS) will require companies to disclose emissions of NO_x, SO_x, PM, NMVOCs, NH_3, heavy metals, and other air pollutants covered by EU or national legislation. Companies will be required to disclose: a description of their process to identify business risks; policies to address the problem; governance structure to resolve the problem; operational emissions; targets for reduction; actions and resources allocated to objectives; third-party valuation of reports; assessment of financial risks, impacts and opportunities.
- International Sustainability Standards Board (ISSB): Under International Financial Reporting Standards (IFRS), companies must disclose all material sustainability-related risks and impacts, including air pollution if deemed financially material by the company.
- Sustainability Accounting Standards Board (SASB) Standards: Include metrics for emissions of NO_x, SO_x, VOCs, hazardous air pollutants for high-risk sectors such as air transport, mining and metals, chemicals, and utilities.
- Global Reporting Initiative (GRI) Emissions Standard: Requires disclosure of NO_x, SO_x and other significant air emissions, with ongoing consultation to expand air pollution reporting. The publication of an exposure draft of a new standard is expected in Q2 2026.
- India's Business Responsibility and Sustainability Report (BRSR): Mandates reporting on PM, NO_x and SO_x emissions for specific high-risk sectors.
- The Taskforce for Nature-related Financial Disclosures (TNFD): Core metrics include 'non-GHG air pollutants (tonnes) by type', covering NO_x, SO_x, VOCs, PMs and NH_3, and other significant air pollutants for high-risk sectors.

Action on air pollution is often framed alongside climate change, with a focus on decarbonisation and electrification.

Corporate initiatives to address air pollution are frequently embedded within broader climate strategies, reflecting the overlap between sources of GHG and non-GHG emissions. This integration often prioritises decarbonisation measures, such as vehicle electrification and the transition to renewable energy. Aligning management of climate change and air pollution can create resource efficiencies and streamline ESG initiatives, and also help to build internal buy-in and engagement across the value chain.

However air quality and climate change, while interlinked, are not identical. Consequently, company efforts that focus primarily on climate-related targets do not fully address the health and nature-related impacts of air pollution emissions. Comprehensive air pollution management requires targeted measures beyond decarbonisation to mitigate these risks effectively.

Case Study 6. IKEA leads corporate action on air pollution

Inter IKEA Group, the global franchisor of the IKEA brand, the Swedish multinational retailer of affordable furniture and home goods, is committed to reducing air pollutants across its entire value chain. It is the first multinational company to disclose a multi-year inventory of non-GHG emissions, including NH_3, SO_2, NMVOC, NO_x and $PM_{2.5}$, with annual reporting on progress.

The company has demonstrated further leadership by developing an air pollution mitigation scenario (FY2024 to FY2030), quantifying the impact of its FY2030 climate roadmaps on emissions from production, transport and logistics, retail operations, product use and end-of-life management. This assessment projects, for example, a 51 per cent reduction in black carbon across its operations.

Public health has been a key factor in prioritising air pollution, informed by employee concerns from stakeholders (including co-workers, suppliers and other community stakeholders) about poor air quality in urban areas where the IKEA brand has a presence. Additional considerations include co-worker health (which affects operational costs) and customer footfall (which influences revenue).

To drive action and secure buy-in across its value chain, Inter IKEA Group aligns air pollution management with its climate policy:

- Air pollution is fully integrated into its climate roadmap.
- Action focuses on phasing out coal, transitioning to renewable energy and electrification, targeting some of the highest-impact areas of the business: manufacturing and transport.
- GHG reduction targets (80 per cent absolute reduction in factory emissions and 70 per cent relative reduction in transport emissions by 2030, and ambition for 100 per cent 'zero-emission' vehicles and vessels by 2040) are used as a proxy for air pollution reductions.

Inter IKEA Group also emphases the importance of partnerships in advancing action on air pollution. It is an active member of the Alliance for Clean Air and the Climate and Clean Air Coalition (CCAC), and collaborated with the Stockholm Environment Institute and CCAC to develop the Integrated Guide for Business Greenhouse Gas and Air Pollutant Emission Assessment (2025).

Barriers to addressing air pollution include lack of comparable data on ESG performance and of standardised metrics, alongside regulatory uncertainty and high upfront costs.

