Report | November 2026

Erode Freight Decarbonisation Roadmap

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Suggested citation: Vaid, Shubhi, Kavya Muthukrishnan, Ritika Sen, and Seshadri Raghavan. 2026. *Erode Freight Decarbonisation Roadmap.* New Delhi: Council on Energy, Environment and Water.

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Peer reviewers: Arun Krishnan, Program Director – Climate Finance, WRI India. Ankit Anurag, Director – Consulting & Operations – Energy & Infrastructure – Power & Utilities, KPMG; Vivekanand Kotikalapudi, Director – Transforming Bengaluru; and Sabarish Elango, Programme Lead, CEEW.

Publication team: Archana Chandrashekar (CEEW); Alina Sen (CEEW); The Clean Copy; Enseur; and FRIENDS Digital Colour Solutions.

Acknowledgments: We express our sincere gratitude to the sector leaders who supported and guided us and provided valuable feedback as peer reviewers throughout this study. We would also like to acknowledge the support of the UK Partnering for Accelerated Climate Transitions (UK PACT) programme for enabling this work. We extend our thanks to the Erode City Municipal Corporation's Planning and Engineering Departments for their valuable contributions in shaping the recommendations and reviewing the study. We are equally grateful to the Outreach team at CEEW for their consistent support throughout the process. We sincerely thank everyone for their generosity, guidance and support in this endeavour.

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Image: CEEW

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FOREWORD

Erode is an important commercial and industrial centre in Tamil Nadu, with a strong economic base in textiles, turmeric, agriculture, manufacturing, and trade. The movement of goods plays a vital role in supporting the district's economy by connecting industries, markets, businesses, and communities. As freight activity continues to grow, ensuring efficient, reliable, and sustainable movement of goods has become an important priority for Erode.

I am pleased to present this report, "Erode Freight Decarbonisation Roadmap", prepared by the lead implementing partner-Council on Energy, Environment and Water (CEEW) under the India–UK Partnering for Accelerated Climate Transition (UKPACT) programme. The report provides an assessment of Erode's freight ecosystem, covering freight movement patterns, vehicle characteristics, emissions, and the potential for alternative fuels and electrification.

The findings highlight the need for a phased and coordinated approach to freight decarbonisation. The report identifies opportunities to transition different freight vehicle segments towards cleaner technologies, while strengthening charging infrastructure and supporting infrastructure at key freight hubs, industrial clusters, terminals, and corridors. The proposed roadmap provides a practical pathway for reducing freight-related emissions while maintaining the efficiency of goods movement.

This report is an important step towards strengthening evidence-based freight planning in Erode and supporting the development of a cleaner, more efficient, and sustainable freight system. I am confident that its findings and recommendations will provide useful guidance to government departments, industry stakeholders, freight operators, and other partners in advancing freight decarbonisation in the district.

I appreciate the efforts of CEEW, UK PACT, and all stakeholders who contributed to this initiative. I look forward to continued collaboration in translating the recommendations of this roadmap into meaningful action towards a resilient and low-carbon freight transport system for Erode.

Arpit

Commissioner,
Erode City Municipal Corporation

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Executive summary

India's logistics sector accounts for approximately 5 per cent of the country's gross domestic product (GDP) and handles approximately 4.6 billion tonnes of goods annually, 70 per cent of which is transported by road (NITI Aayog 2021). While medium- and heavy-duty trucks (MHDTs) constitute approximately 3 per cent of the total vehicle fleet, they disproportionately account for 53 per cent of transport-related particulate matter emissions (NITI Aayog 2022). Without targeted interventions, road freight emissions are projected to double from the approximately 400 million tonnes (Mt) of carbon dioxide (CO_2) in 2025 to 800 Mt by 2050 (NITI Aayog 2022; Mohan et al. 2025a). This underscores the need for rapid decarbonisation to meet India's commitments to reduce the carbon intensity of its economy by 45 per cent by 2030 from 2005 levels and reach net-zero emissions by 2070 (GoI 2026).

Tamil Nadu, one of the country's largest freight activity–generating states (CEED 2025), has introduced logistics and electric vehicle (EV) policies in 2023 to accelerate the transition towards cleaner freight transport (GoTN 2023a, 2023b). Within the state, Erode is a major textile and agricultural logistics hub and contributes approximately three per cent of Tamil Nadu's gross state domestic product (GSDP) (DES 2024). However, approximately 99 per cent of its MHDT fleet runs on diesel (VAHAN 2026), while the city's freight emissions profile and decarbonisation pathways remain unquantified. This highlights the need for evidence-based planning and policy interventions towards urban planning and sustainable mobility.

To address this gap, we have developed a comprehensive freight decarbonisation framework for Erode district to identify technology pathways and policy interventions that can support the transition towards low-emission freight transport. It evaluates the existing freight fleet and its

operational characteristics to assess the feasibility of alternative fuel pathways, including natural gas, biodiesel, and electricity. In this study, we have quantified the incremental electricity demand associated with freight electrification and identified the spatial and operational requirements for EV charging infrastructure to support the transition.

Primary surveys were conducted across Erode district and major freight corridors within the district, covering 2,500 samples of vehicle operators and drivers. The surveys captured vehicle operational characteristics, commodity movements, and trip patterns. The primary data were integrated with secondary datasets, including VAHAN registration records and industrial cluster mapping across Erode district.

Key insights from primary and secondary data

- **Freight operations exhibit distinct ownership patterns:** Light commercial vehicles (LCVs) are predominantly rented or leased, medium-duty trucks (MDTs) are largely personally owned, while heavy-duty trucks (HDTs) have a relatively higher share of third-party operator/company ownership.

- **While LCVs dominate urban and last-mile freight,** MHDTs primarily undertake long-distance regional and interstate operations.

- **Diesel dependence is high, and the fleet is ageing:** 15.4 per cent of vehicles are over 15 years old, while only 36 per cent are Bharat Stage VI (BS-VI) compliant, indicating scope to reduce both fuel consumption and vehicle emissions through fleet modernisation and fuel transition.

- **Erode functions as both a freight destination and transit hub,** with more than one-quarter of HDTs registered outside Tamil Nadu, highlighting the importance of accounting for through-traffic and vehicles operating across state boundaries when planning freight decarbonisation.

- **Agriculture and textiles are the dominant commodities transported,** reflecting Erode's industrial profile, and provide a basis for identifying priority freight routes, vehicle segments and charging locations.

Fuel transition pathways for Erode freight decarbonisation

Erode's freight decarbonisation challenges include diesel dependence, an ageing fleet, diverse ownership and operating patterns, and cross-boundary freight movements. Effective interventions must therefore account for vehicle-level electrification readiness, trip requirements and charging infrastructure availability. The following summary presents key findings on emissions, fuel-transition pathways, electrification potential and charging infrastructure priorities.

What are Erode's district emissions in 2025?	Which fuel-transition pathway offers the greatest emissions reduction?	What is the emissions reduction potential by 2045?	How much infrastructure will be needed by 2045?
252 $ktCO_2e$	EV > compressed natural gas (CNG)/ liquefied natural gas (LNG) > biodiesel	44% emissions reduction under the electrification scenario	Number of chargers required (~3,200 under low utilisation or ~1,600 under high utilisation)

1. Erode emissions profile (2025) and business-as-usual (BAU) scenario

Freight transport in Erode emitted 252 kilotonnes of carbon dioxide equivalent (ktCO2e) in 2025, with HDTs accounting for the largest share (51 per cent), followed by LCVs (36 per cent) and MDTs (13 per cent). Without policy intervention, freight emissions are projected to increase nearly two-and-a-half times to 601 ktCO2e by 2045, highlighting the need for accelerated adoption of low-carbon technologies.

2. Freight electrification readiness

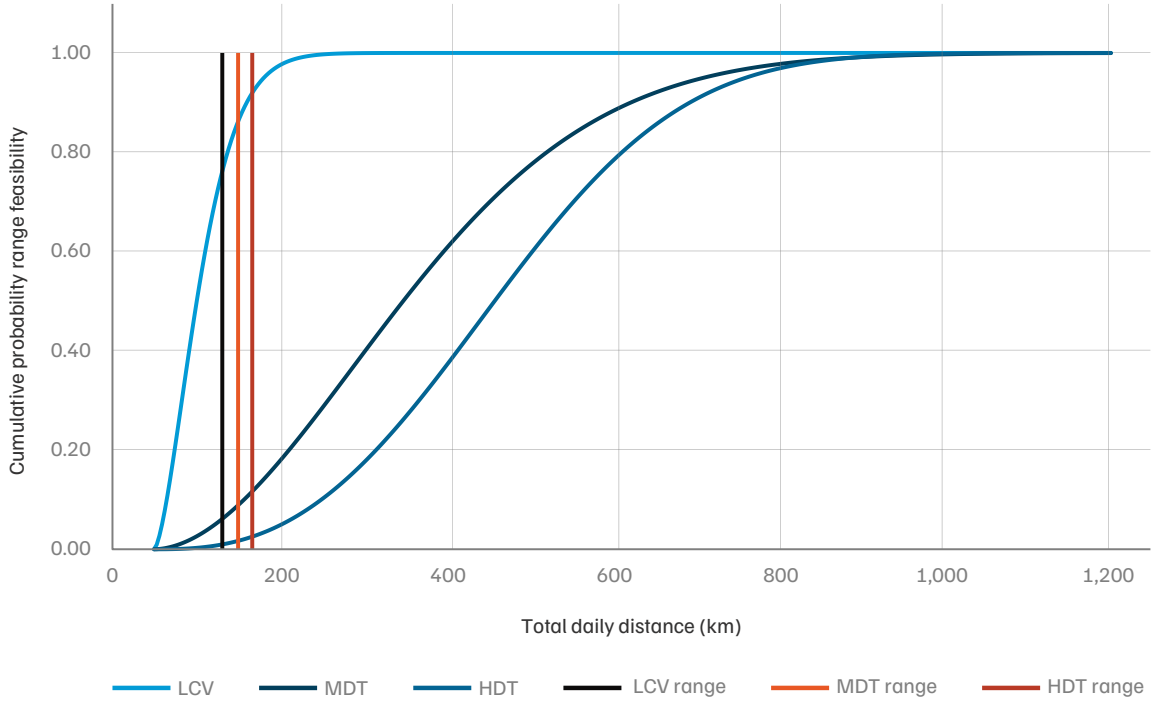
Based on the 2025–26 survey:

a. Among vehicle segments, LCVs exhibit the highest near-term electrification potential, with 58 per cent of vehicles operating within the range of currently available electric LCVs. This increases to 86 per cent with one intermediate charging opportunity.

b. With intermediate charging, the electrification potential of MDTs increases from 18 to 44 per cent, while that of HDTs increases from 2 to 15 per cent.

c. Adoption of e-LCVs is primarily constrained by awareness, battery-related concerns, and upfront costs, whereas charging infrastructure, vehicle range, electricity costs, and financing are identified as the primary constraints to electrification for MDT and HDT operators.

Figure ES1. LCVs exhibit the highest near-term electrification feasibility, with 58% of vehicles' daily driving distance well within the range of current EV model offerings



Source: Authors' analysis.

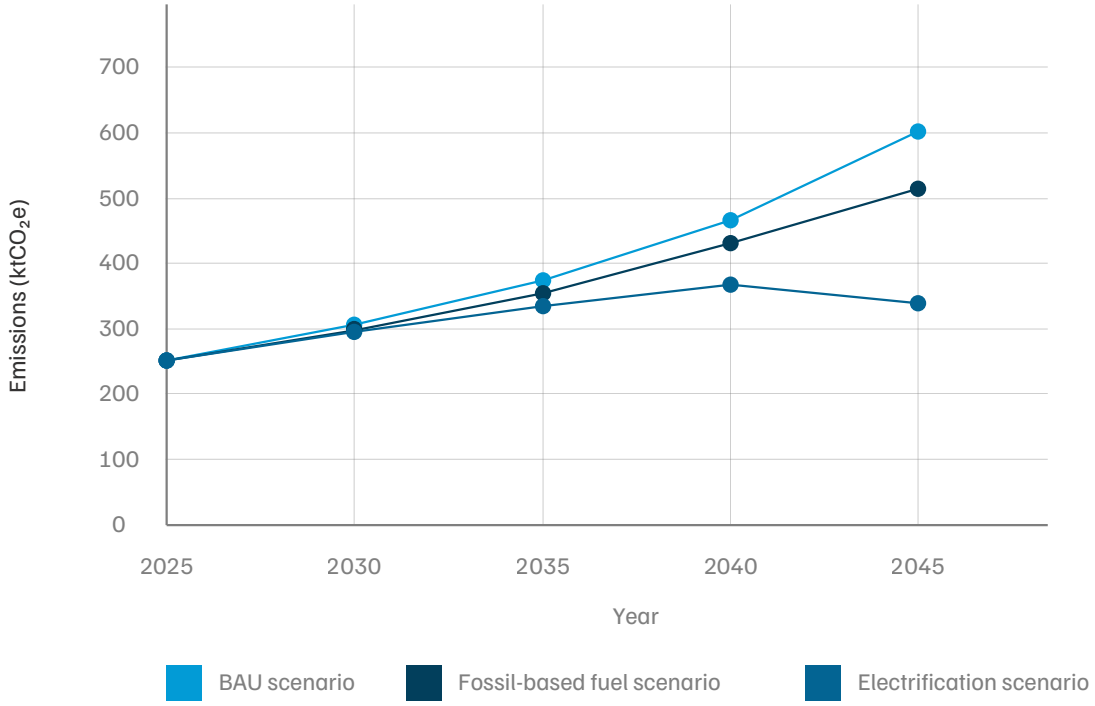
Acronyms: EV: electric vehicle; HDT: heavy-duty truck; LCV: light commercial vehicle; MDT: medium-duty truck

3. Decarbonisation potential of alternative fuel pathways

a. The fossil-based fuel transition scenario (diesel + CNG/LNG + biodiesel) provides a near-term transition pathway, achieving emission reductions of 13–15 per cent across vehicle segments by 2045, while leveraging existing vehicle technologies and refuelling infrastructure.

b. The electrification scenario achieves the highest emissions reduction, lowering total freight emissions by 44 per cent by 2045 relative to 2045 business as usual (BAU) scenario through the phased electrification of 90 per cent of LCVs, 60 per cent of MDTs, and 40 per cent of HDTs.

Figure ES2. By 2045, the fossil-based fuel and electrification scenarios achieve emission reductions of 14% and 44%, respectively, relative to the BAU scenario



Source: Authors' analysis.

Acronyms: BAU: business-as-usual

4. Energy demand and charging infrastructure requirements

a. Under the electrification scenario, annual diesel demand declines by 54 per cent relative to BAU by 2045, reaching approximately 70,400 kL, while electricity demand increases to approximately 1,011 MWh/day.

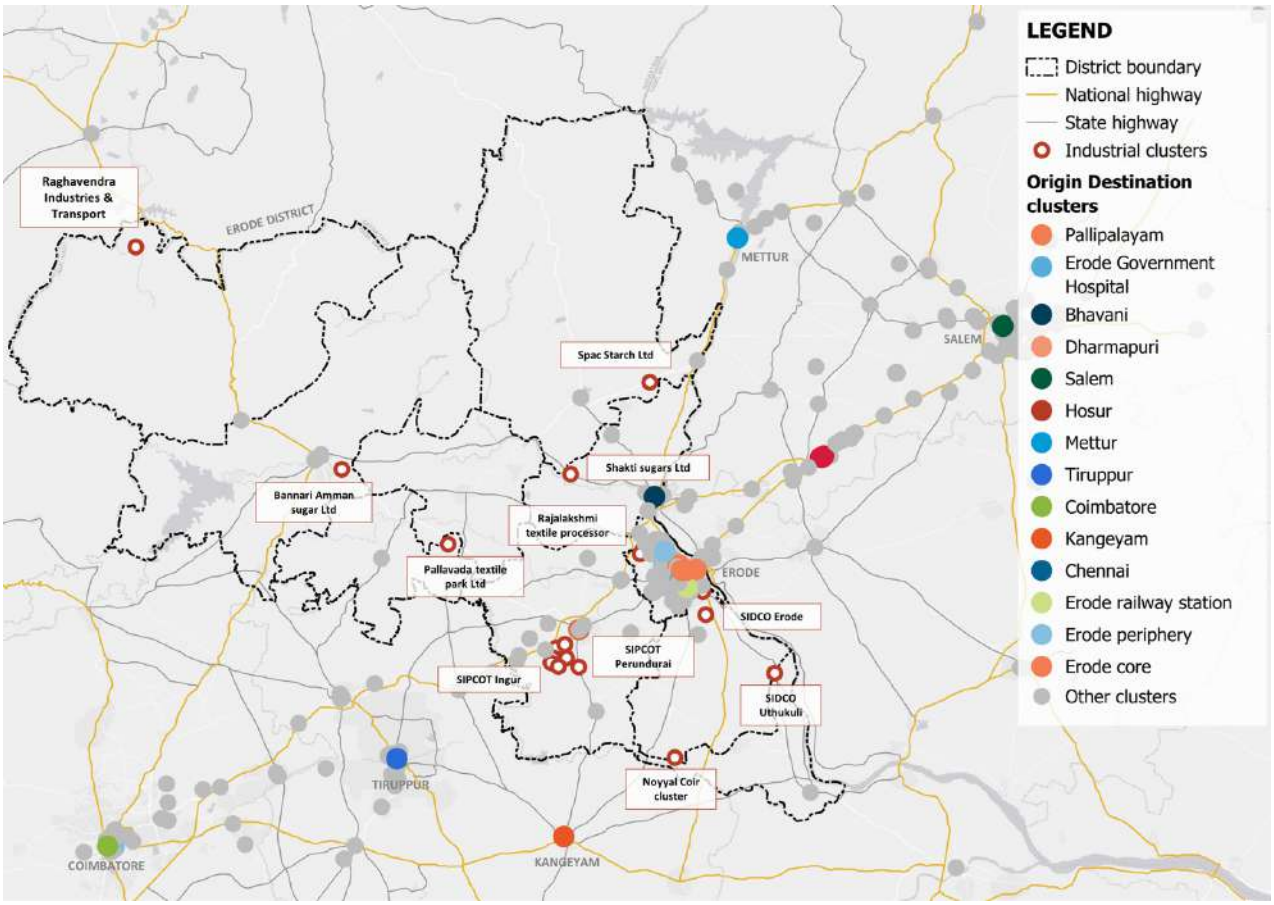
b. Freight electrification will require a phased charging network across vehicle segments. By 2030, Erode would require 88–178 chargers under high- and low-utilisation scenarios, respectively, increasing to 1,605–3,209 chargers by 2045.

c. In the near term, LCV charging needs dominate, requiring 22 kW and 50 kW chargers, while charging requirements for MDTs and HDTs grow significantly by 2045, comprising 120 kW and 240 kW chargers.

5. Charging infrastructure locational priorities

State Industries Promotion Corporation of Tamil Nadu (SIPCOT) Perundurai, SIPCOT Ingur, Small Industries Development Corporation (SIDCO) Erode, SIDCO Uthukuli, Pallavada Textile Park, Bhavani, Chithode, and the Erode–Perundurai and Erode–Bhavani corridors emerge as priority locations for the phased deployment of freight EV charging infrastructure, supporting both urban inter-/intra-city logistics and regional or corridor freight movement.

Figure ES3. Origin–destination (OD) clusters for freight trips overlaid with major industrial estates and freight hubs in Erode district



Source: Authors' analysis.

Phased decarbonisation roadmap

Based on the findings, the phased freight decarbonisation roadmap (2025–45) recommends technology adoption based on vehicle operating characteristics, infrastructure adequacy, and institutional capacity. It prioritises LCV electrification in the near term, leveraging the high operational compatibility of LCVs with current EV technologies and their use in urban freight operations. As charging infrastructure and vehicle technologies mature, the transition expands to MDTs through regional logistics hubs and industrial corridors, followed by HDTs supported by high-capacity charging infrastructure along strategic freight corridors and at truck terminals.

The roadmap combines fleet transition, charging infrastructure deployment, freight planning, financing, regulatory measures, and institutional coordination to ensure that investments align with technology maturity and freight demand. The key recommendations and their implementation timelines are summarised in Table ES1.

