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ZEBRA

ZERO EMISSION BUS
RAPID-DEPLOYMENT ACCELERATOR

Electrifying India's buses

Insights from public deployment and case studies of private intercity operators

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INTRODUCTION

India's transport sector, while vital for economic growth, is a major contributor to greenhouse gas emissions and air pollution, owing largely to road transport and diesel vehicle use. As of 2020, transport made up 14% of India's energy-related emissions, 90% of which was from road transport (Mishra, 2024). Within the road transport sector, buses make up only 1% of the vehicle fleet but account for nearly 15% of carbon dioxide (CO_2) emissions from transport, highlighting their disproportionate climate impact (Nandy, 2024).

The Government of India has made efforts to electrify public bus services. Milestones include the launch of the Faster Adoption and Manufacturing of Electric Vehicles (FAME) scheme, which provided demand incentives for electric vehicles, including buses, and supported deployment of charging infrastructure; the adoption of the Gross Cost Contracting (GCC) model for risk transfer and operator engagement;[1] and the use of demand aggregation to reduce procurement costs. These efforts, alongside a Ministry of Housing and Urban Affairs (MoHUA) benchmark for 50 buses per lakh population for cities with over 20 lakh population, have largely focused on intra-city operations, where public transport undertakings have served as the primary implementing entities.

The intercity bus segment, especially services operated by private entities, is emerging as a critical frontier in India's electrification journey in light of its growing relevance in connecting Tier 1, 2, and 3 cities. This study examines the barriers that limit the viability and scalability of intercity e-bus operations in the private sector. Using a case study approach, the analysis is structured around three pillars—infrastructure, technology, and financing—highlighting challenges and policy considerations to encourage intercity e-bus deployment.

This study begins with a description of India's bus segment, examining the structure of the market, profiling existing bus operations, and reviewing recent government support for bus electrification and related private sector initiatives. It then proceeds into a discussion of the business models and operational approaches of private operators that are leading early intercity e-bus deployment efforts, based on a synthesis of existing use cases. This is followed by a total cost of ownership (TCO) analysis to better understand the economics of intercity e-bus deployment in India. The study closes with a review of key barriers and policy considerations.

1 Under the GCC model, the government is responsible for fare collection and pays private bus operators a set rate over a contract period.

STRUCTURE OF THE BUS SEGMENT IN INDIA

In India, bus transport serves a diverse array of use cases, ranging from long-distance intercity travel to short-distance last-mile connectivity within urban systems. Despite rapid motorization, private vehicle ownership remains relatively low, with only 31 cars and 174 two-wheelers per 1,000 people (Ministry of Road Transport and Highways [MoRTH], 2023). Consequently, a substantial share of the population continues to rely on public transport, predominantly buses, for their daily mobility needs. Buses account for nearly 40% of road-based passenger transport measured in passenger-kilometres travelled (TERI, 2024), highlighting their critical role in India's mobility landscape. India now ranks as the third-largest bus market globally (MoRTH, 2023).

KEY STAKEHOLDERS AND SEGMENTATION IN INDIA'S BUS SECTOR

KEY STAKEHOLDERS

India's bus ecosystem involves three primary stakeholders: original equipment manufacturers (OEMs), state transport undertakings (STUs), and private operators. Each plays a distinct role in shaping public and private bus mobility.

Table 1. Key stakeholders in India's bus sector

Stakeholder	Role	Key functions and characteristics
OEMs	Vehicle design, manufacturing, and increasingly, operations	• Invest in research and development and adhere to evolving emission and safety regulations • Offer a diversified portfolio, including 7 m feeder buses, school buses, and premium intercity coaches • Enter operations through models like GCC • Establish wholly-owned subsidiaries for fleet management
Bus operators	Service delivery across intracity, intercity, and premium segments	• Manage routing, ticketing, maintenance, and regulatory compliance • Operate under varied permit types and funding mechanisms, often via public-private partnerships (PPPs) • Several also operate services under GCC in urban areas
STUs	Public sector operators that deliver essential transit services	• Mandated to ensure affordability and equitable access to mobility • Transitioned from capital-intensive procurement models to contractor-led approaches, notably GCC • Procure fleets via competitive tenders; collect fares while outsourcing ownership and operations • Serve both dense urban corridors and remote rural regions

SEGMENTATION OF INDIA'S BUS MARKET

The bus market in India has grown significantly over the past decade, driven by urbanization, infrastructure development, and increasing demand for public transportation. This expansion has supported demand for public transit and school and staff transport and is reflected across various segments of the bus market, including city buses, intercity buses, and luxury coaches (1Lattice, 2023; Nandy, 2024). This section categorizes India's bus fleet in terms of length, fuel type, ownership, and use case.

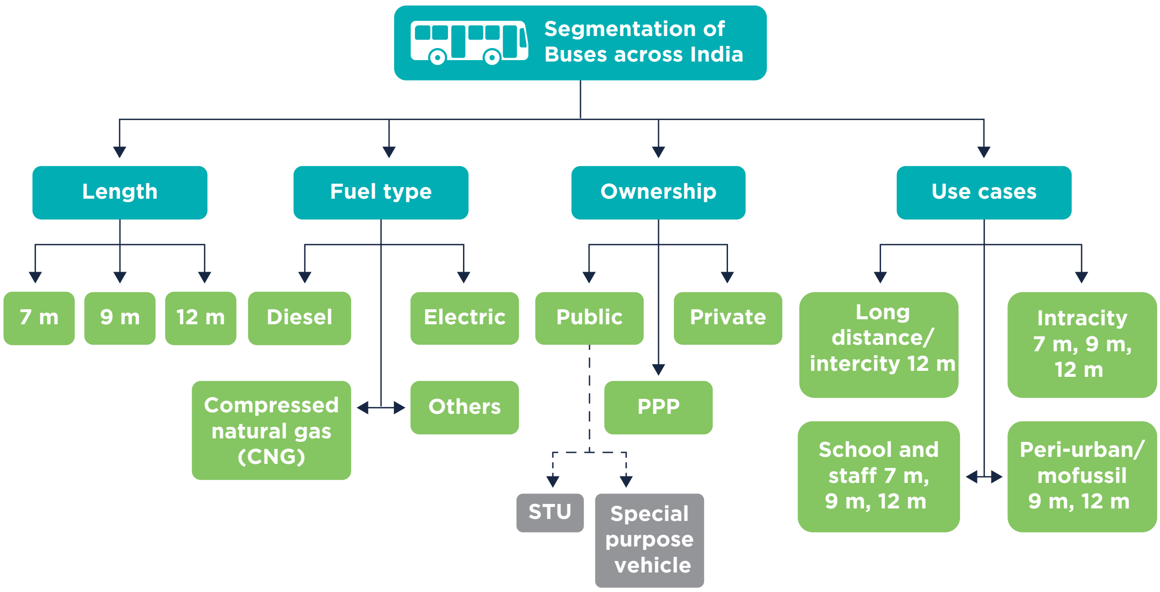

Figure 1. Bus segmentation in India

BUS LENGTH

Table 2 presents the typical lengths of buses operating in India by application and capacity, reflecting national criteria for bus design set out in established manuals and standards.

Table 2. Typical lengths of buses in India

Length	Typical use	Capacity
7 m	Last-mile feeder and shuttle services, transit through dense urban cores	23 seats
9 m	Intracity and suburban transport, school transport, neighbourhood transit	31 seats
12 m	Intracity and suburban transport and intercity transport, primarily in cities with populations over 1 million	40 seats
13.5 m	Intercity coaches	45–53 seats

FUEL TYPE

Table 3 illustrates the fuel mix of buses registered in India as of March 31, 2025, as recorded in the government's Vahan vehicle registry portal. This segmentation reflects the diverse energy landscape and evolving environmental policies affecting bus operations in India.

Table 3. India's bus fleet by fuel type as of March 2025

Fuel type	Number of buses	% of total fleet
CNG	87,825	3.56%
Diesel	2,086,103	84.65%
Petrol	175,724	7.13%
Electric	11,440	0.46%
Other	103,195	4.19%
Total	**2,464,287**	**100.00%**

Source: Vahan Portal (MoRTH, n.d.). Note: The "other" category includes buses with either dual or hybrid fuel types, such as petrol/CNG, diesel/CNG, diesel/liquefied natural gas (LNG), diesel/LNG, and petrol/methanol.

For decades, diesel buses have been the backbone of public transport in India due to their widespread availability and the country's extensive diesel fuel infrastructure. Amid growing environmental concerns, however, CNG buses have become popular in urban areas, particularly where stricter emission norms apply. While the government has recently sought to promote the adoption of electric buses, e-bus deployment remains nascent—making up less than 1% of the total fleet on the road as of March 31, 2025. However, it has been gaining momentum: According to MoRTH (MoRTH, 2025) data, 3,800 out of the 44,000 buses (8.6%) registered in 2024 were electric, a substantial increase from the year prior.

