Just Transition to Zero-emission Trucking in India

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Climate Policy Initiative is an analysis and advisory organization with deep expertise in finance and policy. Our mission is to support governments, businesses, and financial institutions in driving economic growth while addressing climate change. CPI has seven offices worldwide in Brazil, India, Indonesia, South Africa, the United Kingdom, and the United States.

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LIST OF ABBREVIATIONS

Abbreviation	Definition
ACMA	Automobile Components Manufacturers Association of India
ASDC	Automotive Skills Development Council
BEV	Battery electric vehicle
CNG	Compressed natural gas
CPI	Climate Policy Initiative
CSR	Corporate social responsibility
DDU-GKY	Deen Dayal Upadhyaya Grameen Kaushalya Yojana
EV	Electric vehicle
FADA	Federation of Automobile Dealers Associations
FICCI	Federation of Indian Chambers of Commerce & Industry
FY	Financial year
GoI	Government of India
GVW	Gross vehicle weight
HDV	Heavy duty vehicles
ICE	Internal combustion engine
IEA	International Energy Agency
INR	Indian Rupee
JTF	Just Transition Fund
LCV	Light commercial vehicles
MDV	Medium duty vehicles
MHI	Ministry of Heavy Industry
MoRTH	Ministry of Road Transport and Highways
MSDE	Ministry of Skill Development and Entrepreneurship
NAPS	National Apprenticeship Promotion Scheme
NSDC	National Skill Development Corporation
OECD	Organisation for Economic Co-operation and Development
OEM	Original equipment manufacturer
OMC	Oil marketing company
PMKVY	Pradhan Mantri Kaushal Vikas Yojana
PPP	Public private partnership
STT	Short term training
SIAM	Society of Indian Automobile Manufacturers
USD	US Dollar
ZET	Zero-emission truck

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EXECUTIVE SUMMARY

The road logistics industry in India handles 70% of domestic freight and is responsible for 4% of India's energy-related CO2 emissions and 53% of particulate matter emissions (NITI Aayog, 2022). Given that India's truck fleet is projected to grow four-fold by 2050, reducing trucking emissions is critical to achieving the country's Nationally Determined Contribution and net-zero targets. Transitioning to green mobility is also critical from the perspective of public health given the contribution of the transport sector to emissions which impact human health and wellbeing.

Of all the alternatives to internal combustion engine (ICE) trucks, battery electric technology is emerging as the most feasible solution in terms of both cost and technological maturity. Transitioning to battery-electric zero-emission trucking (ZET) presents challenges, including the higher total cost of ownership of ZETs than traditional ICE trucks and limited charging infrastructure. The sector is expected to grow gradually based on several factors including reduction in cost and favorable government policies.

The trucking industry in India employs millions of people in direct, indirect, and induced jobs. It has created 8 million direct jobs and our analysis shows that there are around 9.4 million indirect and 4 million induced jobs. Adoption of ZETs would lead to job losses for workers in ICE-related trades, both in the organized and unorganized sectors, and among induced job holders who work in trucking clusters. Conversely, it would also create new job opportunities in emerging areas. The co-benefits of ZET adoption include a reduction in public health expenditure on ailments related to emissions and a better quality of life. Navigating this transition requires a nuanced approach.

The shift to ZETs should be people-centric and not exacerbate existing inequalities. A comprehensive approach that addresses the social and economic dimensions of the industry's reconfiguration is crucial to ensure that stakeholders are not left behind. This includes not only drivers and fleet owners but also workers in manufacturing (auto companies and their suppliers), aftersales, and induced jobs (e.g., service providers at fuel stations, truck rest stops, restaurants, and retail shops).

Policy and financial interventions should address the needs of direct, indirect, and induced workers, who will require adequate training, reskilling, and job placement programs to facilitate a smooth transition. Equity considerations should also extend to communities impacted by trucking activities, particularly those near major transportation corridors, which stand to bear a disproportionate burden of the transition to ZETs. By investing in workforce readiness and aligning related policies with equity and social justice and strengthening them with transparent information on co-benefits and opportunities can help ensure a more just transition.

A Just Transition Fund for India (JTFI) could be established under the Ministry of Skill Development and Entrepreneurship (MSDE) to fund such efforts. Capitalized using government budgetary support and other sources, such a fund could leverage existing government schemes, including the Pradhan Mantri Kaushal Vikas Yojana for skilling and the Pradhan Mantri MUDRA Yojana for loans.

This fund could finance the multi-pronged approach required for a just transition to ZETs. JTFI-supported programs could reskill workers for the new ZET landscape. Additionally, it could provide loans and grants to ensure that those who cannot be reskilled for jobs in this industry have opportunities to develop alternative livelihoods. Such efforts can help India achieve its environmental goals while protecting the livelihoods of its trucking industry workforce.

INTRODUCTION

Trucking in India is, as in most countries, dominated by internal combustion engine (ICE) vehicles, whose emissions contribute to climate change and reduce air quality. In 2021, the transport sector accounted for 12% of India's energy-related CO2 emissions (IEA, 2023). Within the transport sector, trucks accounted for close to 4% of India's total energy-related CO2 emissions. Trucks also accounted for 53% of India's particulate matter emissions (NITI Aayog, 2022).

India's commercial road traffic is set to grow substantially, leading to increased emissions if cleaner trucking models are not adopted. Roads are used to transport 70% of India's freight, and the number of trucks in the country is expected to quadruple from four million in 2022 to 17 million in 2050 (NITI Aayog, 2022). This, in turn, will quadruple the road freight industry's oil demand, which already accounts for 25% of India's oil imports (*ibid*).

Substituting ICE trucks with zero-emission alternatives in India has the potential to avoid 3.8 gigatons of cumulative carbon emissions by 2050. This reduction would be equivalent to India's entire current annual greenhouse gas (GHG) emissions (WEF, 2023). Zero emission trucks (ZETs) eliminate tailpipe emissions by replacing ICEs with battery electric or hydrogen fuel cells. These technologies show the most abatement potential and technological maturity among available alternatives to ICEs (Advanced Propsulsion Centre UK, 2023). Given that battery electric trucks have a lower total cost of ownership (TCO) than hydrogen fuel-cell trucks, they are a more attractive option for Indian fleet owners (ICCT, 2023). Battery electric trucks are, therefore, the most promising ZET technology to replace ICEs in the medium term in India.

Aside from supporting climate change mitigation, ZETs can have various health and economic benefits. Switching to ZETs could avoid 838 billion liters of diesel consumption by 2050, reducing India's fossil fuel dependence and strengthening the resilience of the nation's energy system (Arora, Lata, & Steiner, 2023). Reduced emissions also improve air quality and public health.

Government regulations and policies can help to accelerate the adoption of ZETs. While manufacturers are developing ZET models for commercial launch and end-users are keen to use this technology to limit scope 3 emissions, fleet owners are reluctant to embrace ZETs unless they achieve TCO-parity with ICE trucks, with widely available charging infrastructure. This is unlikely within this decade without sustained government investment in the research and development of ZETs, concessional lending for fleet owners' acquisition of ZETs, subsidies for manufacturing, funding for upskilling of workers, and the installation of charging infrastructure.

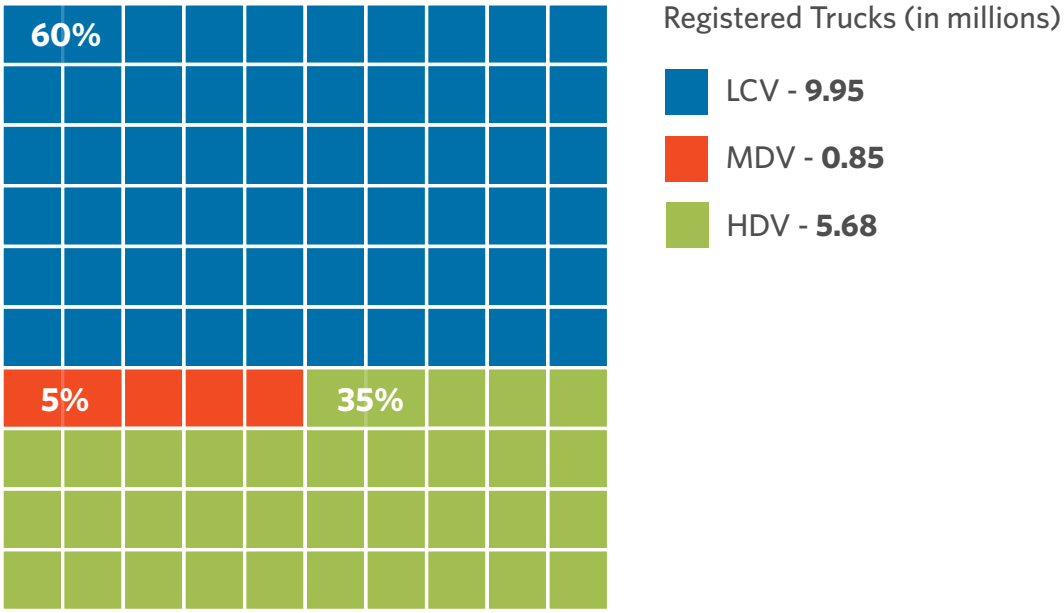
The adoption of ZETs is expected to create new jobs in manufacturing, maintenance, and charging infrastructure development (NITI Aayog, 2021). The transport sector contributes about 6% to India's GDP (Raghuram, 2015) and the trucking industry directly employs eight million people as drivers (British Safety Council, 2022), with many more employed in indirect and induced jobs. However, growth in new jobs in the industry may be offset by job displacement in fossil-fuel-related trades. The formal sector has better mechanisms to weather this transition than the informal sector. These considerations have implications for workforce skilling and government funding of the transition.

Beyond the environmental imperative, the transition to ZETs presents an opportunity for socio-economic transformation. Most studies on ZETs to date focus on its techno-commercial implications, with only a few addressing its just transition elements. This report attempts to fill this gap by examining the impact of the transition on various stakeholders – especially those working in indirect and induced jobs in the trucking industry. The report projects the expected electric truck sales in India to provide a basis for understanding the resource requirement for engendering a just transition. Trucking clusters were surveyed to determine the ratio of direct, indirect, and induced jobs in the sector. From this data, the total employment in the sector is determined, which provides a basis for projecting the funding and skilling needs for a just transition in the sector. This report then provides recommendations on skilling and financing interventions that the government could implement to make the transition to ZETs just. This includes establishing a Just Transition Fund for India which can be housed under the MSDE. The fund can be used for both the reskilling of impacted workers and the provision of loans for induced job holders who are forced to seek alternative livelihoods due to the transition.

1. CURRENT STATUS OF THE TRUCKING SECTOR IN INDIA

The road logistics sector in India is expected to grow at a compounded annual growth rate (CAGR) of 8% to reach USD 330 billion by 2025 (C. H. Robinson, 2024). Road logistics in India is heavily reliant on diesel trucks, of which heavy and medium-duty trucks constitute a fleet of about 7 million vehicles (MoRTH, 2023) (Figure 1). A rapid transition to a greener trucking fleet will boost India's alignment with Paris Agreement goals and India's target of reaching net zero by 2070. This section of the report examines the current industry structure and the nature of employment within it.

Figure 1. Registered trucks in India (January 2024)