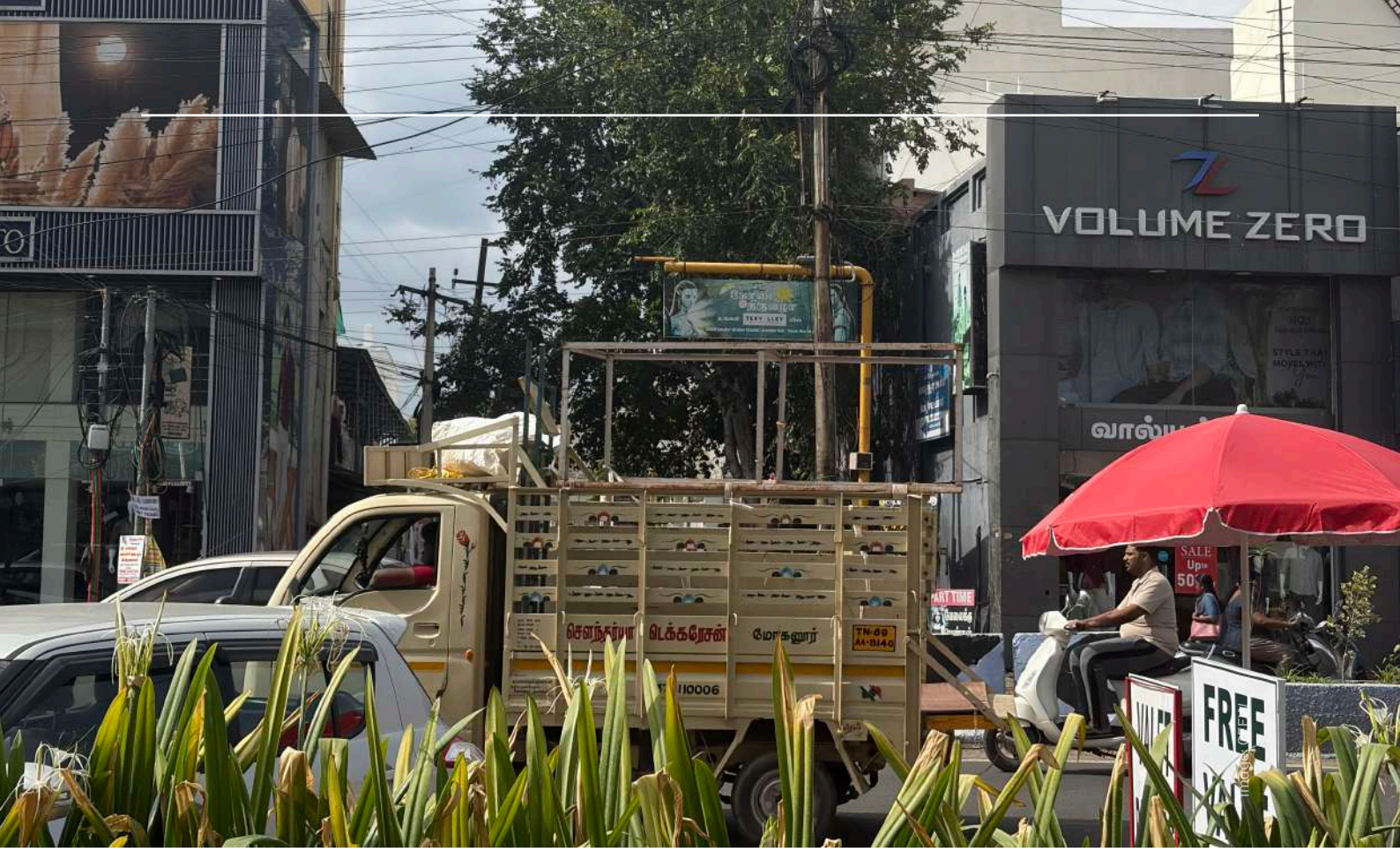
Table ES1. Phased freight decarbonisation roadmap (2025–45)

S. no.	Recommendations	Near-term (2025–30)	Medium-term (2030–35)	Long-term (2035–45)
A.	**Regulatory levers**			
1.	Increase the core-area boundary for entry- and exit-time-based restrictions for diesel trucks during peak hours; exempt EVs from entry/exit restrictions	✓		
2.	Restrict entry/exit of diesel-based LCVs during peak traffic hours in the city; exempt EVs from entry/exit restrictions	✓		
3.	Introduce congestion pricing measures and progressively incorporate environmental performance standards into freight access management			✓
B.	**Urban planning and land-use integration**			
1.	Prepare a comprehensive city logistics plan (CLP) for Erode city in coordination with nearby districts	✓		
2.	Procure only EVs for municipal fleets	✓		
3.	Relocate warehouses/godowns from the core city and railway yard to SIPCOT industrial estates; proposed truck depot at Perundurai Road and textile parks		✓	
4.	Plan for load consolidation for agricultural and textile commodity flows at periphery terminals (Perundurai, Kongampalayam/Chithode) to improve freight movement efficiency and avoid empty trips		✓	
5.	Establish dedicated loading/unloading bays at Erode Central Market and Gani Market and impose a penalty on vehicles parked illegally on roads	✓		
6.	Reserve land at existing and proposed private/public truck depots/terminals and industrial clusters for EV charging infrastructure in the master plan (MP) and comprehensive mobility plan (CMP)	✓		
7.	Prioritise areas near SIPCOT Perundurai, SIPCOT Ingur, Pallavada Textile Park, NH544, NH948, and NH381A for setting up group captive solar energy models	✓		

S. no.	Recommendations	Near-term (2025–30)	Medium-term (2030–35)	Long-term (2035–45)
C.	**Behavioural interventions**			
1.	Promote and explore opportunities for small-scale proof-of-concept pilot electric LCVs/medium- and heavy-duty trucks (MHDTs) with fleet operators/third-party logistics owners and subsequently scale up	✓	✓	
D.	**Financing mechanisms**			
1.	For LCVs, channelise financing through fleet operators and leasing companies, using aggregated procurement, concessional credit, and battery-financing models to reduce upfront costs	✓		
2.	For MHDTs, de-risk early-stage adoption through limited credit guarantees, original equipment manufacturer (OEM) warranties, and secured route-level charging, enabling lenders to scale financing as operating performance is demonstrated		✓	
3.	Prioritise financing based on the dominant commodities transported in Erode, such as agricultural produce, textiles, and fast-moving consumer goods (FMCG)	✓	✓	
4.	Embed electrification within industrial estate lease policies to accelerate fleet electrification		✓	
E.	**Data-driven decision-making and monitoring**			
1.	Develop formal data-sharing agreements between regional transport offices (RTOs), Tamil Nadu Power Distribution Corporation Limited (TNPDCL), SIPCOT/SIDCO to better understand truck movement patterns and stakeholder expectations, such as those of forwarders, shippers and LSPs.	✓		
F.	**State and central government support**			
1.	Mobilise state-level financial support through domestic and international institutions such as the Tamil Nadu Green Climate Fund (TNGCF), Urban Challenge Fund, and the World Bank		✓	
2.	Ensure TNPDCL plans for freight electricity demand of 1011 MWh/day by 2045	✓		

Source: Authors' analysis.

Acronyms: CLP: city logistics plan; CMP: comprehensive mobility plan; EV: electric vehicle; FMCG: fast-moving consumer goods; LCV: light commercial vehicle; LSP: logistics service provider; MHDT: medium- and heavy-duty trucks; MP: master plan; NH: national highway; OEM: original equipment manufacturer; RTO: regional transport office; SIDCO: Small Industries Development Corporation; SIPCOT: State Industries Promotion Corporation of Tamil Nadu; TNPDCL: Tamil Nadu Power Distribution Corporation Limited



1. Introduction

India's logistics sector accounts for 5 per cent of its gross domestic product (GDP), handling 4.6 billion tonnes of goods annually, worth INR 9.5 lakh crore. Road transport carries 70 per cent of this freight demand (NITI Aayog 2021), making it the dominant mode across India's supply chain. Medium- and heavy-duty trucks (MHDTs) constitute only 3 per cent of the total vehicle fleet but are responsible for 53 per cent of particulate matter (PM) emissions (NITI Aayog 2022). Decarbonising this sector is essential for India to achieve its nationally determined contribution (NDC) of reducing the carbon intensity of its economy by 45 per cent from 2005 levels by 2030 and its target of achieving net-zero emissions by 2070 (GoI 2026). If the trucking sector continues on its current trajectory, road freight alone is projected to generate 800 million tonnes of carbon dioxide ($MtCO_2$) in 2050 (NITI Aayog 2022). In response, the Government of India introduced the *India Zero Emission Trucking (ZET) Policy Advisory*, which outlines 30 targeted policy interventions developed in consultation with NITI Aayog (Electric Freight Accelerator for Sustainable Transport platform) and the Office of the Principal Scientific Adviser (PSA) to increase ZET penetration (PSA 2024).

Half of India's freight vehicle registrations are concentrated in eight states, including Tamil Nadu, making these states major contributors to freight-related CO_2 emissions nationwide (CEED 2025). Tamil Nadu ranks second in freight vehicle registration among these states, with a gross state domestic product (GSDP) of approximately INR 31 lakh crore in 2024–25 and a contribution of 9.4 per cent to India's GDP (GoTN 2026). It also has the second-highest number of registered e-MHDTs after Gujarat (CEEW and Climate Group 2025). Through the Tamil Nadu *Logistics Policy and Tamil Nadu Electric Vehicles Policy* (GoTN 2023a, 2023b), the state has committed to promoting an integrated, reliable, cost-efficient, and sustainable logistics system. This dual approach targets structural barriers to fleet modernisation by aligning supply-side

logistics infrastructure with demand-side commercial electric vehicle (EV) adoption. For logistics companies, the financial burden of transitioning from traditional internal combustion engine (ICE) vehicles is reduced through waivers on permit fees, regional transport office (RTO) registration, and motor vehicle tax (GoTN 2023a). On the infrastructure side, the policies grant industrial status to modern warehousing, optimise land utilisation, and provide a 25 per cent capital subsidy for green warehousing initiatives and public charging networks (GoTN 2023b).

Within this state-level framework, Erode district emerges as an important node in Tamil Nadu's freight decarbonisation landscape. According to district estimates, Erode contributed approximately 3 per cent to the state's GSDP in 2022–23 (DES 2024). It is widely recognised as a textile and turmeric hub and forms part of Tamil Nadu's 'textile valley' with Coimbatore and Tiruppur (GoTN 2021). This high-density industrial activity generates substantial road freight demand, with approximately 99 per cent of registered MHDTs being diesel vehicles (VAHAN 2026). Despite this economic and logistical significance, Erode's freight emissions profile remains unquantified, and its targeted fleet decarbonisation pathways remain unclear. This gap mirrors the broader challenge faced by tier-2 industrial hubs across India.

> Erode district is a major agricultural, industrial and educational hub of Tamil Nadu.

1.1 Aims and objectives of the report

This study aims to identify freight decarbonisation pathways and policy interventions that support low-emission freight transport in Erode district. It has the following objectives:

1. Assess the characteristics of the on-road freight fleet to evaluate the operational feasibility of adopting alternative fuel pathways: compressed natural gas (CNG), liquefied natural gas (LNG), biodiesel, and electrification.
2. Estimate existing and future greenhouse gas (GHG) emissions under multiple decarbonisation scenarios using a Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC)-compliant accounting framework.
3. Assess the spatial and operational requirements for freight electrification by estimating EV charging infrastructure demand.

The district, rather than the city, was selected as the study boundary for the following reasons:

1. Freight movement in Erode has a dual nature, with more than 80 per cent of trips by light commercial vehicles (LCVs), medium-duty trucks (MDTs), and heavy-duty trucks (HDTs) crossing municipal boundaries (Sen et al. 2026). A city-only boundary would therefore underestimate the spatial scale at which freight vehicles operate, fuel is consumed, and emissions are generated.
2. Freight decarbonisation requires a multi-pronged approach involving shippers, fleet operators, and logistics service providers (LSPs), whose operations are not constrained by city boundaries.
3. Erode's freight patterns are closely linked to industrial and logistics activity generated both within and beyond the city boundary. Major industrial clusters such as State Industries Promotion Corporation of Tamil Nadu (SIPCOT) estates, manufacturing plants, and factories are located outside the municipal boundary but generate both inward and outward truck movements.
4. The district boundary also aligns better with the granularity, completeness, and temporal consistency of available public datasets. Vehicle registration data, district statistical handbooks, the economic census, and several state and national administrative datasets are generally organised at the district or RTO level. Using the district boundary improves data consistency and facilitates triangulation and harmonisation across multiple sources.

1.2 UK PACT and project overview

The India–UK PACT (Partnering for Accelerated Climate Transitions) Country Fund supports local governments in tier-2 cities through technical assistance and capacity building as these cities rapidly expand and face challenges related to urban planning, mobility, and climate risk. The project aims to strengthen Erode city's sustainable development pathway by integrating climate considerations into long-term planning, governance, and implementation. This is being pursued through three key approaches:

a. engaging and collaborating with multiple stakeholders to promote sustainable, climate-resilient solutions;

b. embedding data-driven and climate-focused mobility strategies; and

c. supporting the municipal corporation in identifying innovative funding mechanisms to scale up climate-resilient mobility interventions.

Growing freight activities in erode underscore the need to develop a cleaner, more efficient, and more sustainable mobility system. This report forms part of the broader urban mobility and climate action roadmap being prepared for Erode to support the development of low-carbon, efficient transport.

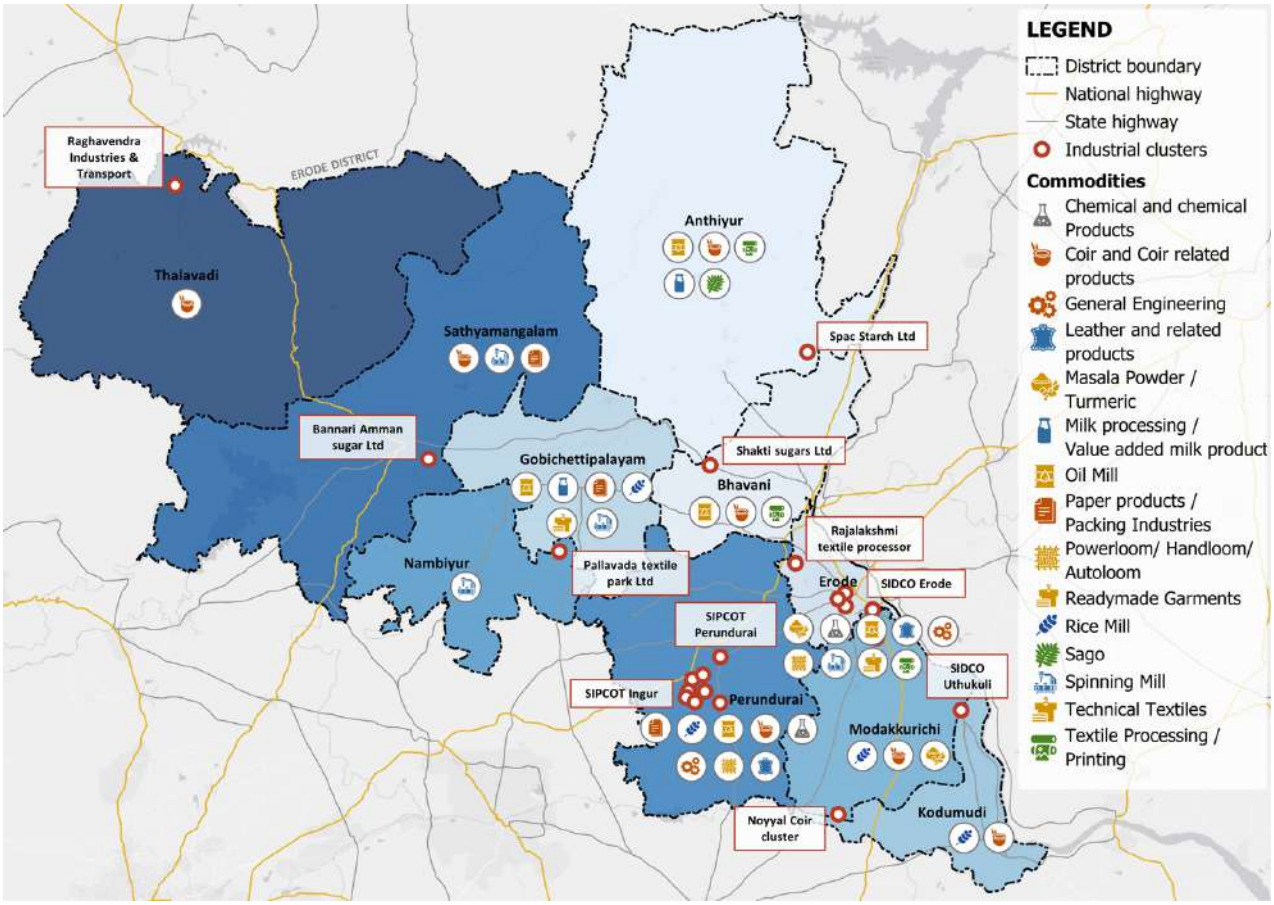
The framework follows a step-by-step process, starting with an assessment of existing transport conditions, supporting infrastructure, freight movement patterns, and on-road transport GHG emissions through studies such as the *Movement of People and Goods* and the *Greenhouse Gas Accounting for On-road Transport Emissions* (Sen et al. 2026; Vaid et al. 2026). Building on these findings, this report focuses on developing a freight decarbonisation roadmap by identifying strategies to improve logistics efficiency, encourage the adoption of cleaner technologies, and support sustainable freight practices.

1.3 Economic profile of Erode district

Erode is situated in the north-western region of Tamil Nadu. This landlocked district is bounded by Karnataka to the north; Tiruppur district to the south; Salem, Namakkal, and Karur districts to the east; and Coimbatore with Nilgiris district to west (Erode District 2026). Erode district covers 8,162 sq km and had a population of approximately 22.5 lakh in 2011 (GoTN 2021), estimated to have increased to approximately 26 lakh in 2025 at an annual growth rate of 1.08 per cent (Census 2011). It is well connected by rail and road to major cities such as Coimbatore, Chennai, and Madurai (Erode District 2026). Administratively, the district is divided into 10 taluks and four municipalities (Erode District 2026).

Erode has the country's largest textile market, is known as the 'turmeric capital of India', and is a commercial and agro-industrial centre of Tamil Nadu (TNUIFSL 2015). Major industries in Erode include agro-based food products, textiles, leather and related products, wood and related products, paper, chemicals, and drugs. Wholesale markets dominate the economy, resulting in high volumes of daily freight movement within city limits (GoTN 2021). While large-scale industries are primarily located on the periphery, such as at SIPCOT Perundurai, Erode city accommodates a range of small- and medium-scale industrial and processing units. These include textile processing and dyeing units, small garment manufacturing units, food processing and packaging units, and repair and maintenance enterprises. The strong presence of micro, small, and medium enterprises (MSMEs) and associated service activities contributes significantly to employment generation and sustains continuous goods movement within the city.

Figure 1. Industrial and commodity clusters in Erode district



Source: Authors' analysis.

Figure 1 shows that industrial activity in Erode district is concentrated around a few major hubs, including Erode, Perundurai, Bhavani, Gobichettipalayam, and Sathyamangalam. Among these, Erode and Perundurai stand out for their strong presence of textiles, technical textiles, spinning mills, textile processing and printing, leather products, engineering goods, rice mills, and chemical products.

Bhavani and Gobichettipalayam have a mixed industrial profile, with oil mills, milk processing, rice mills, technical textiles, textile processing, and coir-related industries, reflecting the district's strong agro-industrial base. Sathyamangalam and Thalavadi are more closely associated with coir-related industries and spinning mills. Anthiyur supports smaller-scale industrial activities, such as sago processing, milk processing, oil mills, and textile processing. Modakurichi and Kodumudi are linked to rice mills, turmeric/masala products, coir products, and textile activities, contributing to commodity movement in the southern part of the district.

Erode district also hosts several industrial estates and industries that support its manufacturing and freight economy. Existing industrial estates include SIPCOT Perundurai, Small Industries Development Corporation (SIDCO) Erode, SIDCO Uthukuli, and SIPCOT Ingur. In addition, sector-specific clusters are being planned and developed, including the Noyyal Coir Cluster, Kongu Coir Cluster, Pallavada Textile Park, and Erode Sizing Common Facility Centre Pvt. Ltd (GoTN 2021), as mapped in Figure 1.

Erode district's transport infrastructure is road-centric, with three national highways: NH544, NH948, and NH381A. NH544 is a 340 km highway connecting Salem, Tamil Nadu, to Kochi, Kerala, and provides direct access to the SIPCOT industrial estate. The NH948 connects Coimbatore to Karnataka, providing Erode with direct connectivity to the Karnataka freight market. The NH381A provides supplementary connectivity between districts, smaller industrial and agricultural clusters, and the main highways. Most major industrial areas are located along or near national highways, particularly in the Erode–Perundurai–Bhavani corridor, facilitating the movement of goods to regional markets. State highways play an important role in connecting industrial and production centres such as Gobichettipalayam, Sathyamangalam, Anthiyur, and Kodumudi to the main highway network and logistics hubs. Together, this road network facilitates the transport of raw materials and finished products between industrial areas and the surrounding agricultural region.

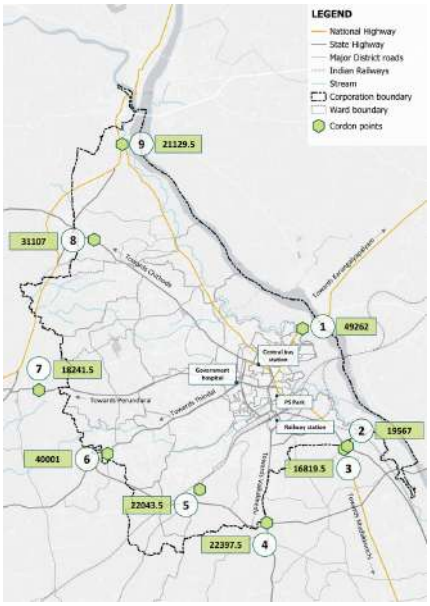
Rising freight traffic in the Erode City Municipal Corporation (ECMC)

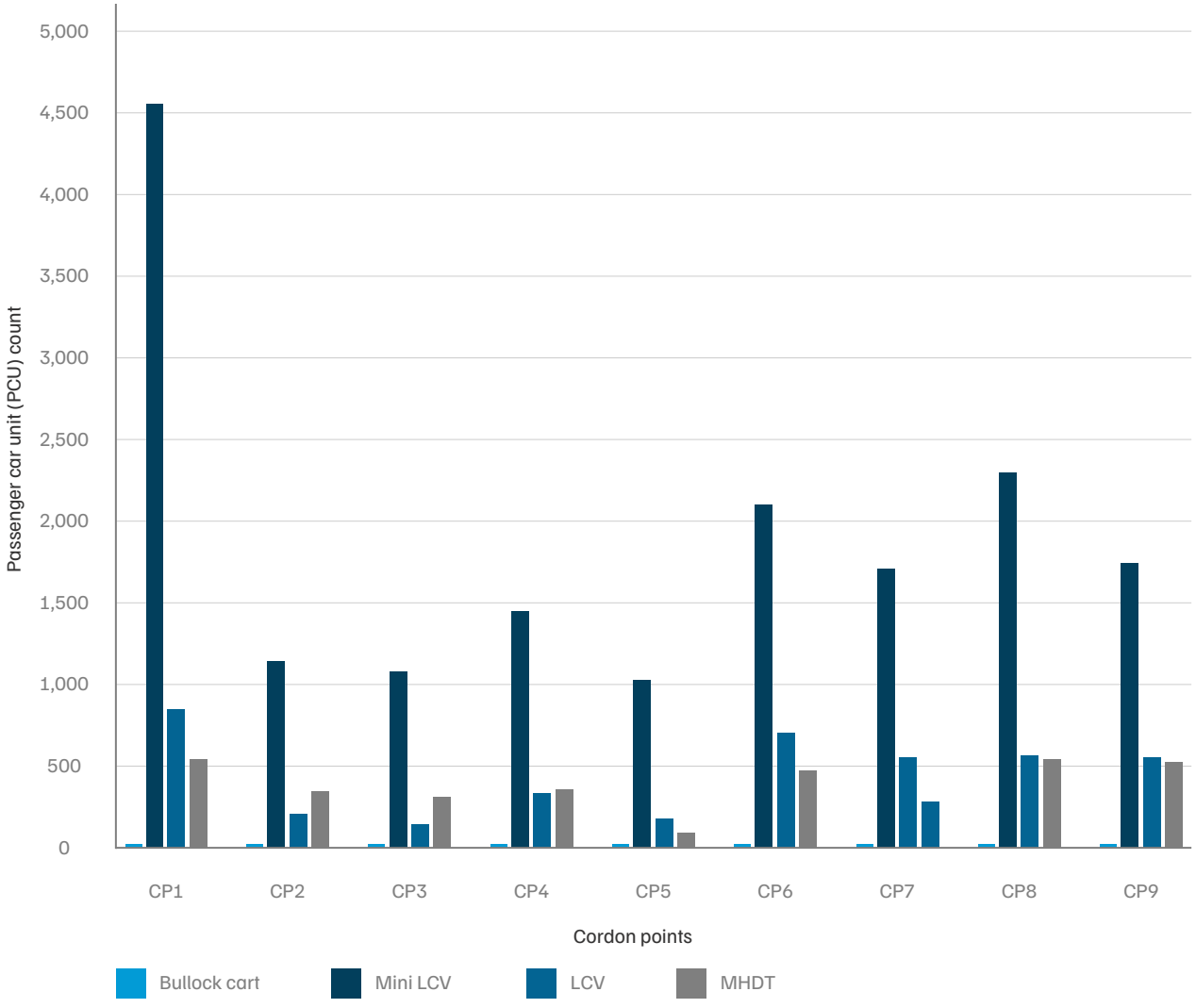
Due to the presence of industries and extensive road-network connectivity, freight traffic at the cordon points (CPs) of the ECMC increased by approximately 31 per cent between 2015 and 2025 (Sen et al. 2026). Wholesale markets, textile trading centres, and industrial pockets within the ECMC area contribute to significant freight movement within the city, which mixes with urban traffic and often causes congestion.

