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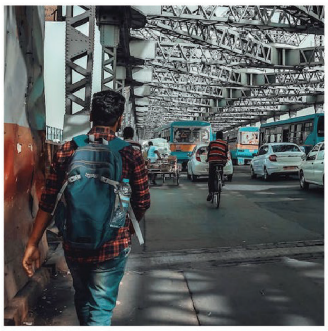
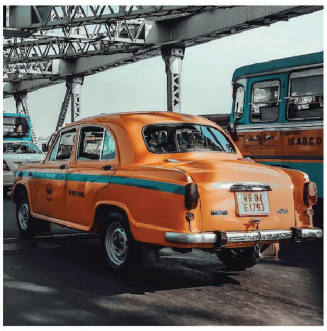
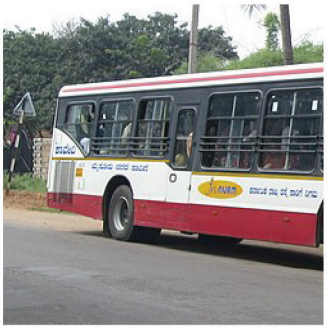
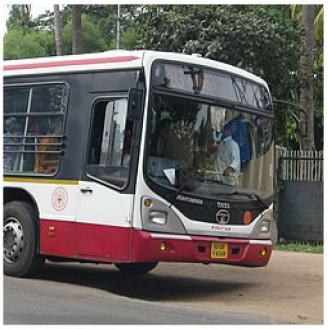

Decarbonising Public Transport in India: An Issue Brief

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AUTHORS
Amir Bazaz, Manish Dubey, Satish Yawale, Ketaki Ghoge

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Introduction

Sustainable urban transportation systems are a key defining element of sustainable urbanisation. This calls for simultaneous pursuit of the agendas of decarbonisation, sustainable development, and resilient transport infrastructure.

Shifting demographic patterns, rising incomes and aspirations, and the need to service mobility demands arising from enhanced economic activity are the most common drivers of transportation demand. Meanwhile, transport, as it exists today, is often inefficient, carbon intensive, and fossil-fuel-dependent. Further, weather and climate extremes pose serious risks to incumbent transportation infrastructure and threaten economic disruption. **In India, transport is one of the fastest growing sectors—and also one of the biggest emitters of atmospheric pollution, specifically carbon emissions.**

Public transportation systems, powered by cleaner fuels or clean electricity, have been widely recognised as an important element of the coupled decarbonisation–development strategy. Despite sustained policy attention, a rapid shift towards public transport, particularly bus-based systems, has been challenging and has delivered mixed outcomes in various Indian cities.

This issue brief focuses on the goals of decarbonisation in the transport sector, summarising contemporary insights that could help frame an actionable agenda in the context of the India's urban public transport systems. The brief suggests that **a modal 'shift' towards public transport, with a focus on public transit systems such as buses, could be the primary vehicle for urban transport decarbonisation in India.** It also emphasises that this shift must be complemented by improving and cleaning up the 'fuel' component and improving user experience of public transport, specifically buses.

Transport Overview: Global Trends and Macro-trends in India

Globally, the transport sector directly emitted around 8.9 Gt carbon dioxide equivalent (CO_2eq) in 2019, up from 5.1 Gt CO_2eq in 1990 (MoEF, 2010). In absolute terms, the transport sector accounts for roughly 15 per cent of total greenhouse gas (GHG) emissions and about 23 per cent of global energy-related CO_2 emissions (IPCC, 2022).

Transport-related GHG emissions have increased rapidly over the last two decades. Since 2010, the sector's emissions have increased faster than for any other end-use sector, averaging 1.8 per cent annual growth. Most regions around the world have witnessed this growth, with substantial growth registered in Asia and Africa. For instance, there was a growth of 5.2 per cent in transport-related GHG emissions in South Asia since 2010, exceeding economic growth rates in the region.

The growth in transport sector emissions has been attributed to the rapid increase in global transport activity levels, which rose by about 73 per cent between 2000 and 2018 (MoHUA, 2019). Addressing emissions from the transport sector is, therefore, crucial for GHG mitigation strategies in many countries. However, the transport sector is an important contributor to economic growth and employment, and decarbonisation strategies must remain cognisant of this.