OWNERSHIP

Table 4 categorizes bus types in India based on different ownership models. Various innovative approaches have been adopted to offer affordable transportation while reducing risks, encouraging innovation, and fostering sectoral growth.

Table 4. Leading deployment models of buses in India

Deployment model	Characteristics
STUs	STUs are government-owned corporations that provide public bus services within and between states. They are characterized by large fleets and regulated fare structures.
Special purpose vehicles (SPVs)	SPVs allow public entities (e.g., municipal corporations) to establish distinct legal entities to oversee and bear the risks associated with public bus operations. Examples include Ahmedabad Janmarg Ltd., which operates the Ahmedabad Bus Rapid Transit System, and Surat Sitilink Ltd., which operates the Surat Bus Rapid Transit System.
Private operations	Private operations are often deployed on intercity or contract routes and are characterized by non-regulated pricing.
PPPs	PPPs involve collaboration between the public and private sectors to provide transit services. Examples include the Delhi Cluster Scheme, a bus transit partnership between the Government of Delhi and private operators, and aggregated bus procurement under GCC contracts via schemes like FAME, NEBP, and PM E-Bus Sewa.

USE CASES

Table 5 categorizes buses by use case. While most buses in India operate on intercity and non-urban routes (Khanna et al., 2024), city buses also make up a substantial portion of the overall fleet.

Table 5. Buses in India by use case

Use case	Description
Intracity	• Frequent stops with high passenger turnover and average speeds • Standing and seating capacity and quick access in and out of buses • Ideal for short- to medium-distance travel within dense urban areas • Includes city buses, bus rapid transit, neighbourhood buses, and metro feeder services
Intercity	• Designed for long-distance travel between cities and major towns • Typically feature air conditioning, reclining seats, and luggage space • Limited stops and time-bound services with pre-booked seating • Operated on highways or expressways, often with overnight journeys
Peri-urban / mofussil	• Link suburban, rural, or semi-urban regions to city centres • Varied frequency and comfort depending on trip length • Often used by daily commuters and not pre-booked • Vital for regional connectivity, often operated by state road transport corporations
School & staff	• Time-specific operations catering to institutions and workplaces • Prioritize high safety standards, often including GPS and CCTV • Fixed routes with minimal variation and typically low fluctuation in occupancy • Usually run under contracts with educational institutions or corporate entities

OPERATIONAL AND CONTRACTUAL MECHANISMS IN INDIA'S BUS SECTOR

Bus operations in India are governed by a variety of contracting and permit-based mechanisms, reflecting the diversity of stakeholders and service models across states. Public bus services are typically managed by STUs, which either procure buses outright through public tenders or engage private players through leasing and concession-based frameworks. With the emergence of electric buses, public authorities have increasingly turned to PPP models to address the capital-intensive nature of bus procurement and operation, especially in urban and intercity contexts. Table 6 presents information on several types of PPP arrangements.

Table 6. Types of PPP arrangements

Model	Details
GCC	• Buses are owned and operated by private providers (often OEMs or subsidiaries) • Fare revenues are retained by the government agency • The government agency pays operators a fixed per-kilometre rate under an agreement that stipulates the monthly minimum assured kilometres to be driven • Operators must provide drivers, maintenance, and charging infrastructure • The government agency provides conductors and may support basic infrastructure, like transformers
Hybrid GCC	• Same structure as GCC, except hybrid GCC includes performance-based incentives for ridership growth
Net cost contract (NCC)	• Buses are owned and operated by private operators • The operator retains fare revenue and bears demand risk • The operator must meet pre-specified service and performance indicators defined by the public agency
Hybrid NCC	• Same structure as NCC, except hybrid NCC operators receive financial support for low-ridership routes

Under the Motor Vehicles Act of 1988, intercity buses and charters are regulated by state and regional transport authorities, which issue different types of permits depending on the nature of the operation. For example, stage carriage permits, issued under Section 72, allow buses to operate on defined routes with boarding and alighting at multiple stops, and are typically used for intracity services; in many states, these permits are predominantly issued to public sector operators (Shridhar, 2016). Contract carriage permits, under Section 74, are widely used by private operators for intercity operations; under such permits, pick-up and drop-off are restricted to fixed origin and destination points without en-route boarding. The All India Tourist Permit (AITP) allows interstate travel for buses designed for tourism; these permits require higher fees but provide flexibility in cross-border operations, as discussed in greater detail below. Meanwhile, temporary permits under Section 87 are used to meet short-term or seasonal demand and are often granted for limited periods.

In practice, there have been challenges implementing this framework. In many cases, operators use contract carriage permits for services that functionally resemble stage carriage operations, leading to enforcement ambiguities. Disparities across states in enforcement, fare controls, and permit issuance have also created operational hurdles for private players, who must navigate varying requirements related to fees, insurance, vehicle age limits, and route approvals (Shridhar, 2016).

The type of bus contracting arrangement or permit used directly influences fleet planning, service quality, and ability to access charging infrastructure. Public agencies often exercise greater control under GCC and Hybrid GCC models, while private operators enjoy higher autonomy under NCC and permit-based models, albeit with greater exposure to operational and financial risks. As electric mobility becomes more prominent, contractual and operational models continue to adapt, reflecting the evolving demands of service delivery, asset ownership, and regulatory compliance in India’s rapidly transforming bus sector.

EXISTING BUS OPERATIONS

As of March 2025, around 2.5 million buses were registered across India (MoRTH, n.d.). Most operated under private operators or institutions (e.g., educational and corporate entities) on a contract carriage basis. According to data gathered by the Association of State Road Transport Undertakings (ASRTU) from 61 STUs, there were 145,490 public buses in operation as of March 2025, of which 97,165 were involved in intercity operations and 48,325 were deployed along urban routes (MoRTH, 2025). Public buses thus constitute approximately 6% of the total operational buses in the country, while 94% of bus operations are managed by private sector operators. Table 7 describes the registered bus fleet as of March 2025 by fuel type, based on MoRTH (n.d.-a) data.

Table 7. Buses registered as of March 2025, by fuel type

Type	CNG	Diesel	Petrol	Electric	Other	Total
Bus	77,982	1,190,615	10,624	11,082	19,289	1,309,592
Educational institution bus	8,267	314,532	4,601	43	445	327,888
Omni bus	1,340	142,317	12,909	254	4,429	161,249
Omni bus (private use)	223	438,539	147,590	61	79,032	665,445
School bus	13	100	0	0	0	113
Total	**87,825**	**2,086,103**	**175,724**	**11,440**	**103,195**	**2,464,287**

Source: MoRTH, n.d.

Definitions: Buses are motor vehicles with seating for more than six passengers, used for hire or reward. Educational institution buses are owned and operated by an educational institution, used exclusively to transport students and staff. Omni buses are buses for hire, not tied to a specific institution or public service. Omni buses (private use) are buses with similar specifications as an omni buses but are registered for private use and not for hire. School buses are specifically designed, painted (typically yellow), and labeled for transporting school children.

Note: The "other" category includes buses with either dual or hybrid fuel types, such as petrol/CNG, diesel/CNG, diesel/LNG, diesel/LNG, and petrol/methanol.

India's 2.5 million buses carry 399 million trips daily, of which intercity buses carry 228 million trips—10 times the daily ridership of Indian railways (Gadepalli et al., 2024). According to data from RedBus released in 2024, intercity buses traveled 4.1 crore kilometres daily as of 2023, averaging 207 km in trip length (Economic Times, 2024). The report also notes that 4.2 lakh distinct bus routes connected nearly 10,000 cities and villages during the year, with plans to add an additional 20,000 new routes attributing to expansion of India's highway network and convenience of last minute travel. Notably, 56% of bus reservations came from smaller towns and non-metro areas highlights how intercity buses are commonly used in such areas to reach airports or train stations (Coach Builders India, 2024).

Table 8 presents annual bus registrations in India from 2019 to 2025 by fuel type. According to ASRTU data and MoRTH annual reports, the number of public buses operating on intercity routes declined from 101,908 in 2022 to 97,165 in 2025, a net reduction of 4,743 buses, as older vehicles aged out of the fleet and delivery of electric buses faced delays (MoRTH, 2022, 2025).[2] By 2030, the Government of India hopes to replace around 800,000 diesel buses with electric ones, including all STU-operated buses (Mukherjee & Mishra, 2023).