The cordon survey across nine locations highlights significant freight movement and reinforces the city's role as a major trade and distribution hub (Figure 2). Overall, LCVs account for a major share of traffic across all corridors, with particularly high movement at CP1, CP9, and CP6. This pattern is linked to MSMEs engaged in textiles, agro-processing, and allied sectors, which rely on shorter, more frequent trips due to limited warehousing capacity. In contrast, MHDTs show higher movement at CP1, CP6, CP8, and CP9, indicating bulk freight movement to major industrial centres such as Salem, Kongampalayam, Perundurai, and Tiruppur (Sen et al. 2026). Although bullock carts account for a very small share of traffic, they support short-distance movement within local markets and among MSMEs.

ECMC serves as a major logistics and commercial centre for textiles and agricultural commodities, linking production centres such as Bhavani, Gobichettipalayam, and Perundurai to regional, national, and export markets. As a result, it experiences two types of freight movement: long-distance corridor traffic and dense last-mile urban freight. While these freight activities are critical to the city's economy, they also contribute significantly to congestion, air pollution, and GHG emissions.

Figure 2. CP1 records the highest freight volumes among Erode's entry/exit points, followed by CP8 and CP6 (Cordon count survey, 2025)





Source: Authors' analysis.

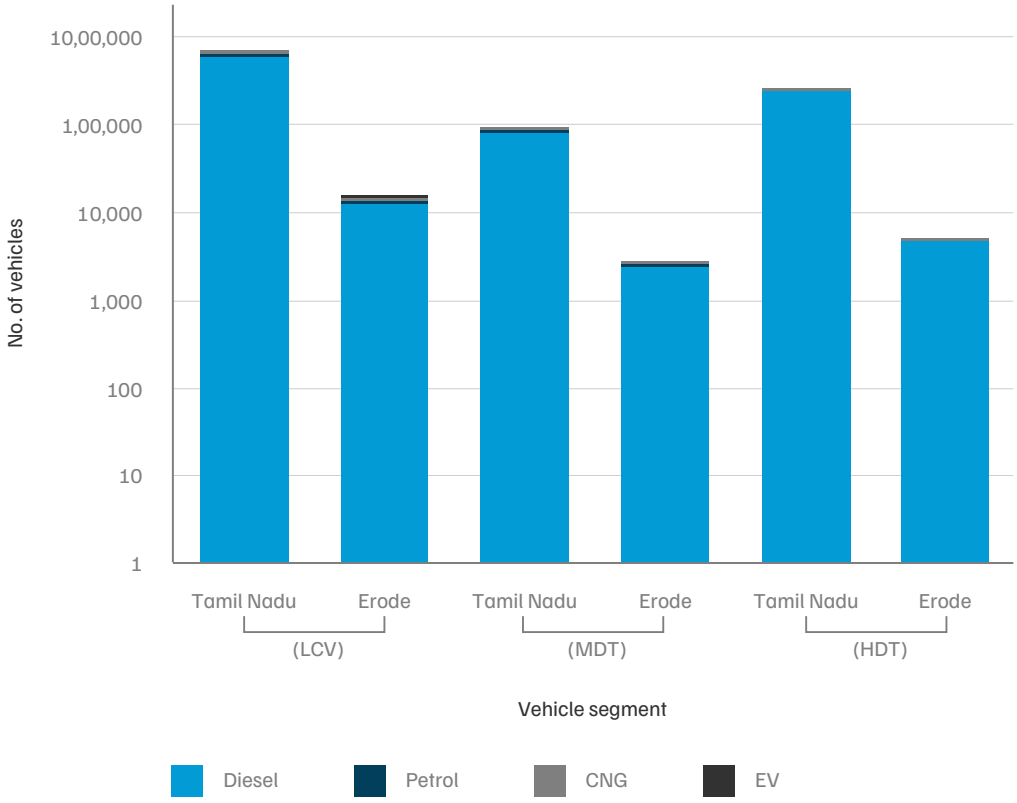
Acronyms: CP: cordon point; LCV: light commercial vehicle; MHDT: medium- and heavy-duty truck; PCU: passenger car unit

Vehicle registrations in Erode district

Erode district has three RTOs: TN33, TN56, and TN86. The cumulative number of freight vehicle registrations 2011–2025 (LCVs, MDTs, and HDTs) across these RTOs is approximately 19,700, excluding unit offices. Erode district accounts for approximately 2–3 per cent of statewide commercial vehicle registrations 2011–2025 (LCVs, MDTs, and HDTs). Freight registrations are dominated by LCVs, which accounted for 64 per cent of total registrations between 2011 and 2025.

The fuel composition of freight vehicles in Erode shows a strong dependence on diesel across vehicle segments (LCVs, MDTs, and HDTs), closely mirroring trends in Tamil Nadu (Figure 3). Diesel vehicles account for 95 per cent of LCVs, 97 per cent of MDTs, and 99 per cent of HDTs registered in Erode. Petrol vehicles are present only within the LCV category, accounting for approximately 3 per cent, while CNG penetration remains limited across all segments at 1–3 per cent. At present, EV penetration is negligible, with a share of less than 1 per cent among LCVs.

Figure 3. Freight fleets in both Tamil Nadu and Erode district are diesel-dominant (~95% of LCVs, ~97% of MDTs, and ~99% of HDTs)



Source: VAHAN (2026).

Note: Unit offices under the RTOs are not considered for Erode district.

Acronyms: CNG: compressed natural gas; EV: electric vehicle; HDT: heavy-duty truck; LCV: light commercial vehicle; MDT: medium-duty truck

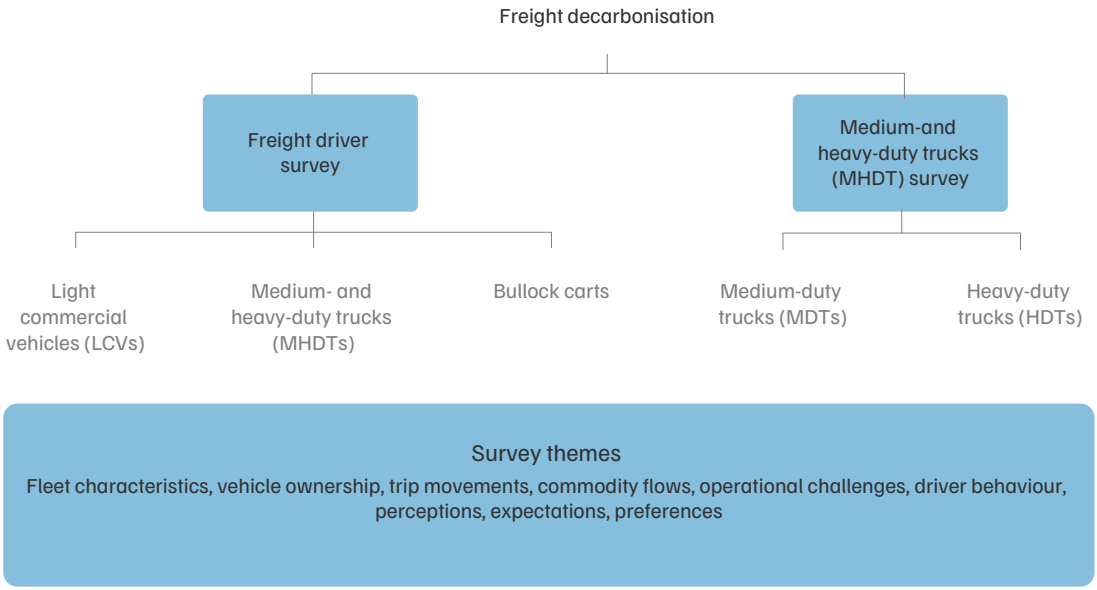
‘Bullock carts in Erode transfer goods from the core city area to consolidation centres on the city’s periphery.

Image: CEEW

2. Baselining freight fleet profile

Primary data were collected through surveys of freight drivers and operators, primarily covering LCVs and MHDTs operating in Erode and along major freight corridors connecting Coimbatore, Tiruppur, Salem, and nearby markets. The final dataset was consolidated from two surveys conducted during October–November 2025 and January–February 2026 into a harmonised sample of over 2,500. The survey included questions across six categories: socio-economic characteristics, vehicle details, trip patterns, operational details, perceptions of and barriers to EVs, and EV transition and adoption.

Figure 4. Primary surveys capturing freight movement in Erode



Source: Authors' compilation based on primary surveys conducted in Erode (2025–26).

A convenience and purposive sampling strategy was employed to balance statistical validity with the ground realities of data collection and respondent accessibility. The survey design ensured a statistically adequate sample size to support district-level analysis at a 95 per cent confidence level with a 5 per cent margin of error ($n \geq 385$), calculated using Cochran's sample size formula (Kang 2021) and applied consistently across survey streams. Figure 4 provides an overview of the surveys undertaken, the groups covered, and the thematic areas captured.

Primary data collection adhered to established ethical research practices involving human subjects, with an emphasis on informed consent, full disclosure, data privacy, and data confidentiality. Survey questionnaires in English are included in the Annexure for reference.

Generalisability and representativeness challenges

Given the absence of a reliable or formal registry of freight sector stakeholders – including drivers, operators, forwarders, and LSPs – higher sample targets were adopted to capture variation across vehicle classes, trip purposes, and operating contexts. Surveys were conducted across major logistics hubs, warehouses, fuel stations, parking locations, toll plazas, commercial markets, highway-facing activity points such as restaurants, key city corridors, and entry/exit routes. The sample also included bullock cart operators ($n = 57$), reflecting underrepresented segments of goods movement in Erode.

While non-probability sampling may introduce some selection bias and certain dispersed or highly informal operators may remain underrepresented, the achieved sample size, spatial spread, and coverage across freight segments provide a robust basis for system-level diagnosis in terms of directionality and magnitude. The findings should therefore be interpreted as a functionally representative, albeit cross-sectional evidence of prevailing freight movement patterns and constraints in Erode.

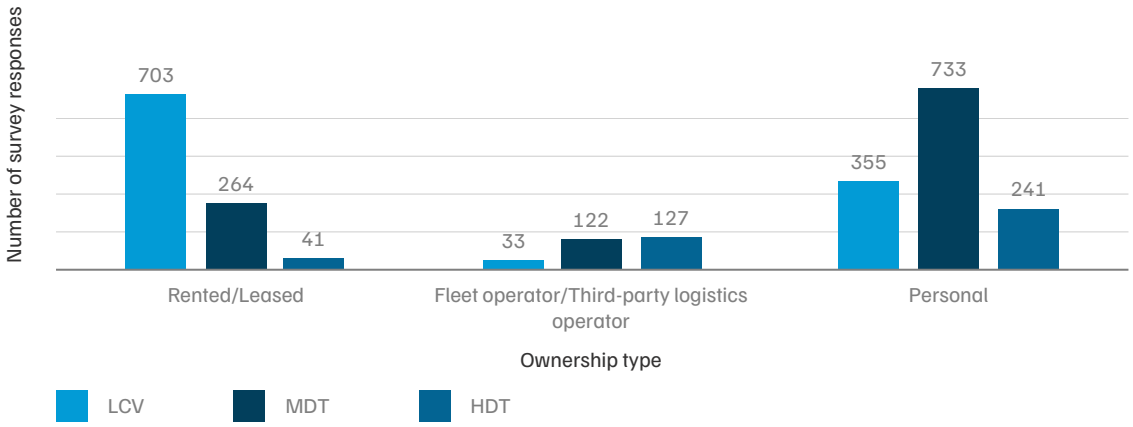
2.1 Descriptive and distributional summaries

The survey captures information on vehicle and fleet characteristics, freight operations, commodity movements, operational constraints, driver behaviour, and technology-related perceptions, expectations, and preferences (see the Annexure for details). The following sub-sections present high-level, fleet-wide aggregate summaries.

2.2 Fleet profile and ownership characteristics

Table A2 (refer to the Annexure) provides the demographic and vehicle profiles of the surveyed freight operators. Figure 5 depicts the ownership structure of the surveyed fleet (N = 2,619) and highlights clear differences across vehicle categories. Most LCVs are rented or leased, MDTs are predominantly personally owned, while HDTs have a relatively higher share of private or fleet ownership. Bullock carts are also largely personally owned. Overall, the ownership profile points to a fragmented freight market.

Figure 5. LCVs are largely rented, MDTs are predominantly personally owned, and HDTs have a relatively higher share of private/fleet ownership



Source: Primary survey conducted by CEEW (2025–26).

Note: Breakdown is with respect to the 2,619 LCV and MHDT samples.

Acronyms: HDT: heavy-duty truck; LCV: light commercial vehicle; MDT: medium-duty truck

Operational, utilisation, and emission characteristics

Table 1 summarises key operational and driving characteristics, while Table A3 (refer to the Annexure) provides a more detailed operational breakdown by vehicle tonnage category. Of the three segments, LCVs (n = 1,091) are oriented towards shorter urban trips, averaging 98.5 km per trip, with the highest trip frequency (2.4 trips per day). In comparison, MDTs (n = 1,119) and HDTs (n = 409) undertake much longer trips, averaging 304.1 km and 389.4 km, respectively. Highway driving dominates these categories, accounting for 79.1 per cent of MDT operations and 77.2 per cent of HDT operations. In addition, HDTs record the longest operational hours (10.2 hours/day), the highest number of tolls and rest stops (6 per trip), and the highest commodity loads (20.7 tonnes).

Net daily earnings rise with vehicle size, increasing from INR 1,374 for LCVs to INR 1,761 for MDTs and INR 1,862 for HDTs (see Table A4 in the Annexure). This is accompanied by higher idle time, which rises from 1.9 hours/day for LCVs to 2.6 hours/day for HDTs. Bullock carts (n = 57) operate at a much smaller scale, averaging 12.7 km per day, with net daily earnings of INR 700, but record frequent trips (5.6 trips/day) for local goods movement.

Table 1. Key vehicle, operation, and driving attributes (average)

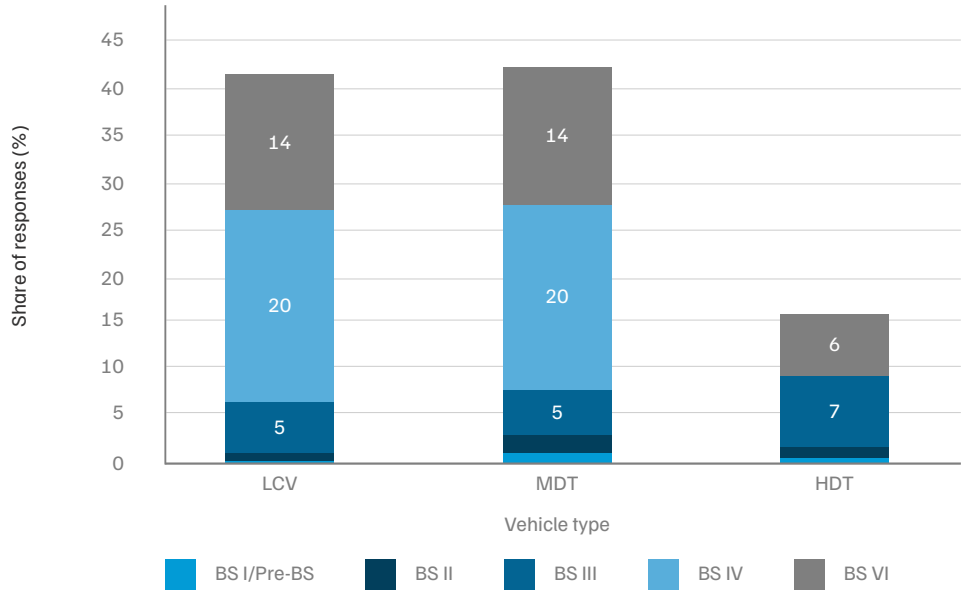
Trip and vehicle characteristics	LCV	MDT	HDT	Bullock carts
Trip distance (km)	98.5	304.1	389.4	2.4
Mileage (km per litre)	11.3	5.6	4.9	-
Average operational hours (hours/day)	9.2	9.8	10.2	7.1
Trip frequency (trips/day)	2.4	1.3	1.3	5.6
Number of tolls, rest stops, and refuelling stops	2.2	5	6	-
City driving share (%)	57.3	21	23	-
Highway driving share (%)	42.5	79.1	77.2	-

Source: Primary survey conducted by CEEW (2025–26).

Note: Breakdown is with respect to 1,091 LCV, 1,119 MDT, 409 HDT samples, and 57 bullock carts (N = 2,676). The mileage is self-reported by the drivers for diesel fleet.

Table A5 (refer to the Annexure) presents aggregate fleet composition and utilisation summaries. Around 15.4 per cent of the surveyed fleet (N = 2,619) is 15 years or older, while Figure 6 shows that only 36 per cent of freight vehicles (LCVs and MHDTs combined) are Bharat Stage VI (BS-VI) compliant. The remaining fleet largely comprises older pre-BS-IV vehicles. Together, these findings indicate slow fleet renewal and continued dependence on older diesel vehicles.

Figure 6. Only 36% of freight vehicles (LCVs and MHDTs combined, n = 2,619) plying in, via, or through Erode are BS-VI compliant

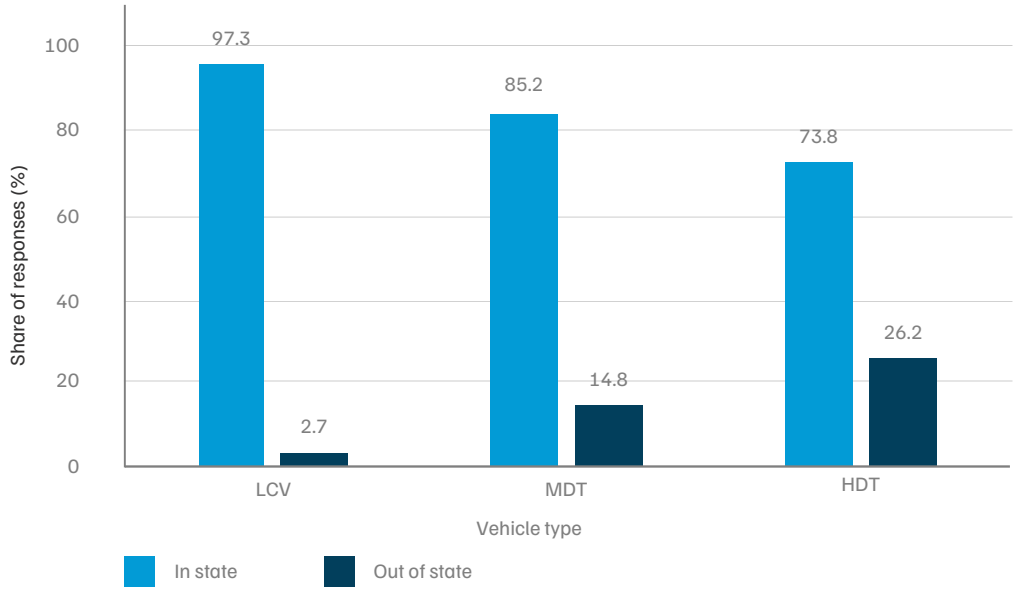


Source: Authors' analysis.

Acronyms: BS: Bharat Stage; HDT: heavy-duty truck; LCV: light commercial vehicle; MDT: medium-duty truck; MHDT: medium- and heavy-duty truck

Figure 7 presents the registration origin of the surveyed fleet across vehicle segments. Vehicles registered in Tamil Nadu largely support freight activity in Erode, particularly among LCVs, where 97.3 per cent are registered in the state. However, the share of out-of-state vehicles increases with vehicle size, reaching 14.8 per cent for MDTs and 26.2 per cent for HDTs. This suggests that while state-registered LCVs largely serve local freight movements, medium- and heavy-duty freight operations have a stronger interstate component.

Figure 7. Nearly all LCVs (97.3%) in Erode are registered in Tamil Nadu, but over one-quarter of HDTs are registered outside the state

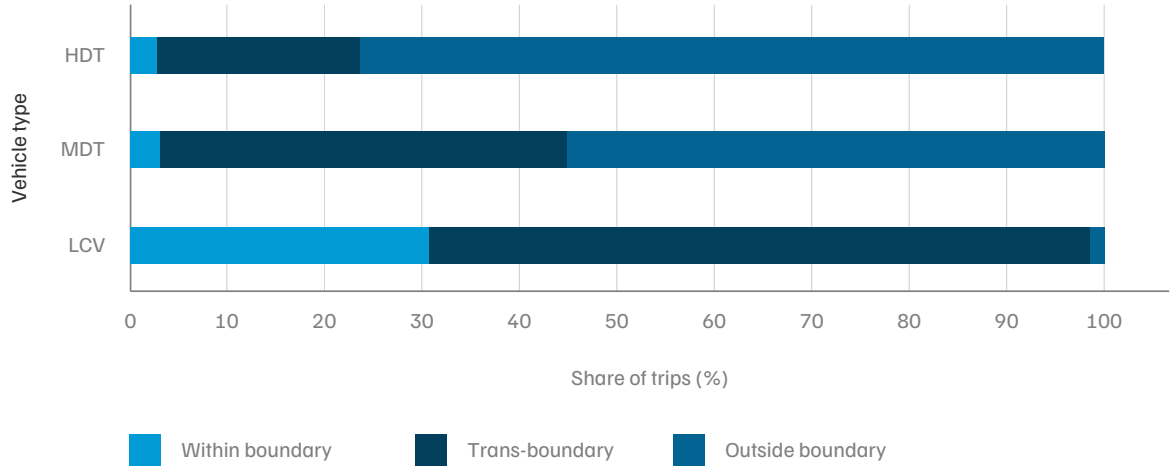


Source: Primary survey conducted by CEEW (2025–26).