In India, increase in population, urbanisation, and economic development has driven transport sector growth. This sector is the fastest-growing sector in the country and accounts for about 13 percent of India's energy-related CO_2 emissions (Dhar, Pathak, & Shukla, 2015; MoEF, 2010). This calls for efforts to make India's transport growth more sustainable and climate compatible. If left unaddressed, continued GHG

emissions and attendant issues of air pollution could undermine India's development trajectory. Modelling exercises (Dhar, Pathak, & Shukla, 2015; TERI, 2018) estimate that, under a business-as-usual scenario, transport-linked energy demand and CO_2 emissions could increase 4.5 times by 2050, relative to 2015.

Trends in Passenger Transport in India

In India, growing population, intensification of economic activity, and increasing per capita mobility needs have combined to result in an increase in demand for passenger transport, which has been faster than economic growth. Global experience suggests that the elasticity of passenger transport demand to gross domestic product (GDP) tends to be higher than 1, signifying enhanced demand as an economy grows. This figure usually ranges between 1.4 to 1.7 and is expected to sustain in the context of a rapidly growing economy like India.

The passenger road transport share, of the total passenger transport demand, in India increased from about 60 per cent to nearly 90 per cent between 2005 and 2015 (Dhar, Pathak, & Shukla, 2015). Road transport has far outstripped demand for rail transport, and this growth is for both intercity and intracity commute.

The preference for road transport is based on convenience. Buses and personal modes of transport like cars and two-wheelers provide point-to-point connectivity, have shorter waiting times, and are, therefore, preferred. Private motorised transport as a mobility choice in India is strongly correlated with an increase in income and these trends are in line with the global experience.

India has witnessed a rapid increase in private vehicle ownership, driven by the need for private motorised mobility in the absence of a good quality public transportation system (Li, 2011; ITF, 2019).

One of the biggest challenges to sustainable transport comes from growth in passenger road transport, particularly an increased preference for private cars and two-wheelers (Ausubel & Marchetti, 2001; Purohit & Dhar, 2015). Growing motorised passenger transport demand in India has been mainly met by road transport (two wheelers, buses, and cars) within cities, and by road, rail, and air for intercity travel. Within cities, two wheelers have emerged as the dominant mode of transport.

In 2019-20, about 3.4 million passenger vehicles, about 750,000 commercial vehicles, and about 21 million two-wheelers were produced in India (IBEF, 2020). Between 2001 and 2011, the percentage of households owning two-wheelers increased 2.5 times. Rise in ownership was even higher in the case of four-wheelers (NITI Aayog, 2021). However, at 15 cars per thousand persons, India's car ownership is amongst the lowest in the world. India's two-wheeler ownership of 82 vehicles per thousand persons is much higher.

India's Transport Decarbonisation Agenda

Multiple existing challenges within the country's transport sector have been recognised and appropriate policy responses have been formulated.

India's transport decarbonisation agenda has a twin focus: (a) modal shift from private to public transport; and, (b) improving and altering fuel architecture through various options like efficiency improvements, electrification, and biofuel blending. In addition, moderation in motorised transport demand is also being pursued through attention to non-motorised transport and transit-oriented development.

These foci have influenced transport sector investment decisions, including investments in metros in several cities across the country. The most recent emphasis has been on electrifying the transport fleet, with an additional goal of addressing air pollution concerns. **Electrification provides emission reduction benefits over a longer term, provided it is accompanied by massive decarbonisation of the power sector. The government also has an ambitious programme to improve fuel efficiency to reduce emissions (See Box-1).**

Box- 1: Recent Initiatives on Electric Mobility and to Improve Fuel Efficiency

The Government of India (GoI) has introduced several measures to enhance the uptake of electric mobility solutions and policies to improve fuel efficiency in a bid to reduce emissions and curb pollution.

