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Comprehensive Guide to Financing the Zero-Emission Trucking Transition in India

Report / September 2024

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About RMI

RMI is an independent nonprofit, founded in 1982 as Rocky Mountain Institute, that transforms global energy systems through market-driven solutions to align with a 1.5°C future and secure a clean, prosperous, zero-carbon future for all. We work in the world's most critical geographies and engage businesses, policymakers, communities, and NGOs to identify and scale energy system interventions that will cut greenhouse gas emissions at least 50 percent by 2030. RMI has offices in Basalt and Boulder, Colorado; New York City; Oakland, California; Washington, D.C.; Abuja, Nigeria; and Beijing. RMI has been supporting India's mobility and energy transition since 2016.

Executive Summary

As India works to achieve its net-zero goals and address the pressing challenges of climate change, transportation has emerged as a pivotal sector for transformative action. Considering the trucking sector's significant contribution to carbon emissions, transitioning to zero-emission trucks (ZETs) is imperative. However, the high upfront costs of ZETs, associated infrastructure, grid upgrades and investment risks in a nascent market — such as technology and demand uncertainties — underscore the need for proactive measures to mobilise finance. Collaborative effort among the government, industry leaders and financiers is essential to ensure India realises the long-term socio-economic benefits of adopting ZETs.

Financial tools such as concessional debt, equity and viability gap funding can kickstart the ZET market until the revenue generated from owning and operating ZETs and the necessary charging infrastructure becomes profitable. These tools can narrow the total cost of ownership (TCO) gap, stimulate demand, expedite mass production and attract private sector investment to foster market growth.

The exhibit below describes how suggested financial tools can be implemented to finance ZET purchase, manufacturing, charging infrastructure installation and requisite grid upgrade to seed the nascent ZET market.

Exhibit 1 **Suggested Financing Tools and Potential Implementation Framework**

Financial Tools		Potential Implementation Framework
Debt	**Concessional debt:** Below-market-rate financing provided by lending institutions	**ZET purchase:** Multilateral development banks (MDBs) and development finance institutions (DFIs) can provide concessional debt to local financiers, and funds can be on-lend to purchase ZETs. Local financiers need long-term capital to provide an extended tenure and low-interest loans for ZET purchases. **Requisite grid upgrade:** Public sector undertakings such as the Power Finance Corporation Ltd. can offer distribution companies (DISCOMs) loan products for line extensions from substations to charging stations.[1]
	Green bonds: Bonds issued by governments, MDBs or companies; investment vehicles that pay investors a fixed rate of return over a specified period	**Charging infrastructure and requisite grid upgrade:** The government can issue green bonds to raise funds for investment for requisite ZET public charging and/or grid upgrades. Under India's Sovereign Green Bonds framework, eligible projects include clean transportation and deployment of charging infrastructure.[2]
	Commercial loans: For ZETs, asset-based financing and commercial lending extended to charging infrastructure providers	**ZET purchase**: There is a need for asset-based loans, where the ZET is the loan collateral, as opposed to fleets taking small business loans or using corporate finance. Banks and nonbanking financial companies (NBFCs) can pilot asset-based financing models for ZETs as the market matures. **Charging infrastructure**: It is essential to refine the financing model for charging infrastructure projects to accommodate long durations, given the extended timeframe required for these projects to become profitable, such as initiating loans with 15-year tenure.
Risk-sharing facilities	**Loan guarantees:** Financial coverage provided to a lender in case of loss	**ZET purchase**: DFIs such as SIDBI, with support from MDBs or philanthropists, can set up a risk-sharing facility covering a share of loss given default.[i]
Equity	**Concessional equity:** Pertains to equity with return expectations below that typically anticipated by market investors	**Charging infrastructure**: The Green Climate Fund or MDBs can establish a financing platform to attract additional private equity investment into the ZET ecosystem.[3]

[i] First loss: This guarantee ensures coverage for a pre-determined initial loss incurred by the borrower on their loans

Exhibit 1 Suggested Financing Tools and Potential Implementation Framework (Continued)

Financial Tools		Potential Implementation Framework
Viability gap financing[ii]	**Purchase incentives:** Offered to defray the initial capital cost of ZET procurement	**ZET purchase**: The Government of India extends ZET purchase incentives for the first several thousand ZETs to drive initial ZET adoption and close the capital cost gap between ZETs and diesel vehicles during initial deployment from 2024 to 2027.
	Grants: Financial assistance provided for specified upgrades and projects that generate public benefitW	**Requisite grid infrastructure**: The government can allocate grants through central sector schemes to fund line extensions and transformer upgrades. Such funding and concessions reduce DISCOMs and charge point operators' (CPO) liability, lowering the electricity cost for ZET charging. **Manufacturing**: Research and development grants can be provided to original equipment manufacturers (OEMs), including small and medium enterprises, to fund innovation in the ZET and charging infrastructure.
	Viability gap funding[iii]**:** Funding to bridge the gap between total project cost and expected revenue for public–private partnership (PPP) projects	**Charging infrastructure**: The Ministry of Finance could extend its existing VGF to offset the revenue-to-cost gap incurred by charge point operators (CPOs) through a one-time grant to develop public charging projects.
Favourable tax treatment	**Government waivers and tax incentives:** Concessions made on taxes, tolls and land	**ZET purchase**: State governments can provide ZET operators exemptions on road taxes, registration costs and toll waivers, reducing the operational costs of ZETs. Such incentives can be gradually phased out as ZET deployment increases. **Charging infrastructure**: Land concessions can be provided for public charging, making public land available for a concessional lease.