Acronyms: HDT: heavy-duty truck; LCV: light commercial vehicle; MDT: medium-duty truck

2.3 Travel pattern and characteristics

Figure 8. LCVs are used for urban and short-haul distribution, whereas MDTs and HDTs are primarily used for regional and long-distance freight movement

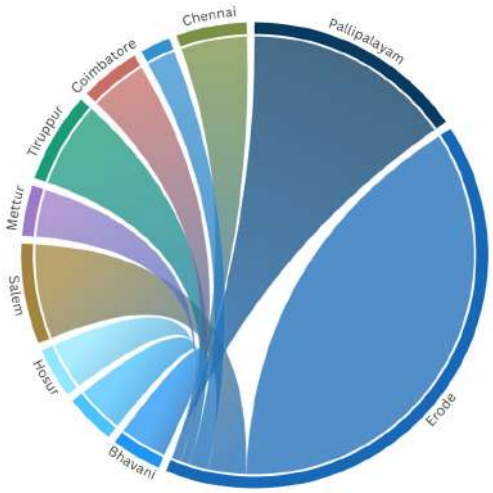


Source: Primary survey conducted by CEEW, 2025-26.

Acronyms: HDT: heavy-duty truck; LCV: light commercial vehicle; MDT: medium-duty truck

The freight trip pattern (Figure 8) highlights the spatial distribution of freight movements associated with Erode district across three origin–destination (OD) categories: (i) within the district boundary, (ii) transboundary, and (iii) outside the district boundary. Most LCVs are used for local and first- and last-mile freight operations, with 31 per cent of trips occurring within the district boundary and 68 per cent involving transboundary movement between Erode and surrounding districts. By contrast, MHDTs are engaged in regional freight movement, with 97 per cent of trips occurring transboundary and outside the district boundary. This indicates that MDTs and HDTs are primarily used for long-distance freight movement and interstate/interdistrict supply chains.

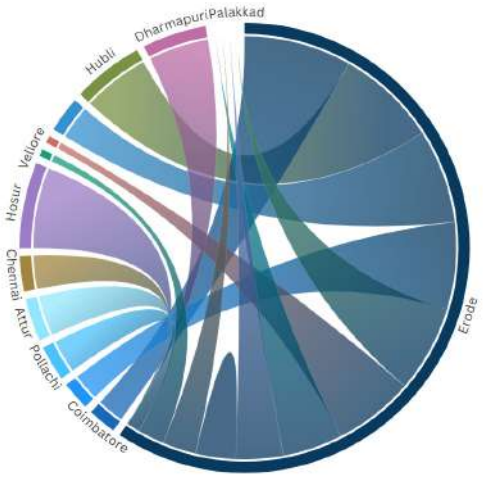
Figure 9. LCV trips are concentrated around Erode, with the strongest linkages to Pallipalayam, Tiruppur, Salem, and Mettur



Source: Authors' analysis.

Acronyms: LCV: light commercial vehicle

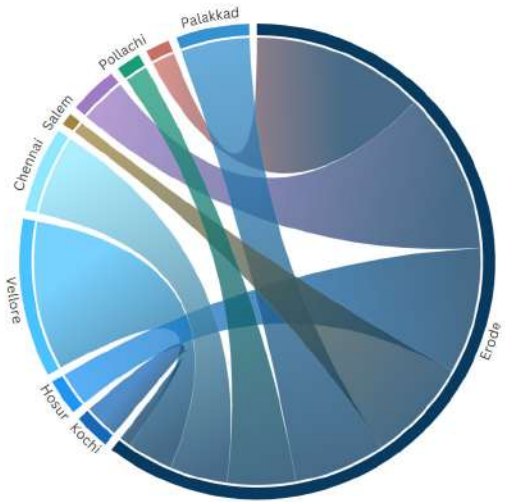
Figure 10. MDTs support regional freight, connecting Erode with industrial centres across Tamil Nadu, Karnataka, and Kerala



Source: Authors' analysis.

Acronyms: MDT: medium-duty truck

Figure 11. HDTs operate primarily on long-distance corridors, linking Erode with Vellore, Palakkad, Chennai, Salem, Kochi, and Hosur

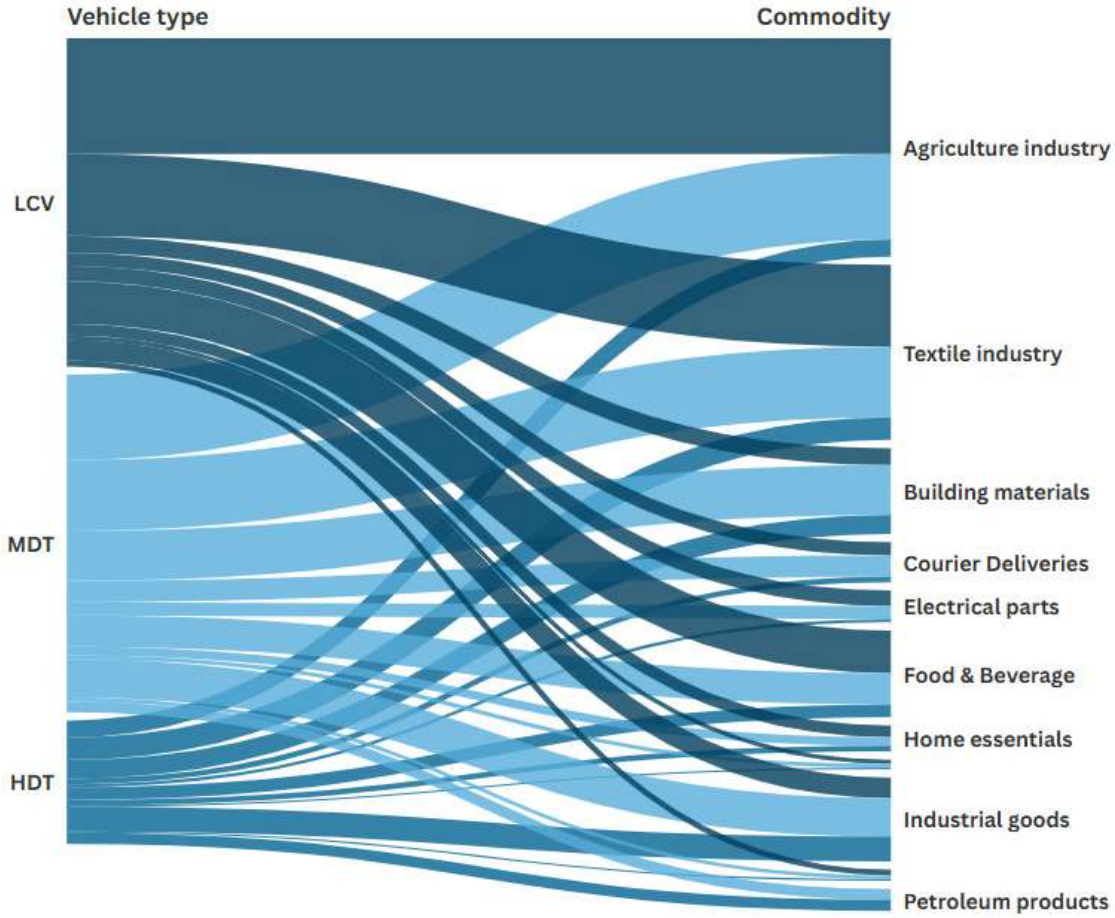


Source: Authors' analysis.

Acronyms: HDT: heavy-duty truck

2.4 Commodity distribution across vehicle segments

Figure 12. Commodity-wise freight movement by vehicle segment, showing LCVs primarily supporting agricultural and last-mile distribution, while MDTs and HDTs transport a broader mix of regional and long-distance freight



Source: Authors' analysis.

Acronyms: HDT: heavy-duty truck; LCV: light commercial vehicle; MDT: medium-duty truck

Commodity composition varies across vehicle segments, reflecting their operational roles. For instance, LCVs primarily transport agricultural produce (24 per cent), followed by textiles and apparel (17 per cent) and food and beverages (9 per cent), indicating their role in local and last-mile distribution. Commodities carried by MDTs are dominated by agricultural products (22 per cent), textiles and apparel (17 per cent), and construction materials (13 per cent), supporting the regional movement of both agricultural and bulk goods (Figure 12). In contrast, HDTs carry a more diverse mix of commodities, with textiles and apparel (5 per cent), construction materials (5 per cent), and agricultural products (4 per cent) being the most common, reflecting their role in transporting industrial and bulk freight over long-distance regional and interstate corridors.

Primary survey conducted across multiple freight vehicle segments.

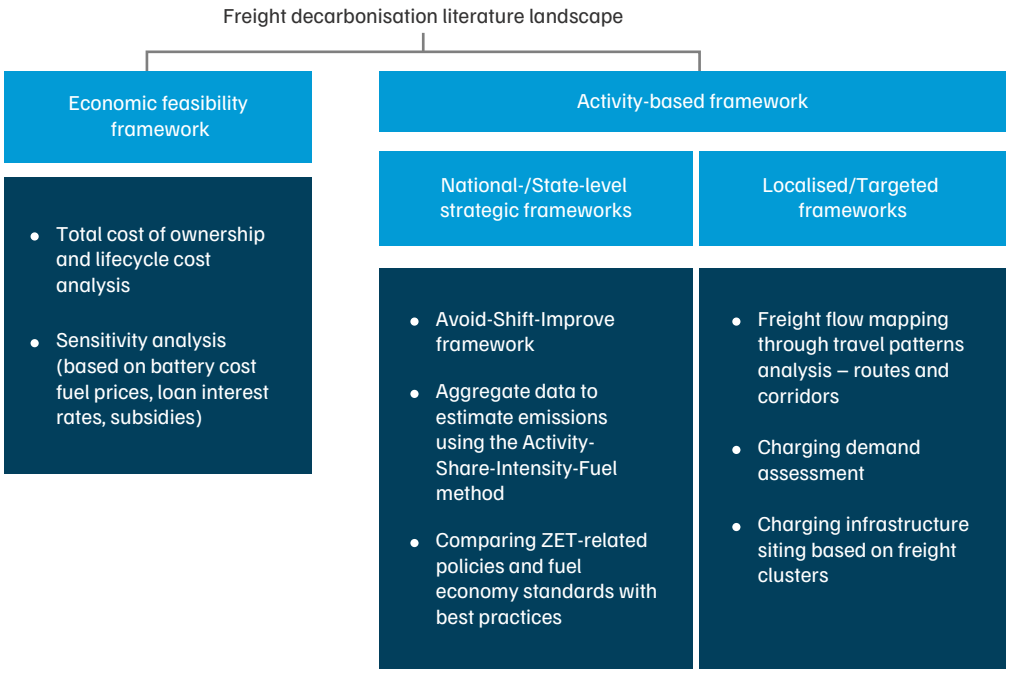
3. Methodological framework

Studies on freight decarbonisation pathways in India use a variety of analytical, operational, and economic methodologies to map the ZET transition. Figure 13 maps these frameworks. Most studies use the Avoid–Shift–Improve (ASI) framework to categorise policy interventions (NRDC 2023), supported by bottom-up modelling techniques such as the Activity–Share–Intensity–Fuel (ASIF) method to forecast freight demand and energy consumption (TERI 2024). While useful for national strategies, this model lacks the granular precision required for city-level infrastructure planning.

To evaluate financial viability, total cost of ownership (TCO) analysis and techno-economic modelling are used to evaluate the long-term capital and operational costs of ZETs relative to conventional diesel vehicles (TERI 2020). These approaches are frequently accompanied by sensitivity analyses that test variables such as battery costs, electricity prices, and interest rates, which are highly sensitive and unpredictable (TERI 2020; ITF 2024). While the TCO model evaluates the economic viability of ZETs, it is first necessary to understand the operational feasibility range of EV adoption targets. We therefore focus on operational feasibility to determine EV adoption.

On the logistical side, several studies conduct OD analyses, route surveys, and geographic information system (GIS)-based spatial mapping to assess freight flows, identify high-traffic clusters, and determine optimal locations for charging infrastructure (TERI 2020). Such models depend on primary data on vehicle kilometres travelled, payload limits, and fleet operational hours (TERI 2020; FICCI 2019). Furthermore, environmental impacts are largely quantified using well-to-tank (WTT) lifecycle GHG accounting to capture both direct and indirect emissions (TERI 2024). Forecasting methodologies frequently use multi-scenario modelling, comparing business-as-usual (BAU) baselines with technology improvements or accelerated ZET adoption, to project future technology adoption trajectories (MPP 2022; TERI 2024).

Figure 13. Literature landscape on freight decarbonisation methodology

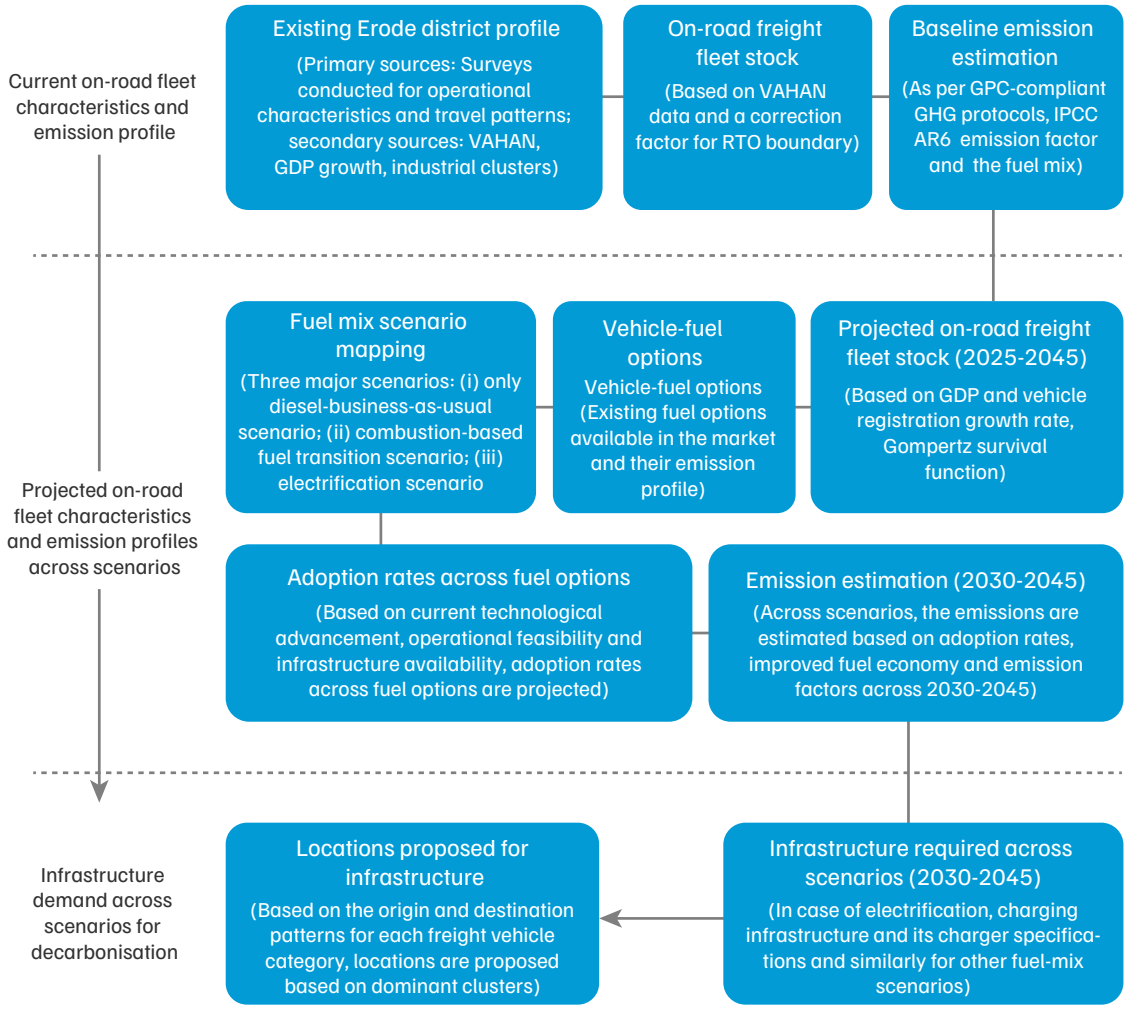


Source: Authors' compilation.

Note: For this study, an activity-based framework is adopted.

We have adopted a structured, bottom-up analytical framework that links existing freight fleet characteristics, transition pathways, and supporting infrastructure requirements, as depicted in Figure 14. Unlike conventional studies that estimate transport emissions using fuel consumption or vehicle registration statistics alone, the framework combines district-level operational data, fleet projection models, and scenario analysis to evaluate the emissions reduction potential of different freight decarbonisation pathways.

Figure 14. Methodology for Erode district freight decarbonisation pathways



Source: Authors' analysis.

Acronyms: AR6: Sixth Assessment Report; GDP: gross domestic product; GHG: greenhouse gas; GPC: Global Protocol for Community-Scale Greenhouse Gas Emission Inventories; IPCC: Intergovernmental Panel on Climate Change; RTO: regional transport office; VAHAN: Vahan Parivahan Sewa dashboard

3.1 On-road freight fleet in Erode district

The analysis begins by developing a profile of the existing freight fleet in Erode district. Primary data from the surveys are complemented by secondary information, including VAHAN vehicle registration records, district GDP growth, industrial clusters, and other socio-economic indicators, to represent the district's freight vehicle profile (VAHAN 2026; Census 2011; GoTN 2026). The existing on-road freight fleet is estimated from vehicle registration data using the Gompertz survival function, which accounts for the gradual retirement of vehicles with age (Mohan et al. 2025b; CSIR-CRRI 2014; CRRI 2019) (see Annexure for details).

The estimated on-road fleet forms the basis for projecting future freight stock over the period 2025–45. The fleet projection growth rate is linked to GSDP, district population, and segment-specific district registrations. In addition to new vehicle registrations, the projection includes replacement demand through a Gompertz survival function, ensuring that future fleet stock reflects both economic growth and the phased retirement of ageing vehicles (refer to the Annexure for more details).

3.2 GPC-compliant emissions inventory framework

Based on the estimated on-road fleet, a GPC-compliant GHG inventory is developed for the road freight sector. Emissions are estimated using vehicle activity data, including annual vehicle kilometres travelled (VKT), annual operating days, vehicle fuel economy, and fuel-specific emission factors consistent with the IPCC *Sixth Assessment Report* (AR6) guidelines (IPCC 2021). The inventory quantifies baseline emissions from the existing freight fleet and distinguishes emissions across different reporting scopes (Figure 15).

Scope 1 includes direct tailpipe emissions from diesel, CNG, LNG, and biodiesel. Scope 2 includes indirect emissions associated with grid electricity used for EV charging, while Scope 3 accounts for a portion of transboundary emissions and transmission and distribution (T&D) losses (WRI, C40, and ICLEI 2014). We have limited this study to tank-to-wheel (TTW) emissions, representing direct operational emissions that can be influenced through local transport planning, fleet transition strategies, and infrastructure interventions.

Since freight activity extends beyond the administrative boundary of Erode district, the inventory incorporates a spatial activity boundary to distinguish freight movements according to their origins and destinations. Freight trips are classified into:

- trips with both origin and destination within the Erode district boundary;
- trips with either origin or destination within the Erode district boundary; and
- trips with both origin and destination outside the Erode district boundary.

The distance travelled inside the Erode boundary is only considered in the emission calculation such as all the trips with Origin (O) and Destination (D) inside the boundary and portion of trips where O or D is inside the boundary. This classification maintains consistency with the GPC reporting framework.

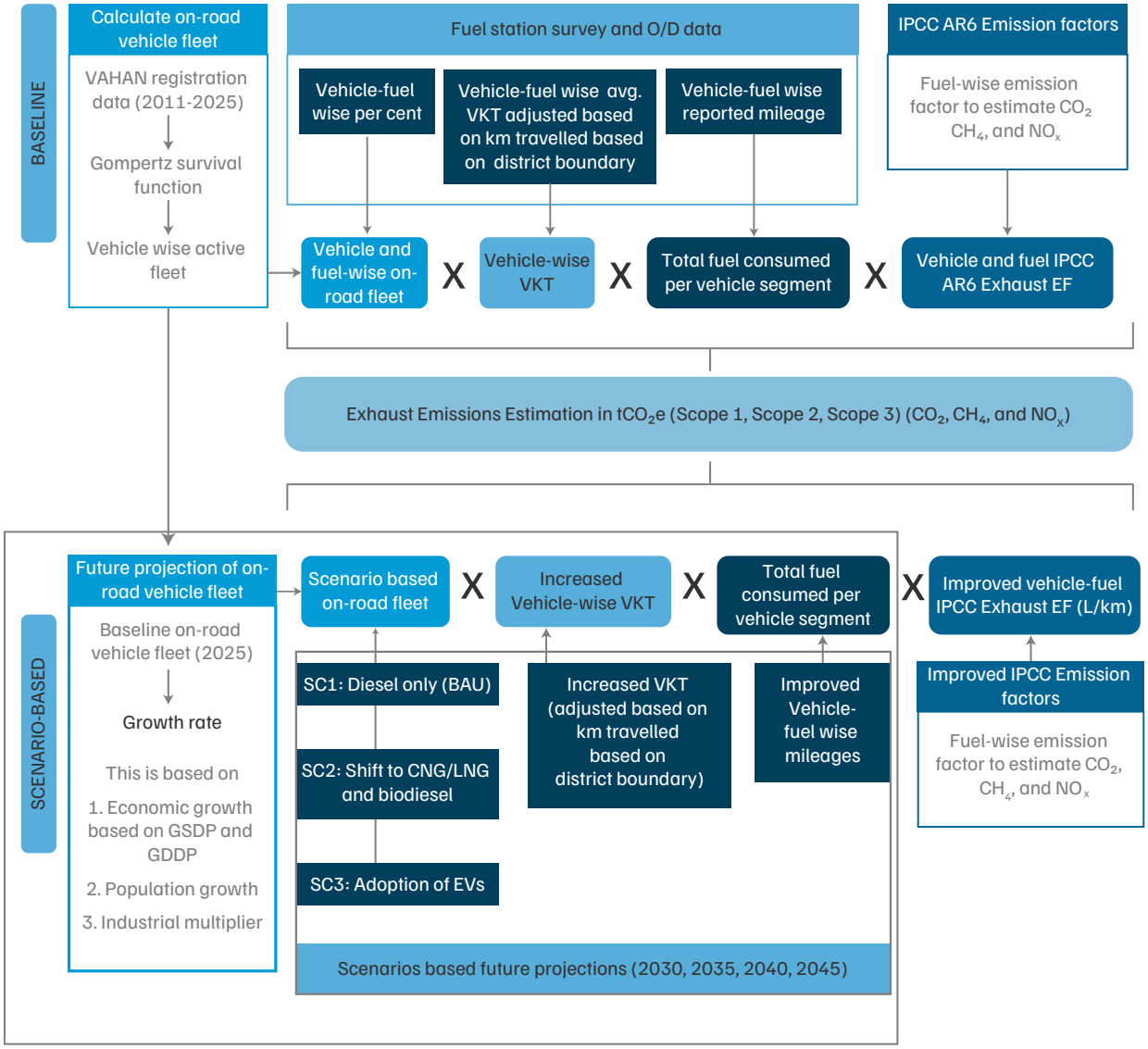
Building on the baseline emissions inventory, the projected on-road freight fleet for 2025–45 is allocated across different fuel technologies under the following scenarios:

(i) the BAU scenario assumes an entirely diesel fleet;

(ii) the fossil-based fuel scenario evaluates the gradual substitution of diesel with biodiesel and CNG/LNG; and

(iii) the electrification scenario assesses the phased transition of freight vehicles to EVs according to operational feasibility, technology maturity, and charging infrastructure availability.