Companies and investors face challenges in accessing reliable, up-to-date data to assess corporate exposure to air pollution risks and liabilities. An analysis of 100 companies' sustainability disclosures in the first year of CSRD implementation found that companies cited data availability and measurement complexity as reasons for limited reporting on non-GHG pollutants.[131]

Compared with other environmental impacts, such as land use or water pollution, it can be difficult to attribute a company's specific contribution to health or ecosystem outcomes. However, a lack of perfect attribution should not be a reason for inaction. Many other systemic externalities – from carbon emissions to occupational health risks – have similar challenges, yet progress has been achieved through collective standards, improved transparency, and proactive engagement. The same principle applies to air pollution: companies can and should act on significant risks and impacts even as measurement frameworks continue to evolve.

Technological advances and expanded datasets are gradually improving data availability for key sectors. For example, tools like Climate TRACE now provide high-resolution, facility-level tracking of $PM_{2.5}$ emissions across more than 660 million industrial sources and, since 2024, have expanded to cover SO_2, NO_x, organic carbon, black carbon, CO, NH_3 and VOCs. Fingerprinting technologies are being developed to enable identification of the sources of chemical pollutants,[147] while life cycle assessment models are beginning to incorporate non-GHG pollutants. This lays the groundwork for product-level environmental declarations that include air pollution metrics. Although current limitations still necessitate reliance on sector averages, increasing corporate disclosure may enable company-level differentiation in product footprints in the future.

Despite growing recognition of air pollution as a risk, standardised reporting and data availability remain limited, making attribution and comparison challenging. Companies and investors would benefit from guidance on consistent measurement and reporting of air pollutants. A benchmark on corporate air pollution has also been proposed to help address this gap (Case study 7).

Other barriers to action include high upfront costs, limited availability of key technologies such as EV fleets, insufficient supporting infrastructure (for example, charging networks), and regulatory uncertainty in certain jurisdictions, particularly in the US. Suggested actions to mitigate against these are outlined in Section 4.

Box 5. Tools to support companies to assess air emissions

A growing number of tools and frameworks are available to help companies assess and manage their air pollution footprint. These support emissions quantification across value chains, facilitate monitoring of operational emissions, and enable reporting aligned with emerging regulatory and ESG frameworks. For example:

- Integrated Guide for Business Greenhouse Gas and Air Pollutant Emission Assessment: Developed by the Stockholm Environment Institute and Climate and Clean Air Coalition, this guide provides a step-by-step methodology for calculating air pollutant emissions across corporate value chains. It includes emission factors for pollutants such as $PM_{2.5}$, NO_x, SO_2, VOCs and NH_3, and supports integration with GHG inventories.
- Global Logistics Emissions Council (GLEC) Framework: Smart Freight Center's GLEC Framework is the global standard for calculating logistics emissions, aligned with ISO 14083. In collaboration with the Stockholm Environment Institute, it now includes a comprehensive methodology for air pollutant emissions accounting (NO_x, SO_x, $PM_{2.5}$, Black Carbon).
- Air Pollution Footprint Partnership Tool: Developed by consultancy Ricardo with support from the Clean Air Fund and Impact on Urban Health, this free tool enables UK-based organisations to estimate their air pollution emissions and associated damage costs. It supports sector-specific analysis and is designed to complement GHG reporting.
- Corporate Air Emissions Reporting Guide: Developed by the Confederation of Indian Industry and Environmental Management Centre for Indian companies.

There are opportunities linked to innovation and market differentiation

Forward-thinking companies (see Case Studies 3, 4, 5 and 6) are proactively addressing air pollution risks, not only mitigating emissions but also establishing market differentiation, avoiding transition risks and creating long-term value. Some investors also recognise that companies acting on air pollution can enhance competitiveness, improve operational efficiency, access new markets and attract additional investment, further reinforcing the financial case for proactive management.

Case Study 7. CCLA seeks to drive investor-led action on corporate air pollution

Asset manager CCLA recognises air pollution as a material risk to human and planetary health, and that resilient companies – and by extension strong investment returns – require a healthy environment supporting healthy communities.

CCLA views air pollution as a “sustainability blind spot” for investors. To help address this, in partnership with Guy’s & St Thomas’ Foundation, they launched a public consultation in late 2024 to explore the possibility of developing a benchmark on a corporate air pollution. The idea was to create a transparent comparison of companies’ management of air pollution, coupled with an investor engagement initiative, helping to embed air quality into responsible investment practice and drive corporate accountability.

