Asian Transport Observatory

Beyond the Tailpipe:

Asia's Evolving Transport Emissions Challenge

An Asian Transport Observatory (ATO) Publication

Beyond the Tailpipe: Asia's Evolving Transport Emissions Challenge

March 2026

Contributors: Sudhir Gota, Alvin Mejia, Mel Eden, Adwait Limaye, Benjamin Soco, Aaron Salang

Cover page picture credits: Heal the planet

ATO (2026). Beyond the Tailpipe: Asia's Evolving Transport Emissions Challenge. https://asiantransportobservatory.org/analytical-outputs/beyond-the-tailpipe-asias-evolving-transport-emissions-challenge/

Asian Transport Observatory

Supported by: ADB ASIAN DEVELOPMENT BANK AIIB ASIAN INFRASTRUCTURE INVESTMENT BANK

Contents

List of Abbreviations

2W	Two Wheeler
ADB	Asian Development Bank
AIIB	Asian Infrastructure Investment Bank
ATO	Asian Transport Observatory
BC	Black Carbon
BEV	Battery Electric Vehicle
BRT	Bus Rapid Transit
CH_4	Methane
CNG	Compressed Natural Gas
EV	Electric Vehicle
GDP	Gross Domestic Product
HDV	Heavy Duty Vehicle
ICE	Internal Combustion Engine
ITS	Intelligent Transport Systems
LDV	Light Duty Vehicle
LNG	Liquefied Natural Gas
LRT	Light Rail Transit
NDC	Nationally Determined Contribution
NMVOC	Non-methane Volatile Organic Compound
NO_x	Nitrogen Oxides
OECD	Organisation for Economic Co-operation and Development
PM	Particulate Matter
$PM_{2.5}$	Particulate Matter with diameter of 2.5 micrometers or less
PM_{10}	Particulate Matter with diameter of 10 micrometers or less
PRC	People's Republic of China
SDG	Sustainable Development Goal
SMG	Seoul Metropolitan Government
SO_x	Sulfur Oxides
UN	United Nations
UNEP	United Nations Environment Programme
USD	United States Dollars
VOC	Volatile Organic Compound
WHO	World Health Organization

1. Introduction

Transport air pollution stands as one of the Asia-Pacific's most pressing and avoidable development challenges. In 2023, poor air quality claimed approximately 7.9 million lives globally, accounting for one in eight deaths. This burden is not shared equally. Nearly 95% of these fatalities occur in low- and middle-income nations, primarily within the densely populated hotspots of Asia.

Transport fuels this crisis by releasing harmful pollutants like particulate matter (PM), nitrogen oxides (NOx), and volatile organic compounds (VOCs), which cause respiratory diseases, heart problems, and cancer. In many Asian cities, aging vehicles and traffic congestion worsen these risks. The economic impact is immense: the World Bank estimates that health issues from ambient PM2.5 pollution cost the global economy up to 6.5% of GDP, with Asia bearing about 4.3 trillion USD—nearly 7.6% of its GDP—hindering economic growth.

Addressing transport emissions is critical to achieving the Sustainable Development Goals (SDGs). Clean air is fundamental to SDG 3 (Good Health and Well-being) and SDG 11 (Sustainable Cities and Communities). Furthermore, this report aligns with the UN Decade of Sustainable Transport. The Decade signals a global consensus: transport must shift from a driver of emissions and pollution to an engine of sustainable development. Asia-Pacific, as the world's most rapidly motorizing region, holds the power to set the trajectory for the entire planet.

What Does This Report Examine?

This report provides a comprehensive assessment of transport-related air pollution in Asia and the Pacific, with emphasis on the road and domestic shipping sectors. It examines the scale of the problem, the sources of pollution, the effectiveness of existing policies, and the barriers to accelerating change.

The analysis reveals both progress and dangerous gaps. Road transport emissions of significant pollutants have decoupled from economic growth in several Asian economies, particularly in high-income countries and in reformers such as the People's Republic of China. This decoupling shows that rapid motorization need not lead to rising air pollution. The adoption of stringent emission standards and fuel quality specifications has been the most effective policy instrument in the region. The speed of Asia's regulatory transformation is unprecedented.

Yet progress is incomplete and unevenly distributed. Outside major markets, smaller economies continue to operate on obsolete standards. The import of used internal combustion engine (ICE) vehicles from wealthier nations allows polluting technology to persist on Asian roads. Domestic shipping—now the fastest-growing source of transport air pollution—remains almost entirely unregulated. Public transport systems, despite massive investment, still fail to serve 1.4 billion urban residents in the region, pushing hundreds of millions toward private motorized transport.

Shot Ed

Most critically, knowledge gaps hinder effective policy-making. Data on domestic shipping is sparse. The gap between laboratory-measured emissions and real-world driving performance remains poorly understood. Source apportionment studies—the tools that determine pollution sources—use inconsistent methods, making it difficult to assess the role of transport in air quality accurately. Until these gaps are addressed, policies will be developed based on incomplete information.

How Is This Report Organized?

This report is structured to move from diagnosis to evidence to action. It first establishes the scale, severity, and concentration of the region's air pollution burden. It then examines transport's specific contribution, revealing that transport accounts for between 0.3% and 18.5% of ambient particulate matter across Asian cities—a wide variation reflecting differences in transport air pollution landscape and policy effectiveness.

The report then traces the sector's emissions trajectory, documenting mixed progress. It examines in detail the major domains of transport air pollution. For each domain, the report assesses existing trends and identifies policy examples. It highlights the regulatory innovations and leapfrogging opportunities that Asia has pioneered.

Finally, the report identifies the critical knowledge gaps that constrain policy design. It calls for urgent investments towards improved data collection, greater methodological transparency and consistency, and expanded real-world emissions monitoring.

The next decade is decisive. The vehicles manufactured today will run at least until 2040. The ports currently being built will shape maritime transport for several decades. The public transit systems under construction will determine whether Asian cities remain livable. The policy frameworks adopted in 2026 will persist long after current leaders have left office. Asia must act decisively now, not because the problem is new, but because the window for change is rapidly closing.

Asia must act decisively now, not because the problem is new, but because the **window for change is rapidly closing**.

2. The Air Pollution Burden is Severe and Concentrated

Air pollution remains a leading environmental risk factor for mortality worldwide, contributing to an estimated 7.9 million deaths in 2023 - roughly one in eight deaths (World Bank, 2025a). Air pollution is now the second leading cause of premature death globally, surpassed only by high blood pressure, and it ranks above tobacco use, diet-related risks, and high fasting plasma glucose.

However, this global impact is not evenly spread. It is primarily centered in developing Asian countries. Data show that 95% of all deaths from air pollution occur in low- and middle-income nations (World Bank, 2025b), with the most affected countries being densely populated Asian nations, which are the primary hotspots of this crisis. In 2019, premature deaths attributed to ambient and household particulate matter (PM2.5) were estimated at 4.7 million across the region (World Bank, 2022).

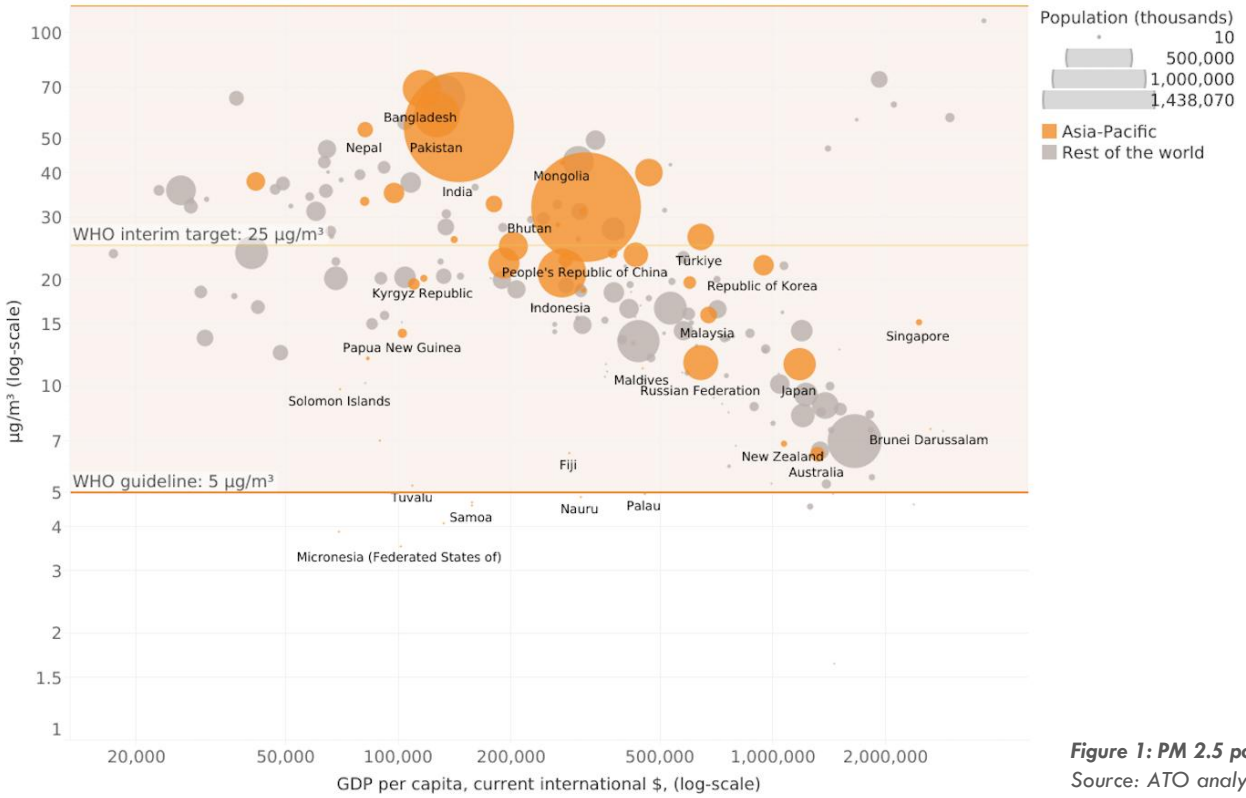


Figure 1: PM 2.5 population-weighted annual average exposure (2023)
Source: ATO analysis and visualization based on State of Global Air (2024)

In 2023, approximately 77% of Asia's population was exposed to PM2.5 levels exceeding 25 micrograms per cubic meter, a decrease from 82% in 2010. The whole region surpassed the 5 microgram per cubic meter guideline, except for some parts of the Pacific nations.

Transport sector fuels this crisis. Diesel vehicles alone account for 72% of the road transport disease burden associated with PM2.5 and ground-level ozone pollution in Asia and the Pacific (Anenberg et al., 2015).

The health burden of air pollution translates directly into a severe economic penalty. The World Bank estimates that the health impacts associated with exposure to ambient PM2.5 resulted in monetary losses equivalent to 4.7% to 6.5% of global GDP in 2020 (World Bank, 2025a). For rapidly developing Asian economies, this represents a significant drag on growth. The costs manifest in multiple ways: direct healthcare spending to treat pollution-related diseases, lost labour productivity due to illness and premature death, and the welfare losses associated with pain and suffering. Within the transport sector, Asia accounts for 70% of the global transport sector's financial penalties.

Asia's unique aspect in transport air pollution is the high concentration of health impacts. These effects are influenced not only by air quality or vehicle numbers but also by factors like population density, exposure levels, existing health conditions, and healthcare access. Poorer communities frequently reside near busy roads, with children working and playing in traffic-heavy areas. This geographic clustering of health risks makes transport-related air pollution in Asia a social justice and inequality issue, beyond just an environmental concern issue.

Air pollution remains a leading environmental risk factor for mortality worldwide, contributing to an estimated 7.9 million deaths in 2023 - **roughly one in eight deaths**

3. Transport is one of the Significant Sources of Air Pollution

Transport is a significant source of criteria air pollutants. Tailpipe emissions, tire and brake wear, and resuspended dust generate a complex mixture of pollutants like particulate matter (PM), nitrogen oxides (NOx), and volatile organic compounds (VOCs). These pollutants have severe health consequences, increasing the risk of respiratory and cardiovascular diseases, cancer, and adverse birth outcomes.