Figure 15. Emissions modelling framework



Source: Authors' analysis.

Acronyms: AR6: Sixth Assessment Report; BAU: business-as-usual; CH4: methane; CNG: compressed natural gas; CO_2: carbon dioxide; EF: emission factor; EV: electric vehicle; GDDP: gross district domestic product; GSDP: gross state domestic product; IPCC: Intergovernmental Panel on Climate Change; LNG: liquefied natural gas; NOx: nitrogen oxides; VAHAN: Vahan Parivahan Sewa dashboard; VKT: vehicle kilometres travelled.

3.3 Vehicle technology transition pathways

The projected freight fleet is allocated across alternative fuel technologies based on vehicle operational characteristics, technology maturity, charging or refuelling infrastructure availability, and market readiness. Across all scenarios, improvements in vehicle fuel economy over time are also incorporated to reflect expected advancements in vehicle technology and efficiency (refer to the Annexure for more details).

Unlike the fossil-based fuel scenario, the electrification scenario requires a range-feasibility assessment based on the observed distribution of daily VKT obtained from the primary freight surveys. For each vehicle category (LCVs, MDTs, and HDTs), the reported daily distances are compared with the usable driving ranges of commercially available electric freight vehicles to estimate the proportion of operations that can be electrified using current technology.

The assessment is further extended by evaluating the impact of one intermediate charging opportunity, enabling the estimation of additional operations that become technically feasible with charging infrastructure. (Refer to annexure for more details) Vehicle-specific adoption rates provide the feasible proportion of the fleet that can transition to EVs based on existing range feasibility. The estimated EV fleet serves as an input for scenario analysis to calculate GHG emissions, electricity demand, and charging infrastructure requirements, as detailed in the Annexure.

3.4 Charging infrastructure estimation and spatial allocation

The projected electric freight fleet is translated into charging infrastructure requirements by estimating electricity demand, charger requirements, and spatial allocation. Vehicle-specific electricity demand is estimated using the projected EV fleet, annual VKT, and technology-specific energy consumption (kWh/km) (see the Annexure for details). Charger requirements are then determined based on rated charging power, efficiency, and annual energy throughput under low- and high-utilisation scenarios, as detailed in the Annexure. Different charger ratings are assigned to vehicle categories based on their operational characteristics and charging requirements as per available market models:

- It is assumed that LCVs utilise 22 kW alternating current (AC) and 50 kW direct current (DC) fast chargers.
- It is assumed that MDTs utilise only DC fast chargers rated at 50 kW, 120 kW, and 240 kW.
- It is assumed that HDTs utilise DC fast chargers rated 120 kW and 240 kW.

The number of chargers required for each power rating is estimated by allocating vehicle-category-specific charging demand across the selected charger types and dividing the corresponding annual energy demand by each charger's annual energy throughput (see the Annexure). The estimated demand is then spatially allocated using OD travel patterns obtained from the primary surveys. Freight generation and attraction clusters are identified by overlaying OD clusters with existing industrial estates, wholesale markets, logistics hubs, truck terminals, and major freight corridors. These locations are prioritised for the deployment of charging infrastructure.

Overall, the framework provides an integrated approach to evaluating freight decarbonisation by connecting fleet evolution, emissions modelling, technology transition, and infrastructure planning, thereby supporting evidence-based investment and policy decisions for district-level freight decarbonisation.

Image: CEEW

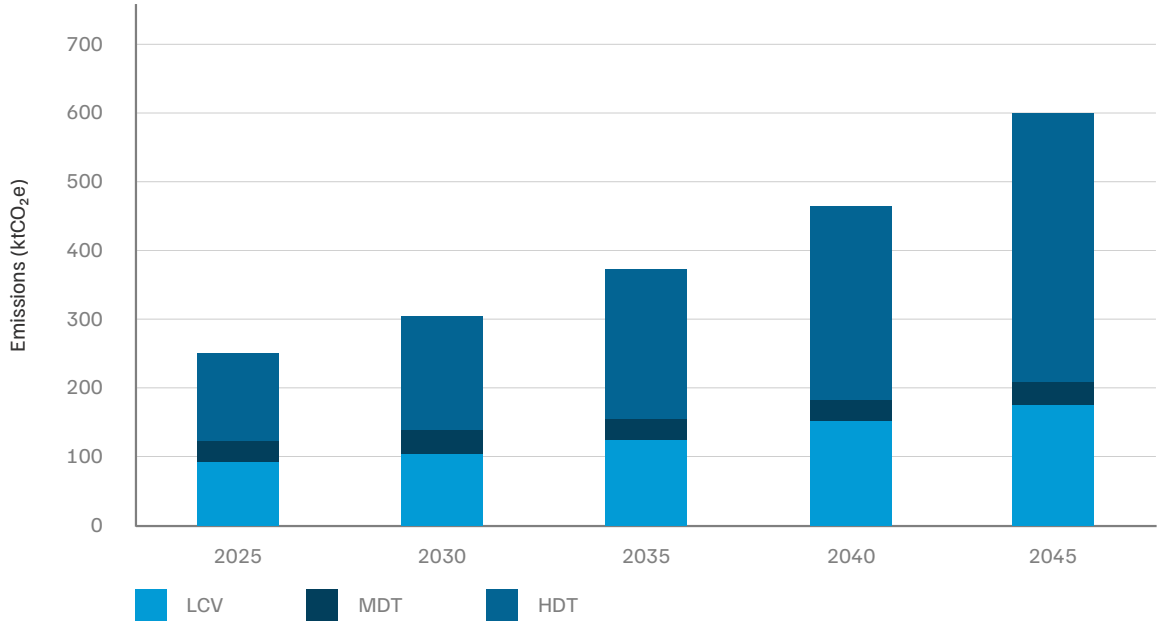
4. Fuel transition pathways for freight decarbonisation

This chapter presents current freight emissions in Erode district, projections under BAU and alternative scenarios, and the infrastructure required.

4.1 Baseline and business-as-usual scenario

In 2025, freight transport emissions in Erode district are estimated at 252 ktCO2e. Accounting for 30 per cent of the fleet, HDTs contribute 51 per cent of total freight emissions (128 ktCO2e), followed by LCVs, which contribute 36 per cent (92 ktCO2e), despite representing 58 per cent of the freight fleet. The disproportionately high contribution of HDTs is attributable to their lower fuel efficiency (4.9 km/l for HDTs compared with 11.3 km/l for LCVs self-reported during survey), compounded by longer driving distances, an ageing fleet, and heavier loads (20.7 tonnes for HDTs compared with 1 tonne for LCVs). Therefore, despite their smaller fleet share, each HDT generates higher emissions than an individual LCV.

Figure 16. Erode freight emissions are projected to rise 2.4-fold, from 252 $ktCO_2e$ in 2025 to 601 $ktCO_2e$ in 2045



Source: Authors' analysis.

Acronyms: HDT: heavy-duty truck; LCV: light commercial vehicle; MDT: medium-duty truck

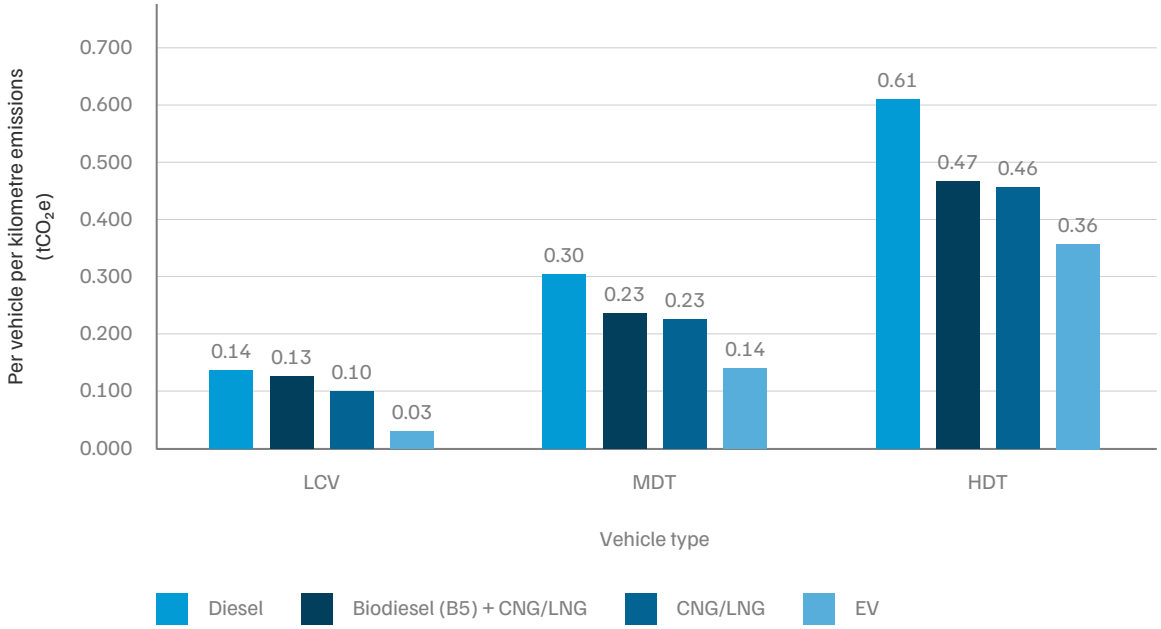
However, this annual emissions profile differs from the temporal distribution of freight activity. This is because HDTs are restricted from entering the defined Erode core boundary between 8.00 a.m. and 8.00 p.m., while LCVs undertake the majority of daytime freight operations within the city. Consequently, measures targeting LCV emissions are likely to deliver greater reductions within the urban confines of Erode, while HDT-focused interventions remain critical for reducing overall annual freight GHG emissions.

Under the BAU scenario, freight transport emissions are projected to increase to 306 $ktCO_2e$ by 2030 (1.2 times the 2025 baseline) and to 601 $ktCO_2e$ by 2045 (2.4 times the 2025 baseline). Over the same period, the freight fleet composition gradually shifts towards heavier vehicles, with the share of HDTs increasing from 30 per cent in 2025 to 43 per cent by 2045. The total freight fleet increases from 18,557 vehicles in 2025 to 47,843 vehicles in 2045, while the share of LCVs declines from 58 per cent to 52 per cent despite an overall increase in the number of vehicles. The increasing dominance of HDTs in both fleet size and emissions is driven by higher annual fleet additions, longer service lives, higher fuel consumption, and greater operational utilisation. Therefore, targeted interventions for HDTs remain critical over the long term.

4.2 How effective are the different decarbonisation pathways?

Per-kilometre GHG emissions intensity varies substantially across freight vehicle categories and fuel pathways, reflecting differences in vehicle energy demand and fuel-specific carbon intensity. Under the diesel baseline, HDTs exhibit the highest emissions intensity at approximately 0.61 tCO2e/km, followed by MDTs at 0.30 tCO2e/km and LCVs at 0.14 tCO2e/km.

Figure 17. Electrification cuts per-km operational GHG emissions by 41–78% relative to diesel, compared with 7 - 23% for CNG/LNG and B5 biodiesel



Source: Authors' analysis.

Acronyms: B5: diesel blended with 5% biodiesel; CNG: compressed natural gas; EV: electric vehicle; GHG: greenhouse gas; HDT: heavy-duty truck; LCV: light commercial vehicle; LNG: liquefied natural gas; MDT: medium-duty truck

For fossil-fuel alternatives, replacing diesel with B5 biodiesel and adopting CNG/LNG reduce HDT emissions by up to 23 per cent, MDT emissions by 23 per cent, and LCV emissions by 7 per cent. These reductions arise from the lower fossil carbon content of the biodiesel blend and adopting CNG fleet while maintaining compatibility with the existing diesel vehicle fleet. Switching to CNG/LNG further reduces emissions intensities to 0.46 tCO2e/km for HDTs, 0.23 tCO_2e/km for MDTs, and 0.1 tCO2e/km for LCVs. Although natural gas produces lower CO2 emissions than diesel, methane (CH4) partly offsets the overall carbon dioxide equivalent (CO2e) reductions, as it has a 27-times higher global warming potential (GWP) than CO2.

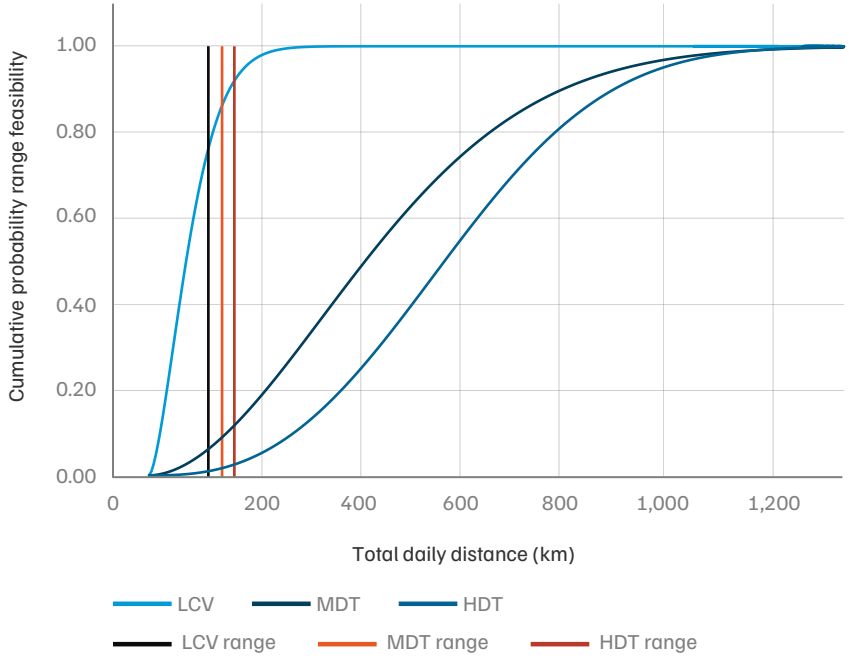
Under the electrification scenario, emissions intensity falls to the lowest level across all freight segments: 0.38 tCO_2e/km for HDTs, 0.14 tCO_2e/km for MDTs, and 0.03 tCO_2e/km for LCVs. This corresponds to reductions of 41 per cent, 54 per cent, and 78 per cent, respectively, relative to the baseline (Figure 17). These residual emissions are entirely Scope 2 emissions arising from electricity transmission and distribution used for vehicle charging.

While per-kilometre emissions intensity provides a useful measure of the operational efficiency of different vehicle technologies, it should not be used in isolation to prioritise decarbonisation strategies. City- or district-level mitigation priorities should instead be guided by aggregate emissions, which account for the cumulative impact of the entire fleet. Aggregate emissions incorporate fleet composition, vehicle activity (VKT), fuel economy, and emission factors, thereby identifying the vehicle categories that contribute most to overall emissions and offer the greatest mitigation potential.

4.3 Vehicle-fuel technology adoption readiness for electrification

The previous analysis identified electrification as the most effective freight decarbonisation pathway, achieving substantially higher GHG reductions than CNG/LNG and biodiesel. CNG/LNG and biodiesel are established technologies that can be adopted with limited changes to existing vehicles and refuelling infrastructure. In contrast, the transition to electric freight vehicles depends on whether current EV ranges and charging infrastructure can support daily operations. Therefore, this section assesses each freight segment's readiness for electrification based on its travel patterns and charging requirements.

Figure 18. LCVs show the highest near-term electrification feasibility: 58% already travel within the 134 km daily EV range, rising to 44% for MDTs and 15% for HDTs with one intermediate charge



Type	EV range (km)	Feasibility (%)
LCV	134	86
MDT	166	44
HDT	149	15

Source: Authors' analysis using CEEW primary surveys (2025–26).

Note: Feasibility includes range feasibility of users with one intermediate charge.

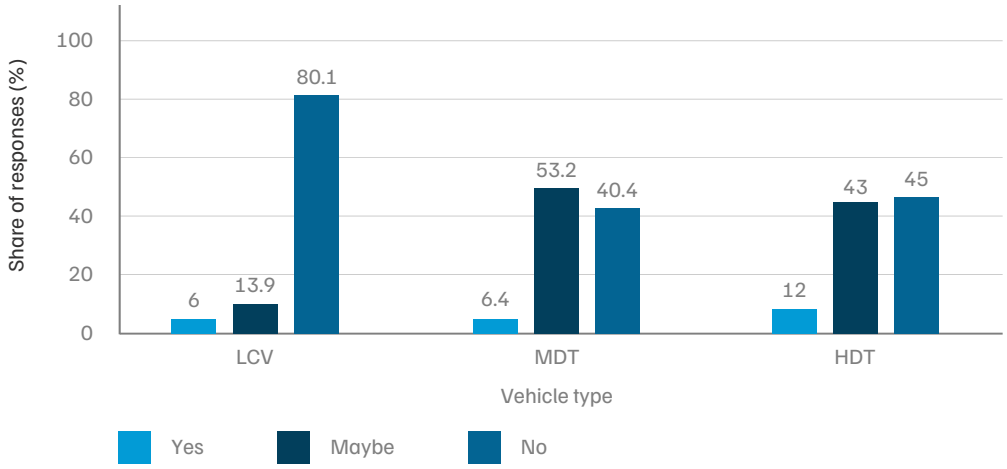
Acronyms: EV: electric vehicle; HDT: heavy-duty truck; LCV: light commercial vehicle; MDT: medium-duty truck

Figure 18 presents the cumulative distribution function (CDF) of daily travel distances to assess the practicality of freight electrification across vehicle segments. The vertical lines indicate the usable EV driving ranges in 2025: 134 km for LCVs, 166 km for MDTs, and 149 km for HDTs (refer to the Annexure). The analysis shows that a large share of LCV operations is concentrated within shorter daily distances, with nearly 80 per cent travelling less than 200 km per day. This indicates strong potential for early electrification using currently available e-LCV models (EVreporter 2024). Specifically, around 58 per cent of LCVs operate within the current usable EV range of 134 km, making LCVs the most suitable segment for rapid near-term electrification. With one intermediate or opportunity charge, this share increases to 86 per cent, demonstrating the potential for charging infrastructure to significantly increase the operational feasibility of e-LCVs.

In comparison, only 18 per cent of MDTs and 2 per cent of HDTs operate within their currently available EV ranges. With one additional intra-day charging opportunity, the transition potential increases to 44 per cent for MDTs and 15 per cent for HDTs. However, a significant proportion of MDT and HDT operations exceed the ranges of current EV models, with or without intermediate charging, indicating the need for wider charging networks and reliable battery-swapping systems, or larger batteries. The longer-distance tail end of the curve reflects freight operations that may require higher-capacity batteries or next-generation long-range electric trucks (Euler Motors 2025).

Despite the high technical potential, only 6 per cent of surveyed LCV operators (n = 1,091) are willing to shift to EVs, the lowest of all segments (Figure 19). In contrast, outright willingness is slightly higher among MDT respondents (6.4 per cent) and notably higher among HDT respondents (12 per cent). More importantly, a majority of MDT respondents (53 per cent) and a substantial share of HDT respondents (43 per cent) fall within the "maybe" category, suggesting that their adoption decisions remain contingent on improvements in technology maturity, charging infrastructure, financing, and operational confidence. This indicates that although behavioural readiness remains weak overall, medium- and heavy-duty freight operators are comparatively more amenable to adoption when supported by a conducive ecosystem.

Figure 19. Across freight segments, over 40% of respondents remain unwilling to shift to EVs, while conditional willingness remains highest among MHDT operators



Source: Primary survey conducted by CEEW, 2025–26.

Note: The breakdown is based on 1,091 LCV, 1,119 MDT, and 409 HDT samples (N = 2,619).

Acronyms: HDT: heavy-duty truck; LCV: light commercial vehicle; MDT: medium-duty truck

The contrast between technical feasibility and willingness to adopt highlights the need to better understand the barriers faced by freight operators. **Heatmaps of barriers to EV adoption (Figures A3 and A4; refer to the Annexure) show that the strongest concerns among LCV drivers include battery safety and warranty, upfront costs, and uncertainty around maintenance and servicing.** Charging constraints are comparatively less important, consistent with the shorter duty cycles of LCVs and their higher compatibility with current EV ranges.

Among MDT and HDT respondents, high electricity costs and downtime-related income loss emerge as dominant concerns, intersecting strongly with charging constraints and upfront costs (Figure A4; refer to the Annexure). Concerns around the limited availability of EV truck models, range and payload limitations, and unfamiliarity with the technology are also more evident in the MHDT segment. Addressing these ecosystem barriers, particularly charging infrastructure, could enable a much larger share of MDTs and HDTs to transition to EVs, as shown in Figure 18.

Given these barriers, it is equally important to understand the improvements that would encourage EV adoption across different freight segments. Among LCV respondents, training, upskilling, and test-driving opportunities emerge as the strongest motivations, followed by driver experience, peer influence, and earnings-related considerations (Figure A5; refer to the Annexure). Driver comfort, reduced fatigue, and operational ease also emerge as important considerations.

For MHDT respondents, the strongest motivational factor is the charging ecosystem, including infrastructure availability, charging speed, and swapping systems (Figure A6; refer to the Annexure). Vehicle availability and range also feature prominently, reflecting concerns regarding long-distance operability and route flexibility.

Taken together, the findings suggest that a one-size-fits-all approach will not be effective in accelerating freight EV adoption. For LCVs, the focus should be on awareness, training, and confidence-building. With 66 per cent of respondents unaware of EV training opportunities and existing EV drivers identified as the most trusted information source, priorities include demonstrations, peer learning, and test drives (refer to Figures A7 and A8). For MHDTs, despite two-thirds of operators agreeing that electric trucks can meet their daily range and load requirements, charging gaps and financing constraints continue to limit uptake (see Table A6 in the Annexure). Thus, the focus for MDTs and HDTs should be on expanding charging infrastructure or battery swapping and strengthening the supporting ecosystem to improve operational viability.

4.4 Where are the highest emissions under alternative fuel pathways?

To evaluate the decarbonisation potential of the freight sector, three transition scenarios were developed, representing varying levels of technology and fuel adoption between 2025 and 2045.

Scenario 1: BAU (diesel-only) scenario: This scenario assumes that the freight fleet continues to operate entirely on diesel, with no transition to alternative fuels or electrification. Improvements in fuel economy are considered to reflect advances in vehicle technology; however, no changes in the fuel mix are assumed. This scenario serves as the baseline against which all emissions reductions are assessed.

