Visioning to implementation

National transport decarbonization policies that match climate targets in China, India, and Vietnam

Yiqian Zhang, Sebastian Castellanos, and Ben Welle

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Agora Verkehrswende
SLOCAT Partnership
REN21

About the authors

Yiqian Zhang
Manager, Climate and Electric Mobility, World Resources Institute
yiqian.zhang@wri.org

Sebastian Castellanos
Senior Manager, Technical Assistance, Electric School Bus Initiative, World Resources Institute
sebastian.castellanos@wri.org

Ben Welle
Director, Integrated Transport & Innovation, World Resources Institute
benjamin.welle@wri.org

Design

Shannon Collins
shannon.collins@wri.org

Suggested citation

Zhang, Y., S. Castellanos, and B. Welle. 2023. "Visioning to implementation: National Transport decarbonization policies that match climate targets in China, India, and Vietnam." Report. Washington, DC: World Resources Institute. Available online at doi.org/10.46830/wrirpt.22.00084.

VERSION 1

December 2023

Acknowledgments

This report was made possible by the generous financial contributions from the German Ministry for Economic Affairs and Climate Action via the International Climate Initiative.

Supported by:

Federal Ministry for Economic Affairs and Climate Action

IKI INTERNATIONAL CLIMATE INITIATIVE

on the basis of a decision by the German Bundestag

Published under the NDC Transport Initiative for Asia (NDC-TIA), this report is a joint effort between the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH; International Council on Clean Transportation (ICCT); International Transport Forum (ITF); Agora Verkehrswende; Partnership on Sustainable, Low Carbon Transport (SLOCAT); Renewable Energy Policy Network for the 21st Century (REN21); and World Resources Institute.

The authors would like to acknowledge the following for their guidance, critical reviews, and research support:

- The report benefited from the NDC-TIA Steering Committee members and project managers, including, but not limited to, Vera Scholz, Urda Eichhorst, and Stephen Draexler (GIZ); Christian Hochfeld, Ernst-Benedikt Riehle, and Elisabeth le Claire (Agora); Maruxa Cardama, Nikola Medimorec, and Angel Rae Cortez (SLOCAT); Hui He and Zifei Yang (ICCT); Rana Adib and Jad Baba (REN21); and Jari Kauppila and Malithi Fernando (ITF). They played pivotal roles in conceiving the idea for the analysis, providing technical support throughout the research, writing, and peer review process.
- Tuan Vu Anh and An Nguyen Ngoc from the Vietnamese-German Transport Research Centre; Ly Tuyet Dang, Tuan Nguyen Anh, and Thao Nguyen Dinh from GIZ Vietnam; and Kangjie Zé Liu, Stephanie Ly, Lulu Xue, Chaitanya Kanuri, and Aparna Vijaykumar from WRI all provided conceptual inputs, review, stakeholder outreach and interview support, and strategic guidance.
- The authors are also grateful to WRI experts Carlos Muñoz Piña, Robin King, and Kathy Schalch, who provided critical insights and support. Yaya Liu, Yifan Ding, and Mende Thuji Yangden, formerly at WRI, all provided interview support and substantive contributions to the report.

We would also like to thank the report's reviewers who have shared their time, expertise, and insights: Amit Kumar, Ashish Sharma, Ramya Mandyam Anandampillai, and Subrata Chakrabarty. The authors are grateful to WRI colleagues for their support in the production of the report, including administrative assistance, editing, graphic design, and layout: Romain Warnault, Emilia Suarez, Renee Pineda, Lauri Scherer, and Shannon Collins.

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Foreword

Transportation is what drives the heartbeat of a vibrant society, allowing communities to function and thrive, facilitating the movement of people and goods, and creating access to opportunities and services. Today, we owe much to the vast improvements in transportation that have occurred over the last century, but we are also now being held back by the same systems.

Transport – accounting for 15% of global emissions – is one of the fastest-growing sources of greenhouse gas emissions. Not only is the sector off-track from keeping warming within 1.5°C by the end of the century, but it is moving rapidly in the wrong direction.

More countries are setting transport-related decarbonization targets in their long-term domestic development strategies and climate action plans. While solutions such as electric vehicles or investments in high-quality public transport are gaining increased attention, the fact is the transport sector needs to move much faster for countries to reach their net-zero targets. Each country must navigate its unique path towards transport decarbonization. However, it is becoming clearer that existing national governance and policy frameworks are not designed to facilitate the ambitious transformations we need.

The challenge and opportunities for transport are magnified in Asia, which has experienced rapid population and economic growth. Since 2000, the number of vehicles on the roads has quadrupled in Asia and transport-related emissions have grown faster than in any other region, with deadly consequences for the 2.3 billion urban inhabitants exposed to polluted air in the region. At the same time, these countries are seeing many forms of low-carbon transport taking off, from bicycles and electric vehicles to the expansion of rail networks.

This report assesses how China, India and Vietnam are translating their climate ambitions into tangible national transport targets, strategies and policies. Together, these countries account for more than half of Asia's transport-related emissions. As we explore their efforts, we shine a light on the governance gaps that persist and identify strategies to enhance ambition and accelerate decarbonization in transport for the next round of NDCs for all countries.

The insights and recommendations contained in this report will make it clear to policymakers, practitioners and all those committed to ushering in a sustainable and climate-resilient future that the best way forward means coming together. The decarbonization of transport cannot be successfully managed in isolation from other sectors. Rather, this system transformation is a critical unifying agenda across key actors and levels of governments, from the national to the local level. Multi-stakeholder platforms for transport will be critical to facilitating knowledge and information sharing, mobilizing finance, enhancing public-private collaboration and ultimately creating systemic change.

Moving forward, the world must reconcile the indispensable role of transportation in peoples' lives with the pressing need for climate action. We need transformative systemic changes to put the planet on a path to avert the worst climate impacts – and the transportation systems that bring us together are one of the best places to start.

Ani Dasgupta

President and Chief Executive Officer

World Resources Institute

Executive summary

Context

Transport matters. The movement of people and freight is the lifeline of economies, providing access to goods, services, and other opportunities. Nevertheless, the sector is confronted with a significant, multifaceted challenge in addressing climate change. Rapid urbanization, economic development, and population growth make finding solutions all the more urgent.

To limit temperature rise to 1.5°C, the Intergovernmental Panel on Climate Change (IPCC) estimates that emissions from the start of 2020 must be held to a maximum of 400 billion tonnes (Gt) of carbon dioxide (CO_2) (IPCC 2023). In this scenario, the transport sector would emit 110 $GtCO_2$ between 2020 and 2050, making up 28 percent of the remaining carbon budget (Teske et al. 2021). Road transport alone will account for 80–100 Gt of the 110 Gt carbon budget. So, to stay within this budget, the 6 $GtCO_2$ that the subsector emits annually will need to be cut in half (IEA 2023). Transport accounted for 14.3 percent of global greenhouse gas (GHG) emissions in 2019, and it is one of the fastest-growing sources of emissions (Climate Watch n.d.). Transport emissions have grown faster in Asia than anywhere else in the world in recent decades, at an annual rate of 3.9 percent, which is twice the global average of 1.9 percent (Gota and Huizenga 2022; Kyriacou and Burke 2023). Making progress in transport in Asia is vital to reaching the Paris Agreement goals. And this can only be achieved through transformative and systemic change enabled by ambitious transport decarbonization targets, actionable strategies, and comprehensive policy packages supported by funding, reflecting the "avoid-shift-improve" (ASI) approach to reducing transport emissions.

By studying how other countries translate their climate ambitions and goals into transport strategies and policies, and how these approaches affect transport emissions, countries can learn valuable lessons for effectively decarbonizing the transport sector (Biber et al. 2017). In Asia, 14 countries—accounting for 26 percent of the global transport emissions in 2019—have made economy-wide net zero commitments (Council for Decarbonising Transport in Asia 2022). Momentum toward zero-emission transport is growing, with countries enhancing ambition and transport-related targets in their NDCs and in their long-term low GHG emission development strategies (LTSs). However, the transport sector still needs to catch up with many others, and each country must follow a unique path.

Accelerating a low-carbon transition requires aligning policy areas and coordinating strategic actions across levels of governance (Braams et al. 2021; Markard et al. 2020). Countries have communicated NDCs, outlining transport mitigation and adaptation actions. But to implement these actions effectively, national policy and regulatory frameworks must align with broader climate ambition. This report examines how three countries—China, India, and Vietnam—are translating their climate commitments into national policymaking and leveraging them to accelerate efforts to decarbonize transport (see Figure ES-1).

HIGHLIGHTS

- This report assesses how three Asian countries—China, India, and Vietnam—are translating their international climate ambition in the nationally determined contributions (NDCs) into national climate change-related transport strategies and policies.
- It analyzes how each country's governance structure and policy planning and development may support or hinder transport decarbonization.
- It synthesizes information from a review of the academic literature, policy documents, and expert interviews to evaluate the *consistency* of policy strategies and instruments and the *coherence* of coordination across policy areas and governance levels in each country.
- It finds that climate ambitions in the transport sector are somewhat consistent with national strategies and goals but coordination across policy areas and levels of governance could be improved.
- It recommends strategies to accelerate transport decarbonization in the next round of NDCs:
  - Align long-term vision with short-term actions in the transport sector.
  - Ensure transport decarbonization is not managed in isolation from other sectors and related policies.
  - Leverage multistakeholder platforms to enable change.
  - Focus on an equitable and just transition.
  - Follow a systematic approach for transport decarbonization.
  - Craft an integrated, comprehensive policy mix for electric mobility with myriad instruments.
  - Support sustainable financing availability and move away from fossil fuels.

About this report

Published under the NDC Transport Initiative for Asia (NDC-TIA), this report is a joint effort between the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ); the International Council on Clean Transportation (ICCT); the International Transport Forum (ITF); Agora Verkehrswende; the Partnership on Sustainable, Low Carbon Transport (SLOCAT); the Renewable Energy Policy Network for the 21st Century (REN21); and World Resources Institute. It presents case studies from China, India, and Vietnam. These countries were selected because they span the region's geography, account for most of its emissions, and have hosted much of the ongoing work of the NDC-TIA partners. China and India together accounted for 58 percent of transport-related emissions in Asia in 2019 (Climate Watch n.d.).

The research included an extensive review of literature and policy documents, as well as expert interviews in each of these countries. It assessed the progress toward implementation and the obstacles to zero-emission transport to help identify the structural and transformational changes needed to reach net zero. It also evaluated each country's mix of policies, investigating whether climate strategies for transport and policy instruments were consistent with one another and whether policy planning was coherent (Rogge and Reichardt 2016; Zepa and Hoffmann 2023). Its objective was to reveal and clarify the enabling conditions critical to the successful decarbonization of the transport sector.

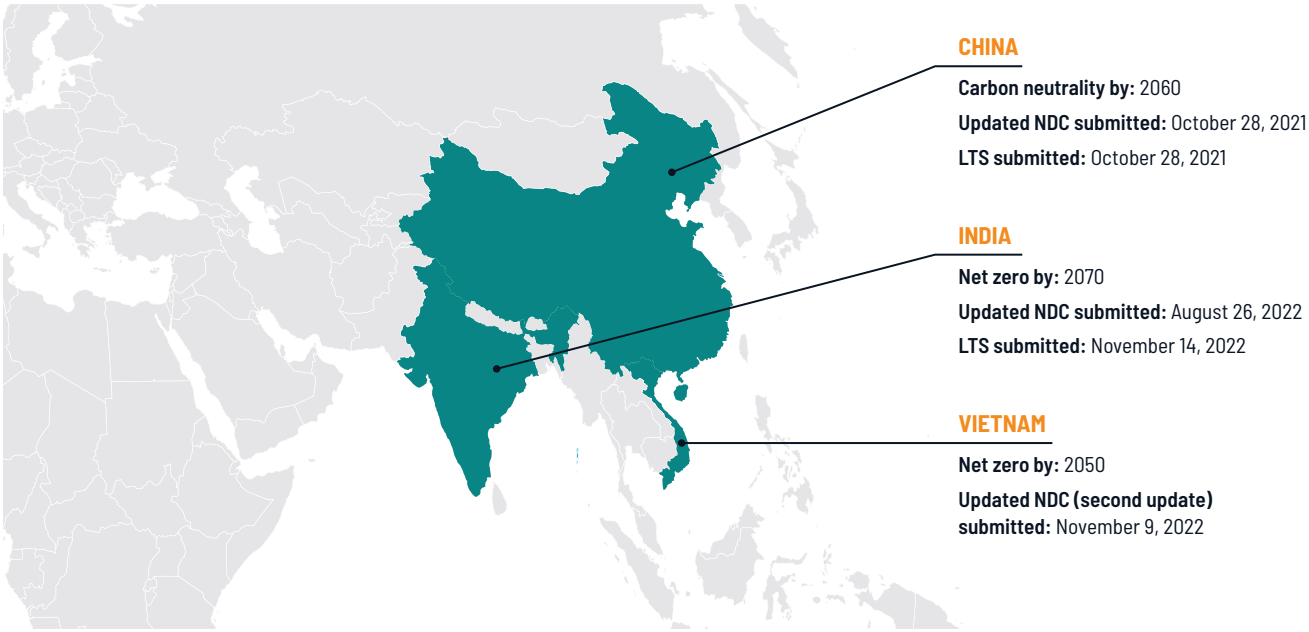
Key findings

Detailed analysis of the three countries' experiences and expert interviews identified the following insights about the impacts of long-term target setting, the barriers to transport decarbonization, and the enabling conditions needed to decarbonize the transport sector enough to reach NDC targets.

Net zero targets provide positive impetus. China, India, and Vietnam have all set economy-wide net zero emissions goals and have referenced them in their NDCs. Evidence suggests that the climate ambition of the three case countries is reflected in their national strategies, but at varying levels of detail. Certain goals and core narratives, such as China's carbon peaking and carbon neutrality goal, are highlighted across national policy documents. Net zero or carbon neutrality goals have become vehicles for crafting new policies and institutionalizing climate action. This is reflected in how climate pledges prompt and shape national legislation, usher in interactive governing entities, mobilize and coordinate financial and other resources, draw attention to national climate governance, and encourage participation of broader stakeholder and subnational governments (Council for Decarbonising Transport in Asia 2022).

Ambitious government leadership is necessary. Governments at the national and subnational levels all play a pivotal role in setting a long-term development vision, defining mobility transition road maps, establishing standards, and providing guidance and necessary infrastructure. Experts say

FIGURE ES-1 | Case countries of the report



Notes: LTS = long-term low greenhouse gas emission development strategies; NDC = nationally determined contribution.
Sources: CAT 2022; Climate Watch 2021a, 2021b; Government of India 2022a, 2022b; Government of Vietnam 2022; MEE 2022.

that another important way for governments to lead and be key enablers for decarbonization pathways is to send consistent policy signals at all levels of government. Our interviews revealed that vehicle manufacturers and operators often are hesitant to make low-carbon investment decisions due to lack of policy clarity.

The concept of a just, equitable transition was rarely articulated during the interviews. A few experts interviewed raised equity issues such as providing affordable electric vehicles (EVs) for lower-income groups, creating new local jobs in the EV supply chain, improving the accessibility and quality of public transport, and considering environmental benefits such as improved air quality. Although the countries studied have made high-level commitments to gender equality, government policies do not explicitly link transport decarbonization and gender or other equity considerations (Interesse and Zhou 2022; Linh 2021).

Questions and barriers around new technologies need to be further addressed. Although battery electric vehicles (BEVs) and hydrogen fuel cell vehicles (FCVs) are commercially available, barriers to widespread adoption include the difficulty of electrifying heavy-duty vehicles (HDVs) and the lack of regulatory framework, financing, or technical expertise (Mao and Rodriguez 2022). China is now the world's largest HDV market, and studies suggest that BEV trucks in the country will achieve total cost of ownership parity with diesel trucks during the second half of this decade (Mao et al. 2021a). FCV technology is lagging behind BEVs in maturity and scale of adoption, in part because costs have remained high.

Financing is critical. Given the immense price tags to decarbonize transport, public investments are essential but will not be sufficient to meet the targets. Private investment will be necessary as well. Experts from Vietnam highlighted the need for better access to finance and a more predictable enabling environment, which would allow the private sector to play a more prominent role in delivering solutions.

Freight transport is receiving growing attention. Freight has been highlighted in the three countries' NDCs and LTSs and other high-level national policy documents. Notably, in its LTS, India aims for its railways to become net zero and for rail to account for 45 percent of freight traffic by 2030. All three countries have emphasized shifting from road transport to more efficient modes (railways and waterways), promoting multimodal transport with logistics hubs, and improving operational efficiency as key strategies for decarbonizing the sector.

One barrier to progress is that the energy and transport sectors are continuing to work in silos. Experts from China revealed that collaboration between transport, land-use, and energy industries is difficult because the relevant government agencies and business groups that would need to communicate and work together often represent different interests. Experts from Vietnam said that a lack of collaborative planning between decision-makers in the power and transport sectors has impeded the rollout of electric buses (e-buses). Insufficient resources and attention have gone into upgrading the electricity grid so that it can power the fleet. One expert from India mentioned that integrated planning between transport and energy sectors is absent in the country, but there are ongoing synergies. For instance, India is exploring "vehicle-to-grid" solutions that allow interaction between EVs and the grid.

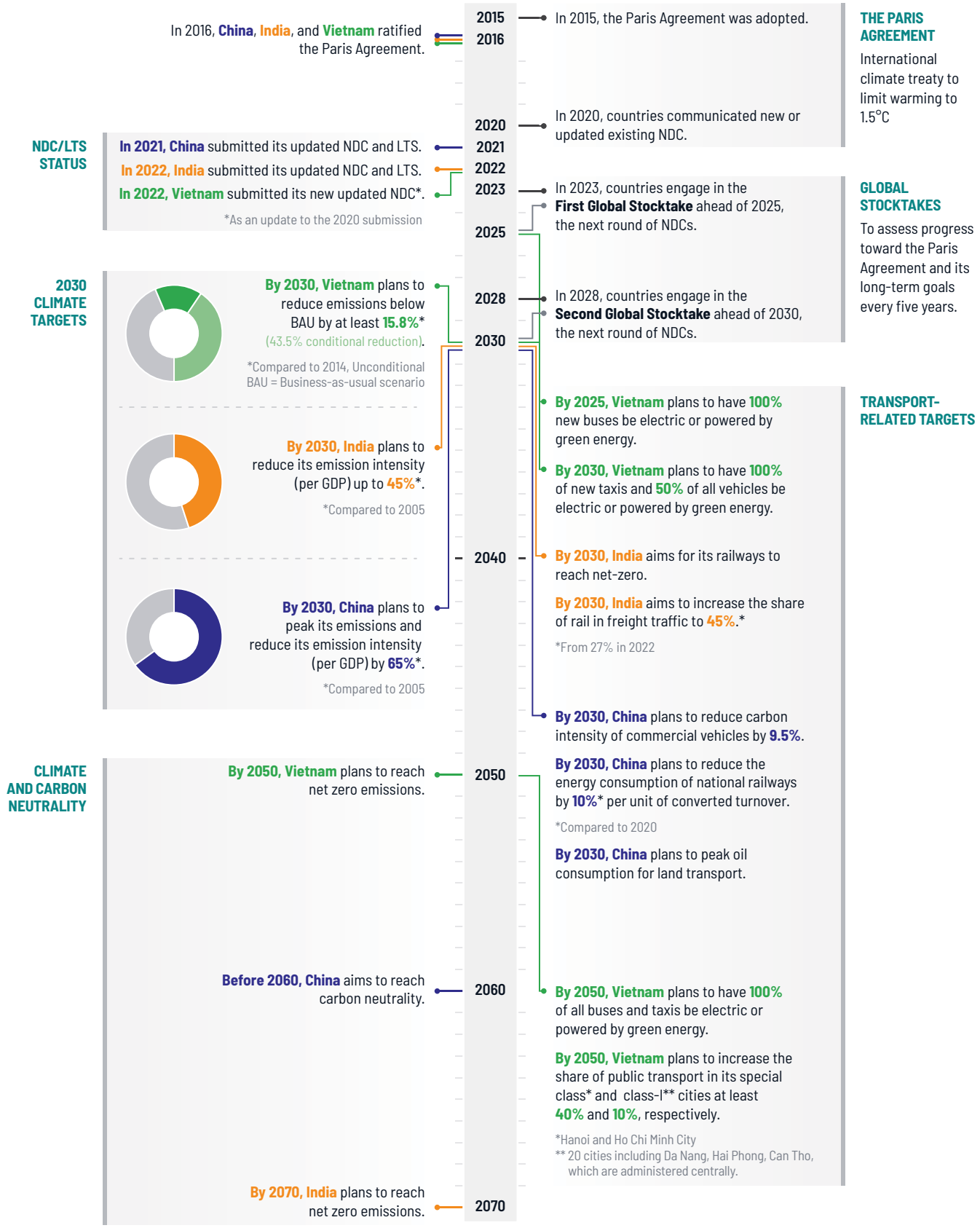
Conclusions

The first Global Stocktake, concluding at COP28 in December 2023, assesses how much global progress has been made in cutting GHG emissions and building resilience and evaluates where more work is necessary to accelerate climate action (Srouji and Cogan 2023). The next round of NDCs is due in 2025, and the Global Stocktake should inform countries updating NDCs, helping them increase their ambition and enhance their actions. The updated NDCs will set emissions reduction targets for 2035 (see Figure ES-2). Drawing on the lessons from the efforts of China, India, and Vietnam to strengthen and implement their NDCs, this report identifies promising opportunities and strategies to enhance transport ambition and implement the policies needed to reach the NDC goals in the transport sector.

As countries announce net zero or carbon neutrality goals, it will be important to align these long-term targets with medium- and short-term actions. Aligning actions with targets requires coordinated governance, common target setting (economy-wide GHG targets and sectoral targets), and common systems for monitoring and assessing progress (Falduto and Rocha 2020; Levin and Fransen 2019). It will be important for these processes to be contextualized, integrated, and aligned with NDCs and for NDCs to fit into a wider national framework of policies and funding strategies. This can offer multiple possible benefits to help reach a low-carbon pathway, such as increasing stakeholder buy-in and tapping the potential of climate finance. In Vietnam, aligning the country's NDC with national strategies and action plans (e.g., climate change, green growth) has gained the support of key stakeholders (e.g., line ministries) and has promoted climate change responses. Including sectoral targets in NDCs can be particularly helpful to attract more targeted international climate finance and send a strong political signal to potential investors (Bongardt et al. 2017; Fransen et al. 2019).

Countries should ensure transport decarbonization is not managed in isolation from other sectors and related policies but rather as a unifying agenda across sectors and levels of governments. Identifying or establishing a leading agency can be instrumental in ensuring consistent strategic planning and financing. China's Leading Group on Carbon Peaking and Carbon Neutrality serves as a formal coordination

FIGURE ES-2 | The three case countries' progress to enhance ambition



Notes: BAU = business as usual; GDP = gross domestic product; LTS = long-term low greenhouse gas emission development strategy; NDC = nationally determined contribution.

Sources: CAT 2022; Climate Watch 2021a, 2021b; Government of India 2022b; Government of Vietnam 2022; MEE 2022; aggregated by authors.

mechanism. India's framework of climate institutions and efforts to design national strategies on energy and electric mobility (e-mobility) are expanding (Dubash et al. 2018). The National Institution for Transforming India (NITI Aayog), the Indian government think tank, has been instrumental in connecting with ministries and coordinating efforts to push forward e-mobility. Vietnam has developed a clear process for translating climate commitments into action plans. This has enhanced collaboration across ministries (e.g., ministries of environment, transport, finance). Subnational governments also need support. They must have the capacity, financial and other resources, and information, such as guidelines, to design a mix of policies that respond to local practices and conditions.

Multistakeholder platforms for transport can enable change. These national- or subnational-level platforms can facilitate regular, targeted discussions among public authorities from the transport, climate, and energy sectors as well as representatives from the private sector, academia, and nongovernmental organizations. These discussions facilitate knowledge- and information-sharing across sectors and countries, enhancing public-private collaboration, identifying tangible solutions to decarbonize transport, and informing future policymaking. India's Forum for Decarbonising Transport, established by NITI Aayog under the NDC-TIA, is helping to catalyze stakeholder engagement and to chart pathways to decarbonize transport.

Considering equity when planning transport infrastructure and services is vital not only for decarbonizing transport but also for creating a more inclusive, integrated transport system for all. In India, women's labor force participation in the transportation and automotive industry ranges from 5 percent to 10 percent (Philip 2018). To enhance women's representation in the electric bus (e-bus) transition, the Indian government is mandating bus procurement tenders with a 25 percent participation rate from women in roles such as drivers and depot staff (Kanuri 2023). China is taking steps to make transport development more equitable, such as constructing barrier-free facilities for people with reduced mobility (Chen 2023). Furthermore, many developing countries have informal public transport (e.g., private buses, auto-rickshaws, motorcycle taxis), providing access to services and markets and creating jobs for lower-income groups. To promote inclusivity in the EV transition, efforts must be made to address the informal or semi-informal sector, where relevant, to enable a broader, more equitable transition (Kustar et al. 2022).

Transport decarbonization requires a systematic approach. Globally, while more countries are committing to e-mobility (*improve*) in their NDCs or LTSs, emphasis on other transport mitigation actions such as mode *shift* to public transport and active mobility, transport demand management (*avoid*), supportive land use, and freight transport is lacking (SLOCAT 2021). Although countries worldwide are pinning their hopes on electric and alternative fuel vehicles, following a more holistic Avoid-Shift-Improve (ASI) approach likely offers the best chance for system-wide change. The ASI approach aims to change the mobility paradigm—the prevailing model or assumptions about mobility—from an approach that is car centered to one that is people centered, provides diverse mobility options, and nudges people toward sustainable travel choices and behaviors. For instance, rather than focusing solely on replacing fossil fuels with electricity to power passenger cars, the ASI approach might incentivize encouraging travel by e-buses or minimizing the need to travel by motorized vehicles. Successful examples are emerging in Guangzhou, China, where some neighborhoods located near bus rapid transit and metro stops are well integrated into the urban fabric (Oval Partnership 2021).

Craft an integrated, comprehensive policy mix for e-mobility. Deploying EVs and charging infrastructure can help improve air quality and reduce emissions, and a myriad of instruments can support this technological transition. These can be financial (e.g., subsidies, registration rebates, taxes), regulatory (e.g., CO_2 standards, zero-emission zones, phaseouts of vehicles with internal combustion engines), and informational (e.g., marketing, communication). Through a decade-long effort, China has become the largest EV producer and consumer, and it has the largest charging network. Its rapid acceleration of electrification in passenger vehicles can be attributed to a combination of factors, including a top-down approach with clear targets and policies; national subsidy programs to initiate and grow the market; and a mix of regulations, such as a zero-emission vehicle (ZEV) mandate and license plate registration. As the market develops and technologies mature, the policy instruments need to pivot.

Because substantial investments are needed to transition to low-carbon transport, all financing channels need to be leveraged and directed away from fossil fuels. Fossil fuel subsidies disrupt the market and send wrong price signals to consumers and investors; eliminating such subsidies will help make sustainable transport solutions more competitive (Council for Decarbonising Transport in Asia 2022). Financing should flow into sustainable infrastructure such as connected public transport networks and high-quality walking and cycling lanes for improved last-mile connectivity. Innovative financing schemes and business models are needed. India's aggregated demand model offers one example of how innovative financing helps to significantly reduce e-bus procurement costs. Through economics of scale and enhanced contract terms, the costs of e-buses can be up to 35 percent lower than the costs of conventional buses (CESL 2023; Vijaykumar et al. 2023). The recent India–United States e-bus partnership aims to deploy 10,000 e-buses in India and provides payment guarantees that will alleviate financier liquidity concerns (Mookherjee 2023).

1. Introduction

Why decarbonize transport in Asia? Why now?

Transport matters. The movement of people and freight is the lifeline of economies, providing access to goods, services, and other opportunities. Rising populations, increasing urbanization, and continued economic development will place more pressure on transportation systems that are essential to a thriving society and economy. But the sector faces a significant, multifaceted challenge in addressing climate change.

Since 2000, Asia has outpaced other regions in population growth, urbanization, economic growth, and infrastructure development. As the economies continue to grow, demand for transport has soared.[1] Between 2000 and 2019, the number of vehicles on the roads rose from 310 million to 1.2 billion. The annual increase in vehicle ownership (7.4 percent) has mirrored annual gross domestic product (GDP) growth rates (7.7 percent) (ADB 2022b). Likewise, passenger and freight transport activity are expected to continue to grow by 30 percent and 60 percent, respectively, from 2020 to 2030 (ATO 2022).

Against this backdrop, transport-related emissions in Asia have grown faster than emissions anywhere else in the world. Asia is responsible for over a quarter (nearly 27 percent) of global transport emissions, and these emissions are growing at a rate of 3.9 percent annually, which is twice the global average (1.9 percent) (ADB 2022a; Gota and Huizenga 2022). Emissions, however, are rising slightly slower than GDP, showing that transportation emissions and development can be decoupled, signaling that there is a path to achieve the Paris Agreement.

Transport emissions, air pollution, and congestion pose major challenges for Asian cities. A United Nations Environment Program study found that in Asia, 2.3 billion inhabitants are exposed to unhealthy levels of air pollution that are more than four times the World Health Organization guideline for clean air (UNEP 2018). The unprecedented volume of automobile traffic has made congestion a severe problem, costing Asian economies an estimated 2–5 percent of GDP annually (Leather 2022). In Metro Manila, the Philippines, the most congested Asian city, drivers lose around 100 hours per year in rush hour gridlock (TomTom 2023). Adopting climate-friendly, sustainable transport measures will bring significant cobenefits, such as improved road safety, cleaner air, and increased access to economic opportunities.

Momentum is growing toward low-carbon, sustainable transport in Asia. Many Asian economies are already constructing metro and high-speed rail systems, with Asia hosting 59 percent of the world's metro and 76 percent of high-speed rail networks, providing sustainable alternatives to car trips (ADB 2022a). In the past decade, China has established the world's most extensive high-speed rail network, with 25,000 kilometers (km) of dedicated lines (Lawrence et al. 2019). Other countries, including India, Malaysia, the Philippines, Thailand, and Vietnam, are planning infrastructure improvements and expansion of rail networks.

Electrification is also picking up speed. Two- and three-wheelers (2Ws and 3Ws) are the dominant modes of transport in many of Southeast Asian countries (Le and Yang 2022). As the technologies and markets mature, countries see the electrification of 2Ws and 3Ws as an opportunity to create a new industry or to leapfrog to an electric vehicle (EV) transition.

New business models and innovations also enable diverse mobility options. These include shared bicycles and scooters as well as carpooling. Ridesharing services such as DiDi, Gojek, Uber, and Ola are rising in the mobility landscape in Asia. Mobility as a service (MaaS) and smart mobility are gaining traction and offer opportunities to make travel safer and smarter (ESCAP 2022). These positive trends signal ways countries can seize the opportunity to embrace a more sustainable, low-carbon transport model that can align the sector with the 1.5°C pathway needed to avoid catastrophic climate change.

These positive trends signal ways countries can seize the opportunity to embrace a more sustainable, low-carbon transport model that can align the sector with the 1.5°C pathway needed to avoid catastrophic climate change.

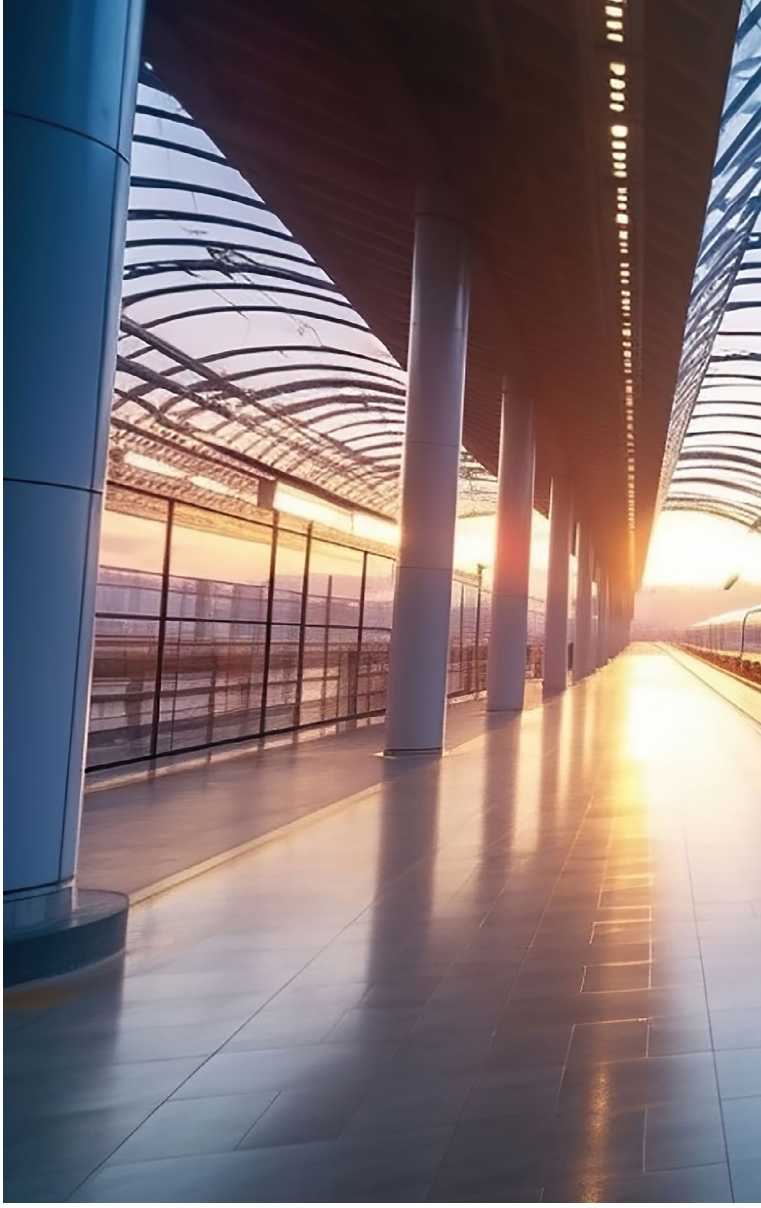
The need to address transport in nationally determined contributions

Under the 2015 Paris Agreement, countries agreed to limit global warming well below 2°C and to strive to limit warming to 1.5°C. To stay within the 1.5°C scenario, the Intergovernmental Panel on Climate Change (IPCC) estimated that a maximum of 400 billion tonnes (Gt) of carbon dioxide (CO_2) could be emitted from the beginning of 2020 until 2050 (IPCC 2023). The transport sector would contribute 110 $GtCO_2$, making up almost 28 percent of the remaining carbon budget. Immediate and deep emissions cuts—more than half of the current and projected levels—are needed for transport, similar to other sectors (IEA 2023). And this can only be achieved with transformative and systemic changes enabled by ambitious decarbonization targets and associated actionable strategies.

Recognizing this urgent situation, many governments in Asia are making net zero emissions commitments. According to the Council for Decarbonising Transport in Asia, 14 countries—responsible for 26 percent of the global transport emissions in 2019—have made economy-wide net zero commitments (Council for Decarbonising Transport in Asia 2022).[2] This includes the world's largest emitters: China and India. Although it is encouraging to see more targets, they vary in terms of time frame (e.g., 2050, 2060, and beyond), coverage of greenhouse gases (GHGs), sectors, legal status (e.g., the targets are enshrined in law or policy documents), among other aspects.

The Paris Agreement introduced several mechanisms and processes to combat climate change. Key among these are the nationally determined contributions (NDCs) and long-term low GHG emission development strategies (LTSs). **NDCs** outline countries' commitments to address climate change and provide a framework for undertaking mitigation and adaptation actions across sectors, including plans to achieve resilient, low-carbon transport systems (UNFCCC n.d.b). Every country needs to prepare and communicate its NDC every five years. Countries submitted the first generation of NDCs in 2015 and will update their pledges in 2025 (Fransen et al. 2022). Countries can also voluntarily submit **LTSs**, which lay out systematic decarbonization road maps and typically contain targets for reducing emissions by 2050 (UNFCCC n.d.a). As of August 2023, 11 Asian countries have submitted their LTSs, including Cambodia, China, Cyprus, India, Indonesia, Japan, Nepal, the Republic of Korea, Singapore, Sri Lanka, and Thailand (Climate Watch 2021a).

Using the geographic regions defined by the M49 Standard of the United Nations, the "Tracker of Climate Strategies for Transport" provides information on transport measures in



NDCs and LTSs in Asia and other regions (SLOCAT 2021; UNSD n.d.). The UN M49 Standard definition for the Asian region is broad and includes countries often considered as being in Eurasia, the Middle East, and South Asia. As of April 2022, 38 countries in Asia have communicated second-generation NDCs. These NDCs include countries' second NDCs, updated NDCs, and newly submitted first NDCs (Bongardt et al. 2022). The following observations are significant:

- A few Asian NDCs contain a transport GHG target, including Bangladesh, Georgia, Israel, Japan, Sri Lanka, and the United Arab Emirates (Table 1). This is in line with the global data, where only 26 of the current NDCs worldwide contain transport emissions reduction targets (Fransen et al. 2022).
- Transport non-GHG targets, referring to transport-related targets not expressed in terms of GHG emissions, mostly relate to the deployment of zero-emission vehicles (ZEVs) and vehicle efficiency improvements, representing 49 percent and 22 percent of the non-GHG transport targets, respectively (Bongardt et al. 2022).