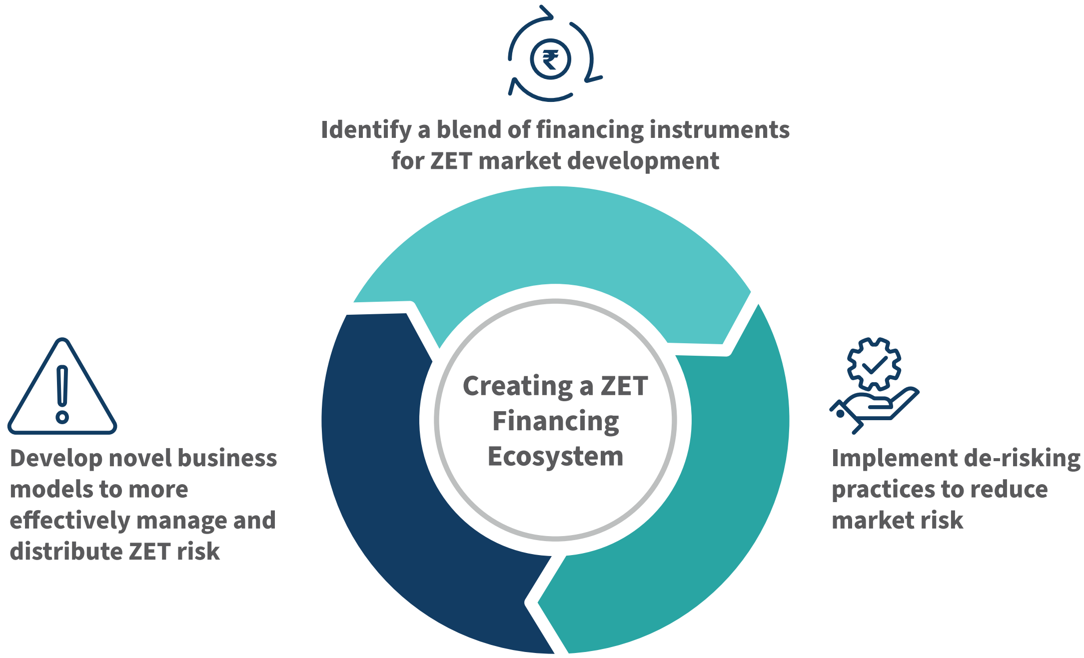
In addition to financial tools, other mechanisms can reduce ZET operational expenses. ZET-specific business models such as leasing, mobility-as-a-service, insurance and warranty development can help manage risks and facilitate the deployment of ZETs in the near term. Implementing complementary de-risking practices such as demand aggregation, ZET corridor development, reduced information asymmetry and aftermarket support can boost market confidence and create a favourable investment environment. These measures mitigate risks linked to ZET capital and operational expenditure, especially in the initial period.

[ii] Viability gap financing is a government budgetary allocation in the form of grants or incentives for ZET purchase, manufacturing, charging infrastructure development and requisite grid infrastructure development. It is also used to close the funding based on the expected cost and revenue expectations as per terms and conditions.

[iii] As per the Ministry of Finance guidelines, viability gap funding bridges the gap between total project cost and expected revenue for PPP projects of the government. "Viability Gap Funding (VGF) Guidelines." Accessed January 29, 2024. https://www.pppinindia.gov.in/report/vgf-guideline_1691500048.pdf.

Exhibit 2 Creating a ZET Financing Ecosystem

Government entities, financiers, OEMs, fleet operators, infrastructure providers and DISCOMs help initiate ZET market development. This report provides stakeholders a roadmap outlining steps and collaborative strategies to transition to ZETs while addressing financial intricacies. Collective action will empower market actors to overcome risks associated with financing ZETs, driving investment in the ZET market.



Background

Financing is crucial for the transition to zero-emission trucks (ZETs). Financial strategies must reduce risk and improve credit access for original equipment manufacturers (OEMs), charging infrastructure providers and fleet operators.

Currently, diesel trucks are well supported by banks and nonbanking financial companies (NBFCs) with asset-based commercial loans and used vehicle financing. However, given the ZET market's nascency, financing options for ZETs are still evolving and expected to develop gradually. As the ZET market expands and these vehicles are manufactured in high volumes, actors are likely to encounter financing hurdles, given that financiers may be cautious about assuming the asset and residual value risks associated with emerging asset classes such as ZETs. Moreover, the existing petrol and diesel stations largely meet the refuelling demand and require limited investment. However, the ZET market requires significant investment in charging infrastructure and requisite grid upgrades, increasing the cost and risk. Subsequently, tailored financial tools and market interventions are essential for mobilising capital to initiate the ZET transition.

This report establishes a comprehensive framework for stakeholders to mobilise ZET financing in India. It begins by providing an overview of the ZET market's current state, highlighting key risks associated with four segments: ZET purchase, manufacturing, charging infrastructure development and requisite grid upgrades. Following this, the report underscores the scale of financing required, financial tools, business models and de-risking practices that can increase capital flows to ZETs while mitigating risks to invested capital. It then details the economics of differing early-moving use cases and role of various stakeholders, including financiers, OEMs, fleet operators and policymakers in enhancing ZET financing. Finally, this report focuses on plug-in charging as a refuelling technology when referring to and costing out requisite infrastructure needs, given its market maturity and ease of incremental deployment. For a comprehensive exploration of ZET technologies beyond plug-in charging, refer to the **Technology Assessment of Zero-Emission trucking on the Delhi-Jaipur corridor**.

ZET ecosystem landscape

The road freight sector is expected to grow exponentially in the coming decades, with a fivefold increase in goods transported by 2050.[4] This underscores the importance of using ZETs to meet the impending freight demand. India could have as many as 0.7 lakh ZETs on the ground by 2030, and these trucks can represent over 50% of the total stock with supportive policy and financing by 2050.[5] In navigating this evolving landscape, a nuanced understanding of key stakeholders becomes paramount, as their collective endeavours will shape the trajectory of India's ZET transition. Notably, in the realm of ZET financing, key stakeholders encompass government ministries, OEMs, infrastructure providers, distribution companies (DISCOMs), banks and NBFCs.

Government: Government bodies play a crucial role in signalling policy direction and allocating financial resources to bolster economic development goals, including ZET adoption. The Ministry of Road, Transport and Highways (MoRTH) oversees regulations and policies related to road transport, logistics efficiency, road infrastructure and transport emissions. The Ministry of Finance is central to mobilising public financing and encouraging investments to spur the ZET transition. The Ministry of Power (MoP) aids in developing public charging infrastructure and requisite grid infrastructure, such as transformers and substations, allocating funds for ZET initiatives. The Department of Heavy Industry (DHI) provides financial incentives and technical assistance by extending schemes such as the Faster Adoption and Manufacturing of Electric Vehicles and the Production Linked Incentive scheme to incentivise ZET manufacturing and adoption. Finally, state and city governments play a crucial role in implementing ZETs in regional electric vehicle (EV) policies and deploying charging infrastructure.

Original equipment manufacturers: The major manufacturers in the trucking sector — Tata Motors, Ashok Leyland and Volvo Echier — dominate with over 85% share in the diesel truck market. However, the shift to ZETs may diversify the OEM marketplace.[6] Startups and subsidiaries such as IPLTech, Olectra and Kalyani Powertrain are introducing ZET models, while established national and international trucking players such as Volvo Trucks, Ashok Leyland and Tata Motors manufacture and pilot zero and low-carbon emission trucks in India.

Fleets: India's trucking market is highly fragmented, with 75% of the fleets owning fewer than five trucks.[7] Small fleet operators own and sometimes operate the trucks, whereas large fleet operators own the trucks and hire drivers for operations. However, small operators lack access to capital and operational expertise, making ZETs difficult to access. Furthermore, low margins and profits of small fleets leave little room for these actors to consider paying a premium for ZETs. In contrast, large operators with superior capital access can finance ZETs, achieving an early breakeven through enhanced utilisation and operational savings. They are also more inclined to prioritise environmental, social and governance (ESG) considerations in fleet upgrades and goods movement strategies.