Scenario 2: Fossil-based fuel scenario (diesel + CNG/LNG + biodiesel): This scenario assumes a gradual diversification of the freight fuel mix through the adoption of CNG/LNG and biodiesel. The share of diesel declines progressively from 100 per cent to 60 per cent by 2045, with CNG/LNG and biodiesel each accounting for 20 per cent of the fleet. This scenario represents a near-term transition pathway that reduces emissions using commercially available technologies without requiring complete fleet replacement.

Scenario 3: Electrification scenario (diesel + EVs): This scenario assumes the phased adoption of electric freight vehicles, with electrification rates varying by vehicle category to reflect technology maturity and operational feasibility. By 2045, 90 per cent of LCVs, 60 per cent of MDTs, and 40 per cent of HDTs are assumed to be electrified, while the remaining fleet continues to operate on diesel. The lower electrification rate for HDTs reflects current constraints related to battery capacity, vehicle availability, charging infrastructure, payload requirements, and long-haul operations. This scenario represents the long-term decarbonisation pathway for the freight sector.

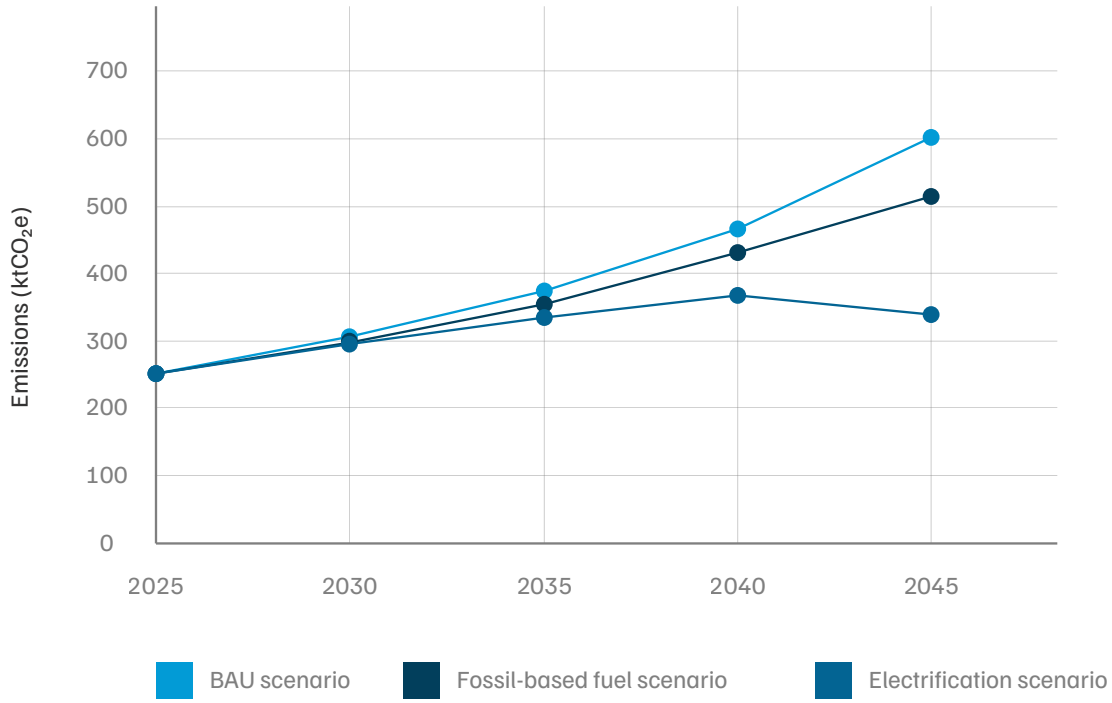
Fuel economy improves by approximately 20 per cent between 2025 and 2045, reflecting expected advances in vehicle technology and powertrain efficiency in the fossil-fuel-dominant scenarios (details provided in the Annexure). The fuel economy of LCVs improves from 11 to 13.2 km/l, MDT fuel economy from 5 to 6 km/l, and HDT fuel economy from 2.5 to 3 km/l over the analysis period. Similar efficiency improvements are assumed for CNG/LNG, biodiesel, and EVs, resulting in lower energy consumption per kilometre and, consequently, lower operational emissions.

Under the BAU scenario, in which the freight fleet continues to operate entirely on diesel, total operational GHG emissions increase from 252 $ktCO_2e$ in 2025 to 601 ktCO2e by 2045, driven by growth in freight activity despite improvements in vehicle efficiency.

The fossil-based fuel transition scenario moderates emissions growth, reducing total freight emissions to 515 ktCO2e in 2045, representing a 14 per cent reduction relative to BAU. Although fuel economy improvements reduce energy demand, continued reliance on fossil-based fuels limits the overall potential for emissions reductions.

The electrification scenario assumes the gradual replacement of diesel-powered freight vehicles with EVs between 2030 and 2045. By 2045, this pathway reduces overall freight-sector GHG emissions by 44 per cent relative to the BAU scenario (601 ktCO2e), as shown in Figure 20. Electrification is assumed to occur at different adoption rates across vehicle categories, reflecting technological maturity and operational feasibility, with 90 per cent of LCVs, 60 per cent of MDTs, and 40 per cent of HDTs electrified by 2045.

Figure 20. By 2045, the fossil-based fuel and electrification scenarios reduce emissions by 14% and 44%, respectively, relative to the BAU scenario



Source: Authors' analysis.

Acronyms: BAU: business-as-usual

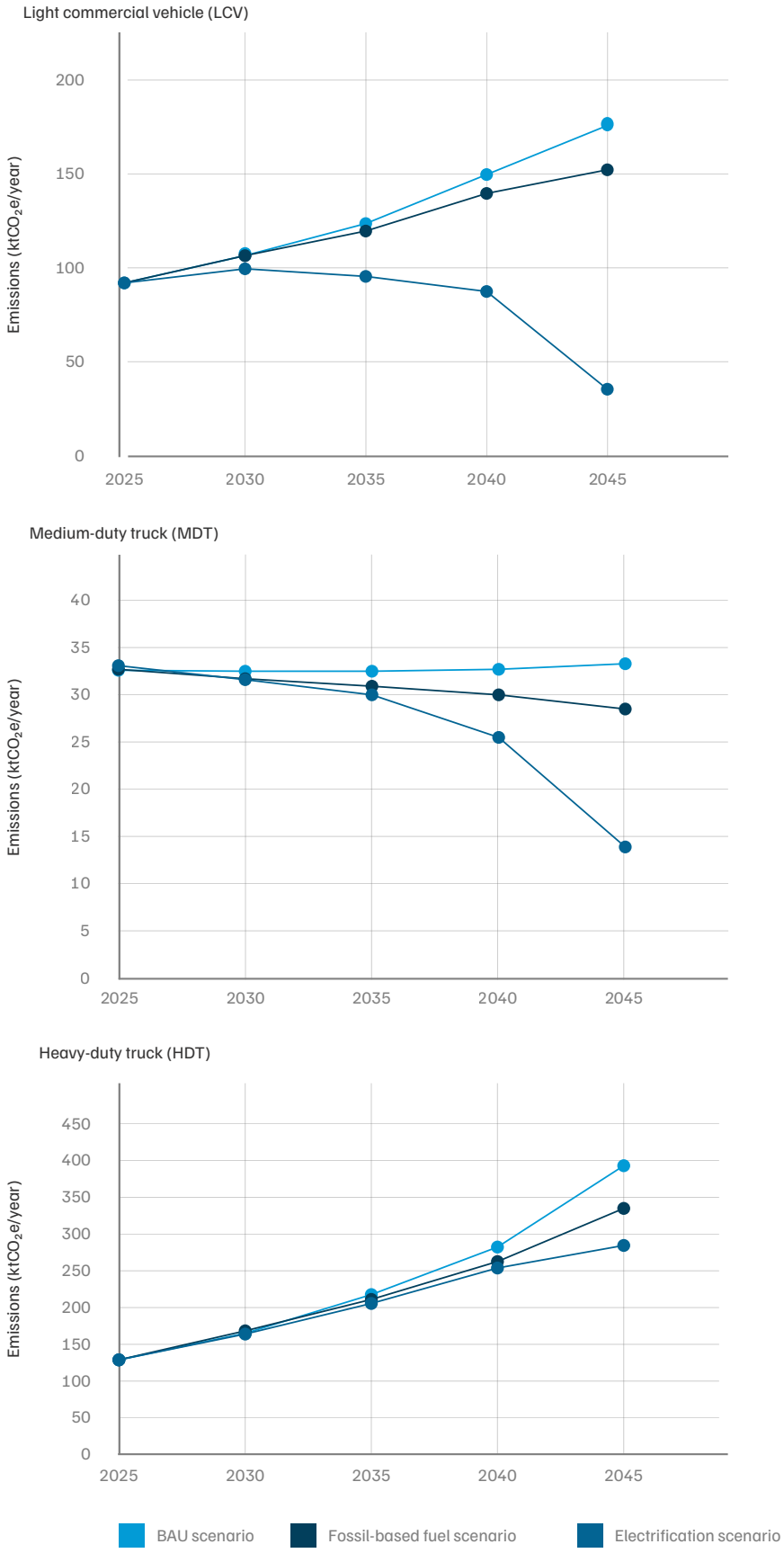
The effect of the fuel transition varies across freight vehicle categories due to differences in energy consumption, utilisation, and assumed rates of fuel and technology adoption. Under the BAU scenario, LCV emissions increase from 92 $ktCO_2e$ in 2025 to 175 $ktCO_2e$ in 2045 despite improvements in fuel economy. The alternative fossil-based fuel transition scenario limits emissions to 152 $ktCO_2e$ by 2045, a 13 per cent reduction relative to BAU, while the electrification scenario reduces emissions to 36 $ktCO_2e$, a 79 per cent reduction. This reduction is associated with the higher EV adoption rate assumed for LCVs (90 per cent by 2045) (Figure 21).

For MDTs, emissions remain relatively stable under BAU at 33 $ktCO_2e$ in 2030 similar to 2025. Diesel fuel economy improves from 5 to 6 km/l, partially offsetting the increase in freight activity. Under the alternative fossil-based fuel transition scenario, emissions are reduced to 28 $ktCO_2e$ (a 15 per cent reduction), while the electrification scenario reduces emissions to 19 $ktCO_2e$ (a 42 per cent reduction).

Under all scenarios, HDTs account for the highest emissions. Under BAU, emissions increase from 128 $ktCO_2e$ in 2025 to 393 $ktCO_2e$ in 2045, although diesel fuel economy improves over the same period. Under the alternative fossil-based fuel transition scenario, emissions are reduced to 335 $ktCO_2e$, a 15 per cent reduction, while the electrification scenario reduces emissions to 284 $ktCO_2e$, a 28 per cent reduction. The lower reductions among MDTs and HDTs reflect the assumed EV adoption rates of 60 per cent and 40 per cent by 2045, respectively, and the higher energy requirements of heavy-duty vehicles.

Trucks have unrestricted access within the Erode Corporation limits, with no time-based entry restrictions.

Figure 21. Projected operational GHG emissions from LCVs, MDTs, and HDTs under alternative fuel transition pathways (2025–45), with an emissions reduction of up to ~79% for LCVs under the electrification scenario



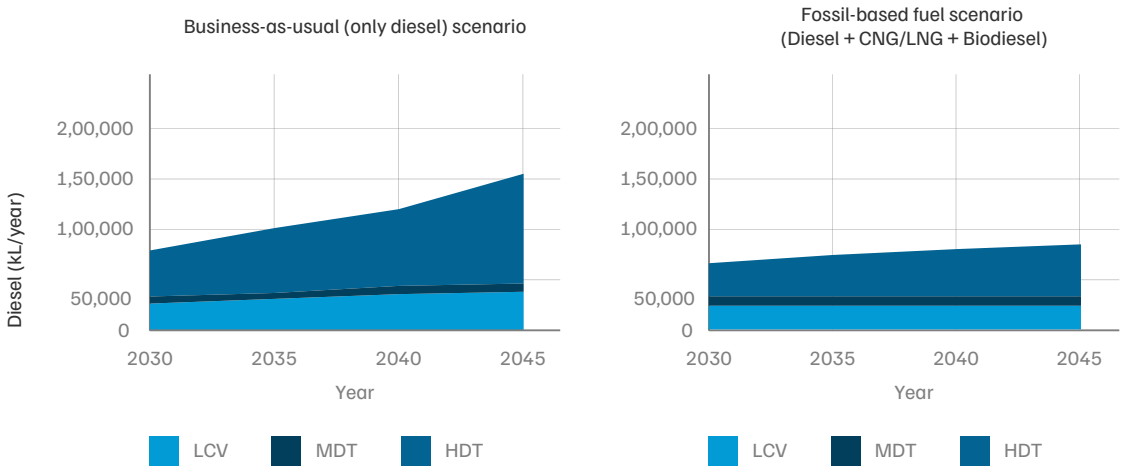
Source: Authors' analysis.

Acronyms: BAU: Business-as-usual

4.5 Freight energy demand shifts towards alternative fuels and electricity by 2045

Under Scenario 1 (BAU), annual diesel demand reaches 153.8 thousand kL by 2045. As shown in Figure 22, the fossil-based fuel transition (Scenario 2) reduces diesel demand to 92.3 thousand kL, a reduction of approximately 40 per cent relative to the BAU scenario. This transition is accompanied by increased demand for alternative fuels, with biodiesel reaching 27 thousand kL and CNG/LNG reaching 21.8 thousand tonnes by 2045. Among vehicle segments, HDTs account for the largest share of both alternative fuels, contributing 68.3 per cent of total CNG/LNG demand (14.9 thousand tonnes; LNG only for HDTs) and 64.5 per cent of total biodiesel demand (17.4 thousand kL) by 2045.

Figure 22. Under the fossil-based fuel scenario, annual diesel demand falls by ~40% by 2045 relative to BAU



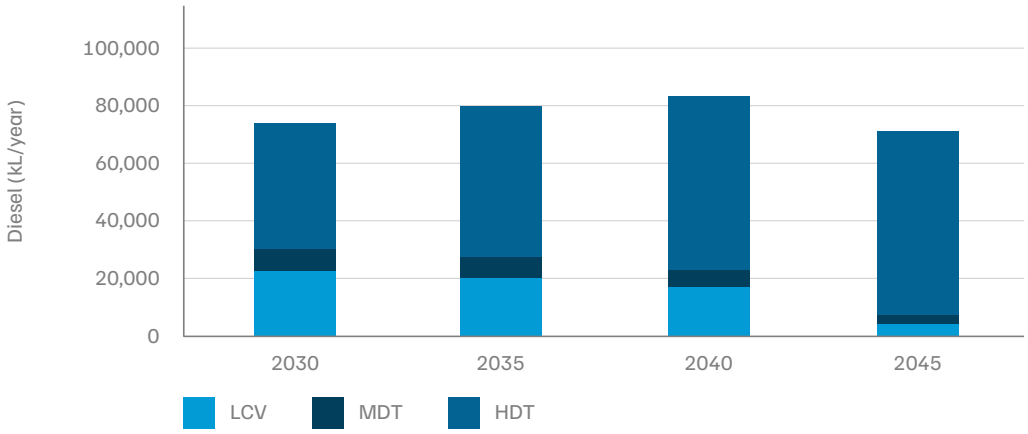
Source: Authors' analysis.

Acronyms: BAU: business-as-usual

The electrification scenario (Scenario 3) reduces annual diesel demand to 70.4 thousand kL by 2045, representing a 54 per cent reduction relative to the BAU scenario (Figure 23). Diesel demand declines by nearly 90 per cent for LCVs, 60 per cent for MDTs, and 40 per cent for HDTs, showing that electrification has the greatest impact on light- and medium-duty freight vehicles. However, HDTs continue to account for nearly 89 per cent of the remaining diesel demand because of their higher energy requirements and lower electrification rate.

As freight transitions away from diesel, demand for electricity and other alternative fuels will continue to increase. This highlights the need to expand biodiesel supply, CNG/LNG refuelling facilities, and EV charging infrastructure to support growing demand. The following analysis estimates the electricity demand and charging infrastructure required under the electrification scenario.

Figure 23. By 2045, the electrification scenario reduces annual diesel demand by ~90% for LCVs, 60% for MDTs, and 40% for HDTs relative to BAU

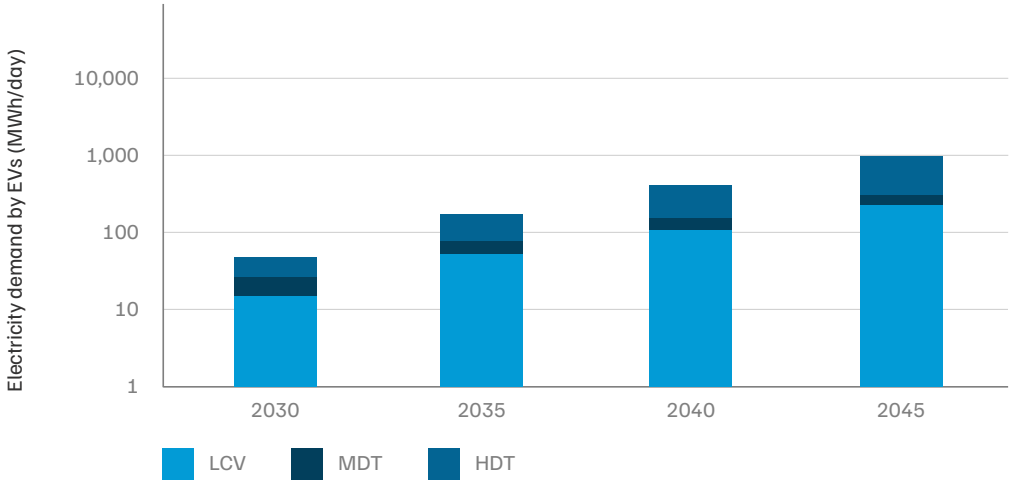


Source: Authors' analysis.

Acronyms: BAU: business-as-usual; EV: electric vehicle; HDT: heavy-duty truck; LCV: light commercial vehicle; MDT: medium-duty truck

Under the electrification scenario, the freight fleet's daily electricity demand is projected to increase from 46 MWh/day in 2030 to ~1011 MWh/day by 2045 (Figure 24). By 2045, the scenario assumes 90 per cent electrification of LCVs, 60 per cent of MDTs, and 40 per cent of HDTs, corresponding to approximately 22,200 LCVs, 1,630 MDTs, and 8,190 HDTs. HDTs account for approximately 70 per cent of total electricity demand (707 MWh/day), despite an electrification rate of 40 per cent, whereas LCVs account for 23 per cent (approximately 230 MWh/day) and MDTs for 7 per cent (approximately 75 MWh/day). This difference is primarily due to the substantially higher energy requirements and operating distances of HDTs. The findings indicate that charging infrastructure planning should be based not only on EV adoption but also on each vehicle category's electricity demand, with particular emphasis on high-capacity charging infrastructure for HDTs.

Figure 24. HDTs account for ~70% of the total EV electricity demand by 2045 despite a lower EV adoption rate than LCVs



Source: Authors' analysis.

Acronyms: EV: electric vehicle; HDT: heavy-duty truck; LCV: light commercial vehicle; MDT: medium-duty truck

The projected electricity demand is translated into charging infrastructure requirements using charger-specific assumptions on power rating, charging efficiency, utilisation, and annual energy throughput. Charger requirements are estimated under low- and high-utilisation scenarios to account for variations in charger occupancy during fleet operations (see Table 2).

Under the low-utilisation charging scenario, the total charging requirement increases from 178 chargers in 2030 to 3,209 chargers by 2045, with approximately 50 per cent higher than under the high-utilisation scenario. The distribution of charger ratings reflects the freight fleet's operational characteristics. LCVs require more lower-power chargers because they have a higher level of fleet electrification and are better suited to depot-based charging. In contrast, MDTs and HDTs require higher-power chargers to meet their daily energy demand and reduce charging time. Consequently, although HDTs account for a smaller share of EVs than LCVs, they drive demand for 120 kW and 240 kW charging infrastructure, consistent with their higher electricity demand.

Table 2. Charging requirements under low- and high-utilisation scenarios

Number of chargers in case of low utilisation of chargers								
Vehicle type	2030				2045			
	22 kW	50 kW	120 kW	240 kW	22 kW	50 kW	120 kW	240 kW
LCV	84	11	0	0	1,236	160	0	0
MDT	0	13	23	3	0	51	92	13
HDT	0	0	28	16	0	0	1,070	586
Total	**84**	**24**	**51**	**19**	**1,236**	**211**	**1,162**	**599**
Number of chargers in case of high utilisation of chargers								
LCV	42	5	0	0	618	80	0	0
MDT	0	6	11	2	0	26	46	7
HDT	0	0	14	8	0	0	535	293
Total	**42**	**11**	**25**	**10**	**618**	**106**	**581**	**300**

Source: Authors' analysis.

Notes: Low utilisation assumptions are 25% (22 kW AC), 20% (50 kW DC), 7.5% (120 kW DC), and 10% (240 kW DC). High utilisation is assumed to be twice the corresponding low-utilisation rate.

4.6 Spatial allocation of charging infrastructure

An OD analysis for different vehicle segments is conducted to understand freight movement patterns and identify key trip generation and attraction centres. The analysis provides insights into the spatial distribution of trips within and outside Erode district, enabling the identification of high-demand nodes suitable for EV charging infrastructure. This section focuses on LCV charging clusters based on their OD patterns, as LCVs are the priority segment for near-term electrification; MHDT clusters are presented in the Annexure.

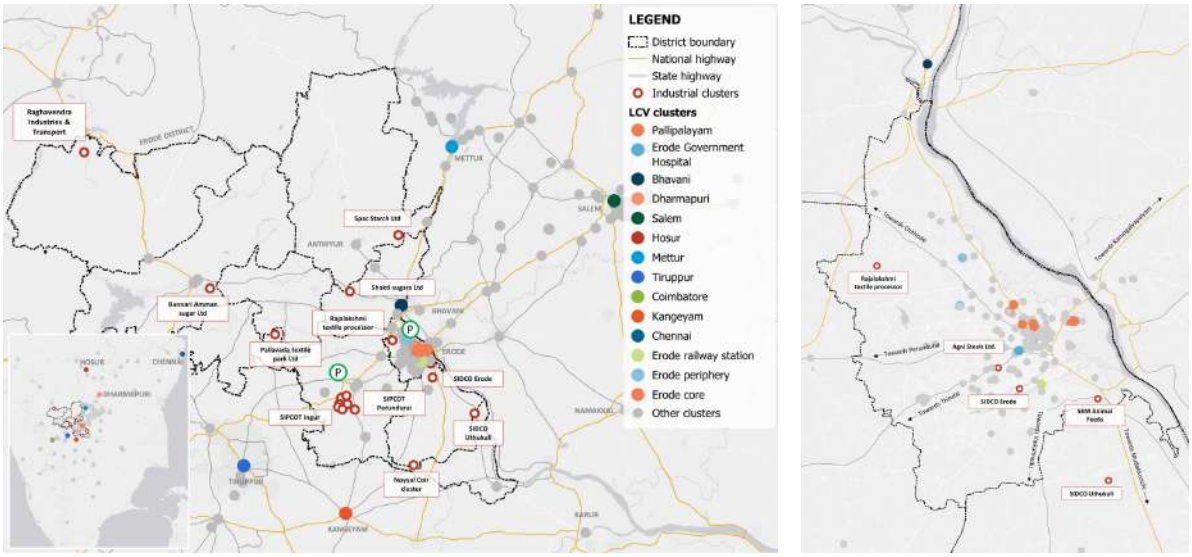
LCV charging infrastructure clusters

The OD cluster analysis for LCVs (Figure 25) identifies freight generation and attraction centres supporting urban logistics and short-haul goods movement. Approximately 99 per cent of trips (either O/D or both O and D locations) are concentrated within Erode district, are concentrated within Erode district, with major trip generation and attraction clusters observed around Erode city, Bhavani, Perundurai, Sathyamangalam, Chennimalai, and Modakurichi.