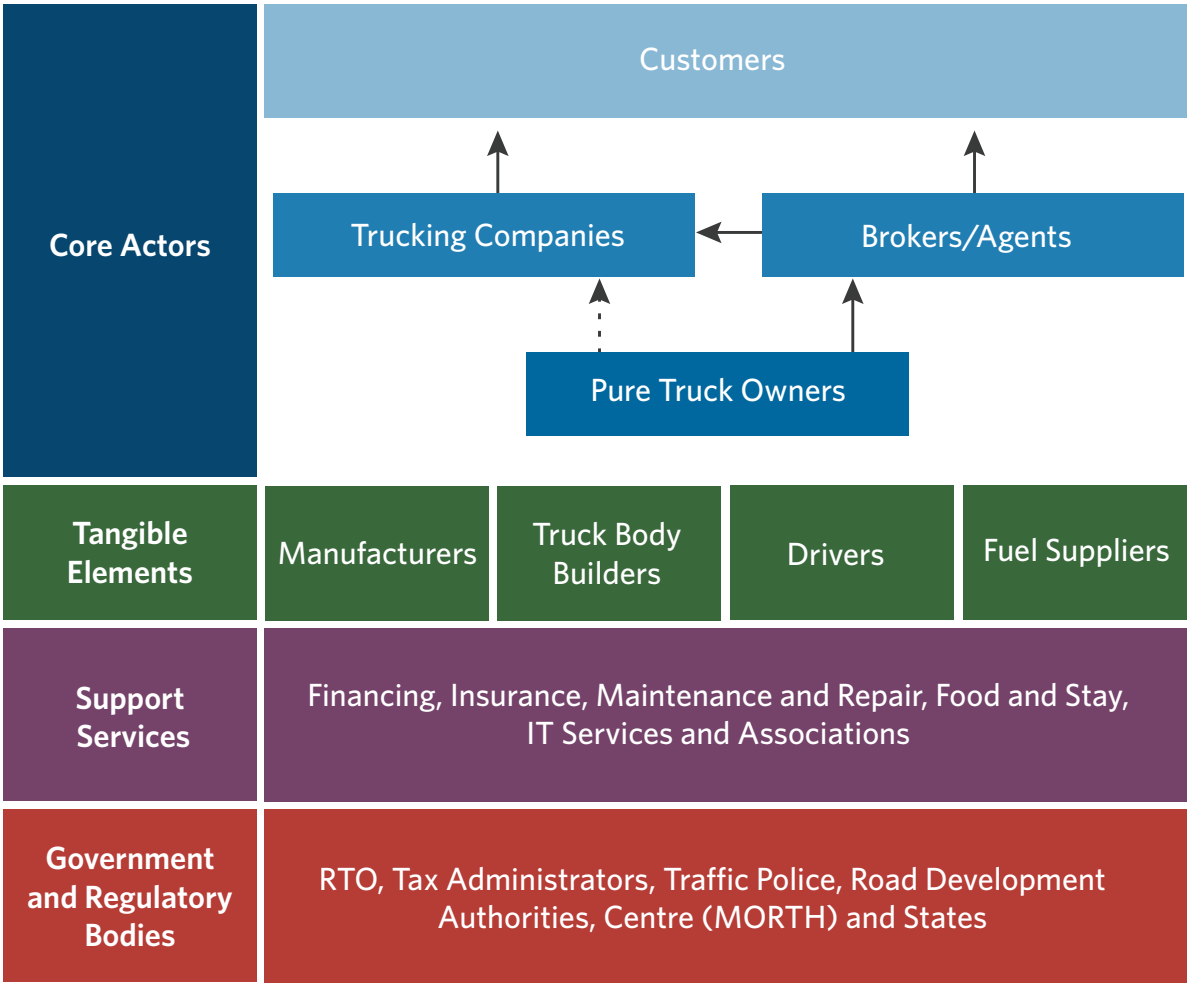


Source: *Vahan Dashboard, Ministry of Road Transport and Highways*

1.1 STRUCTURE OF THE TRUCKING INDUSTRY IN INDIA

India's trucking industry has multiple actors, as shown in Figure 2. While most logistics service providers (LSPs) own some trucks, they tend to remain asset-light and move cargo almost entirely through third parties (Raghuram, 2015). They are directly served by small fleet owners (SFOs) and their brokers/agents. These core stakeholders are supported by four groups: manufacturers, truck bodybuilders, drivers, and fuel suppliers. All these actors are embedded in an ecosystem of support services, the government, and regulatory bodies (Raghuram, 2015).

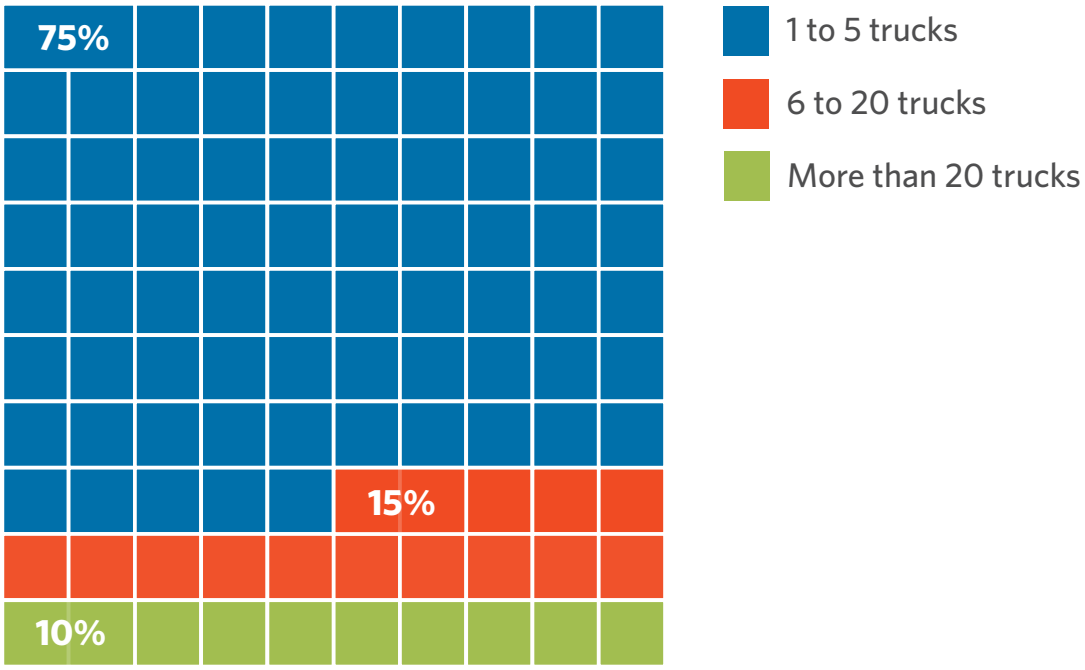
Figure 2. Structure of the trucking industry



Source: *(Raghuram, 2015)*

Limited regulation and low barriers to entry have led to a crowded and fragmented freight market, with numerous SFOs and unskilled drivers. SFOs, which comprise over 75% of the market, own fewer than five trucks (NITI Aayog, 2022). Only about 10% of India's truck fleet is owned by operators with more than 20 trucks (Raghuram, 2015) (Figure 3).

Figure 3. Truck ownership profile in India



Source: *IISD, 2013*

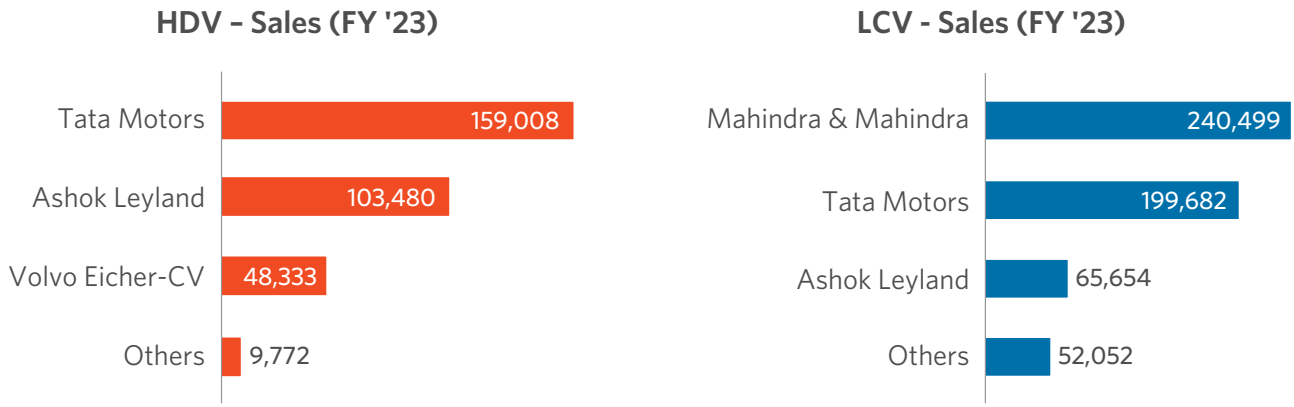
Brokers or agents connect logistics companies to SFOs – matching demand with the fragmented supply. They support consignors (customers) directly or help to connect SFOs to LSPs. Since LSPs have limited means of assessing an SFO's performance, the broker helps to determine the reliability of the SFO (Raghuram, 2015). This allows the LSPs to remain asset-light while managing demand for their services.

Brokers also play an important role in obtaining business for truck operators. SFOs lack market information on consignors, creating challenges in securing adequate loads to fully utilize their assets. Estimates indicate that trucks can be idle for 25% to 30% of the time due to inefficient demand/supply matching (Deloitte, 2020).

In addition, only about 30% of trucks—typically those owned by large fleet operators (LFOs)—have long-term annual contracts with consignors, which have escalation clauses that allow the pass-through of incremental costs (CRISIL, 2018). SFOs do not have the funds or information to obtain such contracts and, therefore, depend on brokers, who decide freight rates and charge high commissions (IISD, 2013).

The truck manufacturing industry is another key stakeholder in the ZET transition. India is the fifth-largest market globally for trucks (C. H. Robinson, 2024). A diverse range of manufacturers cater to various segments, including light commercial vehicles (LCVs) for last-mile connectivity, medium duty vehicles (MDVs) for regional haul, and heavy-duty vehicles (HDVs) for long-haul and construction (Figure 4). India's domestic sales of HDVs grew at a CAGR of 7% between FY 2014 and FY 2023. Four Indian original equipment manufacturers (OEMs) account for nearly all their sales. These companies have also been expanding exports to international markets including Africa, the Middle East, and Southeast Asia.

Figure 4. Sales volume of trucks (FY 2023)



Source: *Society of Indian Automobile Manufacturers*

The Indian government has implemented regulations to improve vehicle safety, emissions standards, and fuel efficiency. The implementation of Bharat Stage VI (BS-VI) emission norms has significantly impacted the industry by pushing manufacturers to develop cleaner and more efficient trucks. Some have started producing electric trucks and buses, with a focus on last-mile delivery and urban transportation. The truck manufacturing industry in India is expected to continue growing as the economy develops and road logistics demand increases. The transition to cleaner and more efficient vehicles, including electric trucks, is likely to shape the industry's future.

1.2 EMPLOYMENT IN THE TRUCKING INDUSTRY IN INDIA

India's growing transportation and logistics sectors are increasing demand for truck drivers, warehouse personnel, and cargo handlers, providing essential employment to semi-skilled and unskilled laborers. Jobs created by the trucking industry can be classified as direct, indirect, and induced jobs.

Direct jobs are those directly connected to the core activities of transporting goods and managing the logistics of trucking operations (Table 1). These include truck drivers and assistants, fleet owners, and other personnel employed by trucking companies. Truck drivers often associate themselves with specific fleet owners. Their salaries consist of a fixed component, with an additional variable component that is typically tied to the distance driven. In a recent survey, truck drivers in India reported a median direct monthly income of INR 17,000 (USD 205)[1] (PPHF, 2022). An additional variable component comes from achieving fuel optimization (approximately INR 1,500 to 2,000 per trip) among other sources; 22.6% of truck drivers reported having to supplement their wages with an alternative source of income.

Indirect jobs encompass roles upstream and downstream of the trucking industry (Table 1). Upstream indirect jobs relate to the manufacture of trucks and their components, while downstream indirect jobs are in aftersales service and fuel stations.

1 A conversion rate of USD 1 = INR 83 has been used.

The automotive ecosystem has many independent service stations. However, in India, not all have well-qualified staff, which will make servicing EV powertrain systems challenging. Reskilling mechanics is crucial to ensure the continuity of this service business, although the impact in the short to medium term may not be significant due to the considerable number of ICE vehicles that still need to be serviced as the transition gets underway.

Induced jobs are roles created because of economic activity generated by the trucking sector (Table 1)**.** These are typically found in localities surrounding clusters where trucking companies and their employees purchase goods and services. They include jobs in local restaurants, hotels, retail stores, and other businesses that benefit from the increased economic activity brought about by the presence of the trucking industry.

Table 1. Job categories and impact on them due to the transition

Job Type	Definition	Impact of the Transition to ZET
Direct Jobs	Jobs directly tied to the core activities of trucking, including truck drivers, assistants, fleet owners, and other company personnel.	▪ **Truck Drivers**: may face changes in income due to differences in ZET operation and maintenance (compared to ICE trucks). May need to supplement wages with alternative income sources. ▪ **Fleet Owners**: may need to adapt their business models and invest in ZET infrastructure.
Indirect Jobs	Upstream indirect jobs- truck and component manufacturing; Downstream indirect jobs - aftersales service and fuel stations.	▪ **Manufacturing:** shifts in demand from ICE to ZET will impact employment in truck manufacturing and related industries. ▪ **Aftersales Service:** mechanics and service personnel will need to upskill for ZET maintenance. ▪ **Fuel Stations:** will need to diversify services beyond fossil fuels.
Induced Jobs	Jobs which arise from economic activity around the trucking sector, such as local businesses benefiting from trucking-related spending.	▪ **Truck-stop businesses**: restaurants, hotels, retail stores, etc., in trucking clusters will see changes in customer base and demand based on ZET adoption.

Source: *CPI analysis*

Another classification of workers in the trucking value chain is based on whether they are covered by the Employees' State Insurance Corporation pension scheme. Jobs covered by this scheme are classified as formal and others as informal.

Formal sector workers, such as employees of manufacturing firms and authorized service stations, have better opportunities for reskilling and redeployment within their companies or elsewhere in the industry. This is not the case for millions of informal workers, such as mechanics and workers at truck lay-bys. Such roles are largely semi-skilled or unskilled and financing will be needed to help these workers secure alternative livelihoods if they are impacted by the transition to ZET.

2. INDIA'S TRANSITION TO ELECTRIC TRUCKING

2.1 ZERO EMISSION TRUCKING IN INDIA

While India's electric vehicle (EV) market is growing, driven by government policy and incentives, ZETs have not yet been as widely adopted as passenger EVs.

There has been selective adoption of commercial EVs in the LCV segment. Short-haul trucks have predictable daily ranges and payloads, return-to-base operations, reliable and dedicated parking, and lend themselves to innovative business models (ICCT, 2023). However, there is hesitance to purchase ZETs for long-haul, open-ended trucking operations.

Consignors are interested in having LSPs deploy ZETs to reduce their scope 3 emissions, but fleet operators are not yet adopting them. A lack of financing options, opacity concerning end-of-life value, the lack of a secondary market, and concerns about limited charging infrastructure for long-distance operations have hindered the uptake of M/HDVs, in particular.