- Although vehicle electrification is a key focus of Asian NDCs, the NDCs do not contain targets on renewable energy in transport. Globally, 39 countries or states/provinces have targets for EVs and renewables generation, but the level of ambition varies (REN21 and FIA Foundation 2020).
- There are various other targets related to the expansion of public transport networks and shifts to more sustainable transport modes.

Looking specifically at **transport mitigation** actions, e-mobility is prominent in Asian NDCs and is included in 66 percent of them. This aligns with the global trend of stressing e-mobility, with 53 percent of all NDCs containing electrification-related measures (Bongardt et al. 2022). Other mitigation actions include mode shift, transport demand management, and low-carbon fuels. The transport goals in the LTSs of China, Japan, and Singapore include a balanced mix of mitigation measures across the avoid-shift-improve (ASI) framework (for more details, see "China" in "Country analysis"). The "Tracker of Climate Strategies for Transport" also includes data on **adaptation** targets and actions in countries' NDCs and LTSs. Twelve Asian economies have updated their transport adaptation actions in their second-generation NDCs. For example, Cambodia will use public transport and EVs to support emergency events, and Japan and Singapore will enhance the resilience of transport infrastructure.

A recent analysis by the Asian Development Bank reveals that although climate change in the transport sector is not yet a predominant focus in Asia, the foundational elements are beginning to emerge, which could serve as the basis for a more all-encompassing strategy in the future (ADB 2022a). Since 2020, various modeling by different agencies shows that the 2050 business-as-usual (BAU) transport emissions projections for Asia have dropped by 37 percent, resulting from a combination of enabling policies and behavioral changes aimed at reducing activity levels (ADB 2022a; Keramidas et al. 2021). Although moving in the right direction, the region is not making fast enough progress to reach the goals set under Paris Agreement (Gota and Huizenga 2022). Reducing emissions from the sector will require a combination of enhanced transport targets, comprehensive strategies, significant penetration of zero-emission technologies and supportive infrastructure, and strengthened policies to nudge behavioral change.

TABLE 1 | Selected transport targets contained in the new or updated NDCs in Asia

TARGETS	TARGET TYPE	COUNTRY	TARGET	SOURCE
Transport greenhouse gas (GHG) targets	Baseline scenario target	Bangladesh	Reduce transport emissions by 9% below business as usual (BAU) by 2030	First NDC (September 21, 2016)
	Base-year target/ fixed-level target	Japan	Reduce transport emissions by 27% by 2030 from the 2013 level, reaching 163 million tonnes of carbon dioxide	First NDC (November 8, 2016)
	Baseline scenario target	Sri Lanka	Reduce transport emissions by 4% (1% unconditional, 3% conditional) below BAU by 2030	Updated NDC (July 30, 2021)
Transport non-GHG targets	Zero-emission vehicles	Nepal	Increase the share of electric vehicles in private passenger vehicle sales to 25% by 2025	Second NDC (August 12, 2020)
	Mode share	India	Increase the share of railways in total land transport from 36% to 45%	First NDC (October 2, 2016)
	Infrastructure	Laos	New bus rapid transit system in Vientiane and associated non-motorized transport by 2030	First NDC (September 21, 2016)
	Biofuels	Laos	Biofuels to meet 10% of transport fuels by 2030	First NDC (September 7, 2016)

Notes: The analysis uses the UN M49 Standard definition for the Asian region. Quantitative targets include both GHG and non-GHG targets. Transport GHG targets refer to reducing GHG emissions from the transport sector by a specific amount in a defined time frame. These can take different forms, such as baseline scenario targets, which are commitments to reduce emissions by a specified amount relative to a projected emissions baseline scenario; base-year targets, which that are commitments to reduce emissions by a specified quantity relative to a base year; and fixed-level targets, which are commitments to reduce emissions to an absolute level in a target year or target period. Transport non-GHG targets are transport-specific targets not expressed in terms of GHG emissions.

Sources: Bongardt et al. 2022; Fransen et al. 2022; SLOCAT 2021.

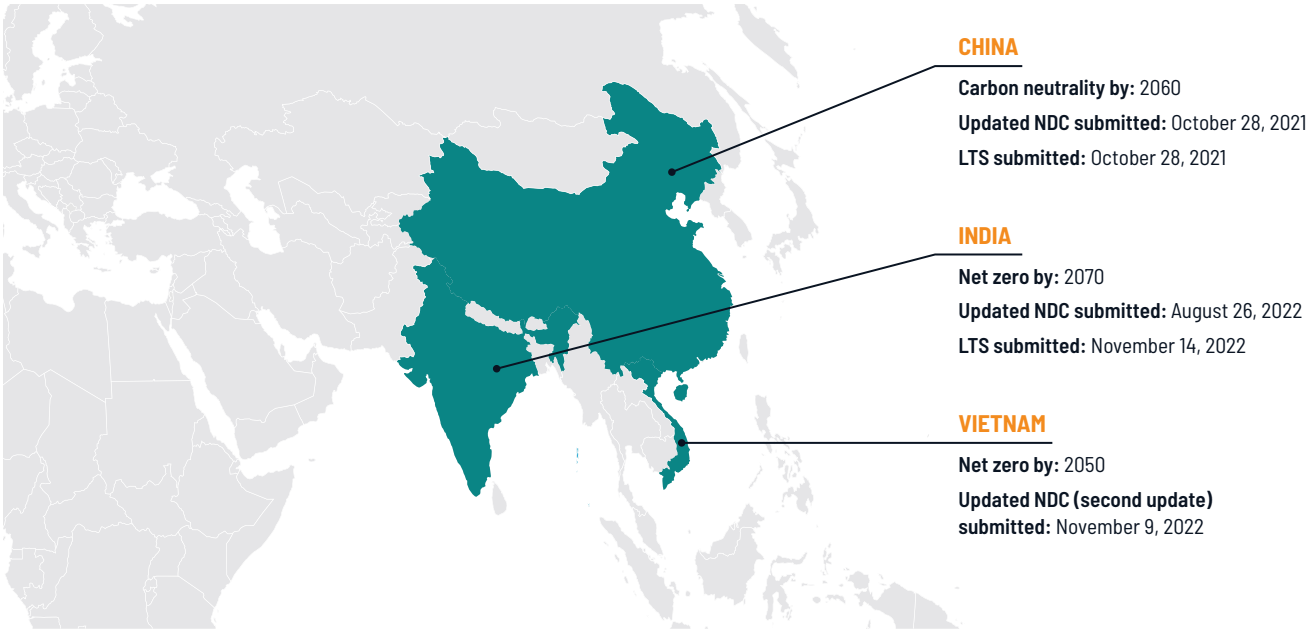
Background of the NDC Transport Initiative for Asia

Getting transportation on track to meet the 1.5°C global warming goal requires zero-emission transport across Asia, and the NDC Transport Initiative for Asia (NDC-TIA) is playing a key role in developing the broad set of transport decarbonization strategies and solutions needed. Financed by the German Ministry for Economic Affairs and Climate Action through its International Climate Initiative, the program aims to facilitate a mobility paradigm shift in China, India, and Vietnam (see Figure 1).

In each country, the NDC-TIA supports sectoral contributions to achieve NDC goals and to raise ambition for long-term climate strategies and the 2025 NDC milestone. The project supports the following activities (NDC-TIA n.d.):

- Developing strategies to control transport GHG emissions and air pollutants in China
- Developing regulatory frameworks and policies to support EV deployment in India
- Developing policy frameworks to reduce transport GHG emissions and promote low-carbon development in Vietnam
- Facilitating lessons learned across countries in Asia and promoting multistakeholder coordination between the public and private sectors (see Box 1)

FIGURE 1 | NDC-TIA project countries



Notes: LTS = long-term low greenhouse gas emission development strategies; NDC = nationally determined contribution.
Sources: CAT 2022; Climate Watch 2021a, 2021b; Government of India 2022a, 2022b; Government of Vietnam 2022; MEE 2022.

BOX 1 | Council for Decarbonising Transport in Asia

The NDC Transport Initiative for Asia program established the Council for Decarbonising Transport in Asia. The council is a group of experts, practitioners, and thought leaders from academia, civil society, business, and financial institutions who have come together to promote critical dialogue on achieving zero-carbon transport in Asia. With a goal of making transport climate friendly, safe, and accessible, council members develop a vision for a sustainable transport sector along with the necessary actions Asian countries will need to take to get there. They act as ambassadors for change by promoting key insights and recommendations that inspire decision-makers to take action.

In 2022, the council published the flagship report *The Path to Zero: A Vision for Decarbonised Transport in Asia,* advocating a vision of the future where "the mobility needs of all [will] be met with zero carbon options, while integrating all modes seamlessly, efficiently and conveniently." The report identifies opportunities and blind spots associated with transport decarbonization and presents a comprehensive approach to enable a transformation to zero emissions in transport.

Source: Council for Decarbonising Transport in Asia 2022.

2. Scope and methodology

Objective and scope of the study

It is not clear how closely national transport policies and strategy frameworks align with countries' broader climate ambitions to harness the untapped potential of sustainable transport. To successfully implement low-carbon transport measures in the context of the Paris Agreement, key government actors (e.g., ministries of transport, environment, climate) will need to take coordinated and concerted measures to strengthen linkages between the planning and implementation of NDCs and national transport strategies.

This report presents case studies from China, India, and Vietnam, linking transport and climate, to identify synergies for developing and implementing transport decarbonization strategies. It addresses these questions:

- To what extent do national transport policies align with these countries' NDCs and LTSs? How are NDCs/LTSs linked with national transport strategies, and what role, if any, do they play in shaping the transformation of the transport sector? How do transport mitigation actions in the NDCs interact with other sectors?
- How can NDC development and implementation be leveraged to accelerate the scale-up of sustainable transport measures? What challenges exist for implementing sustainable transport and enhancing ambitions in NDCs and LTSs in these countries? What opportunities exist for more coordinated management of transport within these processes?
- How can countries strengthen the implementation of climate strategies for transport and raise the transport ambition further in NDCs in the future? What kind of guidance is needed for mainstreaming sustainable transport within climate strategies in a structured manner?
- How can countries accelerate transport decarbonization and engage different stakeholders in developing and implementing transport decarbonization strategies?

Methodology

The following approach and methods were used to explore these questions:

- A review of literature and policy documents to examine the countries' NDCs, LTSs, and net zero pledges as well as their broader national transport policies
- An examination of the process behind transport targets (if available) and transport mitigation action development in the NDCs, to better understand their interactions (i.e., consistency and coherence)
- Expert interviews with representatives from relevant government agencies and other groups to gather new empirical data on how they perceive barriers, opportunities for transport decarbonization, and potential interventions for low-carbon, sustainable transport for other Asian countries

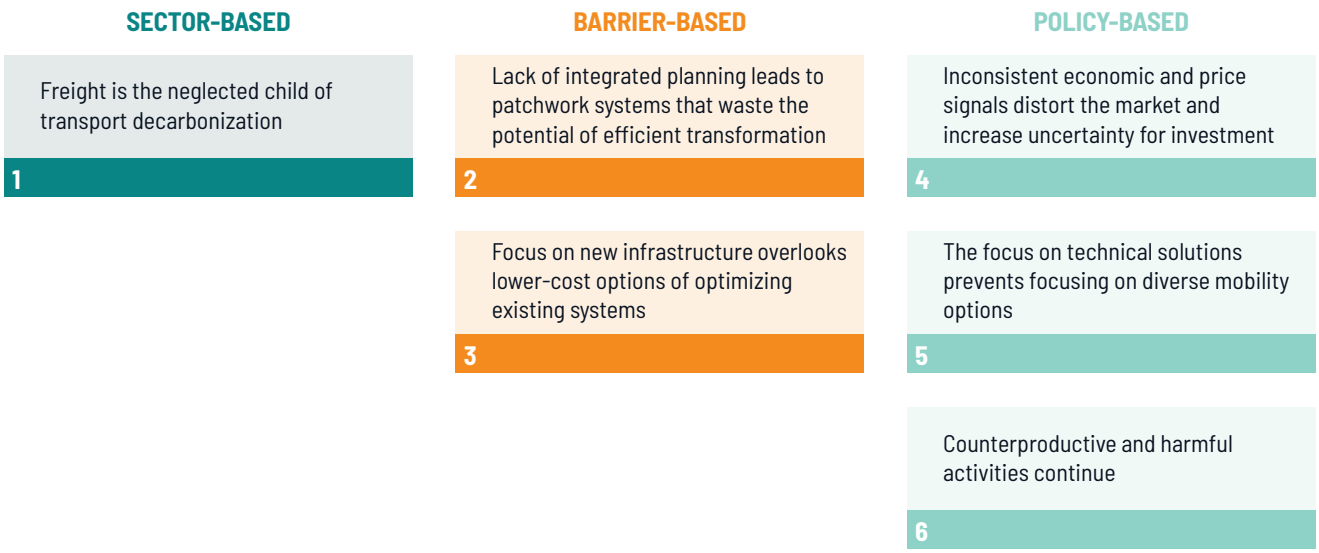
Although a myriad of measures can reduce transport emissions, this research focuses on the widely adopted ASI framework, which breaks down the measures into *avoid* or reduce the need for motorized travel, *shift* to more sustainable modes, and *improve* vehicle and fuel efficiency (SLOCAT n.d.). Given its comprehensiveness, this framework allows comparison of selected key thematic areas across the three countries, including a shift to public transport and active mobility, intermodal freight transport, electric mobility (e-mobility), fuel efficiency improvements, and linkage with renewable energy (see "Country analysis").

To identify enabling conditions and challenges for implementing national transport decarbonization strategies, we assessed whether the three countries are tackling key blind spots. These are identified in the *Path to Zero* report as problems or potential solutions that have not received the attention they deserve in policy planning and implementation, despite their decarbonization potential (Council for Decarbonising Transport in Asia 2022) (Figure 2). The council found that it will be critical to tackle them to enable transport decarbonization. We assessed whether and how planning and implementation of national transport policies focused on these potential solutions:

- Tackling freight transport
- Integrating planning, for instance, by incorporating transit-oriented development (TOD) in city development plans or prioritizing mixed-use and compact cities
- Improving infrastructure and seeking low-cost solutions such as adopting modern information and technology systems or setting new speed limits
- Incentivizing sustainability by sending consistent policy and price signals through taxes, emissions trading systems, public parking fees, and other tools to steer market behavior
- Providing diverse mobility options by considering the integrated transport system as a whole
- Discontinuing counterproductive and harmful activities such as the reliance on private motorized vehicles and fossil fuel subsidies

To clarify how much national transport policy and regulatory frameworks align with broader climate ambition, we employed a policy mix analysis framework. This is used to assess how international commitments translate into national

FIGURE 2 | Overview of key blind spots, identified in the Path to Zero report



Source: Adapted from Council for Decarbonising Transport in Asia (2022).

policymaking, how national governance structures might affect policy planning and development, and how different policy instruments provide an impetus for a decarbonized transport future (see "Alignment analysis").

In sustainability transitions, the concept of "policy mixes" refers to the combination of strategies, policy instruments, and "policy processes by which such instruments emerge and interact" (Rogge and Reichardt 2016). We considered policy mixes across international, national, subnational governance levels and assessed their characteristics for each country: the consistency of policy elements (strategies and policy instruments) and the coherence of policy processes (planning and implementation) (Table 2). The following definition is mainly drawn on work by Rogge and Reichardt (2016):

- For consistency of policy elements, we looked for evidence of how strategic priorities align with each other, how the policy instruments are aligned, and how they contributed to the achievement of objectives.
- For coherence of policy processes, we searched for evidence of coordination and communication across different policy areas and governance levels as well as capacities such as the ability to build networks with key actors, to engage various stakeholders, and to collate and disseminate related knowledge.

HERE ARE MORE DETAILS CONCERNING SOURCES AND METHODOLOGIES:

Literature and policy document review. The study includes analyses of transport content in the NDCs/LTSs/net zero commitments, national transport strategies, and policies and programs. It utilizes the collective knowledge of the transport community and open-source data, including information and data from United Nations Framework Convention on Climate Change (UNFCCC) for transport ambition and actions in the NDCs and LTSs and analyses from Climate Watch on the international mechanisms, country assessment reports, and data and feedback from transport stakeholders in Asian countries. This included an in-depth review of the following:

- Official NDC documents and supporting plans submitted to the UNFCCC and published documents related to the NDC development process
- National climate change plans and strategies and mitigation and adaptation action plans (if available)
- National transport policy documents with a focus on key thematic areas, such as national e-mobility strategies and policies, fuel consumption standards for light- and heavy-duty vehicles (LDVs and HDVs) or CO_2 emissions standards, and freight transport policies and regulations
- Relevant sector programs (e.g., energy)

The literature and policy documents review revealed linkages between transport targets and mitigation actions in the NDCs/LTSs and national transport strategies as well as how transport interlinks with other sectors. We also reviewed the

TABLE 2 | Policy mix analysis framework

POLICY MIX CHARACTERISTICS	ASSESSMENT CRITERIA	ASSESSMENT OF LOW PERFORMANCE	ASSESSMENT OF HIGH PERFORMANCE
Consistency	Alignment of strategic priorities	Policies strategies and instruments undermine each other	Little to no contradictions between policy strategies and instruments
	Instrument-strategy alignment		
Coherence	Alignment of coordination	Uncoordinated policymaking and implementation process	Systematic policymaking and implementation processes across coordination and communication
	Alignment of communication		

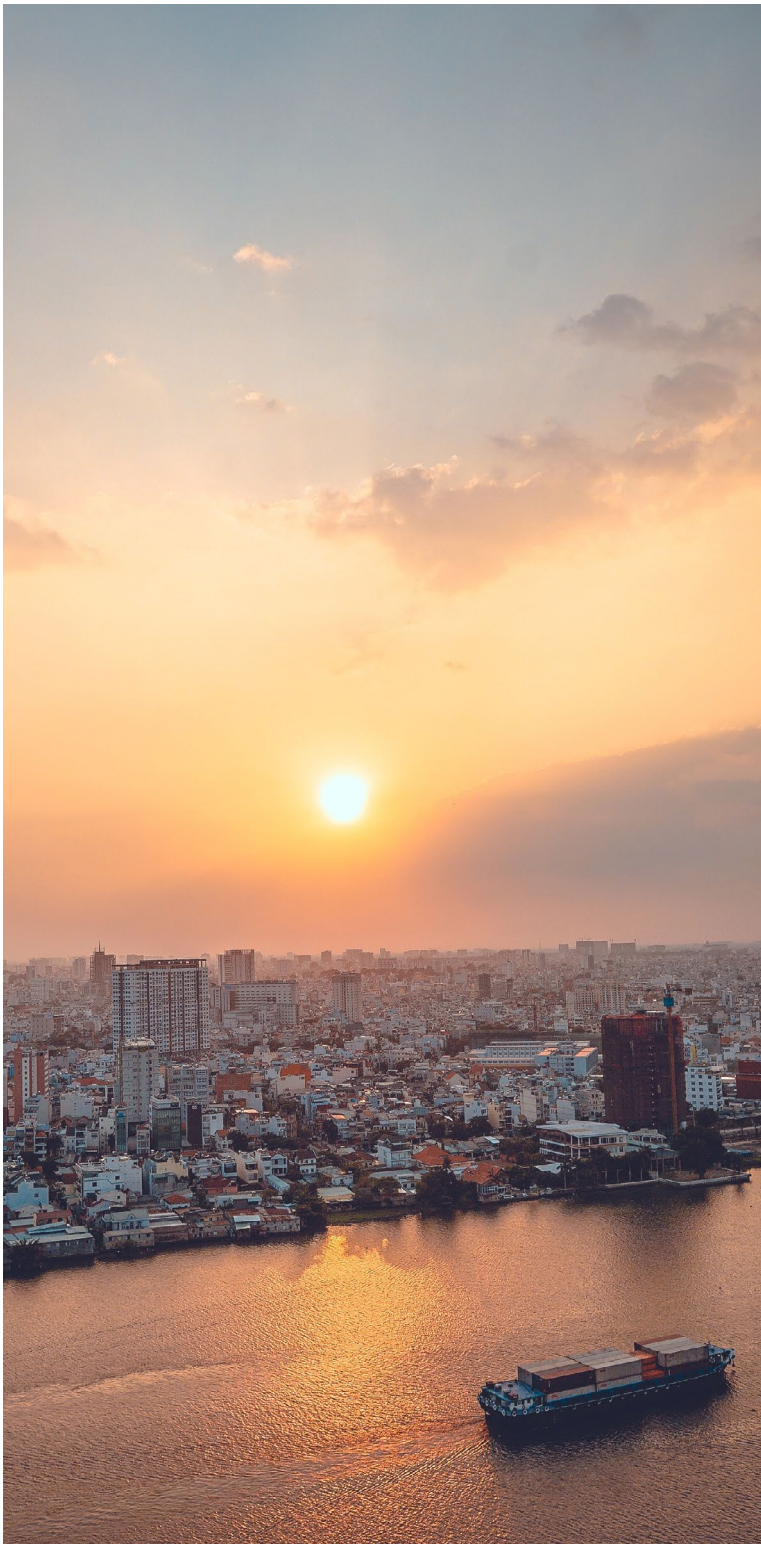
Sources: Adapted from Rogge and Reichardt (2016) and Zepa and Hoffmann (2023).

institutional setting and policy framework for climate change and transport to understand the policymaking process and possible entry points for enhancing transport policy formulation and implementation.

Expert interviews. To identify potential country-specific challenges and lessons learned on translating ambition to decarbonization strategies and implementing national transport policies, we conducted 17 semistructured individual or group interviews with experts who work in transport-, climate-, and energy-related sectors and have both experience and expertise. Various sectors were represented, with eight experts working in national governments or government-affiliated agencies, two in nongovernmental organizations (NGOs), two in academia, two in independent research, and three in industry. Interviews were conducted between October 2022 and March 2023: six for China, five each for Vietnam and India, and one for the broader Asia region (see Appendix A and Appendix B).

We recorded the interviews when applicable and analyzed the transcripts to understand the policy mix characteristics in each country (see "Alignment analysis"). The small sample size of interviewees means that the result might not paint a full picture of developments in each country or include a full range of perspectives. Despite these limitations, the snapshots from interviews reveal themes and relevant issues that underline the complexity of the low-carbon transport transition and shed light on the enabling conditions for a holistic approach for reaching net zero emissions (see "Synthesis of findings").

Expert consultations and workshop. Several consultations also took place with international and local experts working in the countries to discuss bottlenecks to transport decarbonization. We organized a consultation workshop to collect feedback on preliminary findings, comments, and suggestions for improving the study quality and validating the findings in the report.



3. Country analysis

Case studies in this report focus on three Asian countries: China, India, and Vietnam. These countries were selected because they span broad and diverse geographies, NDC-TIA partners are conducting ongoing work in each country, information about them is available, and their policy choices will influence whether global efforts to combat climate change will succeed. China and India together accounted for 58 percent of transport-related emissions in Asia in 2019 (Climate Watch n.d.). These three countries are taking different approaches to decarbonizing transport, and evaluating and comparing these strategies can generate knowledge, enable learning, and inform policy development in the region.

The following sections present case studies from each of the three countries, covering the following:

- General country context
- International climate commitments (NDCs, LTSs, net zero targets) and national transport ambition
- National governance on climate change and transport
- National policy framework for climate change and transport
- The state of transport decarbonization in selected thematic areas, including public transport, active mobility, TOD, freight transport, e-mobility, fuel efficiency improvements, and linkage with renewable energy
- A comparison of the stated transport measures against the blind spots identified by the Council for Decarbonizing Transport in Asia

China

Country context

China is home to one-fifth of the world's population and produces 18.8 percent of the global GDP. It is the largest energy consumer and carbon emitter, accounting for nearly one-third of global carbon emissions (IEA 2021a). Due to rapid urbanization, motorization, and significantly increased transport activity, the country's transport emissions multiplied ninefold from 1990 to 2019 (Figure 3); as of 2019, China's transport emissions accounted for 11.1 percent of the world's total transport emissions, following the United States (21.3 percent) and the European Union plus the United Kingdom (11.2 percent) (Climate Watch n.d.).

That share is expected to rise. Studies suggest that in 2015 China and India were responsible for a quarter of passenger vehicle kilometers traveled, but by 2050 that figure is projected to reach one-third under the BAU scenario. China and India will also see significant growth in surface freight traffic, by road, rail, and inland waterway transport (IWT), from 37 percent to 54 percent between 2015 and 2050 (ITF 2019). Within China's transport sector, road transport has been the largest source of emissions, representing 84.1 percent.

FIGURE 3 | Population, motorization, and transport emissions

Population (2020)[a]	Expected population growth (2020–2050)[a]	Urban population/share of total population (2020)[a]	Motorization rate (2020)[b]	Passenger transport volume (2019)[b]	Freight transport volume (2019)[b]	Transport emissions/share of emissions from fuel combustion (2019)[c]
1.412 billion	**7.9%**	**866.7 million** (61.4%)	**338 road motor vehicles** (per 1,000 inhabitants)	**3,534.9 billion pkm**	**13,998.8 billion tkm**	**1,052.80 $MtCO_2$** (11.8%)

Notes: $MtCO_2$= million tonnes of carbon dioxide emissions; pkm= passenger kilometer; tkm = tonne kilometer.

Sources: a. National Bureau of Statistics of China 2023; b. Riehle et al. 2023. c. IEA 2019.

China's international climate commitments

China's climate change strategy has evolved significantly over the last decade. After the 2015 Paris Agreement, the most notable policy development was the announcement of the carbon neutrality goal by China's President Xi at the 75th UN General Assembly in September 2020 (Ministry of Foreign Affairs 2020).

In 2015, China submitted its first NDC, pledging to peak carbon emissions by 2030, "reduce its carbon intensity by 40%–45% by 2020 and 60%–65% around 2030, when compared to the 2005 level" (MEE 2022). China reported progress on its NDC implementation in 2022, mentioning that it had reduced its carbon intensity by 50.8 percent in 2021 compared with 2005, exceeding its 2020 target (MEE 2022).

Ahead of COP26 in October 2021, China submitted its updated NDC and LTS. Its updated NDC contains five overarching targets, including "(1) Peaking CO_2 emissions before 2030 and achieve carbon neutrality before 2060; (2) Lower carbon intensity by over 65% in 2030 from the 2005 level; (3) Increase the share of non-fossil fuels in primary energy consumption to around 25% in 2030; (4) Increase the forest stock volume to 6 billion cubic meters in 2030 from the 2005 level; and (5) Bring the installed capacity of wind and solar power to over 1,200 gigawatts (GW) by 2030" (MEE 2022). In comparison to its first NDC, the updated version added the fifth target on renewables while strengthening the nonfossil share (up from around 20–25 percent), carbon intensity targets (up from 60–65 percent to over 65 percent) and the forest stock volume target (up from 4.5 billion to 6 billion cubic meters) (see Table 3 for a comparison of the NDCs).

China's updated NDC outlines a set of transport mitigation measures such as accelerating the construction of comprehensive transport networks, promoting multimodal transport, and a mode shift to rail and waterways for freight. The NDC also stresses electrification of vehicles across segments (electric buses [e-buses], taxis, and delivery vehicles) and deployment of charging infrastructure. It says passenger transport will be supported by the expansion of transport infrastructure and networks (urban rail, dedicated bus lanes, and bus rapid transit [BRT]), and improvement of walkways and bike lanes. Green logistics will be developed speedily with improved utilization efficiency. And energy efficiency standards for fossil fuel vehicles and vessels will be progressively upgraded. Intelligent transport is also mentioned in the NDC (MEE 2022).

China's LTS states the country's goal of reaching carbon neutrality before 2060 and outlines a balanced mix of transport measures. It contains carbon intensity reduction targets for various transport subsectors, specifically saying that, "by 2030, 40% of new vehicles sold should be new energy vehicles (NEVs, including BEVs [battery electric vehicles], plug-in hybrid vehicles and FCEVs [fuel cell electric vehicles]); the carbon emission intensity of commercial vehicles will reduce by 9.5% from 2020 level; energy consumption of national railways per unit of converted turnover [will be] reduced by 10% compared with 2020; and oil consumption by land transport peaks by 2030" (NCSC 2021).

With regard to **climate adaptation**, China is increasingly recognizing its vulnerability to climate change as it faces threats from desertification, flooding, and other extreme weather. In its updated NDC, China refers to the National Strategy on Climate Adaptation 2035, aiming to enhance climate adaptation actions and improve climate resilience. For transport, it sets out actions to improve safety, design and construction standards for transport infrastructure, and the resilience of its national highway network.

National governance on climate change and transport policymaking

To understand a country's climate governance, it is necessary to understand its overall governance structure. China's political system is a hierarchical structure with the Chinese Communist Party, the National People's Congress, the central government, and subnational governments (provincial, municipal, county governments and townships) (Teng and Wang 2021).

The key government stakeholders involved with climate change and transport policymaking in China are presented in Table 4. For a more detailed overview of the authorities involved in carbon peaking work in the transport sector, please see Table C-1 in Appendix C.

Because the climate policy is cross cutting, a coordinated cross-ministerial approach for policymaking is essential (Teng and Wang 2021). After announcing its carbon peaking and carbon neutrality goals ("dual carbon" goals) in 2020, China established a Carbon Peaking and Carbon Neutral Steering Group in 2021, chaired by the vice premier of the State Council (MEE 2022; Waisman et al. 2021).

Because the climate policy is cross cutting, a coordinated cross-ministerial approach for policymaking is essential.

NDRC, together with relevant ministries such as MOT, MEE, and MIIT, develops action plans in the 1+N policy system for key areas (more details below). MOT has set up a MOT Leading Group for Carbon Neutral Work to coordinate transport decarbonization. MIIT and MEE are also contributing to the policy development and implementation for the transport sector in the 1+N policy system.

At the subnational level, provinces have also set up carbon peaking and carbon neutrality leading groups. They are chaired by the provincial governors and mayors and relevant departments participate in these groups, serving as cross-departmental and coordination bodies for climate change.

TABLE 3 | Overview of key climate and transport targets in China's first NDC, updated NDC, and LTS

KEY CLIMATE AND TRANSPORT TARGETS	STATUS QUO	FIRST NDC	UPDATED NDC	LTS
Status	—	Submitted in 2015	Submitted on October 28, 2021	Submitted on October 28, 2021
CO_2 emissions trends	Emissions grew on average by 8.7% (2015–19)[a]	Peak CO_2 emissions around 2030 and make best efforts to peak early	Peak CO_2 emissions before 2030 and achieve carbon neutrality before 2060	Carbon neutrality before 2060
Carbon intensity reduction (compared to 2005 level of 810 gCO_2 per unit of GDP)	44% (2020 level of 450 gCO_2)[b]	60%–65%	65%	—
Share of nonfossil fuel consumption by 2030	16.6% (as of 2021)[c]	Around 20%	Around 25%	—
Installed capacity of wind and solar power	Reached 635 GW (as of 2021)[c]	—	Over 1,200 GW by 2030	—
EV deployment targets	24% of clean energy vehicles in new sales (as of August 2022)[d]	—	—	40% share of clean energy vehicles in new vehicle sales by 2030
Modal share targets	Authors do not have this figure	30% share of public transport in large- and medium-sized cities by 2020	—	—
Emission intensity reduction targets in the transport sector (compared to 2020 level)	Energy consumption of national railways per unit of transport decreased by 3.9% from 2020 level (as of 2021)[c]	—	—	Carbon emissions intensity of commercial vehicles reduced by 9.5% in 2030 Energy consumption of national railways per unit of converted turnover reduced by 10% in 2030 Oil consumption for land transport peaks by 2030

Notes: The word *around* provides no specific range of the accepted outcomes and could be interpreted using common sense criteria by the evaluating bodies. Clean energy vehicles include battery electric vehicles and plug-in hybrid vehicles. Em dashes (—) signify no mention in the policy document. CO_2 = carbon dioxide; EV = electric vehicle; g = gram; GDP = gross domestic product; GW = gigawatt; LTS = long-term low greenhouse gas emission development strategies; NDC = nationally determined contribution.

Sources: a. Riehle et al. 2023; b. IEA 2021a; c. MEE 2022; d. Ibold et al. 2022; Mock and Yang 2022; NCSC 2021; aggregated by the authors.

TABLE 4 | Key government stakeholders involved in transport decarbonization in China

STAKEHOLDERS	RESPONSIBILITIES/ROLES
State Council	The State Council is the highest central government hierarchy and is constituted of ministries and commissions across different policy areas. The Central Committee of the Communist Party of China provides political guidance to the State Council.
National Development and Reform Commission (NDRC)	NDRC is the most important supervisory authority for economic development in China, setting its Five-Year Plans. It is considered one of the most powerful ministries in terms of political resources and policy coordination.[a] NDRC is responsible for plans and policies tackling climate change.
National Energy Administration (NEA)	Under NDRC, the NEA is responsible for national subsidy policies and schemes for charging and hydrogen filling stations.
Ministry of Ecology and Environment (MEE)	MEE is responsible for global climate change negotiations. Under MEE, the Department of Climate Change is the focal point for developing China's climate strategies, monitoring progress on the United Nations Framework Convention on Climate Change processes, and participating in international climate negotiations.[b]
Ministry of Transport (MOT)	MOT is responsible for formulating and implementing development plans, policies, and standards for road, water, and air transport. It coordinates work related to integrated transport systems and promotes multimodality.
Ministry of Industry and Information Technology (MIIT)	MIIT oversees industrial development and is responsible for formulating policies related to fuel consumption.
Ministry of Science and Technology (MOST)	MOST leads innovation-driven development strategies.
Ministry of Finance (MOF)	MOF is responsible for issues related to public finance and taxation.

Sources: a. Teng and Wang 2021; b. Waisman et al. 2021; aggregated by the authors.

National policy framework for climate change and transport in China

Climate change is gaining prominence in China's government agenda. This is mirrored in the announcement of dual carbon goals and reflected in the recent Five-Year Plans (FYPs) and other high-level policy documents. The carbon neutrality target will have far-reaching implications on domestic discourse over the coming years. It is influencing key government strategies and policies supporting transport decarbonization in China, described in Table 5.

The 1+N policy system is of particular importance, setting overarching principles and high-level guidance for China's development strategies for key areas and sectors, including energy, industry, transport, and the circular economy (NDRC 2021). The policy reiterates the dual carbon goals and aims to align them with the country's medium- and long-term development plans. Figure 4 describes the timeline of China's key climate and transport policy documents.

Currently, the governments at national and subnational levels in China are developing sectoral emissions-peaking action plans (see Table 6). Experts interviewed for this research mentioned that the emissions peak timing for different sectors may vary and that emissions from the transport sector might peak later than those from industrial manufacturing and construction. Some experts also proposed that China should establish a tiered system for carbon emissions, where certain regions and industries reach their peak emissions earlier than others (Yi 2021). A recent study by the China Academy of Transportation Sciences, a research institution under MOT, finds that if China implements the announced policies, its **transport emissions** could peak by 2034 and oil consumption for land transport could peak by 2030. It also says that the transport sector could peak earlier than 2030 with faster emissions cuts through mode shift and the further deployment of NEVs and other low-carbon technologies (CATS 2022). This is in line with a scenario analysis by WRI China suggesting that **road transport emissions** in China could peak before 2030 if the proposed national policies are implemented (Xue and Liu 2022).

TABLE 5 | Key government strategies concerning China's transport decarbonization

POLICY DOCUMENT	YEAR ISSUED	AUTHORITY ISSUED	CONTENT RELATED TO TRANSPORT DECARBONIZATION
1+N policy system	2021	State Council	China will accelerate the construction of a green, low-carbon transport system. It will optimize the transport structure; further promote low-carbon fuels, vehicles, and infrastructure; improve energy efficiency standards; prioritize public transport; and promote active mobility and green freight.
Outline of the 14th Five-Year Plan (FYP) (2021–25)	2021	National Development and Reform Commission (NDRC)	As China's top-level policy blueprint, the FYP lays down the pathway for China's development for 2021–25. It aims to build modernized, comprehensive transportation systems, promote integrated development of transportation modes, and improve the network effectiveness and operational efficiency. The 14th FYP is subsequently supplemented by a panoply of sectoral FYPs drafted by responsible ministries as well as local plans drafted by governments across levels. MOT issued the 14th FYPs for the development of comprehensive transport services, digital transport, green transport, and transport standardization, among others.
14th Five-Year Plan for the Development of Modern Comprehensive Transportation System	2022	State Council	It targets the share of new energy vehicles (NEVs) in urban buses, taxis, and urban delivery vehicles, reaching 72%, 35%, 20%, respectively, by 2025. It proposes that the carbon dioxide (CO_2) emissions intensity of transport will be reduced by 5% by 2025, compared to 2020.
Implementation Plan for Synergizing Reduction of Pollution and Carbon Emission	2022	Seven ministries, including MEE, NDRC, MIIT, and MOT	It is a vital component of the 1+N policy system and lays the strategic direction of co-reducing air pollutants and emissions. It aims to accelerate low-carbon mobility, promote mode shift, accelerate the adoption of electric vehicles (EVs), especially heavy-duty vehicles. By 2030, NEV sales in new vehicle sales will reach 50% in key air pollution control areas.
National Comprehensive Three-Dimensional Transportation Network Planning Outline (2021–35)	2021	State Council	It provides high-level guidance on developing a comprehensive, integrated transport system. It sets targets to build a transport network of 700,000 kilometers (railways, roads, and waterways) by 2035. It also has various targets related to infrastructure construction and development.
Outline for Building China's Strength in Transport (2020–50)	2019	State Council	It provides a long-term plan for a transition to an efficiency-centered, integrated model. It sets goals to develop an integrated network by 2035 and become a transport powerhouse by 2050. It includes measures to promote integrated planning; expand infrastructure; and promote NEVs, shared mobility, and active mobility. Technological innovations like big data and artificial intelligence will be further leveraged. To enable implementation, the government recognizes the importance of market-based reforms, institutional rearrangements, standards, and norms as well as the investment into research and development.
Action Plan on Green Travel (2019–22)	2019	MOT with 11 other ministries and departments	It proposes that more than 60% of the cities participating in the initiative would have a green travel share of 70% or more. It aims to promote public transport as the backbone of the urban transport system and improve its service quality; promote active mobility; and develop and implement effective travel demand management measures such as traffic signals management, parking management, and behavioral change.

