The Two Faces of Progress:

Decarbonizing Asia's Transport Sector

A Primer for COP 30

October 2025

Asian Transport Observatory

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The Two Faces of Progress: Decarbonizing Asia's Transport Sector- A Primer for COP 30

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Executive Summary

The decarbonization of Asia's transport sector is a story of contradictions. There is progress, but it is uneven. There is ambition, but it is not yet matched by action. The challenges are immense, but the opportunities are greater.

The data is clear. Asia is now the principal source of transport-related greenhouse gases. In 2024, emissions from domestic transport across the Asia-Pacific region reached 2.81 billion tons, a volume now surpassing the combined output of Europe and North America. Since the Paris Agreement, the region's transport GHG emissions have expanded at more than twice the global pace, accounting for nearly ninety percent of the world's total increase from the sector. Forty-one percent of all domestic transport GHG emissions now originate here—a concentration of growth that presents a difficult challenge to established climate pathways.

Yet, this bleak picture masks a more complex reality. A broad-based slowdown has begun. The sector's climate footprint in Asia, which grew at 4% annually before 2015, has been cut to 1.7%. This trend is led by East Asia, where annual emissions growth has slowed significantly from 4.2% to just 0.7%. Road transport, long the dominant emitter at 88% of the total, has seen its own emissions growth decelerate from 4.2% to 1.5% annually since 2015. This appears to be the consequence of targeted policy. Furthermore, a decoupling of economic growth from transport emissions is accelerating. High-income economies are achieving absolute decoupling—where emissions fall as GDP grows—while other income groups are quickening the pace of relative decoupling.

This is the glass half-full. The other half reveals a grim challenge.

The progress is not universal; it is a tale of two Asias. East Asia's success is offset by regions like Central and West Asia, where high emissions growth continues with little abatement. Progress in one group is overshadowed by the sheer scale of growth elsewhere. The challenge has not been solved; it has moved. And while road emissions slow, other transport sectors accelerate. Domestic aviation is now the fastest-growing source of transport emissions, its

In 2024, emissions from domestic transport across the Asia-Pacific region reached 2.81 billion tons, a volume now surpassing the combined output of Europe and North America.

trajectory proving resistant to policy intervention. Its share of global domestic aviation emissions has climbed from 20% in 2000 to 43% by 2024. The transition to a low-carbon transport future has begun. But it is not happening fast enough.

A similar contradiction defines the policy landscape. Ambition at the national level has increased. By 2024, countries representing 93% of the region's population have net-zero targets, a near-total reversal from less than 1% in 2015. Yet this ambition has failed to translate into sectoral accountability. Only 10% of the region's population lives in countries with explicit, binding transport GHG reduction targets in their Nationally Determined Contributions (NDCs). The roadmap for decarbonization is being written, but it is being written elsewhere—a detailed review shows NDCs contain just 17% of all transport-specific climate measures.

The evidence presented here is suggestive rather than conclusive. If these trends toward deceleration and decoupling continue, and if they are reinforced by policy-driven improvements in vehicle efficiency and shifts to lower-carbon fuels, the road to transport emission reductions may be slightly less challenging than initially thought. The question is no longer whether Asia can decarbonize its transport sector, but whether it can do so at the pace and scale the Paris Agreement requires. The current trajectory, while an improvement, is incompatible with that goal. The answer depends on closing the gap between national ambition and concrete transport policy. The future of Asia's transport sector, and its impact on the global climate, hangs in the balance.

The question is no longer whether Asia can decarbonize its transport sector, but whether it can do so at the pace and scale the Paris Agreement requires.

1 The Shifting Epicenter of Global Transport Emissions

The center of gravity for transport emissions has shifted. Asia now stands as the principal source of transport-related greenhouse gases, a region whose expansion is outpaced by just one other. The data arriving before COP30 is unambiguous. In 2024, greenhouse gas emissions from domestic transport across Asia and the Pacific increased to 2.81 billion tons (Figure 1), a volume now surpassing the combined output of Europe and North America. It represents an annual increase of 1.7%, equivalent to 393 Mt of greenhouse gas (GHG) emissions above 2015 levels.

This growth is the central theme. Since the adoption of the Paris Agreement, the region's transport GHG emissions have expanded at more than twice the global pace, accounting for nearly ninety percent of the world's total increase from the sector. Forty-one percent of all domestic transport GHG emissions now originate in Asia and the Pacific—a concentration of growing emissions that presents a difficult challenge to established climate pathways.

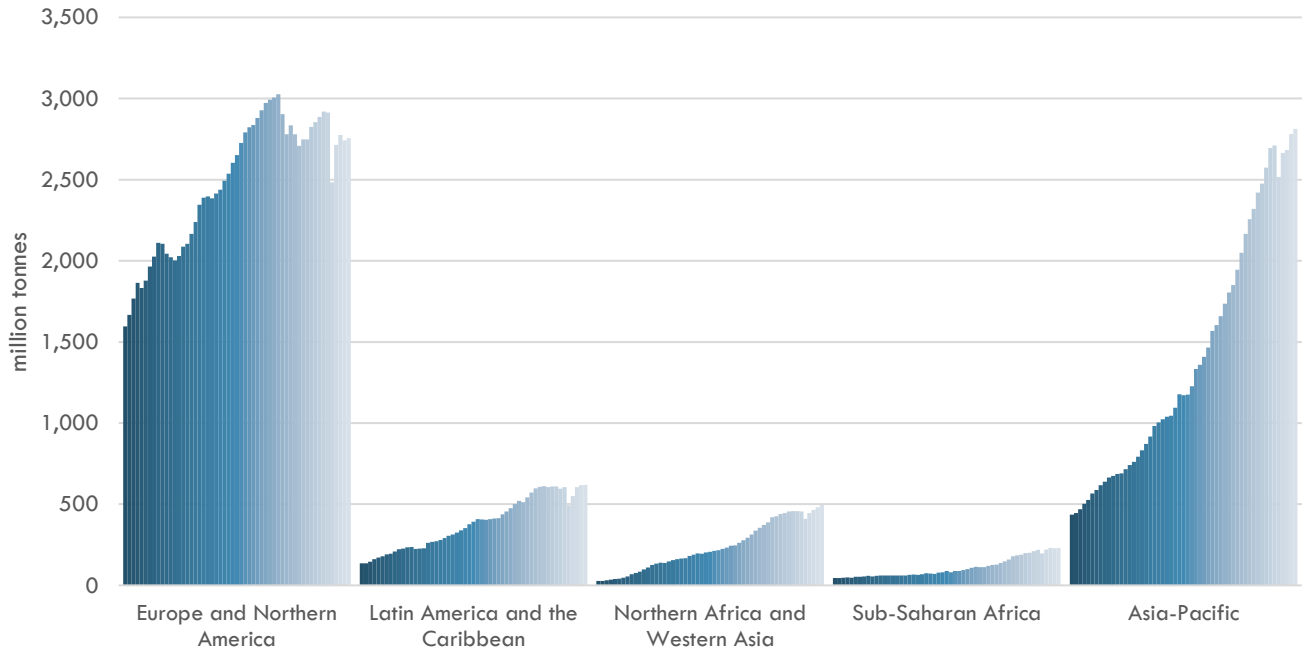


Figure 1. Domestic Transport GHG Emissions, 1970-2024, Million Ton
Source: ATO visualization based on JRC & IEA (2025)

2 Shifts and Changes in the Transport Emissions Landscape

The global transport sector's contribution to greenhouse gas emissions stands at 13 percent. Asia is charting a different course. Its transport emissions share is the world's lowest at 8.8 percent, a level that has remained remarkably stable since the year 2000. In contrast, the emission shares from transport have continued to grow across Europe, North America, and sub-Saharan Africa, their pace outstripping that of other economic sectors. The conventional wisdom, based on the trajectory of developed regions, has always been that as incomes rise, so does transport's claim on the carbon budget (Gota et al., 2022). However, the Asian experience tells a different story. Asia's total transport emissions are growing in absolute terms, and the rest of its economy (especially the power industry) is growing at the same pace (or even faster). The experience suggests a new possibility: that economic growth can be sustained while attenuating the associated rise in transport's share of emissions. This deviation from the historical norm forces a critical question: Is Asia writing a new rulebook for transport development, or is this merely a temporary trend? (Figure 2 and Figure 3).

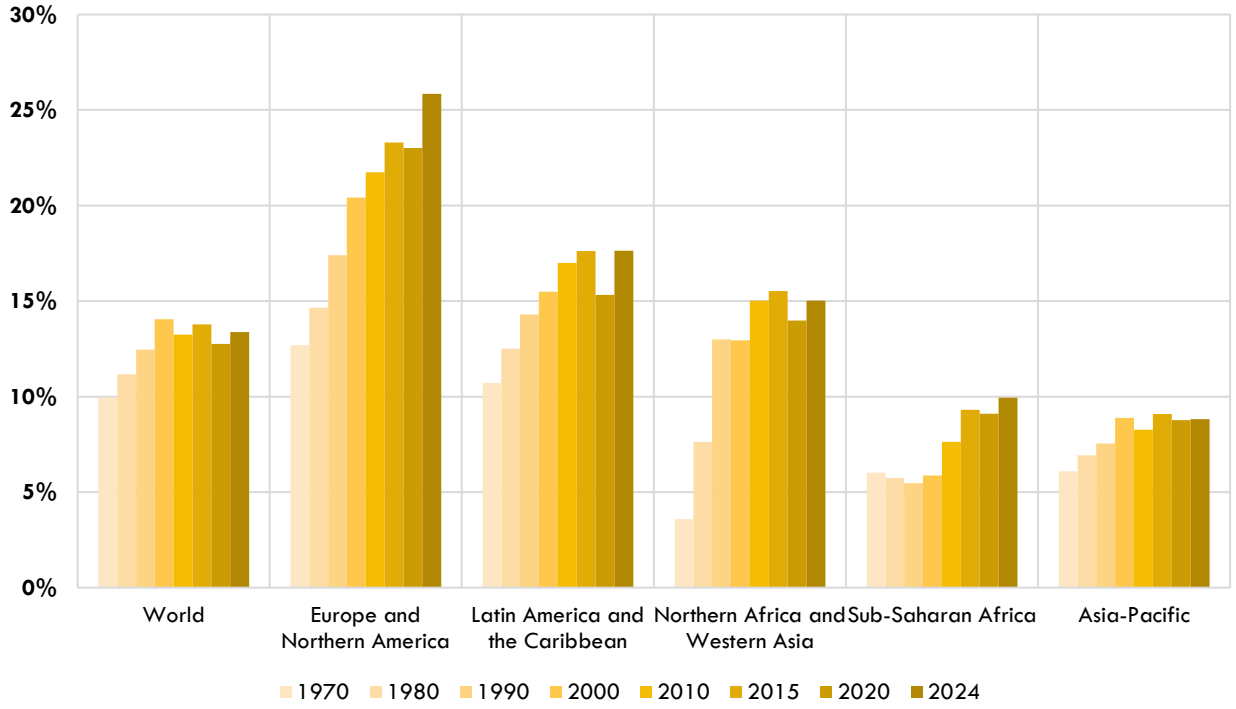


Figure 2. Share of Domestic Transport in Total GHG Emissions (Global)

Source: ATO analysis and visualization based on JRC & IEA (2025)

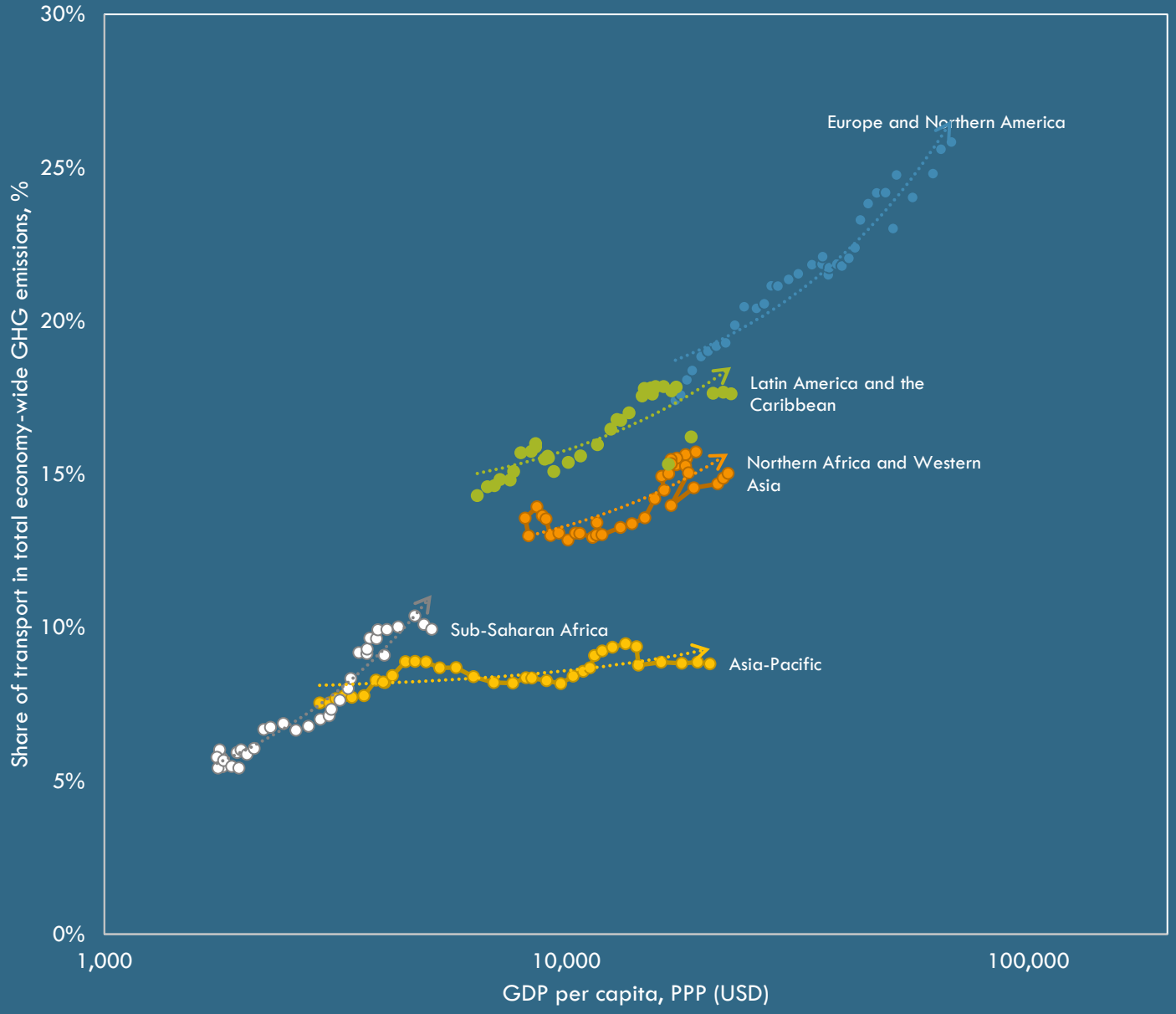


Figure 3. Share of Domestic Transport in Total GHG Emissions and GDP per Capita

Source: ATO analysis and visualization based on JRC & IEA (2025) and World Bank (2025)

Is Asia writing a new rulebook for transport development, or is this merely a temporary trend?

The transport sector's share of total domestic GHG emissions in Asia varies significantly across different sub-regions and income levels. In high-income Asian countries, it makes up 12.5%, aligning with the global average. In upper-middle-income economies, this share decreases to around 8%, while in low- and lower-middle-income economies, it is 8.8%.

Among the sub-regions, the Pacific has the highest transport share in domestic GHG emissions at 17.5%, while East Asia has a lower share of just 7.3% (Figure 4).

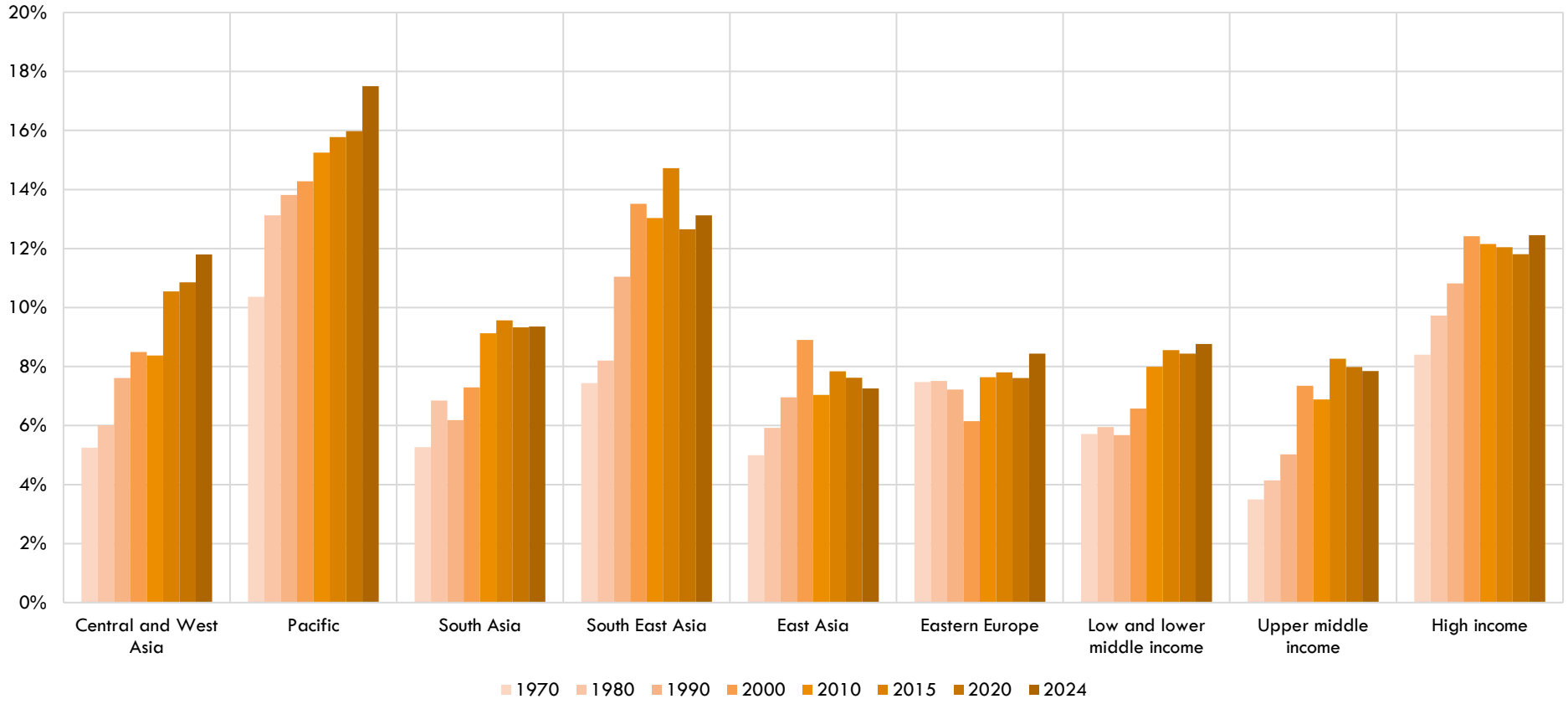


Figure 4. Share of Domestic Transport in Total GHG Emissions (Asia)[1]

Source: ATO analysis and visualization based on JRC & IEA (2025)

[1] Eastern Europe in this graph, and subsequent graphs which utilize this regional categorization equate to the Russian Federation

Since 2000, these shares have only slightly increased in low- and upper-middle-income economies but remain below pre-COVID levels.

Figure 5 below shows the distribution of Asian economies in terms of the average annual growth rates (AAGR) in mode-wise emissions for the period 2000-2015, and 2015-2024. The period since the Paris Agreement has forged divergent paths for emissions across Asia's transport modes. Road transport, long the dominant source of growth, is showing signs of a broad-based slowdown. This positive trend, however, is counterbalanced by an acceleration in other sectors. A growing number of economies are witnessing faster emissions growth from rail and aviation. Domestic shipping, too, is following an upward trajectory in many nations, signaling that the challenge of decarbonization is not shrinking, but shifting from one mode to another.

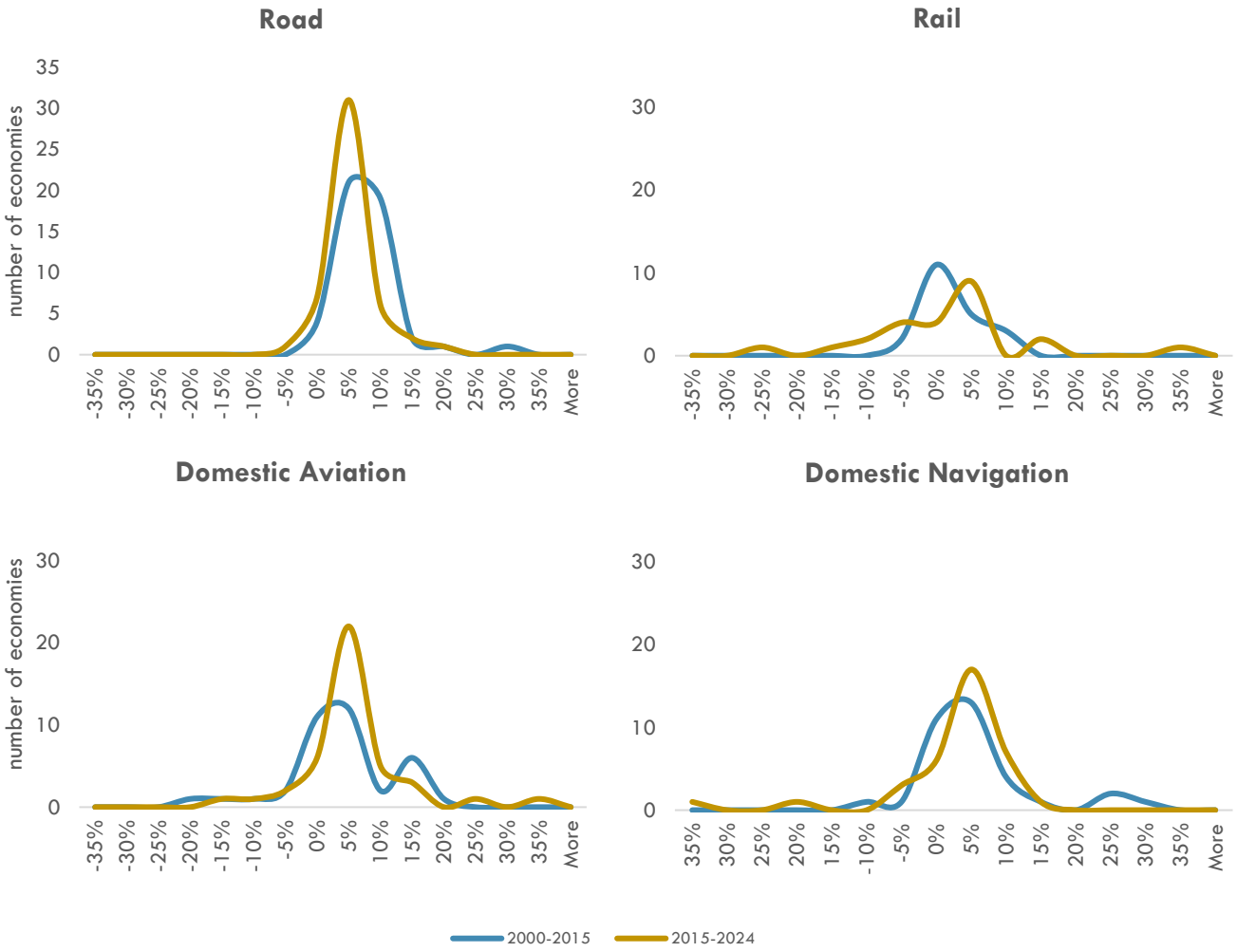


Figure 5. Distribution of Economies by AAGR in GHG Emissions by Mode (2000-2015 and 2015-2024)

Source: ATO analysis and visualization based on JRC & IEA (2025)

3 Transport Emissions Growth – A Tale of Two Asias

The center of gravity for transport emissions has shifted. Asia now stands as the principal source of transport-related greenhouse gases, a region whose expansion is outpaced by just one other (Figure 6,). The emissions trajectory tells a story of rapid escalation through 2018, followed by a brief plateau, and a pandemic-induced disruption, only to see a full recovery surpass previous peaks by 2024 across all its sub-regions. But the character of this growth is no longer the same. A deceleration is evident globally; the annual expansion of the sector's greenhouse gas emissions moderated from 1.9% during the 2000–2015 period to 0.7% in the era following the Paris Agreement. This global trend is reflected more pronouncedly in Asia, where a previously 4% annual growth in the transport climate footprint has been reduced to 1.7% (Figure 7). The climb continues, but momentum has slowed. The glass is half full.