While ZETs offer lower operating costs than ICEs across various freight categories in India, higher upfront costs have kept the TCO for ZETs above that of ICEs. Recent technological advances promise to reduce the cost of batteries, but a trade-off exists between truck weight and range-per-charge, creating a payload penalty for ZETs. Balancing the payload capacity with range will be crucial for successful adoption (Abhyankar, et al., 2022).

Achieving the ZET transition in the M/HDV segment requires a holistic approach, with financial innovation, policy changes, and technological advancements as essential enablers. The Indian government is promoting ZETs to help meet the country's ambitious emission reduction targets. In 2020, NITI Aayog and the OECD's International Transport Forum jointly launched the five-year Decarbonizing Transport in Emerging Economies project, which aims to aid India in developing a pathway towards a low-carbon transport system through modeling tools and policy scenarios.

In 2022, NITI Aayog launched the Electric Freight Accelerator for Sustainable Transport (e-FAST), a platform to foster public-private collaboration on large-scale freight electrification. This initiative has brought on board 16 manufacturers and LSPs who have signaled a collective demand for 7,750 ZETs by 2030. To meet this demand, policy and regulatory efforts will be required to establish market certainty, create scalable pilot support, develop infrastructure, and create financing platforms to attract private investment.

The office of India's Principal Scientific Advisor has also developed the Technical Roadmap for Deployment of Zero-Emission Trucking in India in consultation with experts from various sectors (NITI Aayog, 2023). This document presents a five-year strategy outlining timelines, budgets, and collaborative efforts to facilitate the ZET transition. It highlights priority trucking routes for ZET deployment and the commencement of pilot programs involving 60-70 electric trucks.

Further government intervention is required to explore contextual factors, including road conditions, traffic patterns, and climate, which directly affect the performance of ZETs.

Investigating the energy consumption of ZETs under local conditions is essential to understanding how they perform during routine operations in Indian roads.

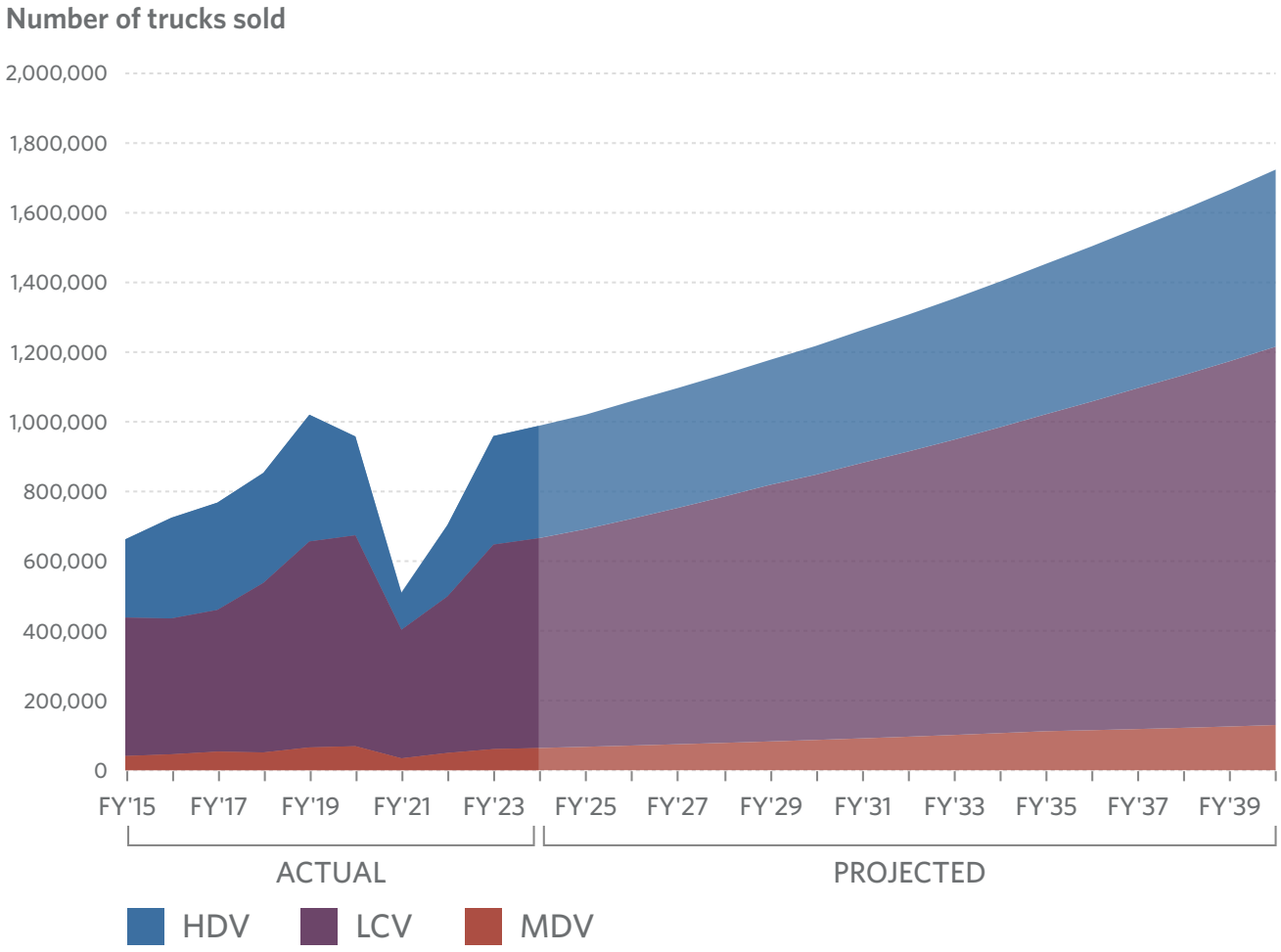
The evolution of long-distance ZETs will also require electrifying open-ended routes. The National Highways Authority of India and other government and private stakeholders will need to cooperate to develop land parcels and land use models across the highway network to develop truck rest stops integrated with charging stations.

2.2 FORECAST FOR ZERO EMISSIONS TRUCKING IN INDIA

Growth in India's truck market is projected to continue, with a slight concentration on LCVs. In FY 2023, approximately 0.95 million trucks were sold, following a slight dip due to factors including the COVID-19 pandemic, the transition to BS-VI emission standards, and adjustments in axle load norms. Sales of trucks are expected to increase to 1.2 million units by 2030 and to 1.7 million units by 2040 (Figure 5).

The LCV segment leads truck sales, due to the expansion of industries like e-commerce, construction, and logistics, as well as increasing demand for fuel-efficient vehicles.

Figure 5. Actual and projected sales of trucks in both fossil fuel and zero-emission categories

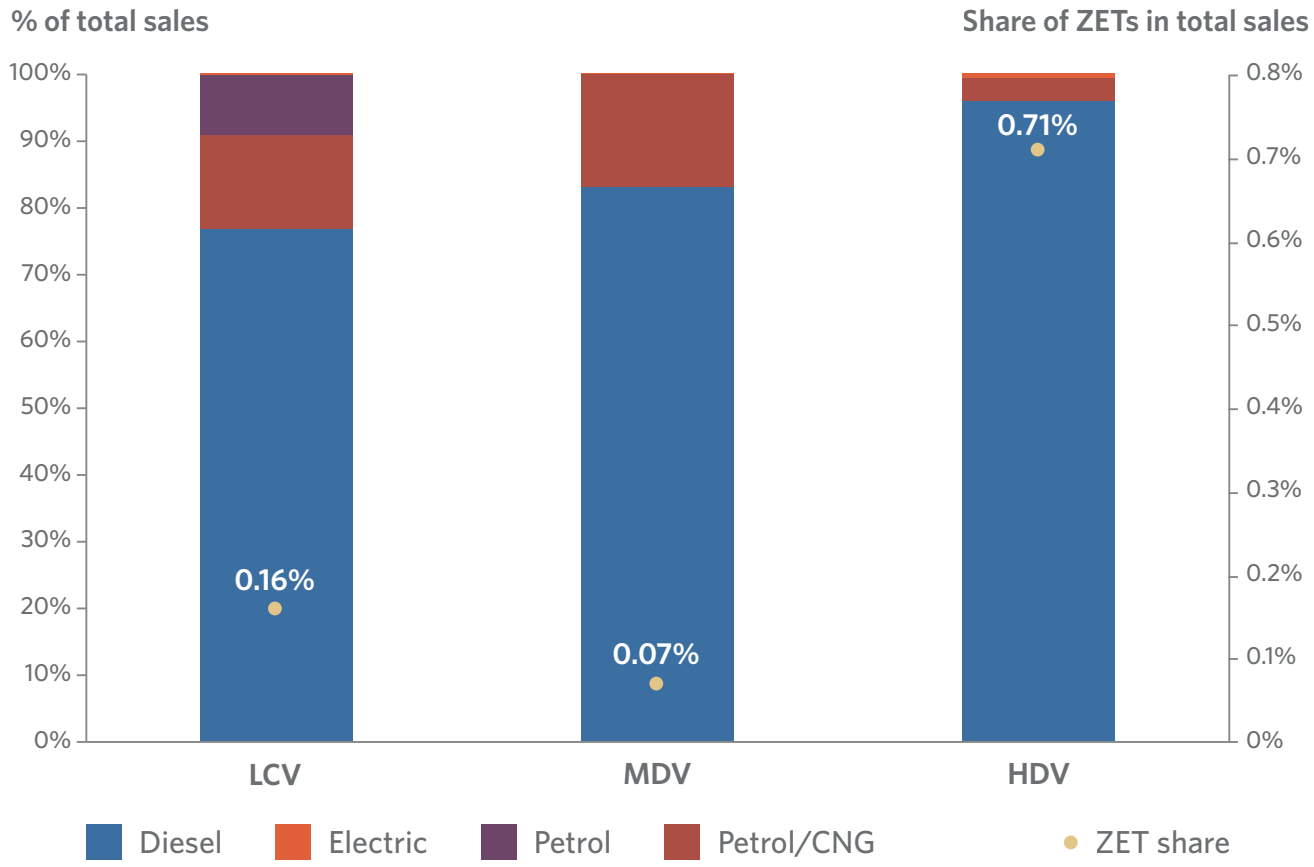


Source: *FADA, CPI analysis*

ZETs have yet to see widespread adoption in India's truck segment, which is predominantly powered by diesel due to its higher power output and widespread availability of both engines and fuel. Sales of compressed natural gas trucks grew initially but declined after the revised gas pricing formula came into effect in 2022.

The sale of ZETs as a percentage of total truck sales is highest in the HDV segment, with 0.71% of new registrations in 2023, followed by LCV (0.16%) and MDV (0.07%). This can be attributed to the low base of HDV sales overall (Figure 6).

Figure 6. Fuel-wise sales of trucks in 2023



Source: *FADA*

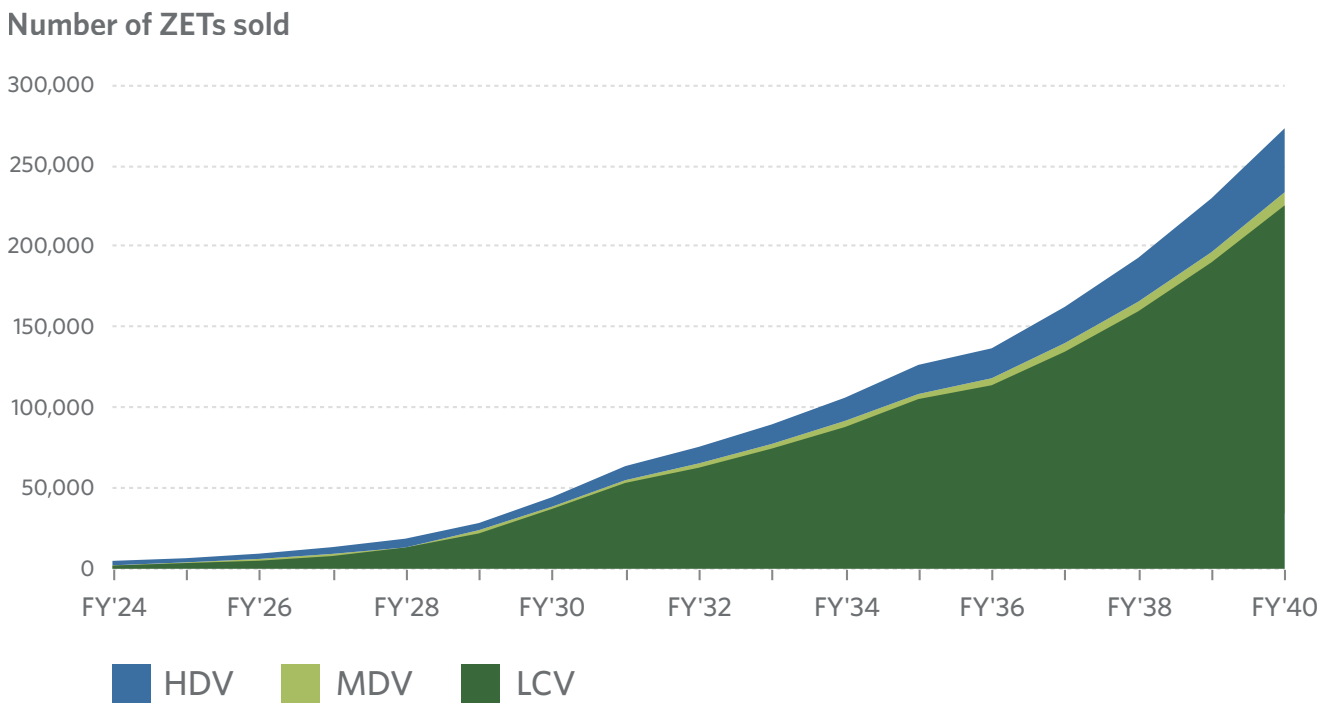
Major Indian commercial vehicle OEMs, and some startups, have started producing ZETs or announced plans to do so. However, they face the challenge of importing powertrain and battery pack components, which are not manufactured indigenously. The reskilling of manufacturing and maintenance personnel must focus on these components and other evolving technologies.