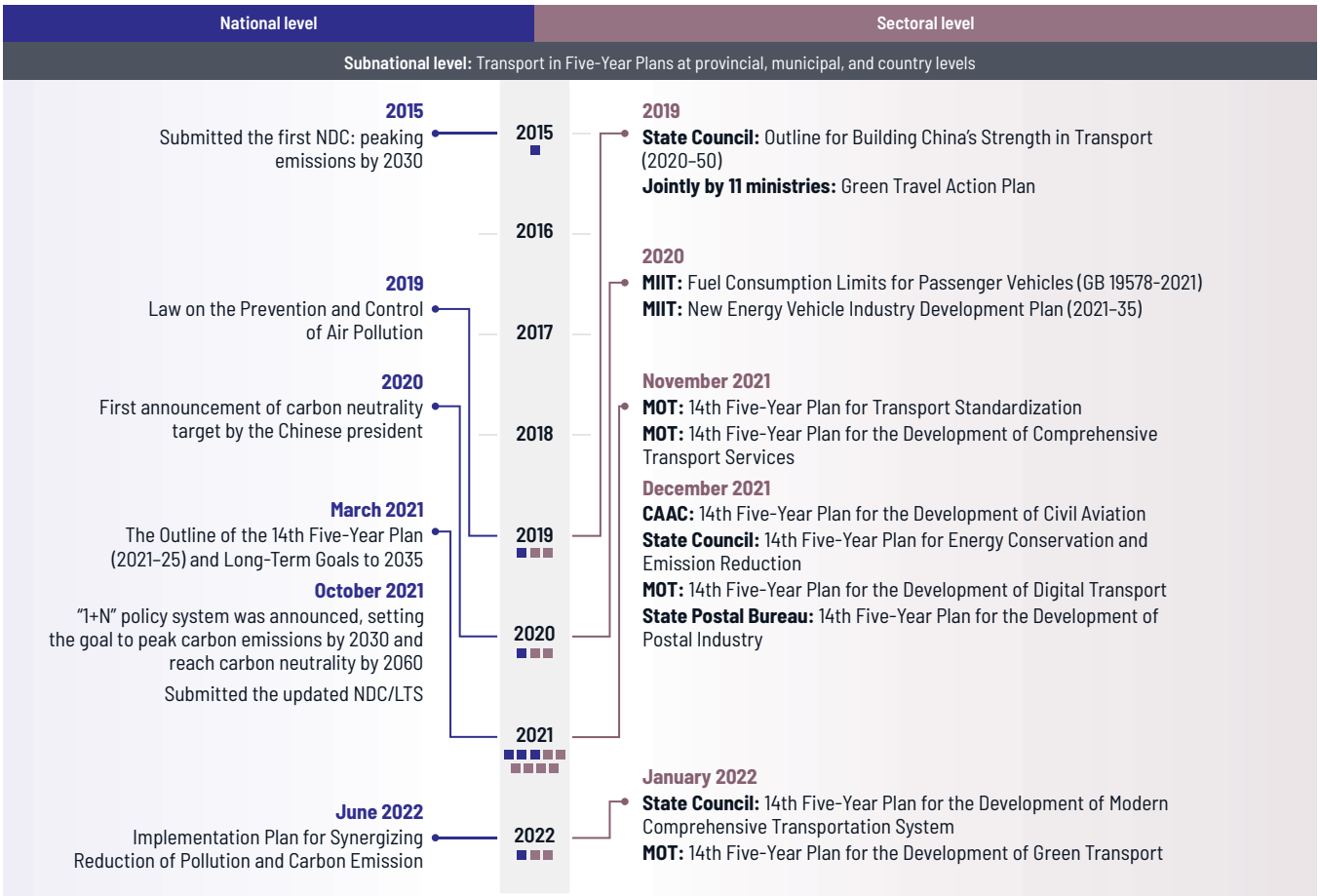
TABLE 5 | Key government strategies concerning China's transport decarbonization (cont.)

POLICY DOCUMENT	YEAR ISSUED	AUTHORITY ISSUED	CONTENT RELATED TO TRANSPORT DECARBONIZATION
New Energy Vehicle Industry Development Plan (2021–35)	2020	State Council	This policy guides China's new energy vehicle development. It aims to build an internationally competitive automobile industry while improving national energy security, air quality, emissions mitigation and boosting economic development. It lays down specific targets for NEV market development, technologies, charging and refueling, and other services by 2025 and 2035.

Notes: In the 1+N policy system for CO_2 peaking and carbon neutrality, 1 stands for the Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality, and N stands for a combination of new plans, the first of which is the Action Plan for Carbon Dioxide Peaking before 2030. Dual carbon refers to carbon peaking and carbon neutrality. MEE = Ministry of Ecology and Environment; MIIT = Ministry of Industry and Information Technology; MOT = Ministry of Transport.

Sources: Data from Ibold and Xia 2022; MEE 2022; NDRC 2021 State Council 2019a, 2019b, 2020, 2022; aggregated by the authors.

FIGURE 4 | Timeline of China's key climate and transport policy documents



Notes: CAAC = Civil Aviation Administration of China; LTS = long-term low greenhouse gas emission development strategy; MIIT = Ministry of Industry and Information Technology; MOT = Ministry of Transport; NDC = nationally determined contribution.

Sources: Data from NDRC (2021) and State Council (2020); aggregated by the authors.

TABLE 6 | Overview of national transport targets outside of China's NDCs and LTS

TARGETS	"1+N" POLICY SYSTEM	14TH FYP IN THE TRANSPORT SECTOR	NEV INDUSTRIAL DEVELOPMENT PLAN (2021–35)
Status	Released in October 2021	14th FYP released in March 2021; various transport-related 14th FYPs issued between 2021 and 2022	Released in November 2020
Emissions trend	Carbon peaking by 2030; carbon neutrality by 2060		
Period	2025, 2030, 2060	2021–25	2025, 2035
EV deployment	• At least 40% of vehicles will be fueled by clean energy in 2030	• Share of NEVs in urban buses, taxis, urban delivery vehicles reach 72%, 35%, and 20%, respectively, by 2025	• About 20% NEV annual sales by 2025 • At least 80% NEVs in new or renewal public fleets (buses, taxis, delivery vehicles) in pilot zones and key air pollution regions by 2025 • 100% electrification of the stock of public fleets by 2035 • Commercialize FCVs
Mode shift	• No less than 70% of travel will be conducted through environmentally friendly means in cities with 1 million or more residents by 2030	• At least 60 cities (with one million or more residents) with over 70% green transport mode share by 2025	—
Infrastructure	—	• High-speed rail network expanded to 50,000 kilometers (more than 95% coverage in cities) • Urban rail network expanded to 10,000 kilometers	• Build the foundation for a hydrogen fuel supply system • Build efficient, convenient charging and battery swapping networks
Emissions intensity reduction by 2030 (compared to 2020)	• Carbon intensity of commercial vehicles will reduce by 9.5% • Oil consumption for land transport peaks • Energy consumption of national railways per unit of converted turnover reduced by 10% • All ground vehicles and equipment at civil airports powered by electricity • The annual growth rate of rail-water container transport volume increase to 15% during 14th FYP period	• Carbon intensity of commercial vehicles will reduce by 5% by 2025 and 9.5% by 2030 • Oil consumption for land transport peaks • Energy consumption of national railways per unit of converted turnover reduced by 10% • The annual growth rate of rail-water container transport volume increase to 15% during the 14th FYP period	—

Notes: "1+N" policy system is for carbon peaking and carbon neutrality. Em dashes (—) signify information was not specified. EV = electric vehicle; FCV = fuel cell vehicle; FYP = Five-Year Plan; NEV=new energy vehicle.

Sources: Data from NDRC (2021) and State Council (2020); aggregated by the authors.

China's transport decarbonization progress in selected thematic areas

The following section provides a snapshot of China's transport decarbonization landscape, following the ASI framework. It focuses on a few thematic areas, including TOD, the shift to public transport and active mobility, intermodal freight transport, e-mobility, fuel efficiency improvements, and linkage with renewable energy. Each thematic area provides a brief overview of relevant policies and the current state of progress in implementation and assesses the potential gaps and barriers to meeting the planned objectives. Lastly, the section compares the measures being taken against the blind spots identified by the Council for Decarbonising Transport in Asia (see "Scope and methodology").

Prioritizing public transport and active mobility. China has heavily invested in public transport infrastructure. The past decade has witnessed large-scale construction of urban metro systems in major cities. China has built 25,000 km of high-speed rail lines, more than the rest of the world combined (IEA 2021a; Lawrence et al. 2019).

In recent years, MOT's integrated urban and rural transport development policy has helped expand and extend public transport to rural areas and even small villages with as few as 100 residents in eastern China (Li et al. 2023). As of 2020, China had more than 704,000 public buses with networks of routes stretching for 16,500 km (MEE 2022). This can be credited to suitable financing mechanisms and enhanced institutional capacity across different levels of government. Fueled by digitalization and innovations, the integration between different modes of transport has improved as well.

The government has gradually recognized the importance of active mobility in reducing air pollution and improving public health. By the end of 2021 nearly 80,000 km of "greenways" were built in many cities, and by 2022 a total of 109 green travel demonstration cities were created (Li et al. 2023). Leading cities such as Beijing, Guangzhou, Shanghai, and Shenzhen all strive to become walking- and cycling-friendly cities during the 14th FYP period. Electric bikes, or e-bikes (i.e., electric-assisted bikes and electric scooters), are gaining prominence.[3] Now there are nearly 300 million e-bikes plying the streets in China, exceeding the number of private vehicles. This trend is even more pronounced in small- and medium-sized cities, with traditional bikes practically being replaced by e-bikes (Li et al. 2023). Despite these achievements, some hurdles remain: vehicles often park in bike lanes, and conflicts between motorized vehicles and bikes can make cycling scary or unpleasant. Connectivity and the quality of infrastructure in rural areas need to be improved. Communication between planning departments is inconsistent, and institutional capacity is limited.

Shared mobility is also sweeping the nation. In China, it is happening on a scale far larger than anyplace else (Yin et al. 2022). Since 2016, shared bikes have seen rapid growth and are widely accepted by the public: more than 35 million shared bikes were deployed in around 300 cities and towns as of 2021. During the COVID-19 pandemic, the use of shared bikes exploded; Beijing saw a 40.8 percent increase compared to the previous year, reaching 690 million trips in 2020 (Li et al. 2023).

China's efforts to encourage low-carbon mobility are complemented by other measures to curb demand for modes of transport that drive up emissions. These transport demand measures aim to limit private vehicle ownership and usage. For instance, Beijing, Guangzhou, Shanghai, and other big cities have introduced vehicle quota systems to cap the number of new vehicle registrations.

Accelerating the deployment of e-mobility. Through a decade-long effort, China has become the world's largest EV producer and consumer as well as EV battery producer, and it has built the largest public and private EV charging infrastructure network of any country (Chu et al. 2023). China dominates the electric two- and three-wheeler (E2W and E3W) market with nearly 9.5 million new registrations out of a global total of 10 million in 2021[4] and has been growing on average by nearly 25 percent annually from 2015 onward (IEA 2022a).

With over 3.5 million new NEVs in 2021, its market represented 51 percent of global new sales (IEA 2022a). According to the China Electric Vehicle Charging Infrastructure Promotion Alliance, there were 4.95 million charging points

across the country as of November 2022 (Xinhua 2022). In 2021, China's market had a ratio of 7 EVs per charging point whereas the worldwide average was 10 EVs per charger (IEA 2022a).[5]

This results from governments' efforts to promote e-mobility coupled with innovations in the private sector over the past decade. Several national plans include targets to substantially increase the proportion of NEVs in new sales, whereas others feature targets to increase local production. These efforts began back in 2012, when China launched the first industrial development plan to promote NEV deployment. The plan covered 2012–20 and set goals to reach 5 million NEV sales by 2020. The second industrial development plan covers 2021–35 and sets a target of a 20 percent share for NEVs in new vehicle sales by 2025 as well as specific targets for public fleets. Notably, China has already surpassed the 20 percent sales target ahead of schedule and expects to reach a 40 percent share by 2030 (Mock and Yang 2022).

In the initial stages of EV deployment, purchase subsidies for EVs played a significant role in driving the market. As the vehicle technology and market matured, the subsidies were phased down five times, starting in 2014, while technical requirements for vehicles were tightened (Jin et al. 2023) (see Figure 5). The purchase subsidies were initially set to cease by 2020, but China extended the program until 2022. In addition, NEV consumers enjoy exemption from the annual vehicle and vessel tax (around ¥510, or US$74, on average for a typical gasoline car) and the vehicle purchase tax (10 percent of the price). The purchase tax exemption began in 2014 and will continue until the end of 2023. The national subsidy scheme for fuel cell electric vehicles was discontinued in 2020 and was replaced by funding for research and development (R&D) and demonstration projects (IEA 2021a). These programs are accompanied by other incentives for driving EVs, including preferential access to vehicle license plates, charging fee subsidies (e.g., Shanghai offers ¥5,000, or US$700, for NEVs), and reduced parking fees (e.g., the first two hours are free for street parking), as well as funding for public charging infrastructure (construction and operation) (Jin et al. 2023). The National NEVs to the Countryside program, in effect since 2020, enables people in smaller cities and suburban areas to get information about NEVs and access to services to help ensure an equitable transition (Jin et al. 2023).

In addition, the central government has promoted good practices in NEV battery recycling and reuse. A battery-specific industrial development plan was published by MIIT, NDRC, MOST, and the MOF in 2017. An emerging business model, battery as a service (BaaS), decouples the purchase of the battery from the EV itself. The government is promoting battery swapping through pilots, coding regulations and standardization, and other measures. In recent years various companies, including NIO, Geely, and BAIC Beijing Electric Vehicle, have been supporting the development of battery swapping infrastructure networks. As of 2021, there were nearly 1,300 battery swapping stations in China (Ibold and Xia 2022).

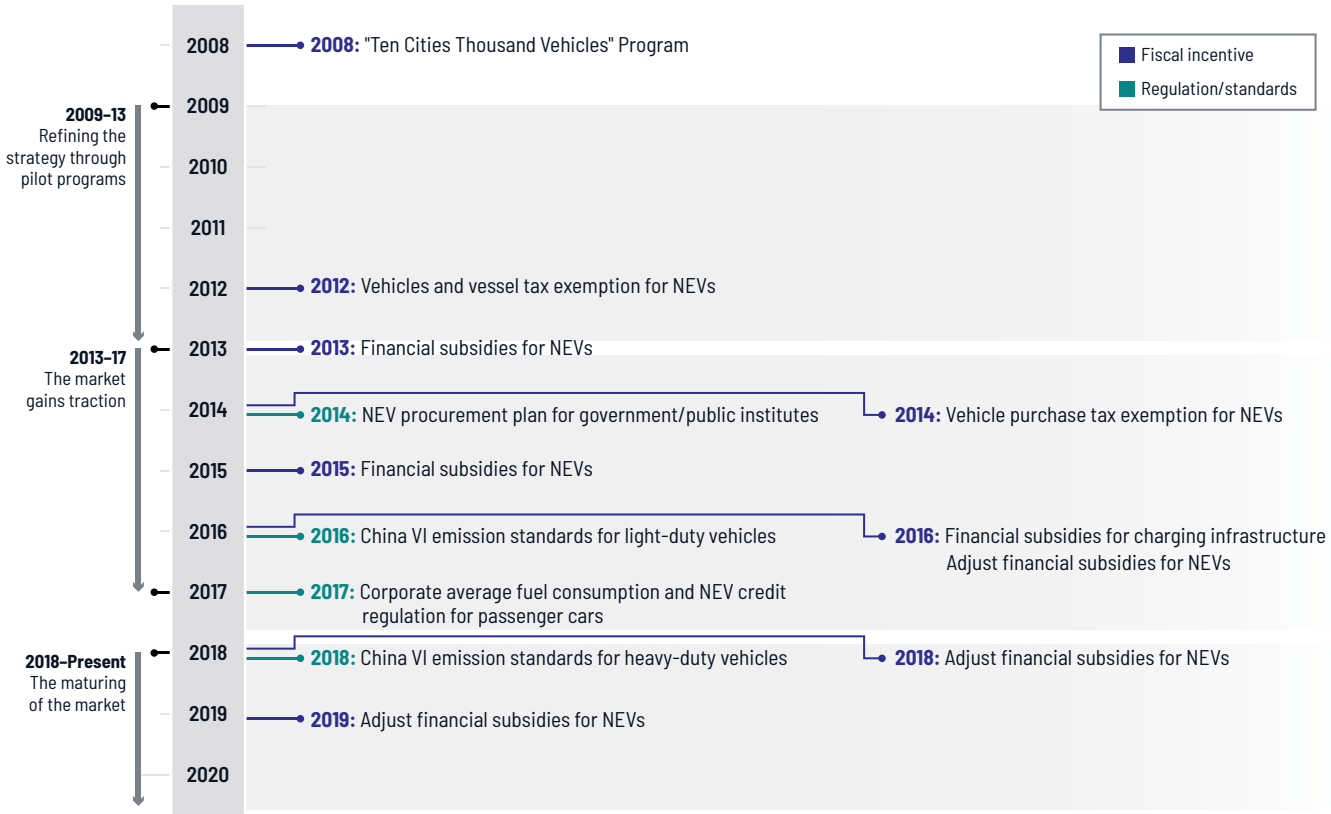
China has also made large strides in adopting new energy buses (including battery electric, plug-in hybrid, and fuel cell buses). A total of 466,000 were operating nationwide by 2021, accounting for 66 percent of the bus fleet (MEE 2022). Of these, more than 250,000 were battery electric buses, making up 38 percent of the new energy buses on the roads (C. Li et al. 2022). A few key measures have supported the fast rollout of e-bus fleets: government subsidies, the mandate to shift to clean buses, and a viable business model. Under this model, relevant stakeholders (governments, manufacturers, bus operators, and charging service providers) share risks, costs,

and collaboration. Subnational governments have also played a critical role in piloting e-buses with innovative procurement practices (Chen et al. 2021). For instance, Shenzhen Bus Group first introduced the whole-vehicle leasing financing scheme, which turned high up-front costs into manageable rental or lease payments throughout the life of the buses (Chen et al. 2021). It is also worth noting that Chinese automaker BYD is a leading e-bus exporter and has established supply and service contracts for e-buses with cities in Latin America, such as Bogotá, Colombia (IEA 2022a).

Zero-emission vehicle regulations. Over the last decade, China has established and improved the fuel consumption (fuel economy) standards for new passenger cars, LDVs, and commercial vehicles. For passenger vehicles, it is estimated that the average fuel consumption has been reduced from 7.3 liters (L) per 100 km in 2013 to 5.6 L/100km in 2020 (R. Wu et al. 2021). To continue with the effort, MIIT released the latest fuel consumption standard in 2021, mandating that fuel consumption for new passenger vehicles fall to 4 L/100km by 2025, a 20 percent reduction from the previous phase's target (MIIT 2021). For HDVs, China introduced the fuel consumption standard in three separate stages, each increasingly stringent (Mao et al. 2021b). The country is currently developing the fourth stage. Considered one of the most effective measures to cut emissions, the standards are expected to generate 17 percent of the emissions reductions in China between 2020 and 2060 (Xue and Liu 2022).

China's corporate average fuel consumption (CAFC) standards for passenger cars are tied to a NEV mandate. It is a modified version of the California ZEV mandate, which requires manufacturers to sell specific numbers of vehicles with the cleanest car technologies available. China's NEV mandate is implemented at the national level. Manufacturers need to earn the credits required by producing low-emissions vehicles and use excess credits to offset deficits in CAFC compliance (Rokadiya and Yang 2019). The policy was introduced in 2017 and rolled out in two phases. Phase 1 of the NEV mandate (2019–20) set annual NEV credit targets at 10–12 percent of the conventional vehicle market. Since the beginning of 2021, when Phase 2 took effect, that share rose from 14 percent in 2021 to 18 percent in 2023 (Chen and He 2021; Rokadiya and Yang 2019). Currently, China is also considering a NEV mandate for light commercial vehicles in addition to the next phase of policy targets for new passenger vehicles (Rokadiya and Yang 2019).

FIGURE 5 | Development of China's EV industry



Notes: NEV = new energy vehicles, including battery electric, fuel cell electric, and plug-in hybrid electric vehicles.

Source: Adapted from Jin et al. (2021a).

Untapping the potential of freight decarbonization. Freight accounts for 65 percent of total transport carbon emissions in China; specifically, road freight is responsible for one-third of goods movement but around 80 percent of freight-related emissions (X. Li et al. 2022). Economic development and urbanization drive rapid growth in demand. Already, the cost of moving freight in China is high; it makes up 18 percent of GDP compared to 8–12 percent in the United States and the European Union (Agenbroad et al. 2016). Against this backdrop, the management of freight has become an important narrative across its national policy documents, such as the 14th FYP and the associated development plans for comprehensive transportation, green transport, road transport, and digital transport. China has set targets in its 14th FYP to reduce the carbon intensity of commercial vehicles by 9.5 percent by 2030, compared to 2020, and to reduce energy consumption of national railways per unit of converted turnover by 10 percent in 2030 (Ibold et al. 2022; NDRC 2021).

For road freight transport, China is accelerating the adoption of zero-emission trucks. It is now the world's largest HDV market, with 1.4 million new sales in 2021 (Mao et al. 2021b). An analysis by the International Council on Clean Transportation (ICCT) suggests that all battery electric trucks in China can achieve the total cost of ownership parity with diesel trucks in the second half of this decade and that cost gap, favoring battery electric trucks, could even reach ¥150,000 (US$21,000) by end of the decade (Mao et al. 2021a). In addition, hydrogen-powered HDVs could potentially be deployed, particularly over long distances. Apart from electrifying the fleets, China has also made significant efforts to improve the fuel efficiency of HDVs by establishing standards, promoting green freight to inform fleets how to operate more efficiently, and creating overload enforcement programs to impose a fine on the driver and carrier company when a truck is overloaded. Nevertheless, due to barriers such as the fragmented and complex nature of the industry, conflicting government regulations,[6] the lack of enforcement, and the lack of technology standardization, not all of these measures have had the desired effect (Yang et al. 2019).

China is also promoting a mode shift from roads to railways and waterways. The ICCT's modeling suggests that a more efficient freight system with mode shift has substantial benefits in the short term, accounting for 17 percent of the 2025 mitigation potential for China's transport system (Jin et al. 2021b). China already relies more on rail and waterways to move goods than North America and Europe. Measured by tonne kilometer (tkm), or the transport of one tonne of freight over a distance of one kilometer, China's rail tkm and waterway tkm rose seventeen-fold from 1990 to 2019 (Xue and Liu 2022). However, to further tap the potential of rail transport, China needs to fix problems such as uncompetitive railway pricing, further improve the quality of service, and provide better connections or intermodal services to move freight to its final destination (Xue and Liu 2022).[7]

Some progress has been made in constructing freight hubs and promoting intermodal freight. MOT provides financial support to well-functioning multimodal freight hubs (logistics parks) and conducts comprehensive assessments of hundreds of hubs to inform policymaking (W. Wang et al. 2022). In recent years, MOT and NDRC have implemented multimodal transport demonstration projects in 16 cities. By 2021, 120,000 new energy delivery vehicles were deployed in the pilot cities (MEE 2022).

Linkage with the energy sector. In its updated NDC and 14th FYP, China has committed to ramping up wind and solar power as well as expanding power infrastructure and energy storage. The 14th FYP for development of renewable energy aims to increase the proportion of green hydrogen used in the transport sector. China's target for FCV deployment is to have 50,000 vehicles and hydrogen refueling stations constructed by 2025 (NDRC 2022). The latest NEV Industrial Development Plan encourages utilizing more electricity generated from renewables for NEV charging and piloting local vehicle-to-grid projects, which allow interaction between NEVs and the grid to regulate peak loads and reduce charging costs. Experts interviewed for this research reveal that collaboration between transport and energy industries is difficult due to vested interests. "State-owned utility companies such as State Grid and China Southern Grid should support the collaborative processes across sectors, and ensure integrated planning, such as in the development of charging and refueling stations," noted one stakeholder.[8]

Table 7 below compares China's stated transport measures against the blind spots identified by the Council for Decarbonising Transport in Asia.

China is accelerating the adoption of zero-emission trucks. It is now the world's largest HDV market, with 1.4 million new sales in 2021.

TABLE 7 | Summary of how China is tackling the key blind spots identified in the Path to Zero report

KEY BLIND SPOTS	CHINA'S STRATEGIES TO ADDRESS THIS BLIND SPOT
Tackling freight transport	Freight is addressed in its NDC, LTS, and a series of national policies. Existing strategies include zero-emission trucks, fuel efficiency standards for HDVs, mode shift for road transport to lower carbon modes (rail and waterways), and multimodal freight hubs.
Integrated planning	MOT has integrated urban and rural transport development policy in place; China prioritizes public transport and is putting more emphasis on active mobility. The integration between modes has improved but is still limited. The Sustainable Urban Mobility Plan concept was first introduced in Foshan, Guangdong, in 2021 and has proven that a participatory approach for integrated development in the Chinese context is feasible.[a]
Infrastructure improvements and low-cost solutions	China invests heavily in public transport infrastructure (metro, high-speed rail); it has a series of policies in place to promote "green travel," such as improving conditions for walking and cycling, traffic signals management, parking management, and behavioral change.
Consistent policy and price signals	Beijing, Guangzhou, Shanghai, and other big cities have introduced vehicle quota systems to reduce travel demand. The EV incentives provide pivotal signals to original equipment manufacturers to develop affordable models. Demand-side policies such as the vehicle purchase tax have proven effective in facilitating EV adoption by increasing the EV market share by 2% in leading Chinese cities.[b] Cities (e.g., Beijing, Liuzhou) organized a series of awareness-raising activities to engage consumers at the initial stages of the EV transition.
Provision of diverse mobility options	The government has issued a series of documents to promote multimodal transport, such as the Notice on Further Encouraging Multimodal Transport, MOT's sectoral 14th FYP, and the National Comprehensive Three-Dimensional Transportation Network Planning Outline. In recent years, MOT and NDRC have implemented a range of multimodal transport demonstration projects.
Discontinue counterproductive and harmful activities	China aims to achieve a 20% share of new energy vehicles in new sales by 2025 and a 40% share by 2030. China has surpassed the 20% sales target ahead of schedule. At the subnational level, Hainan Province has pledged to phase out the sale of conventional passenger cars, light commercial vehicles, buses, and coaches by 2030.[c] China established the Industrial Carbon Emission Information System in 2021. To date, more than 14 automobile manufacturers (e.g., Changan Automobile, DFM, Chery Automobile, Great Wall Motor, and FAW-Volkswagen) and over 800 companies across the supply chain joined the initiative. This system supports calculating the environmental footprint of services or products through all life stages.[d]

Notes: EV = electric vehicle; FYP = Five-Year Plan; HDV = heavy-duty vehicle; LTS = long-term low greenhouse gas emission development strategy; MOT = Ministry of Transport; NCD = nationally determined contribution; NDRC = National Development and Reform Commission.

Sources: a. J. Wang et al. 2022; b. Ma et al. 2017; c. Wappelhorst and Cui 2020; d. CATARC 2023; aggregated by the authors.

India

Country context

India is now the world's most populous country with 1.42 billion inhabitants, and this number is projected to grow by 18 percent by 2050 (United Nations 2022). Over a third of the population resides in urban areas, and urbanization is expected to continue. By 2050, over half of the population (52 percent) is expected to reside in cities (United Nations 2018; World Bank 2022). With a GDP close to $3 trillion and growing, India has become the world's sixth-largest economy (NITI Aayog and RMI 2022). In 2019, India emitted 3,364 Mt of GHG emissions, representing 6.76 percent of global emissions.

India's transport sector consumes almost one-fifth of India's final energy use and is the third-largest GHG-emitting sector, accounting for around 12.1 percent of energy-related emissions (Government of India 2022a; IEA 2021b). Transport emissions per capita were low, however, at 0.23 tCO_2 per capita, compared to other top emitters such as China (at 0.69 tCO_2 per capita, as of 2019) (Climate Watch n.d.). Within the transport sector, road transport contributes to more than 90 percent of the emissions, dwarfing the next biggest emitter, rail transport, which accounts for just 7 percent (Singh et al. 2022).

The need to transport people and goods is growing exponentially with urbanization, rising population and incomes, and expanding e-commerce. Vehicle ownership per capita in India has shot up fivefold since 2000 (Figure 6). Between 2011 and 2019, passenger transport activity increased nearly 2.7 times and freight transport more than doubled (MORTH 2021). Meanwhile, cities are experiencing unprecedented levels of automobile traffic, which pollutes the air and makes travel

increasingly inefficient and time-consuming. Between 2017 and 2022, 39 out of the 50 most polluted cities in the world were in India, and the country ranked eighth in the world for average particular matter ($PM_{2.5}$) concentration in 2022 (IQAir 2023 n.d.). Studies find that over 84 percent of India's population, and primarily the vulnerable groups, are disproportionately exposed to high levels of air pollution (Sharma 2020). Every year, more than 1.7 million people die in India due to respiratory diseases caused or exacerbated by ambient air pollution (Health Effects Institute 2020). Indian cities consistently rank among the world's most polluted, and the TomTom Traffic Index features a few Indian cities in its list of the world's 10 most congested metropolitan areas. In 2022, Bengaluru was ranked the world's second most congested city. Its residents lost an average of 260 hours sitting in traffic per year (TomTom 2023). With climate change, air pollution, and congestion rising, shifting to a sustainable, low-carbon transport system in India is critical.

India's international climate commitments

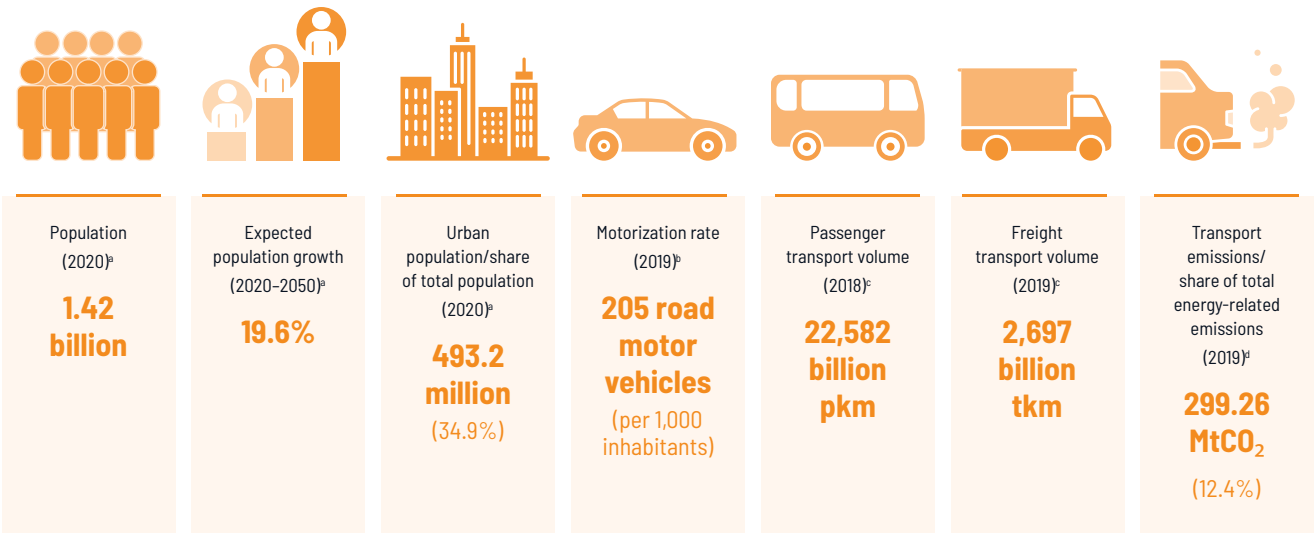
In 2009, India made a voluntary pledge to reduce the emissions intensity of its GDP by 20–25 percent by 2020 from the 2005 level of 2,405 tCO_2e per million dollars of GDP (Climate Watch n.d.). In its NDC submission in 2015, the country committed to reducing the emissions intensity of its GDP by 33–35 percent by 2030 compared to 2005, increasing the share of installed capacity from nonfossil fuels by 40 percent by 2030 and creating an additional carbon sink of 2.5–3.0 $GtCO_2$ (CAT 2023). To date, India has already achieved two of the targets: carbon intensity was reduced by 24 percent in 2016 (MOEFCC 2021) and the share of nonfossil fuel sources for electricity generation reached 41.4 percent as of May 2022 (MOEFCC 2022).

Taking a closer look at the transport dimension, **India's first NDC** mentioned that the country strives to expand the share of total land transport by railways from the current 36 percent to 45 percent by 2030, among other infrastructure-related targets (Government of India 2015) (see Table 8). Its pledged transport mitigation actions included a range of *shift* and *improve* measures, such as promoting shipping and inland water transport, setting fuel-efficiency standards for passenger vehicles, encouraging adoption of EVs and hybrid vehicles, and improving infrastructure (metro, mass rapid transit, and dedicated freight corridors and road networks). It also discusses biofuels and the reduction of fossil fuel subsidies.

At the 26th Conference of the Parties (COP26) in Glasgow in 2021, India's Prime Minister Modi announced that India's target was to reach net zero by 2070. He revealed a few other climate targets, such as reducing 1$GtCO_2$ per year from 2021 to 2030, reducing carbon intensity by over 45 percent by 2030, and increasing nonfossil energy capacity to 500 GW by 2030 (see Table 8) (Ministry of External Affairs 2021).

In August 2022, the Indian government submitted a revised NDC that echoed and incorporated the pledges Prime Minister Modi previously announced. The **updated NDC** aims to reduce the carbon intensity of GDP by 45 percent by 2030 from 2005 levels and includes the long-term goal of reaching net zero emissions by 2070; it also sets a target to have half of its total installed electrical power capacity come from nonfossil

FIGURE 6 | Population, motorization, and transport emissions



Notes: $MtCO_2$ = million tonnes of carbon dioxide emissions; pkm = passenger kilometer; tkm = tonne kilometer.
Sources: a. United Nations 2022; b. ATO 2022; c. MORTH 2021; d. Nazar et al. 2022.

fuels by 2030 (Government of India 2022a). This is conditional on the availability of international finance. This four-page document lacks a clear road map to 2030 or information on finance requirements, and the climate targets "do not bind it to any sector-specific mitigation obligation or action" (MOEFCC 2022). Nevertheless, the same week that it came out, India announced amendments to the Energy Conservation Bill 2022, which requires greater use of renewable energy, and set up a carbon credit trading scheme (Rajeev 2022). According to the Climate Action Tracker, the targets in the updated NDC are closer to its current level of climate action than the first NDC, but India needs to further enhance its ambition to get on track to reach a 1.5°C pathway (CAT 2023).

At COP27 in November 2022, India submitted its **LTS**. India's LTS makes reference to the updated NDCs and reiterates the economy-wide related targets. It provides a breakdown of the specific initiatives and action areas for the power, industry, transport, building, and urban sectors. However, it does not contain an emissions pathway showing how India will reach net zero. For transport, the LTS states that India's railways will reach net zero by 2030 and increase the share of the nation's freight they carry to 45 percent. Four key action areas are included as part of the long-term strategy, including

- reducing fuel demand and GHG emissions through improved fuel efficiency;
- adopting cleaner fuels (increased blend of biofuel, green hydrogen);
- shifting to public and less polluting transport modes (multi-modality, road to railways); and
- electrifying multiple modes (MOEFCC 2022).

The Indian government aims to increase the domestic manufacturing of EV batteries, plan for the increased load on the grid, and establish renewable charging and battery swapping stations to keep up with the EV adoption. It also points out the need to develop policies on EV-related waste and workforce reskilling in the supply chain. It is worth noting that India signed the Zero-Emission Vehicles Declaration at COP26 and will "work intensely towards accelerated proliferation and

TABLE 8 | Overview of key climate and transport targets in India's NDCs and LTS

KEY CLIMATE AND TRANSPORT TARGETS	STATUS QUO	FIRST NDC[a]	PRIME MINISTER'S COP26 SPEECH[b]	UPDATED FIRST NDC[c]	LTS[d]
Status	—	Submitted in October 2015	November 2021	Submitted in August 2022	Submitted in November 2022
Net total emissions	3.17 $GtCO_2e$ (as of 2020)	—	Net zero by 2070	Net zero by 2070	Net zero by 2070
Emissions intensity reduction by 2030 (compared to 2005)	Reduced by 24% (2005-16)[e]	33%–35%	More than 45%	45%	45%
Installed capacity from nonfossil fuel by 2030	41% (as of 2022)[f]	40%	500 GW nonfossil fuel capacity; 50% of its energy requirements from renewables	50%	50%
Transport-specific targets	The share of railways in freight reached 27%[d]	Increase the share of railways in total land transport from 36% to 45% by 2030	—	—	Increase the share of railways in freight to 45% by 2030; railways to become net zero by 2030, leading to annual mitigation of 60 $MtCO_2$

Notes: Em dashes (—) signify no mention in the policy document. CO_2e = carbon dioxide equivalent; Gt = billion tonnes; GW= gigawatt.