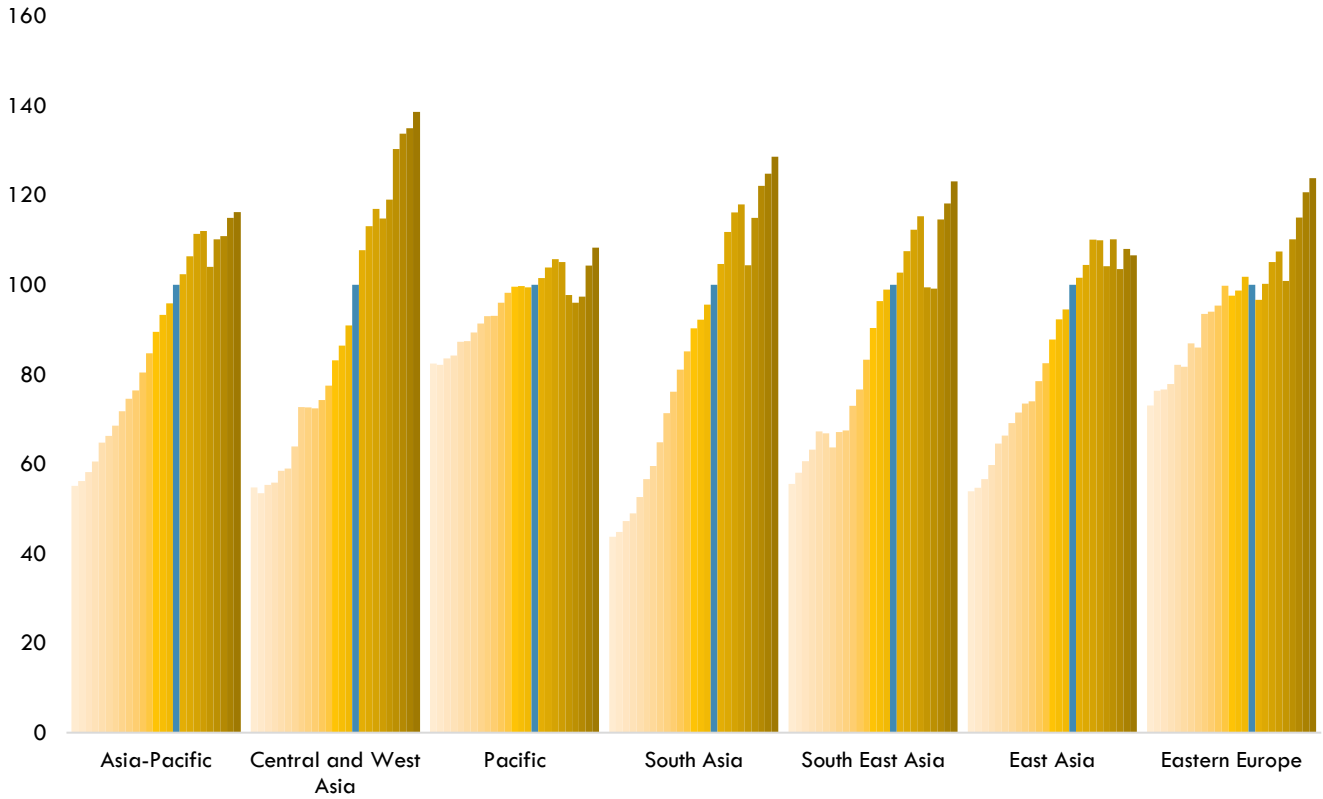


Figure 6. Transport GHG Emissions Index (2000 to 2024), Assuming 2015=100

Source: ATO analysis and visualization based on JRC & IEA (2025)

The global trend on transport emissions growth deceleration is more pronouncedly in Asia, where a previously 4% annual growth in the transport climate footprint has been reduced to 1.7%

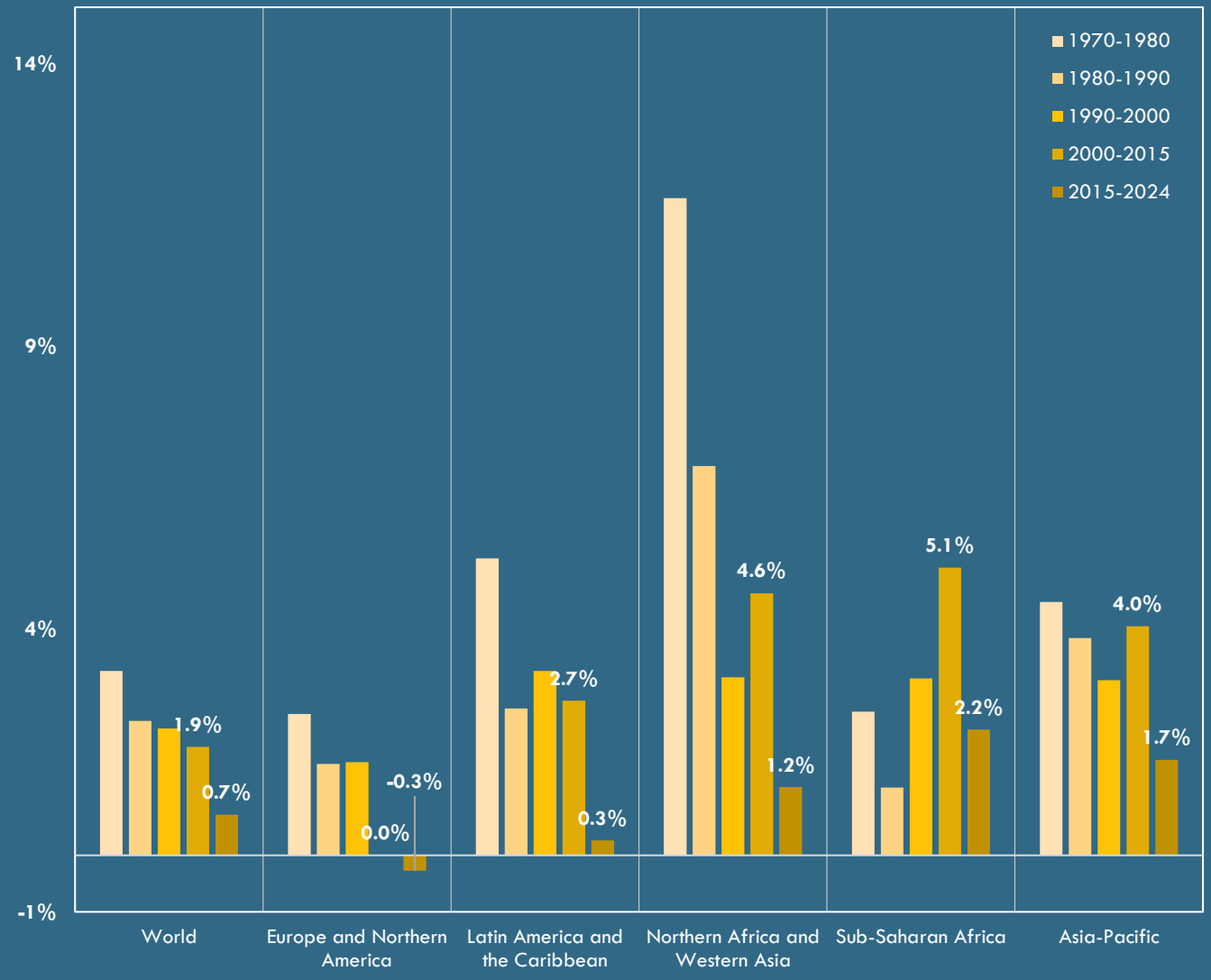


Figure 7. Transport Sector GHG Emissions -Average Annual Growth Rates

Source: ATO analysis and visualization based on JRC & IEA (2025)

Between 2000 and 2015, two-thirds of the economies in Asia registered high (3%-5%) or very high (above 5%) average annual growth in transport GHG emissions (Figure 8). Since the Paris agreement's implementation, the share of nations on this rapid growth trajectory has been reduced to 40 percent.

This marks a significant, policy-driven course correction. Yet, the progress trails the global pace. Outside of Asia, only one-third of countries now exhibit a similar high-growth profile.

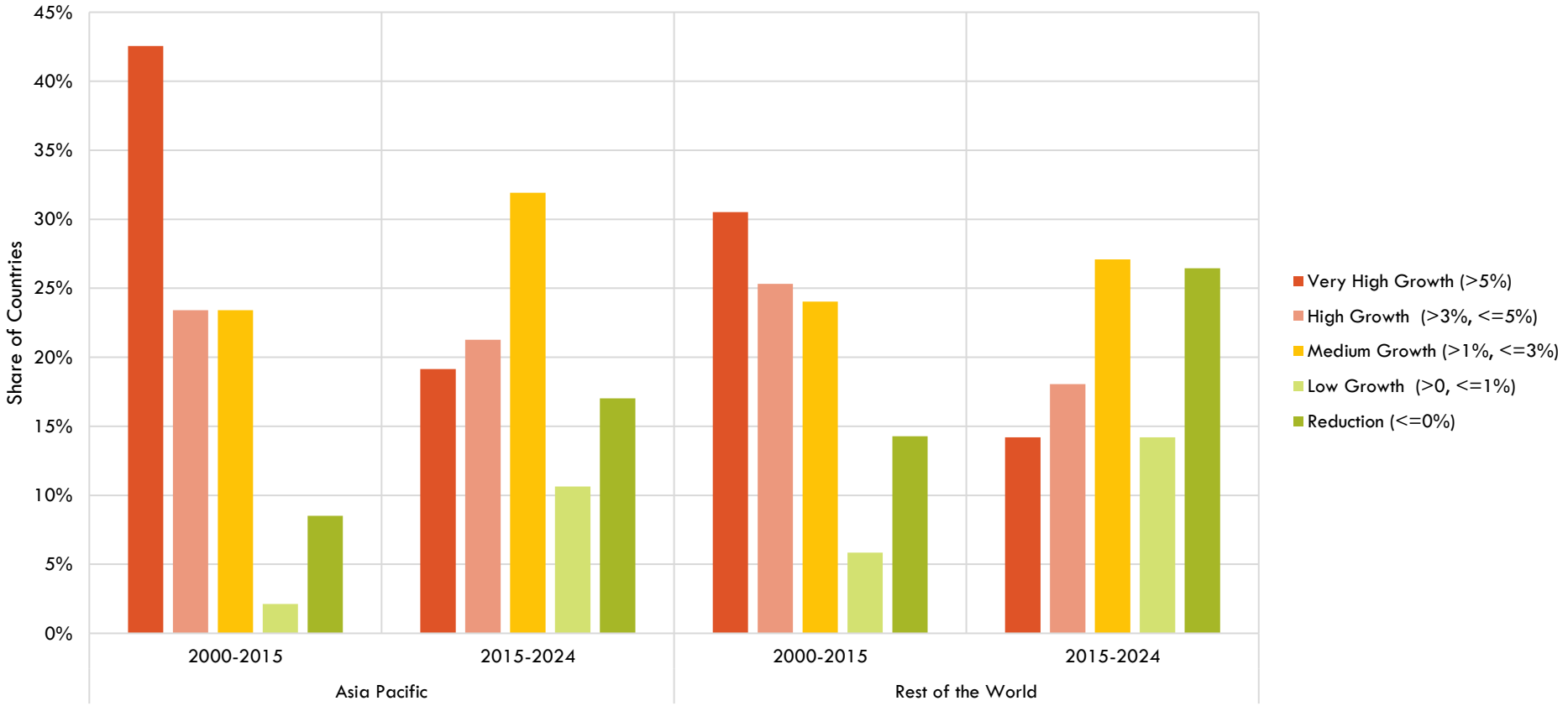


Figure 8. Share of Economies by Growth Categories - Domestic Transport Sector GHG Emissions

Source: ATO analysis and visualization based on JRC & IEA (2025)

The comparison of the 2024 and 2019 (pre-COVID) estimates shows that the majority of the Asian economies have surpassed 2019 GHG emissions levels for rail and domestic navigation (Figure 9). On the other hand, less than half have surpassed their 2019 domestic aviation GHG levels, and only around a third have surpassed their 2019 road transport GHG levels.

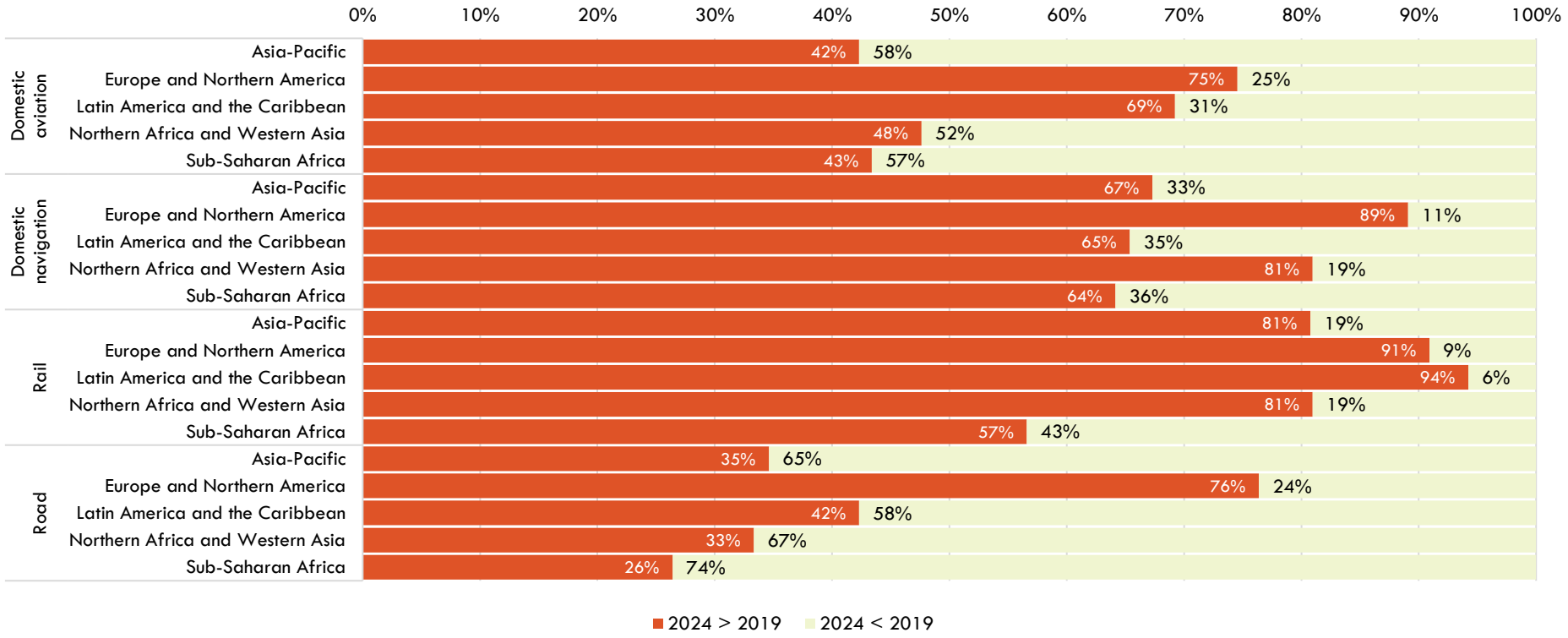


Figure 9. Share of Economies – Increase or Decrease in Modal GHG Emissions - 2024 vs 2019

Source: ATO analysis and visualization based on JRC & IEA (2025)

Beneath the overall trend, Asia's transport emissions story splits into sharply different realities. East Asia is making significant progress; its annual emissions growth slowed from 4.2% to just 0.7% after the Paris Agreement. Meanwhile, Central and West Asia continue to see high emissions growth, with rates only slightly decreasing from 4.1% to 3.7% (Figure 10).

East Asia has markedly slowed its transport emissions growth, while Central and West Asia continue to experience only limited progress in curbing theirs.

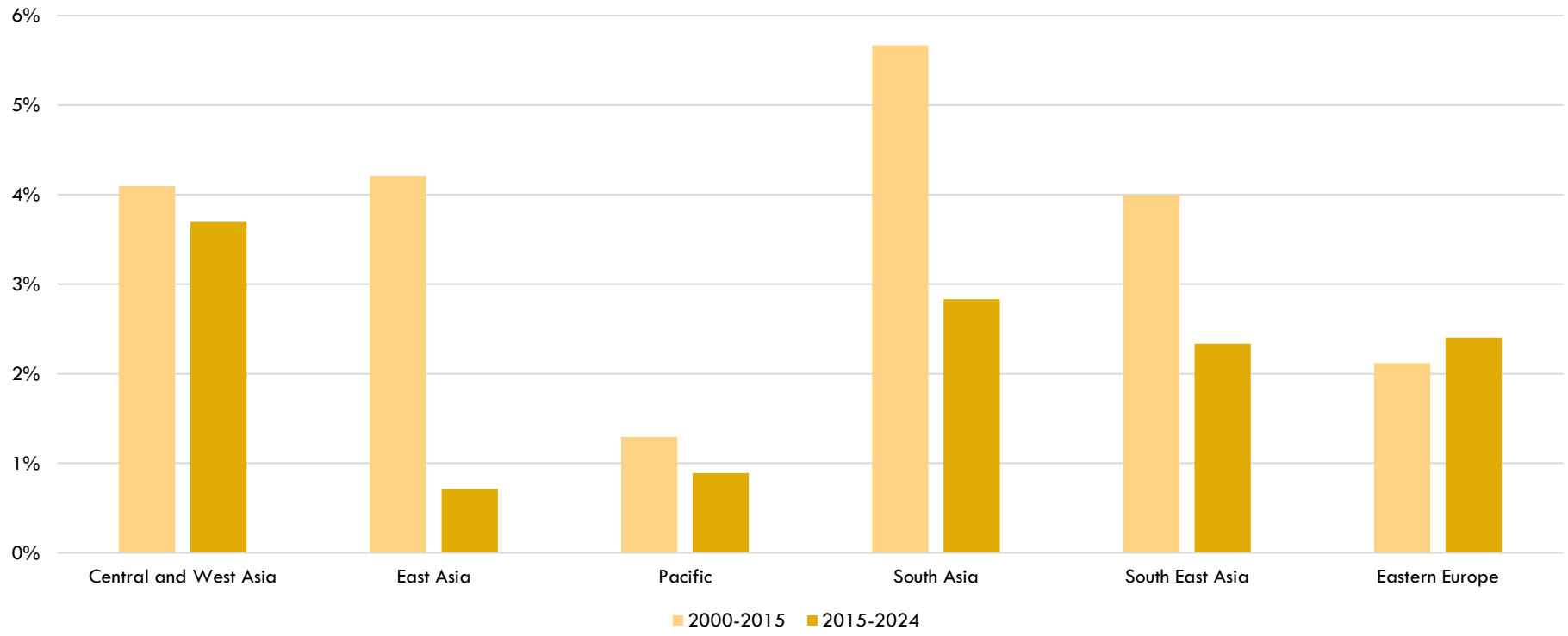


Figure 10. Domestic Transport Emissions - Average Annual Growth Rates Comparison

Source: ATO analysis and visualization based on JRC & IEA (2025)

This is more than just a story of two Asias. A significant structural change is happening. High-income economies on the continent, which accounted for nearly half (46%) of transport emissions in 2000, now contribute less than a quarter (24%) as of 2024. Why then does the challenge intensify? Because the progress of one group has been overshadowed by the sheer scale of growth elsewhere (Figure 11).

This reshuffling of the emissions burden follows a parallel shift in economic gravity; the high-income share of the transport sector's gross value added reduced from three-quarters (75%) in 2000 to just 27% by 2023. The problem has not been solved. It has moved.

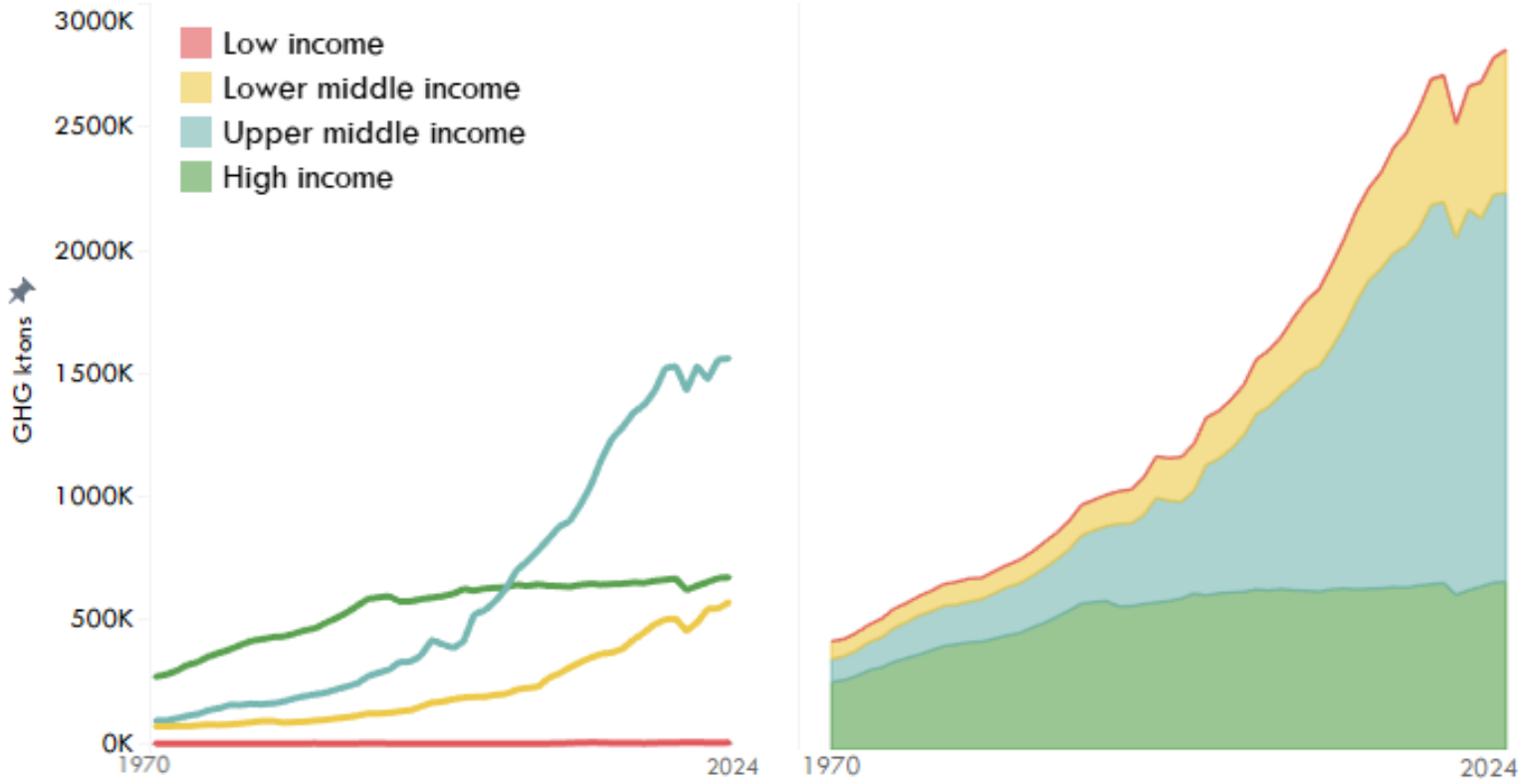


Figure 11. Transport Emissions - Average Annual Growth Rates Comparison (1970-2024)
Source: ATO analysis and visualization based on JRC & IEA (2025)

4 Is Transport the Biggest Source of GHG Emissions Growth in Asia?

Figure 12 below shows the evolution of Asia's GHG emissions (excluding LULUCF) from 1970 to 2024. It compares emission trends in the transport sector with those in other major activity sectors, such as the power industry, industrial combustion and processes, buildings, agriculture, waste, and fuel exploitation. Transport emissions are increasing more rapidly than those from buildings, agriculture, waste, and industrial processes. Nonetheless, the power industry continues to exhibit the most significant growth in both intensity and scale. Since 2015, the transport sector has ranked as the third fastest growing sector. In nearly 30% of Asian economies, the transport sector already accounts for more than 20% of total GHG emissions (excluding LULUCF).