Historically, source apportionment studies estimating the contributions of different source categories to particulate matter (PM2.5 or PM10) have shown wide variation across locations, contexts, and methods. Recent data suggests that approximately 15% of global PM2.5 exposure is due to the transport sector (World Bank, 2025a), though this figure varies significantly by region.

In Asia, transport's contribution to ambient PM2.5 ranges widely. Cities with modern fleets, stringent standards, better public transit infrastructure, and well-maintained transport infrastructure show lower transport contributions. Cities with aging fleets, minimal standards, and congested road networks show higher shares. In Asia, the transport sector's share in ambient PM 2.5 ranges from 0.3% to 18.5%, with a median of 6.2% (State of Global Air, 2024).

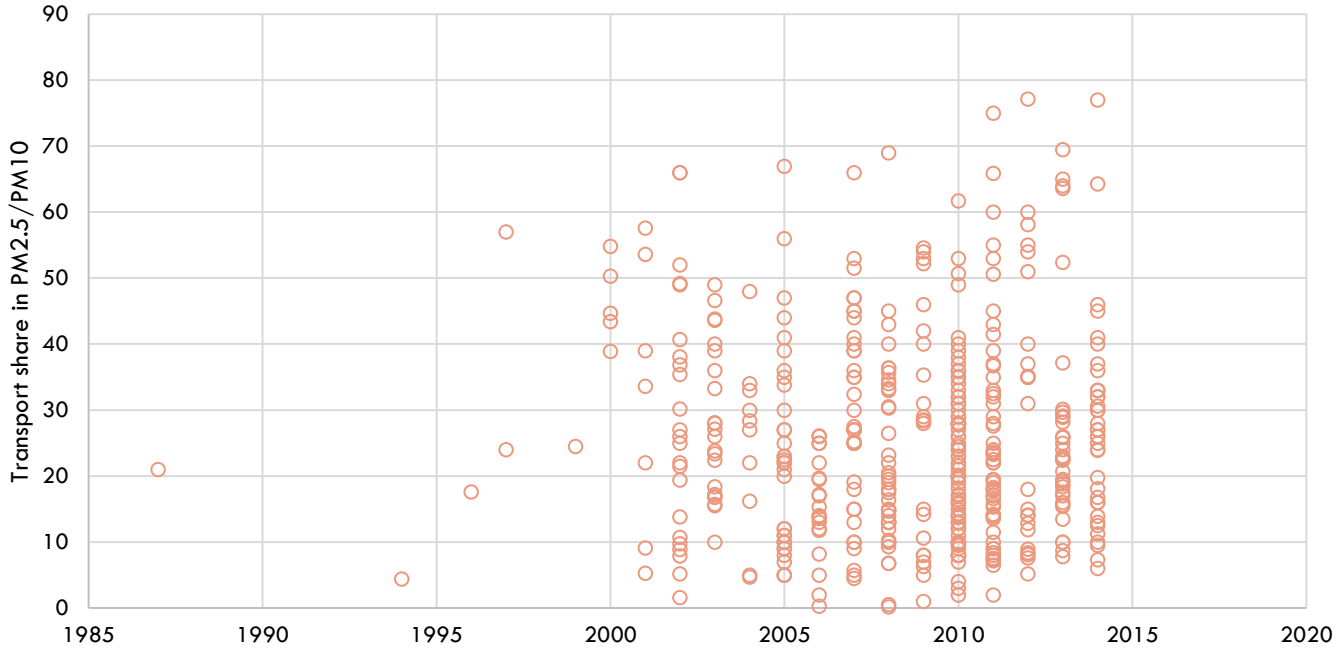
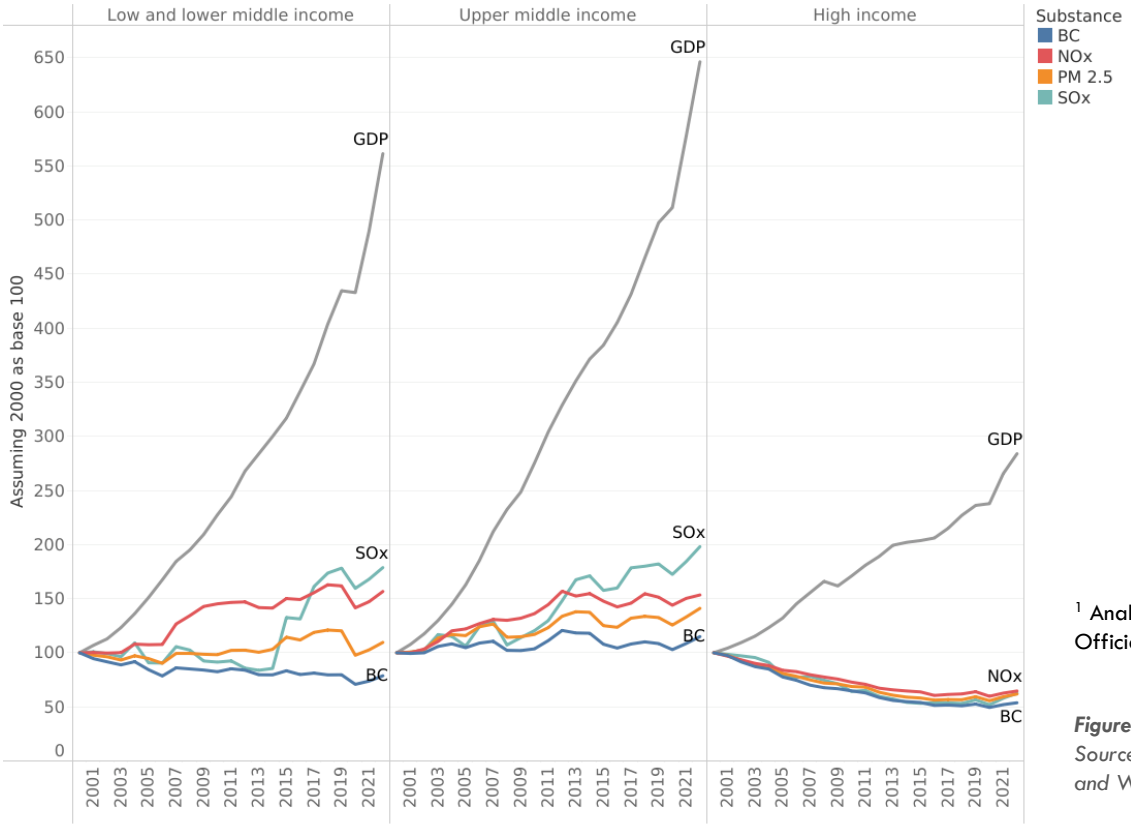


Figure 2: Transport share in ambient PM2.5/PM10 concentration
Source: ATO analysis and visualization based on WHO (n.d.-a) database on local source apportionment studies of particulate matter in the air

4. The Overall Emissions Trajectory: Mixed Progress at the Regional Scale

Analyzing the air pollutant emissions trajectory of the Asian transport sector involves navigating a complex landscape of conflicting trends. The traditional development model links economic growth with increased transport emissions: as economies expand, transport sector energy use and pollution rise.

Since 2000, the region has experienced rapid growth in GDP, infrastructure, and vehicle ownership—averaging annual increases of 7.5%, 2.2%, and 8%, respectively[1]. Yet, emissions of transport-related air pollutants have only modestly risen: 0.9% for PM2.5, 0.7% for NOX, and 1.8% for SOX, with Black Carbon decreasing by 0.5%. In high-income economies, data show that transport emissions of PM2.5, NOX, BC, and SOX have become relatively decoupled from economic growth. Conversely, in lower and upper middle-income economies, there is relative decoupling for PM2.5, NOX, and SOX, and absolute decoupling for BC with respect to economic growth.



[1] Analysis based on World Bank (2025c), Nirandjan, et al. (2022), IRJPro (2024), and Country Official Statistics

Figure 3: Air pollutant emissions decoupling with GDP
Source: ATO analysis and visualization based on European Commission et al. (2024) and World Bank (2025c)

Efforts in the transport sector to cut air pollutant emissions have fallen behind other sectors. In 2022, transport PM2.5 emissions in Asian economies were 8.1% higher than in 2015 on average, while other sectors reduced emissions by 12.7% over the same period (Crippa et al., 2023). This gap underscores the urgent need for faster actions to address transport air pollution.

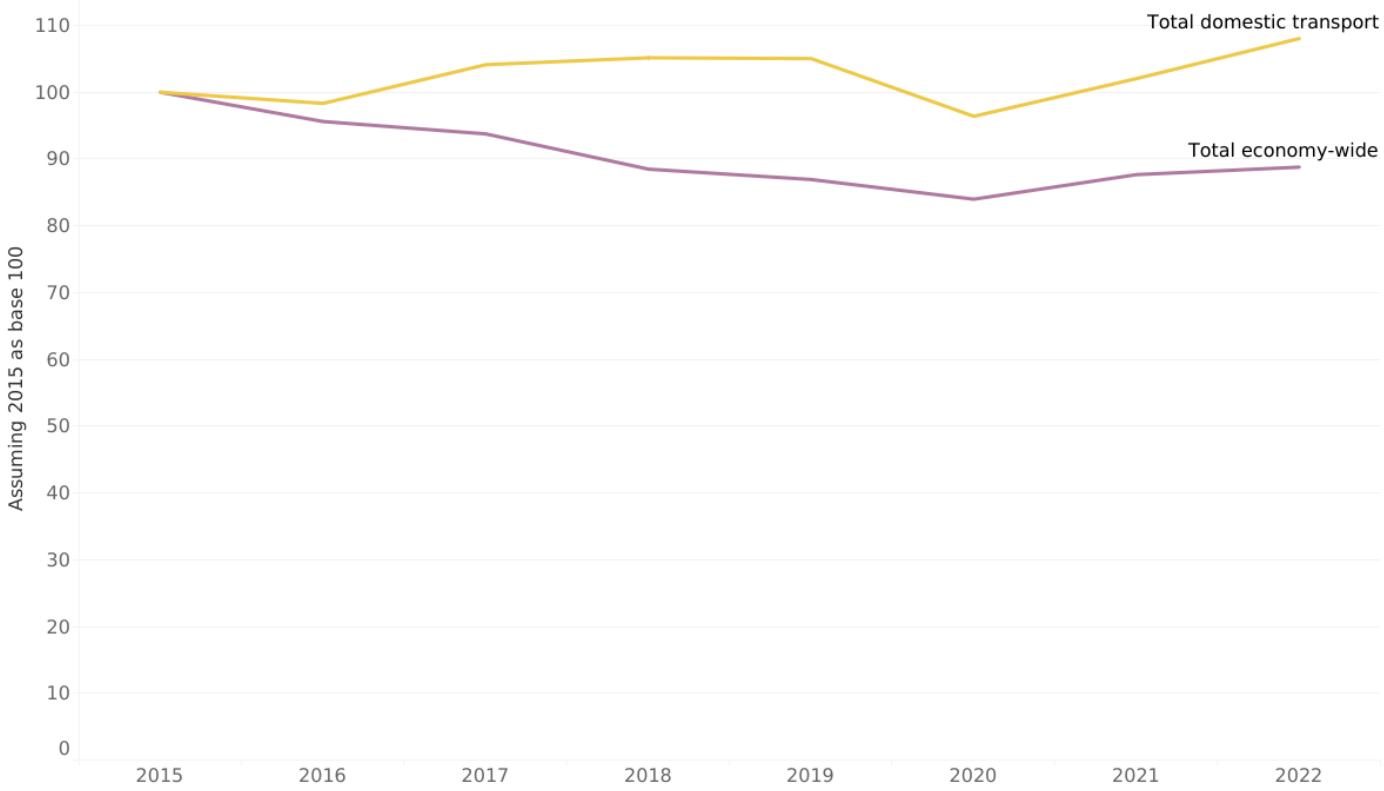


Figure 4: PM 2.5 emissions trend for domestic transport vs. all sectors – Asia (2015 =100)
Source: ATO analysis and visualization based on European Commission et al. (2024)

In lower and upper middle-income economies, there is **relative decoupling** for PM2.5, NOX, and SOX, and **absolute decoupling** for BC transport emissions with respect to economic growth.