Sources: a. Government of India 2015; b. Ministry of External Affairs 2021; c. Government of India 2022a; d. Government of India 2022b; e. MOEFCC 2021; f. CEA 2023; aggregated by authors.

adoption of zero-emission vehicles" and, meanwhile, "call on developed countries to strengthen the collaboration and international support offered to facilitate a global, equitable and just transition" (Accelerating to Zero Coalition 2022).

National governance for transport and climate change policymaking

India has a centralized federal system, and climate policymaking is largely driven by the central government (Hingne et al. 2021; Jörgensen et al. 2015). Parliament is the legislative body that passes laws and is a bicameral legislature composed of a Lower House and an Upper House (Grantham Research Institute n.d.). The Prime Minister's Office and relevant ministries work together to develop national climate change policies. The following government agencies are involved in climate change and transport decarbonization in India (see Table 9). A more detailed description can be found in Table C-3 in Appendix C.

At the subnation level, states and cities play an integral role in implementing climate actions and set out initiatives that are more ambitious than those launched at the national level. India's system enables selected cities **to** compete to make progress on sustainable development (Taeger 2022). State governments are motivated to prepare State Action Plans on

TABLE 9 | Key government stakeholders involved in India's transport decarbonization

STAKEHOLDERS	RESPONSIBILITIES/ROLES
Ministry of Environment, Forest and Climate Change (MOEFCC)	MOEFCC is the nodal agency for formulating, coordinating, and overseeing the implementation of India's environmental policies and programs.
National Institution for Transforming India (NITI Aayog)	The government think tank NITI Aayog provides strategic policy vision for national development priorities, sectors, and strategies. It promotes sustainable, environmentally friendly transport systems and is designated as the nodal agency for the promotion of EV solutions.[a]
Ministry of Road Transport and Highways (MORTH)	MORTH is responsible for formulating policies and regulations pertaining to road transport.[b]
Ministry of Heavy Industries (MHI)	MHI is responsible for promoting the automobile industry and developing vehicle standards. Under the ministry, the Department of Heavy Industries (DHI) is spearheading the policy and implementation measures to electric vehicle (EV) adoption. In 2015, the DHI announced the Faster Adoption and Manufacturing of (Hybrid and) Electric Vehicles scheme.[b]
Ministry of Power (MOP)	MOP is responsible for planning and policy formulation related to the power sector as well as monitoring and implementation of power projects. Together with the Ministry of Housing and Urban Affairs, MOP is also responsible for the compliance and enforcement of fuel consumption and emissions standards. Under MOP, the Bureau of Energy Efficiency oversees the deployment of charging infrastructure.
Ministry of Finance (MOF)	The MOF is charged with taxation and financial legislation.
Ministry of Housing and Urban Affairs (MOHUA)	MOHUA acts as the agency for the coordination and approval of urban transport projects, including metro rail projects, bus rapid transit systems, and financing of metro rail projects.c It has developed a series of policies to guide sustainable urban mobility development. Related to e-mobility, MOHUA plays a key role in amending building bylaws to accommodate EV charging.[c]
Ministry of Civil Aviation	It is responsible for the formulation of national policies for the development and regulation of the civil aviation sector.[d]
Ministry of Ports, Shipping and Waterways	It is the apex body for formulating and administering the rules, regulations, and laws relating to ports, shipping, and waterways, including shipbuilding and repair, major ports, national waterways, and inland water transport.[e]
Ministry of Railways	It exercises all central government policy powers and administers, supervises, and directs the entities that provide most of the rail services in India.[c]
Ministry of Commerce and Industry	It formulates, implements, and monitors foreign trade policy and is entrusted with responsibilities relating to commercial relations. The Logistics Division in the Department of Commerce is responsible for the integrated development of the logistics sector.[f]

Sources: a. NITI Aayog n.d.; b. GIZ and NITI Aayog 2021; c. ITF 2021; d. Ministry of Civil Aviation 2023; e. Ministry of Ports, Shipping and Waterways 2023; f. Department of Commerce 2023; aggregated by the authors.

Climate Change in line with the national strategies and are responsible for the policy implementation. The Ministry of Environment, Forest and Climate Change also provides financial support to states to enhance capacities related to climate change (Waisman et al. 2021).

National policy framework for transport and climate change

The Indian government has taken steps to combat climate change, despite the development challenges that might override other priorities. It focuses on climate policies that help reach development goals and offer environmental and social cobenefits (Dubash et al. 2018). The country's growing edifice of climate policy and climate change consideration is mirrored through executive processes. In 2008, the Prime Minister's Council on Climate Change was set up, consisting of representatives from the public and private sectors to coordinate the climate work (Government of India 2014).

Table 10 describes India's key government strategies related to climate change and transport. Figure 7 presents the major milestones for India's climate and transport policies.

India's transport decarbonization progress in selected thematic areas

The following section provides a snapshot of India's transport decarbonization progress in selected thematic areas. It includes an analysis of how the country is tackling the key blind spots identified by the Council for Decarbonizing Transport in Asia.

Shift to public transport and active mobility. Several national policies, including the National Urban Transport Policy and the Smart Cities Mission, aim to promote public transport (city buses, rail-based system), active mobility, and integrated urban mobility. In the national budget of fiscal year (FY) 2022–23, the national government included targeted capacity-building for states and cities with transit systems to integrate TOD in the planning process and update building bylaws to enable compact urban development (ADB 2023). For example, Ahmedabad has crafted its development plan along with its integrated mobility plan and has developed its land-use and transport strategies concurrently (Sinha 2020).

Buses are a growing form of transportation in India. The number of trips by bus increased by about 38 percent from 2009 to 2019 (MORTH 2021). In 2020, roughly 20 percent of the travel was done by bus, and at least a quarter of the urban dwellers in India rely on public transport (Abhishek 2020).

TABLE 10 | Key government strategies concerning India's transport decarbonization

POLICY DOCUMENT	YEAR ISSUED	AUTHORITY ISSUED	CONTENT RELATED TO TRANSPORT DECARBONIZATION
National Action Plan on Climate Change (NAPCC)	2008	The Prime Minister's Council on Climate Change	The NAPCC lays a foundation for climate action in India while advancing other national priorities. It covers eight national missions, including solar and enhanced energy efficiency, sustainable habitat, and water management. Among them, the National Mission for Enhanced Energy Efficiency aims to improve efficiency in industry. And the National Mission on Sustainable Habitat refers to reducing transport emissions by shifting to public transport, urban planning, and use of alternative fuels. Various line ministries, such as road, rail, power, and urban development, are mandated to implement elements of the NAPCC.
National Electric Mobility Mission Plan (NEMMP)	2013	Department of Heavy Industries (DHI) under the Ministry of Heavy Industries	The NEMMP aims to promote the adoption of electric vehicles (EVs) and hybrid vehicles to enhance national fuel security. The plan sets a target of 6–7 million hybrid and EVs sold annually from 2020 onward.[a] It has four focus areas: creating demand, pushing domestic manufacturing, encouraging research and development, and developing power and charging infrastructure through public-private partnerships or private players.[b]
Faster Adoption and Manufacturing of (Hybrid and) Electric Vehicles (FAME)	2015	DHI	The FAME scheme was launched in 2015 for a period of two years. With a financial outlay of ₹75 crore (US$12 million), the scheme was introduced to reduce the up-front costs of EVs and hybrid vehicles, targeting all vehicle segments.[c]
FAME II	2019	DHI	FAME II includes a significantly increased budget to over ₹100 billion (US$1.4 billion). It provides incentives and charging infrastructure subsidies across vehicle segments. The scheme included measures to promote EV adoption through three verticals: incentivizing EV demand, establishing charging networks, and increasing awareness on the benefits of EVs.[d]

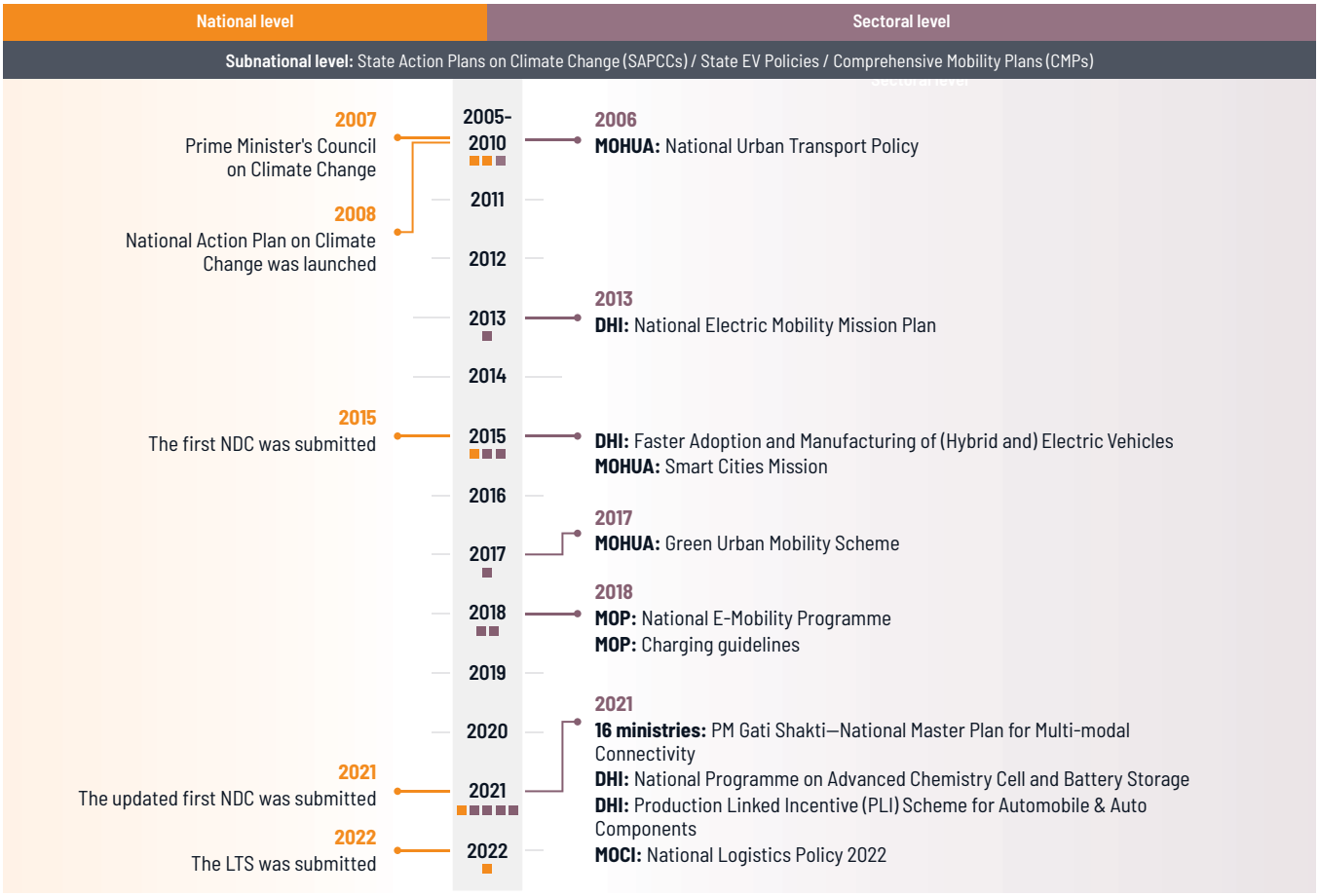
TABLE 10 | Key government strategies concerning India's transport decarbonization (cont.)

POLICY DOCUMENT	YEAR ISSUED	AUTHORITY ISSUED	CONTENT RELATED TO TRANSPORT DECARBONIZATION
Smart Cities Mission	2015	Ministry of Housing and Urban Affairs	This initiative aims to create a clean and sustainable environment through smart solutions.[e] The goal is to create compact areas and replicate good city examples elsewhere. Smart parking and intelligent, multimodal transport systems are highlighted as part of the smart mobility solutions.
National E-Mobility Programme	2018	Ministry of Power	It incentivizes vehicle manufacturers, fleet operators, and charging infrastructure providers to boost the development of the EV industry.[f]
PM Gati Shakti—National Master Plan for Multi-modal Connectivity	2021	16 ministries, including the Ministries of Railways and Roadways	Essentially an online platform, the plan aims to institutionalize holistic planning among stakeholders in major infrastructure projects. It will incorporate the infrastructure projects and schemes of various ministries and state governments.[g]
National Logistics Policy	2022	Logistics Division of the Department of Commerce	It calls for the promotion of more sustainable transport and cleaner logistics operations. It has targets for 2030 to reduce logistics costs, become one of the top 25 countries in the Logistics Performance Index, and create a data-driven decision support mechanism for an efficient logistics ecosystem.[h]

Notes: According to the 2023 Logistics Performance Index, India ranks 38th globally.

Sources: a. Climate Watch n.d.; b. Mitra et al. 2017; c. MHI n.d.; d. NITI Aayog and RMI 2022; e. MOHUA n.d.; f. MOP 2018; g. Government of India 2021; h. MOCI 2022; aggregated by the authors.

FIGURE 7 | Timeline describing the major milestones for India's climate and transport policies



Notes: DHI = Department of Heavy Industries; MOCI = Ministry of Commerce and Industry; MOHUA = Ministry of Housing and Urban Affairs; MOP = Ministry of Power.

Sources: Böhler-Baedeker et al. 2014; ITF 2021; NITI Aayog and RMI 2022; Verma et al. 2021.

Through the Jawaharlal Nehru National Urban Renewal Mission between 2007 and 2014, the government provided funding to improve public transport (bus fleets, BRT, metro rail) across the country, especially in major cities. As a result, 61 cities have formal city bus systems. However, the way cities were selected (based on population) and the approach taken (adding bus fleets) does not necessarily consider the mobility characteristics or travel demand patterns of each city (Gadepalli 2016). Planning did not necessarily considered whether bus routes reached neighborhoods most in need or were connected to other modes of transport to get passengers to their final destinations. Intermediate public transport, such as shared auto-rickshaws and minibuses, serves as feeder modes in larger cities and plays a significant role in providing transport services in smaller cities where adequate public transport is absent. But it is not always well coordinated or integrated with formal public transport systems or connected with land-use planning. Siloed planning lowers ridership. Inefficient planning and lack of finances have been impacting both ridership and revenue. The public transport service providers, mainly state-run entities, reported operating losses of 6–27 percent, mainly due to the rising costs of fuel and bus spare parts (CESL 2023; Gadepalli and Rayaprolu 2020; ITF 2021).

In India, a quarter to half of the passenger trips are met by nonmotorized transport, although the quality of walking and cycling infrastructure is subpar. The shares of walking and cycling in many Indian cities exceed those in other cities of similar sizes globally (ITF 2021). National initiatives such as the Streets4People Challenge and the Cycles4Change Challenge aim to offer low-cost options for making active mobility safer and easier. These include open street events, pop-up bike lanes, and free repairs. Over 100 cities aspire to become cycling friendly, aiming to help residents access jobs, education, and opportunities in a safe, affordable way (ITDP 2023). Influenced by a global market of public bike sharing (PBS), since 2008 there have been many attempts to pilot the PBS systems in India; however, PBS could not sustain beyond the pilot phase due to the absence of a sustainable and robust business model and a holistic approach. A recent WRI India analysis reveals that the systems face challenges, such as lack of coordination across agencies on policies and permissions, a lack of dedicated quality cycling infrastructure, and a lack of user awareness or education of cycling as an efficient and sustainable mode of transportation (Khan et al. 2023).

Electrification of railways. Rail is one of the most affordable and most used modes of passenger transport in India. With an extended network of over 68,000 km, India's rail-based systems carry nearly 23 million passengers daily, accounting for nearly 30 percent of the travel demand (Kamboj et al. 2022; MOEFCC 2022).

For its railways, India targets net zero carbon emissions by 2030 and is working to electrify its rail network by December 2023 (CORE 2023; Government of India 2022b). As of March 2023, over 90 percent of its broad-gauge railway network has been electrified (CORE 2023). Railway energy demand is projected to be about 8,200 megawatts (MW) by 2030. As of February 2023, about 147 MW of solar and 103 MW of wind

power have been commissioned, with an additional 2,150 MW of renewable capacity tied up. The Ministry of Railways plans to progressively procure renewables to meet its future energy demand (Ministry of Railways 2023).

Building an EV ecosystem with support measures. The EV ecosystem in India is still in the early stages, but it has shown increasing promise with recent policy developments, such as the Faster Adoption and Manufacturing of (Hybrid and) Electric Vehicles (FAME) schemes (see Table 10 for more details). Under FAME II, the government aims to electrify 7,000 buses, 1 million 2Ws, 5 million 3Ws, and 55,000 four-wheeler passenger cars (including hybrids) (NAB 2022). The government has also sanctioned 2,877 charging stations across 25 states and announced a plan to install charging stations every 40–60 km along its highways by 2023 (Bennett 2021; MHI 2021). By the end of 2021, India had over 1 million EVs, including 300,000 new registrations of E2Ws and E3Ws (IEA 2022a).

National schemes such as FAME I and FAME II are instrumental in increasing India's EV deployment, manufacturing capacity, and demand. For electric passenger cars, the government provides financial support via purchase incentives, registration fee exemption, and tax benefits. For E2Ws, the government recently increased its purchase subsidy from 20 percent to 40 percent of the vehicle price. The case for E2Ws is strong for a country such as India, where the 2W fleet accounted for more than 70 percent of the registered vehicles (MORTH 2021). The ICCT's analysis finds that E2Ws are consistently more cost effective than the gasoline counterparts, and point charging remains affordable when driven less than 100 km per day (for personal use, the typical average daily distance driven is 40 km) (Gode et al. 2022).[9]

For e-buses, the government provided subsidies for 390 e-buses (approximately 60 percent of the total cost of an e-bus) in 11 Indian cities under FAME I. Currently, around 220 e-buses are operating in 8 cities. FAME II was announced with a target to deploy 7,000 e-buses and provided a subsidy of up to ₹20,000 per kilowatt-hour (kWh), or US$240/kWh, to transport companies. To narrow the gap between the high capital costs of e-buses and less expensive conventional alternatives, FAME II uses an aggregated procurement model to procure e-buses on a gross cost contract basis.[10] The model allows private companies to invest in the purchase of e-buses and charging infrastructure, as well as operations and maintenance, and get paid a fee per kilometer. It limits the up-front capital investments by cities and the need to manage staff and transfers the risks to service providers who are best positioned for risk mitigation. These innovations, plus the national subsidy, reduce the out-of-pocket cost for e-buses to 31–35 percent below the current cost of diesel/compressed natural gas (CNG) buses (CESL 2023). A few key factors contributed to the reduction of costs: the economics of scale, standard specifications across cities, longer concession periods, and better payment terms, among others (CESL 2023; Vijaykumar et al. 2023). Based on the lessons learned, the government now seeks to deploy 50,000 e-buses by 2030.

Separately, India's Production Linked Incentives scheme provides financial incentives to spur manufacturing of automotive components, including e-buses and batteries. To help set up domestic battery manufacturing, the central government provides subsidies based on the applicable subsidy per KWh (maximum base around US$24/kWh) and the percentage of domestic value added on actual sale (at least 25 percent within two years) (Invest India n.d.). Lowering manufacturers' input costs up front then decreases costs for cities seeking to procure e-buses. Other schemes, such as the Phased Manufacturing Programme, impose duties on lithium-ion cells, battery packs, and ancillary components used in EV manufacturing. Deploying these duties has the potential to render India's cell manufacturing cost-effective, leading to a substantial increase in domestic value added (MHI 2022).

A well-established charging network is key to accelerating EV adoption. An essential element of the FAME II scheme is the ₹1,000 crore (US$121.8 million) it dedicates for charging infrastructure (NAB 2022). Establishing common technical standards for charging is also important for the industry to accelerate the adoption of a fully interoperable EV charging solution to transition to EVs more quickly. India's MOP issued guidelines outlining requirements for public charging infrastructure in 2018 and revised the standards in 2022. The revisions include guidance on tariffs, a revenue-sharing model related to land use, and a timeframe for connecting charging

stations to the grid. There are also separate programs to allow public agencies, such as state power distribution companies, to establish public charging infrastructure and to encourage private charge point operators to do so as well (RMI India 2020). Battery swapping is a simple solution to lower EV costs because it reduces the amount of time spent waiting for EVs to charge. A typical E3W charging cycle can be three to four hours—time that can be saved by simply swapping out batteries. This offers a promising approach for widening adoption of EVs in the commercial segment (GIZ and NITI Aayog 2021). India's central government has recently expressed its commitment to spur battery swapping, although the associated policy package is yet to be established (Gode et al. 2022; MOEFCC 2022).

While the central government has spearheaded EV deployment targets by providing direction and setting clear targets, state governments in India have played a key role in accelerating the adoption of EVs and taking climate action. As of February 2023, 26 states and union territories (out of a total of 36) had released EV policies, including Andhra Pradesh, Delhi, Goa, Haryana, Karnataka, Kerala, and Maharashtra, among others. Often, the policies are rolled out with broader goals to broaden EV adoption and attract investments through manufacturing. They vary in scope, but most policies address electrification across multiple vehicle segments. State-specific sales targets for E2Ws, E3Ws, and passenger vehicles are set, along with targets for charging or phasing out internal combustion engine (ICE) vehicles (IEA 2022b). The state EV policies can largely be divided across the following categories:

- **Demand-side subsidy for consumers.** Delhi has a wide range of demand-side incentives, including road tax and registration fee exemptions, purchase subsidies for E2Ws, E3Ws, electric four-wheelers (E4Ws), and e-buses in addition to FAME II. The state has also adopted a scrappage program that allows owners of ICE rickshaws to scrap their old vehicles for a credit toward purchasing an EV (Climate Trends 2023; GIZ and NITI Aayog 2021).

> *It is estimated that the increased share of rail for freight from the current 27 percent to 45 percent by 2030 would potentially lead to an annual reduction of 60 $MtCO_2$.*

- **Industry incentives.** The EV policy of Andhra Pradesh does not provide a subsidy for EV buyers but is focused on manufacturing, EV charging stations, and battery swapping. Similarly, Uttarakhand provides strong support to manufacturing of EV components in the state, including land at concessional rates and an electricity duty exemption for manufacturers. It also provides support to upskill/reskill the EV workforce (GIZ and NITI Aayog 2021).
- **Charging infrastructure.** Delhi pledged to provide at least 18,000 charging points by 2024, which is one charging point for every 15 EVs sold. According to Switch Delhi, a public awareness campaign launched by the Delhi state government, Delhi has more than 1,900 charging stations, close to 2,500 charging points, and more than 230 battery swapping stations (as of June 2023) (DOT n.d.).

Decarbonizing freight. Road transport is the dominant mode of freight transport in India; around 70 percent of the goods in India are transported via road (NITI Aayog et al. 2021). Limited regulation and a low barrier to entry led to a high degree of fragmentation in the freight sector. It is estimated that 75 percent of the market is run by small fleet operators who own fewer than five trucks (NITI Aayog et al. 2021). The operational efficiency of India's truck fleet is 40–50 percent lower than the global average, and the empty running rates are as high as 40 percent, causing high costs and emissions (NITI Aayog et al. 2021). In fact, India's logistics costs account for 14 percent of its GDP, far exceeding the 8–10 percent share of GDP in the developed countries (MOCI 2022).

In addition, the volume of goods transported by road has climbed as the volume transported by rail has fallen. Studies suggest that the percentage of freight carried by Indian railways dropped sharply, from 86 percent in 1951 to 30 percent in 2016 (Gupta et al. 2016). This is largely due to the high cost of carrying freight by rail. The fare-to-freight ratio, a ratio of passenger revenue per passenger kilometer to freight revenue per tonne kilometer, represents the passenger versus freight traffic. Although the global average of rail fare-to-freight ratio is between 0.7 and 1.9, India's ratio is around 0.24, meaning freight bears a disproportionate burden of railway costs (Kamboj and Tongia 2018). Congestion on the railway network is another problem because train tracks are shared between passenger and freight trains.

To support freight transport decarbonization, the government focuses on three building blocks: shifting to rail, increasing logistics efficiency, and switching to clean vehicles. Rail is the most energy efficient means of transport in India (ITF 2021). It is estimated that the increased share of rail for freight from the current 27 percent to 45 percent by 2030 would potentially lead to an annual reduction of 60 $MtCO_2$ (Government of India 2022b). Solutions that would enable more freight to move by rail include increasing the rail network's capacity (more trains and tracks) and better intermodal transportation

where goods are loaded and unloaded to reach their final destinations. To date, the government has invested in two dedicated freight corridors: Mumbai–Delhi, with 1,520 km, and Ludhiana–Dankuni, with 1,856 km. These corridors are long-distance, high-capacity freight rail routes. A few other projects are aimed at developing IWT and improving existing ports, including those in Sagarmala and the Jal Marg Vikas. The Logistics Efficiency Enhancement Program promotes multimodal logistics parks and digital solutions and improves freight distribution, storage, and warehousing to enhance logistics efficiency (Jeong 2017; NITI Aayog et al. 2021).

Clean energy transition. At present, India's transport sector is mainly fueled by petroleum products (95 percent) and biofuels (Kamboj et al. 2022). Demand for oil and coal is growing faster in India than anywhere else in the world. India is also among the fastest-growing markets for gas (Singh 2021). As of March 2023, coal contributed to about 73 percent of total electricity generation during 2022–23 (CEA 2023). Studies suggest that to reach a 20 percent overall reduction in GHG emissions, by 2030 India's electricity carbon intensity needs to be 46 percent below current levels, which stand at 713 gCO_2/kWh, well above the Group of Twenty (G20) average of 445 gCO_2/kWh (Abdul-Manan et al. 2022; Climate Transparency 2022b).

The government has plans to diversify energy generation by expanding development of solar and wind power and increasing investments in interstate transmission, battery storage, and green hydrogen. Renewables are growing rapidly, resulting from policies to reduce taxes and attract investment as well as initiatives to develop transmission infrastructure. Notably, the share of renewables in India's energy supply reached 13 percent in 2021, and the renewable energy investment from corporate and financial institutions reached $14.5 billion in 2022, an increase of 72 percent from 2020 (Climate Transparency 2022b; REN21 2022). Due to the efforts to increase renewable energy capacity, the CO_2 emissions intensity of power has dropped significantly.

Furthermore, eliminating government subsidies for fossil fuels is a crucial element for achieving successful transitions to cleaner energy systems, as emphasized in the Glasgow Climate Pact (UNFCCC 2022). According to a report released by the Council on Energy, Environment and Water, India's fossil fuel subsidies have fallen by 72 percent between FY2014 and FY2021. Despite good progress on government reform, fossil fuel subsidies are nine times more in FY2021 than subsidies for renewable energy (Aggarwal et al. 2022). There is a need to continue to reform and accelerate efforts to phase out inefficient fossil fuel subsidies while introducing new support to meet clean energy targets.

Fuel efficiency standards. India has adopted fuel efficiency standards for all vehicle types, including LDVs (with a gross vehicle weight less than or equal to 3.5 tonnes) and HDVs (over 3.5 tonnes). The standards are mass based and set in terms of L/100 km.[11] According to its 2014 corporate average fuel consumption standards, the manufacturers must meet targets for new passenger cars of 5.49 L/100 km in FY2017–18, and the more stringent requirements of 4.77 L/100 km would take effect in FY2022–23 (IEA 2021b).[12] An International Energy Agency (IEA) assessment suggests that the average fuel consumption of new cars sold in 2018 was 9 percent above the target for that year, exceeding the legal limit (Roychowdhury and Chattopadhyaya 2021). The government updated and

loosened the standard for FY2022–23, saying consumption must be less than 4.89 L/100 km for new cars, making it easier for the industry to comply (BEE 2023).

India passed fuel consumption standards for commercial vehicles weighing over 3.5 tonnes in 2019, after passing one for HDVs weighing over 12 tonnes in 2017. India is one of the first countries to have standards for HDVs on paper, but the process of implementing them has been on hold due to industry opposition (Roychowdhury and Chattopadhyaya 2021). The latest research on HDVs in India suggests that the country can significantly reduce HDV fuel consumption using cost-effective technologies, including improvements in ICE technology (e.g., engine, drivetrain, auxiliary improvements), hybrid technology, and electrification (Yadav et al. 2023).

Table 11 provides a comparison of India's stated transport measures against the blind spots identified in the *Path to Zero* report.

TABLE 11 | Summary of how India is tackling the key blind spots identified in the Path to Zero report

KEY BLIND SPOTS	INDIA'S STRATEGIES TO ADDRESS THIS BLIND SPOT
Tackling freight transport	India referred to freight in its LTS, aspiring to increase the share of rail to 45% for freight, which would lead to an annual reduction of 60 $MtCO_2$. The government launched the National Logistics Policy in September 2022, aiming to reduce logistics costs to global benchmarks by 2030. The National Rail Plan for India 2030 echoes the LTS. It aims to create a "future ready" railway system by 2030 and increase the modal share of railways in freight to 45% from the current 27%.[a] To decarbonize freight, the government focuses on three building blocks: shifting to rail, increasing logistics efficiency, and switching to clean vehicles.
Integrated planning	Several national policies, including the National Urban Transport Policy and Smart Cities Mission, aim to promote integrated planning and facilitate compact development. The government has a series of initiatives to strengthen the country's urban planning capacity and requested technical support from international development partners such as the Asian Development Bank. Under the Jawaharlal Nehru National Urban Renewal Mission (JNNURM), the government provided funding to improve public transport in selected cities. Cities were required to prepare a Comprehensive Mobility Plan before applying for JNNURM funding. The National Transit-Oriented Development Policy focuses on sustainable mobility (e.g., encouraging high-density, mixed-use, and compact developments with inclusive housing). Nevertheless, India's public transport system faces challenges, including the lack of intermodal travel, the lack of a feeder system for first- and last-mile connectivity, and insufficient coordination with land-use planning agencies.[b]
Infrastructure improvements and low-cost solutions	Infrastructure improvement targets are set in India's NDC, LTS, and other high-level transport policy documents. A series of national initiatives promote active mobility. Through the Atal Mission for Rejuvenation and Urban Transformation, funds (around US$13 billion) are allocated for urban development, including measures to enhance active mobility by creating sidewalks and biking facilities. The National Master Plan for Multi-modal Connectivity aims for coordinated implementation of infrastructure projects across 16 ministries.
Consistent policy and price signals	The government provides financial support for wider adoption of EVs in various forms, such as purchase incentives and tax benefits. The government has incentivized action by the private sector; for example, the Production Linked Incentives scheme provides fiscal incentives to enhance manufacturing capabilities for automotive components.
Provision of diverse mobility options	The Logistics Efficiency Enhancement Program promotes multimodal logistics parks and aims to reduce logistics costs via improved freight aggregation, distribution, storage, and warehousing.[c]
Discontinue counter-productive and harmful activities	Thanks to government reform, India's fossil fuel subsidies have fallen by 72% between FY2014 and FY2021; despite good progress, fossil fuel subsidies were nine times more in FY2021 than subsidies for renewable energy and EVs.[d] In 2020, roughly US$469 billion were spent on fossil fuel subsidies, accounting for 2% of public spending.[e]

Note: EV = electric vehicle; FY = fiscal year; LTS = long-term low greenhouse gas emission development strategy; $MtCO_2$ = million tonnes of carbon dioxide emissions; NDC = nationally determined contribution.

Source: a. Ministry of Railways 2022b; b. Srivastava and Nair 2021; c. Jeong 2017; d. Aggarwal et al. 2022; e. Climate Transparency 2022b; aggregated by authors.

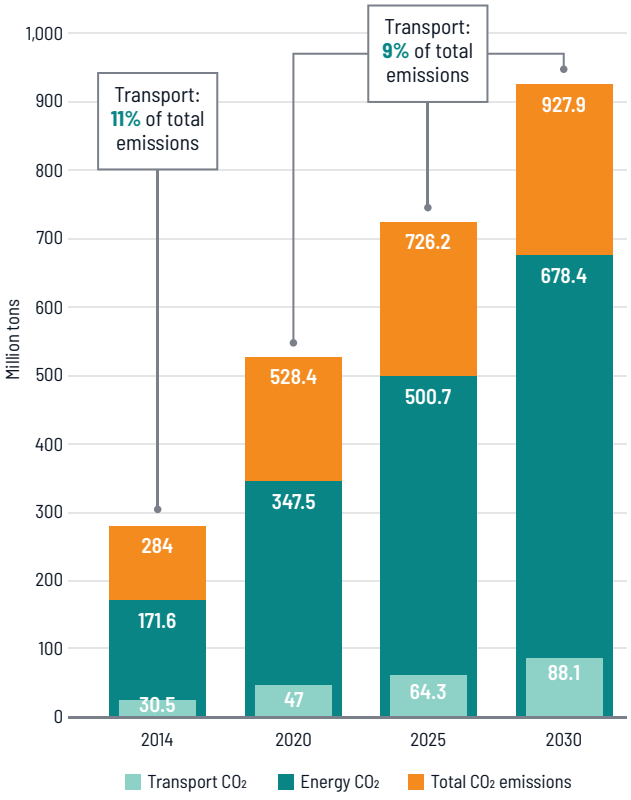
Vietnam

Country context

Vietnam is projected to develop fast, with its national GDP growing at an annual rate of 7 percent between 2020 and 2030. The country's population was estimated at 96.4 million in 2019, and it is expected to reach 104 million by 2030 (World Bank and ADB 2021). Due to rapid urbanization and economic development, the country has seen a steep increase in transport demand and vehicle ownership. Passenger traffic (in terms of passenger kilometers traveled) increased over 10 percent per year between 2009 and 2019, and freight traffic (tonne kilometers) grew by 5 percent per year during the same period (JICA 2021) (see Figure 8). Vehicle ownership soared as well; passenger car and motorcycle ownership grew by 177 percent and 138 percent, respectively, between 2016 and 2020 (Vietnam Register n.d.). The unprecedented level of motorized traffic has led to rising emissions, air pollution, congestion, and more hazardous roads.

Vietnam is the 11th highest carbon emitter among Asian economies (BP 2022). Its overall emissions will triple between 2014 (GHG inventory base year) and 2030 under the BAU scenario (Government of Vietnam 2022) (see Figure 9). Transport accounted for 10.8 percent of the total national GHG emissions in 2014 (Government of Vietnam 2022). Under the BAU scenario, transport emissions are expected to nearly triple between 2014 and 2030; and 80 percent of the transport emissions can be attributed to road transport (Oh et al. 2019).

FIGURE 9 | Vietnam's transport emissions baseline and projection under the BAU scenario



Note: CO_2 = carbon dioxide.

Source: Government of Vietnam 2022; Oh et al. 2019.

FIGURE 8 | Population, motorization, and transport emissions

Population (2021)[a]	Expected population growth (2020–2050)[a]	Urban population (2021)[a]	Passenger transport volume (2020)[b]	Freight transport volume (2020)[b]	Transport emissions/share of total emissions (2019)[c]
98.51 million	**14%**	**36.5 million**	**632 million pkm/day**	**807 million tkm/day**	**38.65 $MtCO_2$** (11%)

Notes: $MtCO_2$= million tonnes of carbon dioxide emissions; pkm= passenger kilometer; tkm=tonne kilometer.

Sources: a. General Statistics Office 2022; b. JICA 2021; c. World Bank and ADB 2021.

Vietnam's international climate commitments

Vietnam is vulnerable to the impacts of climate change, which makes mitigation a priority for its government. The country has developed a set of climate change mitigation and adaptation strategies, policies, and programs. Vietnam submitted its **first NDC** in 2016 and an updated one in 2020, committing to cut GHG emissions between 9 percent (using its domestic resources) and 27 percent (with international support) by 2030, compared to BAU (Government of Vietnam 2016). In 2021, during COP26, the country announced a target to achieve net zero by 2050 (CAT 2022).

In November 2022, Vietnam submitted its **updated NDC** to the UNFCCC, increasing its unconditional contribution to a 15.8 percent reduction below BAU and its conditional target a 43.5 percent reduction (Government of Vietnam 2022). Vietnam is one of the few countries that revisited its NDC targets in 2022. The mitigation sectors in the updated NDC remain unchanged from its previous NDC. However, the 2022 NDC provides a breakdown of sectoral targets and policies and puts forward a detailed implementation plan (Nguyen et al. 2023; Zhang 2022b). Compared with the 2020 NDC, the updated 2022 NDC features GHG emissions targets and measures that are more numerous, clear, and transparent.