The highest concentration of freight activity is along the Erode–Bhavani and Erode–Perundurai corridors, closely aligned with major industrial hubs such as SIPCOT Perundurai, SIPCOT Ingur, SIDCO Erode, and other industrial estates, including sugar industries in Bhavani and Sathyamangalam, a textile park in Chennimalai, and SIDCO Uthukuli. Further, around 64 per cent of freight clusters are located within the Erode city boundary, coinciding with key wholesale markets such as Erode Central Market and Gani Market, as well as other warehouses and logistics hubs, highlighting the city's role as the primary freight distribution centre in the district.

Beyond the district, significant freight linkages exist with nearby industrial and commercial centres such as Salem, Tiruppur, Coimbatore, Kangeyam, Mettur, Dharmapuri, Hosur, and Chennai. These freight clusters represent priority locations for LCV charging infrastructure. Given the relatively shorter operating distances and regular dwell periods associated with loading and unloading activities, depot- and destination-based charging can be prioritised at industrial estates, wholesale markets, and logistics hubs, subject to land availability and electrical infrastructure.

Figure 25. OD clusters for LCV trips overlaid with major industrial estates and freight activity hubs in Erode district, highlighting key freight corridors and areas of concentrated logistics activity



Source: Authors' analysis.

Acronyms: LCV: light commercial vehicle; OD: origin–destination

Stakeholder consultation workshop on freight decarbonisation recommendations for Erode.

5. Recommendations and phased decarbonisation roadmap

Freight transport is projected to remain a major contributor to transport-sector GHG emissions in Erode. The findings of this study demonstrate that freight decarbonisation will require a combination of technology transition, charging infrastructure development, and enabling policy interventions rather than a single mitigation measure.

The analysis also highlights significant differences across freight vehicle segments in their operational characteristics, electrification readiness, and infrastructure requirements. Of all segments, LCVs exhibit the highest near-term electrification potential, with 58 per cent of vehicles already operating within the available electric driving range, increasing to 86 per cent with one intermediate charging opportunity. In contrast, MDTs and HDTs support a greater share of regional and long-distance freight operations, resulting in lower near-term electrification potential and greater dependence on high-capacity charging infrastructure. By 2045, HDTs are projected to account for approximately 70 per cent of total freight electricity demand despite representing a lower share of EVs than LCVs. Charging infrastructure planning should therefore account for vehicle-specific energy demand rather than fleet size alone.

Based on the freight movement analysis, commodity flows, industrial cluster assessment, and charging infrastructure modelling, the study identifies three priority areas for the phased implementation of freight decarbonisation interventions.

Table 3. Priority areas for phased freight decarbonisation interventions

Clusters	Priority locations
Urban logistics hubs	Erode Central Market, Gani Market, and warehouses
Industrial clusters	SIPCOT Perundurai, SIPCOT Ingur, SIDCO Erode, SIDCO Uthukuli, Pallavada Textile Park
Regional freight corridors and truck terminals	Bhavani, Chithode, Perundurai, Erode Lorry Owners' Association (LOA) lorry stand, proposed Perundurai truck terminal, and NH544

Source: Authors' analysis.

5.1 Key recommendations

The recommendations are structured across six key intervention areas: regulatory levers; urban planning and land-use integration; behavioural interventions; financing mechanisms; data-driven decision-making and monitoring; and state and central government support.

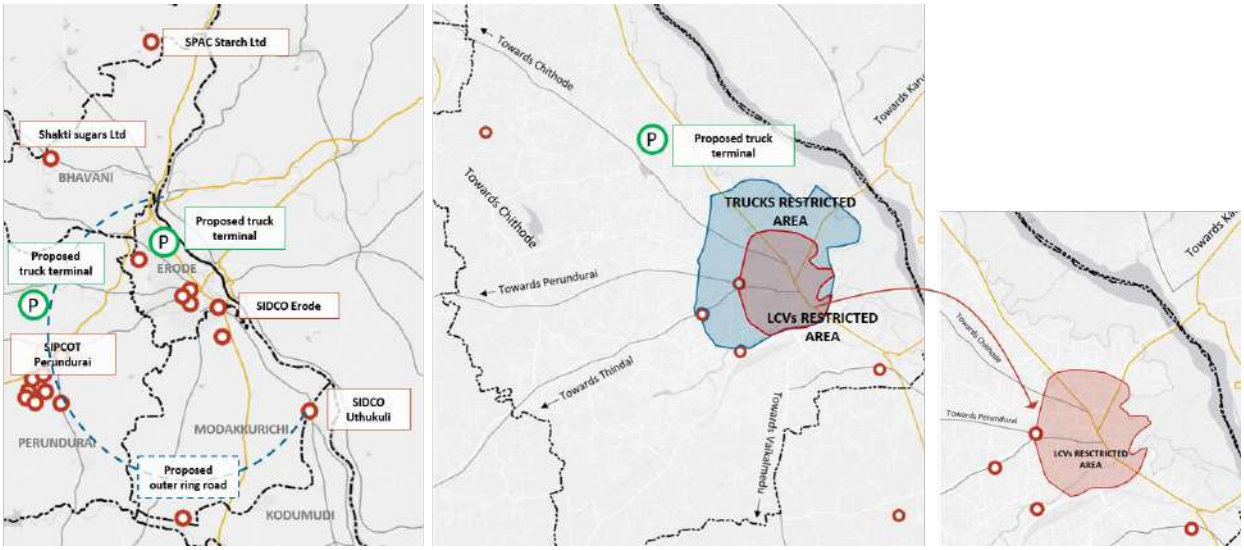
Regulatory levers

1. Expand the core-area boundary for entry and exit time-based restrictions for trucks

a. Retain the existing truck's restricted boundary as per CMP for LCVs entry-exit during peak hours (8:00 a.m.–10:00 a.m. and 6:00–8:00 p.m.).

b. Delineate restricted boundaries for MHDTs in proximity to the proposed terminals, enabling freight vehicles to wait at the terminals and enter the city only during permitted time windows.

Figure 26. Proposed time-based entry-exit restriction boundary for LCVs and MHDTs for freight management



Source: Authors' analysis.

2. Introduce congestion pricing measures and progressively incorporate environmental performance standards into freight access management

a. Assess the feasibility of congestion charging for goods vehicles entering the designated core area during peak periods.

b. Extend the existing truck ban to additional core-adjacent roads, such as Erode–Perundurai and Erode–Chithode.

c. Exempt electric freight vehicles from core-area entry restrictions as an early incentive for freight electrification.

d. Assess environmental performance-based access requirements for freight vehicles in the designated core area over the medium to long term, subject to the availability of compliant vehicles, peripheral freight terminals, and transition support.

Lead/Supporting agencies: Erode City Municipal Corporation (ECMC), Erode traffic police, National Highways Authority of India (NHAI), and state highways

Urban planning and land-use integration

1. Prepare a comprehensive city logistics plan (CLP) for Erode

Prepare a CLP separately or incorporate a section into the CMP to institutionalise freight planning and decarbonisation within the city's long-term transport and land-use planning. The CLP should draw on the evidence generated through this study to:

a. Use findings from the primary surveys, covering more than 2,500 samples, and the cordon-point survey to characterise freight operations and movement patterns.

b. Integrate the commodity flow assessment, OD analysis, freight movement analysis, and industrial cluster mapping into freight planning.

c. Incorporate the GPC-compliant freight GHG inventory and freight decarbonisation scenarios into planning and monitoring.

These data points can help in identifying designated freight corridors, preferred truck routes and last-mile delivery routes, logistics hubs, truck terminals, urban consolidation centres, and priority charging locations based on commodity flows and industrial clusters.

Lead/Supporting agencies: ECMC, NHAI, state highways, and RTO

2. Electrify municipal fleets

a. **Mandate the procurement of electric light freight vehicles for all future government fleet purchases,** including solid waste collection vehicles, maintenance vehicles, inspection vehicles, and other municipal service vehicles, wherever commercially available, to position government fleets as early adopters of freight electrification.

b. Align fleet replacement with natural vehicle retirement cycles and prioritise vehicle categories operating predictable daily routes suitable for overnight charging at government offices.

Lead/Supporting agencies: ECMC and other government departments

3. Relocate warehouses/godowns from the core city boundary

a. Redirect godowns and warehouses from the railway yard and city core towards industrial estates and freight nodes at SIPCOT Perundurai, SIPCOT Ingur, SIDCO Erode, SIDCO Uthukuli, and Pallavada Textile Park, building on the 2015 CMP proposal. Use Bhavani and Chithode as secondary locations for agro- and turmeric-linked warehousing with truck parking and EV charging infrastructure, developing on the existing Kongampalayam/Chithode terminal) (TNUIFSL 2015), to consolidate freight nodes rather than treating decongestion and decarbonisation separately.

b. Convert vacated core-city sites (railway yard and Nethaji Market) into formal loading/unloading bays for EV-only last-mile delivery zones once warehousing relocation is complete.

Lead/Supporting agencies: ECMC, SIPCOT, and SIDCO industrial estates

4. Consolidate agricultural and textile freight at peripheral terminals

a. Establish load-consolidation facilities for agricultural and textile commodity flows at peripheral terminals, including Perundurai and Kongampalayam/Chithode to improve vehicle utilisation and reduce empty trips.

Lead/Supporting agencies: ECMC, Directorate of Town and Country Planning (DTCP), SIPCOT and SIDCO industrial estates, and Erode LOA

5. Establish dedicated loading and unloading bays at major markets

a. Establish dedicated loading and unloading bays at Erode Central Market and Gani Market.

b. Enforce parking regulations and impose penalties on goods vehicles parked illegally on surrounding roads.

Lead/Supporting agencies: ECMC, DTCP, and Erode traffic police

6. Reserve land for freight EV charging infrastructure

a. Incorporate the charging infrastructure requirements estimated in this study into future land-use planning.

b. Reserve land for freight charging infrastructure within master plans (MPs) and CMPs at industrial estates, logistics parks, truck terminals and public/private truck parking facilities.

c. Prioritise charging infrastructure deployment according to projected charger capacity:

d. Assess feeder capacity, transformer loading, and substation capacity through Tamil Nadu Power Distribution Co Ltd (TNPDCL) before committing capital expenditure (CAPEX) to determine network upgrade requirements. These investments could also generate incremental electricity sales and revenue as EV demand increases, strengthening the financial case for targeted network upgrades.

Lead/Supporting agencies: ECMC, SIPCOT and SIDCO industrial estates, Erode LOA, private truck depots, and the highway department

Table 4. Charger specifications across top origin and destination clusters in Erode

Charger specifications	Locations
22 kW–50 kW	Erode Central Market, SIDCO Erode, SIPCOT Ingur and SIPCOT Perundurai
50 kW–120 kW	Bhavani, Chithode, Sathyamangalam, SIPCOT Ingur, SIPCOT Perundurai, Pallavada Textile Park, Erode LOA, proposed truck terminal
120 kW–240 kW	Erode LOA, proposed Perundurai truck terminal, NH544

Source: Authors' analysis.

7. Identify locations for renewable energy plants near industrial clusters and truck depots

Projected freight electrification will increase electricity demand to approximately 1011 MWh/day by 2045, with heavy-duty vehicles accounting for around 70 per cent of total demand.

a. Integrate renewable energy generation with future freight charging infrastructure to reduce operating costs and improve long-term energy resilience.

b. Prioritise renewable-powered charging hubs at SIPCOT Perundurai, SIPCOT Ingur, Pallavada Textile Park, and other locations mentioned in Table 4 to reduce dependence on peak grid electricity and improve charging reliability.

c. Adopt site-specific renewable energy models for freight charging infrastructure

- group captive solar for high-tension (HT) consumers at SIPCOT Perundurai, SIPCOT Ingur, Pallavada Textile Park;
- third-party open-access power purchase agreements (PPAs) at SIDCO Erode and SIDCO Uthukuli; and
- behind-the-meter rooftop solar with storage at the proposed Perundurai truck terminal and warehouse facilities.

Lead/Supporting agencies: TNPDCL, Tamil Nadu Generation and Distribution Corporation Limited, ECMC, SIPCOT and SIDCO industrial estates, Erode LOA, private truck depots, and the highway department

Behavioural interventions

Pilot projects for electric LCVs and MHDTs

Conduct peer-led EV demonstration programmes at the cluster level to demonstrate vehicle performance and build confidence among operators with low willingness to adopt EVs.

a. Conduct peer-led EV demonstration programmes at Erode Central Market with leasing and rental fleet operators and at SIPCOT and SIDCO industrial clusters for e-MHDTs, using existing EV drivers to demonstrate vehicle performance, establish operational feasibility, and build confidence among operators.

b. Pilot e-LCVs for textile freight at SIPCOT Perundurai and Pallavada Textile Park, with expansion to MDTs in Phase 2, delivered through peer-led demonstrations and leasing or battery-as-a-service arrangements for the rented LCV fleet, anchored by SIPCOT estate management and major textile generators.

c. Pilot e-LCVs for agricultural and turmeric freight on predictable short-haul market routes prioritising Erode Central Market and Gani Market, alongside SIDCO Uthukuli, Bhavani and Chithode, with aggregated procurement through fleet operators and commodity priority financing, anchored by ECMC, market committees, and agri-logistics aggregators.

Lead/Supporting agencies: ECMC, SIPCOT, and SIDCO industrial estates

Financing mechanisms

1. Develop segment-specific financing models

The ownership profile of freight vehicles indicates that financing strategies should differ across vehicle segments.

- **LCVs: Channel financing through fleet operators and leasing companies**
  - Channel financing through fleet operators, aggregators, and leasing companies to reflect the prevalence of leasing and rental arrangements among LCVs and enable aggregated procurement.
  - Provide concessional credit or credit guarantees to these businesses through the Small Industries Development Bank of India (SIDBI) and other public-sector financial institutions, while commercial banks and non-banking financial companies (NBFCs) provide vehicle loans.
  - Use aggregated procurement to enable operators to purchase EVs in larger volumes at lower costs, while battery-financing or battery-as-a-service models can reduce the upfront vehicle cost.
- **MHDTs: De-risk early-stage MHDT financing rather than subsidising vehicle purchases**

  Most MHDTs are owned by individual owner-operators, making upfront cost and charging uncertainty major barriers to electrification.
  - Establish a limited state-backed credit-guarantee facility for participating banks and NBFCs during initial deployment, targeted at predictable, high-utilisation routes.
  - Complement the credit guarantee with original equipment manufacturer (OEM) battery warranties and residual-value commitments, and secure charging access through route-level charging requirements.
  - Demonstrate replacement performance and operating economics, enabling lenders to assume more financing risk as market evidence develops.

Lead/Supporting agencies: Tamil Nadu Urban Infrastructure Financial Services Limited (TNUIFSL), TNPDCL, state government, and financial institutions (SIDCO, NBFCs)

2. Prioritise financing by commodity sector

- Prioritise financing programmes for freight sectors characterised by regular operations and relatively lighter loads, including agricultural produce transport, urban retail distribution, courier and parcel services, fast-moving consumer goods (FMCG) distribution, textile logistics, and milk and dairy logistics.
- Target medium- and heavy-duty industrial freight associated with textiles, engineering goods, and bulk commodities in later phases as charging infrastructure expands, and assess rail as an alternative transport for these commodities.

Lead/Supporting agencies: TNUIFSL, TNPDCL, state government, and financial institutions

3. Leverage industrial estate policies to accelerate fleet electrification

- Leverage SIPCOT lease policies to accelerate EV adoption by linking preferential lease terms and infrastructure access to fleet electrification commitments from third-party logistics operators and major freight generators.

Lead/Supporting agencies: SIPCOT and SIDCO industrial clusters

Data-driven decision-making and monitoring

Establish formal data-sharing agreements

Establish formal data-sharing agreements among relevant agencies to support periodic updates to freight demand assessments, emissions inventories, and charging infrastructure planning.

- Obtain vehicle registration, scrappage, and fitness data from **RTOs on a yearly basis.**
- Integrate **TNPDCL** data on feeder capacity, transformer loading, and electricity demand into freight electrification and charging infrastructure planning.
- Incorporate **SIPCOT and SIDCO** data on industrial estate land availability and logistics development into freight infrastructure planning.
- Integrate **charging point operators (CPOs)** with the unified Bharat e-charge platform to enable standardised charging-station data collection and monitoring.

Lead/Supporting agencies: ECMC, RTO, TNPDCL, SIDCO, SIPCOT, and the state transport department

State and central government support

1. Mobilise state-level financial support

- Prepare detailed project reports through TNUIFSL to assess eligibility for and access relevant incentives under the *Tamil Nadu EV Policy,* including the 25 per cent capital subsidy for charging infrastructure and green warehousing, and the Tamil Nadu Logistics Policy's permit-fee/RTO/motor-vehicle-tax waivers.
- Explore blended finance mechanisms through TNUIFSL, including green bonds and carbon finance, to support capital expenditure (CAPEX) for truck terminals and high-power charging infrastructure.

- Explore opportunities for ECMC to access domestic and international institutions such as the Tamil Nadu Green Climate Fund, Urban Challenge Fund, and the World Bank (TNGCC 2022; World Bank 2023; Thakre 2024).

Lead/Supporting agencies: ECMC, RTO, TNUIFSL, and the state transport department

2. Incorporate projected freight electricity demand into distribution planning

- Plan for freight electricity demand of 1011 MWh/day by 2045 under TNPDCL
- Incorporate freight electrification into multi-year distribution investment plans, including feeder augmentation, substation, and transformer capacity expansion.

Lead/Supporting agencies: TNPDCL and the state transport department

5.2 Phased decarbonisation roadmap

The proposed roadmap adopts a phased implementation approach aligned with vehicle electrification technology maturity, freight operating patterns, charging infrastructure development, and institutional readiness. Recognising that different freight vehicle categories require distinct transition pathways, the roadmap prioritises LCV electrification in the near term, followed by MDTs and, ultimately, HDTs.

In the near term, LCV electrification should be accelerated through depot- and destination-based charging and, where feasible, battery-swapping stations at major freight-generation centres, including Erode Central Market, SIDCO Erode, SIPCOT Ingur, SIPCOT Perundurai, and other industrial estates. As vehicle technology and charging infrastructure mature, electrification should expand to MDTs operating through regional logistics hubs and industrial corridors centred on Bhavani, Chithode, Perundurai, and Sathyamangalam, as well as the Erode–Bhavani and Erode–Perundurai freight corridors.

> A phased freight transition, prioritising LCVs first, followed by MDTs and HDTs as technology and infrastructure mature.

In the long term, HDT decarbonisation should be supported by deploying high-capacity charging infrastructure at truck terminals, major industrial clusters, and strategic freight corridors. Priority locations include LOA lorry stand, the proposed Perundurai truck terminal, and the NH544 freight corridors connecting Salem, Coimbatore, and Kochi.

Together, these interventions provide a phased pathway for reducing freight emissions while supporting efficient freight movement across the region. The roadmap comprises three implementation phases spanning 2025–45, reflecting the road freight sector's progressive transition to low-carbon technologies.

Phase 1 (2025–30): Establishing the foundation for freight decarbonisation

The first phase focuses on establishing the institutional, technological, and infrastructure foundations required to initiate freight decarbonisation in Erode. The analysis indicates that LCVs present the strongest near-term electrification opportunity, with 58 per cent of vehicles already operating within the available EV driving range, increasing to 86 per cent with one intermediate charging opportunity. However, LCV operators also exhibit the lowest willingness to transition.

Given their role in urban logistics and first- and last-mile freight distribution, LCVs should therefore be prioritised for the initial transition. Meanwhile, biodiesel and CNG/LNG can serve as interim transition fuels for MDTs and HDTs, for which vehicle availability and charging infrastructure continue to constrain electrification.

This phase should establish an enabling ecosystem for freight electrification through the preparation of a CLP, deployment of an initial charging network at key urban logistics destinations and industrial estates, electrification of government freight fleets, implementation of LCV demonstration pilots, and introduction of regulatory measures to improve freight operations. Institutional coordination, freight data-sharing mechanisms, and segment-specific financing models should also be established during this phase to support subsequent implementation.

Phase 2 (2030–35): Scaling regional freight electrification

The second phase focuses on expanding electrification beyond urban freight distribution to regional freight operations. By this stage, improvements in vehicle technology and charging infrastructure are expected to increase the operational feasibility of e-MDTs. The range-feasibility assessment indicates that 44 per cent of MDT operations become technically feasible with one intermediate charging opportunity, highlighting the importance of expanding the regional charging network. At the same time, 53 per cent of MDT operators report conditional willingness ('maybe') to adopt EVs, suggesting that charging availability, financing, and confidence in operational range are important determinants of adoption during this phase.

Accordingly, charging infrastructure should expand from urban depots to regional logistics hubs, industrial estates, and freight corridors, with greater deployment of 50 kW and 120 kW chargers. This phase should also prioritise relocating freight-intensive activities from the city core, developing urban consolidation centres, deploying renewable-powered charging hubs, and implementing owner-focused financing mechanisms.

Phase 3 (2035–45): Mainstreaming heavy-freight electrification and renewable grid integration

The final phase focuses on reducing emissions from heavy freight operations, which remain the largest source of freight emissions under all scenarios. Although 40 per cent of HDTs are assumed to be electrified by 2045, they account for approximately 70 per cent of total freight electricity demand because of their higher daily energy consumption and longer operating distances. Consequently, infrastructure planning should shift from expanding the number of charging locations to increasing charging network capacity through 120 kW and 240 kW high-power chargers while strengthening supporting electricity distribution systems.