Charging point operators (CPOs): India has a growing number of charging infrastructure providers such as Sun Mobility (battery swapping provider), Magenta Group, Charge Zone and Statiq actively deploying stations. In addition to battery charging, a series of players are investing in and exploring the viability of hydrogen and liquid natural gas refuelling technologies for trucking applications. While most of them target urban areas for two-wheelers, three-wheelers and cars, with limited attention to electric buses (e-buses), focus on developing heavy-duty charging infrastructure along highways has increased. For example, Charge Zone aims to establish a network comprising 5,000 fast chargers along state and national highways by 2025. This high-speed supercharging infrastructure will accommodate over 75,000 EVs daily, including ZETs.[8]

The Ministry of Heavy Industries (MHI) actively promotes heavy-duty EV charging in India. It has sanctioned 1,576 EV charging stations across 16 highways and 9 expressways, mandating at least 1 fast charging station every 100 kilometres for long-range and/or heavy-duty EVs.[9] These requirements and deployment of such charging stations will facilitate access to the charging infrastructure suitable for ZETs, given their large battery packs and need for high-power capacity charging.

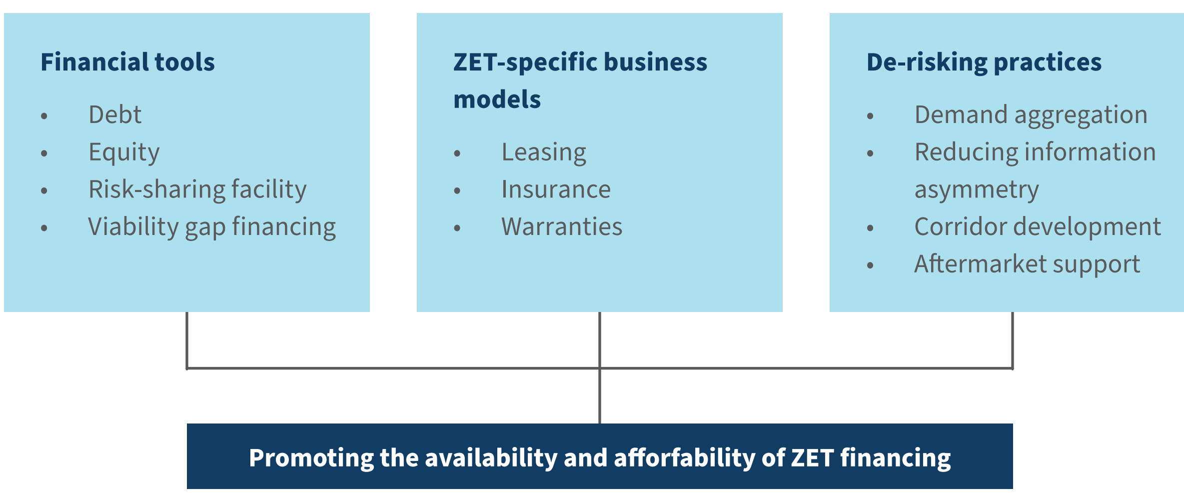
Distribution companies (DISCOMs): The grid system comprises a complex network of generator plants, transmission lines, substations and distribution systems. DISCOMs manage and operate distribution networks to provide power to end consumers. Given the anticipated power demand from ZETs, it is crucial to assess the capability of the existing infrastructure to support ZET charging. For the near term (within approximately five years), generation and transmission capacity is generally adequate; however, power availability and quality issues should be addressed at the distribution level. Collaboration with DISCOMs is essential for creating frameworks and action plans to manage the anticipated charging load from ZETs and facilitate a smooth transition to sustainable energy sources.

Banks and nonbanking financial companies: Numerous financiers offer commercial vehicle loans for internal combustion engine (ICE) trucks, with banks and NBFCs being the primary players. The banking sector encompasses public sector undertaking (PSU) banks (State Bank of India and Bank of India) and private sector banks (HDFC and ICICI). Private sector banks typically focus on large-scale financial transactions for fleets in urban areas, while PSUs offer long-duration loans (up to 84 months) in urban and rural areas.[10] NBFCs operate either as captive or noncaptive vehicle financiers. Captive vehicle financiers[iv], often owned by OEMs, offer financing to facilitate the sale of specific OEM vehicles and provide loans for the products of other OEMs.[11]

Banks and NBFCs are studying the ZET market and will evaluate appropriate financing options as ZET products enter the market. As the market expands, banks and NBFCs may be well positioned to extend credit lines to ZETs, given their financial relationships, enabling them to tailor existing commercial credit lines for trucking procurement. Additionally, banks have experience in underwriting fleet operators, which are more likely to procure ZETs initially. Once the performance of ZET products and after-sales service are established, NBFCs and banks will be better positioned to finance ZETs, leveraging their existing network of small fleet operators to extend lending to these actors.

Various entities, including government bodies, financiers, OEMs, fleet operators, infrastructure providers and DISCOMs, play crucial roles in kickstarting the development of the ZET market. This report serves as a guide for stakeholders, offering a clear roadmap and collaborative strategies to transition to ZETs by addressing the complex financial aspects involved. By developing ZET-specific financial tools, business models and de-risking practices, market participants can mitigate the risks associated with financing ZETs, thereby fostering investment in this burgeoning market.

Exhibit 3 Three Levers to Promote ZET Financing



[iv] Captive vehicle financiers tie up with specific OEMs (outside their product) but are not necessarily open to financing all OEMs; https://psa.gov.in/CMS/web/sites/default/files/publication/RMI-EVreport-VF_28_1_21.pdf.

Existing barriers in ZET ecosystem

The adoption rate of ZETs remains low despite the inherent advantages they offer, primarily due to lack of available ZET models, insufficient infrastructure and unprepared grid system. These challenges are interlinked with and stem from high costs and lack of favourable financial mechanisms.

- **High upfront costs and unfavourable ZET lending terms**: The capital costs of ZETs are four to five times higher than those of their diesel counterparts. Financing for ZETs is scarce with no asset-based loans available for ZETs, as financiers are hesitant to underwrite the product and residual risks associated with ZETs. Consequently, financing ZETs as a standalone asset is not common practice. Financing for a ZET is offered at high interest rates and typically comes as a business loan. Additionally, the absence of warranties, guarantees and aftermarket support for ZETs exacerbates the financial barriers faced by potential adopters.

- **High manufacturing costs associated with nascent technology**: Establishing ZET manufacturing is crucial to kickstarting the ZET market by providing affordable models that match freight duty cycles, thus driving demand. However, there is no ZET supply due to high R&D and production costs, technological uncertainties and lack of stable demand to produce at scale.