- India has directly transitioned from BS-IV (Euro-IV) fuel quality standards to BS-VI (Euro VI) fuel quality from 2020. Vehicles have also been upgraded, with most vehicles having catalytic convertors and meeting at least BS-IV emission norms. Driven by local pollution concerns, the government has also introduced bioethanol and biodiesel in transport fuels and pursued aggressive policies to replace diesel with CNG as the primary fuel.
- The National Electric Mobility Mission Plan (NEMMP, 2019) provides a road map for faster adoption and manufacturing of electric vehicles in the country. As part of NEMMP, the Ministry of Heavy Industries introduced the Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) scheme. FAME offers incentives to buyers of electric vehicles, along with grants for pilot projects, public charging infrastructure, and technology development.
- The National Policy on Biofuels mandates a blending of biofuels of about 20 per cent in transport fuels. This is an ambitious target, and several steps have been undertaken to broaden the feedstock base for biofuel production, while R&D of new technology and feedstock is being supported to achieve this. The national programme on upgrading the quality of transport fuels has significantly helped in reducing vehicular emissions.

Long term energy–environment–economy modelling exercises validate the focus on fuels and the proposed modal shift towards public transport as a dominant lever to decarbonise. These strategies remain valid over a short-to-medium-term horizon (Naran, et al., 2021)**.**

Three factors are likely to shape pathways to decarbonise the Indian transport sector, specifically in the urban context:

First, the energy and emission trends from transport have high path dependence on infrastructure and urban form. Therefore, infrastructure choices would be crucial in ensuring a particular modal choice for mobility.

Second, efficient urban infrastructure systems, such as mass transit systems, have high upfront costs. This indicates the need for a carefully crafted strategy for public transport, indicating a balance between high-cost (metro) and moderate-cost (bus) mobility solutions.

Third, policies to adopt cleaner and more efficient technologies, such as electric vehicles, will need to be in sync with the goals of systemic reforms in the transport system so as to significantly shift demand and supply patterns. For example, uptake of electric mobility solutions has been constrained due to slow turnover time to replace old, inefficient vehicle stocks and building of new charging infrastructure. Though India has seen rapid turnover in transport infrastructure systems during the past decade, particularly with respect to intracity metro rail networks (Mittal, Dai, & Shukla, 2016), these have been located in bigger cities that underwrite demand for services.

Key Issues in the Indian Urban Public Transport System

Lack of efficient, affordable, and accessible public transportation: Transit systems in most Indian cities are characterised by overly used, poor quality bus systems and lack of good quality intracity rail systems. Public transport is often underdeveloped and fails to meet the fast-growing demand in the absence of an integrated urban transport vision (NTDPC, 2014). Attracting people to public transport requires sufficient spatial coverage of transport with adequate level of service provisioning at affordable fares (IPCC, 2014; Moberg, et al., 2019). This has remained a challenge in the Indian context[1]. The poor frequency of buses, their overcrowding at peak hours, and their lack of comfort are other factors influencing bus use in India.

Increasing congestion and air pollution: Congestion is an outcome of two factors: growth in the number of vehicles on the road, and limitations to the expansion of road space. Efforts by city authorities to augment road infrastructure are often nullified by the increase in private vehicles, induced traffic volumes and, in turn, greater congestion. A sharp rise in traffic congestion has significantly contributed to air pollution, underscoring issues of fuel quality, engine specifications and old, inefficient, vehicle stock.

***Cost, time value, and transport taxes*:** The cost and time taken to commute has forced people to shift to private transport. In some countries, public transport is heavily subsidised to promote its usage—and this has been successful. The high tax on transport fuel and other related taxes such as high road tax and high parking fee, for example in Tokyo, have also nudged people into opting for public transport. Both cost and taxation issues are still evolving in the Indian context but need to be considered for enabling meaningful shifts towards public transport.

Challenges in electrification of the transport system: While the GoI has ambitious vehicle electrification plans, widespread availability of Electric Vehicle (EV) charging infrastructure remains a significant challenge (NITI Aayog, 2021). From a consumer perspective, robust and reliable charging infrastructure networks are required to build confidence in the technology and overcome the often-cited barrier of range anxiety (She, Qing Sun, Ma, & Xie, 2017). India's unique mobility pattern necessitates an EV policy that is tailor-made to the Indian context, and the availability of reliable charging infrastructure, driven by clean energy, would require significant focus.