Table 8. Annual bus registrations by fuel type, 2019–2025

Year	CNG	Diesel	Electric	Petrol	Total
2019	3,996	88,099	506	4,258	96,859
2020	2,977	42,329	88	499	45,893
2021	1,088	16,693	1,176	178	19,135
2022	5,187	40,189	1,990	158	47,524
2023	5,052	71,742	2,676	2,713	82,183
2024	7,708	90,362	3,736	3,864	105,670
2025 (through 03/31)	2,964	27,355	1,018	783	32,120
Total	**28,972**	**376,769**	**11,190**	**12,453**	**429,384**

Source: MoRTH, n.d.-a; Note: The data highlight four major fuel categories for comparison and do not include other fuel categories (e.g., hybrid or two or more combination fuel types).

Annual bus registration data indicate a steady increase in newly added buses in India across all fuel types, with no clear pattern of increase or decrease for any particular category. While diesel buses continue to dominate in absolute terms, the share of electric buses has increased substantially since 2021. This trend is particularly evident in the 2023 and 2024 registration figures, where electric buses constituted a growing proportion of total registrations. The transition has been driven by a combination of factors, including targeted national- and state-level policy incentives (such as FAME II, NEBP, PM E-Bus Sewa, and PM E-Drive) and dedicated electric bus procurement programs. Despite an overall dip in registrations in 2020–2021, attributed to pandemic-related disruptions, post-2022 data reflect a strong recovery and an accelerating shift towards bus

2 MoRTH mandates a fitness test for all commercial vehicles; those that fail are scrapped.

fleet electrification. Registrations of petrol and CNG buses have also been on the rise, likely owing to a lack of supply and the high upfront cost of electric buses (Keerthi, 2025).

In India, 95% of bus operators manage fleets of fewer than 50 vehicles and 78% manage fleets of fewer than five. Meanwhile, the top 5% of operators account for 61% of the total fleet (Gadepalli et al., 2024). The country's bus market is thus highly fragmented among small operators and concentrated among larger ones.

GOVERNMENT SUPPORT FOR E-BUSES IN INDIA

India's approach to strengthening its urban public transport systems has evolved considerably over the last two decades. Beginning with the introduction of the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) in 2005, the central government has progressively refined its strategy to align with broader sustainability and climate objectives. This section provides an overview of key national initiatives supporting bus-based public transport, with a specific emphasis on the shift toward electrification.

FOUNDATIONAL PHASE: JNNURM (2005–2014)

The JNNURM program marked the first major central government intervention to modernize city public transport fleets. Targeting 111 cities and clusters, the program sanctioned approximately 9,532 buses, with ₹4,597 crore in central assistance (MoHUA, 2014). Although primarily aimed at diesel and CNG fleet renewal, JNNURM institutionalized public transport as a priority within urban policy and financing frameworks. The scheme also established a precedent for central government support in the procurement and operational enhancement of buses.

EARLY ELECTRIFICATION: FAME I (2015–2019)

The FAME I scheme introduced electric mobility into the public transport policy landscape. Launched as a pilot program, FAME I supported the procurement of 425 electric buses across nine cities between 2017 and 2019, including 400 battery electric buses and 25 hybrid buses allocated to the Mumbai Metropolitan Region Development Authority (Ministry of Heavy Industries, 2024). The scheme permitted cities to procure buses through outright purchase or under the GCC model, with demand incentives linked to localization levels. While the program achieved 100% deployment of allocated buses, there were implementation challenges, including non-standardized contract structures, a lack of operational experience among STUs, and inconsistent pricing bids, highlighting a need for structural reforms in procurement and financing (Convergence Energy Services Limited [CESL], 2023).

SCALING AND STRUCTURING: FAME II (2019–2022)

Building on FAME I, FAME II was launched in 2019 with a total outlay of ₹10,000 crore, of which ₹3,500 crore (35%) was allocated for approximately 6,862 electric buses. Unlike its predecessor, FAME II mandated the use of the GCC model and introduced a model concession agreement (MCA) to standardize bidding and contractual terms across cities. Initial screening identified 64 cities, and 36 request for proposal (RFP) tenders were issued for 3,390 buses with enhanced subsidy caps of up to ₹50 lakh per bus. The remaining buses were procured under a demand aggregation process through CESL, a subsidiary of Energy Efficiency Services Limited (EESL), a joint venture of state-run power companies. Table 9 presents the number of buses allocated and supplied under each process.

Table 9. Bus procurement under the FAME II scheme

Procurement type	Allocated	Supplied	Pending
RFP	3,390	3,192	198
Demand aggregation via EESL/CESL	3,472	1,597	1,875
Total	**6,862**	**4,789**	**2,073**

Despite these institutional improvements, cities continued to face capacity constraints, especially in managing operational expense (OpEx)-based contracts, developing charging infrastructure, and aligning timelines of project milestones with subsidy disbursal. Electricity tariffs and infrastructure readiness varied substantially across states, and COVID-19 further disrupted procurement schedules.

DEMAND AGGREGATION AND BENCHMARKING: GRAND CHALLENGE (2021–2022)

In 2021, the Government of India launched the Grand Challenge, a centralized demand aggregation program through CESL that targeted nine high-demand cities with populations exceeding 4 million, including Delhi, Mumbai, Bengaluru, and Kolkata. Using an OpEx-based GCC framework, the program aggregated demand for 5,450 e-buses (up from an initial 3,472) with standardized technical and commercial specifications. CESL introduced a unified RFP process with defined parameters, such as daily minimum kilometres, charging infrastructure, and a 12-year contract duration. Benchmark prices attained through this process were 23%–27% lower than diesel bus operations and 31%–35% lower when FAME II subsidies were applied (CESL, 2023). This demand aggregation model significantly de-risked private investment and reduced procurement inefficiencies, offering a replicable framework for subsequent large-scale tenders.

PROGRAMMATIC EXPANSION: NATIONAL ELECTRIC BUS PROGRAM (NEBP, 2022–PRESENT)

To institutionalize this aggregation strategy, the NEBP was launched with the long-term goal of deploying 50,000 e-buses. The first NEBP tender secured 6,465 buses across six states and union territories, with rates as low as ₹39.8/km—approximately 29% lower than prevailing diesel bus OpEx (Press Trust of India, 2023). These buses are expected to have cumulative operations of 5,718 million km, displacing 1,842 million liters of diesel and avoiding 4.62 million tonnes of CO_2 over 12 years (Press Trust of India, 2023). However, the subsequent NEBP tender, for 4,675 buses in Tier 2 and Tier 3 cities, was characterized by limited OEM participation (Kumar, 2023). The absence of subsidies, higher operational risks under the GCC, and limited depot readiness may have constrained participation in this second tender, highlighting that financial guarantees and other policy support may be needed to promote e-bus adoption in non-metropolitan contexts.

EQUITY IN DISTRIBUTION: PM E-BUS SEWA (2023–PRESENT)

The PM e-Bus Sewa scheme was launched in 2023 with an outlay of ₹20,000 crore to deploy 10,000 e-buses across 169 Tier 2 and Tier 3 cities. While the NEBP tender had not provided financial subsidies to support e-bus deployment in these cities, the PM E-Bus Sewa has made provision for purchase subsidies as well as financial incentives to support infrastructure development. Managed by CESL, the scheme entailed a PPP model with central government assistance covering both rolling stock and upstream (behind the meter) infrastructure (MoHUA, 2023). Moreover, to mitigate financial risk for OEMs, the government introduced the payment security mechanism, a fund to ensure timely disbursal of payments to private operators and OEMs under the GCC model to address the issue of potential payment default by STUs.

FLEET RENEWAL AND TARGETED DEPLOYMENT: PM E-DRIVE (2024–PRESENT)

The most recent initiative, PM e-Drive, has allocated ₹4,391 crore for the procurement of 14,028 e-buses through a demand aggregation model targeting nine large cities. Prioritizing fleet replacement within STUs, the scheme incorporates region-specific procurement pathways to account for operational challenges in hilly, coastal, and island geographies. Cities were allowed to adopt non-OpEx procurement where viable to reflect local market constraints. Table 10 presents support for electric bus adoption by scheme.

Table 10. Support for electric bus adoption, by scheme

Scheme	Launch year	Electric buses sanctioned	Funding allocation	Procurement model
FAME I	2015	425	₹280 crore sanctioned for buses (electric and hybrid)	Choice of outright purchase (CapEx) or GCC (OpEx)
FAME II	2019–24	6,862	₹3,545 crore earmarked for e-buses	GCC (OpEx, per-km subsidy); 3,390 buses procured through direct STU procurement and 3,472 through demand aggregation via CESL
NEBP	2022–23	1st tender: 6,465 2nd tender: 4,675	₹82,000 crore	GCC (OpEx) through demand aggregation via CESL
PM e-Bus Sewa	2023	10,000	₹20,000 crore earmarked as central government assistance for bus GCC cost and changing infrastructure	GCC (OpEx, per-km subsidy) through demand aggregation via CESL; subsidies also include charging and bus-related infrastructure.
PM e-DRIVE	2024	14,028	₹4,391 crore earmarked for e-buses in nine cities with populations over 4 million	GCC (OpEx, per-km subsidy), procurement through demand aggregation via CESL; support includes infrastructure, research and development, and charging for intra- and intercity buses

PRICE DISCOVERY: REDUCING PER-KILOMETRE OPERATING COST OF E-BUSES IN INDIA

Central government support for e-bus adoption in India began with a pilot in Himachal Pradesh in 2015 by the Department of Heavy Industry (now the Ministry of Heavy Industry). The learnings from this pilot provided a benchmark for indicative prices. The Himachal Road Transport Corporation's (HRTC) first service began in 2017, with 25 electric buses (Singh, 2022). Government-supported procurement processes have since been critical for driving down costs and improving efficiency.