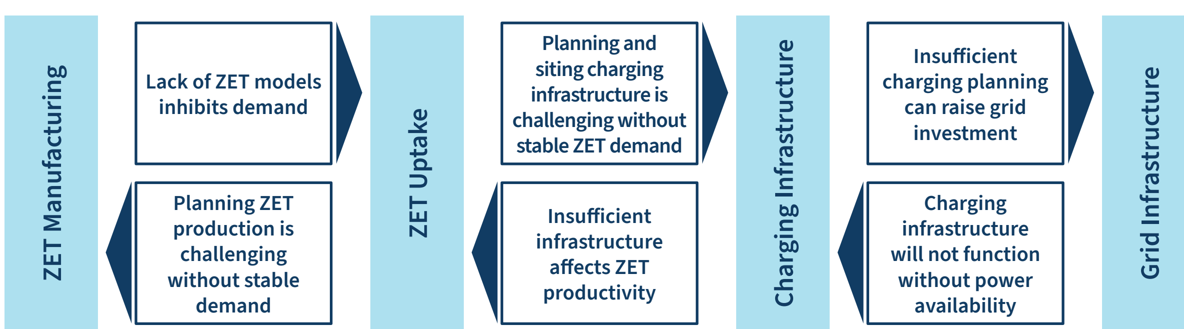
- **High cost of charging infrastructure**: The nascent and costly nature of charging infrastructure required for ZETs and capital costs of installation pose a significant challenge. Lack of clear demand visibility and sector-wide charging technology further complicates the utilisation and financial viability of the infrastructure.

- **High costs of grid upgrades**: The availability of power is crucial to meet the high power demands of truck charging. Enhancing power availability comes with significant expenses and potential delays in permitting and licensing. This also demands an extended planning period and adds to the already substantial costs.

The abovementioned challenges are inherently interrelated, as lack of available ZET models and insufficient infrastructure eliminates confidence and demand in the market. These demand issues present significant challenges for OEMs in establishing consistent production facilities and for infrastructure providers in effectively planning and deploying infrastructure projects.

Moreover, inadequate planning and foresight around the deployment of charging loads lead to grid unpreparedness and challenges in managing increased loads. This interconnectedness underscores the importance of adopting a comprehensive and coordinated strategy to tackle these challenges. It involves acknowledging their interdependencies and devising thorough solutions to realise the complete potential of the ZET ecosystem.

Exhibit 4 Interrelationships of ZET Market Segments and Associated Risks



ZET market risk assessment

Each market segment in the ZET ecosystem – ZET manufacturing, ZET demand, charging infrastructure and grid infrastructure – encompasses distinct factors and risks inherent to its operations and future scalability. Understanding the underlying risks within each market segment is crucial for more efficient risk management and mitigation. These risks can be broadly defined as asset, business model and customer risks. Asset risks stem from performance concerns regarding ZETs, charging infrastructure or other ancillary electrical equipment and lack of residual value for these trucks. Business model risks pertain to truck utilisation, paucity of aftermarket support, technology obsolescence and overall operability of a specific ZET segment. Customer risks arise from the ability of ZET borrowers to repay their loans and emergence of technology startups in the ZET ecosystem. The following section identifies specific risks, enabling financiers and ZET market participants to develop a more nuanced understanding of the financing ecosystem.

Risk assessment for ZET purchase: Given the early stage of the ZET market, uncertainty shrouds its technology performance. Furthermore, the high cost of ZETs and absence of a resale market contribute to the financial risks associated with ZET demand and deployment. Maintenance challenges arising from shortage of skilled technicians, market disaggregation with numerous small fleet operators and prevalence of customers new to credit contribute to the lending risk.

Exhibit 5 ZET Demand and Purchase Risk Assessment

Risk Type	Description
Customer risk	The trucking market predominantly comprises small owner-operators often lacking formal credit histories, and new-to-credit customers are generally considered a more risk-prone segment. Small owner-operators are susceptible to market volatility and do not have the capital to bear disruptions in revenue generation, making it challenging to sustain loan payments during business fluctuations.
Lack of battery interoperability	No standardisation in battery packs poses risks due to compatibility issues, safety concerns and market fragmentation. Batteries are currently not interchangeable across model or vehicle types. Uncertainty regarding resale applications and inability to scale manufacturing can slow the adoption of battery-powered technologies.
Technology obsolescence	Technology risks arise from concerns about the vehicle's performance and long-term operability and durability of key components such as batteries. Various battery chemistries exist, and no single type has emerged as superior, leading to variations in cell performance depending on the battery type and manufacturer. Additionally, ZET technologies include battery-electric trucks, hydrogen fuel cells and hydrogen combustion trucks. Given the emergent nature of all technology types, there is a perceived and real risk that a particular technology might become outdated, leading to high sunk costs.

Exhibit 5 ZET Demand and Purchase Risk Assessment (Continued)

Risk Type	Description
Absence of secondary market	Today, trucks in India have been operating for as long as 20 years and have had two or more owners throughout their lives. Given a truck's prolonged life, the secondary or used truck market is a core component of today's trucking sector. The absence of a secondary market for ZETs and batteries poses a risk for financiers and demand purchasers regarding their ability to resell the vehicle or reclaim the value in case of default.
No maintenance technicians	Lack of skilled maintenance technicians for ZETs can present complications in case of mechanical failure, rendering a truck inoperable for prolonged periods and affecting its productivity and operations.
Utilisation risk	The utilisation of a ZET is crucial, as long distances travelled represent a great opportunity to capitalise on its operational savings. The inability of truck operators to adequately utilise ZETs due to limited ability to access charging or prolonged charging times presents logistics challenges and risks. Additionally, the increased weight from ZET batteries can reduce the payload capacity, which reduces the amount of goods that can be transported and revenue. Such reduction contributes to overall utilisation risk and can affect operators' ability to generate revenue, which, in turn, affects their ability to repay loans.

Risk assessment for ZET manufacturing: The financing risks associated with ZET manufacturing include high research and development (R&D) costs, costs of production facilities, economies of scale challenges, technology obsolescence risks, demand volatility, lack of skilled labour, supply chain vulnerability and counterparty risks.

Exhibit 6 ZET Manufacturing Risk Assessment

Risk Type	Description
High R&D costs	R&D of nascent ZET technology demands significant initial investments. Manufacturers face uncertainties in costs due to the newness of the technology, leading to high expenses in design.
High cost of production facilities	Establishing production facilities for ZETs demands substantial capital investment. The costs can be high regardless of whether the manufacturer is retrofitting existing facilities or designing a new one.
Economies of scale challenges	The Indian trucking market contains numerous small-sized fleet owners and operators, resulting in fragmented demand for ZETs. Small operators are often capital-constrained and seek to minimise cash expenditures. Thus, they face challenges related to the demand pull and financing of new trucks. This fragmented market structure could limit the initial ZET demand, elevating the per-unit manufacturing cost. Realising economies of scale becomes challenging due to this fragmentation, thus increasing the risks.