5. Road Transport: The Success Story with Limits

Road transport has delivered the most visible progress. Based on the European Commission's estimates (2024), between 2010 and 2022, road transport emissions of nitrogen oxides (NOx) dropped by 0.4%, sulfur oxides (SOx) by 0.6%, and Black Carbon (BC) by 2.5% annually across Asia and the Pacific. During the same period, methane (CH4) and non-methane volatile organic compounds (NMVOCs) slightly increased by 0.7% and 0.1%, respectively. This occurred despite the road sector's vehicle fleet expanding by approximately 8% per year[2].

During the same period, road transport emissions (exhaust and non-exhaust) of particulate matter with diameters of 10µm (PM10) and 2.5µm (PM2.5) or less declined by 0.1% and 0.8% per year, respectively. Although both PM10 and PM2.5 saw significant reductions, the proportion of non-exhaust emissions—such as from brake and tyre wear or road abrasion—is rising in percentage terms. In 2022, these accounted for 52.6% and 37.9% of road transport PM10 and PM2.5 emissions.

The share of road transport in Asia's total transport emissions has decreased across all major pollutants. For instance, the road sector's contribution to transport PM 2.5 emissions dropped from 44% in 2010 to 35% in 2022; NOx emissions decreased from 79% to 72%; and SOx emissions saw further decrease from 4% to 2% during the same periods. This decline is remarkable given the context: Asia added approximately one billion vehicles to its fleet and over 9 million kilometers of road infrastructure since 2000.

The aggregate regional data masks significant inequality in progress. Asia can be divided into distinct tiers based on their income and emissions trajectories:

- High-Income Economies: Countries such as Japan, South Korea, and Singapore have shown consistent declines in transport-related air pollutant emissions since 2000. These nations have effectively decoupled transport growth from pollution by adopting advanced standards early and developing mature public transport systems.
- Upper-Middle-Income Economies: Nations like the People's Republic of China, Indonesia, and Thailand saw significant slowdowns in emission growth after 2000, with notable absolute reductions occurring after 2010. Some of these countries are currently in the most aggressive phase of pollution control, rapidly tightening standards to catch up with the West.
- Lower- and Middle-Income Economies: In many developing nations of South and Southeast Asia, the picture is mixed. The sheer rate of fleet growth in these countries often threatens to overwhelm the gains made per vehicle.


Oat Appleseed

[2] Analysis based on Country Official Statistics

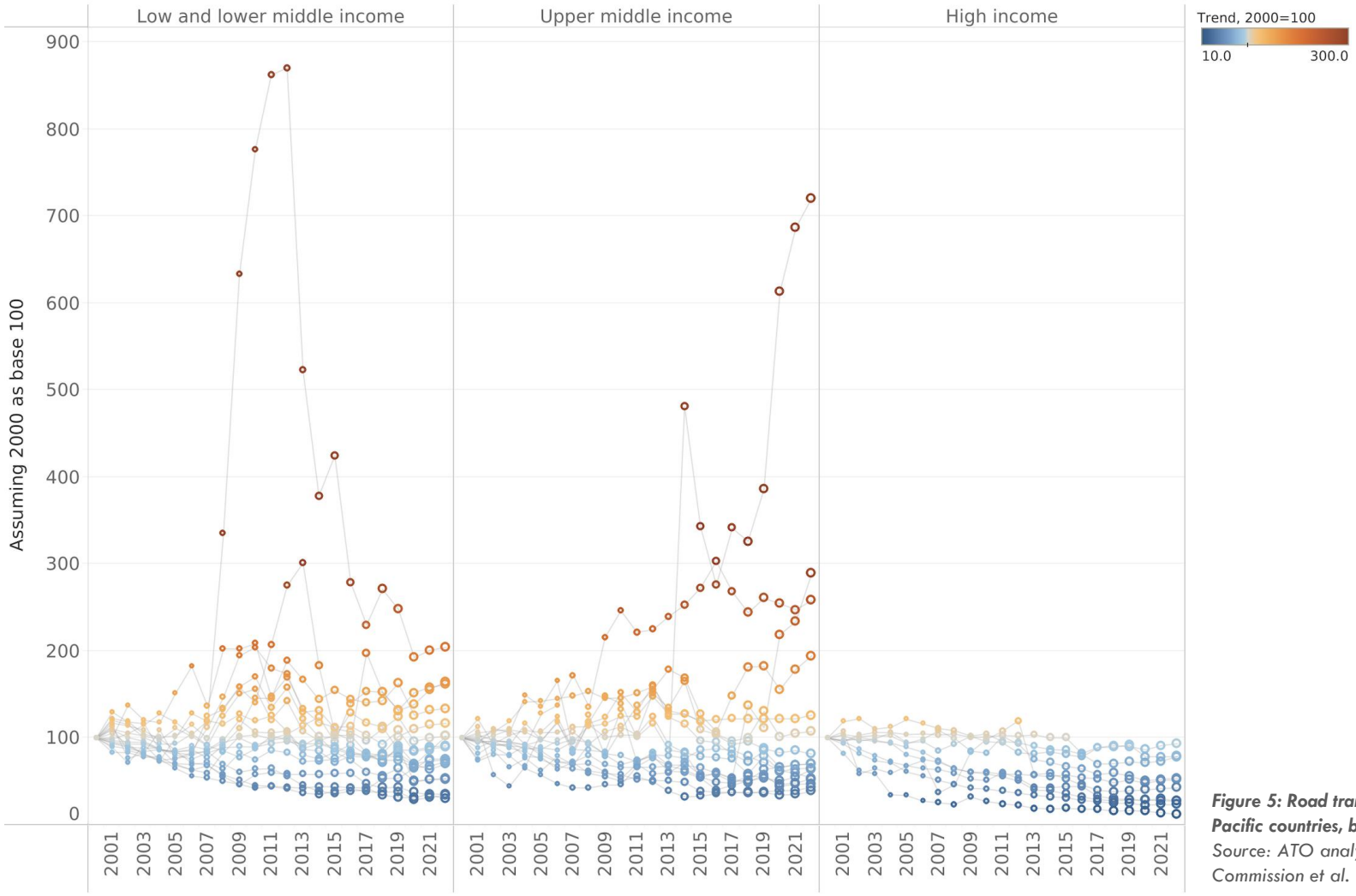


Figure 5: Road transport PM 2.5 exhaust emissions trend in Asia-Pacific countries, by income level (2000-2022)
Source: ATO analysis and visualization based on European Commission et al. (2024)

Proportion of **non-exhaust emissions**—such as from brake and tyre wear or road abrasion—is **rising in percentage terms**

6. The Importance of Heavy-Duty Vehicles

Diesel-powered heavy-duty vehicles— particularly trucks and buses— are the dominant source of harmful air pollution from road transport in Asia and the Pacific. Diesel exhaust is a complex, potent mixture of pollutants. It is classified as a known human carcinogen linked to respiratory, cardiovascular, and other chronic health impacts (WHO, 2012).

Although they are estimated to account for only 7% of all vehicle registrations in the region, they are responsible for a disproportionately large share of emissions, producing about 57% of PM2.5 and 64% of NO_x emissions. The public health risk is especially pronounced in the region's urban areas, where diesel vehicles operate in high-density, congested streets. This proximity amplifies the exposure—the proportion of emissions inhaled by people living and working nearby. Diesel vehicles alone account for 72% of the estimated burden of disease attributable to road transport PM2.5 and ground-level ozone pollution in Asia and the Pacific (Anenberg et al., 2019).

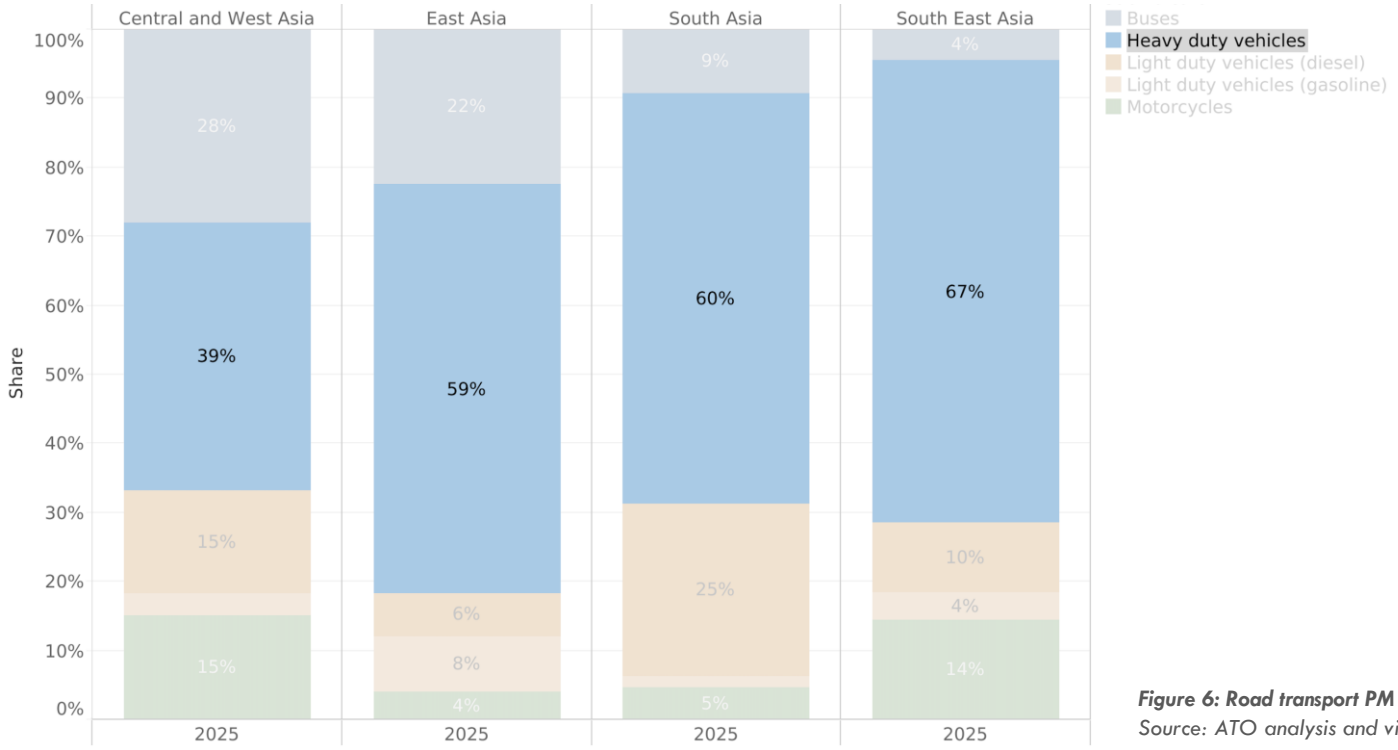


Figure 6: Road transport PM 2.5 emissions, share by vehicle type
Source: ATO analysis and visualization based on IIASA (2025)

Occupational exposure adds another layer of complexity. Professional drivers, mechanics, and workers in the freight and mining industries are exposed to prolonged diesel exhaust (IHME, 2023). Evidence from multiple countries shows this exposure is rising. It underscores the urgency of accelerating cleaner vehicle standards and fleet renewal.