As noted above, the FAME I scheme piloted 425 e-buses. The program included 60% purchase subsidies on the upfront cost of buses, allowing procurement via outright purchase or GCC. Tables 10 and 11 present information on the bid rates that resulted under Fame I under outright purchase and GCC arrangements, respectively.

Table 11. Details on GCC procurement under FAME I by participating city

City	OEM	Bus type	Bid rate (₹/km)	Remarks
Bengaluru	Goldstone	9 m AC bus	29.28	Cost of electricity borne by the STU
Hyderabad	Goldstone	9 m AC bus	36.00	Cost of electricity borne by the STU
Ahmedabad	Tata Motors	9 m AC bus	48.00	
Mumbai	Goldstone	9 m AC bus	57.00	
Jaipur	Tata Motors	9 m AC bus	70.00	
Mumbai	Goldstone	9 m non-AC bus	51.00	
Bengaluru	Goldstone	12 m AC bus	35.35	Cost of electricity borne by the authority
Hyderabad	Goldstone	12 m AC bus	40.30	Cost of electricity borne by the authority

Table 12. Details on outright purchase procurement under FAME I by participating city

City	OEM	Bus type	Bid rate (in lakhs ₹)	Remarks
Indore	Tata Motors	9 m AC bus	85	
Lucknow	Tata Motors	9 m AC bus	85	
Kolkata	Tata Motors	9 m AC bus	77	Price of chargers separate
Jammu	Tata Motors	9 m AC bus	99	Price of chargers separate
Guwahati	Tata Motors	9 m AC bus	99	Price of chargers separate
Kolkata	Tata Motors	12 m AC bus	88	

In 2019, the FAME II scheme brought several advancements by mandating the GCC-based procurement using a standardised MCA issued by the Government of India.

CASE STUDY: ELECTRIC BUS PROCUREMENT IN MAHARASHTRA

The evolution of electric bus procurement in Maharashtra offers insights into how contract structuring and procurement scale shape price discovery. A 2022 ICCT study (Dhole, 2022) analysed e-bus adoption by Brihanmumbai Electric Supply and Transport (BEST, in Mumbai), Pune Mahanagar Parivahan Mahamandal Ltd. (PMPML), and Navi Mumbai Municipal Transport (NMMT) and their distinct procurement pathways under the FAME I and FAME II schemes. Over time, these agencies moved from smaller pilots and outright purchases to larger tenders using the GCC model with assured kilometre provisions. This shift enabled the agencies to unlock more competitive per-kilometre rates, as vendors responded more favourably to structured, long-term demand with reduced financial uncertainty. Tables 13–15 show the progression of this price discovery in each case.

BEST, MUMBAI

Table 13. Annual electric bus procurement for BEST

Year	2017	2018	2019	2021*	2022	2022
Scheme	FAME I		FAME II			
Procurement model	Outright purchase	GCC	GCC	GCC	GCC (double decker)	GCC
Number of buses	Midi non-AC: 6	Midi AC: 20 Midi non-AC: 20	Midi AC: 200 Standard AC: 140	Mini AC: 100 Midi AC: 400 Standard AC: 1,400	10 to 10.5 m AC: 900	Standard AC: 2,100
Contract Cost (₹/km)	N/A (outright purchase)	Midi AC: 55.17 Midi Non-AC: 51.75	Midi AC: 74 Standard AC: 83	Mini: 43.75 Midi: 44 Standard: 54.85	56	46.81
Contract period	N/A (outright purchase)	10	10	10	12	12
Assured km	N/A (outright purchase)	4,000/month	4,750/month	5,800/month	5,000/month	5,800/month

* This procurement was cancelled for administrative reasons in February 2022 and a fresh tender was floated later.

PMPML, PUNE

Table 14. Annual electric bus procurement for PMPML

Year	2018/2019	2021 (FAME II)	2021
Procurement model	GCC	GCC	GCC
Number of buses	Midi AC: 25 Standard AC: 125	Standard AC: 150	Standard AC: 350
Contract cost (₹/km)	Midi AC: 40.32 Standard AC: 58.5	63.95 (includes depot development)	67.4 (includes depot development)
Contract period	10 + 2 years	10 + 2 years	10 + 2 years
Assured km	225/day	225/day	225/day

Note: Approximate electricity cost for PMPML = ₹8/km; approximate conductor cost for PMPML = ₹11/km.

NMMT, NAVI MUMBAI

Table 15. Annual electric bus procurement for NMMT

Year	2018	2021
Scheme	FAME I	FAME II
Procurement model	Outright purchase	GCC
Number of buses	Midi AC: 30	Midi AC: 45 Standard AC: 105
Contract cost (₹/km)	Maintenance cost under comprehensive maintenance cover (CMC): 7.05	Midi AC: 52.2 Standard AC: 69.9
Contract period	CMC for 10 years	12 years
Assured km	N/A (outright purchase)	6,050 per month for midi AC 6,780 per month for standard AC

Note: Approximate conductor cost per km for NMMT = ₹ 11/km.

Even with a standardised MCA framework, cities experienced widely different prices, showing that local context is critical for price discovery. Differences in fleet size, assured kilometre commitments, technical specifications, and inclusion of costs like depot development played a major role, as did bidder perceptions of credit risk linked to each city's financial health. For example, BEST's rates fell from ₹83/km in 2019 to ₹44–₹47/km by 2022, driven by larger procurements, better contract design, and stronger institutional capacity. This underscores that beyond national policy, city-level execution, and smart contracting are key to unlocking cost-effective electric bus adoption.

CESL'S GRAND CHALLENGE & NEBP: E-BUS PROCUREMENT TURNING POINTS

Following the FAME I and II schemes, NITI Aayog identified key improvements needed for India's electric bus transition. Their analysis indicated that focusing procurement on major cities with capable transit agencies and adopting aggregated demand models could drive faster e-bus uptake (CESL, 2023). The Grand Challenge brought a record-low operational cost of ₹43.49 per kilometre in the bidding process, 28%–52% cheaper than FAME II contracts. When accounting for subsidies, the costs were 31%–35% lower than those of diesel/CNG buses, translating to projected savings of more than ₹10,800 crore over the 12-year contract period (CESL, 2023). The Grand Challenge thus outperformed both conventional fuels and previous tenders across various bus types and cities. Figure 2 visualizes this rate comparison, capturing the evolving price trajectory of electric bus procurement across procurement models, from early tenders and FAME contracts to the consolidated, subsidy-free NEBP model (CESL, 2023).