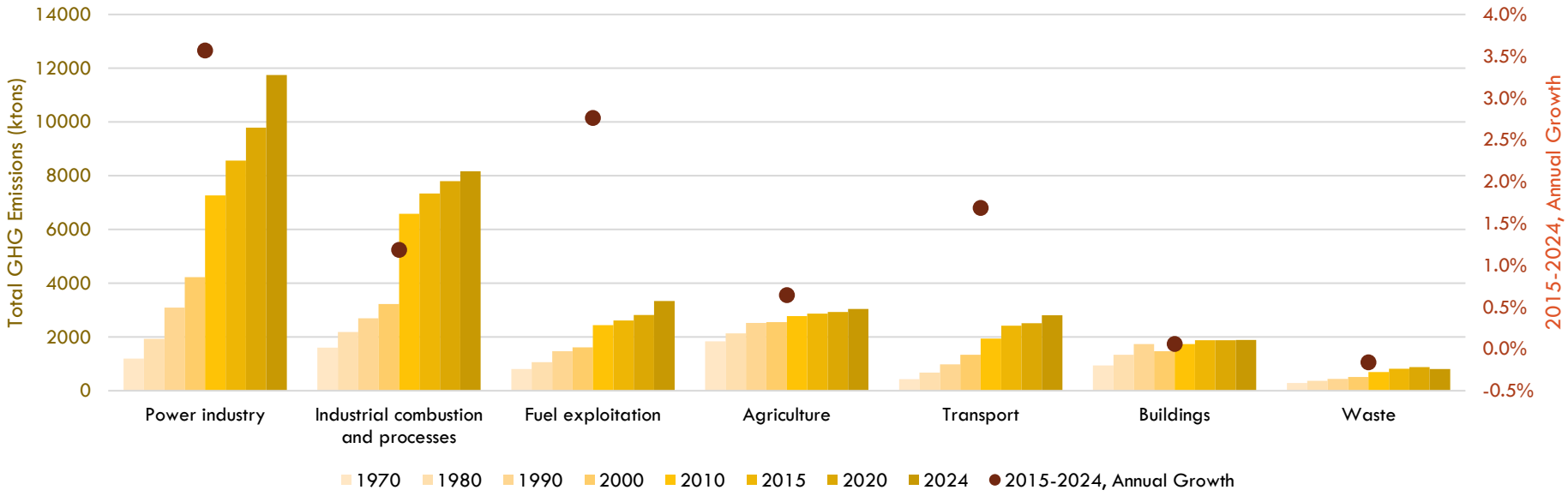
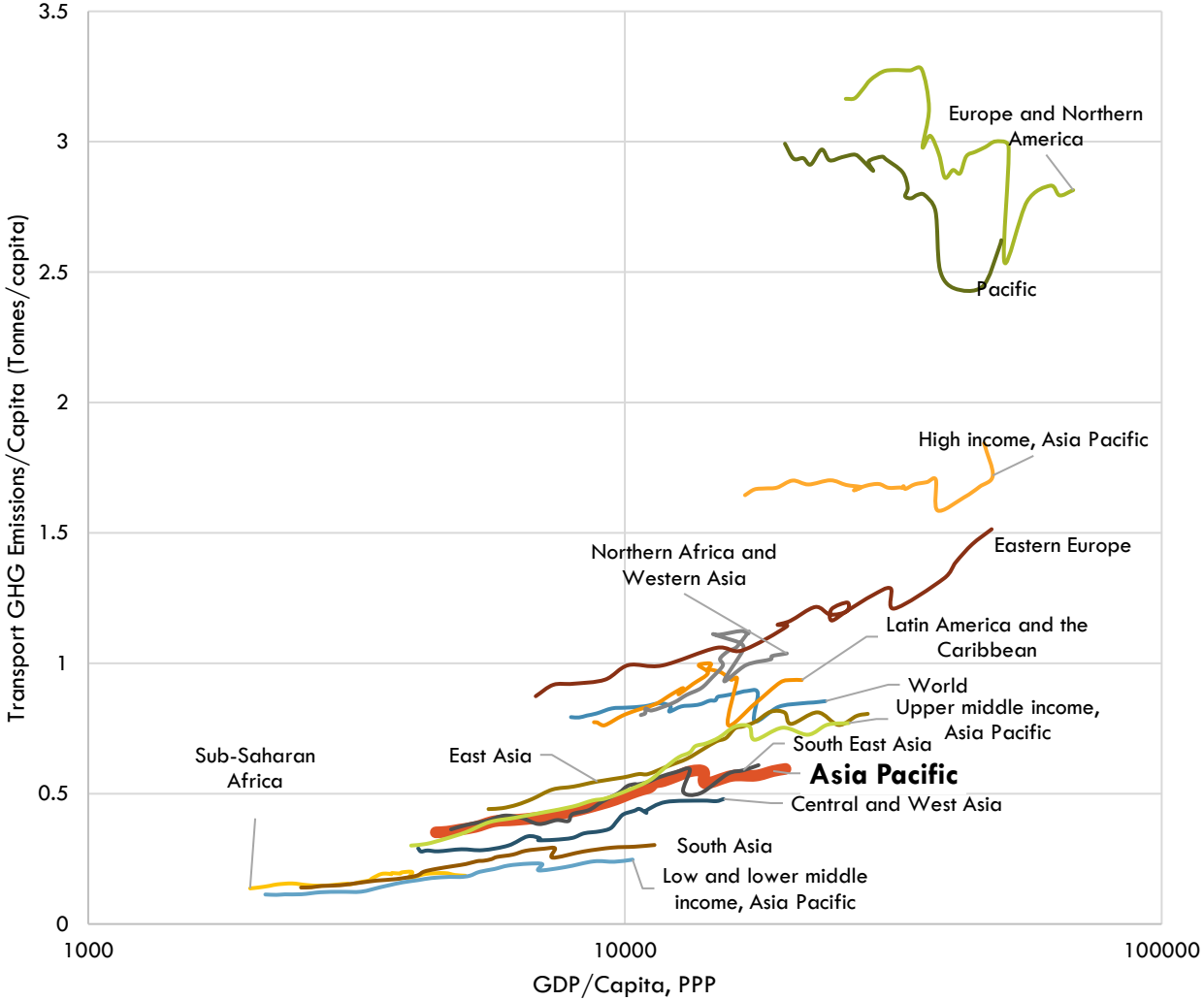


Figure 12. Total GHG Emissions and Average Annual GHG Emissions Growth by Sector (2015-2024)

Source: ATO analysis and visualization based on JRC & IEA (2025)

5 Asia's Transport Emissions: Growth and Decoupling Trends Since the Paris Agreement



Since the Paris Agreement, Asian countries have shown mixed results in separating their economic growth (GDP) from transport emissions. This variation mainly results from slow and uneven improvements in energy efficiency. Most high-income economies in the region have achieved absolute decoupling, with transport emissions decreasing despite economic growth. In contrast, many upper-middle-income, lower-middle-income, and low-income countries have only reached relative decoupling, where transport emissions grow more slowly than GDP but do not decrease in absolute terms. The critical insight, however, is this: the pace of that relative decoupling is quickening (Figure 13).

Figure 13. Transport GHG per Capita and GDP per Capita (2000-2024)
Source: ATO analysis and visualization based on JRC & IEA (2025) and World Bank (2025)

Figure 14 shows the change trajectories of the transport GHG emissions of various sub-regions and economies. Some economies have been highlighted for standing out in terms of pace and direction (acceleration or deceleration).

Some of the time series graphs in this paper are plotted with GDP per capita on the x-axis. This effectively accounts for the impact of income on emissions and the varying pace of economic growth over time, highlighting structural differences between countries. However, the trend over time can still be observed in the charts. To facilitate comparisons across time, some data are also presented as time series. We find that much of the variation in per capita emissions comes from differences in incomes. Still, there are also significant differences between countries with similar incomes, reflecting variations in transport services and types of fuel. The reasons for these differences warrant further analysis.

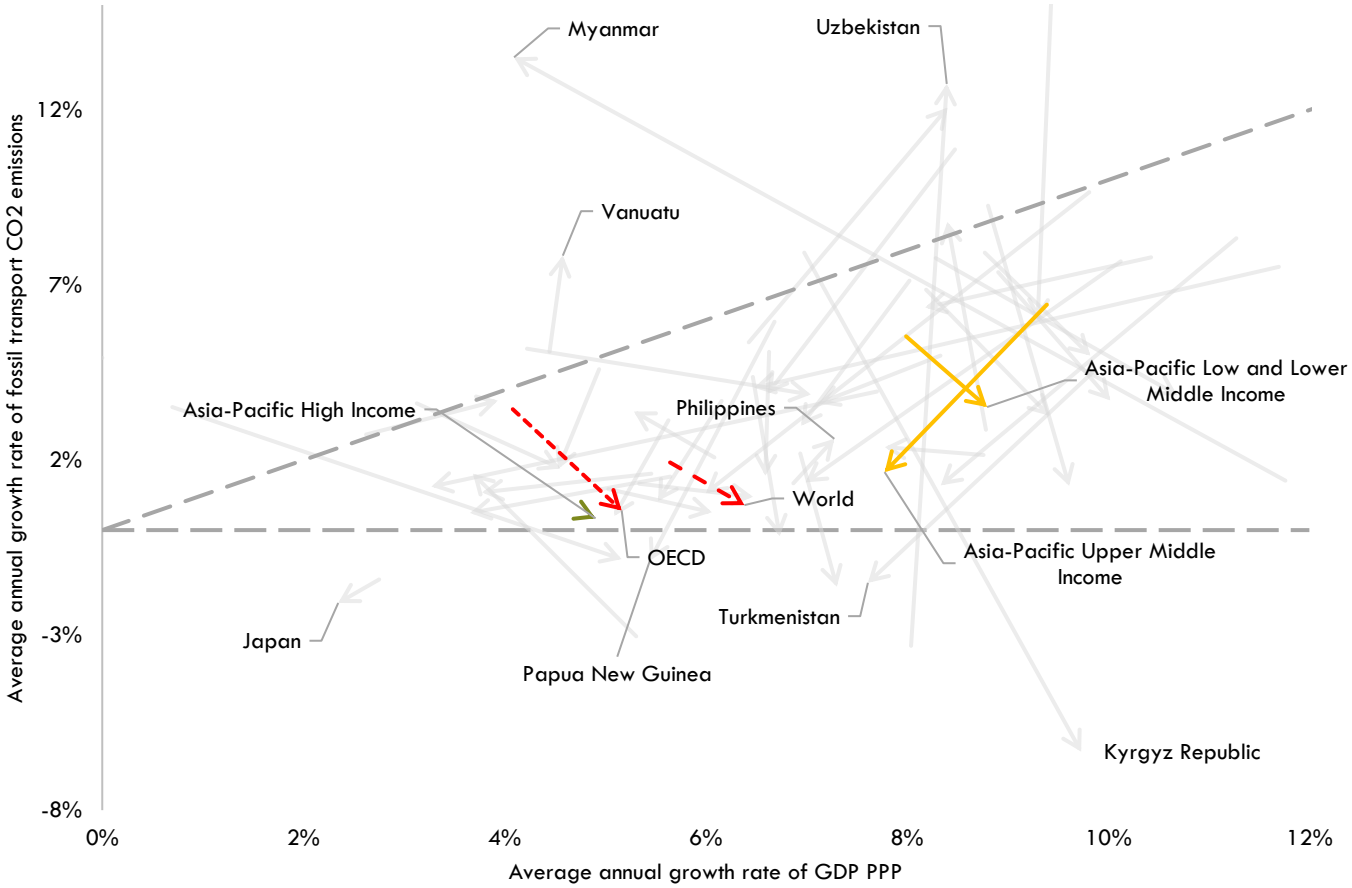


Figure 14. Annual Average Growth Rates of Transport GHG Emissions and GDP (PPP)

Source: ATO analysis and visualization based on JRC & IEA (2025) and World Bank (2025)

Note: The arrow depicts the AAGR in the periods 2000-2015 vs 2015-2024 with the latter being the end with the arrow.

6 Road Transport: The Dominant and Decelerating Emitter

In 2024, road transport remained Asia's primary source of transport-related GHG emissions, accounting for approximately 88% of the total emissions. Railways, domestic aviation, and inland waterways contributed considerably less, with shares of 1.7%, 6.5%, and 3.8%, respectively (Figure 15).

This headline figure, a one percentage point above the 87 percent recorded in 2000, tempts a simple conclusion: inertia. That is, a quarter of a century has yielded no meaningful structural change. This conclusion would be wrong.

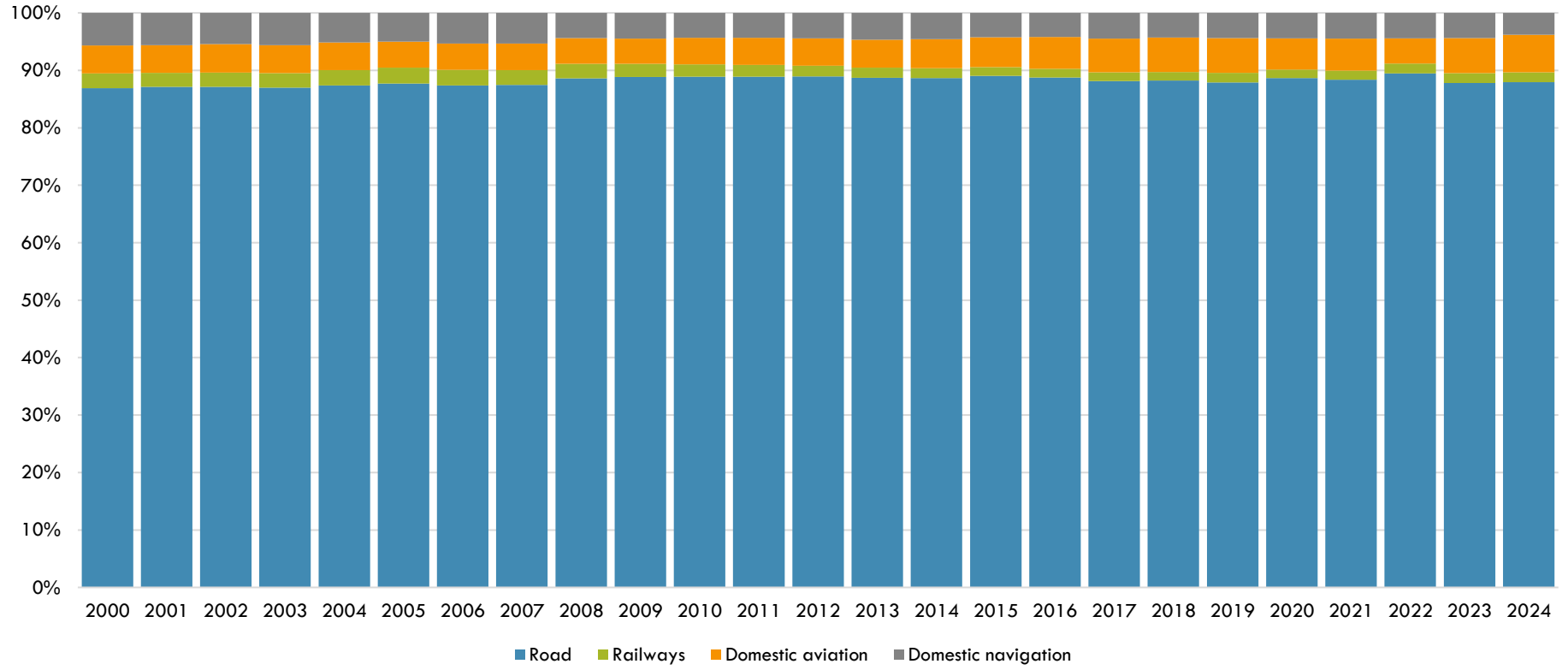


Figure 15. Transport GHG Emissions Share by Mode

Source: ATO analysis and visualization based on JRC & IEA (2025)

The critical story is not in the static shares but in the pace of growth. Between 2000 and 2015, road transport GHG emissions grew at a rate of 4.2% (Figure 16). However, following the implementation of the Paris Agreement, we observe significant reductions in growth, with an annual rate of only 1.5%, which is outpaced by the increase in road infrastructure (1.9%) and the vehicle fleet (6.7%).

Road transport emissions rose rapidly before 2015 but have since grown much more slowly, even as road networks and vehicle fleets continue to expand.

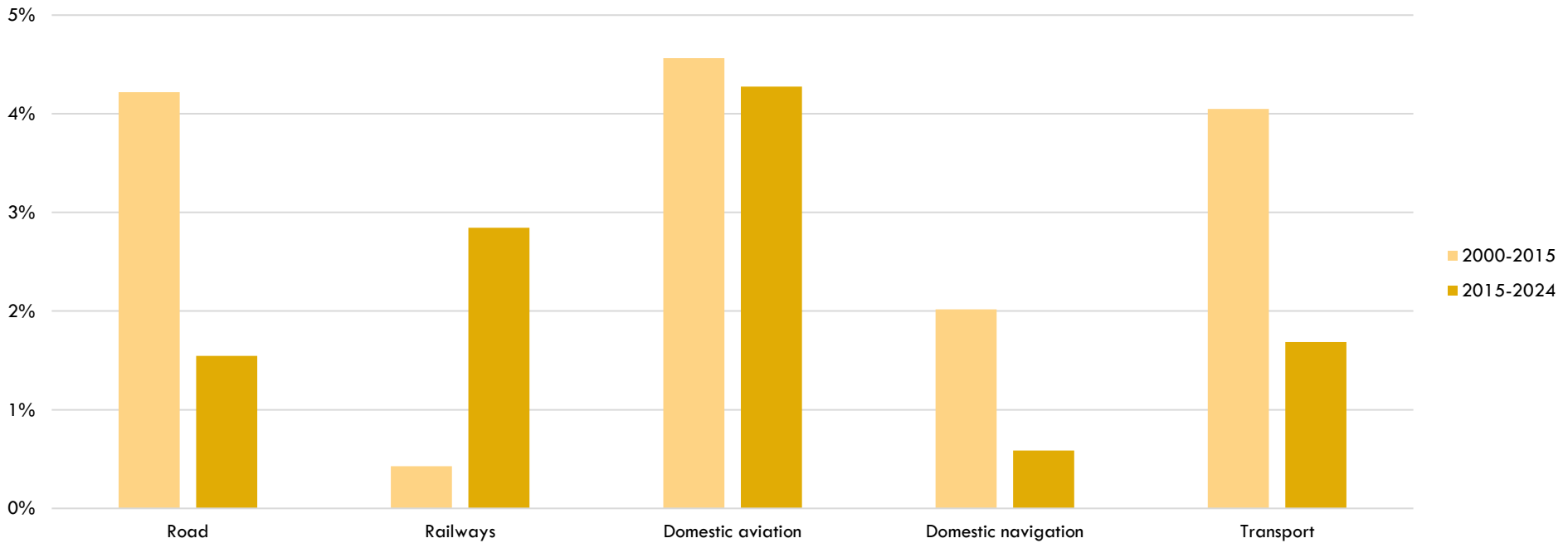


Figure 16. GHG Average Annual Growth Rates by Mode

Source: ATO analysis and visualization based on JRC & IEA (2025)

The East Asian region, especially the People's Republic of China, has been leading the deceleration in road transport GHG emissions (Figure 17 and Figure 18).

The implementation of transport mitigation measures is starting to show results, with road transport GHG emissions 4% below 2018 levels as of 2024. Since 2018, economies with the highest increase in road CO2 emissions have been Myanmar, Tajikistan, Mongolia, the Maldives, and Kazakhstan. Economies with absolute reductions in road GHG emissions are Turkmenistan, Bhutan, Brunei Darussalam, Japan, and the Lao People's Democratic Republic.

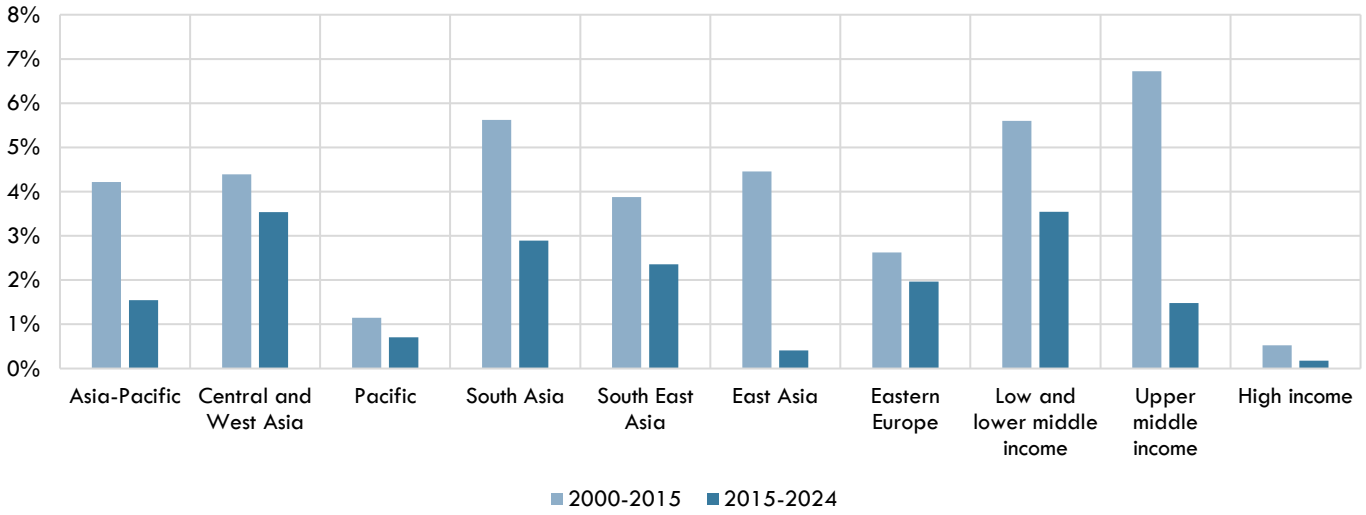


Figure 17. Transport GHG Average Annual Growth Rates by Sub-Region, Region, and Income Classification

Source: ATO analysis and visualization based on JRC & IEA (2025)

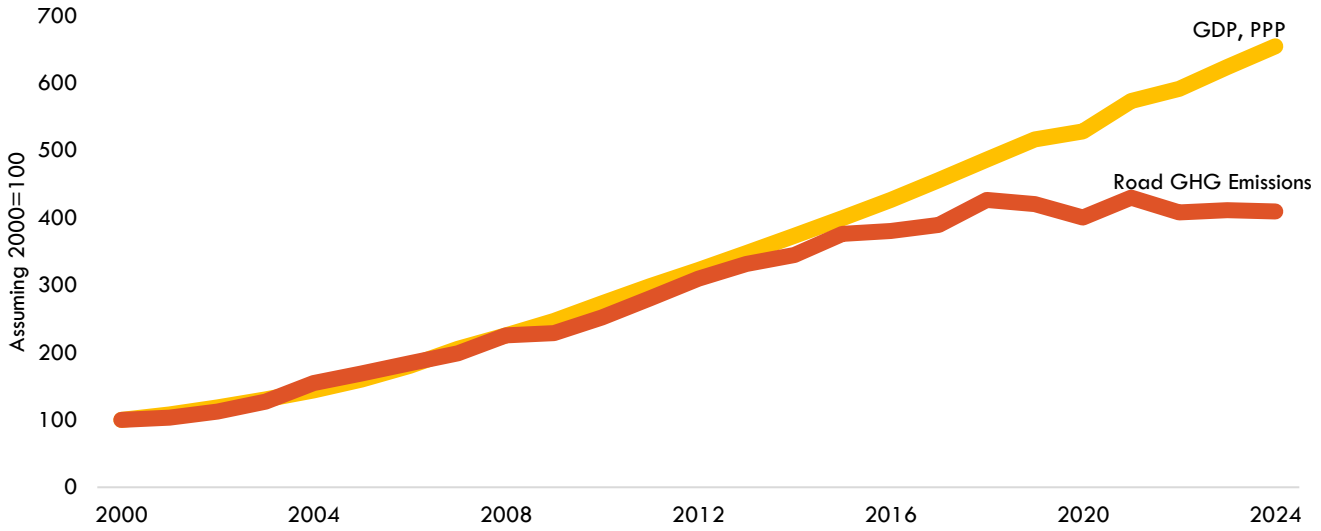


Figure 18. Road GHG Emissions and GDP (2000 as 100)– People's Republic of China

Source: ATO analysis and visualization based on JRC & IEA (2025)

7 Road Transport Emissions: Diverse Patterns

The composition of CO2 emissions from road transport in Asia reveals distinct patterns across different income levels. Light-duty vehicles, such as passenger cars, SUV's and taxis, consistently account for a significant share of road transport GHG emissions (Figure 19). However, this share varies considerably, representing 55% of emissions in low- and lower-middle-income economies, 45% in upper-middle-income economies, and 41% in high-income economies. The contribution of two-wheelers, including motorcycles and scooters, also displays significant differences. While they account for a negligible 1% of emissions in high-income economies, their share rises to 4% in upper-middle-income economies and a substantial 14% in low- and lower-middle-income economies. These disparities highlight the diverse nature of road transport systems and the varying reliance on different vehicle types across income levels in Asia, which has important implications for targeted emissions reduction strategies.