Exhibit 6 ZET Manufacturing Risk Assessment (Continued)

Risk Type	Description
Technology obsolescence	As mentioned earlier, various ZET technologies 'refuel' trucks by way of slow and fast charging, induction, catenary, swapping and hydrogen-based systems. Furthermore, technology uncertainty is compounded by variability in battery chemistries and their performances. Battery technology is rapidly evolving, and customer preferences for batteries and 'refuelling' technologies pose obsolescence risks.
Demand volatility	Shifting technology preferences and the trucking market's disaggregated nature create demand uncertainty, which is naturally cyclical, seasonal and influenced by macroeconomic trends.[12] Conversely, sudden high demand might strain the ability to meet purchase requirements promptly.
Lack of skilled labour	Due to the nascent stage of the market, specialised labour skilled in manufacturing and repairing ZETs is missing. The primary risk faced by OEMs is the absence of skilled mechanics, which could result in inadequate after-sales service. This, in turn, may diminish confidence in the product and ultimately reduce sales.
Supply chain vulnerability	The large size of batteries and other specialised components required for ZETs necessitates OEMS to primitively source raw minerals and specialised parts for ZETs. Disruptions or geopolitical tension could impede the production of these components, affecting both manufacturing capabilities and financing.
Suppliers	ZET manufacturing is a complex process involving coordination among multiple stakeholders, including battery manufacturers, vendors and providers of specialised parts. Costs in the manufacturing process could go up if any of these suppliers fail to deliver components timely.
Use-case adaptability	Different trucking purposes demand various technologies and truck sizes. This diversity necessitates a wide array of fit-to-purpose models, posing a challenge for manufacturers to achieve economies of scale while meeting diverse customer demands.

Risk assessment for charging infrastructure: Infrastructure risks involve uncertainties in electricity tariffs, security concerns for chargers, need to harmonise demand and supply, regulatory uncertainties, liability issues and challenges in charger utilisation. These risks are elaborated in the **Exhibit 7** on the next page.

Exhibit 7 ZET Charging Infrastructure Risk Assessment

Risk Type	Description
Demand uncertainty and low utilisation	Although the Indian ZET market is growing, the absence of stable long-term demand projections for ZETs complicates the estimation of infrastructure demand. Low utilisation of ZET chargers presents a financial risk for CPOs, directly affecting business revenue and profitability. To minimise financial risks, CPOs must keep up with ZET market supply and demand and ensure that charging infrastructure does not expand too slowly or fast.
Power supply	Investment in upstream electrical infrastructure, involving tasks such as transitioning from single-phase to three-phase power, installing extra transformers and upgrading cabling, is vital for seamless charging operations. However, it comes with substantial associated costs. Furthermore, CPOs must collaborate with their local DISCOMs and transmission company (Transco) for these upgrades, introducing soft costs and elevating the risk of project delays.
Electricity tariff, specifically demand chargers	Uncertain electricity tariffs can affect revenue. DISCOMs levy demand charges on industrial consumers (in this case, CPOs) if the maximum power demand exceeds certain thresholds; these costs can vary significantly by region. The variability in demand tariff and opacity in interconnection charges make it challenging for CPOs to manage their impending costs.
Technology lock-in	Various infrastructure technology options, including charging, swapping, catenary and induction, are available in the market. With multiple industry players adopting different technologies, there is a risk associated with technology obsolescence. Certain technologies may become outdated as the industry evolves, influencing the long-term viability and compatibility of infrastructure investments.
Servicing liability	Chargers, particularly public chargers, are susceptible to network or equipment failures. Servicing chargers presents added liability risk. Maintenance and replacement can also disrupt regular operations, lead to additional costs and potentially impede revenue generation. Moreover, ZET chargers can potentially cause high-voltage shocks, leading to overheating and maintenance challenges. Given the high-voltage nature of chargers, maintenance personnel need to be trained or certified to manage high-voltage loads.
Regulatory uncertainty	Land concessions and other subsidies can offset the costs of developing charging infrastructure. However, the absence of clearly defined regulations with specific time horizons makes it challenging for charging operators to depend on and incorporate these incentives into their deployment plans. Without such clarity, charging providers may find it difficult to forecast costs and scale operations.
Security concerns	Public-facing chargers can be prone to property damage and theft. In the event of damage or theft, the cost to repair or replace a charger would be a financial risk for the operator.

Risk assessment for grid: Grid infrastructure risks include difficulties in power demand forecasting, regulatory uncertainties, supply chain disruptions, operational disruptions, competition with other electricity users and coordination across the value chain. These risks collectively highlight the complex landscape of financing and developing the ZET infrastructure, emphasising the need for comprehensive strategies to mitigate potential challenges. The exhibit below details the risks associated with grid infrastructure.

Exhibit 8 Requisite Grid Risk Assessment

Risk Type	Description
Variability in power demand forecast	Grid upgrade planning must commence early to account for construction and regulatory approval time. Therefore, investment decisions hinge heavily on precisely forecasting future power demand linked to truck charging, which can be challenging. Underestimating the magnitude of necessary grid upgrades can impede the pace of trucking electrification and result in customer loss. Conversely, overestimating power demand can diminish project profitability.
Challenges in managing investment returns	With the electrification of the trucking sector and rapid growth in electricity demand from buildings, industries and other transport segments, substantial investment in grid infrastructure will be necessary in the coming decades. However, due to the scale of investment needed and current financial state of DISCOMs, achieving infrastructure expansion at the required pace and in a financially sustainable manner poses challenges.
Regulatory delays	Regulations affect grid infrastructure's approval, planning, construction and maintenance. Clear and consistent policies, standards and regulatory procedures are crucial to the financial viability of grid infrastructure investment. Frequent changes or ambiguities in regulations can delay projects or impose additional compliance costs.
Supply chain disruptions	Supply chain disruptions, especially in the timely delivery of electric grid equipment, pose significant challenges to grid infrastructure investments. The scarcity of specialised manufacturers and skilled labour exacerbates these disruptions. In 2023, global markets witnessed prolonged lead times and increased costs for transformers, causing delays in grid upgrade projects related to renewable integration and EV charging infrastructure. These supply chain challenges will eventually affect the financial returns of grid investment.
Power quality and constant power supply	Power outages and grid fluctuations can disrupt electricity supply to chargers, affecting the ability to supply the maximum rated power load to ZETs.
Coordination across the value chain	The effective development of grid infrastructure relies on seamless coordination among various stakeholders, including charging station developers, DISCOMs, local energy regulatory commissions, fleet operators and financial institutions. Communication bottlenecks with any of these entities can lead to project delays and increased costs. Ensuring efficient communication channels and collaboration among stakeholders is paramount to preventing development delays and optimising project timelines and budget constraints.