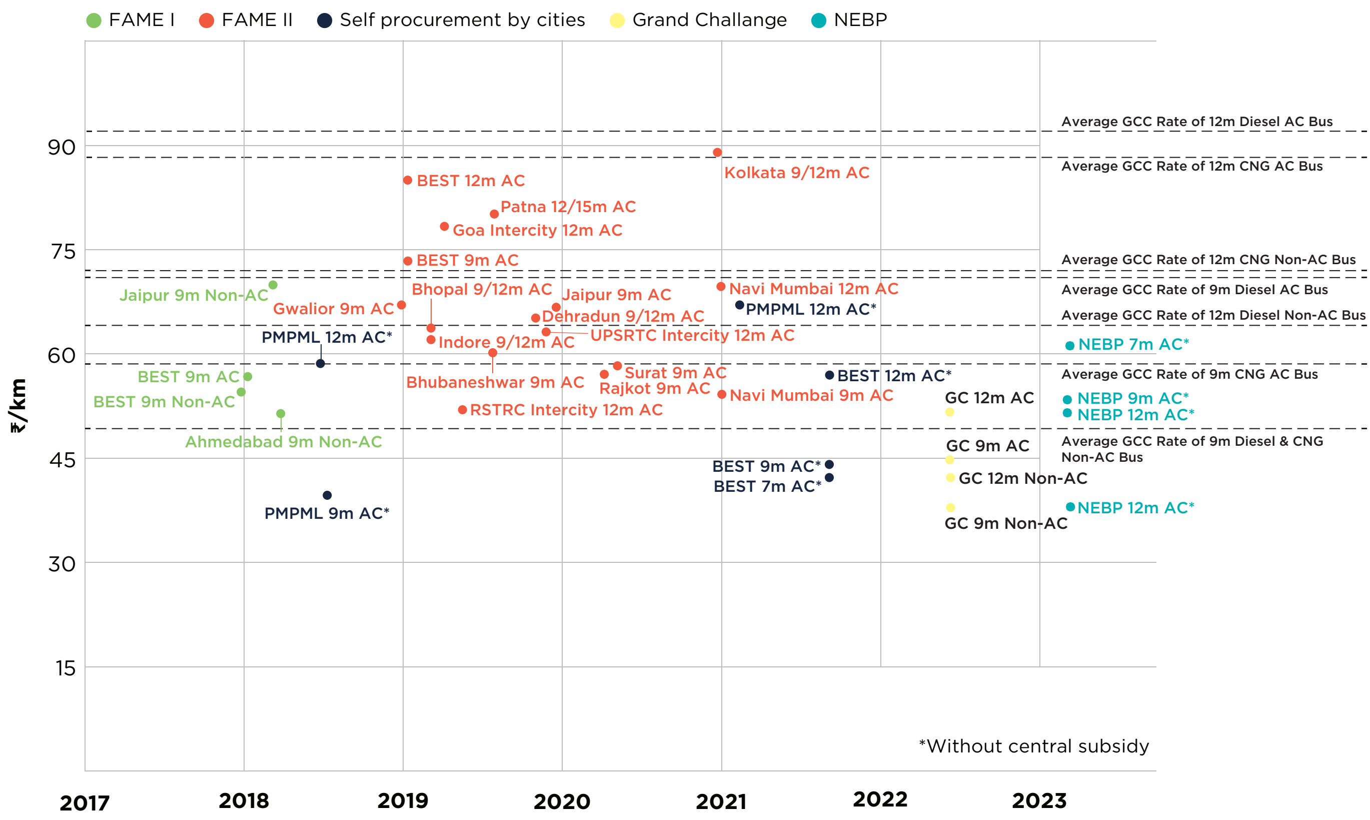

Figure 2. Rate comparison under each challenge/scheme

Aggregated procurement has helped India unlock economies of scale in e-bus deployment, driving down per-kilometre operating costs. As subsidy frameworks evolve, sustained cost reductions will depend on competitive bidding, smarter contracting, and market maturation. India's next leap lies in scaling this model across states with greater private sector participation.

PRIVATE SECTOR INITIATIVES

India's bus transport sector is characterised by a high degree of privatisation, particularly in the intercity and informal transit segments. For private operators, the AITP has served as a key regulatory mechanism enabling them to run long-distance intercity bus services across state boundaries. Originally intended for tourism-related, non-scheduled travel, the AITP allows buses to operate nationwide upon payment of a higher quarterly permit fee (of approximately ₹1.7 lakh), without requiring route-level approval from individual states. This regulatory flexibility has made the AITP a preferred framework for private players, including those deploying electric buses, to offer scheduled-like intercity services that functionally resemble line-haul operations. Cities like Delhi, Mumbai, and Bengaluru have also introduced aggregator licenses—that is, permits for companies running premium buses like CityFlo, Uber Shuttle, and Chalo—for tech-enabled, app-based bus operations. Collectively, these permit structures define the operating landscape for bus-based services in India, with the AITP serving as a practical workaround for private electric bus deployments in the intercity segment.

Among early entrants in the intercity electric bus segment, NueGo leads with a fleet of 255 electric buses, followed by FreshBus with 25 (Keerthi, 2025). Other operators such as Leafy Bus and FlixBus have also begun intercity e-bus operations. FlixBus, a major player in Europe's zero-emission transport landscape, is expanding its electric fleet as part of its global sustainability strategy and has expressed strong interest in electrification in India since commencing operations last year.

Electric bus deployment by these private operators continues to face supply-side constraints. Based on stakeholder consultation, the current manufacturing pipeline is largely geared toward fulfilling bulk orders from governments for public sector deployment under the GCC model. Consequently, private operators, particularly those with smaller fleet sizes or limited institutional support, encounter difficulties in accessing vehicles, establishing charging infrastructure, or securing cost-effective financing. Moreover, unlike state-contracted services, these operators lack guaranteed revenue streams, making their business models more susceptible to volatility in demand and fuel prices (Keerthi, 2025).

The Ministry of Heavy Industries has drafted a framework for the development of electric vehicle public charging stations (EVPCS) along 40 designated highway corridors (Government of India, 2024). While not explicitly targeted at the private bus sector, these corridors present opportunities for the scaling of private intercity electric bus services. The availability of charging infrastructure on long-distance routes is likely to influence future routing choices and fleet expansion strategies among private carriers operating under the AITP model.

The operating landscape for private electric bus deployment in India has thus been shaped by permit design, manufacturing orientation, and infrastructural availability, among other factors. While early market activity has emerged in part through a circumvention of traditional regulatory channels via the AITP, the long-term scalability of such operations will depend on the resolution of foundational institutional and infrastructural asymmetries.

PRIVATE E-BUS OPERATOR CASE STUDIES

This section presents case studies to examine private operators that are leading early deployment efforts and highlight key trends in deployment, infrastructure, and operations. The objective is to explore the motivations driving these operators to enter the electric bus segment, understand the strategic choices behind their operational models, assess the initiatives undertaken, and identify the geographies and corridors they are targeting for expansion. Information in this section is based on stakeholder consultations.

Most intercity e-bus services are concentrated along 250–300 km corridors (Dhingra & Wadhwa, 2021), using 12 m air conditioned coaches with effective ranges between 280 and 320 km. These buses typically operate under AITPs, allowing interstate movement without state-level permissions. Two main operational models characterize the private intercity e-bus market in India. Under the owner-operator model, buses are self-owned, providing end-to-end control over the fleet, depot, routing, and fare systems and enabling consistency in service delivery and operational planning. Under the aggregator model, bus operators rely on a partner operator to manage a platform to coordinate ticketing, branding, and scheduling.

Charging infrastructure plays a pivotal role in the viability of intercity e-bus operations. During the stakeholder consultation, we found that most operators deploy 180–240 kW DC fast chargers, placed at terminals and en-route charging locations, strategically placed around 150 km apart. These are typically powered via high-tension lines, with investment models varying based on whether charging assets are owned or contracted. Owner-operators generally own the charging infrastructure they use, and co-locate passenger rest areas with charging points to maximise asset use; under aggregator models, operators rely on partner depots, enabling faster scale but introducing some variability in charger access and scheduling. Capital expenditure approaches also differ across models. Owner-operators invest directly in vehicles, depots, and chargers, often through internal accruals or OEM-linked financing, while reliance on aggregators can enable growth through the use of partner-led infrastructure with shared responsibilities and limited upfront CapEx. The PM E-Drive scheme includes subsidies to support the deployment of charging infrastructure for buses along highways, with a focus on electrifying 40 priority highway corridors (Government of India, 2024). This is expected to help intercity operators deploy electric buses.

Digital ticketing is now standard across the intercity e-bus segment, though platforms vary by model. Owner-operators often use proprietary apps with features like seat selection, trip tracking, and customer loyalty programs. Aggregator models typically operate centralised booking platforms across multiple fleets, enabling wider reach. While integration with urban or multimodal systems remains limited, both models are advancing customer convenience through digital interfaces. Operators also have sought to enhance passenger comfort at bus depots, including through the establishment of waiting lounges equipped with amenities.

To enhance vehicle efficiency, reduce operations and maintenance costs, and build workforce capacity, many owner-operators have implemented EV training programs for drivers and technicians. Aggregator models, for their part, generally rely on training protocols set by partner operators, which vary in their level of standardisation. Meanwhile, performance indicators such as energy consumption, charger uptime, and route-level operating costs are gradually becoming more transparent, presenting an opportunity to strengthen benchmarking and informed decision-making concerning the deployment of e-buses.

Both models demonstrate scalable pathways. Owner-operator services offer consistency and control but require greater capital and land access. Aggregator models entail partnerships between multiple actors, which can lead to gaps in service provision, but can enable rapid expansion and market access. Future policy support could focus on standardising shared infrastructure, training frameworks, and data transparency to strengthen the overall ecosystem and accelerate corridor-level electrification. Table 16 summarizes the insights from our stakeholder conversations.

