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The climate mitigation ambition-capacity gap in the global transportation sector

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Dear Editor,

The United Nations Environment Programme pointed out that, to realise the 2030 targets, global carbon emissions must be reduced to 33 Gt. Various strategies have been implemented to realise the climate mitigation targets worldwide, such as reducing energy intensity and enhancing renewable energy.[1] However, the current progress of decarbonisation in the transportation sector remains insufficient. In 2023, the transportation sector was responsible for approximately 15% of global greenhouse gas emissions, indicating an emission reduction gap of 3.2 Gt compared to the 1.5°C targets.[2] In this paper, we compare 2030 decarbonisation targets in the transportation sector of countries, evaluate their effectiveness, identify the challenges, and offer recommendations to support global carbon reduction and climate goals. This study contributes to the understanding of global carbon reduction efforts by systematically comparing the ambition-capacity gap in the transportation sector across major economies, offering a novel cross-country perspective that links policy ambition with practical implementation capacity. Unlike previous studies focusing on single-country analyses or emission trends, this paper highlights the mismatch between decarbonisation goals and feasible capacity, thereby providing actionable insights for policymakers aiming to design more realistic and equitable transition pathways.

THE AMBITION-CAPACITY GAP IN THE TRANSPORTATION SECTOR

The transportation sector remains an essential source of global carbon emissions, with substantial disparities in emission levels and mitigation strategies among major economies.[3] Figure 1A indicates that the United States is the largest emitter in the transportation sector in 2023. The widespread use of fuel vehicles in the United States resulted in 20.7% of global transportation-related emissions. The United States has committed to transportation decarbonisation, primarily through vehicle efficiency standards, electric vehicles (EVs) incentives, and investments in charging infrastructure. China is the world's largest overall carbon emitter and the second-largest contributor to transportation-related carbon emissions, accounting for approximately 13.2% of emissions in the global transportation sector. They have established a strategic objective to increase the EV penetration rate to 50% by 2035. The government's strong policy support, including subsidies and tax incentives, has accelerated EV adoption. Besides, the European Union represents 9.3%, has an ambitious regulatory framework for transportation decarbonisation, including stringent CO_2 emissions standards for new vehicles and plans to phase out internal combustion engine cars by 2035. Japan has prioritised hybrid vehicle technology and fuel efficiency improvements, with automakers leading in low-emission vehicle innovation. India, contributing 4.2% to global transportation emissions, committed to realising carbon neutrality before 2070.[4] Overall, we can find substantial cross-country disparities in transport sector emissions in Figure 1, as well as the mitigation instruments and decarbonisation strategies adopted. These divergences will introduce considerable uncertainty into the attainment of national emission reduction targets.

Figure 1B shows the projected transportation emissions of the top 10 countries under current policies and the Nationally Determined Contributions (NDCs) by 2030. The changes in carbon emissions under current polices are calculated according to the current carbon emission trend. In comparison, the changes in carbon emissions under unconditional NDCs are estimated based on the mitigation targets stated in countries' NDC submissions by 2030, relative to 2023 levels. The top 10 countries account for 61% of global transportation emissions. Some countries have adopted targeted strategies to reduce emissions in the transportation sector, while others lack sector-specific emission reduction measures or face challenges in policy implementation. For example, China and the USA contribute to a substantial decline in transportation emissions through public transportation and EV adoption, aligning with the NDC commitments. The EU aims to phase out internal combustion engine cars by 2035 through stringent CO_2 emission standards for new vehicles, while Japan focuses on advancing hybrid and hydrogen fuel cell technologies to decarbonise its transport sector. In contrast, Russia, Brazil, and Indonesia do not have adequate policy measures and frameworks for climate reductions in the transportation sector, which significantly widens the mitigation gap between stated goals and actual policies. Brazil and Indonesia are projected to increase transportation emissions under current conditions, which might raise concerns about their ability to meet NDC commitments. Figure 1B indicates that substantial reductions in transport sector emissions will not be guaranteed under current policies, even for those countries where overall emissions have already peaked. By contrast, all top 10 emitters demonstrate clear and significant declines in transport emissions under the NDC scenarios. This means that decarbonising the transportation sector has been a widely shared goal among major economies, but there are still big gaps between climate mitigation ambition and capacity across countries. We need to pay attention to the decarbonisation barriers in the global transportation sector.

BARRIERS TO BRIDGING THE CLIMATE MITIGATION GAP IN THE TRANSPORTATION SECTOR

The existing barriers indicate that some national NDCs exceed current technical, financial, and institutional capacities. The first is the insufficient infrastructure to support electric vehicles, lack of access to clean fuels, and underdeveloped urban public transportation systems. This challenge is particularly pronounced in developing countries, where fiscal constraints significantly impede the development of charging infrastructure and clean energy distribution networks. The second is the limited access to mature low-carbon technologies. We can find that developed economies have made substantial advances in battery technologies and clean grid systems, whereas developing nations often lack the financial support, low-carbon technological innovation, and green solutions. The third barrier is that the fragmented governance and policy inconsistencies hinder coordinated climate efforts, as seen in non-standardised and non-uniform emission standards and regulatory frameworks across countries. For example, the EV share in the United States was nearly 10% in 2023, substantially lower than China's 30%, according to the IEA's Global EV Outlook 2024. One potential reason is that the policy fragmentation across states and changing federal priorities have hindered the implementation of policies in the USA.[5] For European countries, the EU has adopted clean electricity to promote the electrification transition in the transportation sector. However, the uneven transportation infrastructure and lax policy enforcement hindered the effectiveness of the decarbonisation efforts across EU countries. Thus, we need to bridge the ambition-capacity gap in transportation decarbonisation by introducing well-defined sector-specific targets, expanding charging infrastructures, increasing climate finance assistance, and enhancing international collaboration.