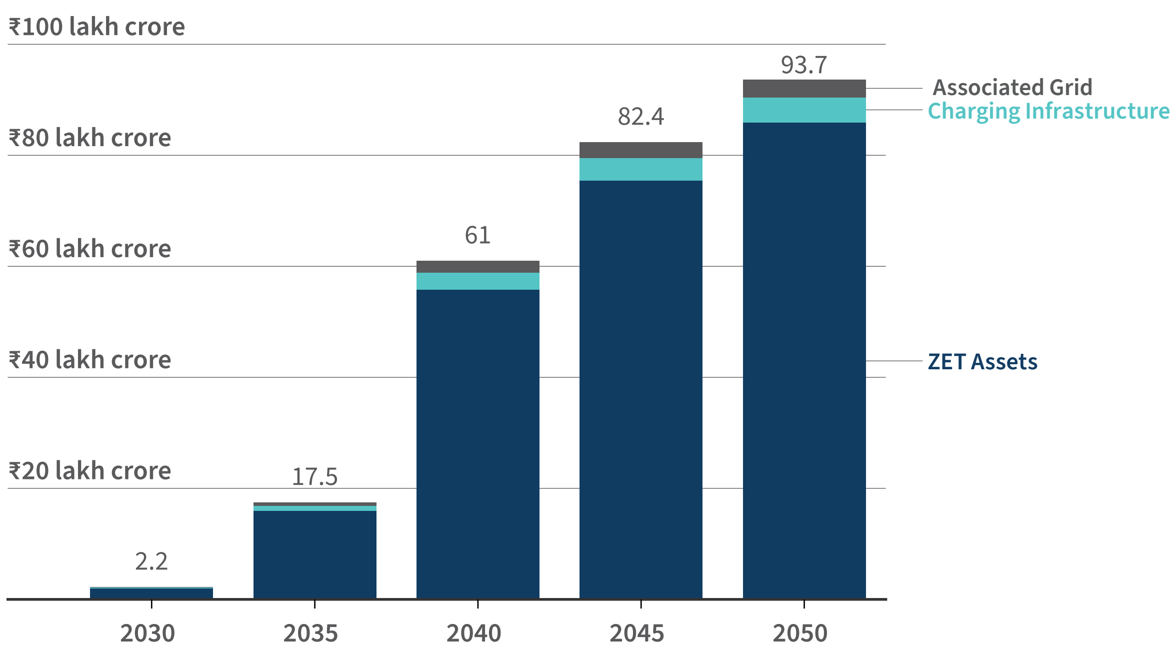
Concerted efforts must be directed towards ZET manufacturing, consumer purchase, charging infrastructure development and grid enhancement. Stakeholders must diligently assess the risks inherent in each market segment and comprehend their impact on the broad ZET ecosystem. Financial support for ZET supply and demand and enhancement of charging and grid infrastructure development can help the market effectively break the circular issue of prioritising either ZETs or charging infrastructure, thus ensuring a synchronised and sustainable transition.

Market size

Although ZETs are expected to represent over 50% of the truck stock by 2050 as a result of favourable policies and supportive market conditions,[13] this will require substantial investment. By 2030, a cumulative investment of ₹2 lakh crore (US$26 billion) will be necessary to enable the deployment of ZETs and associated infrastructure and grid upgrades. To further scale and solidify the ZET transition, a cumulative investment of ₹257 lakh crore (US$3 trillion) will be required through 2050.

The exhibit below shows the total investment required across four segments: ZET purchase, ZET manufacturing, charging infrastructure and grid upgrades. Such investment costs are derived based on ZET sales. ZET asset costs are derived based on assessment of the balance of truck cost, cost of batteries and profit multiplier to account for manufacturing costs.[v] The costs associated with charging infrastructure and grid upgrades were determined by estimating the charging and power demand, cost of charging infrastructure and necessary ancillary electrical equipment upgrades. See **Appendix B** for more details.

Exhibit 9 **Cumulative Investment to Facilitate ZET Transition Through 2050 in Five-year Cumulative Increments**



Source: pManifold

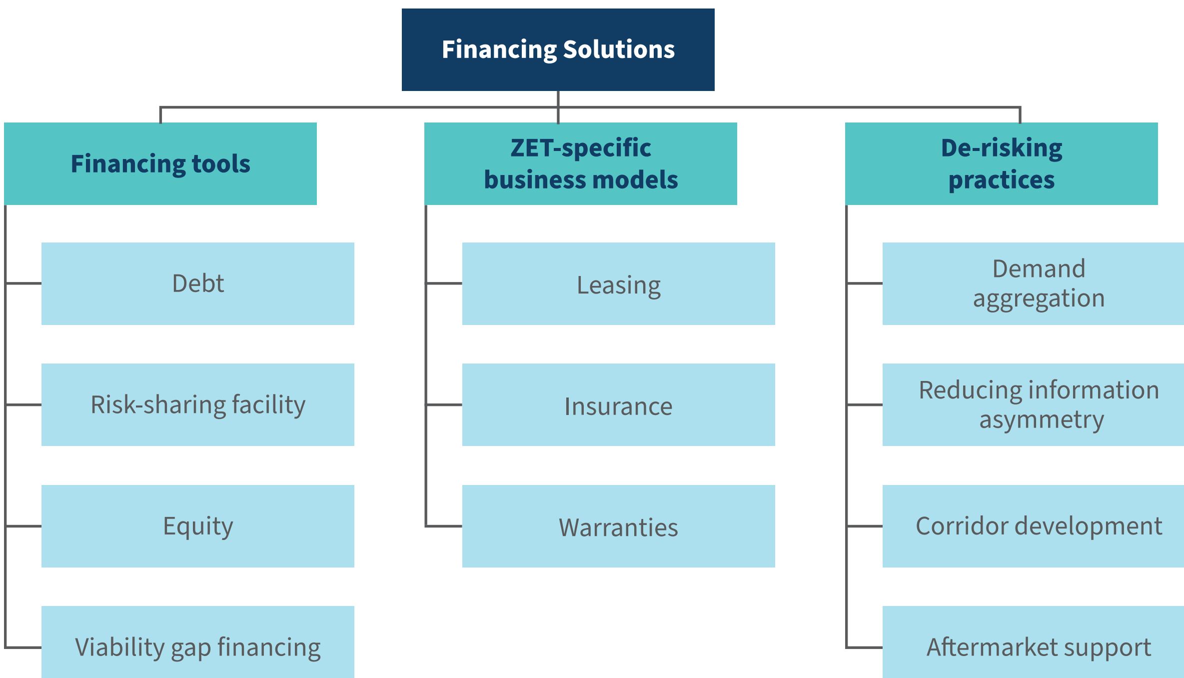
Note: The financial investment was calculated using RMI analysis, detailed in **Appendix B**, based on a modelled ZET sales penetration.[14] The investment is directly linked to the market penetration of ZETs.

v Profit multiplier refers to the additional mark-up manufacturers apply on a vehicle to recoup a profit.