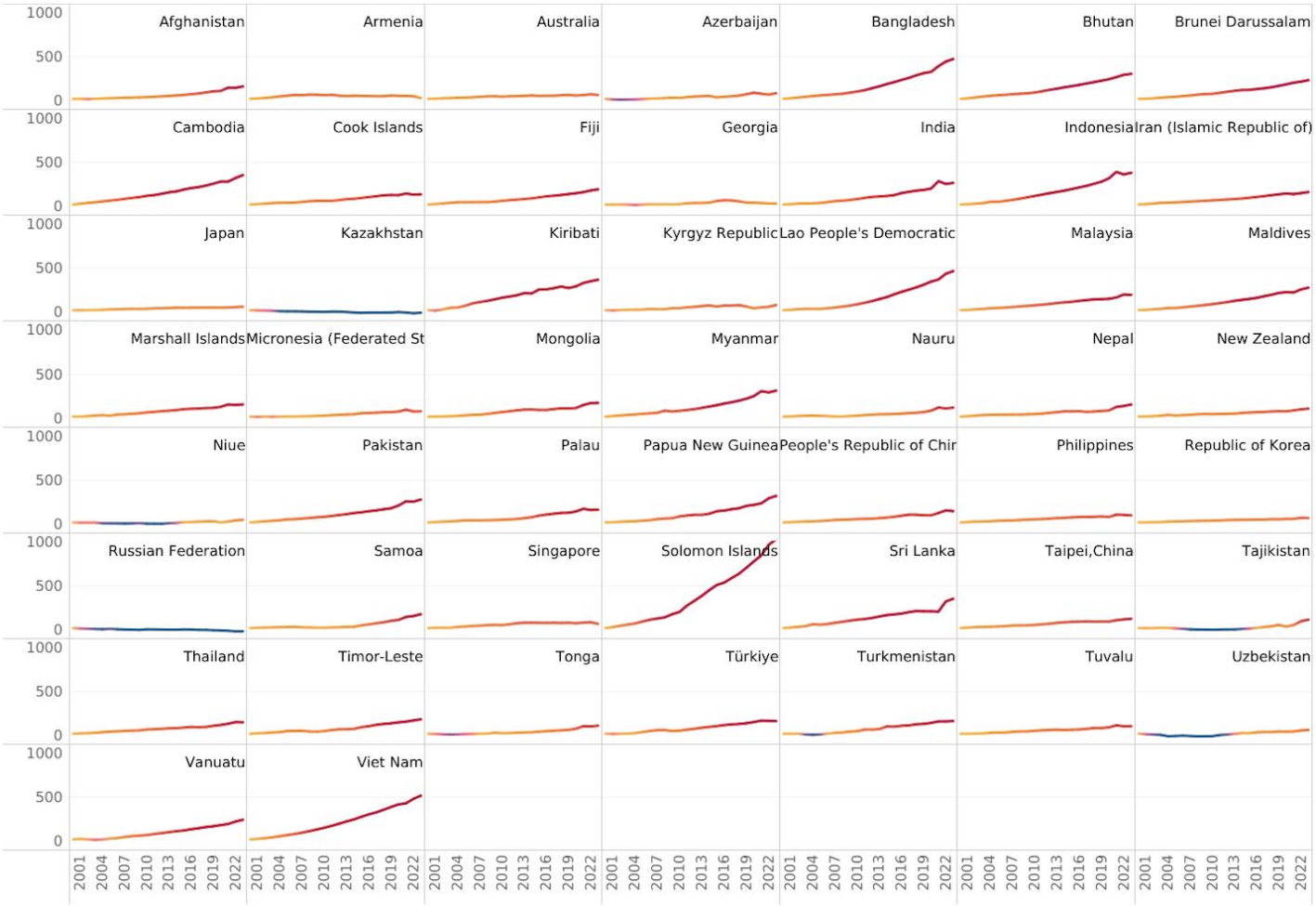
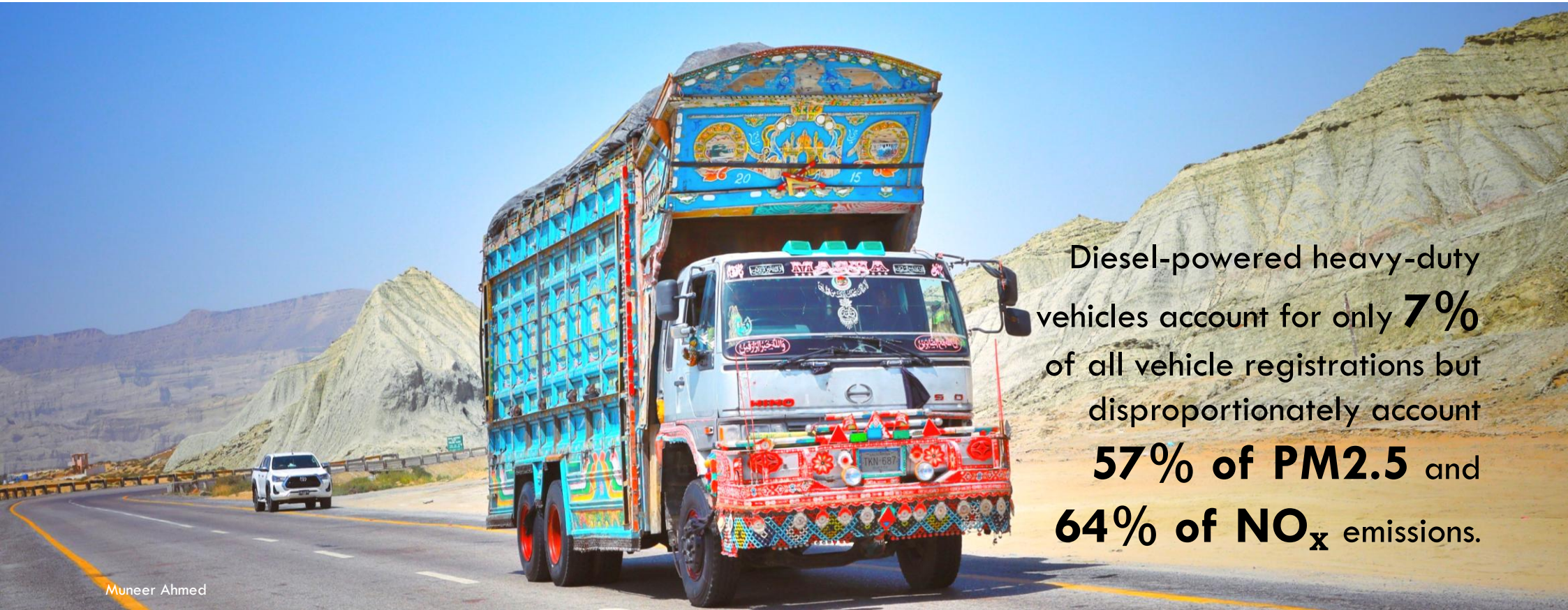


Figure 7: Deaths due to occupational exposure to diesel engine exhaust (trend) (assuming 2000 as base 100)
Source: ATO analysis and visualization based on IHME (2025)

Many Asian economies are strengthening policies and targets to reduce air pollutant emissions from heavy-duty vehicles (HDVs). Armenia is focusing on renewing and upgrading its bus fleet, with its Long-term Low Emissions Development Strategy aiming for a gradual shift to electric, gas, biofuel, and hydrogen-powered vehicles. Fiji is tackling HDV emissions through age restrictions on used vehicles, combined with mandatory Euro 5/V fuel-efficiency and carbon standards, as outlined in its NDC Investment Plan. Bhutan aims to achieve 20% market share for electric freight trucks by 2030, according to its Energy Transition Pathways for SDG 7 roadmap. Pakistan has set a more aggressive target in its First Biennial Update Report, aiming to have 90% of heavy-duty trucks be electric by 2040. Bangladesh plans to introduce hydrogen-powered heavy-duty trucks under the Mujib Climate Prosperity Plan 2022-2041. The People's Republic of China is also moving quickly, with the Action Plan for Energy Conservation and Carbon Reduction 2024-2025 promoting the electrification of public-sector vehicles and the development of zero-emission freight fleets. Azerbaijan intends to have all passenger buses in Baku equipped with electric or CNG motors by 2025, as stated in their Updated NDC. Cambodia supports this transition by reducing special duties on trucks and electric trucks, as detailed in their Truck Modernization Strategic Plan.



Muneer Ahmed

7. Vehicle Emission, and Fuel Quality Standards: Instruments of Change

The adoption of vehicle emission standards, together with corresponding fuel quality standards, has been the most effective policy instrument in Asia's battle against transport pollution. Such regulations have driven rapid technological evolution across the region's vehicle fleet and the quality of automotive fuel supply. The speed at which some Asian economies have adopted these standards is unprecedented.

By January 2025 (UNEP, 2025), 20 Asian countries had set national standards for sulfur levels at 50 ppm or less for both diesel and petrol. Also, 16 countries had fully adopted Euro 4/IV or higher vehicle emission standards. Meanwhile, 13 countries are working on implementing or adopting low sulfur fuel standards, and 14 countries have not yet fully adopted Euro 4/IV or higher vehicle emission standards for new vehicles. The shifts have been in major automotive markets. In 2010, only 9% of the Asian vehicle fleet was getting registered in countries adhering to Euro 4/IV or better standards. By 2025, this figure had increased to nearly 99%. This massive expansion of regulatory coverage means that most new vehicles entering Asian markets today are, in theory, several magnitudes cleaner than the average vehicle on the road a decade ago. Our analysis indicates that, despite improvements, implementing better vehicle emission standards with fuel quality remains imperfect in several Asian jurisdictions. We observe "tiered" market structure across the region:

- Advanced Adopters (Euro 6/VI equivalent): People's Republic of China (China 6/VI), India (Bharat Stage 6/VI), Singapore, and South Korea have leapfrogged to the highest global standards. India's transition from BS-4/IV directly to BS-6/VI, skipping stage 5/V, represents one of the most aggressive regulatory leaps in automotive history.
- Middle Tier (Euro 4/5, Euro IV/V): Many ASEAN nations, including Thailand, Indonesia, and Viet Nam, are currently implementing Euro 4/IV or Euro 5/V standards. Malaysia, for instance, has targeted Euro 5/V for petrol and diesel vehicles by 2026.
- Lagging Adopters: Some smaller economies continue to operate on older standards (Euro 2/3, Euro II/III), creating pockets of high emissions and complicating regional vehicle trade.

A vehicle produced today will most likely remain on Asian roads through 2040. Further, air pollutant emissions do not drop immediately when a new standard is legislated. The benefit is realized only as the fleet turns over—as old vehicles are retired and replaced by compliant ones. In many Asian countries with low motorisation, vehicles are assets that are kept in service for decades. Therefore, the full air quality benefit of the vehicle emission standards and fuel quality improvements adopted today may not be fully visible in ambient air quality data for a decade or so. This delay highlights the need for supplementary policies to accelerate the retirement of high-emission vehicles.

There are opportunities for leapfrogging. For example, Pakistan is trying to improve its regulatory framework. The National Clean Air Plan mandated a complete shift to Euro 5/V standards by 2025. It further targets Euro 6/ VI compliance by 2030. However, progress has been limited. To leapfrog, the government is identifying incentives for refineries to transition toward Euro 6/VI-compliant fuels. Fiji is taking a similar path. The NDC Investment Plan specifies that age limits for imported used vehicles must be combined with Euro 5/V or equivalent standards. This dual approach prevents the dumping of obsolete technology. The Clean Air Plan of Cambodia targets sulfur levels that meet Euro 5/V specifications. It also requires 80% of fuel stations to comply with EU standards. By 2027, all imported cars must meet Euro 5/V requirements. The Cambodia Truck Modernization Strategic Plan notes that Euro 4/IV was already introduced for passenger cars in 2022. Azerbaijan is trying to use fiscal levers to force fleet renewal. The Updated Nationally Determined Contribution recommends increased excise coefficients for gasoline and diesel cars older than seven years. Since 2023, the import of cars older than ten years has been restricted. The People's Republic of China is also scrapping old technology vehicles. The Guiding Opinions on Promoting the Integrated Development of Transportation and Energy policy promotes the elimination of vehicles meeting National IV and below standards.