CONCLUSIONS

The global transportation sector remains a critical challenge for climate

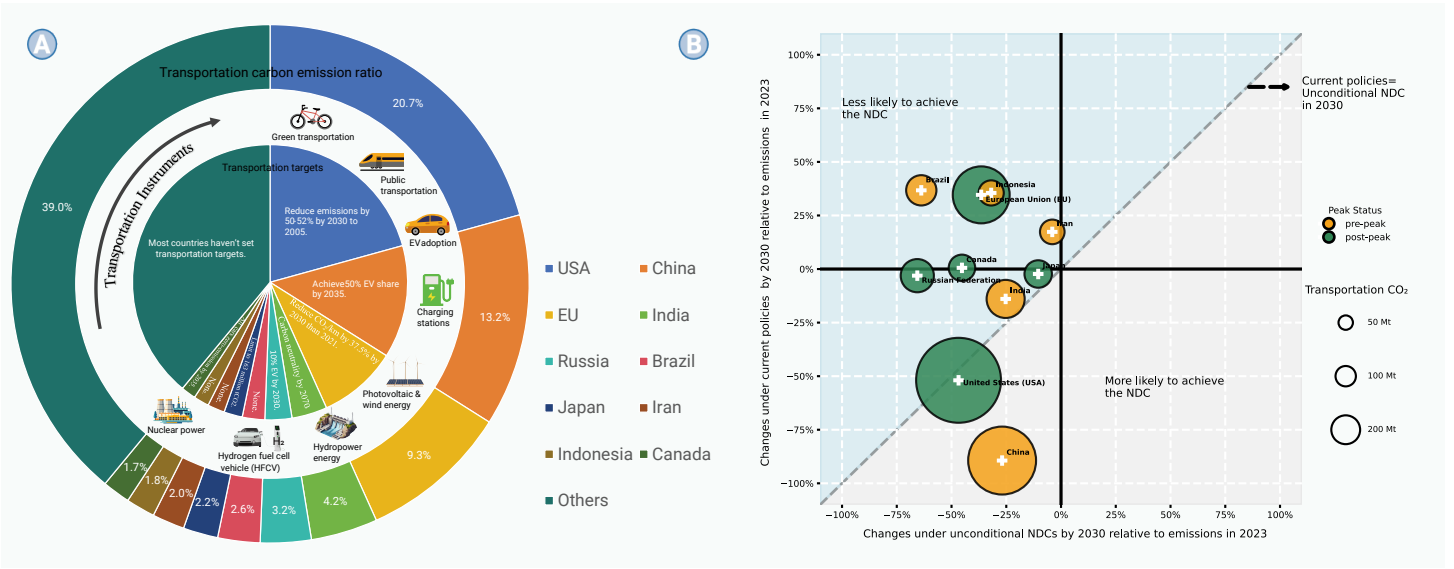

Figure 1. Scenarios of transportation carbon emission and mitigation capacity for the top 10 countries A. Carbon Emissions-Policy Instruments-Targets in the transportation sector. B. The ambition-capacity gap of the top 10 transportation carbon emission countries. Notes: The data in Figure 1A is sourced from the Emissions Database for Global Atmospheric Research (EDGAR) and the International Energy Agency (IEA). The data in Figure 1B is obtained from the Paris Agreement, Nationally Determined Contributions (NDCs) and the Emissions Database for Global Atmospheric Research (EDGAR).

change mitigation, with substantial gaps between ambitions and capabilities across nations. We highlight stark differences in transportation sector emissions and mitigation efforts across major economies. The divergence in transportation sector's climate targets between countries with defined transportation sector targets, such as China, the USA, and Japan, and those without, such as India and Brazil, underscores the necessity of comprehensive and enforceable transport policies to bridge the existing emissions gap and advance global climate objectives.

The current policies remain insufficient to meet global climate goals for most of the top 10 countries. Only a few countries, like the EU and China, have implemented decarbonisation policies in the transportation sector. In contrast, many others have not established clear climate mitigation strategies to bridge the current ambition-capacity gap. To bridge this mitigation gap in the transportation sector, we need stronger climate actions, targeted commitments, rigorous enforcement, and enhanced international cooperation to improve the climate mitigation capacity towards the 2030 targets. From a policy perspective, governments should prioritise decarbonisation strategies in the transportation sector, including the deployment of low-carbon transport technologies, green infrastructure investment, and carbon pricing mechanisms that incentivise sustainable mobility. Enhanced technology transfer and financial support for developing economies are also essential to narrow the global ambition-capacity gap.

This study's limitation lies in its reliance on aggregate national targets, which may not fully capture sub-sectoral or city-level dynamics. Future research could incorporate sector-specific emission pathways, policy stringency indices, and dynamic modelling to better assess how nations can align their transport systems with global climate neutrality goals.

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AUTHOR CONTRIBUTIONS

Jing Liang: Project conception and development, data analysis, research design, manuscript editing, funding acquisition. Wenqian Ren: Project development, data analysis, methodology, manuscript writing. Xu Peng: Data collection, data analysis, manuscript editing, funding acquisition. All authors contributed to the manuscript and approved the final version.

DECLARATION OF INTERESTS

The authors declare no competing interests.