Fleets and trucking operators need capital to procure ZETs, requiring banks and NBFCs to evaluate how they can leverage existing commercial credit lines for investment in ZETs. Investment in public charging infrastructure is also a prerequisite, necessitating the establishment of PPPs to leverage funding for charging infrastructure and grid upgrades.

Funding the transition to ZETs necessitates the implementation of financial tools, namely, concessional debt, equity investment, risk-sharing facilities and viability gap financing, to bridge the funding gap for ZET projects and attract additional private sector investment. ZET-specific business models then enable market actors to distribute ZET-related risks to entities better equipped to manage them. Lastly, the de-risking practices adopted by multiple parties are vital in reducing risks across the ecosystem. A well-coordinated strategy is imperative for facilitating the transition to ZETs. The following sections delve into the significance of deploying various financing solutions and how these three levers can be implemented to fund the ZET transition in India.

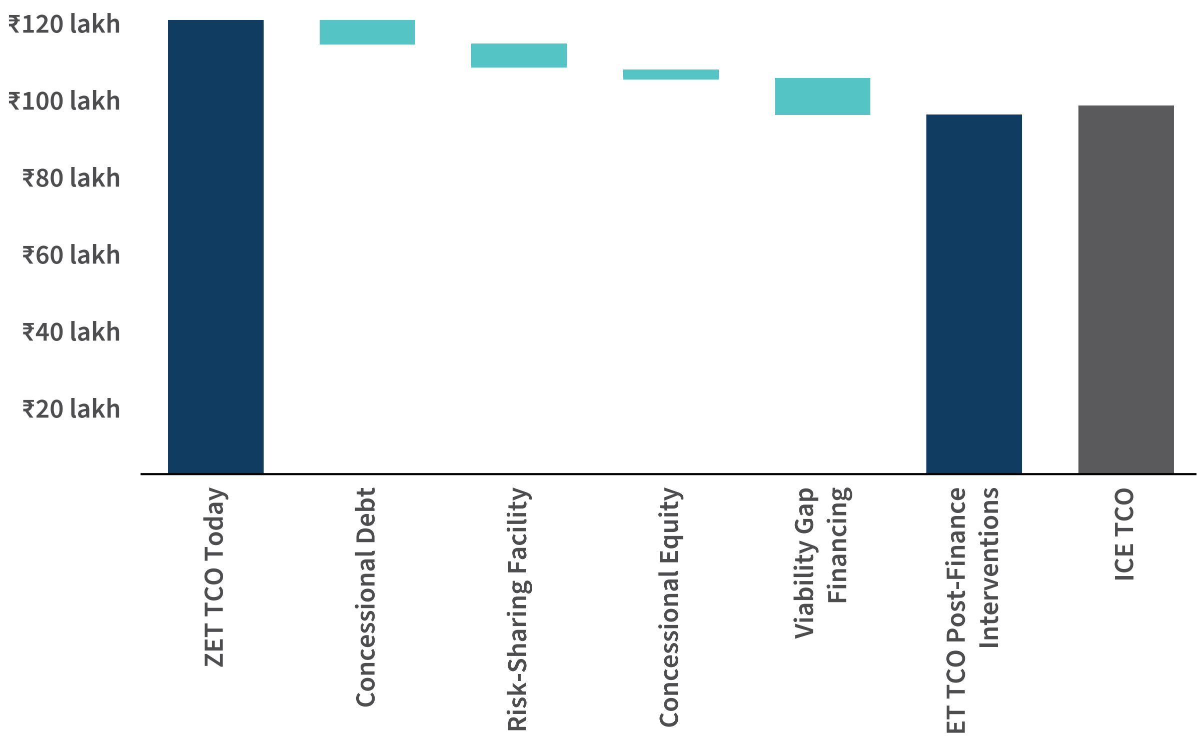
Exhibit 10 ZET Financing Solutions



ZET Financial Tools

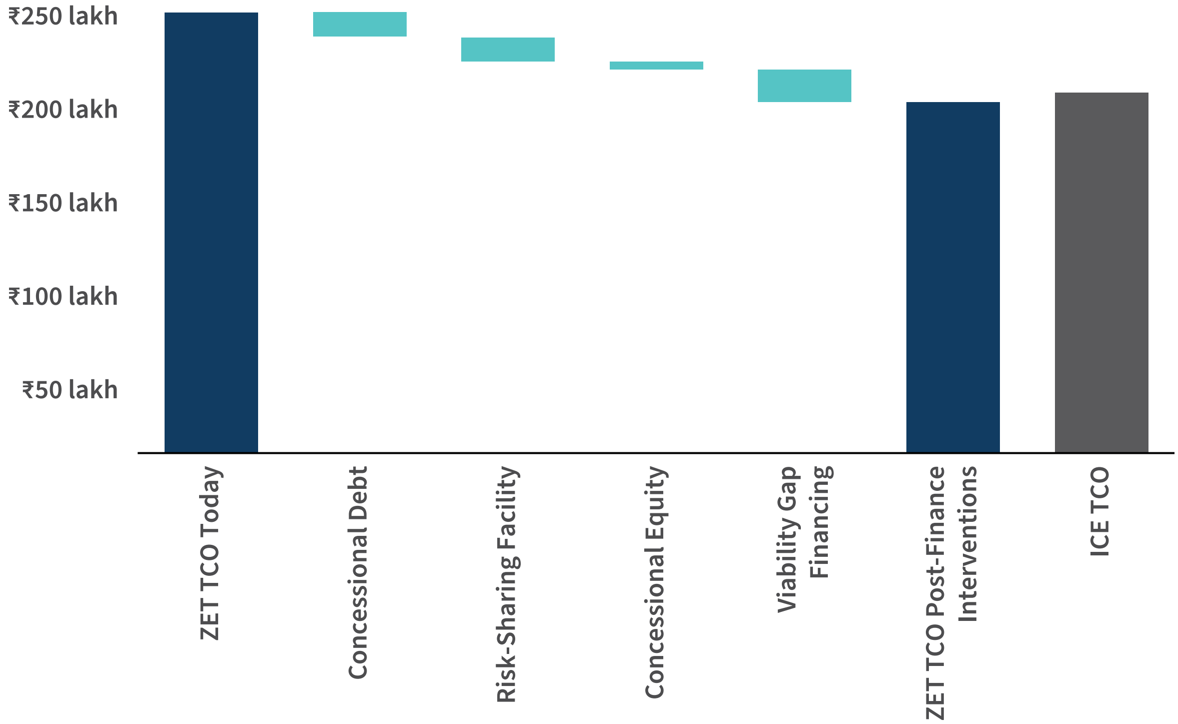
Facilitating the transition to ZETs requires implementing financial tools to mobilise private capital. This section delineates the significance of various financial instruments, including concessional debt, equity, guarantees and viability gap financing, as such tools are crucial for leveraging public capital to incentivise increased private-sector investment in the emerging ZET market. These tools, when combined, can close the total cost of ownership (TCO) gap. In today's market conditions, the TCO of ZETs is 20%–30% higher than that of diesel trucks. However, by employing financial tools, ZETs can eventually achieve a slight TCO advantage, demonstrating the efficacy of blended finance in facilitating ZET adoption.