Adoption of vehicle emission standards, together with corresponding fuel quality standards, has been the **most effective policy instrument** in Asia’s battle against transport pollution

8. Dumping of Used Vehicles

The Asia and the Pacific region holds a significant position in the global used-vehicle market, although its import share remains modest relative to Africa and Eastern Europe. Between 2015 and 2022, the four major global exporters—Japan, the European Union, the United States, and the Republic of Korea —shipped at least 23 million used LDVs to low- and middle-income countries. Asia-Pacific accounted for 16% of this volume, or approximately 3.7 million vehicles.

Asia-Pacific economies have shown varying levels of progress in dealing with used vehicles. While Asian nations have generally moved faster than African countries to set age limits, a large Asian market means that even stricter trade standards still result in millions of used vehicles remaining operational for many years. By December 2025, 47% of Asian economies had either banned or adopted "good", and “strong” policies on used light-duty and heavy-duty vehicle imports, according to an update of UNEP data. In December 2023, those figures were 50%, indicating stagnation in used-vehicle import regulations (UNEP, 2024).

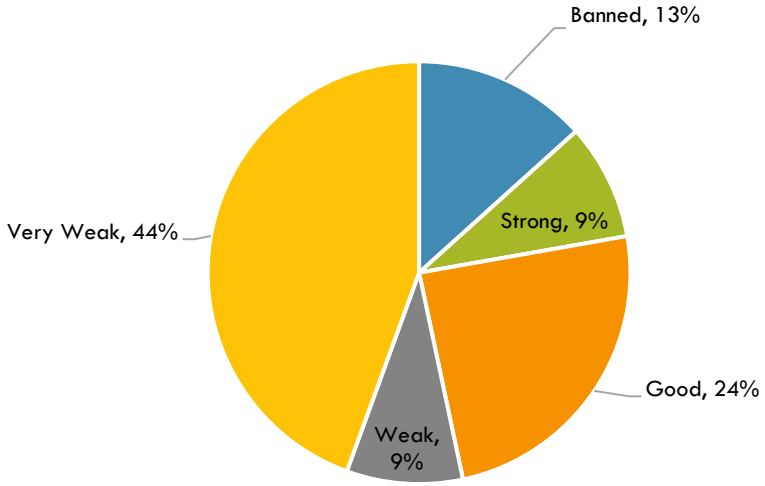


Figure 8: Used Vehicle Regulations-2025, 45 Economies
Source: UNEP (2024)

While standards may be adapted, enforcement remains a key issue. Countries with formally adopted standards for the import of used vehicles frequently lack the enforcement capacity, inspection infrastructure, and information systems necessary to verify compliance. The absence of mandatory, harmonised pre-import inspection protocols allows non-roadworthy vehicles to enter circulation. Lack of data availability adds complexity: many Asian countries do not routinely publish disaggregated import statistics, obscuring the true composition of imported fleets and limiting the ability to base policy adjustments on evidence.

The emergence of used EV imports introduces new opportunities and risks. Beyond providing more affordable access to electric vehicle options, used electric vehicle imports can accelerate fleet electrification in markets where the introduction of EVs remains constrained by high upfront costs, limited model availability, and slow domestic manufacturing transitions. By lowering barriers to entry, used BEVs can help build early demand for charging infrastructure, maintenance services, and grid integration, creating positive feedback effects for the broader electric mobility ecosystem. Used BEV imports also offer a faster pathway towards reducing on-road emissions in urban areas with severe air quality challenges. When paired with minimum battery health standards and clear end-of-life management rules, these vehicles can extend the productive life of existing assets while avoiding the emissions associated with manufacturing new vehicles.

Between 2017 and 2022, the European Union, Japan, and South Korea exported about 105,273 used electric vehicles globally. Asia-Pacific received 25,299 units—approximately 24% of the total (UNEP, 2024). Purchasing used electric vehicles offers lower-income consumers in Asia an affordable pathway to low-emission transport. However, realizing this benefit requires deliberate policy coordination between exporting and importing nations to ensure that importing nations do not become dumping grounds for defective batteries or inferior technologies. There is a significant risk that technology transfer could become technology dumping.

Many countries are trying to implement policies for regulating the import of used vehicles. For example, since 2023, Azerbaijan has proposed restricting the import of passenger cars older than 10 years. This measure, detailed in the Updated Nationally Determined Contribution, aims to rapidly modernize the national fleet. Fiji is proposing a dual approach. They combine age limits for imported used vehicles with mandatory Euro 5/V fuel-efficiency and carbon-emission standards. These regulations are central to their NDC Investment Plan. Cambodia aims even higher, targeting a 30% reduction in total used car imports by 2030 under the Clean Air Plan of Cambodia.

By December 2025, **47% of Asian economies** had either banned or adopted "good", and “strong” policies on used light-duty and heavy-duty vehicle imports

9. Two Sides of the E-mobility Transition: Vehicles and Grids

Asia is leading the global electric vehicle race, particularly in the two- and three-wheeler markets. Approximately 82% of the global electric vehicle (EV) stock is located in Asia. Roughly 94% of all EVs sold in the region are electric two-wheelers and three-wheelers. Since the implementation of the Sustainable Development Goals and the Paris Agreement, the share of electric vehicles in the Asian vehicle trade has increased from 4.4% in 2019 to 16.6% in 2024. This "leapfrogging" is driven by policies, economics, and urban utility. Yet, the air quality benefits are only partially captured due to the electricity grid's composition. The analysis of Asian railway electrification serves as a warning. While railway track electrification has increased from 42% in 2010 to 66% in 2024 in Asia, reductions in air pollutant emissions have been muted because the electricity grids in countries with high-density railways remain coal-intensive. Historically, between 2000 and 2015, the grid in Asia actually became more carbon-intensive. However, a tipping point was reached around 2015, and grid intensity has since begun to decarbonize at an annual rate of -1.4%.

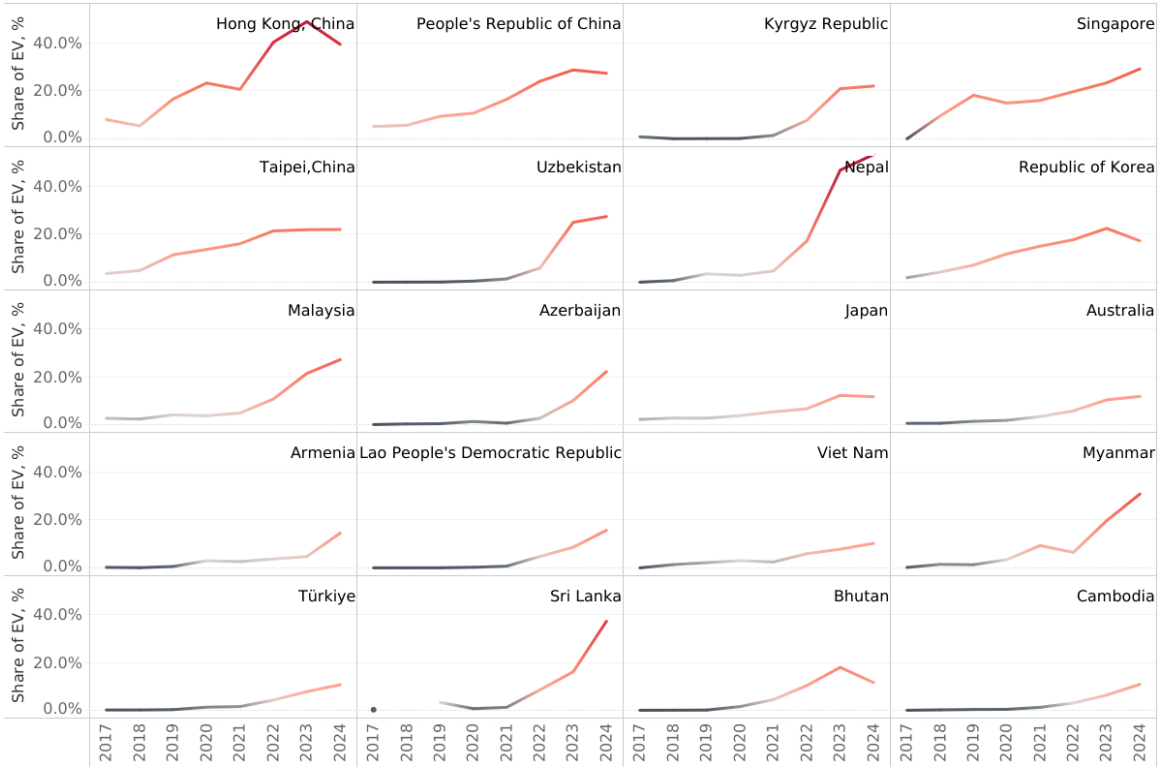


Figure 9: Asia-Pacific economies with at least 10% share of electric vehicles in road vehicle trade (import and export)
Source: ATO analysis and visualization based on Trademap (2025)

Asian countries are actively promoting the switch to electric transport with various policies. People's Republic of China leads with bold goals, aiming for at least 80% of new or upgraded public transport and logistics vehicles in key areas to be electric, supported by the "Green Transportation '14th Five-Year' Development Plan." Pakistan has an "Electric Vehicle Policy" targeting 30% market share for passenger cars and 90% for heavy trucks by 2030 and 2040, respectively. Brunei Darussalam plans for 60% of total annual vehicle sales to be electric by 2035. Malaysia is developing an EV ecosystem to capture 38% of the market by 2040, as part of its National Energy Policy 2022-2040. In Nepal, the "National Implementation Plan for Climate Change Mitigation and Adaptation (2080-2087)" aims to have electric vehicles account for 25% of all domestic passenger car sales by 2025. Smaller nations are also taking steps; Nauru is testing its first electric bus for public transit in early 2024 under the "Nauru Integrated Infrastructure Strategic Plan, 2024". These strategies reflect a regional dedication to cleaner mobility through incentives and regulations.

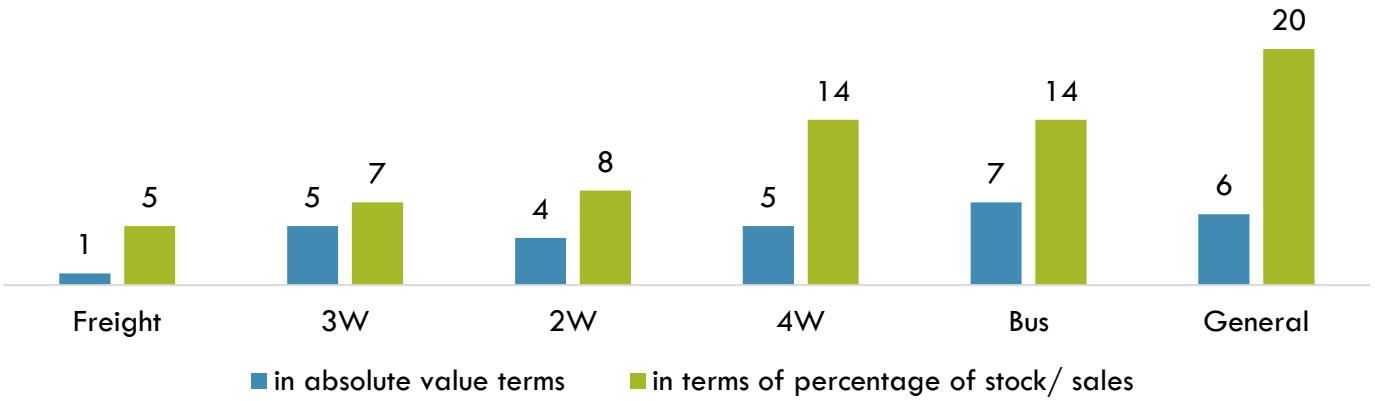


Figure 10: Count of countries (out of 43) with EV Targets disaggregated by sub-modes
Source: Asian Transport Observatory (2025)

Approximately **82% of the global electric vehicle (EV) stock** is located in Asia.