Developed with Chronos Sustainability, the benchmark would seek to:

- define investor expectations for companies, especially in urban transport;
- drive transparency and disclosure on air pollution impacts;
- provide investors with tools to evaluate corporate practices; and
- showcase good practice in pollution management.[148]

4. Conclusion and recommendations

Conclusion

Air pollution is no longer a peripheral environmental issue, it is a material, systemic risk that intersects with climate change, nature loss and human rights. Its impacts on health, productivity, ecosystems and economies are profound, far-reaching and increasingly undiversifiable. As regulatory frameworks tighten, enforcement strengthens and litigation expands, companies across high-emitting sectors face escalating operational, financial and reputational exposure.

Despite this, corporate action and disclosure remain insufficient. Many companies continue to focus narrowly on decarbonisation, overlooking harmful non-GHG pollutants and the disproportionate impacts of air pollution on vulnerable communities. This gap presents a clear challenge for investors seeking to manage risk, uphold stewardship responsibilities and support resilient, future-proof business models.

Investors have a critical role to play in driving corporate action. By integrating air pollution into investment analysis, engaging companies on comprehensive pollution reduction strategies, supporting innovation and advancing transparency in disclosures, investors can help accelerate progress toward cleaner air, healthier communities and more sustainable economies. Addressing air pollution is not only essential for protecting long-term value—it is fundamental to advancing climate goals, safeguarding nature, upholding human rights and promoting health equity.

Recommendations

ShareAction's Clean Air Initiative urges investors to take action to align portfolios with long-term value creation while contributing to improved health and environmental outcomes. Our recommendations highlight steps investors can take in their own practices and in engagements with companies, standard setters and policymakers:

1. Integrate air pollution into investment analysis and decision-making.

- **Publicly recognise air pollution as a material investment risk and an opportunity** to signal commitment and accountability;
- **Embed air pollution into responsible investment strategies**, considering its intersections with climate, nature and human rights, and reflecting this in investment policies, in objectives and targets, and in reporting;
- **Identify exposure to high-risk sectors** using tools such as the Exploring Natural Capital Opportunities Risks and Exposure (ENCORE) database or Science-based Targets Network (SBTN) materiality screening tool;
- **Assess companies in these high-risk sectors** for exposure to air pollution, quality of risk management, and financial significance;
- **Integrate findings into investment decision-making**, including valuations, portfolio construction and capital allocation.