Regarding transport, the updated 2022 NDC references the Action Programme on Green Energy Transformation to illustrate transport mitigation actions but does not mention any specific transport sector targets. The transport measures are broadly formulated and focus on the *shift* and *improve* measures under the ASI framework (Arnd 2020; Oh et al. 2019) (see Table 12). Studies by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) have explored **mitigation scenarios** and considered the most cost-effective transport measures that can be financed with Vietnam's domestic resources. These

TABLE 12 | Vietnam's main climate targets

CLIMATE COMMITMENTS	FORMULATION OF TARGET	TRANSPORT ACTIONS
First NDC (2016)	• 8% greenhouse gas emissions reduction below business as usual (BAU) in 2030 (excluding industrial process emissions) • 25% reduction below BAU in 2030 (excluding industrial process)	• Implement management solutions for fuel quality, emissions standards, and vehicle maintenance • Develop public transport, especially bus rapid transit in large urban centers • Shift from road to rail and inland waterway transport (IWT) • Encourage buses and taxis to use compressed natural gas (CNG) and liquefied petroleum gas
Updated NDC (2020)	• 9% reduction below BAU in 2030 (unconditional) • 27% reduction below BAU in 2030 (conditional)	• Fuel economy limits for new vehicles • Incentives for electric vehicles, electric two-wheelers • Deploy e-buses • Shift from private vehicles to public transport • Shift from road to rail • Shift to IWT and maritime transport • Incentives for clean-energy vehicles such as CNG buses • Use of biofuel (biogasoline E5) • Increase truck load factor **These transport measures are estimated to reduce 19.31 $MtCO_2$ emissions by 2030[a].**
Updated NDC (2022)	• 15.8% reduction below BAU in 2030 (unconditional) • 43.5% reduction below BAU in 2030 (conditional)	• Transport actions remain unchanged; in addition, it includes sectoral pledges, including the Global Methane Pledge, pledge to phase out coal, and Just Energy Transition Partnerships
Net zero by 2050	• Absolution emissions level in 2050: 185 $MtCO_2e$	• Enshrined in policy document

Notes: Biogasoline E5 fuel contains up to 5 percent bioethanol and 95 percent gasoline. CO_2e = carbon dioxide equivalent; Mt = million tonnes.

Sources: a. Nguyen et al. 2023; CAT 2022; Changing Transport n.d.; Climate Watch 2020, 2021a; aggregated by the authors.

include imposing fuel consumption limits for new vehicles; moving freight from road to IWT and coastal transport; introducing EVs of various kinds, such as passenger cars, 2Ws, and buses; and increasing truck load factors (Oh et al. 2019).

For climate adaptation, Vietnam's overall goal is to enhance resilience and adaptive capacities. Vietnam's National Adaptation Plan was approved by the Prime Minister in 2020 (IKI n.d.). Currently, it is being reviewed for transformative adaptation programs in priority areas. Transport adaptations are not featured in its NDCs, and the content remains general, including upgrading transport facilities and developing the expressway and the inter-region transport system.

Vietnam's updated NDCs include several sectoral initiatives, including the Global Methane Pledge, which was launched at COP26 to cut methane emissions in all sectors by 30 percent over the next decade, and the pledge to phase out coal-fired power generation (CAT 2022). Additionally, in 2022, Vietnam joined a Just Energy Transition Partnership (JETP), under which it will receive US$15.5 billion of public and private finance.[13] Key elements of the agreement include accelerating its plan to phase out coal and increasing the share of renewable energy generation from the planned 36 percent to at least 47 percent (CAT 2022; Foreign, Commonwealth & Development Office 2022). EVs are mentioned as one of the target fields for investment.

National governance on climate change and transport

In Vietnam, the climate and transport policymaking process aligns with the institutional structure of the political system. Administration is divided into four levels: the central government and three levels of local government (provincial/city, district, and commune/town level). Among them, central and provincial governments can propose policies (Contreras et al. 2015). Table 13 provides an overview of key ministries involved in transport decarbonization (see Table C-5 in Appendix C for more details).

After Vietnam announced its net zero target at COP26, it established a National Steering Committee chaired by the prime minister, which includes several line ministries, National Assembly agencies, academic institutions, and experts (Nguyen et al. 2023). This committee steered the development of key national strategies and plans to implement commitments set at COP26. These include the National Climate Change Strategy to 2050 (NCCS), the Action Programme on Green Energy Transformation, and the Regulation on Reduction of Carbon and Methane Emissions of the Transportation Sector.

TABLE 13 | Key government stakeholders involved in Vietnam's transport decarbonization

STAKEHOLDERS	RESPONSIBILITIES/ROLES
Ministry of Natural Resources and Environment (MONRE)	Established in 2003, MONRE is the leading agency in managing responses to climate change. It leads and coordinates the assessment of NDC-related GHG mitigation efforts with relevant ministries, sectors, and localities.
Ministry of Transport (MOT)	MOT is responsible for developing transport policies and planning and managing national transport infrastructure.
Ministry of Industry and Trade (MOIT)	MOIT is responsible for policymaking related to energy use and issuing standards for vehicle manufacturing.
Ministry of Science and Technology (MOST)	MOST oversees the development of vehicle emissions standards and technical regulation on fuels.
Ministry of Planning and Investment (MPI)	MPI develops national guidelines for climate change finance and investment. It is responsible for coordinating and allocating funds for energy sector proposals by line ministries and sectoral agencies.
Ministry of Finance (MOF)	MOF is tasked with budget management, such as recurrent expenditures for climate change and public investment balance. It is also responsible for developing financial incentives for manufacturing and operating electric vehicles, as well as developing incentives for providing charging infrastructure and charging services.
Ministry of Construction (MOC)	MOC is responsible for administering construction, buildings, urban infrastructure, and public services. It is also responsible for promulgating urban planning guidelines and building design codes to integrate charging facilities in urban planning and facilitate e-mobility uptake.

Notes: GHG = greenhouse gas; NDC = nationally determined contribution.

Sources: Contreras et al. 2015; Le et al. 2022; aggregated by the authors

National policy framework for climate and transport

In Vietnam, policies and regulations are issued in the form of laws (issued by the National Assembly), resolutions (issued by the government), government decrees, decisions (issued by the prime minister and ministers), circulars, technical regulations, and technical standards (Linh 2021). In general, sustainable transport policies are guided by the following laws, national strategies, and action plans: environmental protection, climate change, and green growth (Table 14). Table 15 provides a detailed comparison of the transport targets contained in Vietnam's national climate and transport strategies, and Table 16 describes the transport measures included in these strategies.

Apart from the strategies above, Vietnam has a few policies in place to promote clean energy and enhance energy efficiency, such as Resolution 55, the National Energy Development Strategy, and the Power Development Plan 8 (PDP8). Other transport strategies and policies do not list climate change as their primary rationale but do address the cobenefits of low-carbon transport, such as clean air and road safety. The transport subsector plans, such as the Transport Infrastructure Master Plan, Railway Transport Development Strategy, and Inland Waterway Infrastructure Master Plan, set out these development strategies. For a more detailed list of policies, please see Table C-6 in Appendix C.

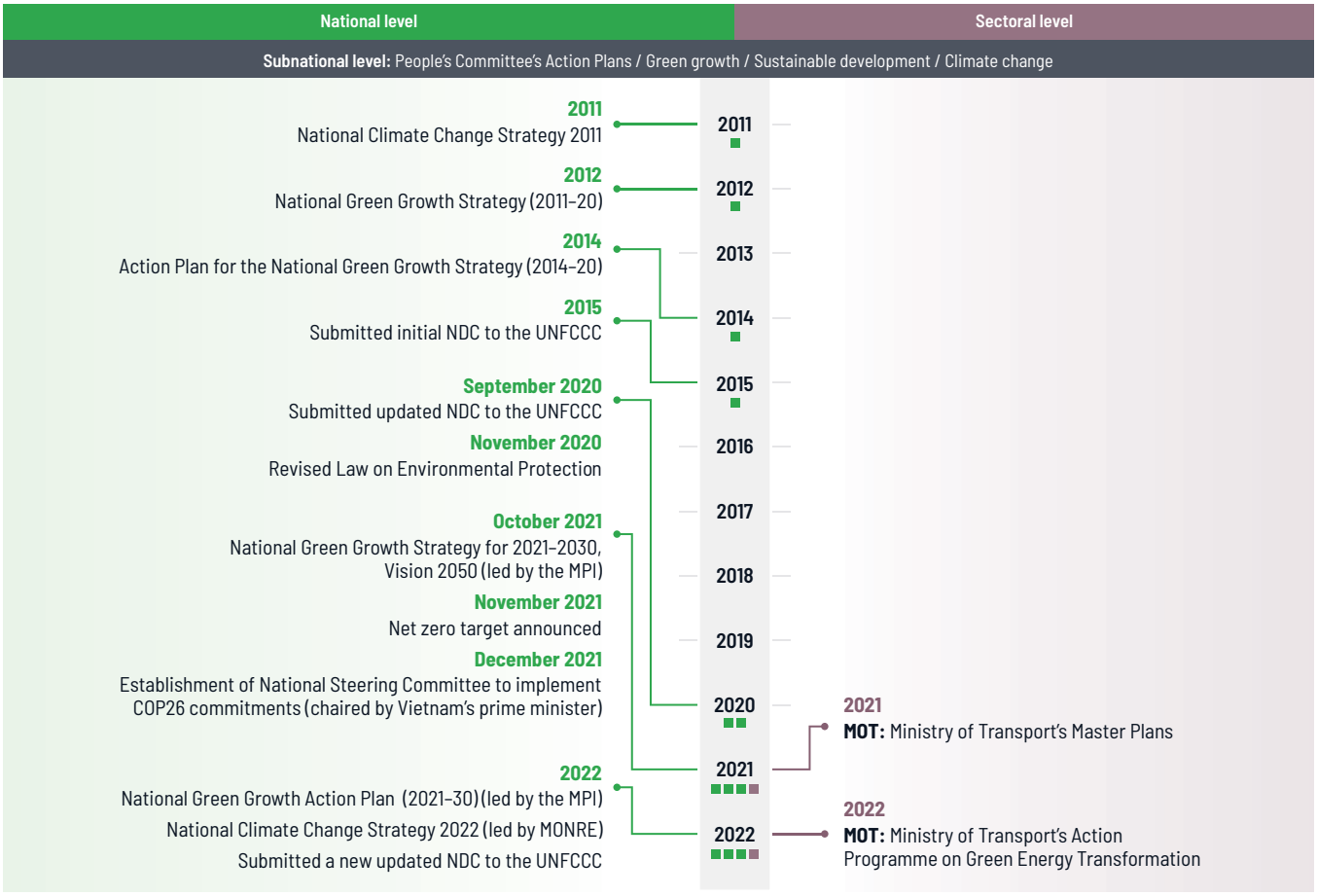
TABLE 14 | Key government strategies concerning Vietnam's transport decarbonization

POLICY DOCUMENT	YEAR ISSUED	CONTENT RELATED TO TRANSPORT DECARBONIZATION
Revised Law on Environmental Protection (LEP)	2020	The revised LEP entered into force in January 2022. The law replaces a previous version published in 2014 and provides details for implementation, including promotion of low- or zero-emission vehicles, the use of renewable energy, the development of public transport, and control of private vehicles. The government is mandated to set up GHG (greenhouse gas) inventories and a national measurement, reporting, and verification system.
Regulation on GHG Mitigation and Protection of the Ozone Layer (Decree No. 06/2022/ND-CP)	2022	The government decree set a target to reach 563.8 $MtCO_2e$ by 2030. For transport, it has a target to reduce at least 37.5 $MtCO_2e$ by 2030.
National Climate Change Strategy to 2050 (NCCS)	2022	The NCCS is the first policy in the country to outline a pathway to reach carbon neutrality. It sets out specific mid- and long-term sectoral targets. The NCCS has set out the following strategic measures for transport: reducing transport related emissions by enhancing energy efficiency and effectively and promoting the transition to clean energy use by regulating fuel consumption and emission standards; shifting travel demand from roads to rails, inland waterways, and coastal transport; and expanding the road network and north-south railway network.
National Green Growth Strategy for 2021–2030, Vision 2050 (NGGS)	2020	The NGGS is an important effort on sustainable economic development. It sets a few economy-wide and sectoral targets, including the goal of reducing GHG emissions intensity per unit of GDP by at least 15% by 2030 and 30% by 2050, compared to 2014.
National Green Growth Action Plan	2022	The Action Plan focuses on 18 sectors, 57 tasks, and 134 subtasks. The Ministry of Planning and Investment is the focal point of the development and implementation of the NGGS.
Action Programme on Green Energy Transformation	2022	The program's overall objective is to develop a zero-emission transport system by 2050 and reduce carbon and methane emissions from the transport sector. It outlines specific targets for different modes of transport (road, rail, inland waterways, shipping, aviation, urban traffic) in both the short and long term.

Note: The National Green Growth Action Plan categorizes transport-related activities into six primary areas, including green transport infrastructure, standards and norms, vehicle transformation, fuel quality management, transport infrastructure, and digital transformation. GDP = gross domestic product; $MtCO_2e$ = million tonnes of carbon dioxide equivalent.

Sources: MPI 2021; Thanh 2022; Le et al. 2021; aggregated by the authors.

FIGURE 10 | Timeline describing the major milestones for Vietnam's climate and transport policies



Notes: COP26 = 26th Conference of the Parties; MONRE = Ministry of Natural Resources and Environment; MOT = Ministry of Transport; MPI = Ministry of Planning and Investment; NDC = nationally determined contribution; UNFCCC = United Nations Framework Convention on Climate Change.

Source: Adapted from Le et al. (2021).

TABLE 15 | Transport targets contained in Vietnam's national climate and transport strategies

TARGETS	Status quo	National Green Growth Strategy (NGGS; 2021) and Action Plan (2022)	Action Programme on Green Energy Transformation (2022)	Regulation on GHG mitigation and protection of the ozone layer (2022)
STATUS	–	The NGGS was issued in 2021 and the Action Plan was released in 2022	July 2022	January 2022
IMPLEMENTATION PERIOD	–	2030, 2050	2025, 2030, 2050	2030
EMISSIONS REDUCTION (BY 2030)	Transport sector contributed to 44.64 $MtCO_2e$ emissions (as of 2019)[a]	–	–	Reduce transport-related emissions by at least 37.5 $MtCO_2e$
ELECTRIC VEHICLE (EV) DEPLOYMENT	1.9 million EVs as of 2020; Ho Chi Minh City is piloting 15 e-buses; Hanoi is providing 5 subsidized e-bus routes[b]	By 2030, share of buses using clean energy in special-class cities reaching 15% of existing bus fleet, share of buses using clean energy in class-I cities reaching 10% of total newly sold buses	By 2025, all new buses will be electrified or use green energy By 2030, 50% of the vehicles will be electric or use green energy; 100% of new taxis will be electric By 2050, 100% of buses and taxis will use electricity and green energy	–

TABLE 15 | Transport targets contained in Vietnam's national climate and transport strategies (cont.)

SHARE OF PUBLIC TRANSPORT (BY 2030)	As of 2020, the share of public transport hovered around 10% in Hanoi, 5% in Ho Chi Minh City, and the share was less than 1% in other cities[c]	By 2030, share of public transport in special-class and class-I cities reaching 20% and 5% respectively	By 2030, share of public transport is expected to reach 45%–50% in Hanoi, 25% in Ho Chi Minh City, 25%–35% in Da Nang, 20% in Can Tho, 20%–15% in Haiphong, and at least 5% in class-I cities	—
SHARE OF PUBLIC TRANSPORT (BY 2050)	As of 2020, the share of public transport hovered around 10% in Hanoi, 5% in Ho Chi Minh City, and the share was less than 1% in other cities[c]	By 2050, share of public transport in special-class and class-I cities reaching 40% and 15%, respectively	By 2050, share of public transport is expected to reach at least 40% and 10% in special class cities and class-I cities, respectively	—

Notes: Vietnamese cities are classified hierarchically into six classes: special class and classes I to V based on their socioeconomic characteristics, population size, and infrastructure development. Hanoi and Ho Chi Minh City are special-class cities. There are 20 class-I cities, including Da Nang, Haiphong, and Can Tho, which are administered centrally (Minh Son 2020). Em dashes (—) signify that information was not specified. $MtCO_2e$ = million tonnes of carbon dioxide emissions.

Source: a. Climate Watch n.d.; b. Vietnam Register n.d.; c. Ngoc et al. 2022; other data and information from the respective policy documents; aggregated by authors.

TABLE 16 | Key transport measures contained in Vietnam's national climate and transport strategies

KEY TRANSPORT MEASURES	NATIONAL CLIMATE CHANGE STRATEGY	NATIONAL GREEN GROWTH STRATEGY AND ACTION PLAN	ACTION PROGRAMME ON GREEN ENERGY TRANSFORMATION
Support shift to public transport	X	X	X
National measures to support active mobility			X
Fuel economy standards	X	X	X
Support for low-carbon fuels			X
Mandatory vehicle labeling		X	
MRV system for transport	X		
Mode shift from roads to rails and inland waterways	X		X
Investment in infrastructure	X	X	X
Support mechanism for EVs and charging infrastructure		X	X
Support low-carbon freight			X
Digital governance in transport		X	

Note: EV = electric vehicle; MRV = measurement, reporting, and verification. X signifies that the policy documents make a direct reference to a specific transport measure.

Source: Categorization of transport measures is based on Riehle et al. (2023); aggregated by authors.

Vietnam's transport decarbonization progress in selected thematic areas

The following section provides an overview of Vietnam's transport decarbonization measures, following the ASI framework. It focuses on a few measures, including the shift to public transport and active mobility, intermodal freight transport, e-mobility, fuel efficiency improvements, and linkage with renewable energy. The measures are compared against the blind spots identified by the Council for Decarbonising Transport in Asia (see the "Methodology" section under "Scope and methodology").

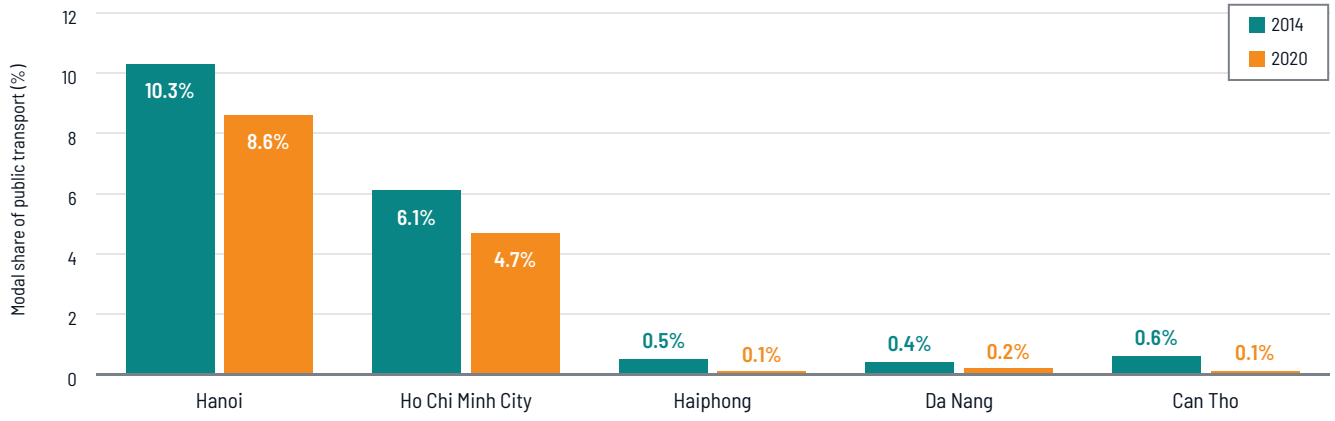
Promote public transport. Vietnam's existing measures to encourage the use of public transport include parking management and vehicle and fuel taxation (Contreras et al. 2015). Its efforts to shift to BRT and mass rapid transit are limited by lack of investment and largely focus on large and medium cities. Studies suggest that bus ridership in big cities has actually fallen in recent years as private cars and motorcycles have proliferated. Public transport has also lost riders due to poor service and accessibility (JICA 2021). As of 2020, the modal share of public transport hovered around 10 percent in Hanoi, 5 percent in Ho Chi Minh City (HCMC), and the share was less than 1 percent in other cities (Figure 11) (Ngoc et al. 2022).

With the support of the NDC-TIA project and the Transformative Urban Mobility Initiative E-Bus Mission project, HCMC is currently conducting a bus restructuring study and plans to extend its bus network with 179 new routes by 2030, improve the connectivity to urban railway stations, and increase the share of green energy buses (including CNG buses and e-buses) so that they make up almost 53 percent of the fleet by 2030.

Accelerate the adoption of e-mobility. The deployment of EVs is still at the initial stages. But impetus has come from the net zero target, transport-related measures set in national strategies, and support from the local EV industry. EV sales in Vietnam have risen at least a thousandfold, from just 1,579 in 2010 to about 1.9 million in 2020, primarily driven by sales in E2Ws. Sales of E2Ws took off between 2019 and 2020, with their market share expanding from 5 percent to 8 percent, and as of June 2020, 1.35 million E2Ws plied Vietnam's roads (Vietnam Register n.d.). Two-wheelers, which include motorcycles and mopeds, account for over 90 percent of the motorized vehicle fleet (United Nations 2018). Electrifying the 2W fleet not only offers the opportunity to reduce GHG emissions and clean up the air but also to meet the mobility needs of lower-income groups. In addition, E2Ws offer the advantages of relatively low capital costs and almost negligible charging infrastructure requirements (Briceno-Garmendia et al. 2022). However, policies to support the production of E2Ws, their supply chains, and the provision of battery swapping services do not exist yet in Vietnam. With proper policy support, the country could lead in E2W production and the E2W supply chain in Asia (Le et al. 2022).

To promote EVs, the government introduced a policy of waiving the registration fee (10 percent of the vehicle price) for EVs purchased from March 2022 onward (VietNamNet 2022). WRI's recent cost-benefit analysis suggests that implementing purchase subsidies and registration rebates in the early stage of EV adoption in HCMC could deliver positive benefits to private EV owners. These include potential cost savings in up-front costs due to subsidies provided by the government, lowered operating costs of EVs, and social benefits associated

FIGURE 11 | Modal share of public transport in five Vietnamese cities in 2014 and 2020



Notes: HCMC = Ho Chi Minh City; the number of trips made by public transport in the five Vietnamese cities above decreased from 2014 to 2020, and the modal share dropped from 3.6 percent to 2.7 percent on average during the same period.

Source: Ngoc et al. 2022.

with reduced severity of climate change disasters and improved public health. The analysis suggests that each new EV may generate up to US$76 per annum in net private benefits (Tesoriere et al. 2023). And there is now a legal basis to add subsidies to existing incentives. It comes from a new national resolution (No. 98/2023/QH15) passed in July 2023 that requires HCMC to implement policies and incentives to individuals, households, cooperatives, and enterprises to transition to green energy vehicles and to provide supportive infrastructure (National Assembly of Vietnam 2023b). Currently, the NDC-TIA is working with the HCMC Department of Transportation to develop supporting policy measures to accelerate the EV deployment.

Vietnam's government is also attempting to promote e-buses. The central government has requested that five major cities—Hanoi, HCMC, Haiphong, Da Nang, and Can Tho—support the development of clean buses. Hanoi and HCMC are supposed to collaborate with the Ministry of Transport (MOT) and Ministry of Finance (MOF) to develop road maps of the e-mobility transition and allocate budgets. The NDC-TIA project has supported HCMC in developing the first e-mobility action plan in the country, to be integrated into the city master plan.[14] The incentives for public e-buses include lower special consumption tax rates, preferential loans for investment in infrastructure development, exemption from import duty and registration fees, and subsidies for operating costs and bus ticket fares (Le et al. 2021). However, the industry needs more financial support to accelerate e-bus adoption. HCMC is currently piloting a subsidized e-bus route with 15 e-buses and is planning to pilot four other routes in late 2023 (see Box 2). Hanoi provides five subsidized public e-bus routes. Several other cities (Da Lat, Da Nang, Hue, Nha Trang, and Vung Tau) operate mini e-buses, but these are not subsidized and are only for tourism purposes. Furthermore, technical standards and regulations for e-buses, specifications for charging infrastructure and energy supply, and plans for e-bus deployment are yet lacking.

Development of fuel consumption standards. The Vietnamese government argues in its NDCs that limiting fuel consumption of motorized vehicles is one of the most effective ways to mitigate emissions (Government of Vietnam 2022). The latest modeling suggests that with Vietnam's domestic resources, limiting fuel consumption could potentially reduce 5 $MtCO_2$ in the transport sector by 2030 (Nguyen et al. 2023).

BOX 2 | VinFast is fast-tracking the e-mobility transition in Vietnam

VinFast—Vietnam's first and largest domestic car manufacturer under the biggest conglomerate, VinGroup—has launched some battery electric vehicle models and offers a monthly rental battery scheme to customers. Recently, VinGroup launched the Green and Smart Mobility Joint Stock Company, an entity dedicated to using VinFast electric vehicles (EVs) and scooters for rental and taxi services. In addition, VinFast has established 2,000 charging stations for EVs and battery swapping stations for electric two-wheelers in many cities. It aimed to roll out 150,000 chargers across the country in 2022.

VinBus, the bus operator under VinGroup, is operating the pilot e-buses in Ho Chi Minh City and Hanoi. Currently, it receives 44 percent of the operating costs from Ho Chi Minh City during the trial phase, and the rate will be adjusted after the government issues technical specifications and cost norms. To further ramp up e-bus manufacturing, VinFast has received climate financing, with US$135 million led by the Asian Development Bank. This will also be used to develop a national charging network for EVs.

Sources: ADB 2022a; Automotive World 2023; Kiet 2022.

Although Vietnam has not yet established national standards, certain necessary elements have been prepared. Since 2020, energy labels with information about fuel consumption are required for 2Ws.[15] There is huge potential for technology improvements in the less-efficient 2W fleet and vehicle electrification. The ICCT's recent research suggests that average fuel consumption in 2020 fell by 4.3 percent compared to 2019, largely due to the increasing penetration of E2Ws (Tran et al. 2022). Most recently, the NDC-TIA conducted a fuel consumption assessment for passenger vehicles (up to nine seats), serving as a foundation for future policies designed to set new emissions standards.

Vietnam has seen rapid growth in transport infrastructure over the past decades, improving people's access to services and opportunities.

Modal shift to IWT and railways. Vietnam has seen rapid growth in transport infrastructure over the past decades, improving people's access to services and opportunities. Although the road network has expanded rapidly and reached over 630,000 km in 2018, railways and inland waterways have not been given adequate attention, accounting for just 2 percent of intercity transport (Le et al. 2021). Vietnam's 2022 NDC demonstrates that the switch to more cost-effective and less carbon-intensive modes, such as rail and IWT for freight transport, could potentially reduce up to 2.5 Mt of transport emissions by 2030. In addition, the government has been exploring plans to make the switch; however, there has been limited progress. Nearly 80 percent of the freight transported (in terms of tonnes) are carried by road vehicles, and just 16 percent are transported via waterways (General Statistics Office 2022). The Action Programme on Green Energy Transformation and the Vietnam National Railway Master Plan both propose targets for switching to electric trains for national railway lines and using electricity and green energy for loading/unloading operations. However, there is no specific road map for doing this.

Linkage with the energy sector. Vietnam's electricity generation is fossil fuel heavy. Fossil fuel made up about two-thirds of the country's power mix in 2019; 46 percent of that generation used coal. According to the IEA, Vietnam's fossil fuel subsidies accounted for 3 percent of its GDP in 2021 (IEA n.d.). Nevertheless, there are signs of movement toward renewable energy and away from plans to support coal generation. Vietnam is the 10th-biggest producer of solar power worldwide and has one of the fastest-growing markets; between 2017 and 2021, the share of electricity generated by solar increased from negligible levels to nearly 11 percent (Do et al. 2021). Hydropower is the largest source of renewable energy, representing 16 percent of the primary energy supply in the country (BP 2022). In August 2023, Vietnam passed the PDP8, the country's first energy sector blueprint to consider Vietnam's 2050 net zero commitment (National Assembly of Vietnam 2023a). The PDP8 is laudable for setting energy-mix targets to reduce coal-fired power generation (from 38 percent in 2022 to 20 percent in 2030) and increase solar and wind power (from 13 percent to 27 percent) (Energy Institute 2023). However, this plan does not contain any concrete measures

to integrate e-mobility power supply and demand, missing an opportunity to align the energy and transport sector targets and decarbonize an increasingly electric transport system.

Financing for e-mobility and low-carbon transport. As a middle-income country, Vietnam's public resources are limited, and it lacks the capacity to fund large-scale transport projects. In recent decades the share of Vietnam's public funding allocated to the transport sector has hovered around 2 percent of GDP (JICA 2021). The country depends heavily on financing from international partners and funds such as the Green Climate Fund (GCF).

Currently, several public and multinational donors have shown interest in e-mobility and its role in facilitating green, inclusive growth in Vietnam. VinFast received US$135 million in financing led by the Asian Development Bank and US$50 million from the Australian government to support the manufacture of e-buses and the development of a national charging network for EVs (ADB 2022a; Australian Embassy n.d.). One expert interviewed mentioned that Vietnam's transport ministry officials have helped VinFast access necessary financing. In addition, one interviewee highlighted the importance of climate ambitions underpinned by clear transport targets because this helps reduce uncertainty for investors.

Table 17 compares Vietnam's stated transport policies and measures against the blind spots in the *Path to Zero* report.

TABLE 17 | Summary of how Vietnam is tackling the key blind spots identified in the Path to Zero report

KEY BLIND SPOTS	VIETNAM'S STRATEGIES TO ADDRESS THIS BLIND SPOT
Tackling freight transport	Freight transport is addressed in MOT's Action Programme on Green Energy Transformation and the Vietnam National Railway Master Plan. These are some of the proposed measures: shifting from road to rail and IWT, promoting intermodal freight, electrifying trains for national railways, using green energy for loading/unloading, reducing empty running, and improving operation efficiency. A road map on how to implement these measures is yet absent.
Integrated planning	National comprehensive plans and provincial plans are formulated, considering integrated land-use and transport planning.
Infrastructure improvements and low-cost solutions	MOT's Action Programme and the National Green Growth Action Plan promote the use of modern technologies, digital transformation, and intelligent traffic management to improve the road and rail systems.
Consistent policy and price signals	The government has set EV deployment targets and is currently developing new fuel consumption standards for passenger vehicles (under nine seats), which will incentivize ICE manufacturers to invest in manufacturing EVs and their components. Existing supporting measures for adopting EVs includes reduced registration fees and a special consumption tax. The government has organized communication campaigns on environmental protection and climate change in general to raise awareness and knowledge. The local manufacturer (VinFast) and some other manufacturers have introduced E2Ws to the market, but the actions are still limited. Vehicle manufacturers as well as charging service providers and operators are waiting for incentives (e.g., direct subsidies for EVs and EV parts, preferential loans, reduced taxes) from the governments (national and local) to participate in the process.
Provision of diverse mobility options	The government has plans to invest in transport infrastructure to entice the shift to more sustainable and cost-efficient modes, such as rail and IWT. Currently, however, a lack of investments has delayed the roll-outs of mass rapid transit in Vietnamese cities, reinforcing the dominance of private motorized vehicles.
Discontinue counterproductive and harmful activities	As in many other Asian economies, Vietnam has traditionally subsidized fossil fuels, and the subsidies accounted for 3% of its GDP in 2021, according to the IEA. Vietnam joined a Just Energy Transition Partnership in 2022, under which it will receive US$15.5 billion of public and private finance, to accelerate the phaseout of coal and increase the share of renewable energy generation from the planned 36% to at least 47% by 2030.[a] In addition, Vietnam is allocating investment to more sustainable alternatives, including public transport and nonmotorized transport infrastructure and services (e.g., park and ride).

Notes: E2W = electric two-wheeler; EV = electric vehicle; ICE = internal combustion engine; IEA = International Energy Agency; IT = inland waterway transport; MOT = Ministry of Transport.

Source: a. CAT 2022; Foreign, Commonwealth & Development Office 2022; aggregated by authors.

Summary of country analyses

China, India, and Vietnam have all set economy-wide net zero goals and have referenced them in their NDCs. The three countries have defined different timelines, varying legal statuses, and approaches to translating them into domestic policies. China's carbon neutrality target is not yet enshrined into law but has become a narrative across its policy documents. India has pledged to reach net zero by 2070 and has envisioned its rail network becoming net zero by 2030. Vietnam's net zero target is legally binding and generates positive momentum for the country to implement more ambitious policies. Table 18 summarizes each country's net zero targets.

As observed in the Table 19 below, the three countries reference their respective national climate change strategies, development plans, and transport sectoral plans in either their NDCs or LTSs. China's updated NDC and LTS contain a balanced mix of transport measures across the ASI framework. In comparison, India's updated NDC (2022) does not specifically mention transport, and its LTS focuses strongly on *improve* measures such as vehicle electrification, fuel efficiency improvement, and adoption of clean fuel. India also proposes to encourage the *shift* to public transport. Vietnam does not have an LTS but has submitted a second update of its NDC, which provides a sectoral breakdown of targets and policies and contains reference to its Action Programme on Green Energy Transformation. The Action Programme contains comprehensive *shift* and *improve* measures but limited mention of the *avoid* measures, and it lacks planning to integrate transport with land use in the long term. With the support of the NDC-TIA program, Vietnam is currently developing transport mitigation scenarios; a measurement, reporting, and verification (MRV) system for transport sector; fuel economy standards; and an e-mobility road map and implementation plans pertaining to the Action Programme.

The three countries have all set specific EV deployment targets, such as to reach a specified percentage of EVs (by vehicle segment) in the new vehicle sales in a target year. The countries aspire to a modal shift from road to rail and IWT and to shift from private motorized vehicles to public transport. Specifically, India has a target for rail to be net zero and aims to raise the share of rail freight to 45 percent by 2030 from the current level of 27 percent (Ministry of Railways 2022b). As of March 2023, over 90 percent of its broad-gauge railway network has been electrified (CORE 2023). Both China and Vietnam have set targets to increase the share of public transport in their modal splits. Table 20 summarizes the national transport targets specified in each country's key government strategies.

Table 21 breaks down the different measures contained in each country's respective national transport plans, programs, and policies. All three countries have measures in place to promote the use of public transport, albeit with different focuses: improving the infrastructure and connectivity of the bus network, renewing bus fleets, or establishing technical standards. To support the uptake of EVs and charging infrastructure, governments have taken a combination of measures at different stages of development and have applied them to their respective country-specific context.

TABLE 18 | Overview of net zero/carbon neutrality targets across the three countries

COUNTRY	TARGET YEAR	TARGET STATUS	TARGET SOURCE
China	Carbon neutrality before 2060	In policy document (October 28, 2021)	China's LTS (October 28, 2021); China's updated NDC (October 28, 2021); Climate Ambition Summit 2020 (December 12, 2020); speech (July 27, 2021)
India	Net zero by 2070	In policy document (August 26, 2022; November 14, 2022) In political pledge (November 1, 2021)	India's LTS (November 14, 2022); India's updated first NDC (August 26, 2022); speech during COP26 World Leaders Summit (November 1, 2021)
Vietnam	Net zero by 2050	In policy document (July 2022)	Vietnam's updated NDC (second update) (November 9, 2022); speech during COP26 World Leaders Summit (November 1, 2021)

Notes: COP26 = 26th Conference of the Parties; LTS = long-term low greenhouse gas emission development strategy; NDC = nationally determined contribution.
Sources: Climate Watch 2020, 2021a, 2021b.

TABLE 19 | Overview of transport targets and measures in the NDCs and LTSs across the three countries

COUNTRY	NDC/LTS STATUS	EMISSIONS TARGETS	TRANSPORT-RELATED TARGETS	KEY TRANSPORT MITIGATION ACTIONS IN NDCS AND LTSS
China	Updated NDC (October 28, 2021); LTS submitted (October 28, 2021)	Peak CO_2 emissions before 2030; achieve carbon neutrality before 2060	• Carbon emissions intensity of commercial vehicles reduced by 9.5% in 2030 from 2020 level[a,b,c] • Energy consumption of national railways per unit of converted turnover reduced by 10% in 2030 from 2020 level[a,b,c] • Oil consumption for land transport peaks by 2030[a,b,c]	A balanced mix of measures under the ASI framework; the LTS states three key areas: • Develop a low-carbon and efficient transport system • Accelerate the transformation of the energy structure in the transport sector • Speed up the construction of a green travel system
India	Updated NDC (August 26, 2022); LTS submitted (November 14, 2022)	Reduce emission intensity by 45% by 2030	• Rail to reach net zero by 2030[d] • Increase the share of rail in freight traffic to 45% by 2030 from 27%[d,e]	Its LTS does not contain *avoid* measures but includes a range of *shift* and *improve* measures, ranging from promoting rail, shipping, and IWT; setting fuel efficiency standards for passenger vehicles; adopting EVs and hybrid vehicles; and infrastructure improvements. It also contains goals related to the share of biofuel and reduction of fossil fuel subsidies.
Vietnam	Updated NDC (second update; November 9, 2022)	15.8% reduction below BAU in 2030 (unconditional); 43.5% reduction below BAU in 2030 (conditional)	Referenced in the Action Programme on Green Energy Transformation to reduce carbon and methane emissions from transport[f]	Its NDC includes comprehensive *shift* and *improve* measures but limited coverage on *avoid* measures. Its updated NDC promotes the following: • Fuel economy limits for new vehicles • Shifting from private vehicles to public transport • Shifting from road to rail, IWT, and maritime transport • Incentives for clean energy vehicles such as CNG buses, E2Ws, cars, and buses • Use of biofuel • Increased load factor of trucks

Notes: ASI = avoid-shift-improve; BAU = business as usual; CNG = compressed natural gas; CO_2 = carbon dioxide; E2W = electric two-wheeler; LTS = long-term low greenhouse gas emission development strategy; NDC = nationally determined contribution; a. China's updated NDC; b. The "1+N" policy system, including the Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality and the Action Plan for Carbon Dioxide Peaking before 2030; c. The Outline for the 14th Five-Year Plan; d. India's LTS; e. India's National Rail Plan; f. Vietnam's updated NDC.

Sources: CAT 2022, 2023; Climate Watch 2021a, 2021b; MEE 2022; Government of India 2022a, 2022b; Government of Vietnam 2022; Ministry of Railways 2022a.