Prominent truck manufacturers in India have also initiated the journey to adopt ZETs. For example, Tata Motors, which holds a substantial market share, has committed to achieving net-zero emissions for its trucks by 2045.

CPI analysis indicates that annual ZET sales will reach 0.04 to 0.09 million units by 2030 and around 0.27 to 0.38 million units by 2040 (Figure 7 and Figure 8). This is based on CPI's projection of annual commercial ZET sales in India using a proprietary model based on public and proprietary datasets, insights from expert interviews, and in-house expertise (see Annexure 3 for details).

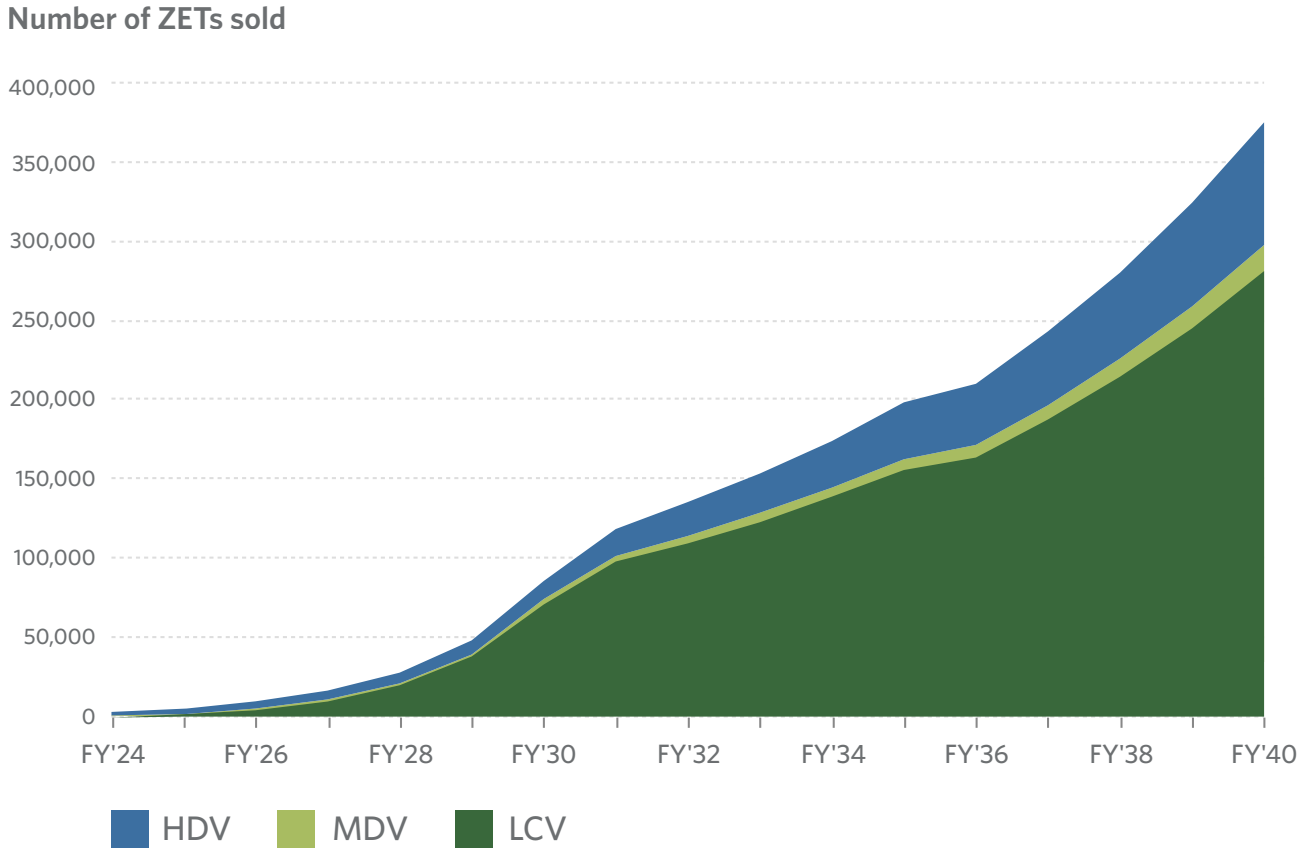
The two scenarios modeled are: 1) business-as-usual (BAU) with no major policies to increase ZET penetration; and 2) an ambitious scenario with sector-specific policies aligned with the government's net-zero and climate targets.

Figure 7. Projected ZET sales – BAU Scenario



Source: *CPI analysis*

Figure 8. Projected ZET sales – Ambitious Scenario



***Source**: CPI analysis*

The growth potential of ZETs in India is limited by several factors. Government policies and initiatives will be significant in determining their penetration, as observed by the difference in outcomes of the two scenarios. ZET growth is also linked to the development of other technologies, such as flex-fuels, which can work on existing ICE engine platforms. Given that the weight of trucks limits their range, LCVs can run on lighter battery packs than M/HDVs. This is reflected in our projections, which show that by the year 2040, almost 22% to 28% of the LCV fleet in India will be electrified, compared to only 7% to 12% of the HDV fleet. ZET adoption also depends on the parallel development of a charging network, especially on highways serving M/HDVs.

2.3 EVOLUTION OF CHARGING INFRASTRUCTURE FOR ZETS

Infrastructure for ZETs primarily relates to the charging ecosystem. A transition is happening in various countries, including India, from charging infrastructure designed for passenger EVs to higher-capacity applications such as electric buses and electric M/HDVs.

The beachhead model of truck electrification proposed by the Drive to Zero initiative projects that predictable delivery routes will be among the first to be electrified (Drive to Zero, 2020). Preparation for this is ongoing, with several companies entering the last-mile connectivity

space using LCVs. Most new entrants in this market are vertically integrated with their charging infrastructure, whether they own or lease their fleets. However, it will be more challenging to electrify the long-haul open-ended routes of M/HDVs.

Lessons may be learned from China, which is leading in ZET adoption globally, accounting for 86% of sales in 2022, with over 50,000 units sold (IEA, 2023). This reflects China's strategy to shift its EV focus to trucks, enabled by battery-swapping technology (see **Box 1**.) In comparison, India's sales of ZET in FY 2023 numbered less than 5,000.

Box 1. Battery swapping as a driver of truck electrification

Swapping batteries can be the most efficient charging method for M/HDVs as it reduces idle time and enhances distance covered in a day. Battery swapping could also help to disperse charging demand, easing the strain on power grids at peak times. Battery swapping takes a few minutes compared to 40 minutes for DC fast charging for an electric truck. It also reduces the spatial requirements of charging stations.

For example, India's first battery-swapping station for public buses in Ahmedabad can charge 12 batteries simultaneously. Established by Ashok Leyland and Sun Mobility, this station allows drivers to make one 3-to-4-minute battery swap per trip. The frequency of swaps enables reduced battery size, which in turn maximizes bus space, allowing more passengers to be accommodated.

Battery swapping is a key reason for China's success in the electric truck market. The national and local governments have promoted battery swapping since 2020. In 2022, almost half of electric trucks sold in China were equipped with swap-capable batteries (Hongyang Cui, Yihao Xie, and Tianlin Niu, 2023).

As of February 2024, the Government of India has set up 12,146 public EV charging stations across the country but has not commenced the development of rapid charging stations for trucks (PIB). Given the slow pace and low numbers of high-capacity charging stations being set up by the government, the private sector could play an enabling role.

In addition, it is important to note that trucking can be fully zero-emission only when the charging infrastructure is powered purely by renewable sources. The weighted average emission factor for India's power sector as of December 2023 was 0.716 kgCO2/kWh (Central Electricity Authority, 2023). In comparison, a similar data point available for a country in the European Union, namely Poland, suggests that the grid GHG emissions of Poland were 0.600 kgCO2e/kWh (ICCT, 2023). Hence, the emissions intensity of the power sector in India must be reduced in tandem with the growth of ZETs to fully reduce trucking sector emissions.

Fuel stations will be impacted by the transition to ZETs. The Indian fuel retail market is organized and consolidated, with fuel stations catering to vehicles ranging from two-wheelers to heavy trucks. The industry operates primarily through retail outlets owned by government oil marketing companies (OMCs), which may be operated by either the OMC or a dealer. The OMC may also lease fuel stations to another company which then has them operated by a dealer (HPCL, 2024). The expansion of CNG vehicles has introduced another business model called the dealer-owned, dealer-operated model. Adani Gas, for instance, has launched over 300 dealer-owned

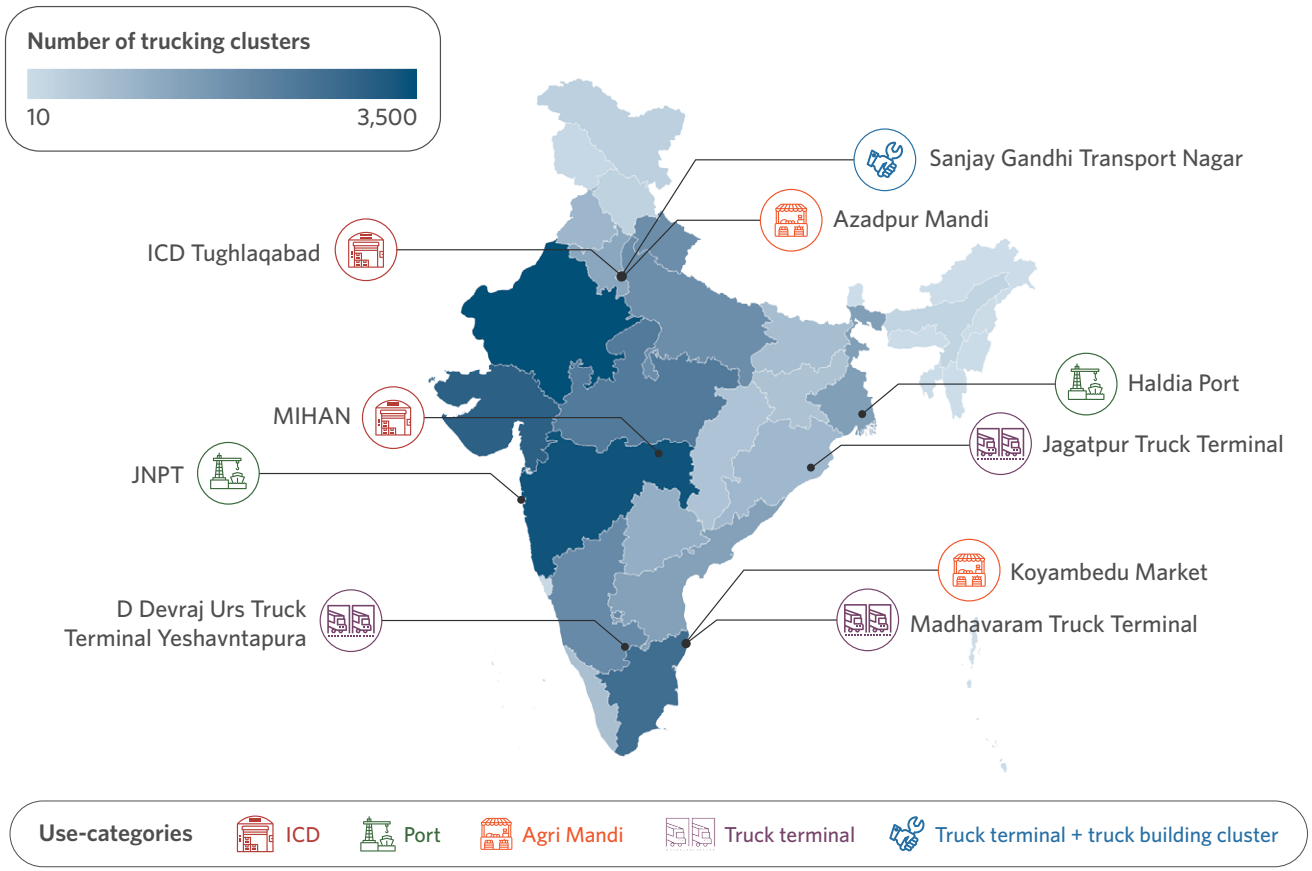
and -operated CNG stations, which allows dealers to own and manage stations, with oversight of critical infrastructure by Adani Gas (Adani Gas, 2022).

Given that the projected uptake of ZETs will be gradual over the next decade, fuel stations have an opportunity to evolve into charging stations or diversify into other businesses. OMCs are taking the lead in this by setting up charging facilities at fuel stations across India.