2. Strengthen stewardship and engagement with high-emitting sectors.

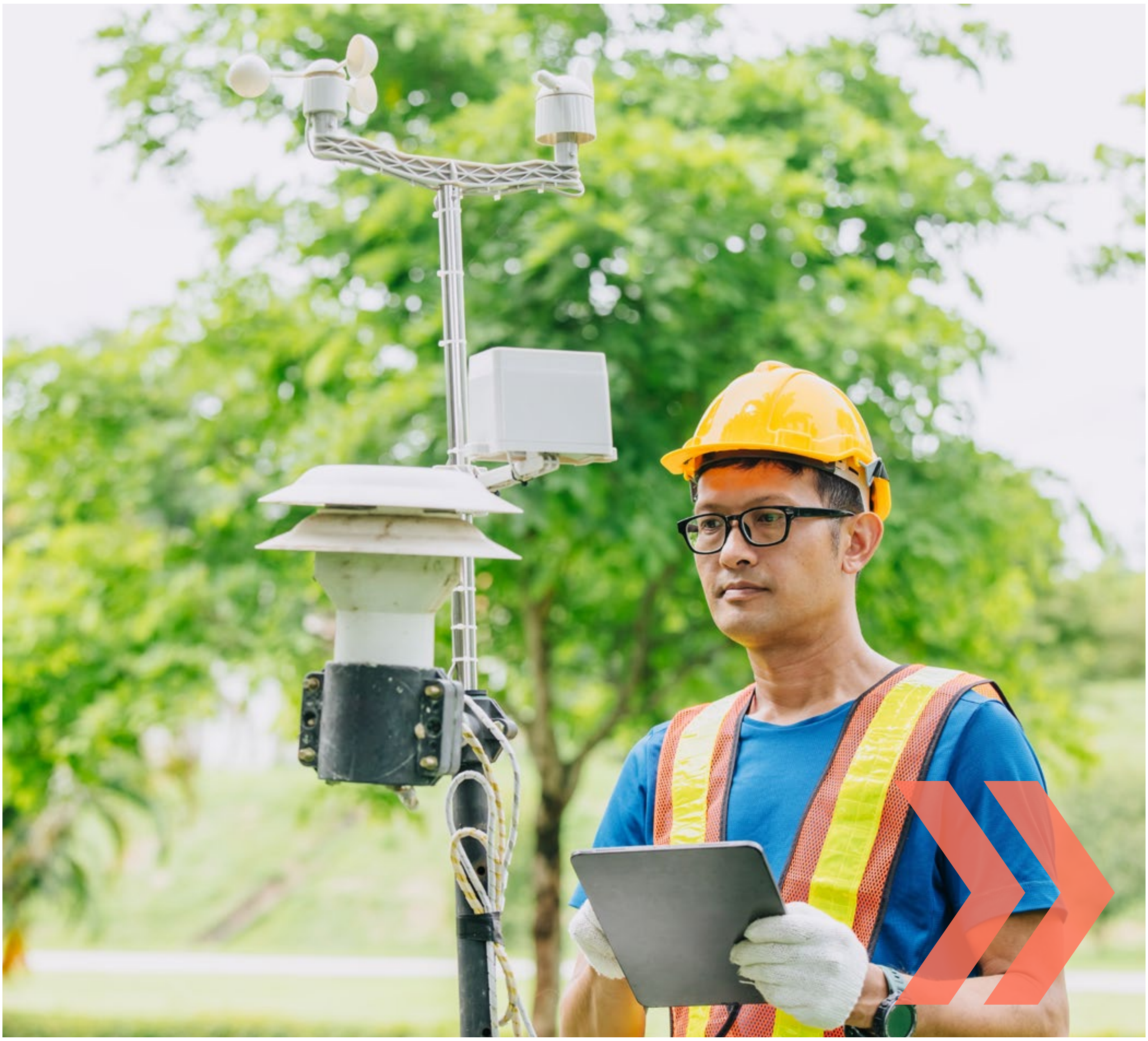
- **Engage companies to drive improvement** – prioritising sectors with high urban exposure and significant community health impacts – including to:
  - recognise air pollution as a material issue (for example, where air pollution disproportionately affects low income, marginalised and racialised communities, this can be a driver of risk and catalyst for litigation)
  - monitor and disclose comprehensive air pollutant inventories including scopes 1, 2 and 3 (see Boxes 4 and 5)
  - disclose time-bound, science-aligned reduction targets for reducing air pollutant emissions (see Box 4 for guidance)
  - implement well-designed, efficient policies and targeted mitigation measures that consider air pollution in the context of climate change, nature loss and upholding human rights
  - engage in collaborative industry initiatives and in policy making processes aimed at enhancing corporate action on air pollution across sectors and supply chain

3. Support innovation and adoption of cleaner technologies.

- **Support innovation in low-emission technologies** such as non-exhaust emissions mitigation in alignment with regulation and societal needs;
- **Contribute to the financing of low-emission technologies** and air quality improvements, including supporting the development of blended finance and other innovative structures.

4. Advance transparency, disclosure and data quality.

- **Advocate for stronger corporate disclosure and regulation**, engaging with regulators, industry groups and standard-setting bodies to ensure consistent, credible and enforceable regulations.
- **Support policy interventions that encourage companies to internalise the negative externalities**