10. Importance of Non-Exhaust Road Transport Emissions

Road traffic contributes to air pollution through two main pathways- exhaust/tailpipe and non-exhaust. Most attention is on tailpipe emissions. However, non-exhaust emissions are an increasingly significant source of pollution. These arise from the wear of brakes, tires, and road dust re-suspension caused by moving vehicles. Non-exhaust particles now significantly contribute to traffic-related pollution. In 1970, they accounted for only 7% of PM 2.5 emissions from transport in Asia. By 2022, that share rose to 13%. Moreover, by 2022, non-exhaust emissions comprised 38% of PM 2.5 and 53% of PM10 emissions in Asia's road sector. This trend could continue. As ICE-vehicle emission standards get more stringent, coupled with increasing electric vehicles penetration, the relative importance of non-exhaust emissions from road transport will increase. Battery electric vehicles only solve the tailpipe exhaust problem. Moreover, in some cases, BEVs can be heavier than their ICE counterparts, which can lead to increase tire and road wear (Haghani et al., 2024). Policy makers must look beyond the tailpipe and consider vehicle weight, tire composition, and urban dust management which are the emerging policy priorities.

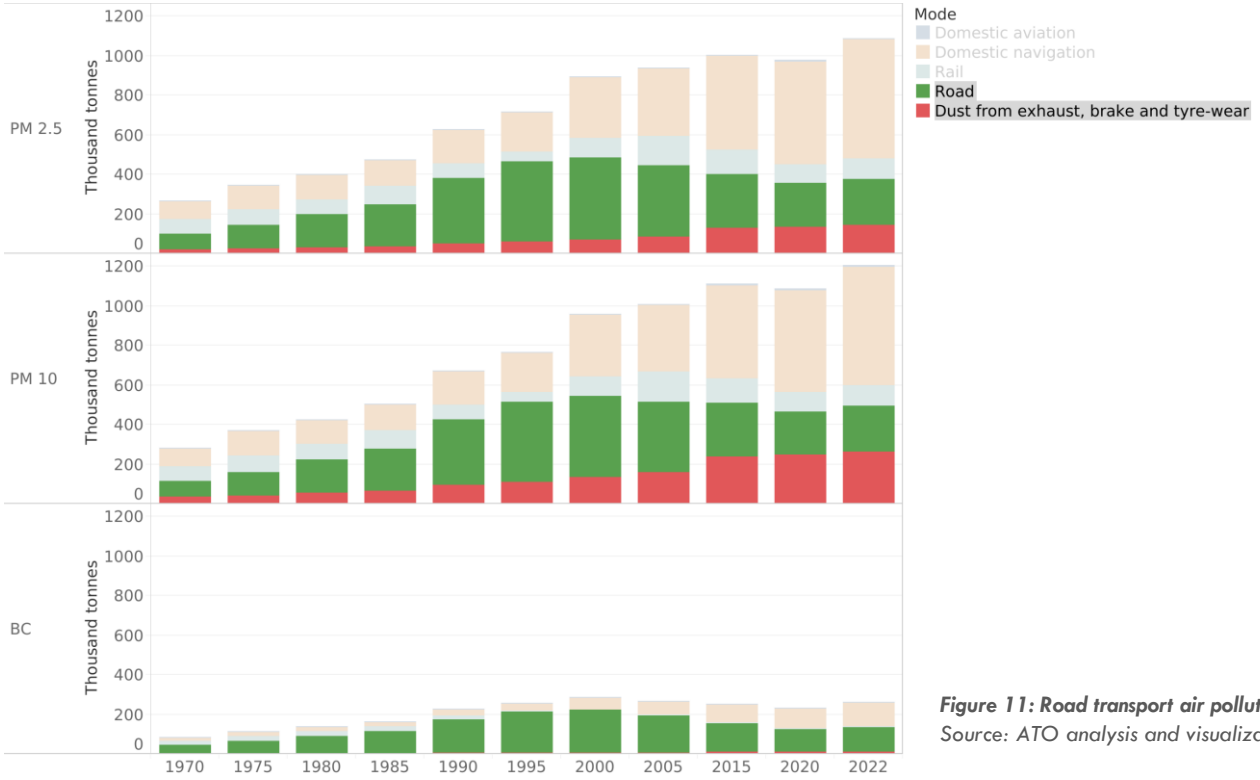


Figure 11: Road transport air pollutant emissions
Source: ATO analysis and visualization based on European Commission et al. (2024)

The increasing importance of non-exhaust emissions from road transport is already being recognized in Europe, as it introduces Euro 7/VII emission standards this year, which includes limits for non-exhaust emissions such as tire abrasion, and brake particle emissions across all motor vehicle categories (EU, 2026). No similar standards have been adopted in the Asian region. Most of the non-exhaust-related measures are focused on suppressing dust resuspension on roads in general, such as street sweeping, washing, and the use of dust-suppression vehicles (with mist systems), such as the one being done in various cities in India, which has also issued relevant guidelines under the National Clean Air Program (TOI, 2025). The Seoul Metropolitan Government (SMG) has put road dust high on its agenda since the mid 2000s, particularly as road dust was found to constitute a significant amount of ultrafine PM particles. SMG provided washing equipment (SS, 2016), and have integrated utilizing dust absorbing trucks (SMG, 2017).

By 2022, non-exhaust emissions comprised **38% of PM 2.5 and 53% of PM10** emissions in Asia's road sector

11. Public Transport in Crisis?

Public transport remains one of the most effective tools for decoupling economic growth from rising passenger transport-related air pollutant emissions. While the region has seen massive infrastructure expansion, a significant gap remains between current capacity and the urgent needs of the Paris Agreement and the 2030 Sustainable Development Goals.

Asia faces a public transit crisis. Currently, about 1.4 billion urban residents in Asia and the Pacific lack convenient access to public transport (ATO, 2025). "Convenient access" is defined as living within 500 meters of a bus stop or 1,000 meters of a rail station with frequent service. Currently, only 17% of the 3,133 urban centers in the region provide this access to at least half of their population. This deficit erodes the public transport mode share.

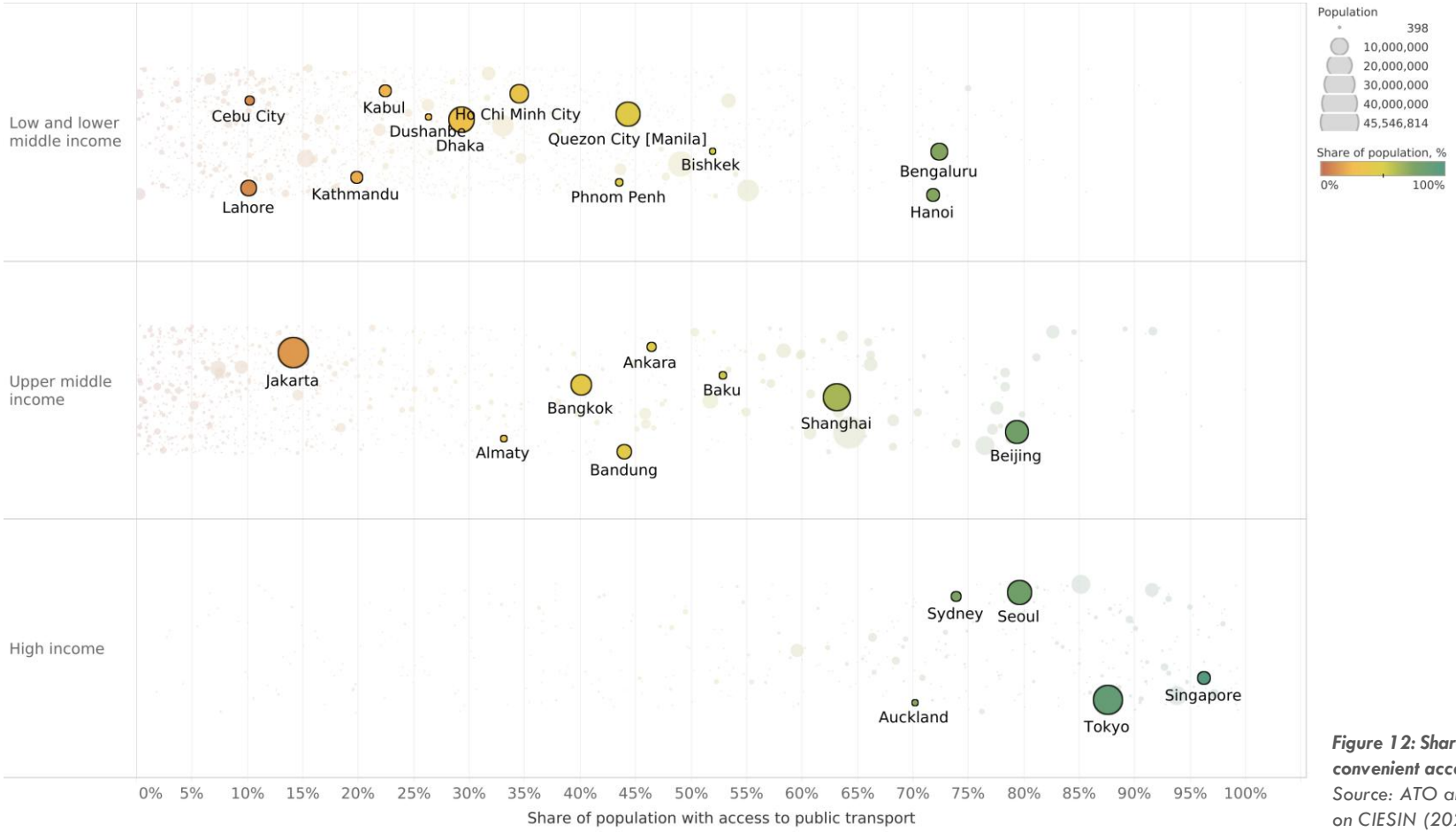


Figure 12: Share of population with convenient access to public transport
Source: ATO analysis and visualization based on CIESIN (2023)

A compilation of estimated mode share data across 110 Asian cities from 2018 to 2023 reveals a clear shift towards private motorized travel (Google, 2025). The data indicates increasing popularity of motorcycles, with about 75% of the sample cities (91) showing growth in motorcycle usage. Specifically, 25 cities experienced over a 10% rise in motorcycle mode share, predominantly in Asian regions. Car usage grew in approximately 40% of the cities (107), with some cities seeing a decrease in car use even as motorcycle adoption increased. Meanwhile, walking and cycling declined in roughly 90% (102) of the cities, with 23 cities experiencing more than a 5% drop, reflecting a move away from active transportation modes toward motorcycles and cars. Public transport remained relatively stable, with 39 cities observing a slight increase (under 5%), while 65 cities experienced declines. Only six cities—Almaty, Dhaka, Nur-Sultan, Peshawar, Tbilisi, and Ulaanbaatar—noted increases over 5% (Google, 2025).

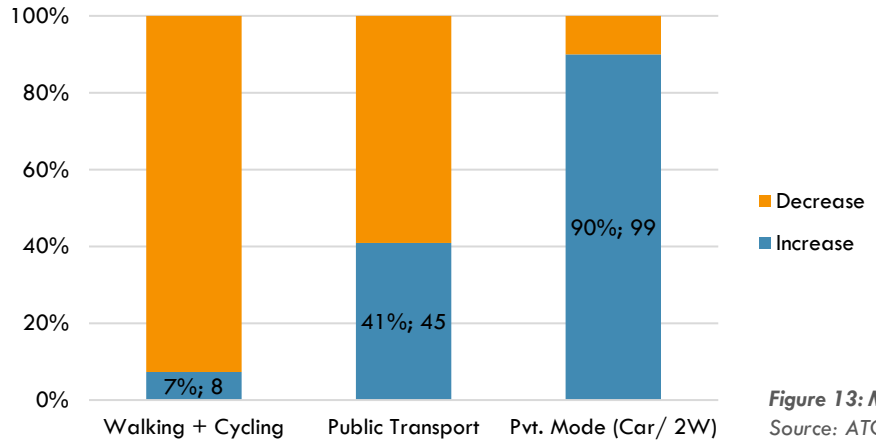


Figure 13: Mode share trend in cities
Source: ATO analysis and visualization based on Google (2025)

Asia leads the world in transit expansion. Since 2010, the region has accounted for 72% of all new rapid transit infrastructure globally, including Metro, Light Rail (LRT), and Bus Rapid Transit (BRT) systems. Cities are rapidly building high-quality transit lines to improve urban access. In 2015, 118 cities in Asia and the Pacific had a total rapid transit length of about 10,000 kilometres. By 2021, due to massive rapid transit investments in the region, about 154 cities had a total network size of 17,000 kilometres (ITDP, n.d.).