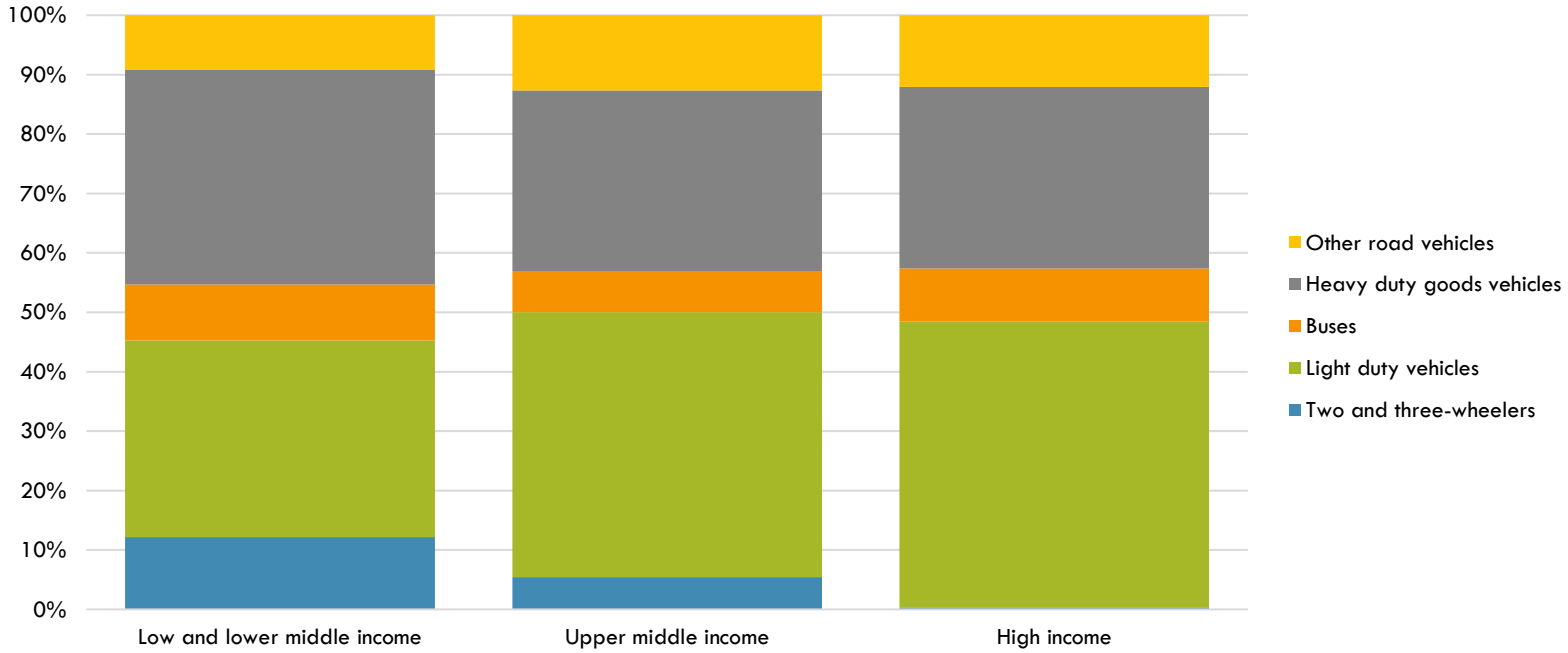


Figure 19. Road Transport CO2 Emissions Share by Sub-mode by Economy Income Type

Source: ATO analysis and visualization based on IIASA (2025)

A closer look at the modal shares in the road transport CO2 emissions is reflective of the nuanced characteristics of transport systems in the sub-regions. For example, two-wheelers contribute more prominently to the total emissions in Southeast Asia and South Asia (Figure 20). These disparities demand targeted, and context-sensitive strategies. A policy for cars in Seoul is not a policy for motorcycles in Hanoi.

Differences in modal emissions highlight regional contrasts, underscoring the need for context-specific, mode-sensitive transport policies.

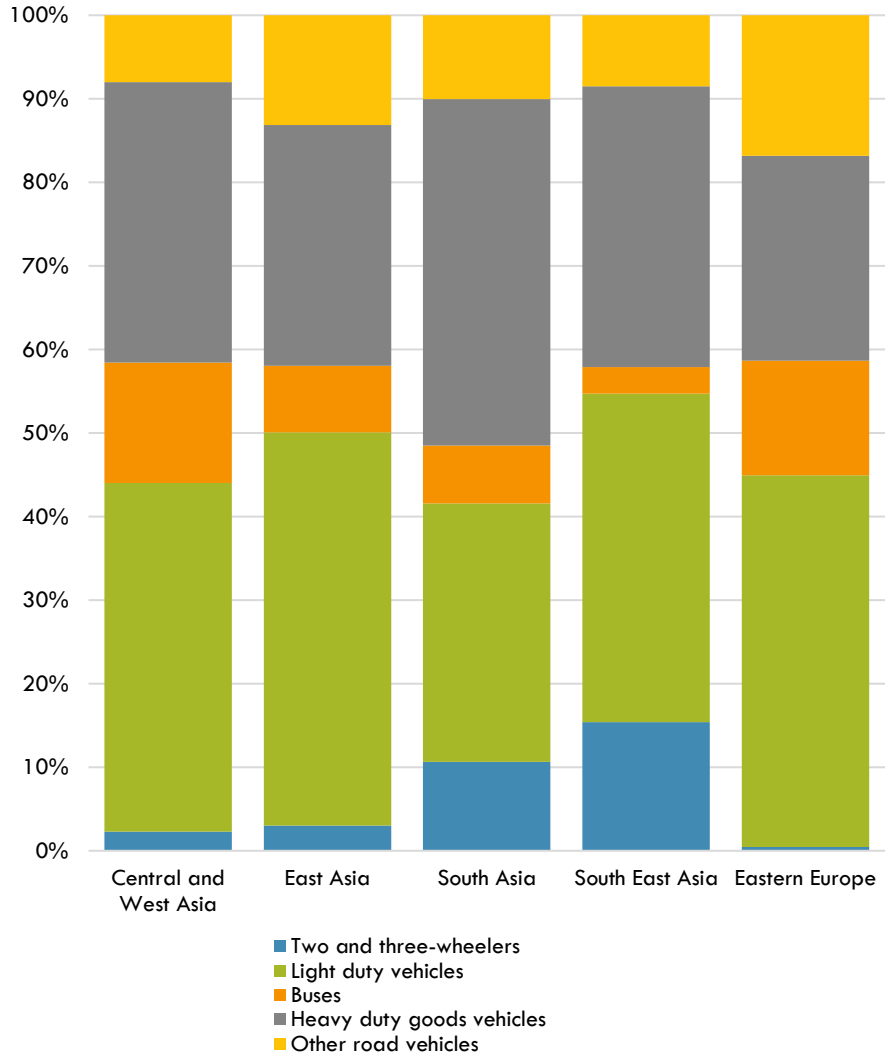


Figure 20. Road Transport CO2 Emissions Share by Sub-mode by Sub-region

Source: ATO analysis and visualization based on IIASA (2025)

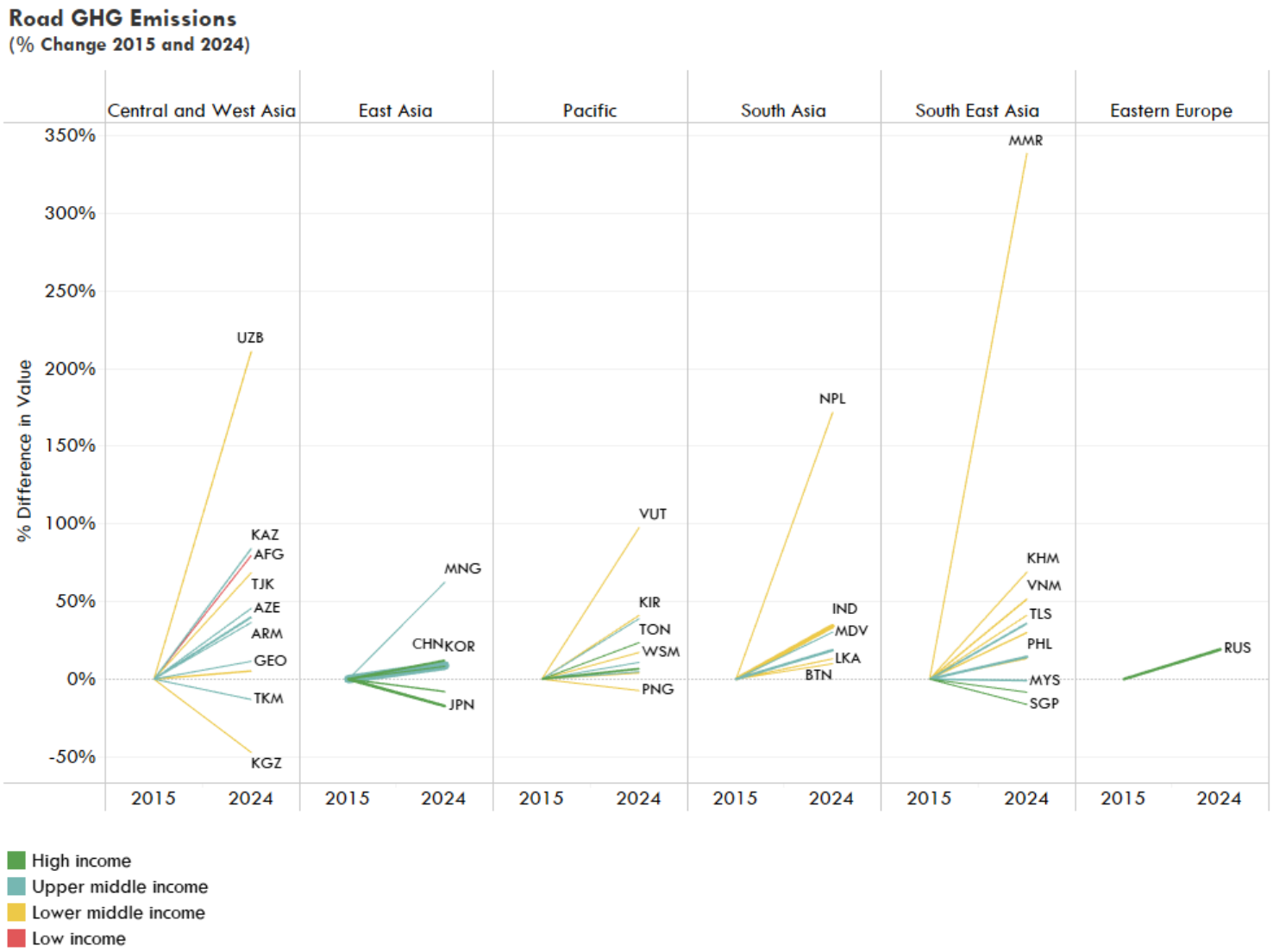


Figure 21. Road Transport GHG Emissions Trajectories (2015 vs 2024)

Source: ATO analysis and visualization based on JRC & IEA (2025)

Diversity is also evident in the varying growth rates of economies in terms of road transport GHG emissions. Several lower-middle-income economies have more than doubled their road transport GHG emissions in 2024 in comparison to 2015 (Figure 21). Economies with larger shares in the region's total road transport GHG emissions have been growing at much slower paces over the last decade.

8 Electric Vehicles: Nearing a Tipping Point?

While Asia is frequently indicated as the undisputed leader of the electric vehicle revolution, accounting for 60% of the global growth in electric cars and nearly 90% of new electric buses between 2015 and 2023 (IEA, 2025b), a closer examination of the data reveals a more complex and varied picture. The narrative of Asian transformation masks significant challenges that warrant a more granular analysis.

The data on new vehicle sales, or flows, certainly paint a picture of rapid, although uneven, diffusion. The People's Republic of China is a clear outlier, with electric vehicles reaching a remarkable 48% of new car sales, setting a formidable benchmark. Yet is this exponential growth representative of the entire region? Other nations follow at a considerable distance. While Viet Nam (17%), Australia (13%), and Thailand (13%) appear to be entering an "early majority" phase of adoption, major automotive markets like the Republic of Korea (9%) and Japan (3%) remain firmly in the "early adopter" stage. India, at a mere 2.1%, is only just embarking on its transition. This heterogeneity in adoption rates begs the question of what underlying structural, economic, and policy factors are driving such different outcomes.

To understand the impact, we must distinguish between the flow of new sales and the composition of the total vehicle stock. High sales figures are one thing; transforming the entire fleet is another challenge altogether. The existing stock of billion older, internal combustion engine vehicles creates a powerful inertia, ensuring they will remain on the roads for years, if not decades, to come. This reality of slow fleet turnover is why, even in a pioneering market like the People's Republic of China, the share of EVs in the total fleet remains modest. Indeed, the 5% stock share—often considered a tipping point for market diffusion—has been breached by only a handful of economies. This contrast between rapid sales growth and slow fleet turnover underscores a fundamental challenge for decarbonization (Figure 22) (Figure 23).

Finally, the region's dominance in trade statistics also requires careful interpretation. The twelve-fold explosion in Asia's electric vehicle trade, reaching 106 billion USD by 2023, is heavily skewed by two- and three-wheelers, which constitute approximately 90% of the world's electric fleet in these categories. While crucial for mobility, their lower economic value can mask the actual depth of the transition. Simply looking at aggregate figures, then, may lead to an overly optimistic or pessimistic assessment of the decarbonization of transport in Asia. The critical question remains: how quickly can we overcome the powerful inertia of the existing stock?

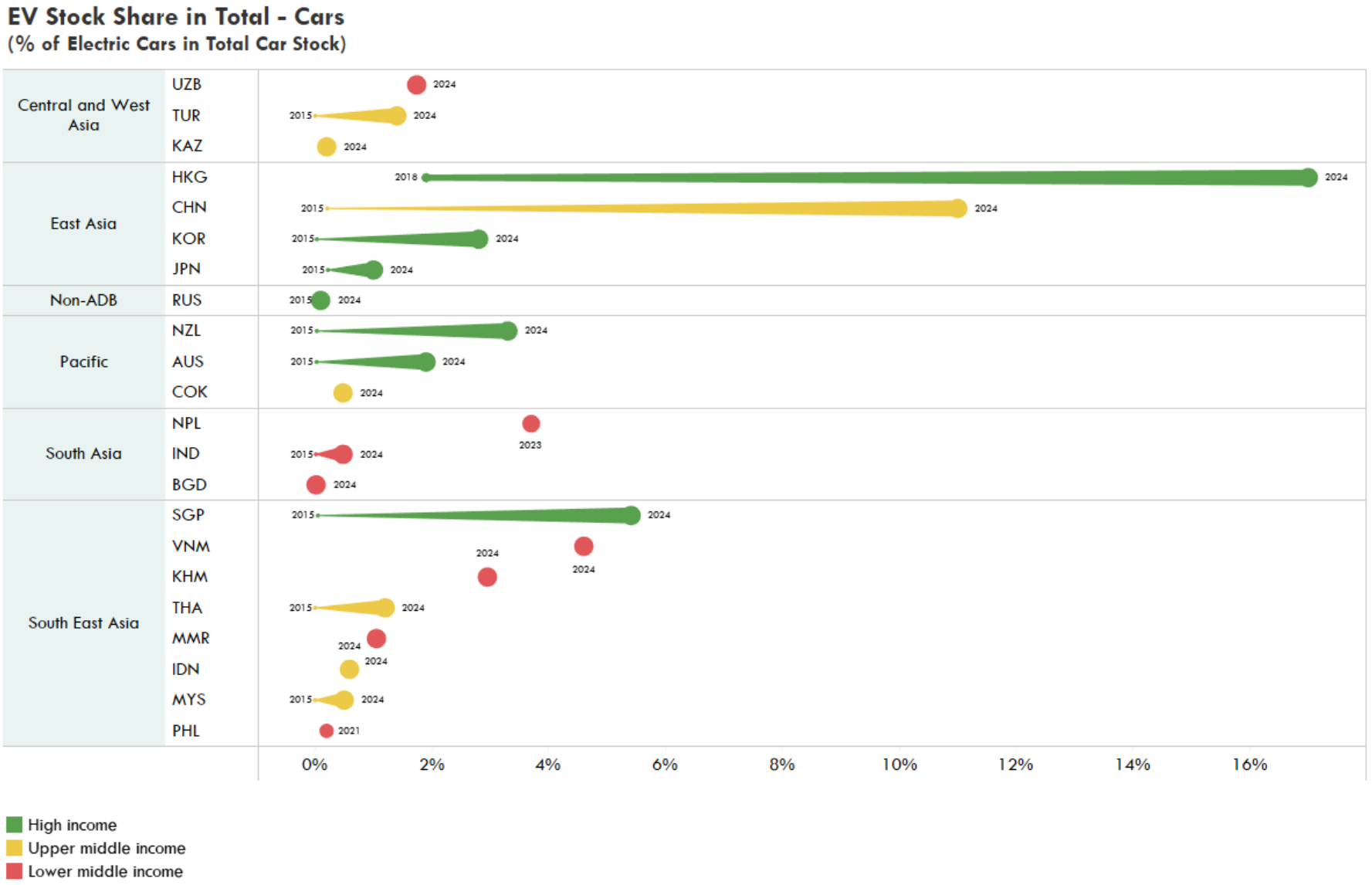


Figure 22. Historical EV Stock Share

Source: ATO analysis and visualization based on IEA (2025a) and vehicle registration estimates

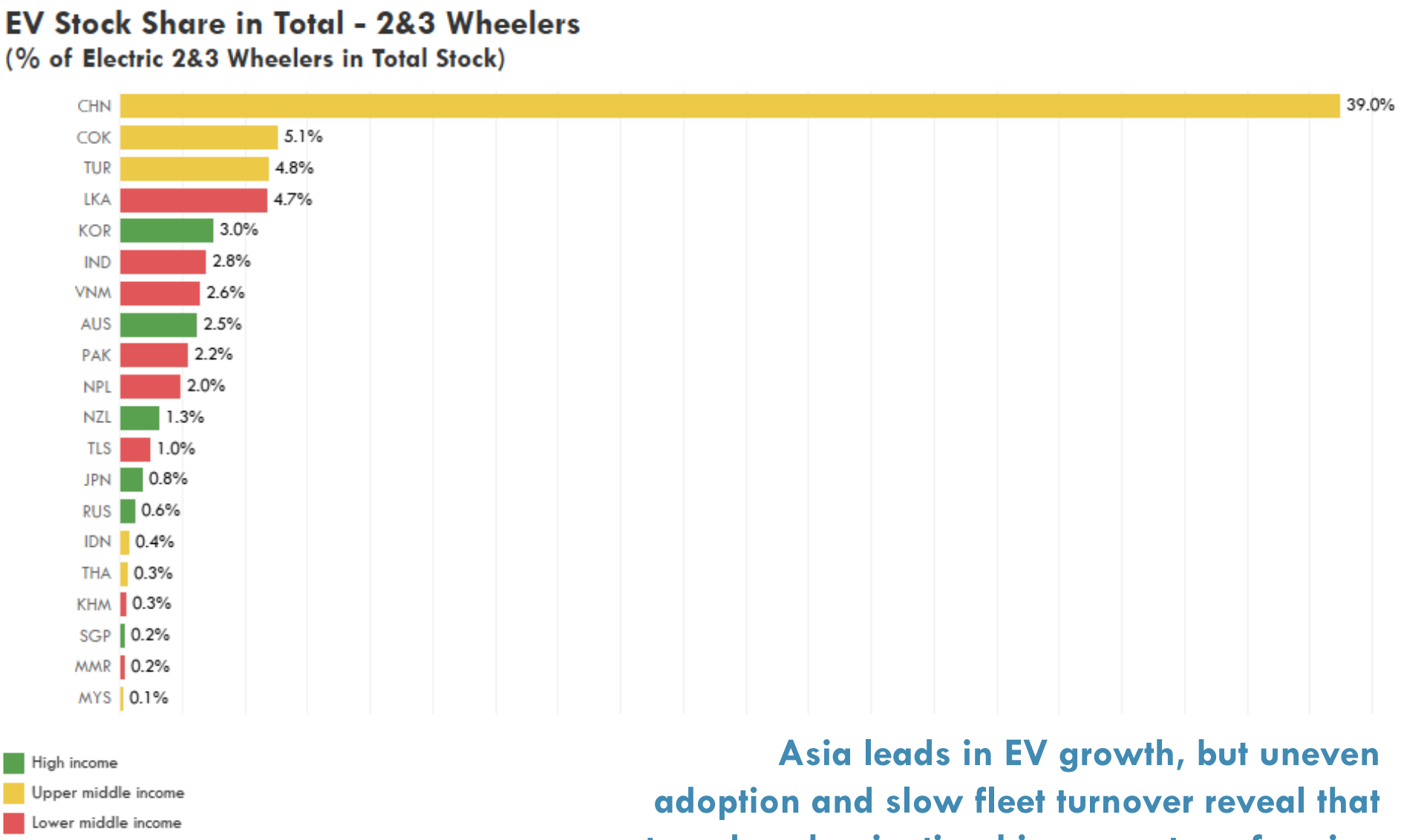


Figure 23. EV Stock Share by Economy

Source: ATO analysis and visualization based on IEA (2025a) and vehicle registration estimates

Asia leads in EV growth, but uneven adoption and slow fleet turnover reveal that true decarbonization hinges on transforming existing vehicle stocks, not just new sales.

9 Concentrated Growth: The State of Biofuels in Asian Transport

Bioenergy for transport takes many forms: bioethanol, biodiesel, biomethane, and advanced fuels such as hydrogenated vegetable oil. Their distinct advantage is their utility. They can power the existing global fleet of combustion vehicles now, requiring few technical changes. This makes them a present-day tool for decarbonization, offering one of the few viable, low-carbon solutions for the heavy-duty trucks, ships, and aircraft that are otherwise difficult to decarbonize.

Global demand has never been higher. In 2022, consumption reached a record 4.3 EJ (170,000 billion liters), surpassing levels seen before the COVID-19 pandemic disruption (IEA, n.d.). In the Asia-Pacific region, the use of these fuels has increased, but the story is one of unrealized potential. Biofuels' contribution to the region's transport CO2 emissions grew from 0.8% in 2015 to 2.3% in 2024. Although overall transport CO2 emissions rose by 16% since 2015, biofuel-related transport emissions increased by 244%.

This growth, however, cannot mask a fundamental inertia. The transport sector lags far behind others in diversifying its energy mix. Transport is a relatively small player in the global bioenergy landscape, accounting for just 7% of the total supply, while over 80% is used for heating. Within Asia, the transport sector's share of biofuel emissions is even smaller, at 1.8%. Yet, this is growing in global significance. Asia's share of global transport biofuel emissions increased from 8% in 2015 to nearly 19% in 2024. The region is becoming a larger force in a field that remains startlingly small (Figure 24).