Appendix 1. Air quality regulations in seven jurisdictions: a summary

Jurisdiction	Summary
EU	The EU operates the world's most comprehensive and legally binding air pollution regulatory environment. Integrated standards, national emission ceilings and progressive vehicle standards directly target member states, vehicle manufacturers and industrial emitters with escalating compliance requirements toward zero emissions by 2035–2040. Administrative and judicial enforcement pathways include European Commission infringement procedures, financial penalties, type-approval gatekeeping, and notably strong citizen enforcement rights through the European Court of Justice litigation. Compliance is uneven across most member states.
UK	The UK operates a comprehensive but fragmented regulatory environment through domesticated EU standards supplemented by post-Brexit frameworks that create overlapping jurisdictional responsibilities (across Department for Environment, Food and Rural Affairs; devolved administrations; Vehicle Certification Agency; Driver and Vehicle Standards Agency; and new oversight bodies, the Office for Environmental Protection and Environmental Standards Scotland) targeting government compliance rather than direct corporate regulation. Enforcement relies heavily on judicial intervention with landmark cases brought by NGO ClientEarth establishing NGO enforcement precedents that forced government plan revisions, while technical compliance operates through type-approval gatekeeping, market surveillance penalties up to £50,000, and potential criminal sanctions. Paradoxically, persistent ambient air quality failures coexist with national emission ceiling compliance.
US	The US operates a comprehensive federal system through the Clean Air Act with unique California waiver authority creating dual regulatory tracks that manufacturers must navigate, while enforcement combines substantial federal penalties with state implementation requirements backed by federal funding sanctions. Corporate risks centre on federal emissions violations with precedent-setting financial penalties and the strategic challenge of managing compliance across competing federal–California standards, where California's increasingly influential zero-emission mandates adopted by multiple states create market access implications despite ongoing federal–state legal tensions.
India	India's air pollution regulatory framework combines nationwide ambient standards (NAAQS 2009), vehicle-focused emission standards (Bharat Stage VI), and supporting programmes like the National Clean Air Programme (NCAP 2019) and Corporate Average Fuel Consumption (CAFC) norms (2017). Together, these instruments cover ambient air quality, fleet-average fuel efficiency and tailpipe emissions, supported by monitoring networks and judicial oversight. The system has delivered progress, particularly through BS-VI vehicle standards and city action plans, but enforcement remains uneven, with persistent non-compliance in major urban areas (especially $PM_{2.5}$ and PM_{10}), the absence of binding national emission ceilings, weak transparency on manufacturer compliance, and coordination gaps between agencies. Judicial intervention (notably by the Supreme Court and National Green Tribunal) has been critical in driving implementation where executive enforcement lags. Overall, India's framework is ambitious and multi-layered but continues to face significant challenges in translating policy intent into consistent, nationwide air quality improvements.

Appendix 1. (continued)

Jurisdiction	Summary
China	China has built a comprehensive regulatory framework for mobile-source air pollution, anchored in the Air Pollution Prevention and Control Law and the Environmental Protection Law, which empower national and local authorities to set binding ambient standards, issue centrally driven action plans, and enforce stringent vehicle and fuel rules. This framework is backed by one of the world's largest monitoring networks and public disclosure requirements, with enforcement carried out through type approval, inspections, in-use testing, penalties, and direct political accountability of local officials. The system has delivered dramatic reductions in $PM_{2.5}$ and other pollutants, but challenges remain in winter smog control, regional pollution transfer, uneven provincial capacity, and compliance risks such as tampering or data falsification. Compared with the EU or US, China relies less on economy-wide pollutant ceilings and litigation and more on top-down targets and administrative enforcement. For companies, this creates both regulatory certainty and reputational risk: strong national standards and aggressive timelines drive rapid fleet upgrading and technology adoption, but uneven enforcement and public scrutiny mean that compliance failures (for example, defeat devices, falsified data) can quickly escalate into legal sanctions, reputational damage, and potential market exclusion.
Thailand	Thailand's air pollution regulation is transitioning from fragmented, reactive measures to a more integrated and strategic framework. Ambient standards are improving, and transport controls are advancing through Euro standard adoption and fuel upgrades. However, enforcement remains uneven, especially outside urban centres, and systemic gaps in data, coordination and legal authority persist. The pending Clean Air Bill could be transformative, introducing rights-based enforcement and consolidating regulatory responsibilities. Until then, Thailand's approach remains aspirational, with progress dependent on stronger institutional capacity, cross-sectoral integration, and consistent implementation across regions and sectors.
Indonesia	Indonesia's air pollution regulation is evolving toward greater coherence, with updated ambient standards, vehicle emission controls, and sectoral planning instruments. However, enforcement remains uneven, and the absence of binding national emission ceilings weakens systemic accountability. The Jakarta litigation (see page 33) has spurred reform, but implementation gaps persist across regions and sectors. While the regulatory architecture is improving, progress depends on strengthening institutional capacity, enhancing data transparency, and integrating air quality goals with climate and transport policies.

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