Using Avoid–Shift–Improve Framework for Transport Decarbonisation

On-road passenger and freight vehicles dominate global transport-related CO_2 emissions and offer the largest mitigation potential. An Avoid–Shift–Improve (ASI) framework is an effective way to strategise GHG emissions reduction from the transport sector, particularly road transport.

'Avoid' strategies focus on reducing total vehicle travel, driven by compact urban form and other policies that minimise travel distances and promote efficient transport through pricing and demand management programmes. Research suggests that implementing urban form changes could reduce GHG emissions from urban transport by 25 per cent in 2050, compared with a business-as-usual scenario (Creutzig, et al., 2015a;2015b; Creutzig, 2016).

[1]According to the guidelines of the Ministry of Housing and Urban Affairs, cities need to have at least 60 buses for every 100,000 people. No city in India—except Bengaluru—meets this norm. Delhi, for example, requires at least 11,000 buses to meet the needs of its population. But, for over a decade, its total bus fleet has hovered between 6,000 and 7,000 (including privately operated 'cluster' buses). This is a significant reason for the high density of privately-owned motorised vehicles in Indian cities. This trend is predominant in metropolitan cities owing to higher economic activity and concentration of a massive population.

Denser, more compact cities with mixed land use patterns can reduce the distances between where people live, work, and pursue leisure activities, which, in turn, can reduce travel demand and impact GHG emission trajectories.

'Shift' strategies shift travel from higher-emitting to lower-emitting modes. These strategies include more multimodal planning that improves active and collective transport modes.

'Improve' strategies reduce per-kilometre emission rates. These strategies include hybrid and electric vehicle incentives, lower carbon content, cleaner fuels, and high emitting vehicle scrappage programmes.

In the context of passenger transport in the Indian context, shifting demand patterns is a key component of the decarbonisation agenda. These are commonly measured by estimating cross elasticity of demand across transport modes. Cross elasticity estimates suggest that transit users are responsive to reductions in the cost of driving. Research indicates that consumers are particularly attentive to **waiting time when making mobility choices and thus, in absence of a predictable public transport system, favour private motorised vehicles** (Fearnley, et al., 2018)**. These results provide additional evidence that increasing the use of active transport (such as walking or cycling) and public transport (like buses) would require interventions that makes car use more expensive.**

Issues for Reflection

A transport-sector-focused decarbonisation agenda for Indian cities will need to mainstream the development dimension as a dominant goal. Decarbonisation strategies would need to align with delivering development outcomes ranging from reduced poverty and supporting livelihoods to better health outcomes, enhanced road safety, and reduced pollution.

A sustainable transportation system has synergies across several Sustainable Development Goals (SDGs) including universal good health, decent work, ending poverty, reduced inequality, growth, energy, health, and poverty, which are central issues in most of our cities. However, assessment of such synergies as dominant levers of transport decarbonisation is yet to take centre stage.

The key issues in bringing decarbonisation and development agendas together relate to the following:

- Institutional fragmentation: This inhibits the development of a comprehensive city and sub-city mobility plan, undermining the integration of sustainable development and delivering a fragmented discourse.
- Consumer and cultural aspirations: A modal shift towards public transport is competing with an upwardly mobile aspirational, asset-acquisitive mindset. Behaviour change efforts need to be considered to encourage a shift towards public transport. Further, public transport would need a reimagination around understanding the diverse nature of its consumers, such as children and the elderly, in order to create a policy response framework that makes it attractive as the dominant mobility choice. This would necessitate a deeper understanding of demand and its provisioning.
- Connections between intermediate public transport, livelihoods, and mass transit solutions: These are connected in complex ways in Indian cities. While thinking about decarbonisation and development, these connections would need careful consideration.

Importantly, any sustainable mobility prescription must align mobility provisioning with multiple dimensions of wellbeing, such as perceptions of safety, accessibility, and affordability. Articulation of these non-material aspects as key success indicators would enable the creation of significant and sustained demand for sustainable mobility, including bus-based public transport.

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Floor 7A, Chaitanya Exotica, 24/51 Venkatnarayana Road, T Nagar Chennai 600 017. India T +91 44 6630 5500 / 6555 6590

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