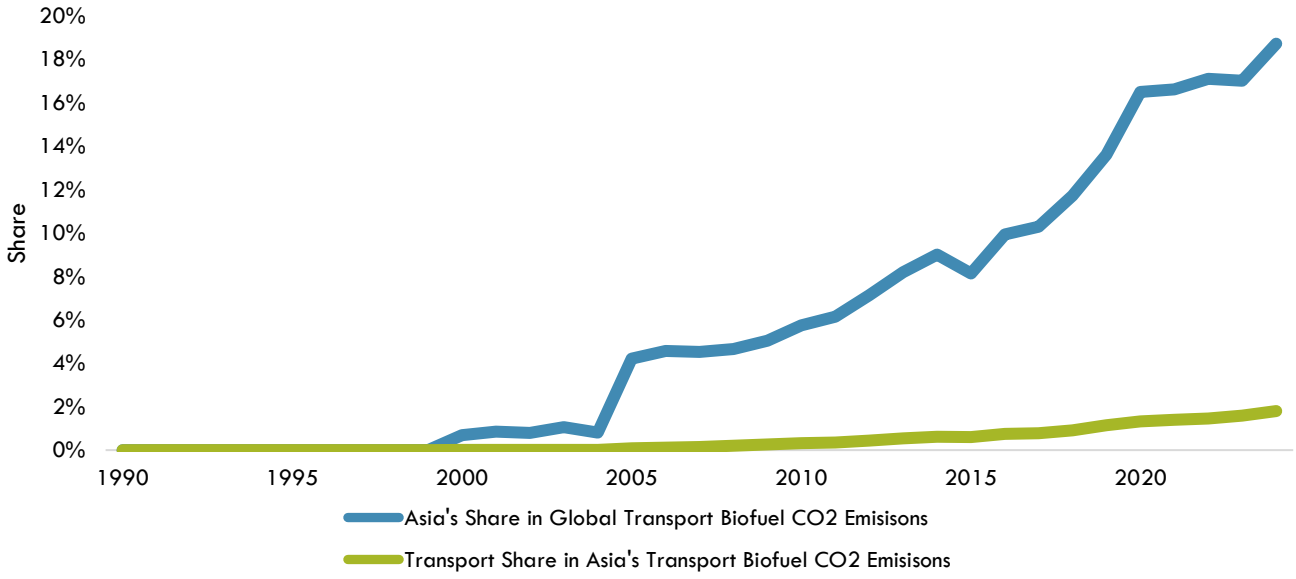


Figure 24. Asia's Share in Transport Bio Emissions and Transport's Share in Asia's Transport Emissions

Source: ATO analysis and visualization based on JRC & IEA (2025)

Figure 25 below depicts the distribution of Asia's GHG emissions attributable to fossil and bioenergy for the different GHG types and modes. Consumption in Asia is concentrated. Just five nations—Indonesia, India, the People's Republic of China, Thailand, and Malaysia—account for nearly all of it, commanding close to 90% share of the region's transport biofuel CO2 emissions. Within this core group, the rate of expansion is startling. Since 2015, emissions from transport biofuels have grown at an annual pace of 38% in Indonesia and 25% in India.

Biofuel consumption in Asia is highly concentrated. Just five nations—Indonesia, India, the People's Republic of China, Thailand, and Malaysia—account for nearly all of it, commanding close to 90% share of the region's transport biofuel CO2 emissions. Within this core group, the rate of expansion is startling. Since 2015, emissions from transport biofuels have grown at an annual pace of 38% in Indonesia and 25% in India.

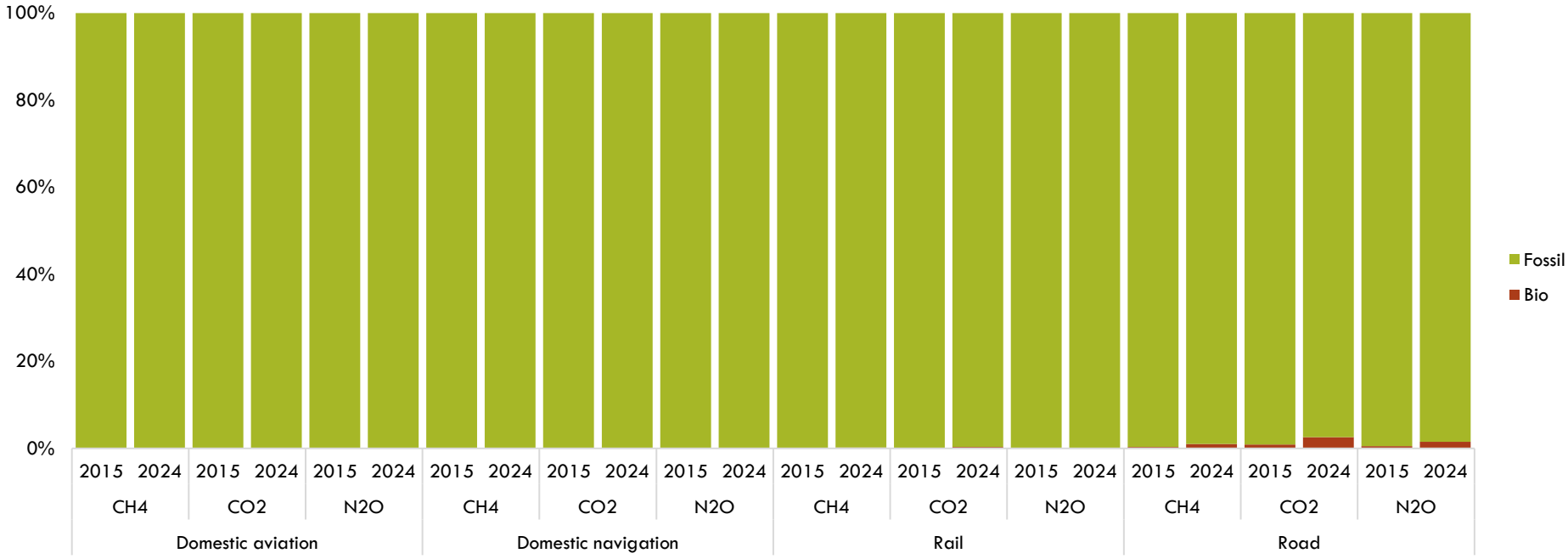


Figure 25. Fossil-based vs Bio-based GHG Emissions by Mode

Source: ATO analysis and visualization based on JRC & IEA (2025)

10 Railways in Transition: Growth, Electrification, and Emissions Trends in Asia

Railways in Asia are expanding at a historic pace. From 2000 to 2023, a 234,000-kilometer network expansion occurred, with construction speed more than doubling after 2010, reflecting a major shift in policies and investments toward a transport mode often associated with lower emissions. However, closer scrutiny of the data uncovers a paradox: during this period of significant investment, greenhouse gas emissions still increased in the sector.

Domestic railway GHG emissions in Asia grew at an average annual rate of only 0.4% between 2000 and 2015, followed by an average yearly rate of 2.8% between 2015 and 2024 (Figure 26). These trends underscore the importance of railway decarbonization measures, particularly electrification. In terms of growth in railway GHG emissions, the Russian Federation, and Central and West Asia, have been growing the fastest in the last decade. Significant deceleration in railway emissions growth is notable for Southeast Asia, while East Asia has retained negative average growth rates since the beginning of the century.

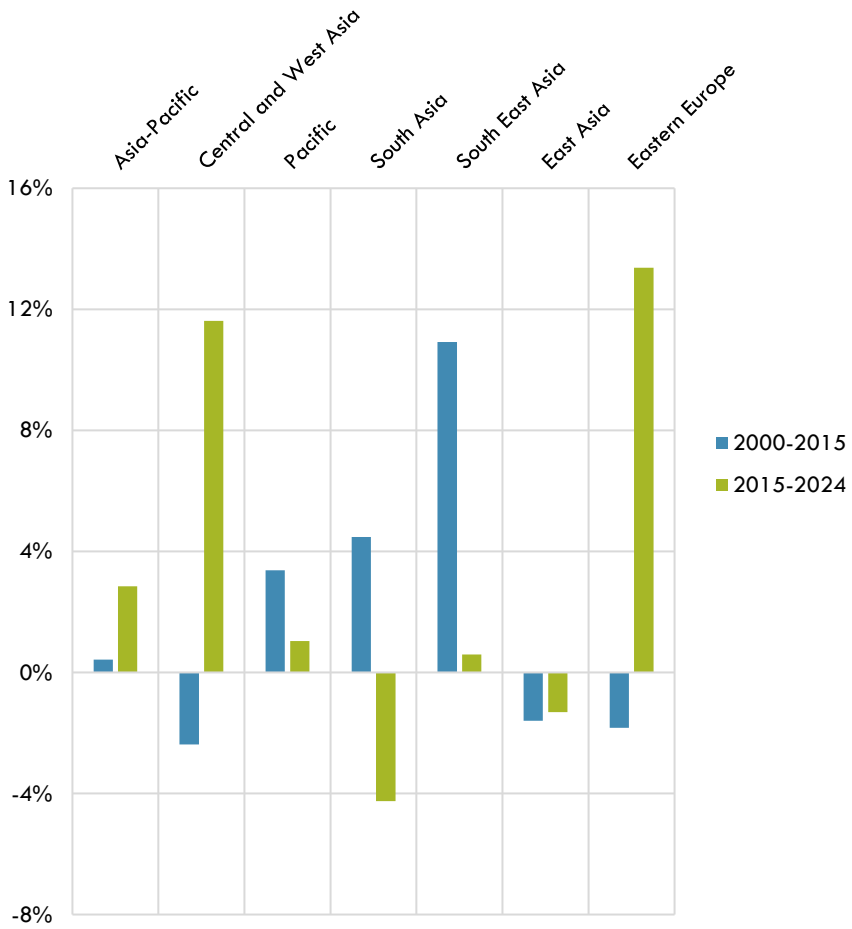


Figure 26. Railway GHG Emissions by Sub-region
Source: ATO analysis and visualization based on JRC & IEA (2025)

In terms of the magnitude of railway GHG emissions, these are currently dominated by a few economies. Eighty-five percent (85%) of the emissions are attributed to the Russian Federation, the People's Republic of China, India, Kazakhstan, and Australia (Figure 27).

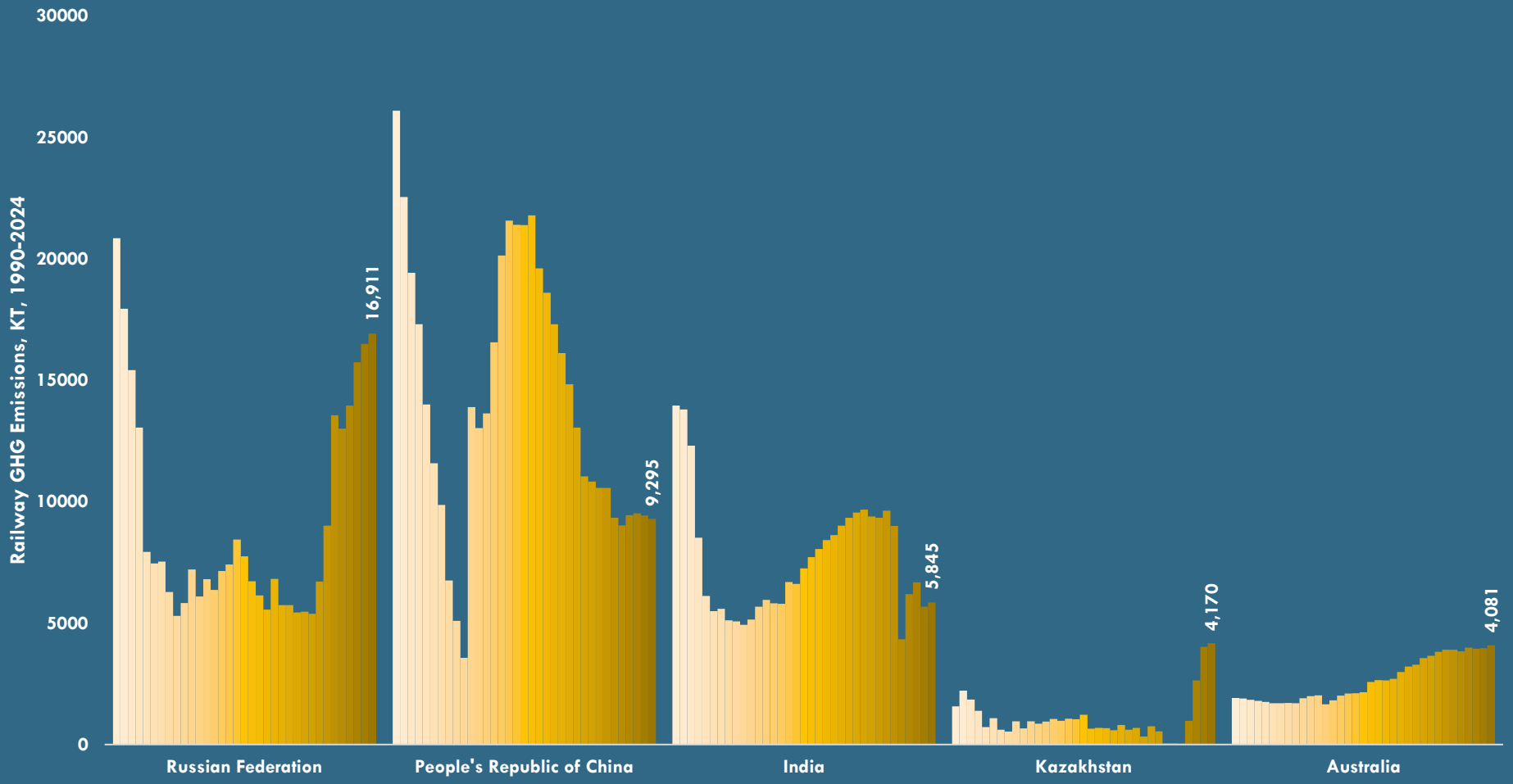


Figure 27. Railway GHG Emissions 1990-2024 (kilotons)
Source: ATO analysis and visualization based on JRC & IEA (2025)

A defining feature of rail modernization in the Asia-Pacific has been an improvement in energy efficiency. The sector's energy intensity—a measure of energy consumed per unit of economic output—reduced from 64 megajoules per thousand USD of GDP in 2000 to just 17 in 2022. This decoupling of energy use from economic activity is linked to a systemic shift in a few major economies toward electrification. In 2023, 56% of total tracks were electrified, up from 34% in 2000. Consequently, the share of electricity in the sector's final energy consumption expanded from 28 percent to 59 percent over the same period, a transformation visible in the changing composition of the rolling stock itself. The transition towards electrification of the Asian railways is also evident when we look at the evolution of the rolling stock towards electrified units, as depicted in Figure 28.

The decoupling of energy use from economic activity is linked to a systemic shift in a few major economies toward electrification.

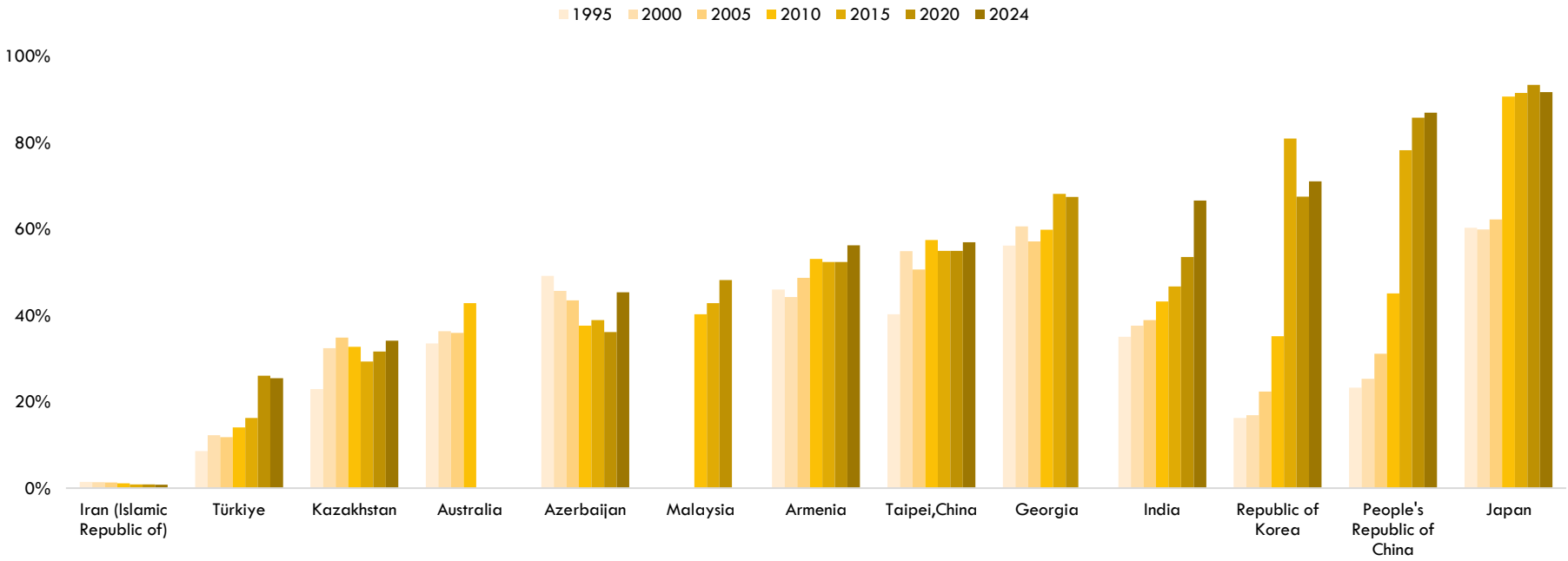


Figure 28. Share of Electrified Locomotives and Multiple Units

Source: ATO analysis and visualization based on JRC & IEA (2025) and UIC (2025)

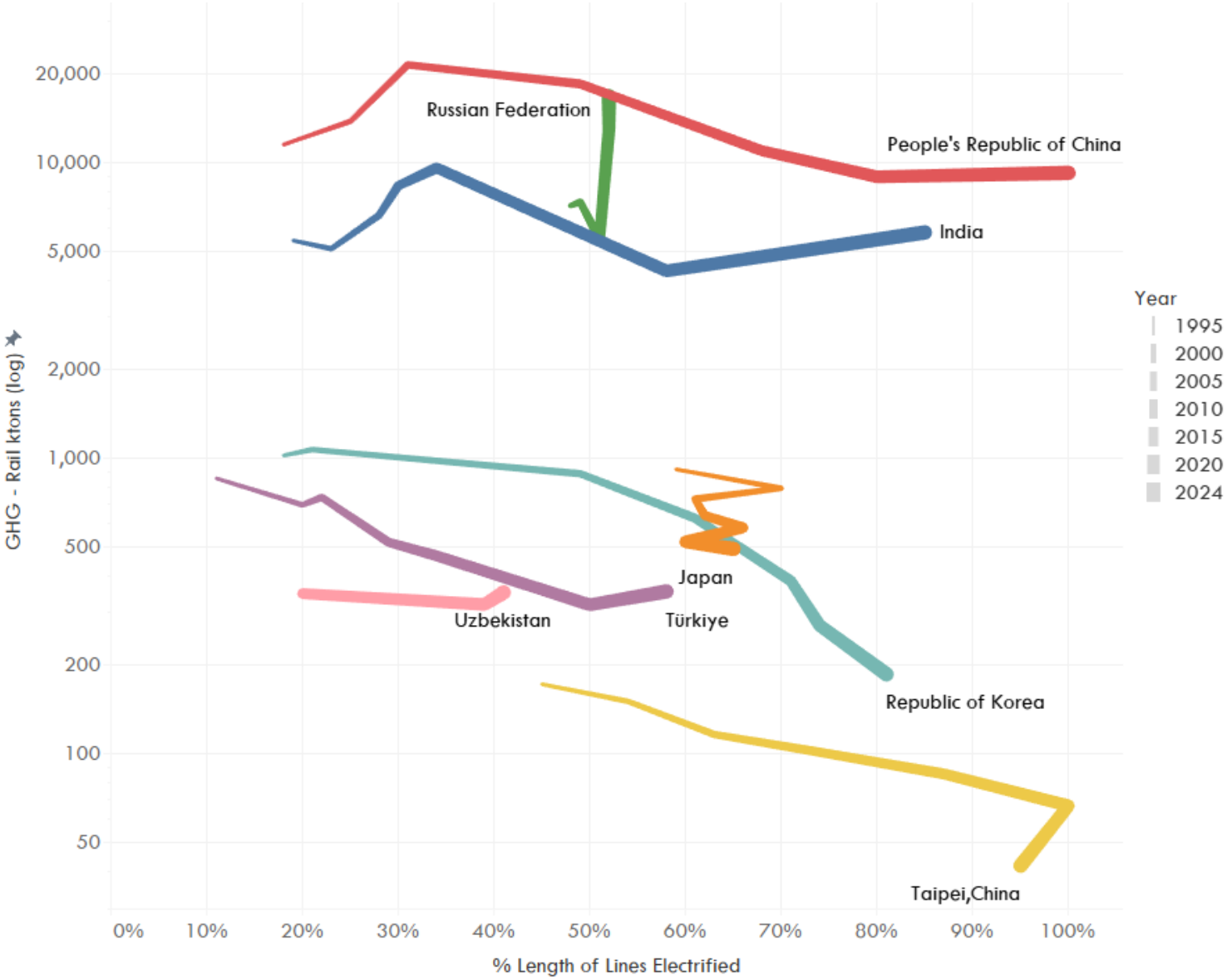


Figure 29. Railway GHG Emissions and % of Tracks Electrified

Source: ATO analysis and visualization based on JRC & IEA (2025) and UIC (2025)
Note: Data presented in 5-year increments (1995 to 2020, and 2024)

In terms of railway electrification, significant progress has been made in East and South Asia, making the impact more visible. Figure 29 depicts how rail GHG emissions have been curtailed in several economies which have transitioned towards electrifying their rail systems.

11 The Rising Trajectory of Asia's Aviation Emissions

Domestic aviation's contribution to Asia's total greenhouse gas emissions appears minor at first glance—just 0.6%. This figure, however, conceals a uniquely persistent challenge to decarbonization. The sector's emissions trajectory has proven resistant to policy intervention. The annual growth rate, which stood at 4.6% between 2000 and 2015, has only marginally slowed to 4.3% since then, establishing aviation as the fastest-growing source of emissions among all modes of transport and other primary energy-consuming sectors. Figure 30 below depicts the overall percentage growth of GHG emissions by mode in Asia from 2015 onwards.