2.4 TRUCKING CLUSTERS ANALYSIS

Trucking clusters in India were analyzed to understand indirect and induced employment due to the trucking sector. Unlike in developed economies, there are no organized sector truck stop companies in India. Our survey indicated that trucks cluster around sites including rest stops, agricultural mandis (wholesale markets), ports, inland container depots, industrial estates, special economic zones, weighbridges, and warehouses. A mapping of these clusters was done to understand their spread across the country. A cross-section of these clusters was then considered for a survey on the indirect and induced jobs likely to be impacted by the ZET transition (Figure 9). The surveyed trucks include LCVs, MDVs, and HDVs, which carry a range of cargo types, including containers, bulk cargo, agriculture commodities, and break-bulk cargo for last-mile delivery. Annexure 2 summarizes further details about this survey.

Figure 9. Map of trucking clusters in India and survey locations



Source: *CPI analysis*

Two trends will impact indirect and induced jobs in trucking clusters: technological advances and sector formalization. Long-distance electric trucks will need charging points at regular intervals on highways to operate. During this period of rapid technological evolution, the range of batteries and the use of charging points will reconfigure trucking clusters.

Charging point operators (CPOs) incur fixed costs, including land leases, capex for charging stations, maintenance expenses, and salaries. In addition, CPOs must be close to high-capacity power lines to receive adequate voltage. To ensure a return on investment, CPOs need to have a minimum number of charging guns and a minimum utilization level. To defray their high fixed costs, they should also seek parallel revenue streams by offering services such as retail, boarding, lodging, EV maintenance and repair, and advertising.

In parallel, truckers seeking to minimize idle time due to charging will value access to retail, boarding, and lodging at charging stations, especially on long-distance routes. This could further consolidate and formalize truck stops across the highway network.

This formalization and relocation of truck stops will cause job losses in some locations and gains in others. Some existing clusters will stop being patronized, leading to unemployment or a need for worker reskilling. While fuel stations and related businesses will be impacted, the projected slow uptake of ZETs over the next decade gives them time to evolve into charging stations or to diversify into other businesses.

Informal service providers will lose business and revenue, impacting induced and informal jobs. Understanding the nature of this job displacement will be key for deploying policies and financial interventions for making this transition just.

3. IMPLICATIONS OF A JUST TRANSITION TO ZETS

Our analysis shows that there are currently about 9.4 million indirect jobs and about 4 million induced jobs in the trucking industry in India. A shift to ZETs creates a need for extensive reskilling of this indirect workforce currently employed in the ICE vehicle value chain. It also requires financing alternative livelihoods for induced job holders who cannot be reskilled for new roles. A just transition framework must consider multi-dimensional and interconnected aspects of the transition to ensure an optimal outcome for all stakeholders who stand to lose out due to the transition.

3.1 COMPONENTS OF A JUST TRANSITION

Figure 10 shows a Just Transition Framework across four dimensions: recognition, procedural, distributional, and restorative justice (European Environmental Agency, 2024).

Figure 10. Components of a Just Transition Framework

Source: *(European Environment Agency, 2024)*

Context-specific solutions are required to meet the needs of different stakeholders across different geographies. This framework should therefore be customized to meet the needs of those likely to be impacted by the transition to ZETs, by identifying relevant parameters and metrics for each pillar, as outlined in Table 2. Section 4 of this report proposes solutions for engendering a just transition in this sector by focusing on skilling and financing alternative livelihoods – both of which have elements of all these components of a just transition.

Table 2. List of parameters and metrics for a just transition to ZET

Justice dimension	Parameter	Metric
Recognition	Identifying stakeholders affected by the transition (individuals and groups covering regions, social groups, gender, age, etc.)	• Have all the stakeholders – direct and indirect - been identified? • Has the distribution of jobs (direct, indirect, and induced) by job role, gender, and sub-sector been identified? • Have the incentives (for skilling) required for different stakeholders for ZET been identified?
	Stakeholder-wise quantitative and qualitative impact measurement	• What is the extent of the impact of this transition on job roles? • What is the number of jobs lost/gained categorized by job role? • How many new job roles are created?
Procedural	Procedural fairness in identifying the concerns of different stakeholders regarding the choices made for the transition	• Have all impacted stakeholder groups been consulted by the government in a structured manner? • What are the grievance redressal pathways available to them? • Is access to skilling or financial assistance for different stakeholders easy?
Distributional	Fairness in engaging with stakeholders during the transition	• How easy are grievance redressal pathways to access? • Has an assessment been made to determine the cost or burden of transition on the stakeholders? • How is the burden of the differential impact of the transition on diverse stakeholder groups distributed?
Restorative	Mainstreaming of affected stakeholders with a well-defined roadmap	• Have the reskilling and upskilling options for stakeholders been identified? • Have the affected stakeholders been included in the mainstreaming strategy?
	Fairness in financial inclusion of affected stakeholders during the transition	• Has the cost or compensation to manage the negative impact of the transition on livelihoods of different stakeholders been estimated? • Is the estimated cost or compensation sufficient to restore their livelihoods?

Source: *CPI Analysis*

Just transition concerns need to be foregrounded to formulate optimal implementation strategies and a related monitoring mechanism as the transition progresses. Synchronized efforts by the government and private sector are required to strengthen partnerships and alliances to ensure that the transition is just at all levels.

3.2 EFFECTS OF THE TRANSITION ON EMPLOYMENT

As identified in Section 1.1, key entities in the trucking industry include trucking companies, brokers, and fleet owners. These are, in turn, serviced by truck manufacturers, truck bodybuilders, drivers, and fuel suppliers, forming an ecosystem that includes support services, government bodies, and regulatory entities.

SFOs lack the certainty of long-term contracts and mostly attach their fleets to trucking companies that interface with customers and manage their logistics. This semi-formal arrangement is untenable for ZETs; long-term financing is required for ZETs, which is only available to companies with reliable income afforded by long-term contracts.

In addition, the typical tenor of a truck loan in India of up to 60 months may be inadequate for ZETs, given that secondary capex is required to replace batteries in the middle of the vehicles' lifetime. Hence, longer tenor loans or refinancing of existing loans are required.

CPI's survey conducted for this study found that there are 0.7 indirect downstream informal jobs for every direct job in India's trucking industry (see Table 3). Given that there are 8 million truck drivers in the country (British Safety Council, 2022)[2], there are around 5.6 million related indirect jobs in fuel stations and unorganized sector mechanics.

Table 3. Ratio of direct, indirect, and induced jobs in the survey locations

Total number of direct jobs across the survey sites	19,170
Total number of indirect (downstream informal) jobs across the survey sites	12,509
Ratio of indirect (downstream informal) jobs to direct jobs	0.7
Total number of induced jobs across the survey sites	9,513
Ratio of induced jobs to direct jobs	0.5

Source: *CPI and pManifold analysis*

Indirect formal jobs, such as those in OEMs and formal aftermarket service, will also be impacted by the transition. We calculate that there are 3.8 million upstream indirect jobs in manufacturing, sales, and service of trucks.[3]

Adding the upstream and downstream indirect jobs in the trucking industry, the total indirect jobs in the trucking industry are around 9.4 million. Many of these, especially those related to ICE powertrain and electronics, will be impacted by the ZET transition. However, these workers are largely in the formal sector and can be reskilled to work in the ZET value chain.

The most vulnerable among indirect workers are the informal sector service mechanics, who are spread across India. OEMs may limit access to ZET software and electronic components, as well as related expertise, to authorized dealers and service stations due to safety and intellectual property considerations. This will impact informal sector mechanics who require access to skilling in the new technologies to survive the transition to ZET. The unregistered, small-scale activities that define the informal sector pose challenges in skills enhancement. This sector's structure restricts access to official training and opportunities for improving skills, complicating structured skilling initiatives compared to the organized sector.

Induced jobs in the trucking industry will be the most vulnerable in the transition to ZETs. Our survey indicates that there are about 0.5 induced jobs for every direct job in the sector, translating to 4 million jobs across India. Since these jobs do not require any specific skills or

2 There are multiple estimates of the number of truck drivers in India. The estimate used in this report is based on figures from the British Safety Council.

3 The overall value of India's automotive industry, including light, medium, and heavy-duty vehicles, is USD 90 billion, with 19 million direct and indirect jobs (PIB, 2023). The value of M/HDV trucks market in India in 2021 was USD 11.2 billion (Research and Markets, 2022). For LCVs, assuming an average price of INR 1 million per LCV and with 0.57 million registrations in FY 2023 (FADA), translates to annual sales of USD 6.8 billion[1]. Hence, the total LCV, MDV and HDV sales per annum totals USD 18 billion. Taking the number of workers in proportion to the market size gives 3.8 million workers engaged in truck manufacturing, aftermarket sales and service.

educational attainment, they are held by the most vulnerable sections of society. Depending on how the sector formalizes, almost all induced jobs may be under threat – especially those in informal truck rest stops across India's highway network. Financing alternative livelihood creation via financial support mechanisms such as MUDRA loans, which are aimed at micro and small-scale entrepreneurs, provide a possible path for the impacted induced job holders to find alternative livelihoods.

3.3 SPATIAL RECONFIGURATION DUE TO INDUSTRY

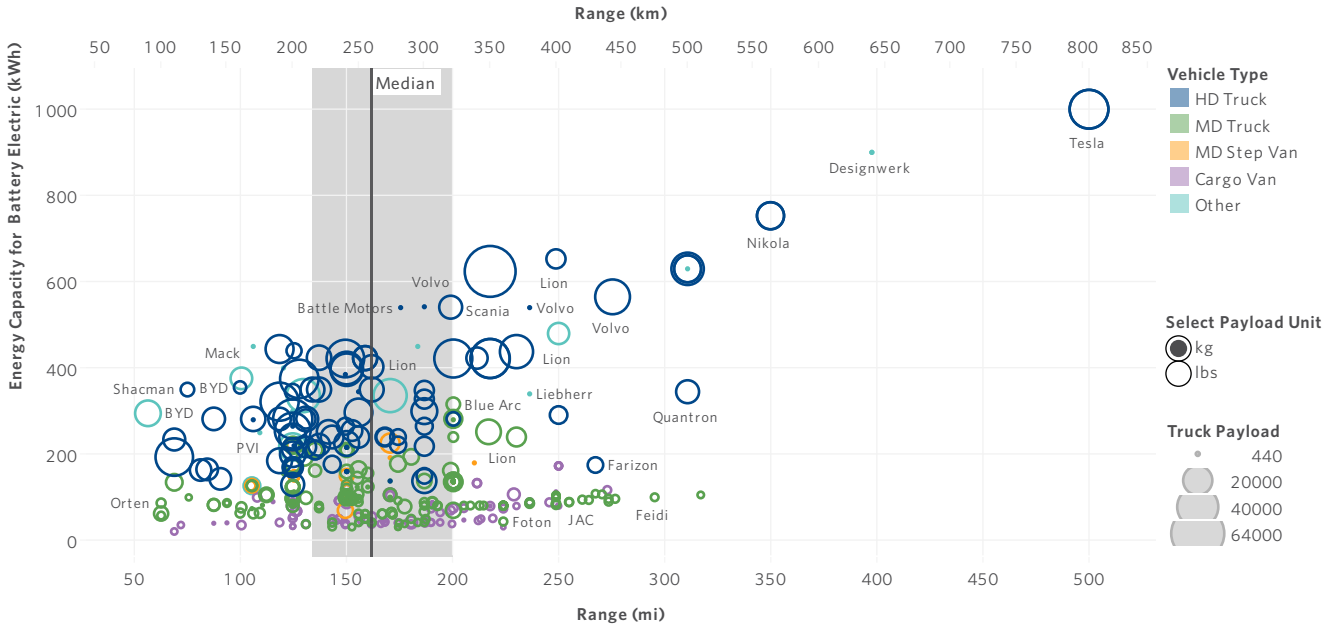
The clustering of ZETs around charging stations rather than informal truck rest stops will impact jobs in informal truck stops across the Indian highway network. Over time, electric charging will formalize truck stops and their related workforce. While formal roles will increase alongside a decrease in related informal ones, a net loss in jobs is expected due to higher efficiencies in the formal sector.

Figure 11 shows the range of several trucks produced across the world as of 2023 (CALSTART, 2023). The median range for commercially available ZETs globally stands at slightly above 402 km per charge. However, models that are commercially available in India have a range of 110 km to 180 km per charge (JMK Research & Analytics, 2024). Our survey found that HDVs in some use-categories in India travel up to 460 km per day, meaning that they would need to recharge multiple times every day.

The data for battery energy density is clustered around 200 kWh for HDVs and around 100 kWh for M/LCVs.[4] An estimate predicts that the energy density of batteries could increase by 50% between 2024 to 2030 (S&P Global, 2018), which would increase the range of ZETs given the same battery payload. India must expand its charging network and raise battery charge densities for locally manufactured trucks to global standards to take advantage of such technological advancement.

4 The definitions of heavy-duty trucks, medium duty trucks and cargo vans shown in the figure are those given by CALSTART.

Figure 11. Range of battery electric trucks



Source: *(CALSTART, 2023)*

3.4 EFFECTS ON DEALERS AND SUPPLIERS

Dealerships, which are responsible for vehicle sales and services, also manage local product promotion and last-mile delivery. Dealerships, which are well-equipped to handle sales and services for ICE trucks, will have to update their knowledge and skills for ZETs. This will particularly affect the services aspect of the business, which will involve handling software, electronic hardware, and battery-related issues. Like truck manufacturers, dealerships must invest in training to minimize the impacts of this transition.