TABLE 20 | Overview of national transport-specific targets also outside of NDCs and LTSs across the three countries

KEY TRANSPORT TARGETS	CHINA	INDIA	VIETNAM
Reduction in carbon emissions intensity (e.g., transport subsegments)	X		X
EV deployment (e.g., share of EVs in the new vehicle sales)	X	X	X
Charging and refueling	X	X	
Mode shift (road to rail; road to water)		X	
Share of public transport in the modal split	X		X
Infrastructure improvement	X	X	X

Notes: X signifies that the national policy documents make a direct reference to a specific target. EV = electric vehicle.
Source: Aggregated by authors.

TABLE 21 | Overview of national transport measures also outside of NDCs across the three countries

NATIONAL MEASURES	CHINA	INDIA	VIETNAM
National program to support shift to public transport	X	X	X
Measures to support active mobility	X	X	
National-level measures to support new mobility services	X		
Fuel consumption standards for LDVs	X	X	X
Fuel consumption standards for HDVs	X	X	
Pricing instruments such as taxes	X	X	X
Support mechanism for EVs and charging/refueling infrastructure	X	X	X
Measures to support low-carbon freight	X	X	X
Mandatory biofuel targets	X	X	
Support for other low-carbon fuels (e.g., renewables, green hydrogen)	X	X	X

Note: X signifies that the national policies make a direct reference to a specific attribute. EV = electric vehicle; HDV = heavy-duty vehicle; LDV = light-duty vehicle.
Sources: Categorization of measures is based on Riehle et al. (2023), aggregated by authors.

4. Alignment analysis

Drawing on the empirical evidence from transport decarbonization in China, India, and Vietnam, we evaluated the policy mix characteristics in each country, considering consistency and coherence.

Accelerating a low-carbon transition requires alignment across policy areas and coordination across levels of governance (Braams et al. 2021; Markard et al. 2020). Policy instruments may offer huge potential but be difficult to implement due to the complexity of governance structures and the lack of financial resources or technical capacity (Axsen et al. 2020).

Drawing on the empirical evidence from transport decarbonization in China, India, and Vietnam, we evaluated the policy mix characteristics in each country, considering consistency and coherence. A detailed analysis framework can be found in the "Methodology" section under "Scope and methodology." Detailed quotes from the stakeholder interviews in each country and evidence from other existing literature can be found in Appendix D. (See also "Summary of alignment analyses.")

Alignment analysis of China

Analysis reveals a high level of consistency between China's international climate commitments (i.e., NDC and LTS) and its national policies, programs, and plans. Varying objectives among government agencies cause fragmentation and impede coordination of policy processes, but wider stakeholder participation can contribute to greater coherence (see Tables D-1 and D-2).

Consistency of policy elements

Our findings show the good practices and areas for improvement in China's policy mix for transport decarbonization. First, we find that climate ambition—specifically its carbon peaking and neutrality target—is well reflected in the national strategies and has become a core focus and narrative. China provides a good example of aligning the NDC with existing policies. The emissions targets and transport-specific targets defined in China's updated NDC and LTS align with China's 1+N policy system and with the 14th FYP, among other plans. "The impact of carbon neutrality target on the transport sector is a gradual, interactive process, with constant feedback. We refined these requirements for different transport subsectors, even for traffic signal management and right-of-way," noted one expert interviewed. "The ministries would set sectoral targets in the national policy documents before including them in the NDCs."

Second, certain goals reverberate across national strategic documents, but these vary across dimensions such as implementation timeframe, geographic specificity, or governance level. For instance, whereas the 1+N policy system sets a national goal of NEVs composing a 40 percent share of new vehicle sales by 2030, the Implementation Plan for Synergizing Reduction of Pollution and Carbon Emission lays out the target of a 50 percent share of NEVs in new sales in key air pollution zones by 2030 (MEE 2022). In addition, the NEV Industrial Development Plan 2021–35 indicates that NEVs should account for no less than 80 percent in new or renewed public fleets (buses, taxis, delivery vehicles) in pilot zones and key air pollution regions by 2025, but the 14th FYP for the Development of Comprehensive Transport Services stipulates that the share of NEVs in urban buses, taxis, and urban delivery vehicles will reach 72 percent, 35 percent, and 20 percent, respectively, by 2025.

The ZEV mandate, the policy instrument operationalizing China's deployment of EVs and charging infrastructure, has played a major role in overcoming barriers to large-scale electrification and is seen as consistent with its ambitious targets. However, China's ZEV mandate provides manufacturers with emissions compliance flexibility, which makes some analysts wary. They caution that the government is encouraging fast deployment of NEVs at the cost of fuel efficiency of ICE fleets and the interplay might dilute the intended emissions benefits (Zhang and He 2022). They point out that the carbon intensity of the grid used to charge EVs is high, which could limit the benefits of replacing ICE vehicles with EVs. And, at the same time, the GHG standards for ICE vehicles are not very stringent (Rokadiya and Yang 2019).[16] It is therefore critical for the government to carefully consider the overall impact on emissions from implementing such policies.

Coherence of policy processes

China has established a functioning coordination mechanism to implement climate commitments and NEV deployment. The Leading Group on Carbon Peaking and Carbon Neutrality is the central agency coordinating China's carbon peaking work across sectors. Experts interviewed mentioned that "cross-ministry coordination is definitely there. The central government has had cross-sectoral coordination since the beginning. . . . 1+N is divided into several key areas and

industries, and each area has its own lead department. For example, the MIIT will consult with other departments, but it must go through the approval of the Leading Group on Carbon Peaking and Carbon Neutrality to keep the coherence." As part of the NEV Industrial Development Plan 2012, an interministerial coordination mechanism was established in 2013 to coordinate efforts around the EV ecosystem. Led by MITT, it consists of 20 ministries and agencies under the State Council (Song et al. 2023). In the past decade, China's national EV policies started with supporting vehicle manufacturing and technologies, and the scope of the policies broadened to other aspects, such as embedding EVs in the energy systems (Trencher et al. 2021; Z. Wu et al. 2021). This is reflected in China's governance structure. A growing number of ministries have been involved in policy planning and implementation and efforts across policy areas are increasingly coordinated (Song et al. 2023).

However, policy coordination is fragmented in some areas. MEE holds the primary responsibility for reducing both GHG emissions and air pollutants, and MIIT is tasked with overseeing fuel efficiency regulations and mandates. To simultaneously reduce GHG emissions and improve air quality, it is advisable to explore more coordinated efforts involving various authorities when establishing future emissions standards. For instance, because MIIT lacks the authority to enforce compliance on vehicles already on the market, it could collaborate with MEE by sharing CO_2 approval data and enable MEE to verify vehicle performance during emissions testing (Dennis and Zhang 2022).

Finally, we find that wider stakeholder participation and strong policy communication facilitates policy implementation. According to the experts interviewed, the central government seeks expert advice through consultation with academia, research institutes, associations, and NGOs. China has also seen a gradual increase in private sector participation, especially in the EV and energy transition.

Alignment analysis of India

Consistency of policy elements

We find that the transport ambition contained in India's LTS is reflected in national strategies (see more details in Tables D-3 and D-4). The target to increase the share of the railways in freight to 45 percent echoes the language used in the National Rail Plan for India 2030 (Ministry of Railways 2022a). However, other pledges made internationally do not fully align with national programs and schemes. For example, India's NDCs do not contain any sectoral targets for the transport sector. And critical perspectives find that its NDC commitments "understate the ambition in its own national climate policies" (Gopalakrishnan 2022). It is also observed that, unlike in the European Union, where robust global goals influence domestic policies in a way that pushes them to higher standards, countries such as India tend to shape their commitments based on whether they can realistically achieve and surpass them according to their existing climate policies (Chandrasekhar 2022).

India's LTS and the National Action Plan on Climate Change explicitly mention the role of states as engines of climate action and the need to enhance their capabilities. Research on India's domestic climate policy demonstrates that the states are given a more significant role in designing policy objectives and instruments compared to other subnational governments worldwide (Jörgensen et al. 2015). Building on national e-mobility strategies and EV deployment targets, dozens of

states have EV policies in place or are in the process of formulating them (IEA n.d.). The state EV policies aim to promote manufacturing and increase EV demand, but their scope and focus areas vary (see "Country analysis" for more details). For instance, the EV policy of Andhra Pradesh concentrates on manufacturing and does not provide an EV purchase subsidy, whereas the Delhi EV policy offers private vehicle owners an incentive to purchase EVs. The heterogeneity of policies may seem detrimental to coherence, but states' varying approaches can make them laboratories of learning that can offer lessons and models for identifying which policies work best with lower regulatory costs. The experts interviewed highlight that state governments play a critical role in driving the EV transition and implementing national goals, and the central government works to get their buy-in during the early stage of policy development.

Despite the government's economic and regulatory measures aimed at encouraging the shift to e-mobility, the scale-up of e-buses faces challenges. Efforts lack adequate standardization and technical specification, capacity to manage procurement processes, and financial resources. Also, the State Road Transport Undertakings require capacity-building to help upskill personnel and prepare them to tackle challenges for transitioning from ICE buses to e-buses (CESL 2023; Vijaykumar et al. 2023). Experts interviewed repeatedly mentioned the need for innovative financing schemes to ensure large-scale access to loans or commercial financing to accelerate wider deployment of e-buses. For instance, national level guarantees to ensure timely payment could help derisk and unlock such financing. Table 22 summarizes key findings and evidence for policy consistency.

Coherence of policy process

India does not have transport-specific emissions reduction targets in its updated NDC, although it does have a national e-mobility strategy. We find that coherence in policymaking has improved. But more could be done to enhance communication and interaction between policy areas. Several ministries, departments, and expert agencies with varying interests and priorities are all involved in developing overall e-mobility policy. Experts confirm that the National Institution for Transforming India (NITI Aayog) has stepped in to play a larger coordinating role and has connected with key ministries that draft relevant EV policies and coordinate efforts to promote EV solutions. It would be ideal, however, to establish a dedicated body at the central level to manage e-mobility. Integrated planning between transport and energy sectors is absent in India, but there are ongoing synergies. "The energy sector is no longer about supply side; this goes to demand side. The mobility sector could have a bigger role in driving energy . . . and it will take some time," noted one interviewee. The growing EV penetration and variable renewable energy sources all call for a paradigm shift in how electricity systems operate, for instance, embracing opportunities for "vehicle-to-grid" solutions such as plugging in EVs and allowing their batteries to store electricity and then release it back into the national grid depending on the grid's needs and capacity.

Communication campaigns to raise awareness about EVs have been organized. For example, the Switch Delhi campaign aims to inform, encourage, and motivate Delhi residents to switch from polluting vehicles to EVs. It also informs them about the incentives and infrastructure being developed under Delhi's EV policy (Department of Transport n.d.). This helps to increase consumer trust and facilitate EV adoption.

Due to a top-down governance structure, the participation of wider stakeholder groups is limited. Nonetheless, experts interviewed mentioned that advisory groups and representatives from private sectors have helped governments formulate e-mobility and energy strategies.

Alignment analysis of Vietnam

We find a high degree of alignment between Vietnam's updated NDCs and its national climate strategies. However, due to vested interests across sectors, policy coordination remains fragmented and limited (see more details in Tables D-5 and D-6).

Consistency of policy elements

The overall ambition and targets for decarbonization in the NDCs are reflected in the country's national-level strategies. The climate targets set in its NCCS align with Vietnam's updated 2022 NDC in terms of economy-wide emissions reduction targets and its net zero goal. Vietnam's 2022 NDC includes information about the MRV system, which is regulated via government decrees. The Regulation on GHG Mitigation and Protection of the Ozone Layer under the revised Law on Environmental Protection sets sectoral targets for GHG reduction (e.g., energy, agriculture) and stipulates that different government ministries and agencies collect data and establish GHG inventories (Baker & McKenzie 2022; Nguyen et al. 2023).

Certain transport mitigation actions are repeated across the national strategies and action plans: use of clean energy vehicles, improvement of vehicle and fuel efficiency, promotion of public transport, and a shift from road to IWT for freight. The experts interviewed consider the government's international climate commitments to be a driver for transport policy development. The alignment with national strategies has also helped gain key stakeholder support in the transport sector (Bongardt et al. 2017). Nevertheless, across national strategies and action plans, we find some inconsistencies, which might limit institutional resources and support for relevant actors. For instance, the National Green Growth Strategy aims to increase the share of public transport in the modal split in class-I cities by **15** percent by 2050, whereas in MOT's Action Programme on Green Energy Transformation, it says the public transport coverage is expected to reach at least **10** percent in class-I cities by 2050.

However, Vietnam will require significant policy design and implementation across key sectors to align with its NDCs. For the transport sector, we find a lack of supporting policy instruments to achieve the strategic goals and targets. Although MOT announced the Action Programme, a comprehensive

policy package to support and implement the stated measures is not yet in place. Experts interviewed expressed the following concerns:

The Action Programme covers various modes of transport, including road, rail, IWT, maritime, and aviation transport; however, private vehicles in use are not considered. Freight is largely overlooked, although there is some mention of shifting from road to railways and IWT.

The government's analyses across transport subsectors are not rigorously aligned, including existing situations, emission projection, energy efficiency across transport modes. Other studies identified additional shortcomings in current processes for transport planning in Vietnam: demand forecast is neither comprehensive nor coordinated, meaning subsector authorities look only at their own planning without regard to the other subsectors (JICA 2021).

Importantly, for Vietnam to reach its net zero target, huge financial resources and large investments are required. This is underscored by the large difference between Vietnam's conditional (43.5 percent of emissions reduction) and unconditional (15.8 percent) goals. Thus, Vietnam's policy package needs to provide the right incentives and generate investments in low-carbon transport solutions.

Coherence of policy processes

We find policy coordination across ministries, but it is fragmented at the national-local nexus, and policy communication is not sufficient to reinforce public support for decarbonization.

Experts interviewed confirm that policy coordination and planning across the ministries, such as the Ministry of Natural Resources and Environment (MONRE), MOT, the Ministry of Planning and Investment, and the Ministry of Industry and Trade, function well. MONRE led and coordinated the NDC update process with sectoral consultations among line ministries. Experts explained that MOT prioritized transport actions based on data, modeling, and the legal framework for the transport sector to ensure effective implementation. MONRE created national emissions reduction scenarios and associated strategies based on the data provided by other ministries and on implementation costs. This ensures horizontal integration across ministries.

However, policy coordination lacks involvement of representatives from the subnational governance level. Some studies suggest that consultation between MOT and local governments needs much improvement (JICA 2021). One stakeholder also mentioned that due to the top-down policymaking process, cities must receive approval from government ministries to implement projects, and the responses are often slow.

Lastly, policy communication remains weak and needs to be strengthened. The participation of the public in policy consultation is not apparent, although some firms, including VinFast, VinBus, and the *Green and Smart Mobility Joint Stock Company*, have been increasingly involved. Most private sector firms are waiting for significant incentives from the governments (national and local) to participate in the uptake of e-mobility. Given that actions to promote awareness of EVs are positively connected with higher EV deployment, experts stressed the importance of public communication and the wider sustainability benefits of low-carbon transport (Adhikari et al. 2020; Lutsey et al. 2015).

Summary of alignment analyses

To address climate change, countries must understand how to translate international mechanisms into national strategies, how these are transformed into concrete policies, and how these policies might enable or hold back efforts to decarbonize transport in the future (Biber et al. 2017). In the section above, we analyzed the consistency of strategies and policy instruments as well as the coherence of policy processes in China, India, and Vietnam. These countries exhibit some common yet distinctive characteristics. Table 22 presents a summary of the analyses.

TABLE 22 | Summary of alignment analyses across three countries

CHARACTERISTICS	ASSESSMENT CRITERIA	CHINA	INDIA	VIETNAM
Consistency	Alignment of strategies	The climate ambition at the international level is consistent with targets in the national strategies. Certain goals reverberate across national strategic documents, but there is variation across dimensions.	The climate ambition and the national transport policies are not sufficiently linked. In alignment with the national e-mobility strategy, more than a dozen of states have drafted or announced state EV policies, experimenting with individual approaches to accelerate EV adoption, tailored to local specifics.	The climate ambition at the international level is reflected in climate and transport strategies at the national level. However, there is inconsistency between national goals and targets and the lack of comprehensive policies that would enable Vietnam to reach those goals.
	Instruments that support these strategies	Policy instruments might potentially negatively affect each other. Some analysts caution the fast deployment of NEVs at the cost of fuel efficiency of ICE fleets and the interplay might dilute the intended emissions benefits.	E-mobility is prioritized as an important strategy to decarbonize transport. State governments are using various policy instruments to incentivize a fast switch to EVs.	Currently, no comprehensive policy package supports the implementation of transport measures.
Coherence	Coordination of policy processes	There is coordination mechanism for climate governance at the national level, but interministerial coordination could be improved.	Improved policy process coherence in developing overall e-mobility policy; however, more can be done to improve communication and interaction between policy sectors.	Policy coordination across ministries functions well, except for the difference between regulations and their enforcement.
	Alignment of communication	Strong policy communication and broader stakeholder participation facilitate implementation.	Policy communication remains relatively weak.	Policy communication remains relatively weak.

Notes: EV = electric vehicle; ICE = internal combustion engine; NEV = new energy vehicle.

Source: Analysis by the authors.

The role of multistakeholder platforms in enabling change

Policies facilitating transitions to more sustainable economies empower stakeholders and increase their participation. This, in turn, contributes to more systematic policies (Bolwig et al. 2019). Given the complexity and dynamics of mobility transitions, multistakeholder platforms (MSPs) have the potential to enhance policy coherence across governance levels. As part of the NDC-TIA, MSPs in China, India, and Vietnam have facilitated the sharing of knowledge and information among representatives from different interest groups, enhanced collaboration across sectors, and informed future policymaking (see Table 23).

In **China**, to achieve the dual carbon goals, the NDC-TIA facilitates MSPs at national and provincial levels to ensure polices are crafted with streamlined communication at the national level. In Guangdong Province, the NDC-TIA supports government efforts to develop a road map for carbon peaking that aligns with China's NDCs (Dennis and Zhang 2022). In **India**, the Forum for Decarbonising Transport was launched to catalyze stakeholder engagement for more ambitious transport actions. As part of the forum, the NDC-TIA organized a series of workshops covering critical conversations around the carbon market, financing, and modeling pathways (Zhang 2022a). This encourages collaboration and coordination across actors from transport, climate, energy, and finance, thus creating synergies that facilitate sustainable, low-carbon development in India. In **Vietnam**, the Action Programme on Green Energy Transformation includes responsibilities and roles for MOT and other relevant ministries as well as provincial/local governments (Grantham Research Institute 2022). However, further plans on specific arrangements for coordinating, and guidance on how to engage key stakeholders, have yet to emerge. One expert interviewed mentioned that private companies and associations have participated in meetings and workshops organized by MOT, contributing to emissions reduction policy development. Experts also mentioned that research institutes are playing an increasing role in Vietnam's mobility landscape and supporting the implementation of sustainable transport projects. However, more can be done to support R&D, to help make EVs more affordable for consumers, and to find innovative solutions.

TABLE 23 | The role of MSPs across the three countries

EXAMPLES OF COORDINATION	CHINA	INDIA	VIETNAM
What is it?	National and provincial advisory councils	Forum for Decarbonising Transport	Stakeholder engagement process as part of the NDC-TIA
Who is involved?	Experts from national government-affiliated agencies, provincial-level public institutes (climate, transport, energy), universities, research institutes, and NGOs	State-level ministries, industries and businesses, research, and finance institutions	National government agencies (Ministry of Transport, Ministry of Planning and Investment, Ministry of Finance, and Ministry of Industry and Trade), private sector, and development organizations
Knowledge dissemination	Facilitated cross-departmental dialogues	Facilitated cross-country and cross-sectoral knowledge exchange	Small coordination meetings involving ministries were organized to deliberate e-mobility development and enhance knowledge and awareness
Government-industry collaboration	Facilitated public-private engagement	Facilitated in-depth conversations on several critical topics, such as financing, just transition, and skill development in the electric vehicle industry	Facilitated public-private engagement in various aspects, e.g., finance mechanisms for e-bus adoption and how to engage financial institutions to mobilize untapped resources
Inform policymaking	Exchanged views on provincial carbon peaking road map to support policymaking	Supported policymaking for more ambitious transport action	Supported the implementation of Vietnam's climate ambition, building GHG emission mitigation scenarios in the transport sector and developing the national e-mobility road map and fuel consumption standards for passenger cars (under nine seats) and two-wheelers

Notes: GHG = greenhouse gas; NDC-TIA = NDC Transport Initiative for Asia; NGO = nongovernmental organization.

Source: Aggregated by the authors.

5. Synthesis of findings

Based on a detailed analysis of the three countries' experiences and stakeholder interviews, this study examined the impacts of long-term target setting, barriers to transport decarbonization, and enabling conditions that would facilitate the implementation of NDCs in the transport sector. It offers original empirical insights into countries' experiences in translating ambition into action and unpacks the governance structure behind policy development. It also assembles corroborating evidence from other reports on transport decarbonization in Asia (see Box 3).

The importance of setting net zero targets as well as emissions targets for transport

Evidence from our analysis suggests that the goals of net zero or carbon neutrality have become vehicles for policy change. This is reflected in how climate pledges prompt and shape national legislation, mobilize and coordinate financial and other resources, draw attention to national climate and transport governance, and stimulate involvement from a wider range of stakeholder and subnational governments (Council for Decarbonising Transport in Asia 2022; Waisman et al. 2021) (see Box 4). This echoes similar findings from the *Path to Zero* report.

China, India, and Vietnam all have set economy-wide emissions targets in their NDCs and LTSs, however, only Vietnam has set a sectoral emissions target for transport. In these three countries, as in many others that have non-GHG targets in their NDCs, the most common transport non-GHG targets are for EV deployment, followed by vehicle efficiency improvement targets and targets to shift to more sustainable modes (see "Summary of country analyses"). Both China and India have listed transport policies, programs, and projects in their NDCs or LTSs to illustrate that they have these targets, but they do not outline transport-specific decarbonization pathways (see Box 5). Although supportive of the overall carbon neutrality goals, experts from China emphasized that each

BOX 3 | Recommended resources

THE PATH TO ZERO: A VISION FOR DECARBONISED TRANSPORT IN ASIA

It is time to transform transportation in Asia to achieve climate goals and ensure sustainable development. The report outlines the opportunities and obstacles linked to achieving zero-emission transport in Asia by midcentury. It identifies "blind spots" that are impeding progress on climate action and require focused consideration in future policy development and implementation.

TOWARDS DECARBONISING TRANSPORT 2023: A STOCKTAKE ON SECTORAL AMBITION IN THE G20

In light of India's Group of Twenty (G20) presidency in 2023, this report analyzes the current state of decarbonization and climate ambition in the transport sectors of G20 countries. It aims to contribute to global dialogues on sustainable transportation and the pursuit of the goals outlined in the Paris Agreement.

Sources: Council for Decarbonising Transport in Asia 2022; Riehle et al. 2023.

BOX 4 | How Vietnam translates climate ambition into action

Vietnam is a good example of how strong international climate targets can drive domestic discourse. Following the announcement of the net zero target at the 26th Conference of the Parties (COP26), the government established a National Steering Committee chaired by the prime minister and representatives from line ministries. The committee steered the development of key national strategies, programs, and action plans to implement its commitments, such as the National Climate Change Strategy and National Green Growth Action Plan.[a] Vietnam's Law on Environmental Protection (2020) is the most important legal document pertaining to climate change and greenhouse gas (GHG) emissions reduction. As a subset of this law, the Regulation on GHG Mitigation and Protection of the Ozone Layer was issued by the prime minister in 2022. It includes a transport-specific emissions reduction target by 2030. Adopting the net zero target within high-level policy documents ensures its long-term stability and may help advance near-term action.[b]

Vietnam submitted its updated nationally determined contribution (NDC) in 2022. As one of the few countries that revisited its NDC targets, Vietnam's 2022 edition raised both its level of ambition and the coordination of processes compared to the previous NDCs. Vietnam's NDC is considered a vital instrument for the country to communicate mitigation

BOX 4 | How Vietnam translates climate ambition into action (cont.)

and adaptation ambition.[c] It is clear from the stakeholder interviews that the NDC process has been valuable; the net zero target and other climate commitments in its NDCs impel the country to assess climate action and seek a national consensus on future development. Our findings suggest that the government has put a great deal of effort into engaging key actors to help update its NDC and align climate action. Coordination across key government actors, such as the Ministry of Natural Resources and Environment and the Ministry of Transport (MOT), has improved, and the strategic planning is more coherent than before. Experts interviewed revealed that MOT is consulted during NDC development, and it is a coordination body for implementing steps promised in the NDC related to transport.

Vietnam's updated NDC refers to the Action Programme on Green Energy Transformation and contains quantitative GHG emissions reduction targets for the transport sector. The experts interviewed expressed a lack of confidence that Vietnam was going to be able to reach its transport targets. They shared concerns that current policies are not sufficient to drive a large-scale transition and lack actionable plans and the level of detail needed to inform the implementation. Ho Chi Minh City is still at the nascent stage of e-mobility adoption. One of the fundamental barriers to streamlining implementation is the lack of standards and regulations on bus operations and charging infrastructure. Charging methods also need more standardization. The government was viewed as needing to play a pivotal role in defining these standards.

Uncertainty also surrounds the issue of finance. Vietnam needs a high level of international support, including access to climate finance and technology transfer. It is estimated that, with international support, the emissions reduction potential of electrification (cars, two-wheelers, and buses) could be 3.3 times higher than that with domestic resources.[d] The NDC Transport Initiative for Asia is currently supporting government efforts to set up the measurement, reporting, and verification system for transport; to develop an e-mobility road map; and to create a fuel consumption standard for passenger cars, along with efforts to develop new financing mechanisms (for more details, see the "Vietnam" in "Country analysis").

Sources: a. Nguyen et al. 2023; b. CAT 2021; c. Taeger 2022; d. Nguyen et al. 2023.

BOX 5 | India shows more ambition in its national policies than in its NDCs

Although the climate targets in India's nationally determined contributions (NDCs) and long-term low greenhouse gas emission development strategies (LTSs) reveal its current ambitions, they do not paint a complete picture of its decarbonization progress and developments. Previous analysis reveals that India shows more ambition in its national policies than in the NDCs or LTSs. The country's first NDC does not have an explicit sectoral emissions target for transport, and its updated first NDC submitted in 2022 does not mention any sectoral actions. Nevertheless, India amended its Electricity Conservation Bill following the submission of the revised NDC, requesting greater use of renewable energy and setting up its domestic carbon market.[a] It has also made great strides in accelerating e-mobility deployment at the national and state level. An analysis by the Climate Action Tracker finds that India will likely overachieve its conditional NDC target of 50 percent nonfossil fuel capacity by 2030.[b] According to the latest modeling by the Central Electricity Authority, a statutory body under the Ministry of Power, as of March 2022 India had reached a 41 percent share of nonfossil fuel capacity with 416 gigawatts, including hydropower, nuclear, and renewable energy sources.[c]

Similar observations can be made in other countries. A recent stocktake on transport decarbonization in Group of Twenty countries reveals that they show more ambition in their national policy than stated in their NDCs.[d] Looking at climate actions in Asia, research finds that 17 out of 33 updated Asian NDCs include actions on electrification, yet these same countries have more electric vehicle (EV) targets in their national policy documents. And countries that do not include electrification in their NDCs have EV targets as well.[e]

Sources: a. Rajeev 2022; b. CAT 2023; c. CEA 2023; d. Riehle et al. 2023; e. ADB 2022b.

sector has its own trajectory to make deep cuts in emissions, and a sector-specific pathway is important. They also mentioned that the peak time for different sectors might vary, and emissions from the transport sector might peak later than the industry and construction sectors.

Ambitious government leadership is necessary

A shift to low-carbon, sustainable transport systems needs to be supported by market-based solutions. Still, the scale and speed required are only possible with carefully designed and integrated government interventions. Experts outline that governments at the national and subnational levels all play a pivotal role in setting a long-term development vision, defining mobility transition road maps, establishing standards, and providing guidance and necessary infrastructure.

Stakeholders say that another important way for governments to lead and be key enablers for decarbonization pathways is to send consistent policy signals at all levels of government. There is consensus that vehicle electrification is, by far, one of the most important and effective strategies to decarbonize transport, and companies are willing to respond where the policies are the strongest. In contrast, where clear policies are lacking, vehicle manufacturers and operators often are hesitant to make low-carbon investment decisions. Stakeholders interviewed say that although big companies are at the frontline of the transformation, smaller companies often lack the resources, knowledge, or agency to pursue emissions reduction opportunities without wider incentives or support. One stakeholder from Vietnam noted that road maps are developed but provide limited guidance on how fleets should be decarbonized.

An equitable net zero transition needs to be on the radar

The concept of a just and equitable transition was rarely articulated during the interviews. A few stakeholders raised equity issues, such as providing affordable EVs for lower-income groups, creating new local jobs in the EV supply chain, improving the accessibility and quality of public transport, and considering the broader sustainability benefits of low-carbon transport, such as improved air quality. The literature review reveals that the three countries, in general, have made high-level commitments to gender equality and targets to increase the representation of women in leadership roles; however, there is a lack of explicit connections made between transport decarbonization and gender (Interesse and Zhou 2022; Linh 2021).

Besides, despite being a critical element of urban mobility, informal public transport is all but missing from climate discussions and commitments (Kustar et al. 2022). Safe access for vulnerable groups (e.g., women and children) is a more apparent problem in countries such as **India** because residents rely more on informal transport. Drivers often compete for passengers in informal transport systems, increasing the risk of speeding and accidents. In India, speeding accounted for 56 percent of traffic fatalities in 2021, and 2Ws accounted for the highest proportion of the total deaths, with 44.5 percent (Jadhav 2022).

Questions and barriers around new technologies need to be addressed

Technologies such as electric and hydrogen fuel cells are commercially available for road vehicles. For passenger vehicles, strides in battery technology have improved performance, and economies of scale have reduced costs. However, adoption at scale depends on further innovation and lower costs. For HDVs, interviewees recognize the benefits of electrifying the fleet, but they acknowledge challenges that need to be overcome, including high overall daily energy storage needs, heavy loads over long distances, and the need for high-speed charging along routes. The ICCT's analysis suggests that all battery-electric trucks in **China** can achieve total cost of ownership parity with diesel trucks in the second half of this decade (Mao et al. 2021a). Although China has become the global leader for HDVs, boasting a thriving manufacturing sector with substantial demand, other emerging markets are not as prepared to embrace ZEV technology for long-distance HDV operations. This is primarily because they lack the necessary regulatory framework, financing mechanisms, or technical knowledge (Mao and Rodriguez 2022).

Stakeholders say that another important way for governments to lead and be key enablers for decarbonization pathways is to send consistent policy signals at all levels of government.

FCV technology lags BEV, in maturity and scale of adoption, in part because costs have remained high. FCV is available for LDVs. Although the installed capacity to produce hydrogen with electrolyzers and the number of projects has grown significantly in the past decade, the production of renewable-based hydrogen remains low (REN21 and FIA Foundation 2020). A few interviewees are either agnostic or skeptical of hydrogen in freight transport as a near-term option. Its value chain comprises a range of technologies needed to produce, transport, store, and consume, each at a different stage of maturity (IEA 2021a). Furthermore, there are other drawbacks, including the amount of renewable electricity generation capacity needed to make "green" hydrogen, the high propensity of hydrogen gas leaks, and current production costs.

Finance should not block decarbonization

Given the immense price tag to decarbonize transport, a key message from the stakeholders is that public investments are essential, and more investment is needed than what has been promised. This transition requires considerable investment from both the public and private sectors. To limit global warming to 1.5°C, the IPCC estimated that mitigation investment flows into transport need to rise to seven times the current level (IPCC 2023). Under the UNFCCC framework, the GCF is planning to use US$200 million to leverage US$1.3 billion from the private sector—in both equity and loans—to support EV owners and operators in **India** (GCF 2022). The GCF is also leveraging its own funds for public finance in **China's** Shandong Province to support transport initiatives (GCF 2019).

Stakeholders from **Vietnam** highlighted the need for better access to finance and a more predictable enabling environment, which would allow the private sector to play a more prominent role in delivering solutions. Government agencies, especially those responsible for mobilizing finances and allocating funds, should create a fertile investment environment to attract the necessary private capital. One stakeholder noted that every financial channel is important for a country with limited public resources.

Freight is receiving growing attention

Despite the need and potential for freight transport to make deep emissions cuts, this sector has often been under the radar of public authorities, who have historically paid more attention to passenger transport. Freight is highlighted in the three countries' NDCs, LTSs, and other high-level national policy documents. All three countries have emphasized a mode shift from road transport to lower-carbon modes (railways and

waterways), promoting multimodal transport with logistics hubs, and improving operational efficiency as key strategies to achieve decarbonization of the sector (Box 6).

Linkage with the energy sector should be considered

The linkage between transport decarbonization and grid decarbonization was frequently mentioned in interviews. One barrier to progress is that the energy and transport sectors are continuing to work in silos (REN21 and FIA Foundation 2020). Interviewed stakeholders from **China** revealed that collaboration between transport and energy industries is difficult because relevant government agencies and business groups often represent disparate interests. Stakeholders also highlighted the role of state-owned utility companies in supporting the collaborative processes across sectors, for instance, in planning the development of charging and refueling stations.

Before more e-buses are introduced, governments need to carefully plan charging infrastructure and determine the power requirements for charging stations by considering the limitations of local power grids (Li et al. 2019). Stakeholders from **Vietnam** said that a lack of thorough planning limits the ability to determine when and how electric buses can be added, where the depots should be situated, and how the electricity grid will need to upgrade to power e-bus fleets. Other stakeholders cite the complexity of energy systems that are tailored to specific uses and local circumstances, such as those serving urban or rural areas. In addition, policymakers, particularly at the local level, need more understanding about the options for renewables in transport and the benefits of linking them.

BOX 6 | Freight is no longer an afterthought in India

To decarbonize freight, India's government is working on a few building blocks, including shifting to rail, increasing logistics efficiency, and deploying clean vehicles.

At the 27th Conference of the Parties (COP27) in November 2022, India submitted its long-term low greenhouse gas emission development strategy (LTS), which states that India's railways will reach net zero carbon emissions by 2030 and sets a target of increasing the modal share of railways in freight to 45 percent from the current 27 percent.[a] To reach the target, the government is working to electrify its rail network by December 2023, and much progress has been made. As of March 2023, over 90 percent of India's broad-gauge railway network has been electrified.[b] Steps that can help rail increase its share of freight traffic include expanding capacity and enhancing intermodal transportation to ensure freight moves everywhere it needs to go. India has invested in dedicated freight corridors (i.e., long distance, high-capacity freight rail routes). The Efficiency Enhancement Program promotes multimodal logistics parks and digital solutions to improve logistics efficiency.[c] India has additional initiatives aimed at developing inland waterways and improving existing ports, such as the Sagarmala and the Jal Marg Vikas projects.

Studies find that the operational efficiency of the truck fleet in India is 40–50 percent lower than the global average, and the empty running rates are as high as 40 percent, which raises costs and emissions.[d] Recognizing these challenges, India launched the National Logistics Policy in September 2022. It aims to reduce India's logistics costs from about 13–14 percent of the gross domestic product to around 8 percent in the next five years and to create a data-driven decision support system to improve logistics efficiency.[e]

The adoption of electric freight vehicles (e.g., electric three- and four-wheeler freight vehicles and trucks) is still at a nascent stage but is evolving, with vehicle manufacturers and charging service providers emerging across 20 states in India. However, these efforts lack cohesive national/state policies, standardization, and financing, and they receive limited information on transition pathways. The National Institution for Transforming India (NITI Aayog) has launched the e-Freight Platform to accelerate the transition to electric freight.[f]

Sources: a. Government of India 2022b; b. CORE 2023; c, d. NITI Aayog et al. 2021; e. MOCI 2022; f. Mulukutla et al. 2023.

6. Opportunities for enhancing transport ambition

The first Global Stocktake, concluding at COP28 in December 2023, assesses how much global progress has been made in cutting GHG emissions and building resilience and evaluates where more work is necessary to accelerate climate action (Srouji and Cogan 2023). The next round of NDCs is due in 2025, and the Global Stocktake should inform countries in updating NDCs, helping them increase their ambition. The updated NDCs will set emissions reduction targets for 2035 (see Figure 12).

China, India, and Vietnam each pursue different approaches to decarbonizing transport and enhancing climate actions. Although there is no "one-size-fits-all" approach, several areas are key to a country's transformation to zero-emission transport. Drawing on their lessons of strengthening and implementing their NDCs, this report identified promising opportunities to enhance transport ambition and implement the policies needed to reach the NDC goals in the transport sector.

Align long-term climate vision with short-term actions in the transport sector

As countries announce their net zero goals, it will be critical to align these long-term targets with medium- and short-term actions. Long-term targets provide strong, clear political signals. Enshrining these long-term goals in national law or high-level policy documents enhances the country's ability to reach these targets, despite potential political change (Elliott et al. 2023). When guided by a comprehensive long-term approach, well-designed short- and medium-term policy mixes can help scale up innovative technologies (electrification, fuel cell, autonomous driving, etc.) and deploy mobility solutions (MaaS, urban consolidation centers, etc.) that may be needed in the future.