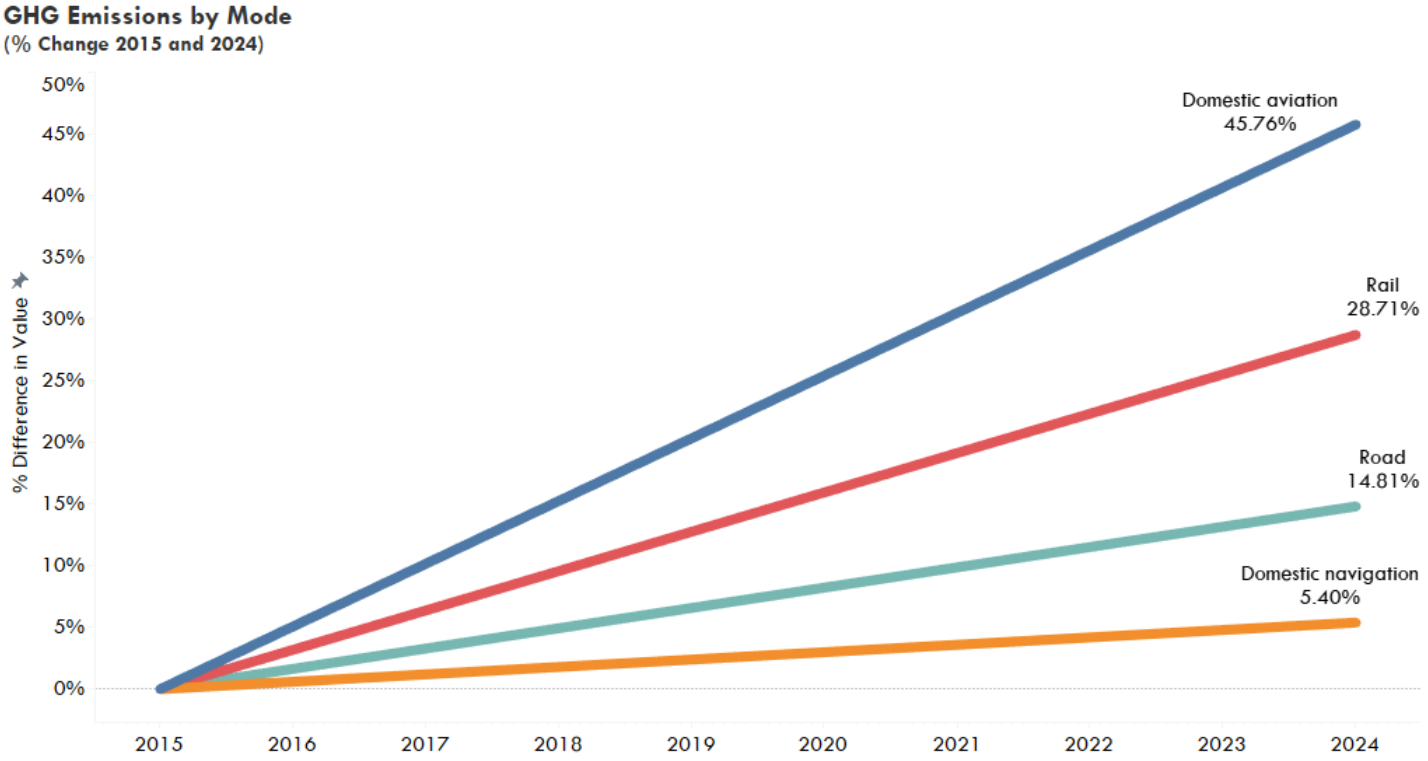


Figure 30. Transport GHG Emissions Trajectories by Mode (Asia) – 2024 vs 2015

Source: ATO analysis and visualization based on JRC & IEA (2025)

The recent growth in domestic aviation GHG emissions does not only stand out in the transport sector, but across the other sectors as well (Figure 31). Aviation activities in the Asia–Pacific region have steadily risen from an average of one flight per thousand people in 2000 to 2.9 flights per thousand in 2019, before the pandemic. However, this number decreased to 1.8 in 2021. Despite this growth, the region's aviation activity remains far below that of Europe, with about 12 flights per thousand, and North America, with 30.

The post-pandemic recovery in aviation travel demand was swift. In 2024, emissions reached nearly 183 Mt GHG, one-third higher than the lowest levels during the pandemic. This increase caused a global shift. Asia's share of worldwide domestic aviation emissions has more than doubled in a generation, climbing from 20% in 2000 to about 43% by 2024. The pace of this growth is now most acute in low- and lower-middle-income economies (Figure 32).

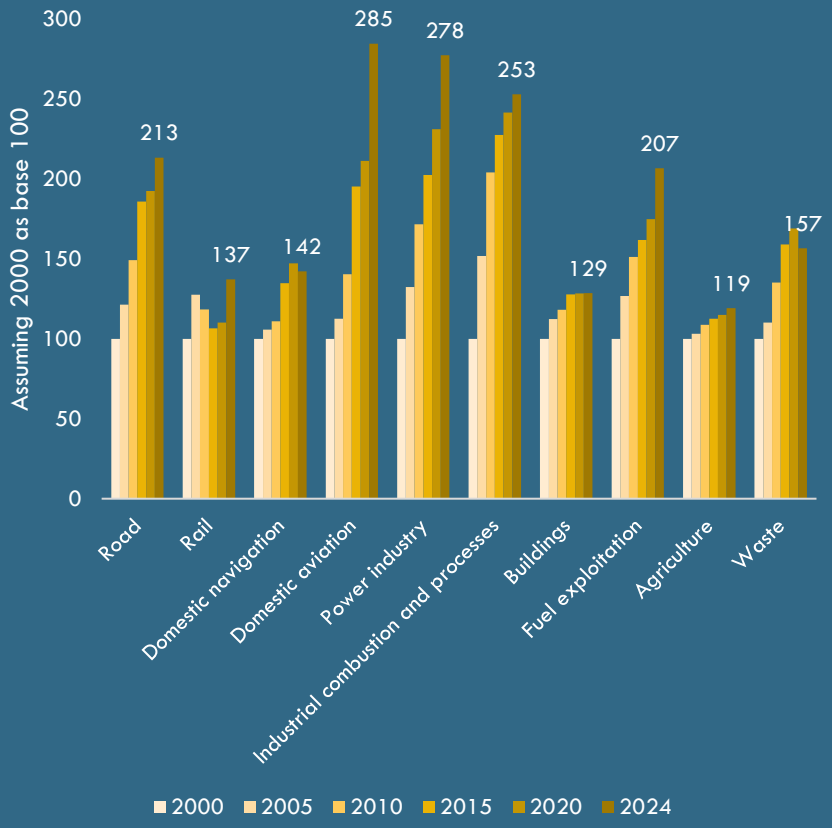


Figure 31. Fossil CO2 emissions 2000-2024
Source: ATO analysis and visualization based on JRC & IEA (2025)

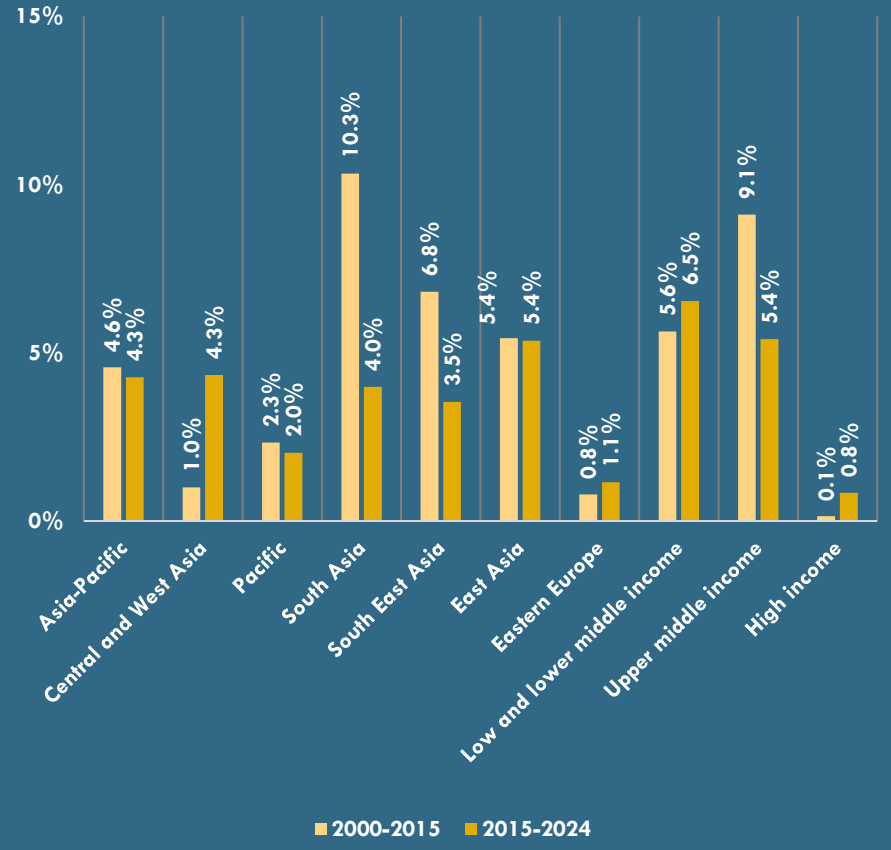


Figure 32. Domestic Aviation GHG Emissions by Sub-region and Income Categories
Source: ATO analysis and visualization based on JRC & IEA (2025)

Examining the individual economies in the Asia-Pacific region reveals a wide range of growth trajectories for domestic aviation emissions from 2015. Most notable are the developing economies in Central and West Asia (Figure 33).

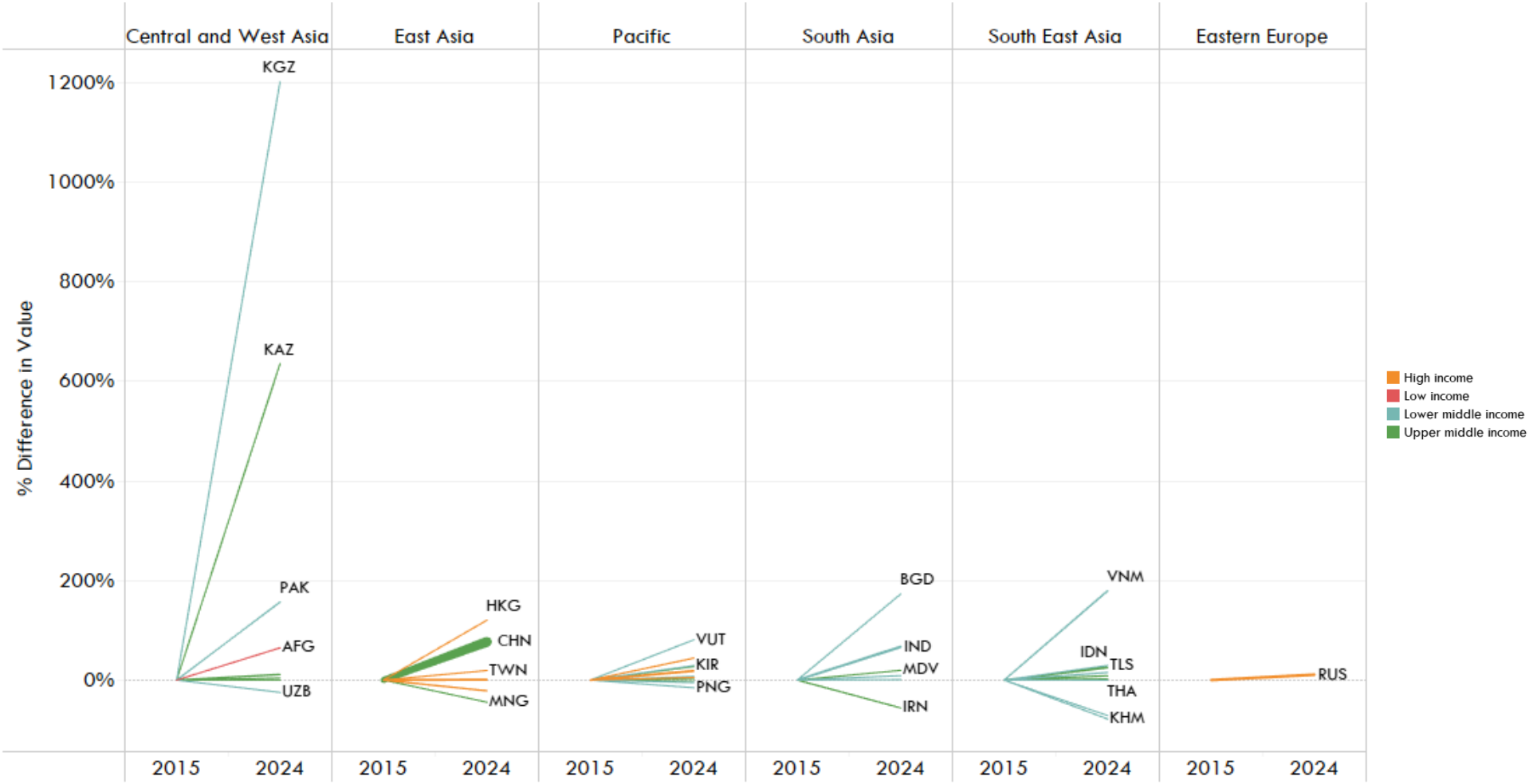


Figure 33. Domestic Aviation GHG Emissions Trajectories (2015 vs 2024)

Source: ATO analysis and visualization based on JRC & IEA (2025)

12 Domestic Navigation Emissions – Diverging Currents

Asia's inland and coastal shipping tells a story of partial decoupling. While greenhouse gas emissions from domestic shipping increased from 75 to 107 million tons between 2000 and 2024, the 1.5% annual growth rate has remained well below the region's GDP growth, even as it outpaced population expansion (Figure 34).

In 2024, however, this long-term trend was abruptly interrupted. Emissions in the past year alone fell 12%—one of the sharpest single-year reductions observed across any transport sub-sector. Is this an anomaly or a new trend?

The sector's emissions geography remains heavily concentrated; the People's Republic of China, which accounts for 94% of domestic freight movement, is the source of nearly two-thirds of domestic shipping GHG burden. However, a concerning and diverging trend has emerged in South Asia. There, the emissions growth rate from domestic shipping has doubled since 2015, sharply increasing from its previous trajectory (2000-2015) (Figure 34).

Figure 34. Domestic Navigation Average Annual Growth Rates by Sub-region and Income Categories

Source: ATO analysis and visualization based on JRC & IEA (2025)

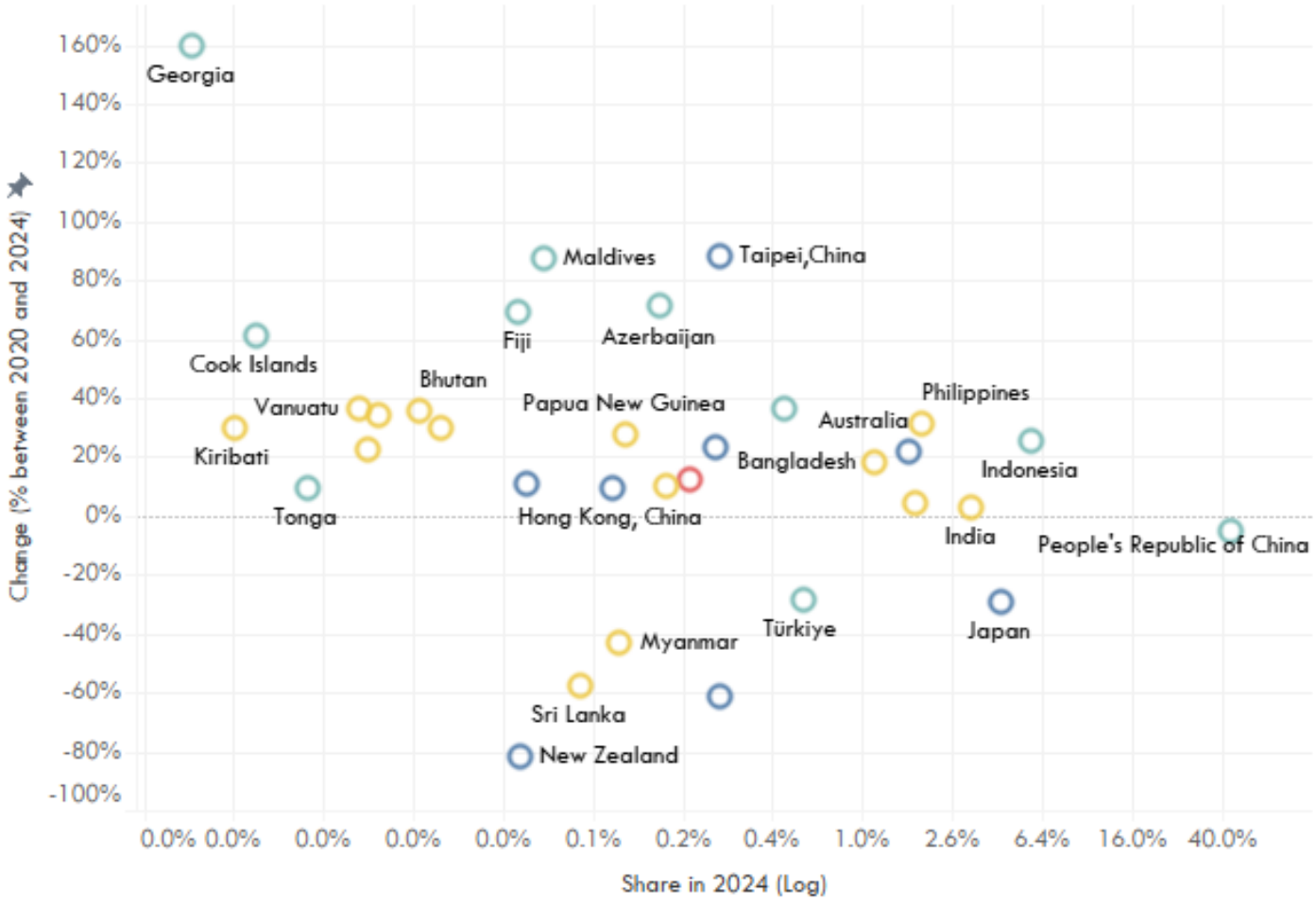


Figure 35. Domestic Navigation GHG Emissions Shares vs Asia's Total (2024) and Change (2024 vs 2020)
Source: ATO analysis and visualization based on JRC & IEA (2025)

Looking at the last 5 years, the largest contributors in terms the total GHGs for domestic navigation: People's Republic of China, and Japan, have exhibited negative average annual growth rates in emissions, even if comparing 2024 values with 2020 (which was during COVID) (Figure 35). It is notable that many economies have had at least 20% increase in domestic navigation GHG emissions since 2020.

Asia's inland and coastal shipping tells a story of partial decoupling. The sector's emissions geography remains heavily concentrated.

As we zoom into selected economies in the East Asian sub-region (Figure 36), several examples of "peaks" —which have occurred around two decades back— in relation to domestic navigation emissions are observable. The estimates for Japan show that peaking has happened in 1997, and the emissions have been cut down to less than half as of 2024. South Korea's emissions peaked in 1993 and has since reduced more 95% on the latest estimates. Taipei,China's domestic shipping emissions peaked in 2001, and emissions have reduced by at least 75%.

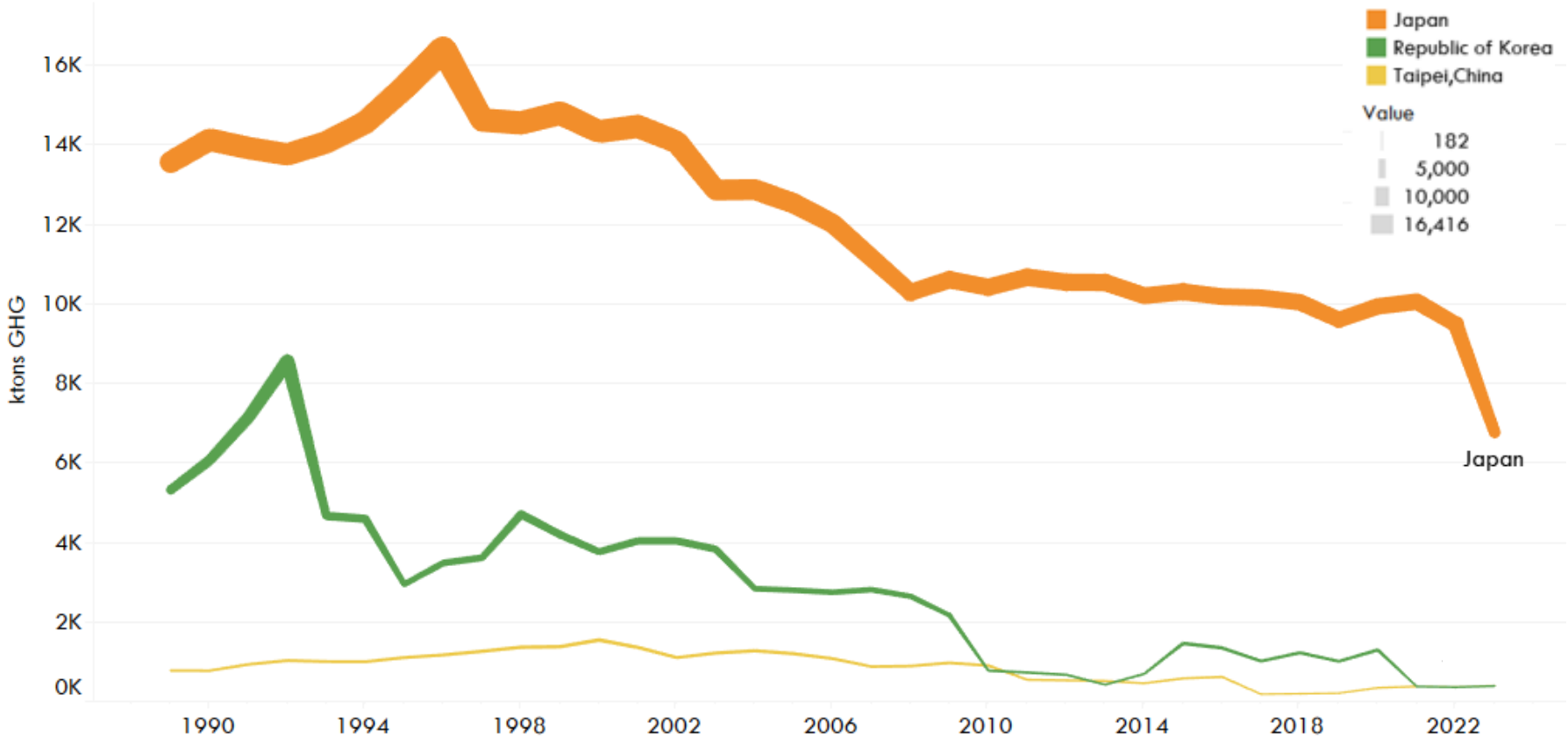


Figure 36. Domestic Navigation Emissions – Selected East Asian Economies (ktons GHG)

Source: ATO analysis and visualization based on JRC & IEA (2025)

An interesting curvature is also observed for the domestic navigation emissions growth trends for India, which seemed to have gradually slowed down and plateaued (Figure 37).

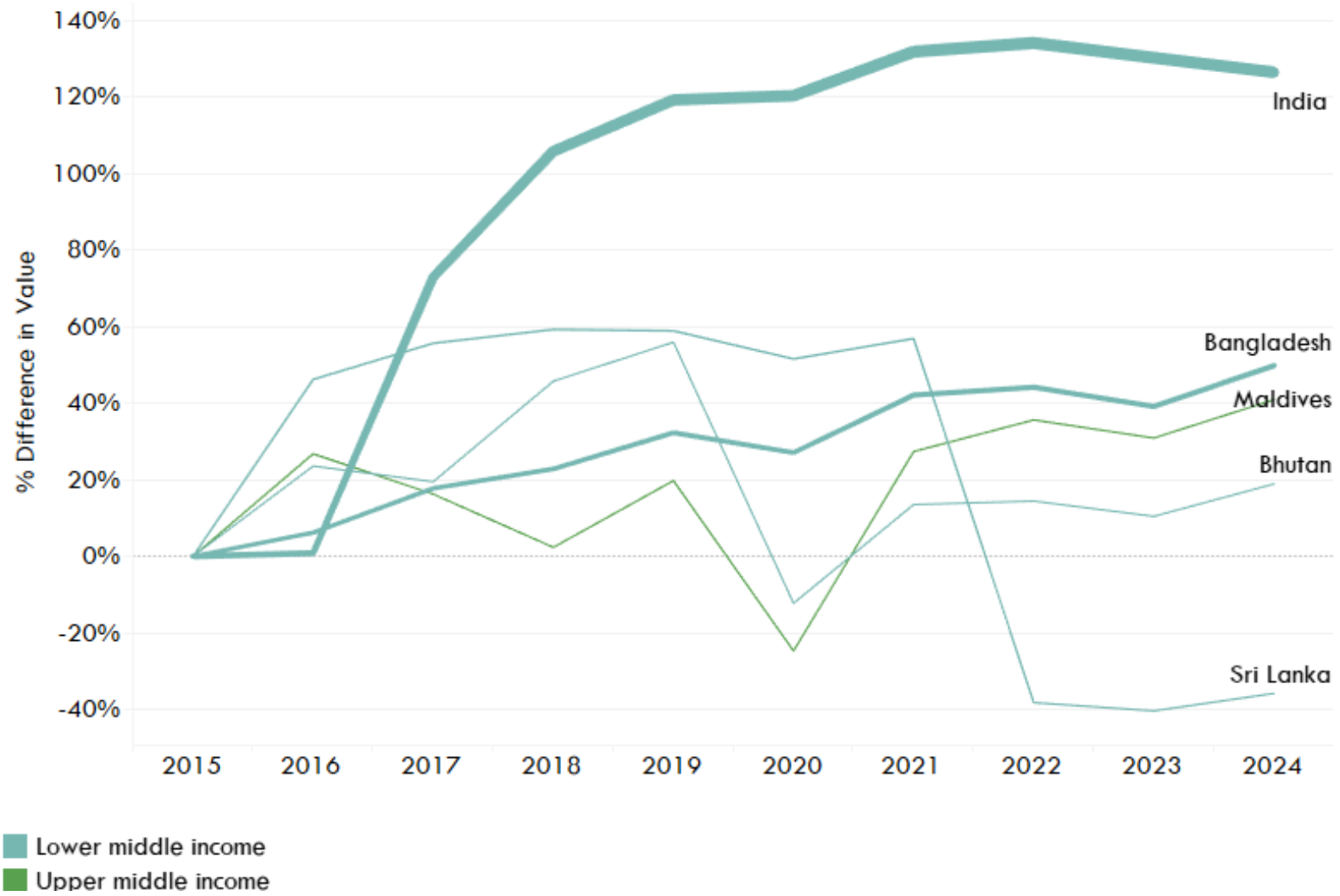


Figure 37. Domestic Navigation GHG Emissions – South Asian Economies (% Change vs 2015)

Source: ATO analysis and visualization based on JRC & IEA (2025)

13 Asia's transport decarbonization progress is lagging

Projections before the Paris Agreement painted a concerning picture, with transport GHG emissions potentially reaching above 7 Gt by 2050, primarily driven by low- and middle-income countries (Figure 38). While our reference scenario developed in 2021 suggests a less severe outcome, the current emissions trajectory indicates a high degree of incompatibility with scenarios that successfully achieve the Paris Agreement's climate goals.