Auto component suppliers who support OEMs in research, development, and manufacturing currently focus on ICE components and must adapt to ZETs by diversifying into electric powertrain components, which requires significant changes in approach and business models. While the transition poses challenges for OEMs, it also presents opportunities for their partners in the supply chain.

3.5 EFFECTS ON GOVERNMENTS AND UTILITIES

Shifting India's transportation energy demand from petrol and diesel to the more diverse sources that power the country's electricity grid will make the economy less vulnerable to oil-related geopolitical risk and oil price shocks. It would also help reduce foreign exchange outflow given that India imported around 85% of its crude oil (212.5 million tonnes) and 19 million metric tonnes of liquefied natural gas in FY 2023 (Petroleum Planning & Analysis Cell, 2024). As the commercial vehicle fleet increasingly transitions to ZETs, the economic benefits of this shift will grow over time. India's OMCs have the potential to establish battery-charging or swapping stations at fuel stations to augment their current operations.

A reduction in tax revenue of up to 15% is predicted if EVs capture 30% of sales by 2030 (CEEW, 2020). The government requires a long-term strategy to raise resources, diversify revenue sources and reduce dependence on fossil fuel taxes.

Power distribution companies (DISCOMs) are in a unique position to both leverage and drive this transition. Given the high voltage requirements of ZET charging stations, DISCOMs can play a key role in the deployment of charging stations through various DISCOM-centric business models. The government can play an enabling role in promoting ZETs by allowing DISCOMs to pass through charging infrastructure costs.

4. INTERVENTIONS BY THE GOVERNMENT TO ENSURE A JUST TRANSITION

The twin government interventions for a just transition to ZETs are skilling support and financing support. Jobs in the organized sector and some indirect jobs in the unorganized sector require skilling support to switch from ICE to ZET manufacturing, maintenance, and repair. Induced jobs in the unorganized sector require financing support in the form of grants or low-cost debt to switch livelihoods.

The key challenge for policymakers in effecting a just transition is in the unorganized sector and for induced jobs. While stakeholders in these jobs will be the most impacted by the transition, their geographical dispersal and the lack of data on them makes it challenging for policymakers to support them effectively. This section explores the twin approaches to making the transition just and provides recommendations for the same. A **Just Transition Fund for India** is proposed for funding reskilling initiatives and for financing alternative livelihoods for engendering a just transition.

4.1 RESKILLING OF IMPACTED STAKEHOLDERS

The transition from ICE trucks to ZETs has the potential to exacerbate existing socio-economic challenges unless the principles of just transition are firmly incorporated, given the potential for job losses across the trucking industry's value chain. Reskilling and upskilling for a just transition will require leveraging India's skill development ecosystem.

It is crucial to take stock of the skill set of workers in the existing value chain and the skills required for the ensuing ZET value chain. A gap analysis is fundamental to formulating appropriate strategies for skilling and reskilling.

In addition, improving skills within the informal sector involves addressing challenges such as access to affordable training, ensuring that training programs align with the needs of the informal economy, and overcoming societal and structural barriers that prevent participation in these initiatives.

Adequate skilling and access to capital can provide significant opportunities. It can enable informal sector workers to leverage entrepreneurial opportunities related to ZET battery swapping, waste management, and recycling. With the right support, retail shops and restaurants near trucking clusters can leverage the opportunity to become potential battery charging facilities.

SKILL DEVELOPMENT FRAMEWORK AND TRAINING MODELS

As outlined in Section 3, there are about 8 million direct jobs, 9.4 million indirect jobs and 4 million induced jobs in the trucking industry. Many of these indirect jobs, especially those associated with the ICE powertrain and electronics, will be impacted by the transition to ZETs. However, these are largely formal sector jobs and their workers can be reskilled to work in the ZET value chain. Box 2 highlights an example of how the organized sector can enable skilling in a structured manner.

Box 2. Case study - addressing the skill gap in the formal sector

Aequs Private Limited is a specialized contract manufacturer operating across the automotive, aerospace, and consumer goods sectors.

The aerospace industry has exacting quality requirements that demand a highly skilled workforce. To address this, Aequs takes a structured skilling approach that combines classroom and practical training to quickly train skilled aerospace technicians.

Aequs's Industrial Knowledge Centre provides a structured 30-month training program for fresh engineering graduates. The program is tailored to enhance technical, behavioral, and leadership skills. It includes rigorous instructor-led training and practical, on-the-job learning, ensuring employees master current technologies and processes. Regular skill assessments help refine this training to keep it relevant to industry needs (Aequs, 2023).

Aequs faced several challenges in integrating academic curricula with practical training. Firstly, aligning classroom theory with the specific technical skills required in aerospace manufacturing operations is complex, requiring constant curriculum updates. Secondly, logistical coordination between educational programs and manufacturing schedules is critical to ensure seamless training without disrupting production. Lastly, maintaining quality training that meets industry-specific standards demands ongoing updates and evaluation of content and pedagogy to ensure a productive, agile feedback loop.

Aequs has partnered with Medhavi Skills University and the National Skill Development Corporation (NSDC) to create an innovative 'Learn & Earn' model, integrating academic studies with practical training. This is designed to provide students with real-world experience at the manufacturing facilities of Aequs, while they complete their academic courses in aerospace manufacturing technology, supported by apprenticeship modules from NSDC.

Source: *media reports and company website*

The most vulnerable workers will be those in indirect jobs such as informal sector service mechanics. **Box 3** highlights how skilling can be provided for informal sector participants by highlighting the case of skilling CNG technicians in Delhi.

Box 3. Case study - addressing the skill gap in the informal sector

In response to increasing pollution from diesel-based transport, Delhi pioneered the transition to CNG for public transportation. This not only improved air quality but also spurred a new labor market focused on CNG technology.

The shift to CNG vehicles caused an acute shortage of mechanics trained in the technology. This skill gap was highlighted by several adverse incidents, including fires in CNG buses due to inadequate maintenance. The existing training infrastructure struggled to keep pace with demand, compounded by the inadequacies in the quality of informal training centers.

The approach to bridging this skill gap was multipronged. Initially, vehicle manufacturers assumed the responsibility of maintaining the new CNG fleets under long-term contracts. This provided a temporary solution but underscored the need for reskilling a larger workforce across the value chain. Enhancements in formal training programs within companies and the introduction of public-private partnerships for training informal sector workers were pivotal in ensuring that the transition was supported by a capable and well-trained workforce.

To address the growing need for skilled CNG technicians, a combination of formal and informal training methods has been employed. Industrial Training Institutes in the National Capital Region have adapted their curricula to include specialized training for CNG mechanics. However, the traditional entry requirements based on formal education attainment have proven an entry barrier for many mechanics. Adjusting these criteria to value practical skills and experience over formal education could make the training more accessible and relevant for informal sector workers.

Source: *media reports and stakeholder consultations*

Broadly, there are three skilling models available to help address the skill gap - government-sponsored, market-led, and private sector-led (Figure 12).

Skilling programs funded by central and state governments can be led through bodies like National Skill Development Corporation (NSDC) and State Skill Development Missions. Market-led programs are demand-driven and are offered for a fee to interested candidates and organizations. Private sector-led programs include those run by OEMs themselves for their workforce or those programs which are funded under corporate social responsibility (CSR) by the company.

Figure 12. Skilling models and schemes based on nature of jobs

	Government-sponsored	Market-led	Private sector
Direct (Truck drivers, assistants & fleet owners)	PMKVY – STT & RPL		CSR; OJT
Indirect (manufacturing jobs, service jobs and fuel stations)	PMKVY – STT; NAPS; DDU-GKY	Fee-based training	CSR; OJT
Induced (local restaurants, hotels, retail stores, etc.)	DDU-GKY; Skilling programs offered by other sector skill councils - Tourism & Hospitality and Retail sector.		

Source: *Media reports and government websites*

GOVERNMENT-SPONSORED SKILLING

Government-sponsored programs play an important role where training providers cater to people who cannot otherwise afford the skilling programs.

Existing programs can be leveraged to provide training for the ZET transition. The Pradhan Mantri Kaushal Vikas Yojana (PMKVY) aims to enable Indian youth to acquire industry-relevant skills, thereby facilitating formal employment. The National Apprenticeship Promotion Scheme (NAPS) promotes apprenticeships supported by financial incentives and technological and advocacy support. The Logistics Sector Skill Council (LSC) has introduced apprenticeship-embedded higher education programs, which provide a combination of academic study and practical apprenticeship opportunities under the NAPS. Deen Dayal Upadhyay Grameen Kaushal Yojana (DDU-GKY) offers placement-linked skilling programs in rural areas. The socially inclusive design of DDU-GKY ensures a focus on socially disadvantaged groups. This can enhance the technical skills of informal sector mechanics in ZET across the length and breadth of India.

Incentivizing skilled mechanics in the informal sector to become instructors and mentors can aid in expanding the reach of such training programs. The erstwhile Skill Development Initiative Scheme (SDIS) of the Government of India was one of the first vocational training programs to involve the private sector. Under the SDIS, private players and small garages were offered financial incentives to provide hands-on training to informal sector workers (MSDE, n.d.). Small garages proficient in EV technology and operating in the informal sector can be recognized and incentivized to become training centers for EV mechanics in the informal sector. This would expand the number of training touchpoints for informal sector workers.

MARKET-LED SKILLING

The NSDC has launched a scheme for market-led, fee-based skilling to create an enabling ecosystem for skilling through private sector entities under various models. It has incentivized private players through funded partnerships (equity, loans, and grants) and non-funded partnerships (leveraging the brand name of the NSDC). Since the scheme is linked to market-based incentives, it may not be the most effective for skilling informal sector mechanics at scale. However, it can be leveraged depending on circumstances for training indirect formal sector job holders.

PRIVATE SECTOR-LED SKILLING

Skill development programs can also be spearheaded by OEMs and component manufacturers, thereby training unorganized sector mechanics to be certified service technicians. For example, Hero Electric partnered with ReadyAssist, a roadside assistance company, to train and upskill 20,000 mechanics in servicing electric two-wheelers (Hero Electric, 2022).

The effective implementation of such programs requires a collaborative approach involving many stakeholders. Public-private partnership (PPP) models can leverage the expertise and resources of both the private sector and the government to address reskilling needs effectively.

An example of a PPP model in skilling is that of Maruti Suzuki, the industry leader in the passenger car market, which has established the International Automotive Centre for Excellence as a joint venture with the Government of Gujarat. This center caters to the skill development of students who have completed schooling or who study in Industrial Training Institutes. It also offers a bachelor's program in transportation and mobility. Another example of PPP is that of Ashok Leyland and the Government of Uttarakhand who have signed a memorandum of understanding to facilitate apprenticeships for 1,000 people for three years fostering skill development (Ashok Leyland, 2024).

The Automotive Skill Development Council (ASDC) can function as a vital cog in the just transition process, supported by industry bodies including the Society of Indian Automobile Manufacturers (SIAM), Automobile Component Manufacturers Association of India (ACMA), and FADA. The ASDC has taken steps to meet the evolving demands of the EV industry by launching programs to train technicians as EV service technicians in partnership with Livguard Batteries (ASDC, 2023). The ASDC has also collaborated with Deutsche Gesellschaft für Internationale Zusammenarbeit to develop a short-term training program for EV technicians (ASDC, 2024).

It is important to consider these training initiatives in the broader context of the trucking industry, which is largely unorganized. This presents challenges and opportunities in implementing comprehensive training and upskilling programs. The opportunities include improving competitiveness of the industry by using this transition as a pivot for investing more in skilling, building a broader ecosystem of skilling and connecting multiple initiatives by varied stakeholders. However, certain stakeholders in the ZET transition have requirements that cannot be met by skilling.

Expansion of skilling and support for those stakeholder groups whose needs cannot be met by skilling will require funding. The government can create a Just Transition Fund for India to meet these objectives.