This phase also requires a transition from pilot-scale implementation to mainstream adoption of electric heavy-duty vehicles. Industrial estates and logistics operators should play a central role in accelerating fleet transition through long-term lease agreements. At the same time, the projected freight electricity demand of 1011 MWh/day requires coordinated investment in distribution infrastructure, transformer augmentation, renewable energy integration, and smart charging systems.

Since heavy-duty freight movements extend beyond Erode district, charging infrastructure planning should be coordinated with neighbouring districts and state agencies to ensure seamless charging availability along major freight corridors. Innovative financing mechanisms, including blended finance and green infrastructure funding, will also be important in supporting the substantial capital investment required for high-power charging infrastructure.

Table 5. Phased freight decarbonisation roadmap (2025–45)

S. no.	Recommendations	Near-term (2025–30)	Medium-term (2030–35)	Long-term (2035–45)
A.	**Regulatory levers**			
1.	Increase the core-area boundary for entry- and exit-time-based restrictions for diesel trucks during peak hours; exempt EVs from entry/exit restrictions	✓		
2.	Restrict entry/exit of diesel-based LCVs during peak traffic hours in the city; exempt EVs from entry/exit restrictions	✓		
3.	Introduce congestion pricing measures and progressively incorporate environmental performance standards into freight access management			✓
B.	**Urban planning and land-use integration**			
1.	Prepare a CLP for Erode city in coordination with nearby districts	✓		
2.	Procure only EVs for municipal fleets	✓		
3.	Relocate warehouses/godowns from the core city and railway yard to SIPCOT industrial estates; proposed truck depot at Perundurai Road and textile parks		✓	
4.	Plan for load consolidation for agricultural and textile commodity flows at periphery terminals (Perundurai, Kongampalayam/Chithode) to improve freight movement efficiency and avoid empty trips		✓	
5.	Establish dedicated loading/unloading bays at Erode Central Market and Gani Market and impose a penalty on vehicles parked illegally on roads	✓		
6.	Reserve land at existing and proposed private/public truck depots/terminals and industrial clusters for EV charging infrastructure in the master plan (MP) and comprehensive mobility plan (CMP)	✓		
7.	Prioritise areas near SIPCOT Perundurai, SIPCOT Ingur, Pallavada Textile Park, NH544, NH948 and NH381A for setting up group captive solar energy models	✓		

S. no.	Recommendations	Near-term (2025–30)	Medium-term (2030–35)	Long-term (2035–45)
C.	**Behavioural interventions**			
1.	Promote and explore opportunities for small-scale proof-of-concept pilot electric LCVs/medium- and heavy-duty trucks (MHDTs) with fleet operators/third-party logistics owners and subsequently scale up	✓	✓	
D.	**Financing mechanisms**			
1.	For LCVs, channelise financing through fleet operators and leasing companies, using aggregated procurement, concessional credit, and battery-financing models to reduce upfront costs	✓		
2.	For MHDTs, de-risk early-stage adoption through limited credit guarantees, original equipment manufacturer (OEM) warranties, and secured route-level charging, enabling lenders to scale financing as operating performance is demonstrated		✓	
3.	Prioritise financing based on the dominant commodities transported in Erode, such as agricultural produce, textiles, and fast-moving consumer goods (FMCG)	✓	✓	
4.	Embed electrification within industrial estate lease policies to accelerate fleet electrification		✓	
E.	**Data-driven decision-making and monitoring**			
1.	Develop formal data-sharing agreements between regional transport offices (RTOs), Tamil Nadu Power Distribution Corporation Limited (TNPDCL), and SIPCOT/SIDCO to better understand truck movement patterns and stakeholder expectations such as those of forwarders, shippers and LSPs.	✓		
F.	**State and central government support**			
1.	Mobilise state-level financial support through domestic and international institutions such as the Tamil Nadu Green Climate Fund, Urban Challenge Fund, and the World Bank		✓	
2.	Ensure TNPDCL plans for freight electricity demand of 1011 MWh/day by 2045	✓		

Source: Authors' analysis.

Acronyms: CLP: city logistics plan; CMP: comprehensive mobility plan; EV: electric vehicle; FMCG: fast-moving consumer goods; LCV: light commercial vehicle; LSP: logistics service provider; MHDT: medium- and heavy-duty trucks; MP: master plan; NH: national highway; OEM: original equipment manufacturer; RTO: regional transport office; SIDCO: Small Industries Development Corporation; SIPCOT: State Industries Promotion Corporation of Tamil Nadu; TNPDCL: Tamil Nadu Power Distribution Corporation Limited

5.3 State policy readiness for freight decarbonisation

Tamil Nadu has established a supportive, albeit partial, policy base for freight decarbonisation. The Tamil Nadu EV Policy 2023 provides 100 per cent road-tax and registration-fee waivers, a retrofitting pathway for commercial vehicles, and demand-side support for charging infrastructure, including 25 per cent capital subsidy for public charging and battery-swapping stations, reduced electricity demand charge (75 per cent for the first two years and 50 per cent thereafter), and a 50 per cent energy-charge concession for daytime charging (8:00 a.m.–4:00 p.m.) (GoTN 2023a). In January 2026, the state extended the 100 per cent motor vehicle tax exemption for all EVs to December 2028 (GoTN 2025). The Tamil Nadu Logistics Policy and Integrated Logistics Plan 2023 also adds industry status for warehousing and a cleaner modal-shift objective, along with a 25 per cent capital subsidy (capped at INR 50 lakh) for green initiatives at integrated logistics parks (GoTN 2023b). At the national level, the PM Electric Drive Revolution in Innovative Vehicle Enhancement (PM E-DRIVE) scheme allocates INR 10,900 crore for truck incentives for N2/N3 vehicles, mandatorily linked to a scrappage certificate, along with INR 2,000 crore for public charging (MHI 2024). However, these measures do not constitute a comprehensive freight decarbonisation framework. Key gaps include:

1. Limited state-level support for e-MHDTs: Tamil Nadu EV Policy incentives do not extend to MDTs and HDTs, leaving support for e-MHDTs entirely dependent on the national PM E-DRIVE scheme.
2. Absence of freight-specific charging standards and targets at industrial and freight nodes: Existing charging provisions are largely technology- and vehicle-agnostic and do not establish targets or planning requirements for high-power charging infrastructure, particularly at depots, freight hubs (SIPCOT/SIDCO), and along major freight corridors.
3. Lack of freight-specific provisions and a grid framework for high-load depot charging.
4. Absence of a state-level freight-specific financing instrument linked to vehicle scrappage, unlike the PM E-DRIVE scheme.

Recommended policy revisions at state level

- Extend state-level demand incentives under the EV policy to N2/N3 e-trucks, co-funded with PM E-DRIVE, to reach the heavy-truck segment.
- Front-load and ring-fence support for LCVs, combining fiscal incentives with depot charging support, given their near-term transition readiness.
- Mandate or earmark freight-charging infrastructure in industrial estates, translating the study's spatial charging priorities into state-level infrastructure planning.
- Extend off-peak/green electricity tariffs to captive depot and fleet charging while enabling renewable-energy open access for high-utilisation freight depots.
- Establish a freight-specific financing facility using partial credit guarantees or blended finance through Tamil Nadu Green Climate Company (TNGCC)/TNUIFSL to address high upfront costs and limited access to vehicle financing.
- Integrate freight corridors and inter-district connectivity into the state charging plan, coordinating infrastructure with neighbouring districts and *National Logistics Policy* and *PM Gati Shakti* schemes for freight corridors.
- Link state-level freight electrification incentives to vehicle scrappage, mirroring PM E-DRIVE certificate requirement and accelerating replacement of the predominantly diesel and ageing freight fleet.

Acronyms

AADT	annual average distance travelled
AC	alternating current
ADT	average daily distance
AR6	Sixth Assessment Report
ASI	avoid–shift–improve
ASIF	activity–share–intensity–fuel
BAU	business-as-usual
BS Norms	Bharat Stage norms
CAPEX	capital expenditure
CDF	cumulative distribution function
CEEW	Council on Energy, Environment and Water
CH4	methane
CLP	city logistics plan
CMP	comprehensive mobility plan
CNG	compressed natural gas
CO2/CO2e	carbon dioxide/carbon dioxide equivalent
CP	cordon point
DC	direct current
DPR	detailed project report
DTCP	Directorate of Town and Country Planning
ECMC	Erode City Municipal Corporation
EF	emission factor
e-LCV	electric light commercial vehicle
e-MHDT	electric medium- and heavy-duty trucks
EV	electric vehicle
FMCG	fast-moving consumer goods
GDDP	gross district domestic product
GDP	gross domestic product
GHG	greenhouse gas
GIS	geographic information system
GoI	Government of India
GoTN	Government of Tamil Nadu
GPC	Global Protocol for Community-Scale Greenhouse Gas Emission Inventories
GSDP	gross state domestic product
GWP	global warming potential
HDT/V	heavy-duty truck/vehicle
HT line	high-tension line
ICE	internal combustion engine
INR	Indian rupee
IPCC	Intergovernmental Panel on Climate Change
IPPU	industrial processes and product use
ktCO2e	kilotonnes of carbon dioxide equivalent
kL	kilolitres
kW/kWh	kilowatt/kilowatt-hour
IPT	intermediate public transport
LCV	light commercial vehicle
LNG	liquefied natural gas
LPG	liquefied petroleum gas
LOA	Lorry Owners' Association
LSP	logistics service provider
MDT	medium-duty truck
MHDT	medium- and heavy-duty truck
MP	master plan
MSME	micro, small, and medium enterprises
MWh	megawatt-hour
NBFC	non-banking financial company
NH/SH	national highway/state highway
NDC	nationally determined contribution
NHAI	National Highways Authority of India
NITI Aayog	National Institution for Transforming India
NOx	nitrogen oxides
OD	origin–destination
OEM	original equipment manufacturer
PCU	passenger car unit
PM	particulate matter
PM E-DRIVE	PM Electric Drive Revolution in Innovative Vehicle Enhancement
PPA	power purchase agreement
PPP	public–private partnership
PSA	Office of the Principal Scientific Adviser

PSA	Office of the Principal Scientific Adviser
RTO	regional transport office
RVSF	registered vehicle scrapping facility
SIDBI	Small Industries Development Bank of India
SIDCO	Small Industries Development Corporation
SIPCOT	State Industries Promotion Corporation of Tamil Nadu
T&D	transmission and distribution
TCO	Total cost of ownership
TNGCC	Tamil Nadu Green Climate Company
TNPDCL	Tamil Nadu Power Distribution Corporation Limited
TTW	tank-to-wheel
TNSAPCC	Tamil Nadu State Action Plan on Climate Change
TNSTC	Tamil Nadu State Transport Corporation
t/$MtCO_2e$	tonnes/million tonnes of carbon dioxide equivalent
TNUIFSL	Tamil Nadu Urban Infrastructure Financial Services Limited
UK PACT	Partnering for Accelerated Climate Transition
VKT	vehicle kilometres travelled
WTT	well-to-tank
ZET	zero-emission trucking

References

CEA (Central Electricity Authority). 2023. *CO2 Baseline Database for the Indian Power Sector.* Central Electricity Authority. https://cea.nic.in/api/cdm-report-version/view-pdf/en/78

CEED (Centre for Environment and Energy Development). 2025. *Decarbonizing India's Trucking Sector: Potential for Zero-Emission Trucks.* Centre for Environment and Energy Development.

CEEW (Council on Energy, Environment and Water) and Climate Group. 2025. *India's Road to Zero-Emission Trucking: Tracking* Early Electrification Efforts. Council on Energy, Environment and Water and Climate Group. https://www.ceew.in/sites/default/files/ceew-cg-madrezero-emission-trucking-for-web-v4-14may25.pdf.

Census. 2011. *Erode District: Population* 2011–26. Government of India. https://erode.nic.in/documents/census/

CRRI (Central Road Research Institute). 2019. Fuel Efficiency Standards of Heavy Duty Vehicles in India. Central Road Research Institute. https://www.iea.org/policies/7452-fuel-efficiency-standards-for-heavy-duty-vehicles

CSIR-CRRI (Council of Scientific and Industrial Research–Central Road Research Institute). 2014. *Fuel Efficiency Standards of Heavy-Duty Vehicles in India.* Council of Scientific and Industrial Research–Central Road Research Institute.

DES (Department of Economics and Statistics, Government of Tamil Nadu). 2024. *District Income Estimate:s Estimation of GDDP/NDDP (Base Year 2011–12).* Department of Economics and Statistics, Government of Tamil Nadu.Erode District. 2026.https://erode.nic.in/

Euler Motors. 2025. "Top 10 EV Trucks in India: Check Ton Capacity, Battery, Charging Time and More." Euler Motors. Accessed May 25, 2026. https://www.eulermotors.com/te/blogs/best-ev-trucks-in-india.

EVreporter. 2024. "Listing of Electric LCVs in India." EVreporter. Accessed May 25, 2026. https://evreporter.com/listing-of-small-and-light-electric-4w-commercial-vehicles-in-india/.

FICCI (Federation of Indian Chambers of Commerce and Industry). 2019. *India Roadmap on Low Carbon and Sustainable Mobility.* Federation of Indian Chambers of Commerce and Industry. https://slocat.net/wp-content/uploads/2022/04/PPMC_2020_India-Roadmap-on-LCST-r.pdf.

GoI (Government of India). 2026. "Cabinet Approves India's Nationally Determined Contribution (2031–35) to Be Communicated to the United Nations Framework Convention on Climate Change." Government of India.

GoTN (Government of Tamil Nadu). 2021. *District Export Action Plan: Erode District.* Government of Tamil Nadu.

GoTN (Government of *Tamil Nadu). 2023a. Tamil Nadu Electric Vehicles* Policy. Government of Tamil Nadu.

GoTN (Government of Tamil Nadu). 2023b. *Tamil Nadu Logistics Policy and Integrated Logistics Plan.* Government of Tamil Nadu.

GoTN (Government of Tamil Nadu). 2025. *Motor Vehicles – Tamil Nadu Electric Vehicles Policy, 2023 – 100% Tax exemption of Motor Vehicle Tax in Respect of All* Battery-Operated Vehicles (Electric Vehicles) *Orders.* Transport Department, Government of Tamil Nadu.

GoTN (Government of Tamil Nadu). 2026. *Economic Survey of Tamil Nadu 2025–26*. Government of Tamil Nadu.

IPCC (Intergovernmental Panel on Climate Change). 2006. *IPCC Guidelines for National Greenhouse Gas Inventories: Chapter 3 Mobile Combustion.* Institute for Global Environmental Strategies.

IPCC (Intergovernmental Panel on Climate Change). 2021. *IPCC Sixth Assessment Report Global Warming Potentials.* Intergovernmental Panel on Climate Change.

ITF (International Transport Forum). 2024. *Pathway to Zero-Emission Trucking in India: Setting the Framework.* OECD Publishing. https://www.itf-oecd.org/pathway-zero-emission-trucking-india.

Kang, Hyun. 2021. "Sample Size Determination and Power Analysis Using the G*Power Software." *Journal of Educational Evaluation for Health Professions* 18: 17. 10.3352/jeehp.2021.18.17.

MHI (Ministry of Heavy Industries). 2024. *Operational Guidelines for PM Electric Drive Revolution in Innovative Vehicle Enhancement (PM E-DRIVE) Scheme.* Ministry of Heavy Industries.

Mohan, Dharshan Siddarth, Sabarish Elango, Hemant Mallya, Himani Jain, and Anannya Jha. 2025a. *What Is Fuelling India's Road Transport Sector? Projecting District-Level Energy Demand.* Council on Energy, Environment and Water.

Mohan, Dharshan Siddarth, Sabarish Elango, Hemant Mallya, and Himani Jain. 2025b. *How Will India's Vehicle Ownership Grow? A District-Level Outlook to 2050.* Council on Energy, Environment and Water.

MoPNG (Ministry of Petroleum and Natural Gas). 2025. "FAQs: Petroleum Planning & Analysis Cell." https://ppac.gov.in/faqs.

MPP (Mission Possible Partnership). 2022. *Making Zero-Emissions Trucking Possible. Mission Possible* Partnership. https://www.energy-transitions.org/publications/making-zero-emissions-trucking-possible/.

NITI Aayog. 2021. *Fast Tracking Freight in India: A Roadmap for Clean and Cost-Effective Goods Transport.* National Institution for Transforming India.

NITI Aayog. 2022. *Transforming Trucking in India: Pathways to Zero-Emission Truck Deployment.* National Institution for Transforming India.

NRDC. 2023. *Energizing Freight: Policy Toolkit for Medium and Heavy-Duty Truck Electrification in India.* https://www.nrdcindia.org/pdf/NRDC_%20Heavy_Trucking.pdf

PSA (Office of the Principal Scientific Adviser to the Government of India). 2024. *India Zero Emission Trucking (ZET) Policy Advisory.* Office of the Principal Scientific Adviser to the Government of India.

Sen, Ritika, Shubhi Vaid, Kavya Muthukrishnan, Niharika Tyagi, and Seshadri Raghavan. 2026. *Movement of People and Goods: Assessing Urban Transport in the City of Erode.* Council on Energy, Environment and Water.

Sharma, Niraj, P. V. Pradeep Kumar, Rajni Dhyani, Ch Ravisekhar, and K. Ravinder. 2019. "Idling Fuel Consumption and Emissions of Air Pollutants at Selected Signalized Intersections in Delhi." Journal of Cleaner Production 212: 8–21. https://doi.org/10.1016/j.jclepro.2018.11.275.

TNGCC (Tamil Nadu Green Climate Company). 2022. *Tamil Nadu Green Climate Fund.* Tamil Nadu Green Climate Company.

TERI (The Energy and Resources Institute). 2020. *Road Map for Electrification of Urban Freight in India (Part-II).* The Energy and Resources Institute. https://www.teriin.org/sites/default/files/2020-12/Report_PART-II_0.pdf.

TERI (The Energy and Resources Institute). 2024. *Roadmap for India's Energy Transition in the Transport Sector.* The Energy and Resources Institute. https://teriin.org/sites/default/files/2024-11/Roadmap%20for%20India%20Energy%20Transition_FINAL%20REPORT.pdf.

Thakre, Manish. 2024. *Enhancing Access to Urban Climate Finance: Learnings from Four Cities in India.* ORF Issue Brief no. 711. Observer Research Foundation.

TNUIFSL (Tamil Nadu Urban Infrastructure Financial Services Limited). 2015. *Erode Comprehensive Mobility Plan.* Tamil Nadu Urban Infrastructure Financial Services Limited.

VAHAN. 2026. "VAHAN Dashboard." Ministry of Road Transport and Highways, Government of India. https://vahan.parivahan.gov.in/vahan4dashboard/.

Vaid, Shubhi, Ritika Sen, and Seshadri Raghavan. 2026. *Greenhouse Gas Accounting for On-road Transport Emissions: A Global Protocol for Community-scale Compliant Inventory for Erode.* Council on Energy, Environment and Water.

World Bank. 2023. *India – Tamil Nadu Climate Resilient Urban Development Program.* World Bank.

World Nuclear Association. 2025. "Heat Values of Various Fuels." World Nuclear Association. https://world-nuclear.org/information-library/facts-and-figures/heat-values-of-various-fuels.

WRI, C40, and ICLEI. 2014. *Global Protocol for Community-Scale Greenhouse Gas Emission Inventories.* https://ghgprotocol.org/sites/default/files/ghgp/standards/GHGP_GPC_0.pdf

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The Council on Energy, Environment and Water (CEEW)—**a homegrown institution** with headquarters in New Delhi—is among the **world's leading climate think tanks**. The Council uses **data, integrated analysis, and strategic outreach** to support public policy, transform markets, shape technology, and nudge behaviour. It addresses pressing regional and global challenges through an integrated and internationally focused approach. The Council prides itself on the **independence** of its high-quality research and strives to **impact sustainable development at scale**.

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SELECT POLICY ENGAGEMENTS

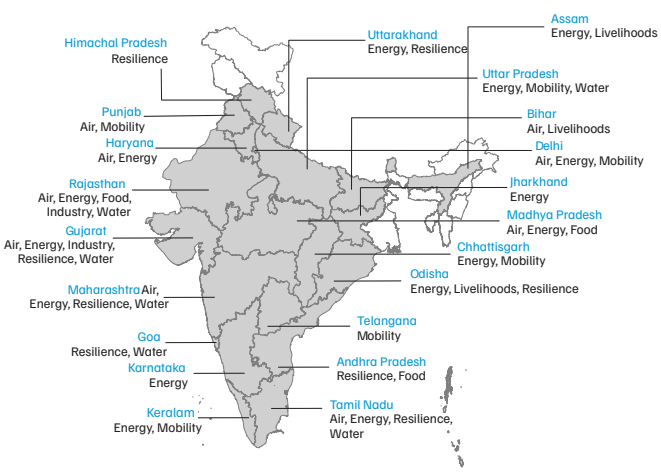
NATIONAL/INTERNATIONAL

2011 | National Water Resources Framework
2014 | 175 GW renewables target
2015 | International Solar Alliance
2016 | PM *Ujjwala Yojana*
2017 | *Saubhagya Scheme*
2019 | *India Cooling Action Plan*
2021 | Net Zero by 2070
2022 | *Mission LiFE*
2022 | *National Bioenergy Programme*
2022 | E-waste (Management) Rules
2023 | G20 Green Development Pact
2023 | *National Green Hydrogen Mission*
2024 | Green Steel Taxonomy
2024 | *PM Surya Ghar Yojana*
2025 | *National Critical Mineral Mission*
2025 | Rajya Sabha Guidelines on Crop Residue Burning
2025 | India's Carbon Credit Trading Scheme (CCTS)
2025 | IFSCA's Framework for Transition Bonds
2026 | Disaster Risk Index for 16th Finance Commission
2026 | India's NDC 3.0
2026 | India's Scenarios towards Viksit Bharat and Net Zero

STATE

2022 | *Rajasthan Organic Farming Mission*
2022 | *Jharkhand State Solar Policy*
2022 | *Uttar Pradesh Vidyut Sakhi programme*
2023 | *Rajasthan Renewable Energy Policy and Green Hydrogen Policy, 2023*
2023 | *Uttarakhand Solar Policy*
2025 | Green Odisha Initiative
2025 | *Maharashtra Climate Action Plan 2.0*
2025 | *Delhi Clean Air Action Plan*
2026 | *Delhi EV Policy 2.0*
2026 | Bihar Promotion of New and Renewable Energy Sources
2026 | Gujarat Integrated Renewable Energy Policy and Green Hydrogen Policy
2026 | *Uttarakhand Mukhyamantri Saur Swarojgar Yojana*
2024-26 |
Directives of Commission on Air Quality Management
Net Zero Roadmaps (BH, GJ, TN, UK)
Agroforestry Roadmaps (AS, MH, OD)
140+ Heat Action Plans (GJ, MH, OD, TN)
Treated Used Water Reuse Plans (MH, UP)
Flood Risk Mitigation Plans (GJ, MH)

21 STATES SUPPORTED



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