This challenge is further compounded by the anticipated increase in transport demand, particularly in the freight sector. Current trends and policies indicate substantial growth in transport activity, potentially outpacing population and infrastructure growth. Projections suggest that passenger and freight transport demand could double or even quadruple between 2020 and 2050. This alarming growth trajectory implies that Asia alone could be responsible for roughly half of the global increase in transport demand.

The current trajectory of transport emissions in Asia poses a significant hurdle to achieving the essential decarbonization goals. Urgent and ambitious action is required to overcome this challenge.

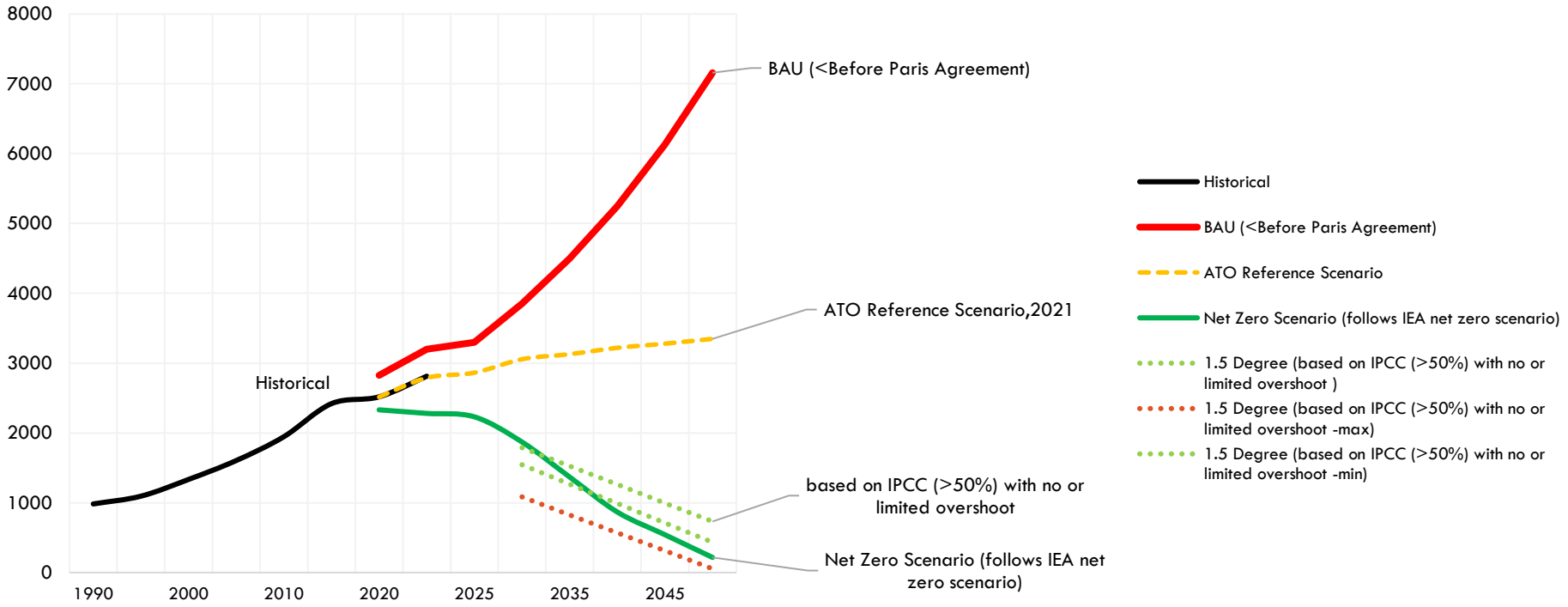


Figure 38. Transport CO2 Emissions (Mt) – Historical Estimates and Projections for Asia

Source: Updated based on Gota and Huizenga (2022)

14 Policy and Ambition: A Widening Gap

The grim statistics give way to some optimism when one turns to policy ambitions. The Asia-Pacific region has witnessed a dramatic shift in its commitment to addressing climate change. In 2015, less than 1% of the region's population resided in countries with ambitious long-term climate goals. However, by 2024, this number increased to a remarkable 93%, highlighting a substantial increase in climate ambition (Figure 39). This shift represents a near-total reversal in political will, aligning with the necessity of climate action.

Yet, the transport sector, a primary source of emissions, remains a blind spot. Currently, only 10% of the region's population lives in countries with explicit greenhouse gas emission reduction targets for the transport sector outlined in their Nationally Determined Contributions (NDCs).

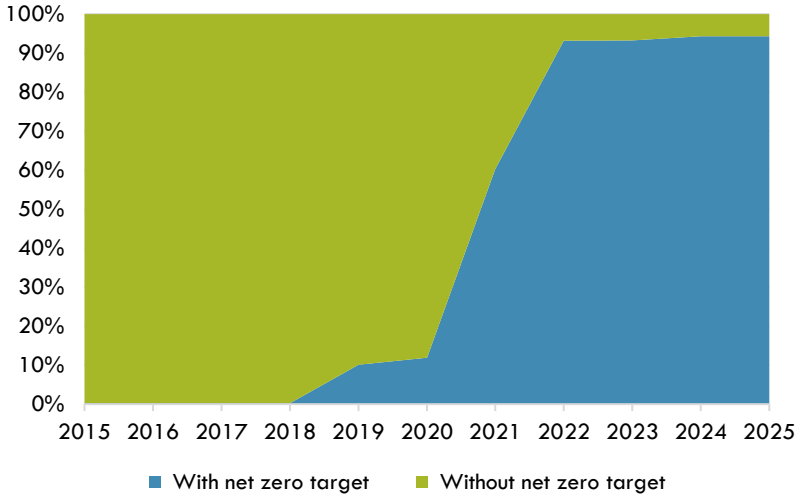


Figure 39. Asian countries with net zero targets, share in population

Source: ATO analysis and visualization based on ATO's policy tracker

The ambition so evident at the national level has failed to translate into concrete, sectoral accountability. While it is true that countries covering 76% of the population have included indirect transport-related measures, the nature of these goals often lacks the intensity and clarity required for deep decarbonization and aligning with national ambitions, creating a dangerous gap between stated intent and measurable progress.

As of 2025, 32 out of 43 countries for which we have analyzed the policies in detail (listed out in annex 1) have announced formal Net Zero targets, with 22 (around 51%) aiming to reach Net Zero by 2050 (Figure 40).

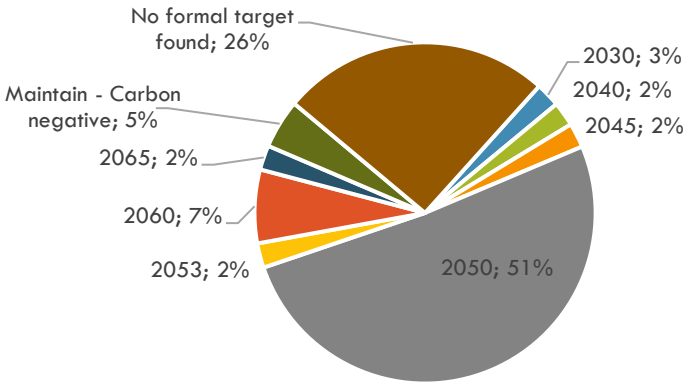


Figure 40. Distribution of Economies by Net Zero Formal Targets

Source: ATO analysis and visualization based on ATO's policy tracker

A clear progression in transport within climate policy is evident. Between 2015 and 2019, only 81% of NDCs included transport-specific measures or targets. Currently, all 14 Asian NDC submissions for 2025 incorporate transport-specific measures or targets. (Figure 41).

Analyzing the transport policies of 43 economies beyond NDCs reveals an exponential growth in policy measures over the years. Notably, documents that focus primarily on addressing externalities surpass those on transport sub modal infrastructure, with climate change being the most prominent theme, accounting for nearly 60% of externality-related documents. The focus is mainly on road infrastructure and operations, which seems to correlate with a slowdown in emissions, especially in bigger economies.

Does this mean that the slowdown in road emissions is not an accident, but rather the consequence of targeted policy and focused investments?

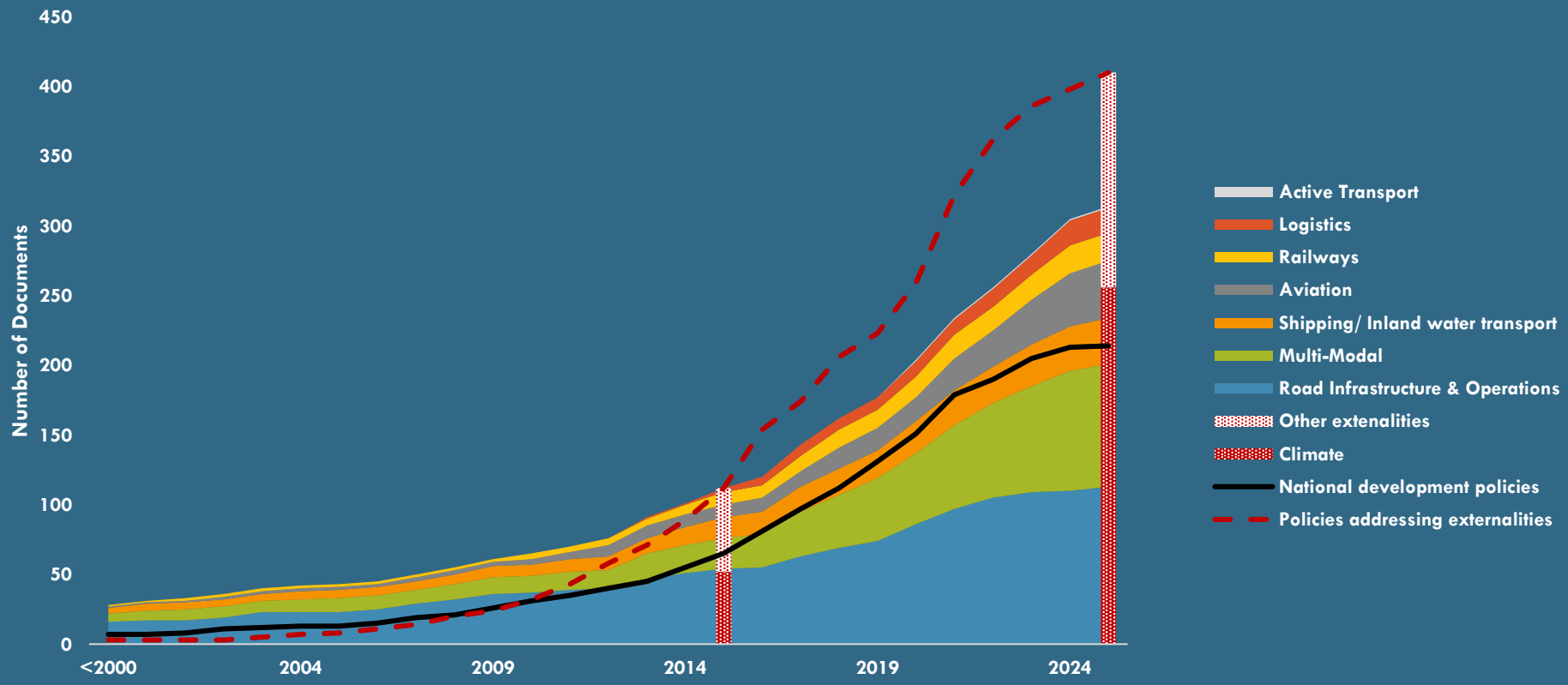


Figure 41. Distribution of Transport Policy and Related Documents by Focus Area
Source: ATO analysis and visualization based on ATO's policy tracker and secondary sources

An overall analysis of the transport climate policy landscape shows that NDCs, despite their political prominence, are only the tip of the iceberg. A detailed review of the policy landscape indicates that NDCs include just 17% of all transport-specific climate measures. The much larger portion is found within the broader set of transport-relevant policy documents. This finding, derived from a more detailed analytical framework, makes one thing clear: relying on NDCs to assess progress is not just insufficient, it is misleading. The NDC may signal a destination (high-level intent), but the roadmap is written elsewhere, often outside the immediate focus of international climate efforts negotiations (Figure 42).

The distribution of modal-specific targets also reflects a nuance: while road dominates in both NDCs and other policies, NDCs show a slightly more balanced attention to rail, shipping, and aviation than other documents (Figure 43).

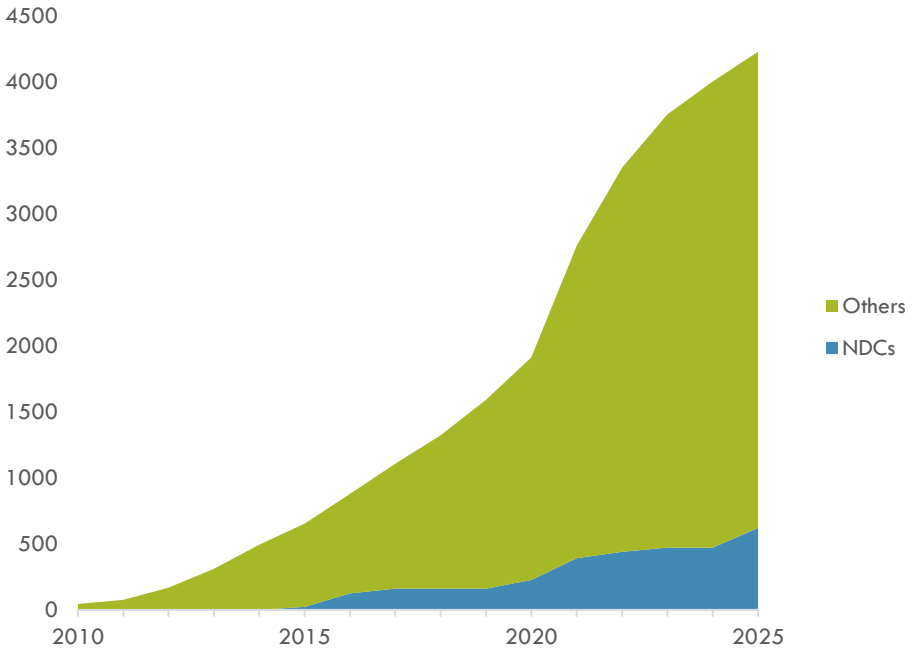


Figure 42. Cumulative Count of Transport-Specific Climate Measures by Document Source[2]

Source: ATO Visualization based on ATO's policy tracker

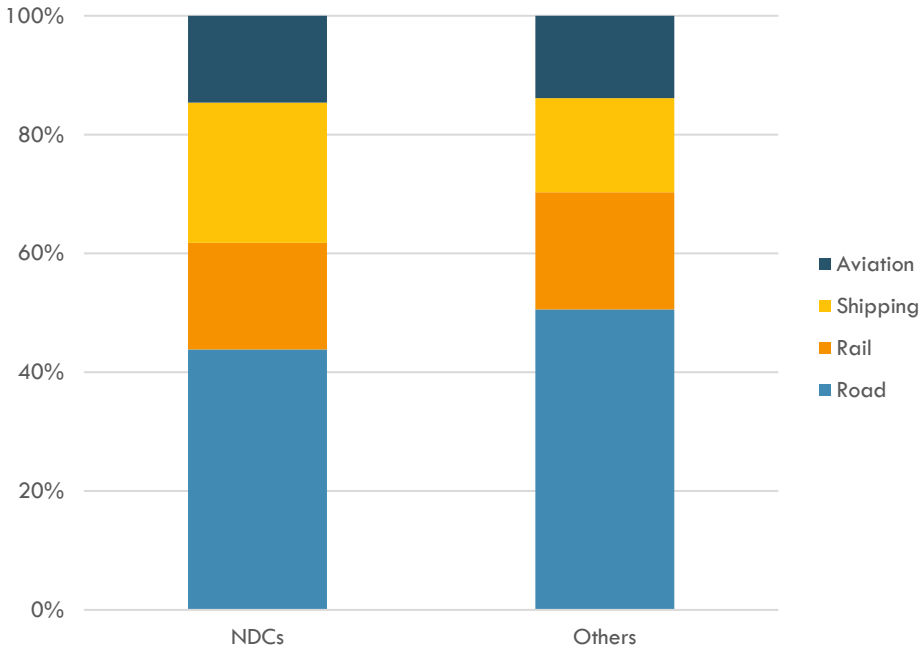


Figure 43. Modal Distribution of Targets

Source: ATO analysis and visualization based on ATO's policy tracker

[2] The count of transport-specific climate measures is derived from the predefined list of policy measure types in the ATO's National Policy Tracker. Each count represents the number of unique instances recorded per document for each measure type.

In terms of thematic priorities, NDCs place the strongest emphasis on renewable energy, e-mobility, modal shift, biofuels, and transport GHG management. In contrast, other transport policy documents highlight public transport improvement, e-mobility, renewable energy, EV charging infrastructure, and vehicle efficiency standards. Notably, electrification (through e-mobility) and renewable energy emerge as cross-cutting themes across both sets of documents (Figure 44).

A look at national climate pledges versus transport-specific policies reveals a telling gap in emphasis. NDCs prioritize renewable energy, e-mobility, and shifting transport modes. Standalone transport policies, however, focus more on the granular details of public transport improvement, EV charging infrastructure, active mobility, and vehicle efficiency standards. Electrification is the common ground.

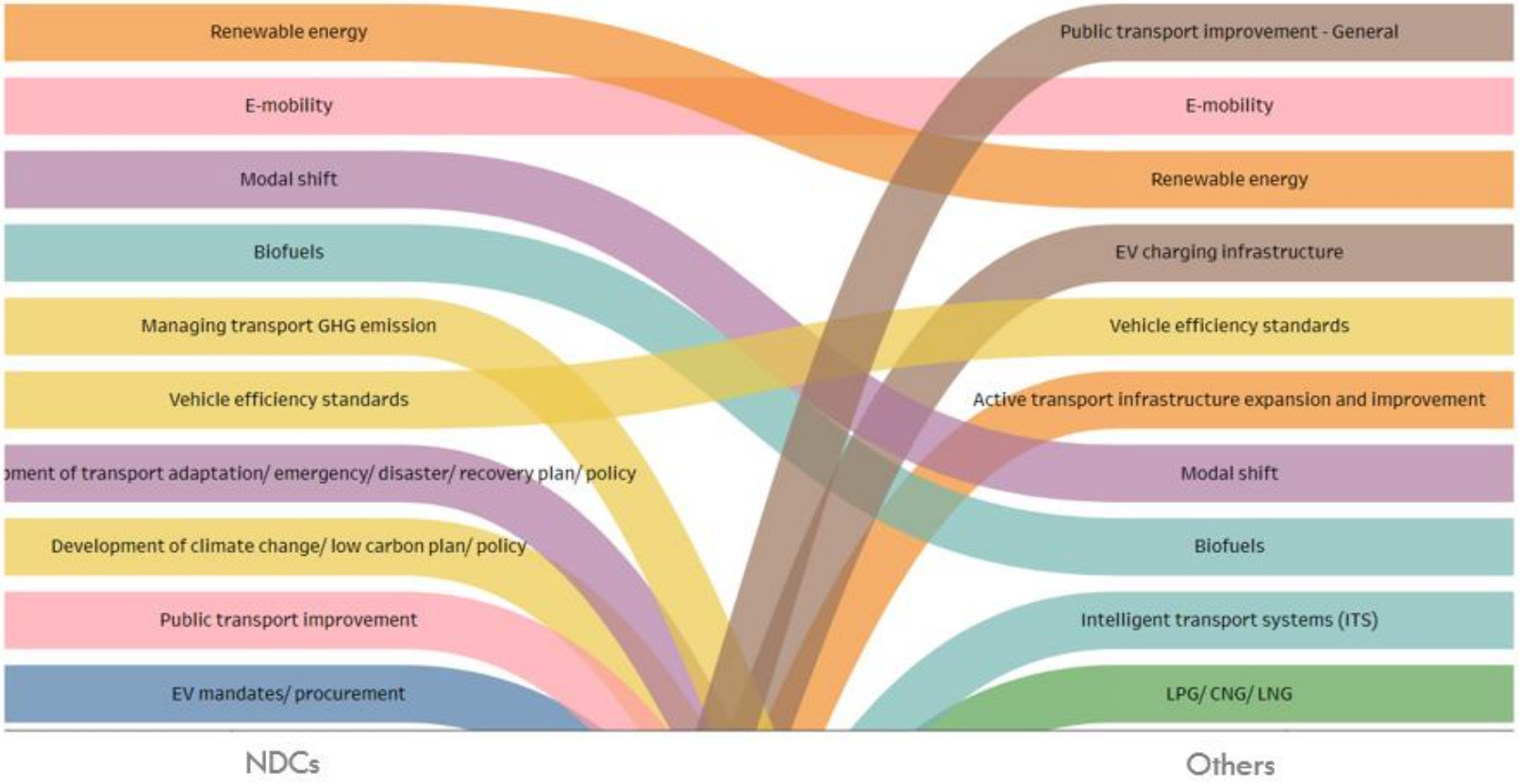


Figure 44. Thematic priorities between NDCs and Other Policy Documents

Source: ATO analysis and visualization based on ATO's policy tracker

The priorities within NDCs themselves have matured over time. Before 2020, climate commitments for transport were broad. They were dominated by renewable energy targets and general goals for managing greenhouse gas emissions and improving public transport. The focus was on energy (Figure 45). In contrast, post-2020 NDCs show a more diversified profile. Modal shift gains greater prominence, while biofuels and renewable energy remain strong priorities. At the same time, new areas are emerging, including EV charging infrastructure, active transport infrastructure, and urban rail expansion, which reflect a shift toward supporting electrification ecosystems and sustainable mobility options. Vehicle efficiency standards continue to hold importance across both periods. Overall, the evolution suggests that while earlier NDCs concentrated on broad energy and emissions measures, more recent submissions are increasingly action-oriented, integrating infrastructure, incentives, and system-level transitions.