4.2 STRUCTURING A JUST TRANSITION FUND FOR INDIA

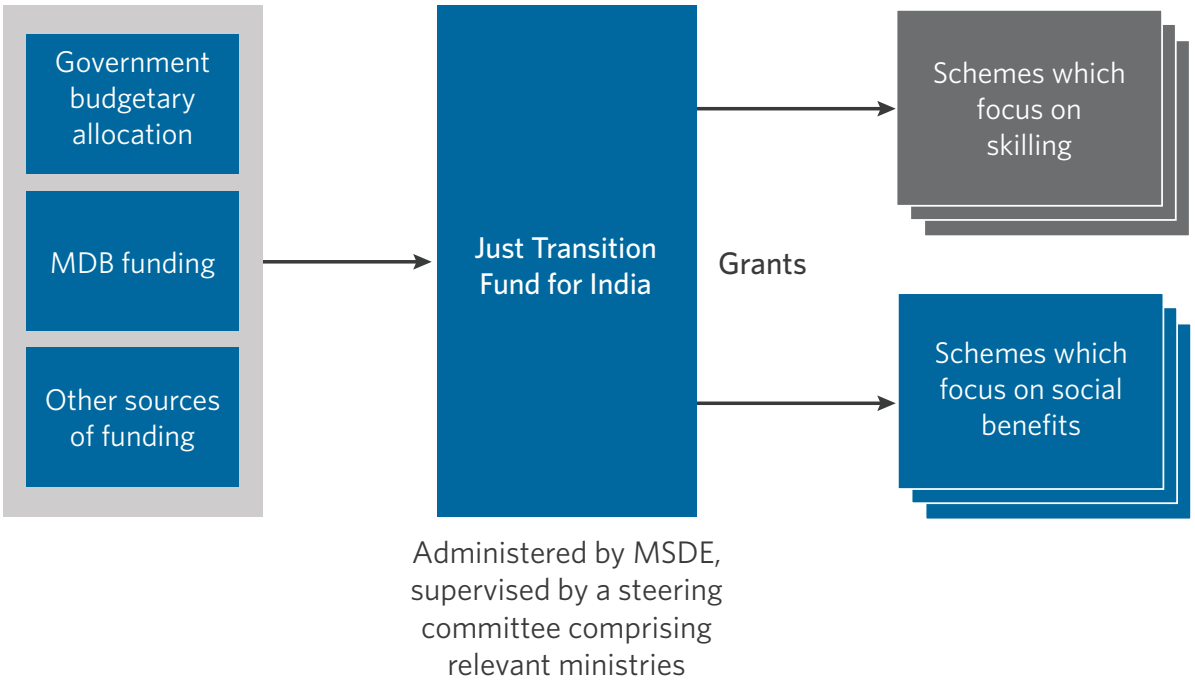
Skilling initiatives for engendering a just transition require funding. Induced job holders who have a marginal existence in trucking clusters will require financial support in the form of grants or low-cost loans to transition to alternative livelihoods. The policy response for such funding needs would be for the government to capitalize a fund to engender a just transition.

A design for a Just Transition Fund for India (JTFI) is provided in Figure 13. The proposed fund would focus both on skilling and financial support for impacted stakeholders. The Ministry of Skill Development and Entrepreneurship is ideally positioned to administer the fund, which can be deployed under the existing schemes of the government.

A broad estimate of the size of the fund is INR 254 billion (USD 3.1 billion)[1] (see Annexure 4). It could be capitalized via the central government budget but could be open to fundraising from other sources such as CSR funds, as well as from multilateral development banks, development finance institutions, and development agencies. The fund allocation would support relevant government schemes which can then reach the ultimate beneficiaries.

A steering committee comprising the MSDE and other relevant ministries could oversee the fund from a sectoral and just transition perspective to ensure optimal allocation. This committee would also monitor key performance indicators of the fund to ensure that its just transition objectives are met. The co-benefits of the transition such as its effects on health, society and the environment can also be monitored. The design also provides flexibility for the funds to be allocated for relevant government schemes and to modify allocation when those schemes are terminated or modified.

Figure 13. Design of a Just Transition Fund



Source: *CPI analysis*

Globally, there are examples of funds dedicated to a just transition. **Box 4** explains the structure of one such fund — the EU Just Transition Fund — which has been structured to incorporate multiple sources of funding and address the just transition needs of multiple stakeholders and industries.

Box 4. The EU Just Transition Fund

Considering the EU's commitment to achieving net zero GHG emissions by 2050, the EU Just Transition Mechanism seeks to alleviate socio-economic impacts in regions reliant on carbon-intensive industries by promoting economic diversification and revitalization. The Mechanism has three pillars: the Just Transition Fund (JTF), Invest EU, and the Public Sector Loan Facility, with an overall financial package of at least EUR 100 billion from 2021 to 2027 (European Commission, 2020)

Just Transition Mechanism

To support and finance people and countries in the EU facing challenges due to the green transition

PILLAR 1

Just Transition Fund will mobilize investments in SMEs, R&D, environmental rehabilitation, clean energy, up/reskilling of workers, and transformation of existing carbon-intensive installations when these investments lead to substantial emission cuts and job losses.

- EUR 7.5 billion under the EU's 2021-27 budget supplemented by national co-financing
- EUR 10 billion from the European Recovery Instrument
- Voluntary contributions by member states from their European Regional Development Fund & European Social Fund Plus allocations

PILLAR 2

InvestEU Fund – the EU's EUR 26.2 Bn budget guarantee program - will provide budgetary guarantee to financial institutions for a wide range of infrastructure projects.

The InvestEU Advisory Hub will provide technical assistance for projects under pillars 2 and 3 of the JTM.

PILLAR 3

Public Sector Loan facility combines EUR 1.5 Bn grants from the EU budget and EUR 10 Bn loans from the European Investment Bank to mobilize public investments.

The JTF strives to ensure a socially fair and equitable clean energy transition (Leppänen & Liefferink, 2022). The JTF, initiated in 2021, will remain operational until 2027 with a total budget of EUR 17.5 billion. It encompasses 15 activities, including backing sustainable investments in technology and enterprises such as support for microenterprises, sustainable tourism, low-emission district heating, and energy storage technologies. It also supports socio-cultural projects addressing energy poverty, culture, education, and community building (EPRC, 2021).

The fund also aims to mitigate the socio-economic costs associated with the energy transition by focusing on environmental restoration, upskilling, and reskilling, and fostering job creation. This includes targeted programs and job-search assistance for affected workers in emerging sectors. The fund is expected to mobilize nearly EUR 30 billion in investments (WRI, 2021).

The allocation to member states is based on five socio-economic criteria, including industrial GHG emissions, employment in industries located in regions with low carbon intensity, employment in coal and lignite mining, peat production, and oil shale and oil sands production (EPRC, 2021). The EU budgetary spending on the JTF will be complemented by national co-financing. (European Commission, 2021).

The JTF plays a pivotal role in the European Green Deal and represents a significant step towards addressing the socio-economic challenges of transitioning to a low-carbon economy.

The proposed JTFI could cover the reskilling needs of the formal and informal sectors in the trucking industry by providing grants to relevant government schemes (e.g., the PMKVY) and departments (such as the ASDC). Mechanisms can be evolved for ring-fencing funding to ensure that it is used primarily to engender a just transition in the trucking sector.

For those highly vulnerable stakeholders who cannot benefit from reskilling (induced jobs which are primarily in the informal sector), the fund could provide grants to various government schemes such as the MUDRA loan scheme. The ultimate beneficiaries could receive funds in the form of grants or concessional loans. In the case of the latter, the grants from the fund can be blended with other sources of debt to achieve concessional interest rates.

5. CONCLUSION AND NEXT STEPS

For effecting a just transition to ZETs, both skilling, and financing are critical to ensure adequate skills in the labor force and the development of alternative livelihoods. This report quantifies the implications of a just transition to zero-emission trucking in India. It lays the groundwork for calculating socio-economic costs and investment requirements for engendering a just transition in line with India's climate related targets.

The next step for enabling a just transition in this sector could be to identify impacted stakeholders and understand their needs in greater detail. This can be followed by the design of targeted policy responses, financial instruments and other mechanisms to address their needs and to enable co-benefits. Obtaining stakeholder feedback can help get their buy-in by helping them recognize the benefits of such interventions in the face of the challenges they face due to the transition. Pilot programs can be conducted to help refine the design of these interventions. The just transition financing facility can then be designed to act as a conduit for the flow of finance for a just transition.

ANNEXURES

ANNEXURE 1: VEHICLE CATEGORIZATION

There are multiple methods of categorizing trucks including the Ministry of Road Transport and Highways (MoRTH) and Society of Indian Automobile Manufacturers (SIAM) classifications.

Commercial vehicles, as categorized by MoRTH, are divided into two main groups: transport and non-transport. Transport vehicles, primarily designed for commercial purposes, encompass freight vehicles like multi-axle/articulated vehicles, trucks, lorries, and light commercial vehicles. Vehicles such as tractors and trailers are in the non-transport category, despite their use in transporting goods such as construction materials and agricultural produce. Within the transport vehicle category, multi-axle/articulated vehicles, trucks, and lorries are further classified as medium or heavy commercial vehicles (M/HDVs) based on their tonnage and gross vehicle weight (GVW). Category N encompasses all power-driven vehicles with at least four wheels used for the carriage of goods. These vehicle categories are laid out in Table A1 below.

Table A1. MoRTH categorization of trucks

Segment	GVW range, in tonnes	Category	Prefixes
LCV	GVW ≤ 3.5	N1	N1A
MDV	3.5 < GVW ≤ 7.5	N2	N2A
	7.5 < GVW ≤ 12	N2	N2B
HDV	12 < GVW ≤ 18.5	N3 2 Axle Rigid	N3A
	18.5 < GVW ≤ 28	N3 Multi Axle Rigid	N3B
	28 < GVW ≤ 49	N3 Multi Axle Rigid	N3C
	30 < GVW ≤ 55	N3 Tractor	N3D

Source: *AIS-017 (Part 6)/D5 Apr 2019 and MoRTH*

Globally, there is no universal definition of truck categories. In the EU, distinctions like N2 (vehicles weighing more than 3.5 tons) and N3 (vehicles weighing more than 16 tons) are employed, while China commonly classifies vehicles as light-duty (3.5-7.5 tons), medium-duty (7.5-12 tons), and heavy-duty (more than 12 tons) (GIZ, 2020).

In this report, the MoRTH segment categorization is followed.

ANNEXURE 2: TRUCKING CLUSTERS AND SURVEY METHODOLOGY

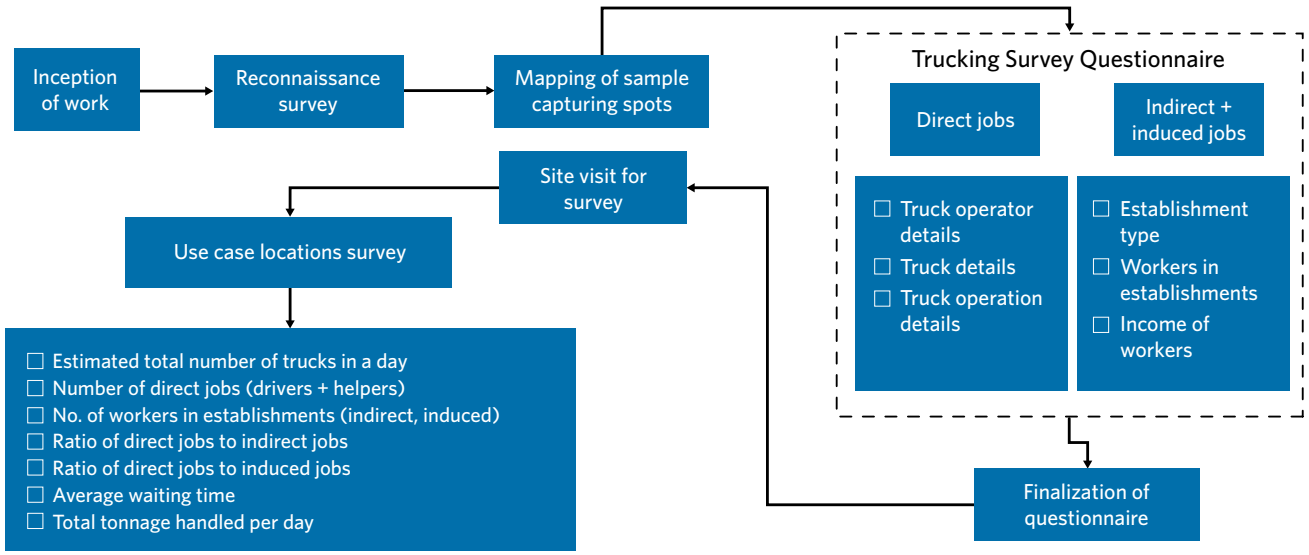
A survey was conducted at 10 major trucking clusters across India, as listed in Table A2. The survey sites include five types of use cases: inland container depot (ICD), port, agri mandi (wholesale market), truck terminal, and transport nagar.

Table A2. Survey locations

#	SITE	LOCATION	USE-CATEGORY
1	ICD Tughlaqabad	Delhi	ICD
2	MIHAN	Nagpur	ICD
3	Azadpur Mandi	Delhi	Agri Mandi
4	Koyambedu Market	Chennai	Agri Mandi
5	JNPT	Mumbai	Port
6	Haldia Port	Kolkata	Port
7	D Devraj Urs Truck Terminal Yeshavntapura	Bengaluru	Truck terminal
8	Jagatpur Truck Terminal	Cuttack	Truck terminal
9	Madhavaram Truck Terminal	Chennai	Truck terminal
10	Sanjay Gandhi Transport Nagar	Delhi	Truck Terminal + Truck Building Cluster

The survey methodology is summarized in Figure A1. First, a reconnaissance survey was conducted at sites to map sampled locations. These include off- and on-street truck parking areas and establishments (e.g., warehouses, workshops, restaurants, shops, street vendors, etc.) where drivers spend money either to get truck-related work done or for personal consumption (e.g., food, clothes, water, tea, sweets, medicine).

Figure A1. Survey methodology



QUESTIONNAIRE DESIGN

The trucking survey questionnaire was prepared in two sections to encompass three categories of employment: direct, indirect, and induced. An extensive literature review was conducted on these employment types to establish precise definitions for the project.

Direct Jobs (for drivers): The direct jobs survey includes questions for drivers on details of their truck operator, truck, and its operations (Table A3).