As the next round of NDCs approaches, countries have the chance to further explore and experiment with alignment in 2025 and beyond. For countries like **India**, which show more ambition in their national policies than stated in their NDCs, harmonizing their NDCs with their policies would offer many potential benefits. Contextualizing, integrating, and aligning NDCs within a wider national framework of policies and funding strategies could increase stakeholder buy-in and accountability and tap the potential of climate finance (Bongardt et al. 2017; Fransen et al. 2019). In **Vietnam**, aligning the country's NDC with national strategies and action plans (e.g., climate change, green growth) has gained key stakeholder support (e.g., line ministries) and led to the promotion of climate change responses. In addition, it is helpful to outline clear, detailed strategies in NDCs. Including sectoral targets in the NDCs can attract more targeted international climate finance and send stronger political signals to investors in general. The alignment can be achieved through common target setting (economy-wide, GHG targets, and sectoral targets), coordinated governance processes, and joint systems for monitoring and assessing progress (Falduto and Rocha 2020; Levin and Fransen 2019). For instance, regular data collection processes and high-quality transport data sharing at the national level will increase the scope of transport measures in NDCs and inform evidence-based policymaking.

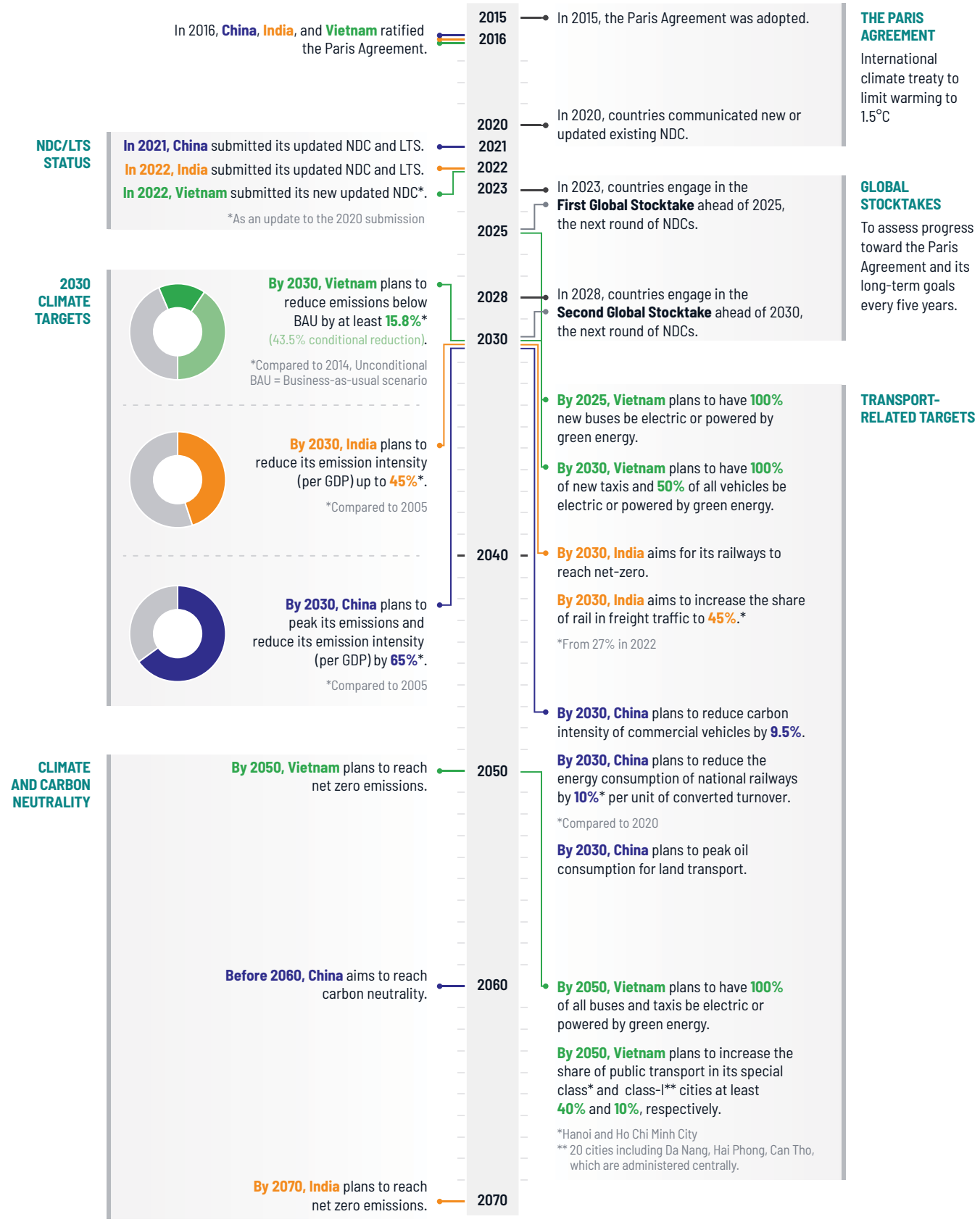
Ensure transport decarbonization is not managed in isolation from other sectors and related policies

Countries can help to ensure that transport decarbonization is not managed in isolation from other sectors and related policies by reaching to other issues such as climate change equity, health, job creation, and industrial development. This highlights the need for a multidisciplinary approach and integrated planning. Identifying or establishing a leading agency can be instrumental in ensuring consistent strategic planning and financing. **China's** Leading Group on Carbon Peaking and Carbon Neutrality provides a formal coordination mechanism. Agencies such as **India's** NITI Aayog have played an instrumental role in connecting with ministries and coordinating efforts to advance e-mobility.

Across the countries studies, transport ministries need to be more strongly engaged in formulating and executing climate policy. These ministries should be involved early in the process of developing NDCs, considering transport policies, collecting relevant data, and putting forward transport-specific targets based on an assessment of mitigation potentials and consistent emissions accounting methodology (Bongardt et al. 2017). In **Vietnam**, a clear process for translating climate commitments into action plans has enhanced collaboration across ministries

As countries announce their net zero goals, it will be critical to align these long-term targets with medium- and short-term actions. Long-term targets provide strong, clear political signals.

FIGURE 12 | The three case countries' progress to enhance ambition



Notes: BAU = business as usual; GDP = gross domestic product; LTS = long-term low GHG emission development strategy; NDC = nationally determined contribution.

Sources: CAT 2022; Climate Watch 2021a, 2021b; Government of India 2022b; Government of Vietnam 2022; MEE 2022; aggregated by authors.

(e.g., ministries of environment, transport, finance). Based on high-level government decrees and regulations, MOT is assigned to coordinate NDC implementation in transport.

Subnational governments also need support. They must have the capacity—financial and other resources as well as information such as guidelines—to design policies that respond to local context. In **India**, the central government has set clear EV deployment targets complemented by supporting mechanisms (such as national subsidies under the FAME schemes), and state governments have played a key role in accelerating the adoption of EVs with state-specific policies and measures.

Leverage multistakeholder platforms for transport to enable change

The active engagement and effective cooperation of broader stakeholder groups can be vital. Groups outside of government can make essential contributions to transport policymaking and implementation that enable change (see "The role of multistakeholder platforms in enabling change"). A comprehensive, inclusive process involving diverse stakeholders will require time and additional costs, but it can ensure buy-in and effective execution. National and subnational MSPs, such as India's Forum for Decarbonising Transport established under the NDC-TIA, bring together public authorities from the transport, climate, and energy sectors; businesses; manufacturers; service providers; and researchers. They facilitate knowledge- and information-sharing across sectors, enhancing public-private collaboration, identifying tangible solutions for decarbonizing transport, and informing future policymaking.

Because of the close linkage between the transport and energy sectors, governments must create space for collaboration and provide frameworks to capture synergies between them. As e-mobility becomes increasingly widespread, EV grid integration is one of the low-hanging fruits where challenges and synergies should be addressed. Technical modeling of renewable-based EV charging, formal and enhanced training, and a joint narrative emphasizing the cobenefits from both sectors would benefit the transport and renewable energy communities (REN21 and FIA Foundation 2020). There are signs of movement toward renewable energy across the case countries, but uncertainty remains over coal power capacity. **China** and **India** have the largest coal pipeline globally, but they have committed to ramping up wind and solar power and expanding energy storage. **Vietnam's** recently announced PDP8 has set targets to reduce coal-fired power generation (from 38 percent in 2022 to 20 percent in 2030) and to increase solar and wind power (from 13 percent to 27 percent) (Energy Institute 2023).

Focus on an equitable and just transition

Considering equity in planning transport infrastructure and services is vital not only for decarbonizing transport but also for creating a more inclusive transport system, economy, and society for all. It includes understanding women's mobility needs and incorporating women's representation at every phase of transport planning and implementation (Kanuri 2023). As EV deployment drastically changes the automotive value chain, gender-inclusive policy interventions to engage women should be crafted, from appropriate upskill development to education and providing employment opportunities for women (WRI India 2022) (see Box 7).

Furthermore, many developing countries have informal public transport (e.g., private buses, auto-rickshaws, motorcycle taxis), providing access to services and markets and creating jobs for lower-income groups. To promote inclusivity in the EV transition, efforts must be made to address the informal or semi-informal sector, where relevant, to enable a broader, more equitable transition.

BOX 7 | How India and China are incorporating a gender and equity lens into transport decarbonization

As in many countries, the transportation and automotive industries are male dominated. In **India**, women's labor force participation ranges from 5 percent to 10 percent.[a] Some gender-inclusive measures to enhance women's representation have been put into action in several states and cities. A noteworthy example is in Mumbai, where two metro stations are exclusively managed by women. Additionally, when it comes to procuring e-buses in India, tenders now require a 25 percent participation rate from women in roles such as drivers and depot staff.[b] Despite these steps, more can and should be done to promote greater equity in the long run.

China is taking some steps to make transport development more equitable, including constructing barrier-free facilities for people with reduced mobility.[c] In Guangdong, disparities between cities are glaring (in terms of gross domestic product, new energy vehicle adoption, motorization rate, financial resources). A recent WRI China analysis suggests that the provincial government should take decarbonization measures for leading cities, such as Shenzhen and Guangzhou, as well as other less-developed cities that are context specific.[d] In the near term (before 2030), in Shenzhen and Guangzhou, accelerated adoption of electric heavy-duty vehicles offers the greatest emissions reduction potential; in other cities in the Pearl River Delta region, promoting urban metro/bus rapid transit systems should be prioritized given their decarbonization potential.[e]

Sources: a. Philip 2018; b. Kanuri 2023; c. Chen 2023; d, e. Miao et al. 2023.

Transport decarbonization requires a systematic approach

Globally, more countries are committing to e-mobility *(improve)* in their NDCs or LTSs. However, other transport mitigation actions, such as mode *shift* to public transport and active mobility, transport demand management (*avoid*), supportive land use, and freight transport, are lacking. Growing evidence shows that *avoid* and *shift* strategies could account for 40–60 percent of transport emissions reductions—and at lower costs than *improve* strategies (SLOCAT 2021; Venter et al. 2019). To make progress on *avoid* and *shift* measures, policymakers need to provide diverse mobility options and nudge people's behavior away from car-centric travel modes.

Deep GHG mitigation in the transport sector requires system-wide change. Policies should therefore consider cobenefits, cost-effectiveness, political acceptability, and transformative potential (Axsen et al. 2020). A multimodal integration, such as integrating active mobility and public, informal, and personal transport, would allow for seamless travel. Integrated land-use planning, in tandem with public transport infrastructure and mixed-used and compact development, will help reduce urban sprawl, favor shorter trips, and encourage shifts away from private vehicles. Previous country analyses find that in the **three countries** studied, urban planning and transport planning are not always integrated due to insufficient coordination between transport and land-use planning agencies. Nevertheless, successful examples are emerging where some neighborhoods located near BRT and metro stops in Guangzhou, **China**, are well integrated into the urban fabric (Oval Partnership 2021). In addition, China

has introduced the Sustainable Urban Mobility Plan concept in Foshan with the aim of integrating transport planning and urban development.

Cities should employ a people-centered approach to urban planning, and the public budget should be prioritized for high-quality, sustainable infrastructure. The mobility needs of vulnerable groups, including children, women, the elderly, and people with reduced mobility, must be considered. Moreover, governments should take a holistic approach to addressing passenger and freight transport. This means ensuring that policies, infrastructure, business models, and energy sources serve both modes. The need to have adequate infrastructure to move freight must be addressed, along with other measures to promote the shift to less carbon-intensive modes such as rail and IWT.

Craft an integrated, comprehensive policy mix for e-mobility

Policymakers could drive faster transport decarbonization by translating national strategies into integrated, comprehensive policies. Publicizing the wider sustainability benefits of e-mobility and shifting to less carbon-intensive modes of transport (e.g., improved air quality, reduced congestion) might improve political acceptability or cost-effectiveness of the policy mix.

A myriad of instruments can also influence various stages of uptake and investment in e-mobility and charging infrastructure. These instruments can be economic (subsidies, registration rebates, taxes), regulatory (CO_2 standards, zero-emission zones, phaseout of ICE vehicles), and informational (marketing, communication). When the EV market is in its infancy, fiscal subsidies play a significant role in scaling

them up. As the market grows, new taxes on ICE vehicles to pay for long-term incentives for EVs offer a long-term path forward. Both fuel consumption standards and ZEV mandates are essential and effective in reducing GHG emissions while sending a positive signal to switch to EVs and guaranteeing their supply (see Box 8). Further, if designed well, other measures such as low- and zero-emission zones and pricing mechanisms play a complementary role in countries' policies. In **India**, a recent analysis by WRI reveals that, to decarbonize road freight, governments need to provide policy support, institute production-linked subsidies, and develop viable business models to enable smaller fleet owners and operators to electrify their freight vehicles (Mulukutla et al. 2023). For **Vietnam**, governments need comprehensive policy packages that provide the right incentives and generate investments, all while sketching a technological path toward a low-carbon economy.

Communication is another central element in facilitating systems change. Awareness-raising campaigns about EVs could increase consumer trust and lead to broader EV deployment.

Support sustainable financing for low-carbon, sustainable transport

Because substantial investments are needed to transition to low-carbon transport, all financing channels must be leveraged and directed away from fossil fuels. Fossil fuel subsidies disrupt the market and send wrong price signals to consumers and investors; eliminating such subsidies will help make sustainable transport solutions more competitive to households and businesses (Council for Decarbonising Transport in Asia 2022).

Governments can facilitate investment in sustainable infrastructure, such as public transport networks and high-quality walking and cycling lanes, to prevent the lock-in of carbon-intensive pathways. Many developing countries aim to construct expensive metro systems or urban rail, so it is essential to ensure the sustainability of the financing model. Innovative strategies for financing should be considered. These may include land value capture strategies, such as development fees and property taxes, a change in procurement models to limit capital investment by cities, public-private partnerships, pricing revenues from car use, and fuel taxes (SuM4All 2022).

Lack of financing is one of the critical barriers to EV adoption in many emerging economies. Innovative financing schemes and business models explicitly designed to address and distribute risks among key actors and expand access can spur deployment (see Box 9). This requires coordinated efforts from the public sector, original equipment manufacturers (OEMs), fleet operators, financial institutions, and multilaterals. Governments should enact favorable policies to help mobilize finance and provide public-backed loans in the near term and allocate grants to R&D to facilitate technological breakthroughs. Mechanisms such as leasing for batteries and/or vehicles and "as-a-service" models add flexibility and mitigate consumer and fleet operator ownership risks. OEMs may also leverage green bonds. And international financial institutions could support governments with financial and technical assistance.

Lastly, market mechanisms such as carbon pricing have untapped potential and can be effective in promoting implementation of low-cost emissions reductions (IPCC 2022). Carbon taxes can tilt the private relative profitability of opting for EVs over ICE vehicles. **China** has a national emissions trading scheme and is piloting regional carbon markets, which include specific transport segments such as buses, metro, and freight (Chen 2023).

BOX 8 | A sustained policy portfolio has driven China's e-mobility journey

After a decade-long effort, China has become the world's largest producer and consumer of electric vehicles (EVs) and batteries and hosts the largest public and private EV charging infrastructure network (see "China" in "Country analysis").[a] Its rapid acceleration of passenger vehicle electrification can be attributed to a combination of factors and its ability to harness the synergies between them. These include an articulated vision that aligns industry, social, and environmental goals; a top-down approach with clear targets and policies; a viable business model where all stakeholders (governments, manufacturers, charging service providers) collaborate to share risks; national subsidy programs to initiate and grow the market; and a mix of regulations, including a zero-emission vehicle mandate and license plate registration.[b] China's experience has demonstrated how policy instruments need to pivot throughout the EV deployment course. In the initial stage, purchase subsidies played a significant role in driving the market. As the vehicle technology and market matured, the subsidies were phased down five times while technical requirements for vehicles were tightened.[c]

In piloting China's mass rollout of e-buses, subnational governments and their innovative procurement practices have played a critical role. The whole-vehicle leasing model introduced by the bus operator in Shenzhen converted high initial procurement costs into more manageable annual lease payments.[d]

To sustain its e-mobility success, China will need to adjust its regulatory and market-driven approaches. Changes should include strengthening new energy vehicle regulations and complementing vehicle fuel efficiency standards with enforceable greenhouse gas emissions standards.[e] China also needs to further improve its technology and research to address bottlenecks in the supply chain and increasing demand for charging or battery swapping infrastructure. The decarbonization of heavy-duty vehicles remains a focus area that requires a combination of incentives, fuel consumption and emissions standards, and technological advances to make it a viable solution.

Sources: a. Chu et al. 2023; b. Chen et al. 2021; c. Jin et al. 2023; d. Chen et al. 2021; e. Jin et al. 2021a.

BOX 9 | How an aggregated demand model helps India significantly reduce e-bus procurement costs

The second phase of the Faster Adoption and Manufacturing of (Hybrid and) Electric Vehicles (FAME II) scheme was announced with a target to deploy 7,000 e-buses for a period of three years. In April 2022, National Institution for Transforming India (NITI Aayog) and Convergence Energy Services Limited concluded the tender of 5,450 e-buses across five Indian cities through the "Grand Challenge" process.[a] By aggregating demand across cities and combining their purchasing power, cities are able to secure record low prices, and the difference could be up to 48 percent lower than other bids.[b] Through the economies of scale, the costs of e-buses are 31–35 percent lower than the current cost of diesel/compressed natural gas buses with the FAME II national subsidy.[c] A few other factors, such as standard technical and contractual terms across cities and longer concession periods, also contributed to the cost reduction. Likewise, the certainty in the payment timeline—by using a national-level payment mechanism—helps derisk financing and improve the bankability of contracts.[d]

Based on the lessons learned, the government now seeks to deploy 50,000 e-buses by 2030. More recently, the India–United States e-bus partnership aims to deploy 10,000 e-buses in India and provides payment guarantees that will alleviate financier liquidity concerns.[e]

Sources: a. CESL 2023; b. Sustainable Bus 2023; c. CESL 2023; Vijaykumar et al. 2023; d. CESL 2023; e. Mookherjee 2023.

Appendices

APPENDIX A. INTERVIEW QUESTIONS

Purpose

The interviews serve as the major source for understanding how countries produced their transport-related commitments in the updated NDCs, their approaches to implementing transport decarbonization strategies, and the enabling factors that facilitated their development. Through the interviews, we seek to understand which issues experts consider most important and the actions they deem urgent to achieve a decarbonized transport future.

The following questions were meant to serve as a guide to enable a semistructured interview. They were adapted as appropriate depending on the experts' expertise and experience. Questions were also modified for different countries as we gained insights into country-specific opportunities and challenges.

Section 1: Broad questions

- Can you describe your current role?
- Have you been involved in the development of the first and/or updated NDC? If yes, which one and how?
- How are the NDCs and long-term climate commitments under the UNFCCC translated to national policy in your country?
- What developments, discussions, or decisions led to the creation of a transport decarbonization strategy in your country? What drives the decarbonization strategy for transport (e.g., economic development, climate targets, air quality)?

Section 2: The impact of carbon neutrality/net zero target setting

- In your opinion, how has your country's net zero/carbon neutrality target setting affected climate targets and policymaking in the transport sector?
- Does the updated NDC affect the transport strategy in your country?
  - If yes, can you explain how?
  - If no, can you explain why?
- How is the updated NDC aligned with other national plans and policies relevant for transportation in your country?
- In your opinion, is your country on track to achieve the targets in the transport sector?
  - If yes, what makes you think so?
  - If no, can you describe why this may be the case?
- Are there any institutional arrangements to enhance coordination (sectors, other processes, national development, etc.), planning, and implementation?
  - If yes, can you describe the coordination process? Any evidence of vertical coordination (national to local)? Any evidence of horizontal coordination (across sectors and ministries)?

- Beyond governments, are there any other stakeholders (private sectors, civil society, and NGOs) engaged in policymaking and implementation related to transport decarbonization?
  - If yes, can you describe which stakeholders are engaged, such as utilities (electricity, gas etc.), transport operators, financial services, research institutes/academia/universities, transport associations, and citizens? Also, which mechanisms are used to engage these stakeholders (e.g., consultation, multimedia communication strategy to inform the public and stakeholders on the policymaking process, open access to policy documents, codrafting and partnership, official public hearings, and discussions)?
- Are measures in place to ensure gender-balanced decision-making processes for transport policies? Are there plans to integrate gender into the design of transport policies? Specify details of measures or plans, if available.

Section 3: Assessing transport decarbonization strategies

- In your opinion, what are some of the major challenges for the implementation of transport decarbonization strategies in your country?
  - **Lack of access to technology** (specify details of technology if available). Which vehicle technologies and driving technologies are most important for transport decarbonization? What opportunities and risks do you see for different modes of transport/for fuel supply and infrastructure? How to mitigate the risks?
  - **Lack of financial resources** (specify financial details if available). Where is funding currently coming from to support transport decarbonization (e.g., international sources, private sector, and development banks)? How can the private sector be incentivized to support implementation? What policies and measures are already in place to facilitate private sector investment? How can they be strengthened?
  - **Lack of institutional coordination/a split in mandates** (specify details if available)
  - **Lack of capacity** (specify whose capacity and what kind, if possible). What are the capacity needs for implementing the strategies? What would the support look like? What is already being done to build capacity?
  - **Other barriers** (list any other barriers not included above, such as lack of data to inform and monitor actions, lack of international coordination, insufficient speed of industry in responding to needed innovations and new technologies). Which data is being collected and analyzed to inform the development and implementation of transport actions and measurement of their achievements? How is data shared between relevant actors? Which access restrictions are in place for the data?
- In your opinion, is the transformation of the transport sector driven by new technology or behavior change? Please specify.
- Looking at the uptake of EVs and charging infrastructure development, which political decisions/policy instruments/regulations have provided an impetus?
  - **Regulations:** Carbon tax/fuel pricing, fuel economy standards/CO_2 standards, phaseout of ICE vehicles, zero-emission zones, parking management
  - **Incentives:** Financial support for EVs (e.g., purchase subsidy, registration rebate, tax credits), public procurement focusing on low-emissions solutions
  - **Information:** Public awareness campaigns, stakeholder engagement with private sector
- From the policy instruments or policies above, where do you see the greatest potential for upscaling and/or replication in Asian countries?
- Transport decarbonization is linked to grid decarbonization. What synergies exist between mobility transition and energy transition in your country? What are the challenges to combine them?
- Did you consider the implications on the grid that EV adoption might have? Are load distributions and the grid impact of integration being considered during the process of planning, implementing, and so forth? Have you been discussing with utility companies at the planning stage? Which developments in other sectors are required to enable the implementation of transport decarbonization strategies?
- Do you have any topics or remarks that have not yet been mentioned above and that you would like to share with us?

APPENDIX B. LIST OF EXPERTS INTERVIEWED

The authors conducted a total of 17 semistructured interviews with 17 experts and officials involved in the NDC development process and climate and transport policymaking for the three countries. The following number of interviews were conducted for each country and the region: 6 interviews for China, 5 for India, 5 for Vietnam, and 1 for the Asia region. Most of the interviews were conducted online. The following lists the experts interviewed by name (when available), relevant position and organization, and date of interview. Experts who preferred to remain anonymous—based on requests for anonymity made by the experts through informed consent forms—are listed only by their position and organization.

China

- Former employee, National Center for Climate Change Strategy and International Cooperation, November 2, 2022
- Shi Hong, Senior Engineer, China Automotive Technology and Research Center, November 28, 2022
- Guo Jie, Director, China Academy of Transportation Sciences, MOT, November 28, 2022
- Ou Xunming, Professor, Tsinghua University, member of the Council for Decarbonising Transport in Asia, November 29, 2022
- Chief Engineer, China Automotive Technology and Research Center, November 30, 2022
- Liu Ran, Director, China Federation of Logistics & Purchasing, December 1, 2022

India

- Manish Chourasia, Managing Director, Tata Cleantech Capital Limited, February 28, 2023
- Ekta Agrawal, Assistant Director, Directorate General of Civil Aviation, March 2, 2023
- Dr. Rahul Walawalkar, President and Managing Director, Customized Energy Solutions, March 6, 2023
- Mahua Acharya, the outgoing Managing Director and Chief Executive Officer, CESL, March 14, 2023
- Sudhendu J. Sinha, Adviser, Infrastructure Connectivity & Electric Mobility vertical, NITI Aayog, March 21, 2023

Vietnam

- Tran Minh Hue, Science Technology, Education and Environment Department, Ministry of Planning, and Investment, November 25,2022
- Tran Anh Duong, Deputy Director General, Science Technology and Environment Department, MOT, December 14, 2022
- Nguyen Trung Hieu, Head of Technical Sub-Committee, Vietnamese Association of Automobile Manufacturers, December 8, 2022
- Nguyen Cong Nhat, Public Transport/Sustainable Transport Expert, February 9, 2023
- Dr. Vu Anh Tuan, Director, Vietnamese-German Transport Research Centre, December 16, 2022

Other experts interviewed

- Tsu-Jui Cheng, Assistant Professor, Department of Transportation and Communication Management Science, National Cheng Kung University, February 22, 2023

APPENDIX C. NATIONAL GOVERNMENT AGENCIES AND KEY POLICIES

Please find below a list of national government agencies for climate change and transport as well as key sustainable transport policies across three countries.

TABLE C-1 | List of national government agencies involved in transport carbon peaking in China

GOVERNMENT AGENCIES	FUNCTION
National Development and Reform Commission	• Operation of the leading group office for carbon peaking and carbon neutralization • Energy conservation–related work of the national leading group for climate change and energy conservation and emissions reduction • Improvement of preferential policies on electricity tariffs • Approval of policies and related promotion policies for the construction of gas refueling stations and charging stations • Policies related to rail and waterway freight fees in the optimization of the transport structure • Promotion of policies for green travel in the later part of the 14th Five-Year Plan (FYP)
Ministry of Ecology and Environment	• Subsidy policies on the obsolescence of old vehicles; approval and fiscal subsidy policies on the construction of gas filling stations • Inclusion of railroad dedicated line construction into the scope of national green development fund support • Incentive and supervision policy for enterprise transport restructuring as well as other related duties
Ministry of Transport	• Policies related to fuel consumption limit standards for operating vehicles • Right-of-way facilitation and parking guarantees for new energy vehicles • Policies on the approval and financial subsidies for the construction of gas refueling stations and charging stations • Promotion of policies on the application of fuel cell technology in the transport sector • Green travel in the 14th FYP and continuation of the 13th FYP vehicle purchase tax funding support • Policies on railway construction for collecting and distributing ports
Ministry of Industry and Information Technology	• Fuel consumption limit standards for new vehicles; dual credit policy for new energy vehicles; and fuel consumption limit standards for natural gas vehicles ex-factory • Standardization of specifications for the repair and maintenance of natural gas vehicles and other related duties
Ministry of Finance	• Financial subsidies related to the phasing out of old vehicles • Promotion and application of new energy vehicles • Construction of refueling stations and charging stations • Fuel cell core technology research and development • Bulk cargo concerning transport restructuring in the mandatory "shift from road transport to railway" • Dedicated railroad line construction for logistics parks and industrial and mining enterprises
Ministry of Housing and Urban-Rural Development	• Approval and fiscal subsidy policies on the construction of gas filling stations, charging stations, and battery swapping stations
Ministry of Science and Technology	• Promotion policies on core vehicle technology and research and development, for example, fuel cell technology

Source: X. Li et al. 2022.

TABLE C-2 | List of key sustainable transport policies in China

LEGAL AND POLICY DOCUMENTS	YEAR ISSUED	CONTENT RELATED TO SUSTAINABLE, LOW-CARBON TRANSPORT
National Road Network Plan	2022	• As part of its plan to sustain a modern economic system, China aims to modernize its national road network with a total length of 461,000 kilometers (km) by 2035 and have it be integrated with advanced information networks, ecological civilization, and national security by 2050. • To achieve this, China will optimize the road network layout, continue expanding expressways and highways, and streamline the "province-city-and-country" connection while considering environmental impacts.
Medium- and Long-Term Plan for the Development of Hydrogen Energy Industry (2021–35)	2022	• The policy outlines China's approach for wider hydrogen energy adoption, focusing on core technology development, demonstration applications, and the production of renewable hydrogen and fuel cell vehicles. • More specifically, it aims to produce 100,000–200,000 tonnes of hydrogen from renewable energy sources per year and have 50,000 fuel cell vehicles on the road by 2025.
14th Five-Year Plan for the Development of Modern Comprehensive Transportation System	2022	• The plan provides guidance for China to embrace an integrated, comprehensive development of transportation by 2025 and complete the transition by 2035. • It focuses on the three-dimensional transportation network, improved infrastructure and facility network, more effective services, more advanced technical equipment, and modern governance capacity-building.
14th Five-Year Plan for Scientific and Technological Innovation in Transportation	2022	• This policy demonstrates China's goal to make significant transportation technology breakthroughs by 2025 by strengthening scientific and technological talent, promoting scientific achievements, improving science popularization, and enhancing international cooperation.
14th Five-Year Plan for the Development of Green Transport	2022	• This plan guides energy structure adjustment and emissions reduction of the transport sector by 2025. • It sets quantitative goals for pollution and carbon emissions reduction, fleet transformation, urban logistics distribution, green travel, and more.
14th Five-Year Plan for Transportation Standardization	2021	• The plan outlines China's goal to build a high-quality, standardized transportation system by 2025, with emphasis on scientific and technological innovations as well as regional construction and rural revitalization strategies.
14th Five-Year Plan for the Development of Comprehensive Transport Services	2021	• The plan accelerates the construction of the National 123 Passenger Transportation Scheme and the Global 123 Freight Circle by 2025 • It aims to build a comprehensive, coordinated transportation service system, including fast and convenient passenger transport, efficient freight and logistics, safe and smooth international logistics, and a clean and low-carbon green transportation system. • The plan calls for building a digital and intelligent transportation system and a strong security emergency service system.
National Comprehensive Three-Dimensional Transportation Network Planning Outline	2021	• The outline includes building a green, safe, intelligent, and cost-effective transport network that covers 700,000 km and integrates railways, highways, waterways, and airports by 2035. • It expedites construction of about 20 international comprehensive transport hub cities and 80 national ones. • It empowers transport infrastructure with new technologies, including the development of intelligent connected vehicles and smart cities.

TABLE C-2 | List of key sustainable transport policies in China (cont.)

LEGAL AND POLICY DOCUMENTS	YEAR ISSUED	CONTENT RELATED TO SUSTAINABLE, LOW-CARBON TRANSPORT
New Energy Vehicle Industry Development Plan (2021–35)	2020	• Following the Energy Conservation and New Energy Vehicle Industry Development Plan (2012–20), the plan calls for a more market-oriented and sustainable development of domestic new energy vehicle industry and guides China in building global competitiveness in automotive innovation.
Outline for Building China's Strength in Transport (2020–50)	2019	• The outline provides an overview of the approaches that the country will take to establish China as a strong transportation country by 2035. • Key areas include improving facilities, enhancing passenger and freight services, enhancing safety and emergency operation capability, improving energy/land efficiency and pollution/emissions treatment, deepening international cooperation, cultivating experts and leaders, and improving transportation management through reform, regulation, education, and public engagement.

Source: Data and information from the respective policy documents, aggregated by the authors.

TABLE C-3 | List of national government agencies for climate change and transport in India

GOVERNMENT AGENCIES	FUNCTION
Ministry of Environment, Forest and Climate Change	• Acts as the nodal agency in the administrative structure of the central government for the planning, promotion, coordination, and supervision of the implementation of India's environmental and forestry policies and programs
National Institution for Transforming India (NITI Aayog)	• Provides strategic policy vision for the government • Promotes sustainable and environmentally friendly transport systems • Actively contributes to the development of a road map for India's mobility • Designated as the nodal agency for the promotion of electric vehicle (EV) solutions
Ministry of Road Transport and Highways	• Responsible for road infrastructure in general, and national highway infrastructure in particular, to achieve enhanced connectivity and quick mobility to a level that accelerates socioeconomic development • Its road transport wing is concerned with formulating broad policies related to countrywide road transport regulations and plans for movement of vehicular traffic with neighboring countries
Ministry of Railways	• Exercises all central government policy powers and administers, supervises, and directs the entities that provide most of the rail services in India
Ministry of Housing and Urban Affairs	• Acts as the nodal agency for the coordination and approval of urban transport projects, including metro rail projects and bus rapid transit systems, and the financing of metro rail projects
Ministry of Power	• Responsible for planning and policy formulation related to the development of the power sector as well as monitoring and implementation of power projects • It issues guidelines for the implementation of charging infrastructure related to e-mobility • Its Bureau of Energy Efficiency coordinates with designated consumers, designated agencies, and other organizations and recognizes, identifies, and utilizes the existing resources and infrastructure in performing the functions assigned to it under the Energy Conservation Act; it is the central nodal agency to enable implementation of charging infrastructure
Ministry of Heavy Industries	• Responsible for promoting the automobile industry; a key stakeholder for this project, liaising with the auto and ancillary industry and for developing appropriate vehicle standards
Ministry of New and Renewable Energy	• Acts as the nodal ministry for all matters relating to new and renewable energy

TABLE C-3 | List of national government agencies for climate change and transport in India (cont.)

GOVERNMENT AGENCIES	FUNCTION
Ministry of Petroleum and Natural Gas	• Concerned with exploration and production of oil and natural gas, refining, distribution and marketing, import, export, and conservation of petroleum products
Ministry of Coal	• Secures availability of coal to meet the demands of various sectors of the economy in an eco-friendly, sustainable, and cost-effective manner
Ministry of Ports, Shipping and Waterways	• Acts as the apex body for formulating and administering the rules, regulations, and laws relating to ports, shipping, and waterways, including shipbuilding and repair, major ports, national waterways, and inland waterway transport
Ministry of Finance	• Given the relevance of taxation and financial legislation for transport, energy, and climate policies, it has a significant relevance for the work on transport decarbonization
Logistics Division, Department of Commerce	• Responsible for developing an action plan for the integrated development of the logistics sector by policy changes, improving existing procedures, identifying bottlenecks, and encouraging technological development in the sector
Ministry of Civil Aviation	• Responsible for formulating national policies for the development and regulation of the civil aviation sector

Sources: GIZ and NITI Aayog 2021; ITF 2021; aggregated by the authors.

TABLE C-4 | List of key sustainable transport policies in India

KEY NATIONAL POLICIES	YEAR ISSUED	CONTENT RELATED TO SUSTAINABLE, LOW-CARBON TRANSPORT
PM Gati Shakti—National Master Plan for Multi-modal Connectivity	2021	• This digital platform brings together 16 ministries, including railways and roadways, for integrated planning and coordinated implementation of infrastructure connectivity projects.
Bharat Stage (BS) VI emission standards for motor vehicles	2020	• The standard is on a par with Euro 6/VI standards for light and heavy road vehicles. The same year, the Ministry of Petroleum and Natural Gas announced a nationwide supply of BS VI fuel in conjunction with the proposed BS VI emissions standard.
Motor Vehicles Act (Amendment Bill)	2019	• The Motor Vehicles Act (Amendment Bill) is an updated version of the 1988 Motor Vehicle Act. It introduced many changes by significantly increasing the monetary fines on traffic offenses.
National Policy on Biofuels	2018	• This policy is an updated version of the earlier one, aiming to blend 20% ethanol in petrol and 5% biofuel in diesel by 2030. • These goals reinforce ongoing ethanol and biodiesel supplies by increasing domestic production, set up second-generation biorefineries, develop new feedstock for biofuels, develop new technologies for conversion to biofuels, and create a suitable environment for biofuels and the integration with main fuels.
National E-Mobility Programme	2018	• The program focuses on the long-term growth of the electric vehicle (EV) industry. This is done by subsidizing vehicle manufacturers, fleet operators, and charging infrastructure providers.
Green Urban Mobility Scheme	2017	• The scheme encourages public-private partnerships for mass transit projects, such as metro rail projects.
National Electric Mobility Mission Plan	2013	• The plan presents a framework for the early adoption of EVs and hybrid vehicles.

TABLE C-4 | List of key sustainable transport policies in India (cont.)