Yet this growth must be viewed in context. Asia and the Pacific has nearly 3,300 urban centres with populations exceeding 100,000. Even with rapid expansion, high-capacity transit systems in the region currently serve only a small share of these urban centers. As a result, the majority of urban residents continue to rely on private vehicles, informal transport, or low-capacity bus services. The mismatch between transit provision and urban growth remains a central challenge, reinforcing the perception of a public transport system under strain rather than one that has reached maturity.

The Transport Enthusiast DC

Heavy railway expansion in the region shows a similar pattern. Approximately two-thirds of global railway route growth occurred within the Asia-Pacific during this period. The network expanded by 234,000 kilometers between 2000 and 2023. Construction rates more than doubled after 2010, reflecting a strategic shift toward lower-emission transport modes; however, the region still lags OECD economies in rail provision, measured for example in kilometers per million people.

Asian economies are taking steps at varying speeds and ambition levels to transform public transit. Azerbaijan plans to upgrade its public transport by requiring all passenger buses in Baku to have electric or compressed natural gas motors by 2025, as specified in its Updated Nationally Determined Contribution. Georgia is addressing urban congestion and air pollution by expanding the Tbilisi metro and optimizing bus networks, as outlined in its Fourth National Communication. Armenia seeks to modernize its bus fleet with hydrogen and electric vehicles through its low-emission development strategy. Pakistan is developing a zero-emission BRT system in Karachi, detailed in its First Biennial Update Report. Nepal is drafting legislation to unify individual operators under a single Mass-Transport Authority to improve service reliability. People's Republic of China's 14th Five-Year Plan aims for 72% of urban buses to be new energy vehicles and the integration of railway, bus, and slow travel networks for better connectivity. Cambodia's Clean Air Plan links route optimization to reducing air pollution. Fiji is deploying Intelligent Transport Systems (ITS) to enhance bus reliability and minimize idling, supported by its NDC Investment Plan. Malaysia targets a 50% modal share for urban public transport by 2040, per its National Energy Policy 2022-2040. Bhutan aims for 50% electric buses and mini-buses by 2030 under its SDG 7 roadmap, speeding up its energy transition. These policies lay the legal and financial foundations for connecting urban development with cleaner air.

Since 2010, the region has accounted for **72% of all new rapid transit infrastructure globally**, including Metro, Light Rail (LRT), and Bus Rapid Transit (BRT) systems

12. Domestic Shipping: Asia's Transport Emissions Blind Spot

Air pollutant emissions from domestic shipping have increased rapidly yet received little policy attention. One of the most critical findings of this review is that domestic shipping has emerged as a massive, growing, and largely unregulated "blind spot" in air quality management in Asia and the Pacific. Data deficiencies obscure the true scale of the problem.

Based on limited data available, emissions from domestic shipping have grown by around 3% per year for PM2.5 and black carbon since 2000, while emissions of NO_x and SO_x have increased by about 2.5% annually. These growth rates surpass the region's population growth, indicating a worsening challenge. Domestic shipping is now a major contributor to transport-related air pollution. Its share of PM2.5 and BC emissions within the sector has increased to 55% and 46%, respectively, from 35% and 22% in 2000. This indicates that, as road transport emissions have been curbed by regulation, the relative share of emissions from domestic shipping has increased. A ship consuming high-sulfur fuel oil produces pollutant emissions many times greater than heavy-duty trucks operating on road fuel.

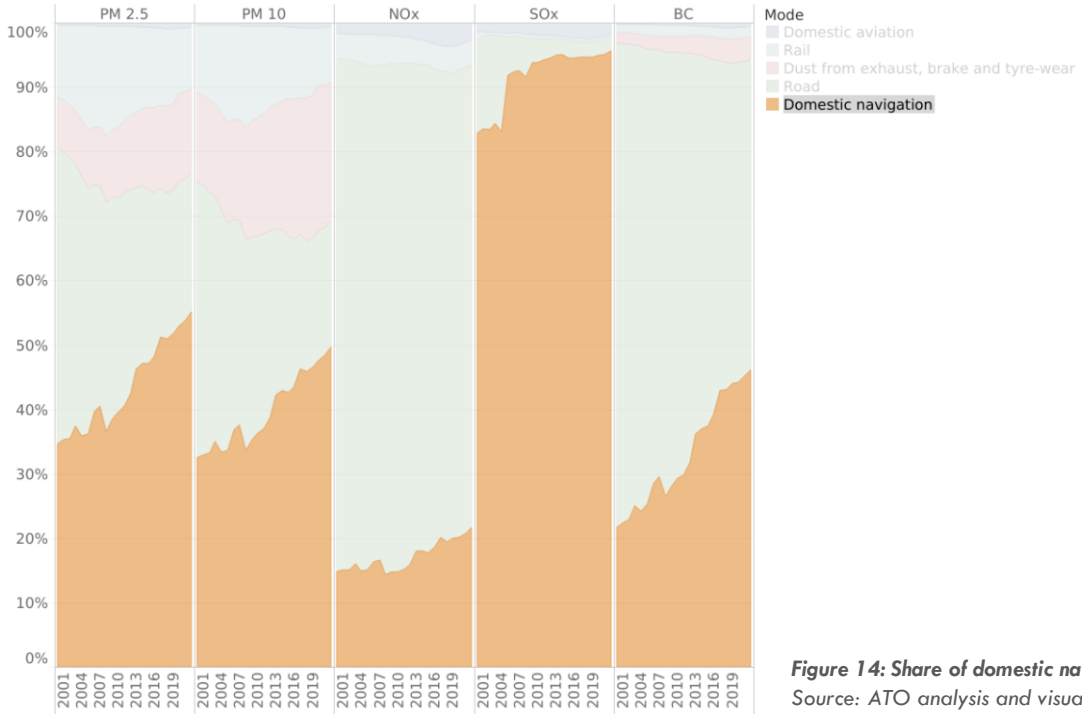
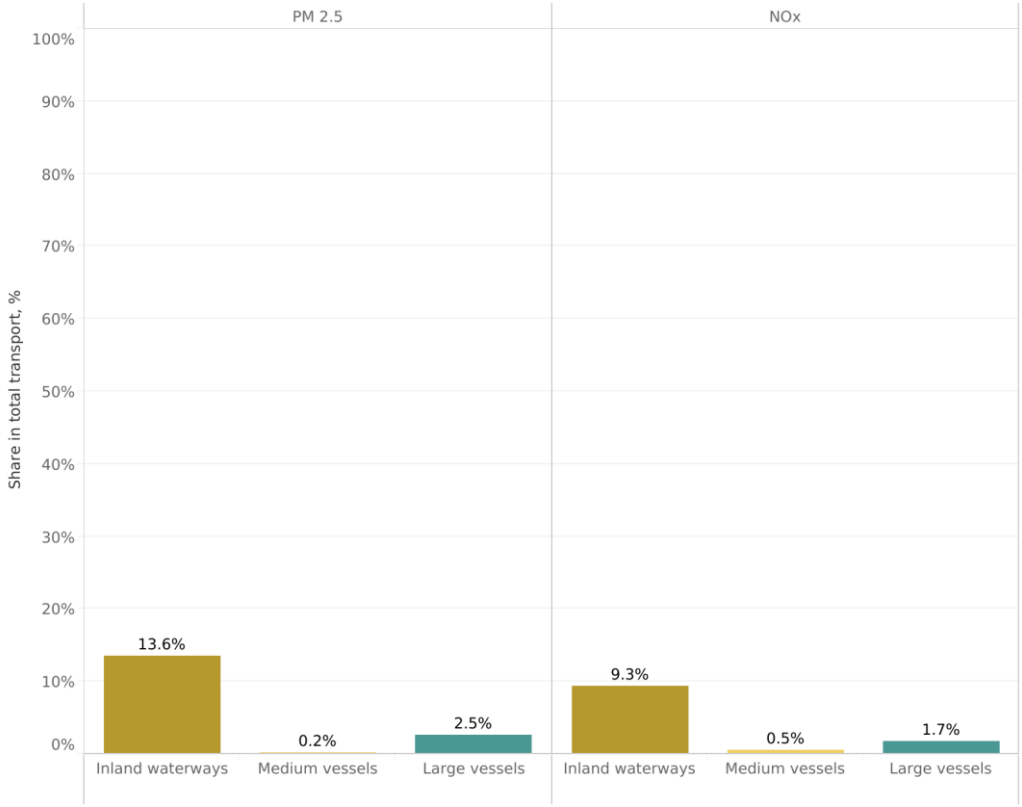


Figure 14: Share of domestic navigation in air pollutant emissions from transport in Asia
Source: ATO analysis and visualization based on European Commission et al. (2024)

This shift is partly an unintended consequence of “modal shift” policies. Many Asian countries have actively promoted shifting traffic from road to water, being shipping as a low-carbon alternative. While vessels are indeed more energy-efficient per tonne-kilometer, they often operate on extremely dirty fuels without the exhaust after-treatment systems mandated for trucks. Thus, a policy success in carbon reduction has created an air quality challenge. Moreover, it highlights the importance of coupling various measures (e.g. in this case, shift and improve) towards yielding the optimal outcomes.

A significant obstacle to reducing domestic shipping air pollution is the limited supply of low-sulfur marine fuel in Asia. Outside major international ports, securing sufficient volumes at competitive prices remains particularly difficult. Operators on domestic waterways in lower-income countries have few viable fuel alternatives. Bunkering facilities, where ships refuel, are underdeveloped in many river systems. Infrastructure such as pipelines and storage tanks in ports requires significant investment. These infrastructure gaps are reinforced by misaligned incentives. Port authorities and operators face immediate and visible costs when switching to low-sulfur fuels, while many of the health and air-quality benefits accrue to downstream communities beyond their direct jurisdiction. As a result, the transition to cleaner fuels has remained slow, despite its potential to deliver significant public health gains.