Table 16. Insights from private sector case studies

Aspect	Owner-operator model	Aggregator model
Ownership	Operator owns fleet, depots, and chargers	Partners own fleet and depots; aggregator coordinates operations
Control	End-to-end control over service quality, scheduling, pricing	Shared control; aggregator handles branding, ticketing, scheduling
CapEx	High upfront CapEx (for vehicles, depots, and chargers)	Low upfront CapEx; relies on partner investment
Financing	Internal accruals, OEM-linked financing	Partner-funded infrastructure; shared responsibilities
Charging infrastructure	Owned by the operator, often co-located with rest areas	Partner depots used; charger access can vary
Deployment speed	Slower due to land, CapEx, regulatory needs	Faster scale-up through flexible partnerships
Service consistency	High consistency in quality and operations	May vary by partner operator
Training & workforce	Structured in-house EV training for drivers and technicians	Partner-led training; varies in standardisation
Digital ticketing	Proprietary apps with advanced features	Centralised platform across multiple fleets
Data transparency	High, with emerging focus on route-level and charger metrics	Depends on partner cooperation; improving gradually
Customer amenities	Invests in gender-inclusive lounges and dedicated infrastructure	Amenities depend on partner depots; driven by aggregator guidelines
Permits	AITP	AITP
Geographic targeting	200–350 km corridors with planned infra at 150 km intervals	Similar corridor focus; en-route infrastructure depends on partnerships
Scalability	Scalable with capital and land access	Scalable with partner onboarding
Opportunities for policy	Land access, grid augmentation, subsidy reform	Shared infrastructure norms, standardised training, and data frameworks

TOTAL COST OF OWNERSHIP

Past studies have demonstrated that the TCO of e-buses is lower than that of diesel buses in India, due to reduced operating and maintenance costs (Khanna et al., 2024; Gadepalli et al., 2024; Vijaykumar et al., n.d.). Electricity tariffs and lower maintenance requirements contribute to this cost advantage. Nevertheless, a consistent theme of our interactions with industry stakeholders, operator associations, and other key players in the bus transport sector was that private operators' hesitation to adopt e-buses stems from their higher upfront cost compared to diesel buses. Financial experts noted that current pricing is heavily influenced by the structure of government tenders, and that more competitive pricing—in other words, a lower upfront cost—will be necessary for broader private sector uptake.

In light of these findings, we conducted a total cost of ownership (TCO) analysis informed by operator inputs to better understand the economic case for intercity electric bus adoption under current market and operational conditions. Specifically, we calculated the TCO of buses operating on the three most common trip lengths cited in stakeholder interviews and found the unit rate cost at which the electric buses are cheaper than diesel buses. We assumed the same drive cycles and driving conditions across the three scenarios, with no significant differences in energy consumption per km across the different trip lengths. Details on the assumptions of this TCO analysis are highlighted in the Appendix.

The results of this analysis are presented in Table 17. As the daily range increased from 250 km to 350 km, e-buses demonstrated an increasing TCO advantage over diesel coaches. Assuming a 10-year ownership period and a battery change in the 5th year, the life-cycle savings increase from 7.05% for a 250 km trip length up to 17.36% for a 350 km trip length, highlighting how enhanced vehicle utilization, amortization of battery capital expenditure, and stable electricity pricing combine to widen the economic gap versus diesel operation. The sections below discuss each of these trip length scenarios in turn.

Table 17. TCO difference between electric and diesel buses

Distance	TCO difference (cost reduction of e-buses relative to diesel buses)	Battery range considered
250 km	7.04%	300 km
300 km	12.81%	300 km (with opportunity charging)
350 km	17.36%	320 km (with opportunity charging)

CASE A. 250 KM TRIP LENGTH WITH 300 KM E-BUS RANGE

An electric bus operating at a distance of 250 km is most appropriate for high-frequency intercity routes with predictable duty cycles and robust depot charging infrastructure. Based on the modelling assumptions outlined in the Appendix, for a prescribed 250 km daily duty cycle, e-buses outperformed their diesel counterparts in cumulative TCO by approximately 7.04% over a 10-year horizon (Figure 4). The break-even point occured in the 7th year, as the moderate premium paid for a right-sized battery pack is offset by substantially lower unit energy and maintenance costs from the first year of operation onward. However, the need for frequent mid-day or opportunity charging can introduce scheduling complexity and may curtail vehicle utilization absent ample depot charging capacity.

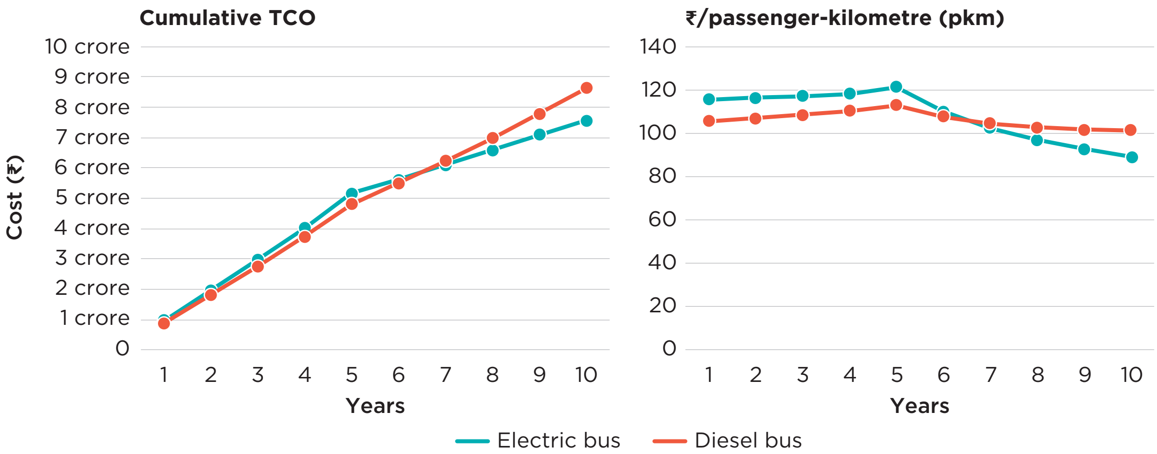

Figure 3. TCO for 250 km bus range

CASE B. 300 KM TRIP LENGTH WITH 300 KM E-BUS RANGE

An electric bus operating for 300 km with opportunity charging presents an optimal balance for medium intercity services supported by moderate charging infrastructure. Extending the duty cycle to 300 km accelerates cost parity, yielding a 12.81% TCO advantage over diesel over the 10-year ownership period with a break-even point in the 5th year, after which the cost of e-buses steadily decreases relative to its diesel counterpart due to lower fuel, operations, and maintenance costs (Figure 5). The larger battery for the 300 km trip increases the up-front capital expenditure, but higher annual travel dilutes the CapEx per kilometre and unlocks deeper operational savings. Optimizing charging availability and bus operational efficiency enable better utilization of electric buses, higher service-revenue ratios, reduced maintenance costs, and lower indirect costs such as driver downtime.

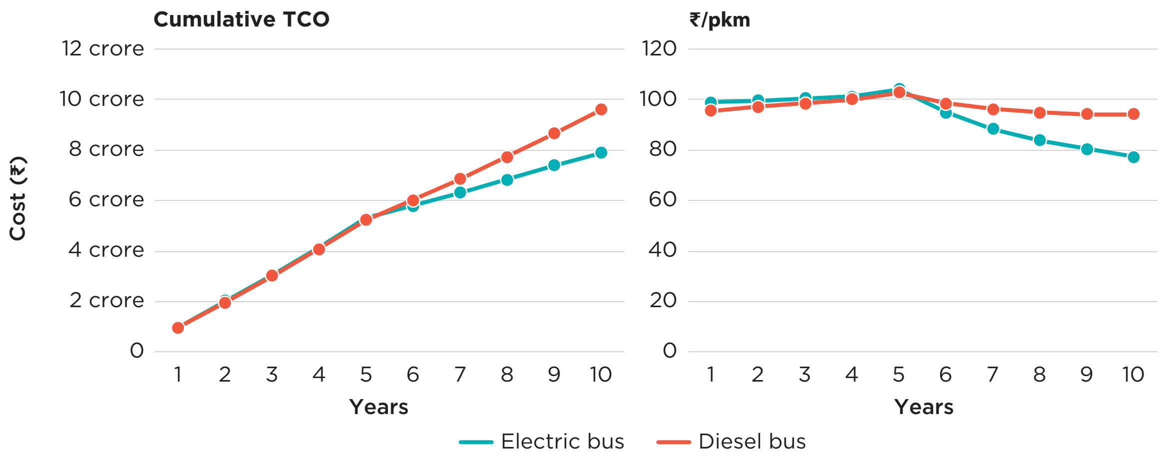

Figure 4. TCO for 300 km bus range

CASE C. 350 KM TRIP LENGTH WITH 320 KM E-BUS RANGE

A 350 km-range e-bus is suited for long-haul intercity corridors, low-frequency services, and regions where charging infrastructure is strategically located for opportunity charging. With a 350 km trip length and 320 kWh battery capacity, e-buses reach cost parity within the first year—the earliest TCO advantage observed among the three cases—and realize a 17.36% cost reduction versus diesel over the 10-year ownership period (Figure 6). Although this scenario requires the highest battery outlay, maximal range utilization, including opportunity charging, ensures the lowest per-kilometre financial burden, while electricity pricing stability shields operators from fuel-price volatility. Moreover, high-capacity batteries retain strong residual value for second-life applications, further improving total economic returns.