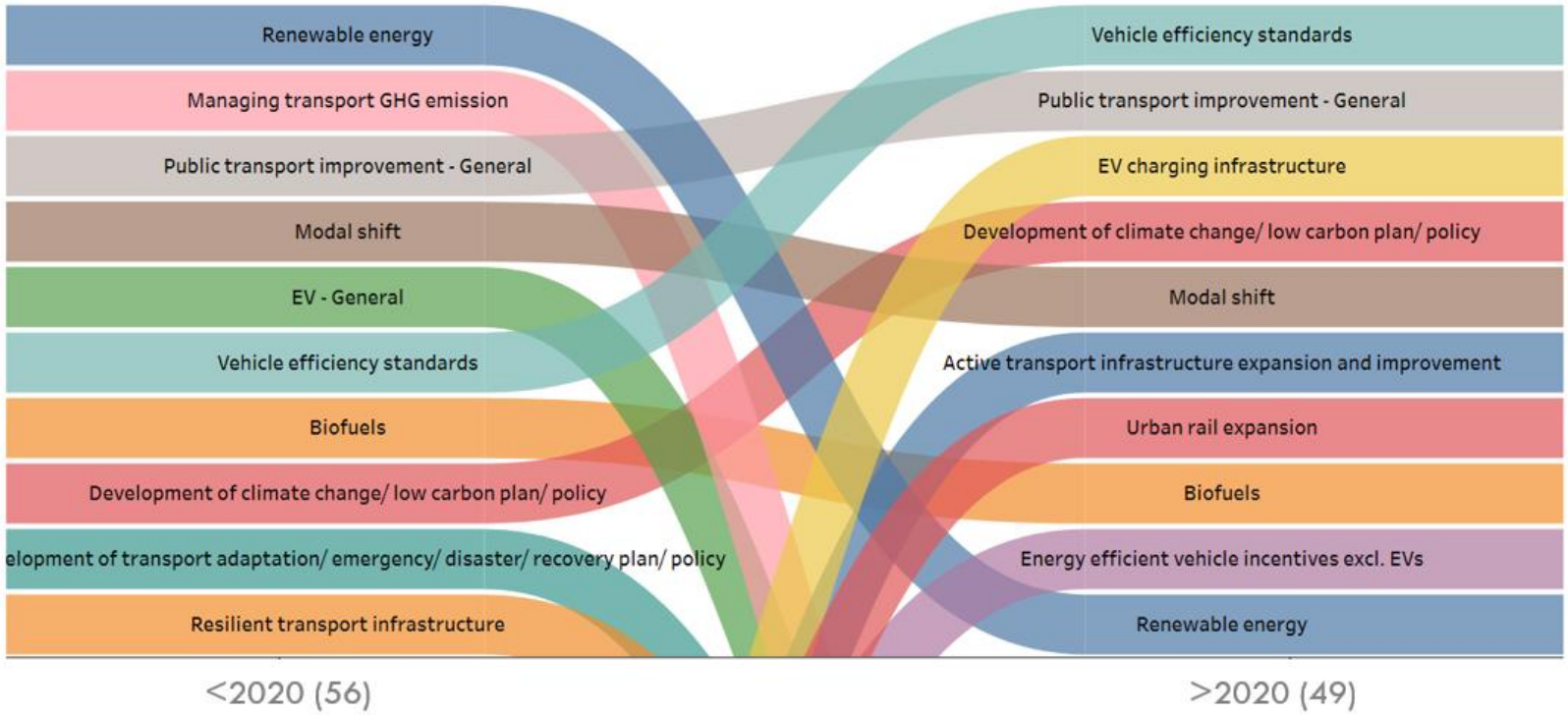


Figure 45. Thematic Priorities Between NDCs Before and After 2020

Source: ATO analysis and visualization based on ATO's policy tracker

Peeking into the wider set of policy documents (including non-NDCs), we see that at least three-fourths of the economies have already adopted climate-related targets across the main transport modes (Figure 46).

Figure 47 illustrates how People's Republic of China's transport and climate policies evolved alongside rising road transport CO_2 emissions. Starting with the 10th Five-Year Plan (2001–2005), early measures focused on stricter emission standards and phasing out high-emission vehicles, followed by the 11th Plan (2006–2010) promoting intelligent transport systems. The 2005 fuel economy standards marked a key early step toward transport decarbonization.

After 2015, policy actions became more climate-focused. The 2016 NDC set measurable transport targets, while the 2017 automotive roadmap and 2020 NEV subsidy programs accelerated vehicle electrification and clean energy use. Recent initiatives—such as the 2021 carbon peaking and 2024 energy efficiency plans—signal a move toward system-wide efficiency and logistics optimization, aligning with a possible emissions peak around 2021.

	Road	Rail	Shipping	Aviation
Azerbaijan	✓	✓	✓	✓
Bangladesh	✓	✓		
Bhutan	✓	✓		
Brunei Darussalam	✓	✓	✓	✓
Cambodia	✓	✓	✓	✓
Indonesia	✓	✓	✓	✓
Kazakhstan	✓			
Kyrgyz Republic	✓	✓	✓	✓
Lao People's Democratic Republic	✓	✓	✓	✓
Malaysia	✓	✓	✓	✓
Maldives	✓		✓	
Marshall Islands	✓	✓	✓	✓
Mongolia	✓	✓		✓
Myanmar	✓	✓	✓	✓
Nauru	✓	✓	✓	✓
Nepal	✓	✓		✓
Pakistan	✓	✓		
Palau	✓	✓	✓	✓
Papua New Guinea	✓		✓	✓
People's Republic of China	✓	✓	✓	✓
Philippines	✓	✓	✓	✓
Solomon Islands	✓	✓	✓	✓
Sri Lanka	✓	✓	✓	✓
Thailand	✓	✓	✓	✓
Timor-Leste	✓	✓	✓	✓
Uzbekistan	✓	✓		✓
Vanuatu	✓	✓	✓	✓
Viet Nam	✓	✓	✓	✓

Figure 46. Presence of Climate-related Targets by Mode

Source: ATO analysis and visualization based on ATO's policy tracker

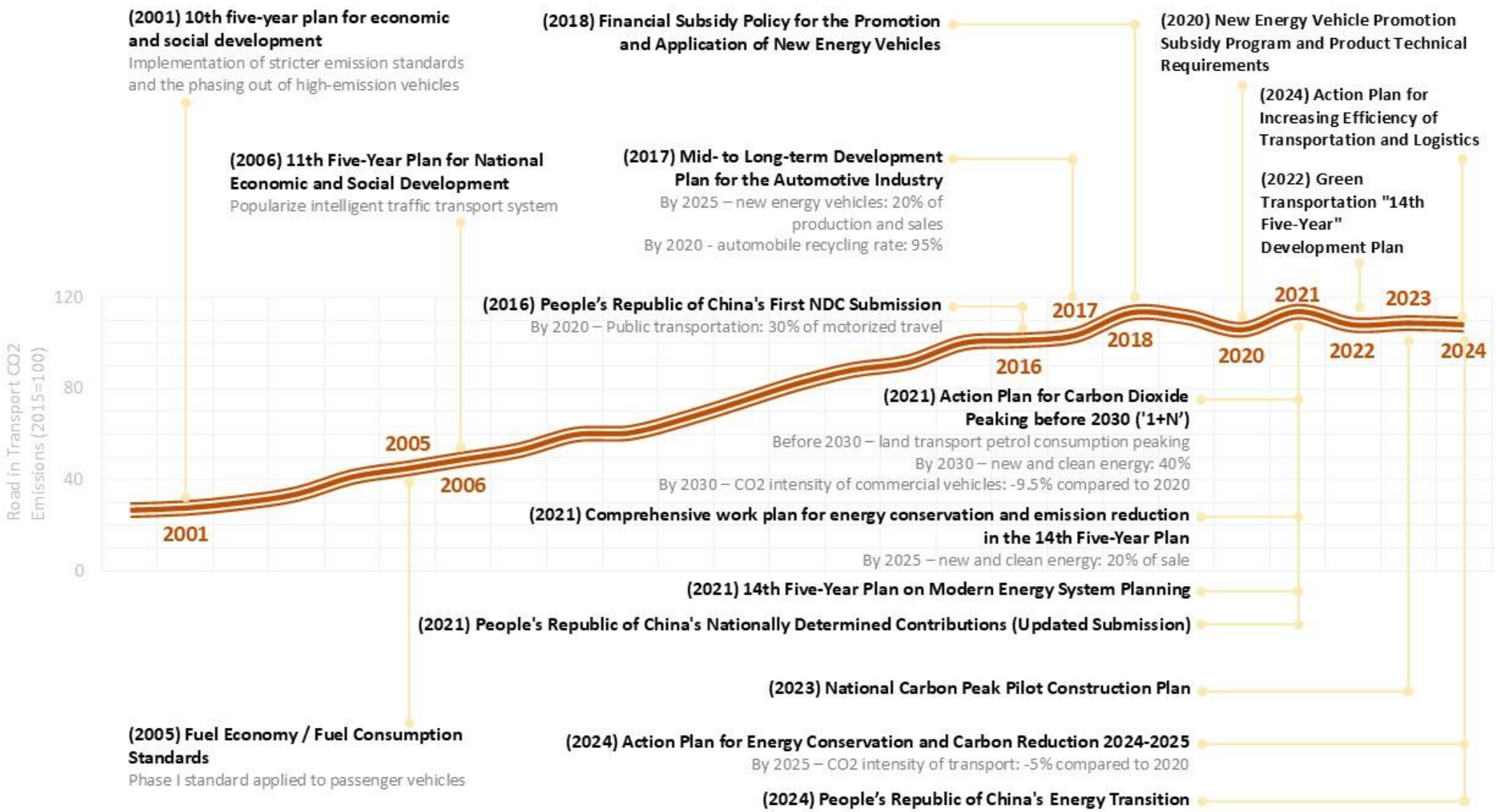


Figure 47. Road in transport CO2 emissions growth in People's Republic of China aligned with the policy landscape

Source: ATO analysis and visualization based on ATO's policy tracker

15 The Other Side of the Coin – Transport and Climate Adaptation

Asia-Pacific urgently needs to tackle the other side of the climate change coin—adaptation. The Asia-Pacific region accounts for 65% of the globally expected annual direct physical damages to transport infrastructure due to climate and various other hazards (Koks et al., 2023). This amounts to an estimated $8.5 billion per year. Low- and middle-income countries account for three-quarters of the estimated damages (CDRI, n.d.). Roads account for 61% of direct costs from transport infrastructure damage. According to Verschuur et al. (2023), global trade valued at approximately $60 billion is threatened by natural hazards– tropical cyclones, earthquakes, river flooding, pluvial flooding, and coastal flooding— at ports, with 70% of this risk focused on Asian countries.

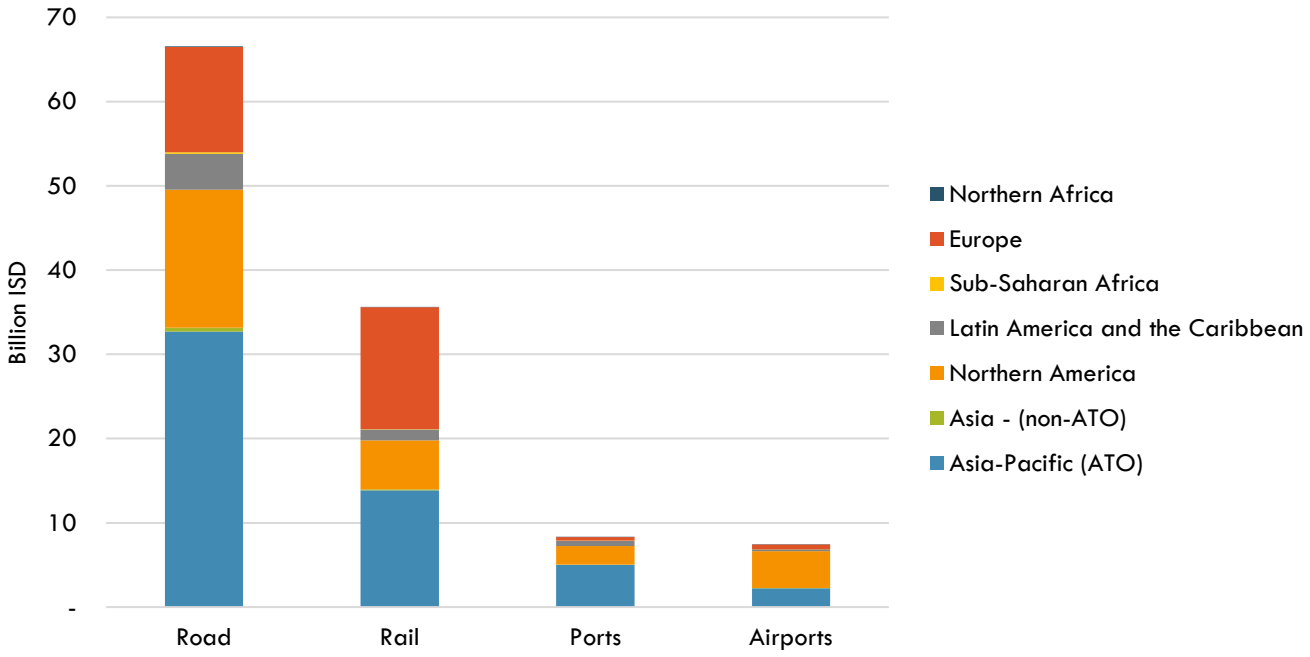


Figure 48. Average Annual Financial Losses due to Environmental Hazards (Billion USD)
Source: (ATO, 2025)

An assessment of climate adaptation and resilience measures in transport across 43 economies reveals that these themes are more frequently addressed in other transport-related policy documents than in NDCs. While NDCs do include some adaptation elements, their coverage is relatively limited, particularly adaptation and resilience elements related to the transport sector. For instance, 15 economies mention the development of transport adaptation, emergency, disaster, or recovery plans in NDCs, compared to 26 economies' other policy documents. Similarly, resilient transport infrastructure (12 in NDCs vs. 24 in others) and infrastructure modification to reduce climate risks (9 vs. 23) appear more prominently outside NDCs.

Other adaptation priorities such as reducing future vulnerabilities, promoting preparedness and rapid recovery, and resilient transport technologies are also much more prevalent in broader policy frameworks. Notably, planning to reduce future vulnerabilities and minimize losses is referenced by only 3 NDCs but by 18 other policy documents (Figure 49).

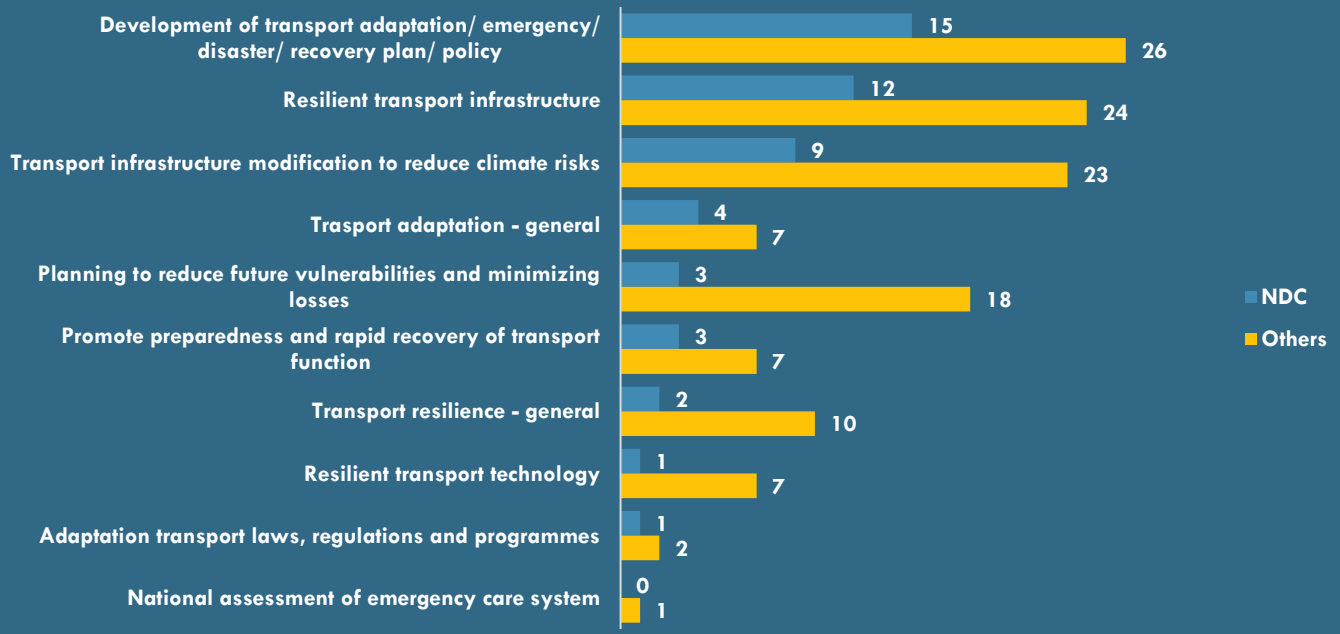


Figure 49. Number of countries with Climate Adaptation and Resilience Policy Measures

Source: ATO Visualization based on ATO's policy tracker

Over the years, transport adaptation measures have become more diverse (Figure 50). In the pre-2015 period, adaptation measures in the transport sector were dominated by general asset management and maintenance practices, with relatively limited attention to disaster preparedness or resilience-oriented approaches. Between 2016 and 2020, however, the scope of measures broadened significantly, with notable growth in disaster notification and early warning systems, resilient transport infrastructure, and climate-informed design standards. Post-2020, policies have further diversified, with sharp increases in the development of adaptation, emergency, and recovery plans, the establishment of asset management information systems, and greater emphasis on planning to reduce future vulnerabilities. While core measures such as asset management and maintenance remain important, the rising focus on climate-resilient infrastructure, preparedness, and advanced management systems suggests a shift toward more proactive and technologically informed strategies.

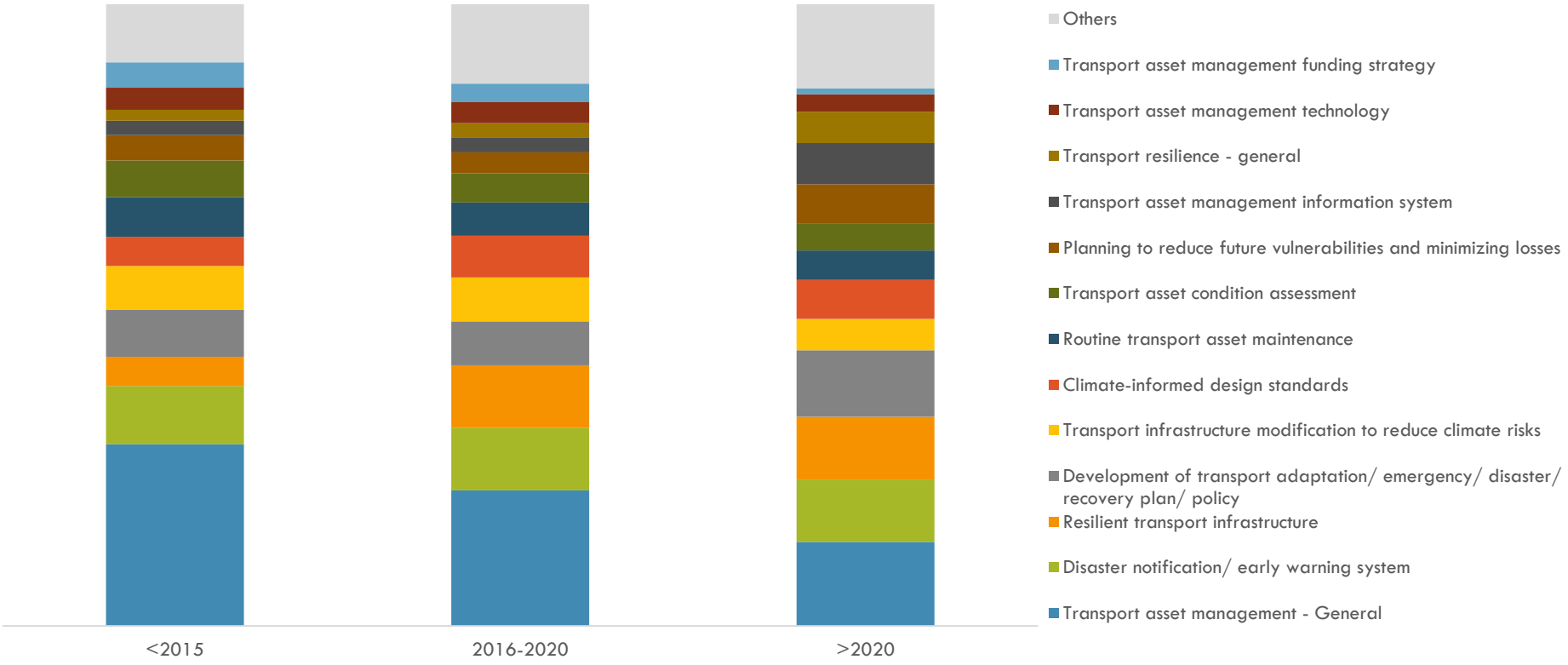


Figure 50. Distribution of Adaptation Policy Measures in Asia-Pacific Countries by Type

Source: ATO Visualization based on ATO's policy tracker

16 Transport Decarbonization in Asia - A Glass Half-Full or Half-Empty?

The evidence is clear but not conclusive. The explosive growth in emissions that defined the turn of the century has slowed, a significant, policy-driven course correction. A decoupling of economic growth from transport emissions, once a distant hope, is now observable in high-income economies and accelerating elsewhere. The rise of electric vehicles and the decarbonization of rail networks show that the transition is not only possible but already underway.

This is the glass half-full.

The other half of the glass shows a grim reality. Progress is uneven, focused on a few leading economies while others risk falling behind. The momentum of a billion legacy vehicles on the roads guarantees that emissions will last for decades, even with aggressive sales of new technology. And sectors like aviation remain stubbornly resistant to decarbonization.

The current trajectory, while an improvement, is incompatible with the goals of the Paris Agreement. Asia's climate ambition, now nearly universal at the national level, has not yet translated into the hard, sectoral targets needed to hold transport accountable. The roadmap for decarbonization is being written, but it is being written outside the formal climate pledges.

The question is no longer whether Asia can decarbonize its transport sector, but whether it can do so at the pace and scale required. The answer depends on the choices made now. It demands a commitment to innovation and a willingness to invest in the infrastructure that will define mobility for the next generation. It requires a recognition that the cost of inaction is far greater than the cost of a managed transition. The future of Asia's transport sector, and its impact on the global climate, hangs in the balance.

The question is no longer whether Asia can decarbonize its transport sector, but whether it can do so at the pace and scale required. The answer depends on the choices made now.

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Annex 1. List of considered NDCs and Implementation Plans

Country	First gen.	Second gen.	Third gen.	Implementation plan
Afghanistan	2016			
Armenia	2017, 2021			
Azerbaijan	2017, 2023			
Bangladesh	2016, 2021, 2021		2025	
Bhutan	2017	2021		
Brunei Darussalam	2015, 2021			
Cambodia	2017, 2020		2025	
Cook Islands	2016			
Fiji	2016, 2020			2017
Georgia	2017, 2021			
Indonesia	2016, 2021, 2022			
Kazakhstan	2016, 2023			
Kiribati	2016, 2023			2021, 2022
Kyrgyz Republic	2020, 2021			
Lao People's Democratic Republic	2016, 2021			
Malaysia	2016, 2021			
Maldives	2016, 2020		2025	
Marshall Islands	2016	2018, 2020	2025	
Micronesia (Federated States of)	2015, 2022		2025	
Mongolia	2016, 2020		2025	
Myanmar	2017, 2021			
Nauru	2016, 2021			
Nepal	2016	2020	2025	
Niue	2016		2025	

Country	First gen.	Second gen.	Third gen.	Implementation plan
Pakistan	2016, 2021		2025	
Palau	2015			
Papua New Guinea	2016, 2020			
People's Republic of China	2016, 2021			
Philippines	2015, 2021			
Samoa	2016	2021		
Singapore	2016, 2020	2022, 2025		
Solomon Islands	2015, 2021		2025	
Sri Lanka	2016, 2021		2025	
Tajikistan	2017, 2021			
Thailand	2016, 2020	2022		
Timor-Leste	2017, 2022			
Tonga	2016	2020	2025	
Türkiye	2021, 2023			
Turkmenistan	2016, 2023			
Tuvalu	2016, 2022		2025	
Uzbekistan	2018, 2021			
Vanuatu	2015, 2022		2025	2021
Viet Nam	2016, 2020, 2022			

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