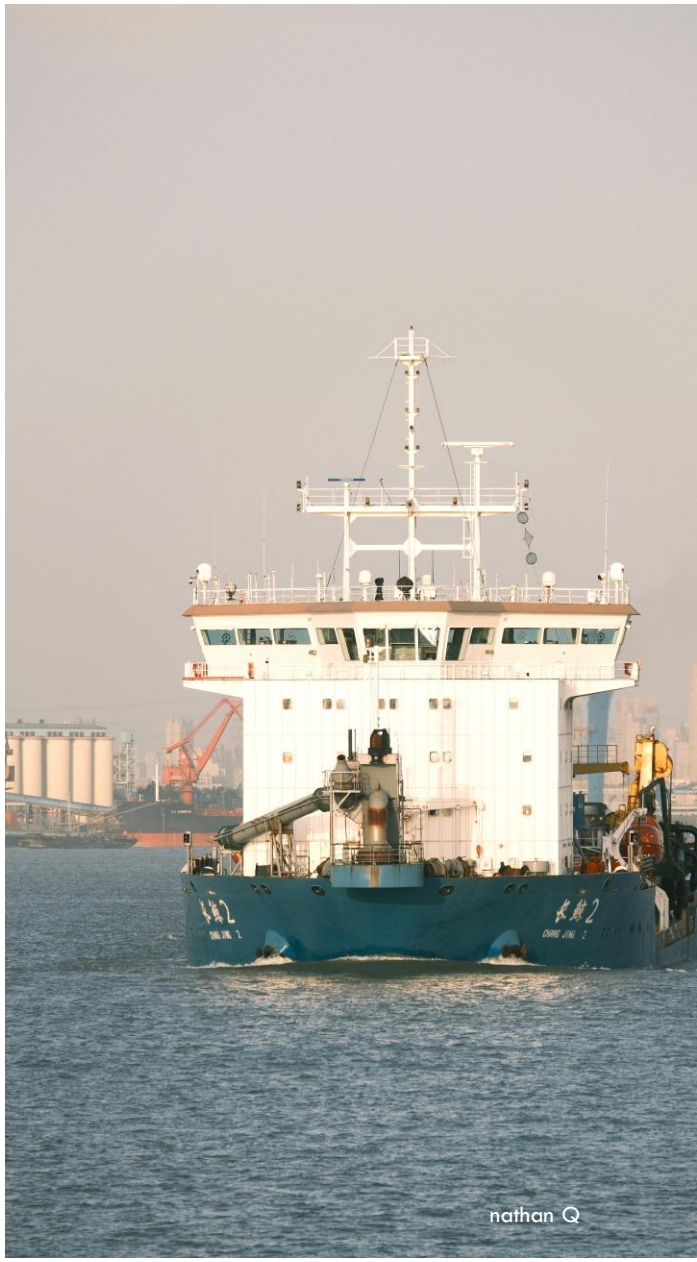


Figure 15: PM 2.5 and Nox emission share of domestic shipping (2025)
Source: ATO analysis and visualization based on IIASA (2025)

Knowledge gaps further complicate investment decisions. Data on domestic shipping vessel activity are scarce, especially in countries with extensive domestic shipping. Many Asian nations lack systematic monitoring of domestic shipping emissions, making policy targets less reliable and progress difficult to verify. The policy landscape reflects these issues. Based on our policy database, only about 24% of air pollution related policies focus predominantly on domestic shipping. Thus, shipping's contribution to overall transport pollution appears significant and, on the rise, representing a missed opportunity for regional coordination.

In terms of policies, we see several emerging trends. Small-vessel electrification is a pathway for emission reduction. Bangladesh is leading this transition by integrating green transport with its massive dredging master plan. The country aims to unlock 10,000 kilometers of river routes for electric inland water transportation. This initiative, detailed in the Mujib Climate Prosperity Plan 2022-2041, pairs route expansion with fiscal tax breaks for electric boats. People's Republic of China is also aggressively scaling its fleet modernization. The Five-Year Action Plan to Accelerate the Construction of a Strong Transportation Nation (2023-2027) promotes oil-electric hybrid and pure electric ships for domestic use. This transformation extends beyond the vessels to the infrastructure that sustains them. Hydrogen and ammonia are the new fuel options being trialed for long-haul domestic shipping. People's Republic of China's Action Plan for Large-Scale Equipment Renewal in Transportation specifically targets the research of methanol, hydrogen, and ammonia-powered ships. People's Republic of China's Action Plan for Energy Conservation and Carbon Reduction 2024-2025 mandates the transformation of domestic transport ships to match port shore power facilities. To incentivize this, the Green Transportation "14th Five-Year" Development Plan proposes integrated service areas that offer ship charging, LNG bunkering, and pollutant reception.

The Marshall Islands is implementing Maritime Regulations that recommend shipowners incorporate environmental protection into their operational procedures. Their Nationally Determined Contribution 2031-35 sets a clear target for zero-emission sea transport. Kiribati is moving toward operationalizing low-carbon vessels through its Kiribati Enhanced NDC. These mandates are often supported by innovative financing. Fiji's NDC Investment Plan includes the National Maritime Action Plan, which draws together mandatory and voluntary actions to attract bilateral and multilateral funding. Fiji is conducting sail-powered passenger and cargo ship trials to reduce dependence on imported diesel.

In Southeast Asia, the Indonesia Blue Economy Roadmap emphasizes clean propulsion technologies. The goal is to green the entire logistics chain, from the ship to the port. Indonesia is prioritizing the capacity building of crews to maintain vessel efficiency, ensuring technology leads to actual emission savings.

Since 2000, domestic shipping's contribution to **PM2.5 and BC** transport emissions has increased from 35% and 22% to **55% and 46%**, respectively.

13. What We Do Not Know?

Despite the breadth of evidence assembled through the Asian Transport Observatory, significant gaps remain that constrain effective policy-making and investments, including those that relate to addressing air pollution from transport. One of the most critical shortcomings is the limited availability of data for non-road transport sub-sectors. As identified in the "blind spot" section, domestic shipping and inland waterways are largely unmeasured. Granular information on vessel activity, fuel types, and real-world emission factors is scarce. Without reliable baseline data and supporting information, it remains difficult to assess the impact of policies accurately or to design targeted and effective interventions.

Evidence-based policy requires precision. Yet, our current understanding of transport's specific contribution to air pollution remains blurred. While we know that 99% of the Asian fleet is registered in countries with Euro 4/IV or higher standards, the gap between laboratory-based type-approval emissions and real-world driving emissions remains poorly understood. Further, we do not have adequate information on fleet renewals.

The source apportionment studies—key tools for identifying pollution sources—are currently too fragmented to support robust regional benchmarking. Different studies use different definitions of emission sources; mapping them to a common sector often yields guesswork rather than science. Second, the background noise of smoke from household cookstoves and biomass heating is sometimes either ignored or incorrectly lumped together with vehicular exhaust (WHO, n.d.-b). This lack of granularity masks the true impact of the transport sector. When combined with the fact that studies are conducted in different years under varying economic conditions, the result is guesswork. We must interpret these findings with caution.

Until we harmonize our methodologies, we risk undercounting local small-scale combustion while miscalculating the transport burden. Further, while we have high-level one-time estimates of deaths attributable to "transport," precisely attributing health burdens to specific vehicle types and local sources remains complex. Quantifying the health benefits of specific transport interventions remains rare in the literature. Further, research on co-benefits remains inadequate for policy prioritization. Sustainable transport policies typically yield multiple benefits, including improved air quality, climate change mitigation, enhanced road safety, economic stimulus, and employment creation. Yet integration of these benefits into cost-benefit analyses remains inconsistent.

There is a need to improve data and modelling in the transport sector. Policies and investments should not be drafted based on limited data from five to ten years ago.

References

Anenberg, S., Miller, J., Henze, D., & Minjares, R. (2019). A global snapshot of the air pollution-related health impacts of transportation sector emissions in 2010 and 2015. https://theicct.org/publication/a-global-snapshot-of-the-air-pollution-related-health-impacts-of-transportation-sector-emissions-in-2010-and-2015/

Anenberg, S., Miller, J., Hnze, D., & Minjares, R. (2015). A global snapshot of the air pollution-related health impacts of transportation sector emissions in 2010 and 2015. International Council on Clean Transportation. https://theicct.org/publication/a-global-snapshot-of-the-air-pollution-related-health-impacts-of-transportation-sector-emissions-in-2010-and-2015/

Asian Transport Observatory. (2025). Policy Tracker [Dataset]. https://asiantransportoutlook.com/transportpolicy/

ATO. (2025). A Dashboard for Sustainable Transport in Asia and the Pacific—Asian Transport Observatory. https://asiantransportobservatory.org/analytical-outputs/sdg-and-decade-of-action-2025/

CIESIN. (2023). SDG Indicator 11.2.1: Urban Access to Public Transport, 2023 Release: Sustainable Development Goal Indicators (SDGI). https://sedac.ciesin.columbia.edu/data/set/sdgi-11-2-1-urban-access-public-transport-2023

EU. (2026, November 29). Vehicle emissions and battery durability (Euro 7): Technical requirements and certification rules | EUR-Lex. https://eur-lex.europa.eu/EN/legal-content/summary/vehicle-emissions-and-battery-durability-euro-7-technical-requirements-and-certification-rules.html

European Commission, Joint Research Centre (JRC), & International Energy Agency (IEA). (2024). Global Air Pollutant Emissions [Dataset]. https://edgar.jrc.ec.europa.eu/dataset_ap81

Google. (2025, April 18). Google Environmental Insights Explorer. https://insights.sustainability.google/places/ChIJbTgmYNLIlzMR0HiSrNoj7V8?hl=en_us

Haghani, M., Ghaderi, H., & Hensher, D. (2024). Hidden effects and externalities of electric vehicles. Energy Policy, 194, 114335. https://doi.org/10.1016/j.enpol.2024.114335

IHME. (2023). GBD Results. Institute for Health Metrics and Evaluation. https://vizhub.healthdata.org/gbd-results

IHME. (2025). State of Global Air 2025 | Institute for Health Metrics and Evaluation. https://www.healthdata.org/research-analysis/library/state-global-air-2025

IIASA. (2025). GAINS Model Online—Greenhouse Gas—Air Pollution Interactions and Synergies. https://gains.iiasa.ac.at/models/

IRJ. (2024). IRJPro [Dataset].

Nirandjan, S., Koks, E., Ward, P. J., & Aerts, J. C. J. H. (2022). A spatially-explicit harmonized global dataset of critical infrastructure. Scientific Data, 9(1), 150. https://doi.org/10.1038/s41597-022-01218-4

SMG. (2017, December 13). 90 fine dust-absorbing trucks to clean the streets in Seoul during the winter time | Seoul Metropolitan Government. https://english.seoul.go.kr/90-fine-dust-absorbing-trucks-clean-streets-seoul-winter-time/

SS. (2016). Street Dust Cleaning: Dust-Free Streets of Seoul | 서울정책아카이브 Seoul Solution. https://www.seoulsolution.kr/en/content/street-dust-cleaning-dust-free-streets-seoul

State of Global Air. (2024). State of Global Air Report 2024. https://www.stateofglobalair.org/resources/report/state-global-air-report-2024

TOI. (2025). Chandigarh implements real-time monitoring for dust control machines to tackle air pollution | Chandigarh News—Times of India. https://timesofindia.indiatimes.com/city/chandigarh/chandigarh-implements-real-time-monitoring-for-dust-control-machines-to-tackle-air-pollution/articleshow/123104607.cms

Trademap. (2025). Trade Map. Trade Map. https://www.trademap.org/Index.aspx

UNEP. (2024, July 3). Used Vehicles and the Environment: Update and Progress 2024 | UNEP - UN Environment Programme. https://www.unep.org/resources/report/used-vehicles-and-environment-global-overview-used-light-duty-vehicles-flow-scale

UNEP. (2025). ACCELERATING THE GLOBAL SHIFT TO A CLEANER ON-ROAD DIESEL FLEET. https://www.ccacoalition.org/sites/default/files/resources/files/ACCELERATING%20THE%20GLOBAL%20SHIFT%20TO%20A%20CLEANER%20ON-ROAD%20DIESEL%20FLEET%20-%20V1.3.pdf

WHO. (n.d.-a). Air quality database. Retrieved April 18, 2025, from https://www.who.int/data/gho/data/themes/air-pollution/who-air-quality-database

WHO. (n.d.-b). Database on source apportionment studies for particulate matter. Retrieved March 4, 2026, from https://www.who.int/data/gho/data/themes/air-pollution/source-apportionment-db

WHO. (2012). IARC: Diesel Engine Exhaust Carcinogenic.

World Bank. (2022). The Global Health Cost of PM2.5 Air Pollution: A Case for Action Beyond 2021. The World Bank. https://doi.org/10.1596/978-1-4648-1816-5

World Bank. (2025a). Accelerating Access to Clean Air for a Livable Planet [Text/HTML]. World Bank. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099032625132535486

World Bank. (2025b). Cleaner Air is Within Reach by 2040: New Report [Text/HTML]. World Bank. https://www.worldbank.org/en/news/press-release/2025/03/27/cleaner-air-is-within-reach-by-2040-new-report

World Bank. (2025c). GDP, PPP (current international $) [Dataset]. https://data.worldbank.org/indicator/NY.GDP.MKTP.PP.CD

Asian Transport Observatory