Table A3. Information gathered and output in the survey of direct jobs

S. No.	Input received from survey	Output
1	Gross Vehicle Weight of truck	Truck GVW (tonnes)
2	Daily distance covered by truck	Average km covered per day (by truck type)
3	Salary of driver	Average income of driver (INR per month)
4	Salary of helper	Average income of helper (INR per month)
5	Waiting hours	Typical time of stay at location

Indirect and induced jobs (for establishments): The establishment survey includes questions on establishment type, enterprise sub-category, scale of establishment, skill and range of education level of workers, workers in establishments, income of workers and estimated number of establishments at the activity location. This provided the outputs shown in Table A4.

Table A4. Information gathered and output in the survey of establishments

S. No.	Input received from survey	Output
1	Enterprise sub-category	Establishment's activities description
2	Estimated number of establishments at the activity location	Estimated total number of establishments
3	Number of workers (total & full time)	Estimated number of workers in establishments
		Estimated percentage of full-time workers
4	Average annual/monthly income of workers (INR)	Average income of workers (INR per month) in establishments
5	Total number of workers / total estimated number of establishments	Number of workers per establishment

The direct jobs survey and establishment survey provided information on the number of direct, (informal) indirect and induced jobs in these trucking clusters. Using this data, subsequent calculations are made to arrive at the ratio between direct and indirect jobs and direct and induced jobs.

ANNEXURE 3: METHODOLOGY FOR ZET FORECAST

SCENARIOS

The ZET forecast has been derived considering two scenarios. Scenario 1 considers a business-as-usual trajectory with no major policies introduced to improve ZET penetration. Scenario 2 considers an ambitious trajectory with sector-specific policies in line with the government's net-zero and climate targets.

PERIOD OF ANALYSIS

The period of analysis for this exercise is from FY 2024 to FY 2040. Three growth periods have been built within the timeframe of the sales forecast with 2030, 2035 and 2040 being assumed as the tipping points, and have been termed as Current Policy phase (FY 2024 to FY 2030), Growth Phase 1 (FY 2031 to FY 2035) and Growth Phase 2 (FY 2036 to FY 2040).

While the sales between FY 2024 and FY 2030 are assumed to be driven solely due to current policies of the government, there is a multiplier effect in the period beyond 2030 due to factors such as reduced TCO due to reducing battery prices and improvement in cell chemistries. In addition, rising diesel prices will have a positive impact on ZET sales once TCO parity is achieved for trucks.

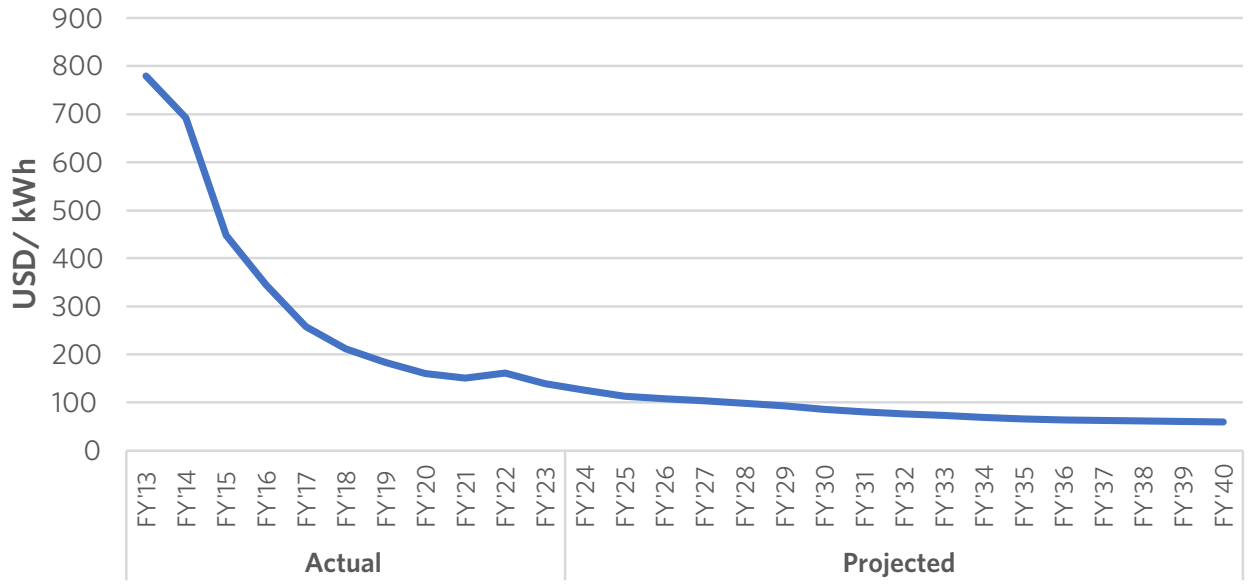
VEHICLE SEGMENTS

The analysis has been performed for Light Commercial Vehicles (LCVs), Medium Duty Vehicles (MDVs), and Heavy-Duty Vehicles (HDVs).

DRIVERS OF GROWTH

- **Cost of Battery:** The cost of lithium-ion batteries is forecasted to come down from USD 139 in 2023 to about USD 85/ kWh in 2030 and USD 59/ kWh in 2040.

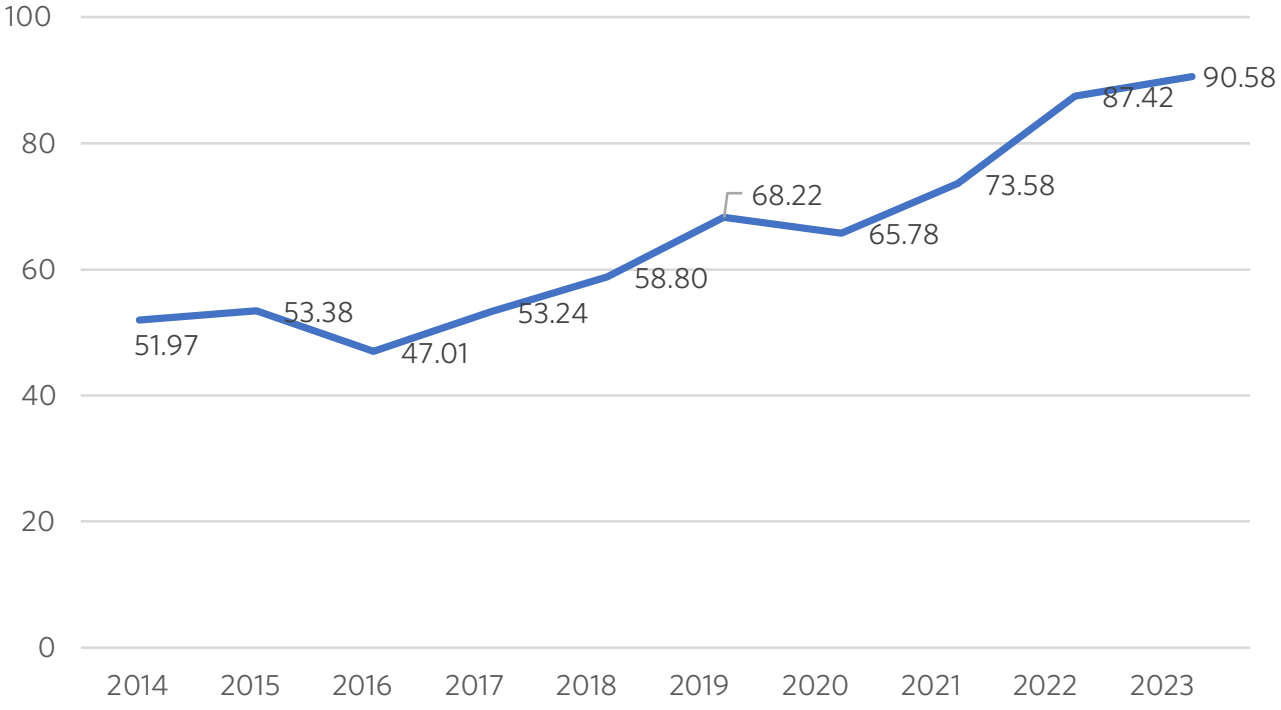
Figure A2. Historical and projected cost of Li-ion battery packs



Source: *(BloombergNEF, 2023), CPI Analysis*

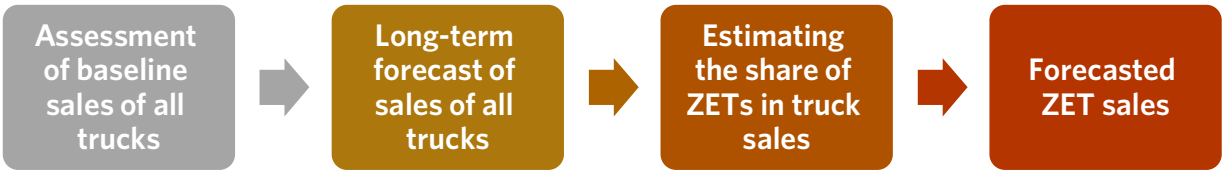
- **Diesel Price:** The average growth rate of diesel price in India is estimated to be 6.37% between FY 2014 and FY 2023 and this is anticipated to increase during the analysis period.

Figure A3. Diesel prices (INR/liter)



Source: *PPAC*

APPROACH



The sales data of trucks in India have been compiled from primary data from FADA. As the historical data for segment-wise sales of trucks in the state of Telangana is not available in the public domain, the same was estimated and pro-rated to the truck sales data at the national level.

Industrial and manufacturing activities play a vital role in the growth of the truck market in India. The sales projection until FY 2040 has been done using the CAGR of the Index of Industrial Production (IIP) from FY 2014 to FY 2023 (Table A5). The IIP of different goods has been considered for the three segments based on the respective use cases. For LCVs, the IIP of non-durable consumer goods has been considered owing to the predominant use of LCVs in last-mile deliveries of fast-moving consumer goods and consumable goods associated with e-commerce. For M/HDVs, the IIP of intermediate goods (B2B deliveries), infrastructure and construction goods has been considered to project the sales until FY 2040.

Table A5. The growth rate of sales in truck segments

Segment	FY'15-FY'23 (CAGR)	FY'24-FY'40 (CAGR projection based on IIP)
Truck	4.54%	3.52%
LCV	4.68%	3.33%
MDV	5.70%	3.81%
HDV	4.05%	3.81%

The inputs shown in Table A6 have been factored in the baseline truck sales numbers to arrive at the forecasted ZET sales in each of the analysis intervals.

Table A6. Inputs for baseline ZET sales numbers

Driver inputs	Scenario	Vehicle segment	Current policy (FY'24-FY'30)	Growth phase 1 (FY'31-FY'35)	Growth phase 2 (FY'36-FY'40)
Target rate of sales by end of period ($R_{t)}$	1	LCV	5%	10%	20%
		M/HDV	1.5%	3%	6%
	2	LCV	10%	15%	25%
		M/HDV	3%	6%	12%
Battery multiplier (M_b)	1,2	All	0	0.2	0.1
Diesel multiplier (M_d)	1,2	All	0	0.23	0.23

Formula for calculating the forecasted sales:

$$\mathbf{S_F} = (S_B{}^*R_t) \times (1+M_b+M_d)$$

Where,

S_F = forecasted sales for the fiscal year

S_B = baseline forecasted sales for fiscal year

R_t = target rate of sales by the end of period

M_b = multiplier for incremental sales due to decline in battery prices

M_d = multiplier for incremental sales due to an increase in diesel price

ANNEXURE 4: ESTIMATE OF THE SIZE OF THE PROPOSED JUST TRANSITION FUND FOR INDIA

There are an estimated 9.4 million indirect jobs in the trucking sector, of which the informal sector accounts for around 5.6 million and the formal sector for 3.8 million. It is estimated that 63% of the automotive workforce will be impacted by the transition (CEEW, 2019). Assuming the cost of reskilling per worker in the formal sector is INR 50,000 (USD 602)[1] and that in the informal sector is INR 15,000 (USD 181)[1], if 50% of the indirect jobs are impacted by the transition, the cost of reskilling would be INR 137 billion (USD 1.65 billion)[1] (Table A7).

Table A7. Cost of reskilling of indirect job holders

Percentage of indirect jobs impacted by ZET transition	50%	60%	70%	80%
Cost of reskilling of impacted workers in the formal sector (in INR billion)	95	114	133	152
Cost of reskilling of impacted workers in the informal sector (in INR billion)	42	50	59	67
Total cost of reskilling for impacted indirect job holders (in INR billion)	**137**	**164**	**192**	**219**

The number of induced jobs related to the trucking sector is estimated at around 4 million. If we assume a 50% split between individual jobs (proprietorships) and small businesses, which employ three people on average, this leads to 2 million individual proprietors and 0.67 million small businesses. Assuming the individual proprietorships avail INR 50,000 (USD 602)[1] in loans on average and small businesses avail INR 200,000 (USD 2,410)[1] in loans on average under the MUDRA scheme, Table A8 provides an estimate of the quantum of loans required for induced job holders to ensure they establish alternative livelihoods.

Table A8. Quantum of loans for impacted induced job holders

Percentage of induced jobs that will be impacted by the transition	50%	60%	70%	80%
Amount of loan that would be required by individuals (in INR billion)	50	60	70	80
Amount of loan that would be required by small enterprises (in INR billion)	67	80	93	107
Total loan amount required by impacted induced job holders (in INR billion)	**117**	**140**	**163**	**187**

Assuming that 50% of indirect job holders and 50% of induced job holders are impacted, an amount of INR 254 billion will be required to capitalize the JTFI.

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