KEY NATIONAL POLICIES	YEAR ISSUED	CONTENT RELATED TO SUSTAINABLE, LOW-CARBON TRANSPORT
Faster Adoption and Manufacturing of (Hybrid and) Electric Vehicles (FAME) II	2019	• Phase II of the FAME scheme began in April 2019, with the budget significantly increased to over ₹100 billion (US$1.4 billion). • Its aim is to provide up-front incentives on public transport, such as procuring more e-buses, and to support the deployment of charging infrastructure.
Metro Rail Policy	2017	• This policy highlights the demand for a high-quality public transportation system to cater to the rapidly growing urban population. The policy also presents the need for a framework to implement metro rail projects. The policy recommends multimodal transport in cities, of which metro rail forms the backbone.
National Policy on Transit-Oriented Development	2017	• The policy serves as the guideline and plays a catalytic role in formulating state- and city-level policies for promoting transit-oriented development.
Smart Cities Mission	2015	• The mission's main objective is to improve the quality of life in cities by promoting a sustainable environment and smart solutions. The three primary areas for efficient urban mobility highlighted in this mission are smart parking and intelligent and multimodal transportation systems.
National Action Plan on Climate Change	2009	• The plan has eight missions that define broad policy directions for reducing India's emissions intensity: National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Ecosystem, National Mission for a Green India, National Mission for Sustainable Agriculture, and National Mission on Strategic Knowledge for Climate Change.
National Urban Transport Policy	2006	• The vision of this policy is to move people rather than vehicles. It aims to provide safe, affordable, quick, comfortable, and sustainable access to all the facilities.
National Auto Fuel Policy	2003	• This policy covers various aspects, such as vehicular emission norms, quality of fuel, and strategies to reduce emissions through vehicle and fuel technology.
Integrated Transport Policy	2001	• The main objective of this policy is to foster the development of various transportation modes for a safe, sustainable, efficient, and regionally balanced transportation system.
Jawaharlal Nehru National Urban Renewal Mission	2005	• Under this mission, cities are provided with funds by the central government to modernize existing urban infrastructure. The main objective of this mission is to empower the urban local bodies to successfully manage the local urban issues. • The mission mandates cities to prepare Comprehensive Development Plans and Comprehensive Mobility Plans, highlighting the significance of land-use and transport planning.
Atal Mission for Rejuvenation and Urban Transformation	2015	• The mission provides basic services to households: water supply, sewerage, and urban transport. • The mission develops green, well-maintained open spaces in cities and reduces pollution by increasing public transport use. • It includes stormwater drains, parking spaces, and recreation centers.

Sources: ITF 2021; aggregated by the authors.

TABLE C-5 | List of national government agencies for climate change and transport in Vietnam

GOVERNMENT AGENCIES	FUNCTION
Ministry of Natural Resources and Environment	• Leads and coordinates the periodic assessment of greenhouse gas (GHG) mitigation efforts related to the nationally determined contribution (NDC) with relevant ministries, sectors, and localities. • Develops National Adaptation Plan • Assesses risks and vulnerability, determines adaptation needs, and addresses loss and damage issues; independently conducts related pilot projects • Raises public awareness regarding climate change and the Paris Agreement • Establishes the measurement, reporting, and verification system for national-scale GHG emissions mitigation action • Advises the government to mobilize resources for climate change; monitors and reports on NDC implementation to the government of Vietnam; supports capacity-building, institutional policy development, and information-sharing related to climate change
Ministry of Planning and Investment	• Balances the annual budget to ensure expenditure by ministries for implementing the National Urban Development Programme; mobilizes official development assistance and promotes investment from domestic and international sources in programmatic activities • Develops national guidelines for climate change finance and investment; coordinates and allocates funds for energy sector proposals by line ministries and sectoral agencies
Ministry of Finance	• Manages the budget (recurrent expenditures for climate change; public investment balance; public debt management)
Ministry of Transport	• Prepares the National Transport Master Plan, Automobile Industry Development Plan, and Green Mobility Plan and submits them to the national government for approval • Organizes a review for the Strategic Environment Assessment and Environmental Impact Assessment reports of projects subject to approval within the ministry's competence • Provides certification standards for environmental facilities of road, railway transport, inland waterways, maritime, and aviation, including leadership in supervising and certifying environmental standards for cars and other motor vehicles • Stipulates technical regulations and energy consumption norms for transport means; guides, inspects, and supervises compliance with energy consumption norms for transport means
Ministry of Construction	• Responsible for state administration on construction, building materials, housing and office buildings, architecture, urban and rural construction planning, urban infrastructure, and public services • Promulgates urban construction/planning guidelines, building design codes to integrate charging facilities in urban planning, and buildings to facilitate e-mobility uptake
Ministry of Trade and Industry	• Responsible for policymaking related to energy saving, energy efficiency, and energy use, including electricity, coal, oil and gas, new energy, and renewable energy. In addition, it is also responsible for issuing standards for automobile manufacturing and assembling enterprises. Under the ministry, the Energy Efficiency and Conservation Office supports implementation of the National Energy Efficiency Programme • Plays a key role in cooperating with the Ministry of Transport, electric vehicle manufacturers, and private developers to assess power demand for integration and development of associated infrastructure for electric vehicles
Ministry of Science and Technology	• Oversees the development and issuance of fuel quality, vehicle emissions standards, and vehicle standards
Ministry of Home Affairs	• Elaborates specific regulations and functions for urban governance; conducts research and proposes models of urban authorities for managing urban systems

Sources: Contreras et al. 2015; Le and Yang 2022; Le et al. 2021; aggregated by the authors.

TABLE C-6 | List of key sustainable transport policies in Vietnam

LEGAL AND POLICY DOCUMENTS	YEAR ISSUED	CONTENT RELATED TO SUSTAINABLE, LOW-CARBON TRANSPORT
Road Traffic Law (Law No. 23/2008/QH12)	2008	• Prioritizes to develop public transport services in urban area, potential for deploying e-buses • Encourages low-carbon technologies on highways; parking spaces and specifications in buildings, new developments, and urban areas need to meet parking demand
Law on Economical and Efficient Use of Energy (Law No. 50/2010/QH12)	2010	• Encourages organizations and individuals to provide consultancy on and design and invest in the development of mass transit networks: manufacture and use energy-saving vehicles and exploit and expand the application of liquefied gas, natural gas, electricity, mixed fuels, and biofuels in replacement of petrol and oil • Transport service providers are responsible for optimizing transport routes and vehicles to raise energy use efficiency; elaborating and applying regulations on maintenance and repair of vehicles under their management to reduce fuel consumption, and applying technological, managerial, and organizational solutions to transport for economical and efficient use of energy • Encourages investors and contractors to apply solutions for economical and efficient use of energy under approved projects and to apply measures for economical and efficient use of energy to work construction
Planning Law (Law No. 21/2017/QH1)	2017	• Regulates comprehensive, integrated planning at national-, urban-, and rural-level, including transport infrastructure and traffic facilities • Requires strategic environment assessment and promotes environment-friendly systems/infrastructure at various levels
Law on Environmental Protection (2020)	2020	• Inspects and certifies transport vehicles as complying with environmental standards • Reduces impacts on landscape and natural heritage when constructing transport facilities • Stipulates that provincial people's committees must formulate measures for traffic channelization and environmental pollution control to mitigate air pollution in special-level and level-1 cities • Promulgates incentive policies for the development of public transport • Promulgates incentive policies for transport vehicles using renewable energy and vehicles with low fuel consumption or low emissions • Promulgates the road map for terminating fossil-fueled vehicles and vehicles causing environmental pollution
Construction Law (Law No. 50/2014/QH13; amended in Law No. 62/2020/QH14)	2020	• Regulates distinct types of construction with various functions • Encourages research, investment, and application of advanced science and technology in construction activities that help save energy and protect the environment to adapt to climate change and sustainable development (including electric vehicles and their associated infrastructure)
National Green Growth Strategy		• Shifts share of fuel usage in the transport sector (toward low-emissions fuel) • Finalizes measurement, reporting, and verification (MRV) system in the transport sector • Applies green and energy-saving technologies in the transport sector • Encourages reasonable and effective development of transport network and system • Promotes investment in public transport; development of green public transport
Sustainable Development Strategy		• Works to control emissions from transport vehicles • Aims to reduce traffic accidents and fatalities • Promotes development of public transport and transport infrastructure and system in consideration of climate change, the disabled, women, children, and the elderly
National Climate Change Strategy		• Guides development of public transport and control of private vehicles • Discusses use of low-emissions fuel and transport vehicles • Establishes MRV system in the transport sector

TABLE C-6 | List of key sustainable transport policies in Vietnam (cont.)

LEGAL AND POLICY DOCUMENTS	YEAR ISSUED	CONTENT RELATED TO SUSTAINABLE, LOW-CARBON TRANSPORT
Environmental Protection Strategy		• Controls environmental pollution in transport activities under Decision No. 855/QD-TTg dated June 6, 2011 • Controls emissions from motorcycles and mopeds in provinces and cities under Decision No. 909/QD-TTg dated June 17, 2010 • Implements the road map for applying emissions standards for road motorized vehicles • Encourages clean-energy and renewable-energy transport vehicles
Vietnam's new updated NDC (2022)	2022	• Same as below
Vietnam's updated NDC (2020)	2020	• Limits fuel economy (motorcycles and cars) • Shifts passenger transport from private vehicles to public transport • Shifts freight transport from road transport to others (railway, inland waterway transport, and maritime) • Promotes clean-energy vehicles such as compressed natural gas buses, e-motorcycles, and e-cars • Encourages biofuel use • Increases truck load factor
Development strategy of transport services to 2020 and orientations to 2030		• Rationally develops transport services in terms of quantity and types of transport in the direction of modernity and convenience, meeting technical standards of safety, energy saving, and environmental friendliness • Calls for the proportion of public transport in Hanoi to meet about 25% of travel demand by 2020, of which urban railways account for 2%–3%; in Ho Chi Minh City, it will meet about 20% of the travel demand, of which 4%–5% is urban railways • Calls for the proportion of public transport in Hanoi to meet about 40% of travel demand by 2030, of which urban railways will account for about 17%; in Ho Chi Minh City, it will meet about 35% of travel demand, of which urban railways will account for about 18%
Develop public transport services by bus (2012–20)		• Prioritizes the application of modern, safe, and environmentally friendly technologies to equip, control, and operate the bus public transport system
Mechanism and policies to encourage the development and use of bus public transport		• Develop criteria to determine the type of vehicle participating in public transport by bus using clean energy as a basis for exemption from registration fees • Gradually structure the convoy in the direction of reducing the average age, giving priority to vehicles using clean fuel and ensuring the proportion of vehicles supporting people with disabilities

Sources: Contreras et al. 2015; Le et al. 2021; aggregated by the authors.

APPENDIX D. ALIGNMENT ANALYSES ACROSS THE THREE COUNTRIES

TABLE D-1 | Consistency of policy elements in China

ASSESSMENT CRITERIA	FINDINGS	ILLUSTRATIVE INTERVIEW QUOTES AND EVIDENCE
Alignment of strategies	International climate ambition is consistent with national strategies and targets. Certain goals reverberate across national strategic documents but there is variation across dimensions.	"When the carbon neutral target was announced, we were finalizing the 14th Five-Year Plan for Green Transport, so we temporarily added low-carbon related content to it. It now has a few more low-carbon related indicators. . . . The impact of carbon neutrality target on the transport sector is a gradual, interactive process, with constant feedback. We refined these requirements for different transport subsectors, even for traffic signal management and right-of-way." (Interview) "The MIIT is therefore re-examining its previous industrial goals and policies to see if they are consistent with the 'dual carbon' goal. The first thing they did was to look at what they had done before, and then the next step was to see if they wanted to continue: do they continue to reach their targets? Do they issue new policies?" (Interview) "The NDC process is legally binding, and it is based on policies designed by various ministries. . . . The targets in the NDCs are produced later than those in the national policies. Domestic legislation comes first before the commitments are communicated via NDCs." (Interview) "The policy—National Comprehensive Three-dimensional Transportation Network Planning Outline—is fully aligned with the goals of the 14th Five-Year Plan (2021–2025) and other relevant policies, roadmaps, and targets."[a] "The core of consistency lies in the Chinese governance structure. When the Implementation Plan for Synergizing Reduction of Pollution and Carbon Emission was drafted, the Policy Research Center of the MEE would forward the relevant materials to the Planning Department of the MOT for comments. At that time, they asked us for a lot of materials when drafting the section on transportation. So, there was a lot of communication and coordination in this process. Such a mechanism ensures that these documents are basically conflict-free." (Interview) "Consistency has been maintained very well. We have been involved in all these policies, and we have considered consistency. In addition, we will consider the rapid development of the industry, and will adjust the targets that may be relatively conservative in new documents." (Interview) The "1+N" policy system sets a goal of a 40% share of NEVs in new sales by 2030, and while the Implementation Plan for Synergizing Reduction of Pollution and Carbon Emission lays out the target to reach a 50% share of NEVs in new sales in key air pollution regions by 2030. The NEV Industrial Development Plan 2021–35 states that NEVs should account for no less than 80% in new or renewed public fleets (buses, taxis, delivery vehicles) in pilot zones and key air pollution regions by 2025, whereas the 14th Five-Year Plan for the Development of Comprehensive Transport Services stipulates that the share of NEVs in urban buses, taxis, and urban delivery vehicles will reach 72%, 35%, and 20%, respectively, by 2025.
Instruments that support these strategies	Policy instruments might potentially negatively affect each other.	"Although China differs from Europe as its ZEV targets are binding on manufacturers, it has a comparatively higher grid CO_2 intensity and generous super-credits and zero-emission accounting. In such a scenario, such ZEV incentives can negatively affect China's 2020 fuel consumption standards by as much as 35%."[b] "The implication is that the government is encouraging fast deployment of NEVs at the cost of fuel efficiency of ICE fleets and the interplay might dilute the intended emission benefits."[c]

Notes: The interviews were conducted in Chinese, and the transcripts illustrated above are translated by the authors. The term dual carbon refers to carbon peaking by 2030 and carbon neutrality by 2060. CO_2 = carbon dioxide; FYP = Five-Year Plan; ICE = internal combustion engine; MEE = Ministry of Ecology and Environment; MIIT = Ministry of Industry and Information Technology; MOT = Ministry of Transport; NDC = nationally determined contribution; NEV = new energy vehicle; ZEV = zero-emission vehicle.

Sources: a. Ibold and Xia 2022; b. Rokadiya and Yang 2019; c. Zhang and He 2022.

TABLE D-2 | Coherence of policy elements in China

ASSESSMENT CRITERIA	FINDINGS	ILLUSTRATIVE INTERVIEW QUOTES AND EVIDENCE
Alignment of coordination	There is a coordination mechanism for climate governance at the national level, but inter-ministerial coordination could be improved.	"Cross-ministry coordination is definitely there. The central government has cross-sectoral coordination since the beginning. . . . 1+N is divided into several key areas and industries, and each area has its own lead department. For example, the MIIT will consult with other departments. But before releasing it, it must go through the approval of the Leading Group on Carbon Peaking and Carbon Neutrality to keep the coherence." (Interview) "The new leading group on carbon peaking and carbon neutrality will serve as a formal coordination mechanism, which integrates climate goals in each stage of sectoral policy making, needs to prove itself for policy coherence."[a] "An Inter-ministerial Joint Meeting System was established in 2013—as mandated by the 2012 NEV Industrial Development Plan. Managed by MIIT, this inter-ministerial coordination mechanism included 20 ministries, commissions, and agencies under the State Council."[b] "The NEV Industrial Development Plan 2021–2035 additionally calls for collaborative implementation from the Ministry of Public Security, MEE, State Taxation Administration, China Banking and Insurance Regulatory Commission, National Energy Administration, and 11 other departments. This underscores the comprehensiveness of the new plan."[c] "The policy [Outline for Building China's Strength in Transport] was since then elaborated by a group headed by Vice Premier Liu He and was coordinated by MOT with the support of relevant departments of the State Council and local governments. More than ten research institutions, including the CATS were involved in the drafting process."[d] "Fuel consumption is managed by MITT. MEE is responsible for reducing air pollution. There is a ministerial coordination mechanism between the departments, depending on the degree of coordination. The impact of not coordinating is that there is no strong policy to push the auto industry to do this. . . . The MITT has a lot of jurisdictions and cars are not the primary one. Car manufacturing from the whole life cycle point of view is not noticeably big when compared to steel, aluminium, and plastics." (Interview) "Numerous government agencies are involved in regulating the freight sector in China. . . . At times, these agencies have put in place conflicting or confusing regulations that disincentivized the adoption of efficient technologies and/or practices."[e]
Alignment of communication	Strong policy communication and broader stakeholder participation facilitate implementation.	"China has been extremely successful in engaging government, corporate, and fleet users of electric vehicles."[f] "Climate policy making in China is not a black box; experts, businesses, industry associations, NGOs and individuals all have different channels to participate in policymaking process."[g] "In China, expert consultation is a standard part of climate policy making. Governments seek expert advice through consultation sessions in virtually every major policymaking process. . . . The scientific community's consensus has played a significant role in China's development of key climate policies. . . . China's climate policy making process also includes consultations with business and industry associations."[h] "The [participation of the] auto industry is highly active. We will set up a working group when formulating policies, with about 40–50 members including vehicle manufacturers and supply chain companies, with 200–300 people at each meeting to provide constructive advice." (Interview)

Notes: CATS = China Academy of Transportation Sciences; MEE = Ministry of Ecology and Environment; MIIT = Ministry of Industry and Information Technology; MOT = Ministry of Transport; NEV = new energy vehicle; NGO = nongovernmental organization.

Sources: a. Teng and Wang 2021; b. Song et al. 2023; c. Chu 2021; d. Ibold and Li 2019; e. Yang et al. 2019; f. Jin et al. 2021a; g. Shen 2017; h. Teng and Wang 2021.

TABLE D-3 | Consistency of policy elements in India

ASSESSMENT CRITERIA	FINDINGS	ILLUSTRATIVE INTERVIEW QUOTES AND EVIDENCE
Alignment of strategies	International climate ambition is insufficiently based on the national transport and energy policies. A number of states have drafted or announced specific electric vehicle (EV) targets and policies, experimenting with individual approaches to uptake EV adoption, tailored to local specifics.	"Strategy setting currently occurs in an ad hoc manner. . . . There is no body playing this role [building consensus around the intent to transform and the pathways to do so]. Moreover, it [the Prime Minister's Council on Climate Change] was never an open and transparent body, nor was it embedded in a larger governance structure with well-defined roles."[a] "There is a complete alignment of the national programs and schemes that we have launched, and alignment of the state EV policies. There could be a possibility that some of them are not very closely aligned. Some of them are little off, but to say that they are not aligned, something is, you know, having a divergent view that will be wrong. . . . So that alignment is what I am seeing is that all of us, all these states agree that gradually we should be shifting to clean transport." (Interview) "When it comes to quantified goals of aviation, it is informed by carbon neutrality by 2020 (whatever emitted by 2020 needs to be offset) and net zero goals by 2050 (all airlines buy carbon offsets). We cannot distinguish domestic and international aviation goals; thus, we need to merge goals." (Interview) "Where central government guidance was strong, as in renewable energy promotion, state plans followed a top-down approach, but even here, there was space for state-level experimentation with alternative policies."[b] "India's states experiment with individual approaches to develop renewable energy, tailored to regional specifics."[c] "India has become a testing ground for policies that seek to integrate climate considerations into development policies, with a growing, if limited, framework of climate institutions and efforts to design and implement co-benefits-based national missions in areas such as energy, urban development, and water, and state and city plans focused on resilience and energy efficiency."[d]
Instruments that support these strategies	Strategic ambition is facing implementation challenges at the local level, but governments are learning fast.	"It will be wrong to pin it down to one. For each and every element of that ecosystem, different policies have worked. Demand creations, developing standards and specifications, creating a solid innovation-based working for recycling. Similarly developing and helping the manufacturers and the OEMs. A number of them are there." (Interviews) "While FAME-I was instrumental in piloting electric buses across 9 cities, the scheme also faced challenges such as cities being unable to achieve project closure due to gaps in procurement process, lack of standardised Gross Cost Contracts leading to widely varying bid prices, or performance of buses purchased outright not meeting operational requirements."[e] "We have seen many of these buses which are being deployed, they are all with large battery packs of like 250 or 300 kWh whereas most of the state transportation agencies have routes which are only 25/30 kWh. So, we could have done in a much smarter deployment of e-buses." (Interviews) "The financial support can be more evenly distributed or can be created with a better framework. And aside from this, there are also some technologies as they are disrupting the sector on a fast pace. So, the biggest challenge which most of the times the companies have faced is just being the right vehicle being available to them." (Interviews)

Notes: FAME = Faster Adoption and Manufacturing of (Hybrid and) Electric Vehicles; kWh = kilowatt-hour; OEM = original equipment manufacturer.

Sources: a. Dubash et al. 2021; b. Aggarwal 2013; c. Jörgensen et al. 2015; d. Dubash et al. 2018; e. CESL 2023.

TABLE D-4 | Coherence of policy elements in India

ASSESSMENT CRITERIA	FINDINGS	ILLUSTRATIVE INTERVIEW QUOTES AND EVIDENCE
Alignment of coordination	Improved policy process coherence however more can be done to improve communication and interaction between policy sectors.	"Public transport does not sit within one ministry; each ministry has an important role. The Prime Minister's office will take coordination role; Sometimes you need to go beyond that to coordinate, we need one entity at the central government to manage e-mobility." (Interview) "Following the NAPCC, many ministries have established climate cells but, for the most part, they have been thinly staffed and with limited capacity."[a] "Episodically, coordinating institutions have waxed and waned over time."[b] "A number of ministries are involved, in addition to NITI Aayog, Ministry of Heavy Industries, Ministry of Power, Ministry of Renewable Energy Sources, Ministry of Environment and Wildlife; So, it is an entirely inter-ministerial approach there. In addition to that, there are different specific ministries of transport, Ministry of Railways, Ministry of Shipping, Port and Inland Waterways, Ministry of Road. So, these are some 7/8 ministries which are involved into it. . . . NITI Aayog championed this, bounced to them for some great ideas that we learned through all the national/international think tanks, through what is going on abroad and through what the best practices are around." (Interview) "NITI Aayog is managing this process very well—gather inputs, push forward looking policies, involve appropriate sectors." (Interview) "NITI Aayog constituted a sub-committee within the Grand Challenge comprising of various stakeholders in e-bus implementation and a separate procurement advisory group. CESL convened the procurement advisory group meetings periodically to seek input from cities on their specifications such as type of buses needed and their operational requirements."[c] "Energy sector is no longer about supply side; this goes to demand side; the mobility sector could have a bigger role in driving energy. There are no vested interests, synergies are going on, and it will take some time." (Interview) "Institutional fragmentation makes it more difficult to establish a well-functioning public transport system."[d] "While the growing involvement of national and state governments and their agencies in climate change policy has been a welcome change, local governments in Indian cities have been notably absent from this process and are seen only as conduits for implementation. This is exacerbated by the governance framework in India, where local governments have very little power and decision-making authority."[e]

TABLE D-4 | Coherence of policy elements in India (cont.)

ASSESSMENT CRITERIA	FINDINGS	ILLUSTRATIVE INTERVIEW QUOTES AND EVIDENCE
Alignment of communication	There is increasing participation of broader stakeholder groups to inform policymaking. Policy communication reinforces policy implementation at state and local levels.	"There is another glaring issue with current climate action in India: it follows a painfully top-down approach. Involvement of the citizenry, both rural and urban, in climate action/decision-making is severely limited."[f] "DGA [Directorate General of Civil Aviation] consults with all industry stakeholders. DGA is working on a national policy on green civilization; currently putting together a committee constituting of government, technical experts, and technical adviser. Another example is the committee on biofuel which has stakeholders such as manufacturers, fuel vendors etc. . . . For example, the private sector is ready to use Sustainable Aviation Fuel and is also willing to purchase carbon credits and offset their emissions." (Interview) "So there is a very active process where every week we [India Energy Storage Alliance; IESA] have anywhere from 20 to 50 companies typically participate based on their interest and then we gather those inputs, we create a draft policy papers, we share those with appropriate government agencies or sometimes government agencies come to us with their questions where they are looking for clarity because they are getting a lot of contradictory views from different individual participants. So, we have CES [customized Energy Solutions] and IESA play a critical role in providing third-party independent feedback to the policymakers by aggregating various industry inputs and putting the best recommendations forward." (Interview) "Awareness has to be there. More and more of awareness each and every person should be sensitized about it that this is how you know, this is our commitment, and this is what is required, why of talk of commitment." (Interview) "Delhi's 'Switch Delhi' is a great example of such initiatives made by the government that informs, educates, and encourages citizens to switch to EVs. In addition, Delhi is ready to deploy a WhatsApp chatbot for citizens to know more about recent developments, and information with regards to vehicle models, dealerships, and cost savings."[g]

Notes: CESL = Convergence Energy Services Limited; EV = electric vehicle; NAPCC = National Action Plan on Climate Change; NITI Aayog = National Institution for Transforming India.

Sources: a. Dubash and Joseph 2016; b. Dubash et al. 2021; c. CESL 2023; d. Srivastava and Nair 2021; e. Jörgensen et al. 2015; f. Dubey 2022; g. TERI 2022.

TABLE D-5 | Consistency of policy elements in Vietnam

ASSESSMENT CRITERIA	FINDINGS	ILLUSTRATIVE INTERVIEW QUOTES AND EVIDENCE
Alignment of strategies	The international climate ambition is reflected in national climate and transport strategies. However, there are inconsistencies of goals and targets across national strategies.	"There are inconsistent targets between different strategies and action plans. . . . There are mislinkage and gaps between different policies. . . . It does not mention private vehicles. The exiting vehicle in use—they should be electric when they are renewed." (Interview) Vietnam's 2022 NDC includes information about the measurement, reporting, and verification system, which is regulated via the revised Law on Environmental Protection and government decrees (06/ND-CP directive). The target share of public transport in class-I cities might differ across the National Green Growth Strategy (15%) and Ministry of Transport (MOT) Action Programme on Green Energy Transformation (10%).
Instruments that support these strategies	There is a lack of supporting policy instruments to achieve the strategic goals and targets.	"The target was set but supporting measures and policy measures behind this was lacking. . . . To increase the share of public transport in major cities, [local governments are] lacking financing, lacking subsidy for operation and maintenance – it is challenging to increase the share of public transport without political commitment, without inducive policy environment." (Interview) "The Decision 876 shows the road map for electrification—that is the first step. Now the second step is to translate the political will to implementation. The specific actions, regulations, institutional arrangements should be put in place to drive the implementation." (Interview) "The MOT is advising the Prime Minister to make a general decision on the target, but specific actions will need to go into the subsector and local governments." (Interview)

Source: Aggregated by the authors.

TABLE D-6 | Coherence of policy elements in Vietnam

ASSESSMENT CRITERIA	FINDINGS	ILLUSTRATIVE INTERVIEW QUOTES AND EVIDENCE
Alignment of coordination	Policy coordination across ministries functions well except for the difference between regulations and their enforcement.	"MONRE took lead in developing the NDCs, they held consultancies from related ministries, and we [MOT] participated in the consultancy, we also provided activities, especially in the transport sector." (Interview) "The transport ministry contributed to the country's NDC."[a] "Vietnam is a good example where the Department for Environment in the Ministry of Transport is responsible for climate change in transport. It was not only consulted during NDC development but is also identified as coordinating body for NDC implementation."[b] "MOIT has proposed electricity and energy planning for Vietnam by 2050. During the development of the policy, they consulted with MOT, we proposed them to have a specific planning for electricity to ensure we have enough electricity stations and usage of other fuels like hydrogen, biogas to meet the future transportation demand." (Interview) "Limited cooperation among government agencies and imbalance between regulation development and enforcement have impeded policy implementation."[c] "The central government should give more autonomy to local governments in implementation. Everything needs to be approved, making local governments exhausted." (Interview)
Alignment of communication	Policy communication remains relatively weak.	"For users, like citizens and enterprises, we can promote communication campaigns and skill development so people have more awareness of the effectiveness of vehicle transformation." (Interview) "Studies on cobenefits of transport decarbonization . . . not only to tackle emissions, but also cleaning the air, improving public health, making life expectancy longer . . . should be mainstreamed in public campaigns." (Interview) "Key documents such as Power Development Plan 8 have been made available in draft form for public comment. The MOIT's regular policy reviews and feedback channels (such as business forums) have provided input for policy revisions."[d]

Notes: MOIT = Ministry of Industry and Trade; MONRE = Ministry of Natural Resources and Environment; MOT = Ministry of Transport; NDC = nationally determined contribution.

Sources: a. Taeger 2022; b. Bongardt et al. 2017; c. Do and Thi 2022; d. Do et al. 2021.

ABBREVIATIONS

ASI	avoid-shift-improve
BaaS	battery as a service
BAU	business as usual
BEV	battery electric vehicle
BRT	bus rapid transit
BS	Bharat Stage
CAAC	Civil Aviation Administration of China
CAFC	corporate average fuel consumption
CESL	Convergence Energy Services Limited
CNG	compressed natural gas
CO_2	carbon dioxide
COP	Conference of the Parties
DHI	Department of Heavy Industries
E4W	electric four-wheeler
E3W	electric three-wheeler
E2W	electric two-wheeler
EV	electric vehicle
FAME	Faster Adoption and Manufacturing of (Hybrid and) Electric Vehicles
FCEV	fuel cell electric vehicle
FCV	fuel cell vehicle
FY	fiscal year
FYP	five-year plan
GCF	Green Climate Fund
GDP	gross domestic product
GHG	greenhouse gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
Gt	billion tonnes
G20	Group of Twenty
GW	gigawatt
HCMC	Ho Chi Minh City
HDV	heavy-duty vehicle
ICCT	International Council on Clean Transportation
ICE	internal combustion engine
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IWT	inland waterway transport
JETP	Just Energy Transition Partnership
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
kWh	kilowatt-hour
LDV	light-duty vehicle
LEP	Law on Environmental Protection
LTS	long-term low greenhouse gas emission development strategy
MaaS	mobility as a service
MEE	Ministry of Ecology and Environment
MHI	Ministry of Heavy Industries
MIIT	Ministry of Industry and Information Technology
MOC	Ministry of Construction
MOCI	Ministry of Commerce and Industry
MOEFCC	Ministry of Environment, Forest and Climate Change
MOF	Ministry of Finance
MOHUA	Ministry of Housing and Urban Affairs
MOIT	Ministry of Industry and Trade
MONRE	Ministry of Natural Resources and Environment
MOP	Ministry of Power
MORTH	Ministry of Road Transport and Highways
MOST	Ministry of Science and Technology
MOT	Ministry of Transport
MPI	Ministry of Planning and Investment
MRV	measurement, reporting, and verification
MSP	multistakeholder platform
$MtCO_2$	million tonnes of carbon dioxide emissions
MW	megawatt
NAPCC	National Action Plan on Climate Change
NCCS	National Climate Change Strategy to 2050
NDC	nationally determined contribution
NDC-TIA	NDC Transport Initiative for Asia
NDRC	National Development and Reform Commission
NEA	National Energy Administration
NEMMP	National Electric Mobility Mission Plan
NEV	new energy vehicle
NGGS	National Green Growth Strategy
NGO	nongovernmental organization
NITI Aayog	National Institution for Transforming India
OEM	original equipment manufacturer
PBS	public bike sharing
PDP8	Power Development Plan 8
pkm	passenger kilometer
R&D	research and development
SLOCAT	Partnership on Sustainable, Low Carbon Transport
3W	three-wheeler
tkm	tonne kilometer
TOD	transit-oriented development
2W	two-wheeler
UNFCCC	United Nations Framework Convention on Climate Change
ZEV	zero-emission vehicle

GLOSSARY

KEY TERMS	DESCRIPTION
carbon budget	According to the IPCC, carbon budget refers to the maximum amount of cumulative net global anthropogenic CO_2 emissions that would result in limiting global warming to a given level with a given probability. The remaining carbon budget indicates how much CO_2 could still be emitted while keeping warming below a specific temperature level.
climate change commitment	Climate change commitment is defined as the unavoidable future climate change resulting from inertia in the geophysical and socioeconomic systems. Diverse types of climate change commitment are discussed in the analysis.
climate neutrality	Carbon neutrality is defined as the achievement of net balance between anthropogenic CO_2 emissions and CO_2 removals by carbon sinks. Climate neutrality recalls the same idea, covering all other GHGs and implying a net balance of in terms of CO_2e.
climate policy (policies for climate change mitigation and adaptation)	Policies are taken and/or mandated by a government—often in conjunction with business and industry within a single country, or collectively with other countries—to accelerate mitigation and adaptation measures. Examples of policies include support mechanisms for renewable energy supplies, carbon or energy taxes, and fuel efficiency standards for automobiles.
decarbonization	The process by which countries, individuals, or other entities aim to achieve zero fossil carbon existence. Typically refers to a reduction of the carbon emissions associated with electricity, industry, and transport. Our analysis examines the policies that could lead to such decarbonization; it does not examine actual physical changes in emissions. We use the term transport decarbonization when we refer to long-term processes of policy development for transport systems transformation toward a low-carbon transport system.
long-term strategies (LTSs)	Countries are also invited to communicate "mid-century long-term low GHG emissions development strategies." An LTS provides a visionary road map for countries to achieve complete decarbonization by midcentury and to ensure prosperity for all.
nationally determined contribution (NDC)	A term used under the UNFCCC whereby a country that has joined the Paris Agreement outlines its plans for reducing its emissions. The Paris Agreement (Article 4) requires each Party to prepare, communicate, and maintain successive NDCs that it intends to achieve. NDCs include targets, measures, and policies and are the basis for national climate action plans.
net zero emissions	Net zero emissions will be achieved when all GHG emissions released by human activities are counterbalanced by removing GHGs from the atmosphere in a process known as carbon removal.
transport policy	Transport policies include the general policies that provide a perspective on transport as part of national development as well as those that give a specific perspective on the development of roads, railways, automotive sector, public transport, e-mobility, and others. It also includes policies to limit negative externalities such as road safety, air pollution, and climate change.

Sources: Biber et al. 2017; IPCC 2023; Levin et al. 2019; UNFCCC n.d.a, n.d.b; aggregated by the authors.

ENDNOTES

1. Asia's economy markedly improved once China reopened following the COVID-19 pandemic lockdowns. Asia has an expected regional growth rate of 4.8 percent for 2023–24 (ADB 2023).
2. This analysis uses the geographic region defined by the UN M49 Standard (UNSD n.d.).
3. According to the "Electric Bicycle Safety Technical Specification" (GB17761-2018), an electric bicycle is "a two-wheeled bicycle with the on-board battery as an auxiliary energy source, with pedal riding ability, that can realise the electric actuation or electric drive function." Electric bicycles have a maximum speed that does not exceed 25 km per hour and weigh no more than 55 kilograms (kg).
4. The number of sales is based on IEA's "Global Electric Vehicle Outlook 2022." The definitions of E2Ws and E3Ws might vary across countries (IEA 2022a).
5. Publicly available chargers, both fast and slow.
6. For example, the use of aerodynamic side skirts retrofitted on trailers is allowed by MOT but not by the Ministry of Public Security (Yang et al. 2019).
7. Partly because of the truck industry's overloading and underbidding.
8. The transcript is in Chinese and has been translated by the authors.
9. The uncertainty in the home electricity tariff results in the variance in the total cost of ownership per kilometer at lower levels of utilization. The ICCT's analysis finds that battery swapping is considered the most economic option when driven more than 140 km per day (Gode et al. 2022).
10. A gross cost contract is a procurement model in which a transit authority hires a bus fleet from a private bus operator for an agreed-upon period and terms in a contract. The operator is responsible for the operation and maintenance of the buses according to the schedule set by the transit authority. In exchange, the transit authority pays an agreed-upon fixed amount per unit distance operated (contract cost). In a "dry" lease, the operator provides buses without drivers, and in a "wet" lease, the operator also provides drivers (Dhole and Gode 2022).
11. It relates to the distance traveled by a vehicle and the amount of fuel consumed. A lower number means it is more efficient.
12. The standard of 5.49 L/100 km is linked with an average car weight of 1,037 kg, and 4.77 L/100 km is linked with an average weight of 1,145 kg. The updated 2022–23 fuel economy standard for new cars adjusted the average car weight to 1,082 kg. Lowering the weight makes it somewhat easier for the industry to meet the standard (BEE 2023).
13. JETPs are financing cooperation mechanisms to help a selection of heavily coal-dependent emerging economies make a just energy transition. For Vietnam, the JETP will mobilize US$15.5 billion of public and private finance to support the country in accelerating its plans to phase out coal and scale up renewables by 2030 (Foreign, Commonwealth & Development Office 2022).
14. Per Resolution 31/NQ-TW.
15. In accordance with Resolution No. 140/NQ-CP and Decision 452/QD-BGTVT.
16. According to Climate Transparency, China's emissions intensity of primary energy is currently 68 tCO_2 per terajoule, about 19 percent above the G20 average.

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ABOUT NDC TRANSPORT INITIATIVE FOR ASIA

This publication is part of the NDC Transport Initiative for Asia (NDC-TIA), which supports China, India, and Vietnam as well as regional and global decarbonization strategies to increase ambition around low-carbon transport.

The NDC-TIA is financed by the German Ministry for Economic Affairs and Climate Action through its International Climate Initiative. The implementing organizations are the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ); the International Council on Clean Transportation (ICCT); the International Transport Forum (ITF); Agora Verkehrswende; the Partnership on Sustainable, Low Carbon Transport (SLOCAT); the Renewable Energy Policy Network for the 21st Century (REN21); and World Resources Institute.

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ABOUT WRI

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Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

Our vision

We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of government, business, and communities combine to eliminate poverty and sustain the natural environment for all people.

Our approach

COUNT IT

We start with data. We conduct independent research and draw on the latest technology to develop new insights and recommendations. Our rigorous analysis identifies risks, unveils opportunities, and informs smart strategies. We focus our efforts on influential and emerging economies where the future of sustainability will be determined.

CHANGE IT

We use our research to influence government policies, business strategies, and civil society action. We test projects with communities, companies, and government agencies to build a strong evidence base. Then, we work with partners to deliver change on the ground that alleviates poverty and strengthens society. We hold ourselves accountable to ensure our outcomes will be bold and enduring.

SCALE IT

We don't think small. Once tested, we work with partners to adopt and expand our efforts regionally and globally. We engage with decision-makers to carry out our ideas and elevate our impact. We measure success through government and business actions that improve people's lives and sustain a healthy environment.

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