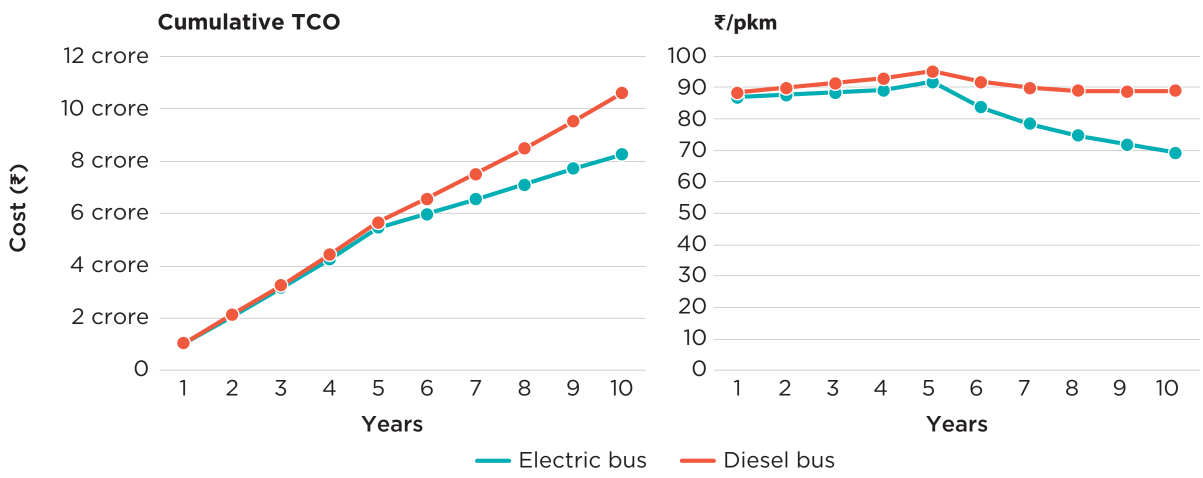

Figure 5. TCO for 350 km bus range

DISCUSSION

In general, the per-kilometre cost of the diesel bus stays high over time owing to assumed fuel-price volatility and escalating maintenance requirements, while the per-kilometre cost of e-bus operations declines owing to fewer moving parts and lower cost of maintenance. Increasing the duty-cycle distance directly enhances capital recovery. For instance, a 350 km range bus allocates battery CapEx over approximately 40% more annual kilometres than a 250 km range vehicle, thereby reducing the per-kilometre financial burden. Building on this principle, battery sizing emerges as one of the most critical levers for reducing the TCO in electric bus operations. The total cost of owning and operating e-buses improves substantially as the battery range increases, but not in a linear fashion: for instance, a 250 km range bus may have a 7%

lower TCO than a diesel equivalent when its battery capacity exceeds the daily travel distance; however, pushing the range to 300–350 km, where battery capacity is of equal or lower capacity than the travel distance, led to estimated savings of 12%–17%.

Deploying well-located charging infrastructure, especially near rest stops, depots, and terminals, combined with standardized, affordable electricity tariffs can unlock operational efficiencies. Such infrastructure allows bus operators to plan their routes and charging schedules more strategically, minimizing downtime and eliminating the need for oversized batteries. This not only makes electric buses more cost-effective for private players but also creates space for competitive fare pricing, enabling broader adoption. As battery technologies continue to evolve and vehicle efficiencies improve, the synergy between right-sized batteries and reliable public charging networks will become central to the success of India's intercity e-bus transition.

CHALLENGES AND THE WAY FORWARD

Electric bus adoption in India's public sector has gained momentum through the demand aggregation process, supported by central government subsidies and other schemes and state-level electrification targets. In contrast, the private intercity electric bus segment has seen a slower uptake, in part due to the absence of dedicated schemes, mandates, and demand aggregation mechanisms.

To better understand the barriers to e-bus uptake in the private sector, the ICCT conducted extensive consultations with a broad range of stakeholders, including representatives from government agencies, private operators, OEMs, financing institutions, academic researchers, and industry associations. Insights were gathered through one-on-one meetings, focused group discussions, closed-door panels, and engagements at leading transport expos and research forums. This input is summarized below in terms of key challenges and opportunities for scaling private-sector electric bus deployment in India.

CHARGING INFRASTRUCTURE

Insufficient charging infrastructure was cited as a key barrier to e-bus uptake. Intercity operators face a dilemma: while mid-route charging is technically feasible and, in many cases, already accessible via highway-side commercial chargers, there are bottlenecks in cities as at the start and end of trips, where access to depot infrastructure is unavailable for smaller operators and there is no dedicated charging infrastructures unless the operator has their own depot, which is only possible for large scale operators. Depot electrification involves high capital expenditure, including for land acquisition, upstream power augmentation, and equipment procurement, often without municipal support. Additionally, most highway-side chargers levy a premium of ₹4–5/kWh above the electricity tariff, substantially inflating operating costs for smaller operators. Equipment reliability remains low; imported chargers frequently underperform under Indian conditions, particularly in high ambient temperatures (above 45 °C), leading to overheating, dust ingress, and inconsistent charging performance.

The Government of India has recognized these gaps and proposed the electrification of 40 national highways as priority corridors in the Draft EVPCS guidelines under its PM E-DRIVE scheme (Government of India, 2024). These corridors present an opportunity to anchor the intercity e-bus market around predictable, optimally distanced routes of more than 300 kilometres, where single-charge operations or minimal en-route top-ups are feasible. However, the current absence of coordinated infrastructure rollout, pricing regulations, and operator integration with city-level mobility planning continues to limit this potential.

To resolve this, the government could consider mandating charging corridors along these 40 highways and working to ensure that they are equipped with standardised, heat-resilient charging technology. Pricing for charging services could be regulated under a cost-plus model (e.g., with markup capped at ₹1/kWh), and public-private charging points could be required to adopt uniform protocols to allow priority access for scheduled intercity buses. Furthermore, city authorities could be required to allocate parking and depot land within mobility plans, particularly for operators offering fixed intercity services, even if not affiliated with state-run undertakings.

TECHNOLOGY

Technological challenges further inhibit adoption. Most available electric buses in India are optimized for urban duty cycles (less than 200 km/day), while intercity routes, particularly in the 300–700 km range, require higher range reliability, robust thermal performance, and consistent battery degradation patterns. According to our consultations, operators remain sceptical of battery warranties, especially for vehicles using imported cells, and face prohibitive battery replacement costs, often constituting up to 40% of the vehicle's value. Moreover, vehicle costs remain high, with intercity electric buses priced between ₹1.5–2.15 crore, far above the target range of ₹1.0–1.2 crore likely to enable mass-market viability.

This gap is exacerbated by skills and service network deficiencies. Along intercity corridors, there is a severe shortage of trained mechanics and drivers familiar with EV-specific issues, especially high-voltage troubleshooting, thermal diagnostics, and battery management system interpretation. Standardized Annual Maintenance Contracts (AMCs) remain poorly enforced, and most OEMs lack after-sales support along long-distance routes. Operators, therefore, remain exposed to significant downtime risk in case of vehicle breakdowns.

Our stakeholder consultations highlighted that a multipronged strategy could help address these challenges. First, the government could support

OEMs to develop products specifically for intercity operations, with suitable range capabilities and enforceable warranties benchmarked to Indian climate conditions. Second, national skilling programs, such as under the National Skill Development Corporation (NSDC) and Automotive Skills Development Council (ASDC) could introduce intercity transport-focused EV service curricula, targeting highway-side service centres and fleet operators. Third, regulating agencies could support the standardization of AMCs to cover remote diagnostics, on-call support, and predictive maintenance, particularly for batteries. Battery leasing models could also be promoted to reduce CapEx and risk exposure for operators.

FINANCING

Financing constraints also continue to stifle the sector. Traditional lenders remain hesitant due to the absence of residual value benchmarks, a non-existent secondary market, and a limited track record of revenue recovery in intercity electric operations. Most private bus operators remain financially fragile post-COVID and outside formal lending channels. Regulatory ambiguity, particularly concerning AITP permits, interstate entry taxes, and urban pick-up/drop-off legality introduce further risk, deterring investors.

A shift to project-based financing could support e-bus adoption by bundling vehicle procurement, charging infrastructure, land, and soft costs under a unified debt structure assessed via revenue-linked models. The government could support this through risk-sharing mechanisms such as first-loss guarantees or viability gap funding for early deployments along the 40 identified corridors (Government of India, 2024). Further, a central data repository could be established to house anonymised operational data (e.g., on revenues, energy consumption, and costs) to support underwriters and policymakers. Regulatory clarity around intercity e-bus permits, tax harmonisation, and pick-up/drop-off legality could also help address investor concerns.

As batteries account for roughly 40%–50% of the total cost of e-buses (Ojha, 2024), the Government of India could also consider supporting battery-as-a-service (BaaS) models, which have gained traction globally as a means of reducing upfront vehicle cost. Leasing batteries on a per-kilometre or monthly basis, as seen in China and Kenya, can also offer financial flexibility for operators (Gowande, 2024; Shi & Hu, 2022). In India, MG Windsor EV introduced a pay-per-use battery model, signalling potential domestic interest in BaaS (TOI, 2024). Stakeholders are also exploring battery swapping for highway use-cases requiring rapid turnaround. The long-term viability of these models will ultimately depend on TCO considerations and operational feasibility across segments (Catsaros, 2024).

POLICY FRAMEWORKS

To promote electric vehicle uptake generally, the Government of India could consider establishing a national policy framework to mandate and guide the development of fast-charging infrastructure along all state and national highways. This framework could include uniform charging standards, affordable electricity tariffs, and integration with existing transport nodes such as bus terminals and rest stops. Such a policy would remove a major barrier for private intercity e-bus operators, reduce capital investment risks, and enable right-sized battery adoption by ensuring predictable access to charging

A dedicated task force or a program could also be launched that shall act as a facilitator for accelerating the deployment of zero-emission buses in the intercity segment, particularly through private sector participation to achieve India's net-zero goals. The program could act as a platform for electric bus adoption in the private sector by marshalling participation from the national government, state government, private bus operators, OEMs, and financers.

CONCLUSION

India's journey toward bus electrification has been shaped by a dynamic interplay of mission-driven public procurement, state-led innovation, and the recent entry of private sector operators. Earlier phases, anchored in schemes such as FAME I and II, focused on catalysing adoption through subsidies and government-owned deployments. Learnings from subsequent initiatives like the Grand Challenge and GCC contracting models showcased the benefits of demand aggregation and price discovery, reducing per-unit costs and accelerating scale. However, such efforts have primarily focused on intra-city applications, with comparatively limited support for the intercity segment, where challenges are more complex and the market more fragmented.

This study identified challenges and opportunities for electrifying India's intercity bus segment. It found that deploying electric buses on higher range (300+ km) routes maximises the estimated TCO benefits, offering up to 19% life-cycle savings. Achieving this level of savings will require strategic planning for fast-charging infrastructure, highway deployment schedules, and depot access within cities for private operators, among other enabling factors. Table 18 summarizes the barriers to intercity electric bus deployment in India and policy considerations identified in this study.

The Government of India's designation of 40 national highways as EV priority corridors is an opportunity to operationalise the intercity transition. However, converting this intent into impact will require synchronized action. As India works toward its environmental and climate goals, electrifying the private intercity bus fleet will be critical to addressing transport sector emissions and positioning the country as a leader in sustainable transport.

Table 18. Summary of challenges and policy considerations

Focus area	Challenges	Policy considerations
Infrastructure	• Absence of structured depot access at terminal nodes, particularly for private operators lacking institutional support. • High upfront costs of depot electrification, including for land acquisition and grid augmentation. • Tariff volatility and poor performance of highway-side chargers under ambient conditions.	• Designate and operationalize corridor-based charging nodes with standardized specifications for thermal resilience and interoperability. • Institute regulated cost-recovery pricing frameworks (e.g., capped cost-plus tariffs) to stabilize operational expenditure. • Integrate depot siting into urban mobility and zoning frameworks, ensuring spatial allocation for intercity services for private operators.
Technology suitability and platform optimization	• Current e-bus offerings remain urban-centric and generally unsuitable for 400–700 km intercity duty cycles. • Thermal management, battery degradation, and drivetrain reliability under extended range and load conditions are insufficiently validated. • Lack of enforceable warranty terms and non-adaptive battery management systems inhibit long-term viability.	• Encourage OEM innovation toward developing intercity buses and chargers with validated performance under Indian environmental, climate and duty-cycle conditions. • Support battery leasing and BaaS models to reduce capital lock-in and improve life-cycle cost predictability. • Mandate enforceable AMCs covering diagnostics, remote support, and failure response protocols aligned with intercity risk exposure.
Financial structuring and investment confidence	• Credit access for private fleet operators is constrained by a lack of collateralizable vehicle value, residual value benchmarks, and operational revenue data. • Fragmented regulatory frameworks (including AITP, inter-state taxation, and pick-up/drop-off legality) amplify perceived risk for investors. • Post-pandemic solvency of operators remains a latent but critical constraint on adoption.	• Promote project-based lending structures that bundle asset, infrastructure, and operational components, underwritten by verifiable demand and cashflow assumptions. • Deploy public-sector risk mitigation tools (e.g., first-loss guarantees, viability gap funding) targeted at early deployment corridors. • Establish a national, anonymized data repository to support underwriting, while concurrently pursuing regulatory harmonization through MoRTH-led coordination mechanisms.
Policy and institutional mechanisms	• Lack of standardised policy for charging infrastructure across India. • Absence of unified platform to tackle financing, procurement, and operational barriers for e-bus adoption by fragmented private intercity operators.	• Launch a national framework to standardize intercity charging, ensure affordable tariffs, and co-locate chargers with rest points. • Set up a separate program to accelerate adoption of zero-emission buses in the private sector.

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APPENDIX

Factor	Diesel bus	Electric bus	Remarks
Type of bus	Intercity AC bus	Intercity AC bus	
Type of battery (kwh)	0	Based on the battery type and distance (300–320 km)	Mulukutla et al., 2022
Type of charger (Kw)	0	80-120	Gadepalli et al., 2024
Time taken by a charger to fully charge a bus (hours)	0	4–6 hrs depending on the charger, bus type and battery capacity	Based on stakeholder consultation
Year of battery replacement (years)	0	5	Based on stakeholder consultation
Operational route length (km)	250/300/350	250/300/350	Based on stakeholder consultation
Travel time per trip (hours)	Calculated for each trip length and time of opportunity charging	5 hrs for 250 km 6 hrs for 300 km 7 hrs for 350 km	Average speed of 60–70 km/h + considering opportunity charging
Operational hours of each bus (hours)	16	16	Based on stakeholder consultation
Charging time at depot at each end (hours)	0	4–6 hrs depending on the charger, bus type and battery capacity	Based on stakeholder consultation
No. of crew per bus	5	6	Based on stakeholder consultation. Including driver + conductor + operations staff
No. of buses per charger	0	4	Based on stakeholder consultation
No. of days operational in a year	340	340	Based on stakeholder consultation,
Cost of bus (INR)	13,000,000	25,000,000	Based on stakeholder consultation
Cost of EVSE (INR)	0	750,000	Mulukutla et al., 2022
Cost of ancillary electrical infrastructure per EVSE (INR/kWh)		300,000	Mulukutla et al., 2022
Total cost of charging infrastructure per bus (INR)	0	525,000	Charger to bus ratio x (EVSE + ancillary electrical infrastructure cost) Based on stakeholder consultation
Cost of battery (INR/kWh)	0	15,000	Based on stakeholder consultation
Cost of battery (INR)	0	4,800,000	Based on stakeholder consultation
Fuel or electricity cost (INR)	90	8	Based on stakeholder consultation
Fuel efficiency (per km)	3.5	1.1	Based on stakeholder consultation
Insurance cost (% of CAPEX)	1%	0.5%	Based on stakeholder consultation
Body reconditioning cost per bus after 5 years (INR)	500,000	300,000	Based on stakeholder consultation
Maintenance cost (INR/km)	20	8	Based on stakeholder consultation
Motor vehicle tax per bus (INR)	100,000	0	Based on stakeholder consultation
Crew staff salary per month (INR)	23,000	23,000	Based on stakeholder consultation
Duration of loan period (years)	5	5	Based on stakeholder consultation
Yearly Interest on vehicle loan (%)	12%	12%	Based on stakeholder consultation
Change in other operating costs/ year (%)	5%	5%	CEIC, n.d.
Change in fuel or electricity price/ year (%)	5%	5%	Ministry of Statistics and Programme Implementation, 2025
Yearly decrease in battery cost (%)	0	12%	Catsaros, 2024
Yearly depreciation rate of bus (%)	10%	10%	Based on industry standards

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FUNDING AGENCY

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