Exhibit 11 Impact of Financial Tools on TCO of Electric MDTs



Note: Light blue bars show cost reduction potential using various financial tools.

Exhibit 12 Impact of Financial Tools on TCO of Electric HDTs

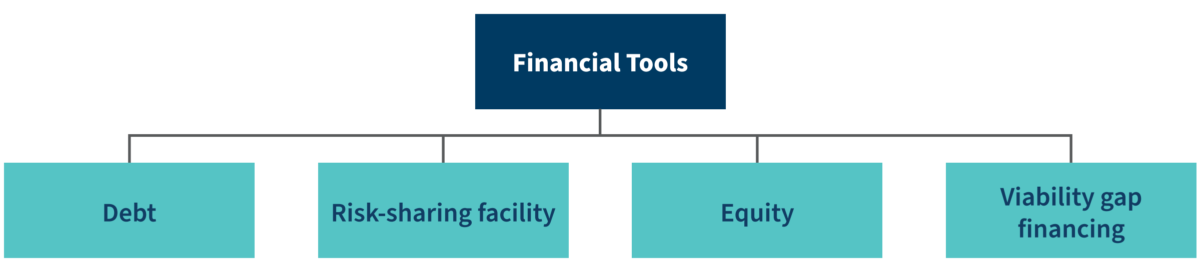


Note: Light blue bars show cost reduction potential using various financial tools.

Together, the implementation of concessional debt, equity, guarantees and viability gap financing can enable ZETs to reach 3% TCO superiority compared to diesel vehicles (see **Appendix A** for details on how these results were modelled; note that residual value is not shown in this exhibit).

Enabling the shift to ZETs requires an orchestrated financial strategy to initiate market development and drive scale. This section outlines the role of different financial tools and how they can be leveraged to spur initial deployment and promote market scale. Concessional interventions can be gradually phased out as the market matures, enabling private capital to sustain market development.

Exhibit 13 Summary of Financing Tools for ZET Market Development



Debt

Ideal applications

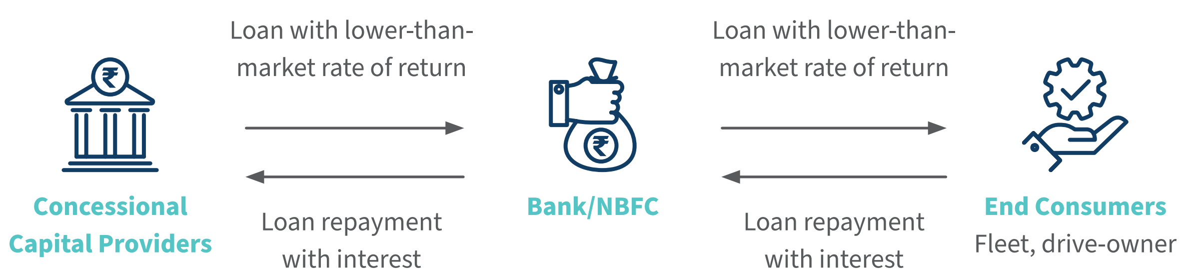
Purchase | **Manufacturing** | **Charging Infrastructure** | **Requisite Grid Infrastructure**

Debt financing is crucial for companies to raise capital, invest in ZETs and ensure reliable electricity supply and robust charging infrastructure for ZET adoption. ZET ecosystem actors can raise debt through concessional debt on favourable terms and commercial loans at market lending terms. Moreover, the government, MDBs and companies can raise debt-based finance through green bonds to support ZET projects.

Concessional debt: Concessional debt refers to below-market-rate financing provided by lending institutions involving loans with long tenures, interest rate reductions and grace periods. Concessional debt allocations can be phased down as the market scales, allowing private finance to support market maturation.

- **ZET Purchase**: The government, MDBs and DFIs can mobilise concessional debt and offer it as low-cost loans to NBFCs and banks to disseminate low-interest loans to purchase ZETs.

Exhibit 14 Concessional Debt and Role of Differing Stakeholders



Commercial loans: Commercial loans are debt-based financing mechanisms provided on commercial lending terms to fleet operators, charging operators and power utilities in the central, state and private sectors.[16]

- **ZET purchase**: Similar to the existing commercial vehicle loan portfolio, banks and NBFCs can broaden their portfolio by providing asset-based loans, where the ZET is financed as a standalone asset used as collateral in instances of default.

- **Charging infrastructure**: Charging providers need long duration capital. As revenue and utilisation stabilise, financiers should consider offering project financing for installing and expanding charging equipment.

- **Grid infrastructure**: Public sector undertakings, Power Finance Corporation (PFC) and Rural Electrification Corporation (REC) can finance power sector projects by lending directly to grid infrastructure providers to install requisite line extensions and transformers for ZET charging.[17]

Impact of favourable financing terms on ZET TCO

Today, HDT ZETs cost five to six times more than a comparably sized diesel truck. Compounded by the high cost of financing, the annual loan payment or equated monthly installment payment for a ZET can be prohibitively high for most transporters. Hence, there is a pressing need for ZET loans with long tenures and competitive interest rates to mitigate the burden of high monthly payments. Moreover, reducing perceived risks associated with ZETs is crucial, as these contribute to higher interest rates than conventional diesel trucks.

Currently, the following financing challenges need to be addressed:

1. No commercial ZET loans are available in the market today. Financiers are comfortable underwriting customer risks but less so underwriting product and residual value risks for ZETs. Consequently, financing ZETs as standalone assets is not a market practice.

2. Project financing or business loans[vi] for retrofitting or purchasing ZETs typically come at higher rates than those for diesel vehicles, which hover around 9%.

3. ZETs require loans for longer tenure than diesel vehicles. The loan tenure for diesel trucks is typically three to five years, and applying the same tenure to ZETs results in prohibitively high loan payments, given the increased cost. These factors affect the affordability of ZET financing and stunt adoption.

Extending ZET tenures and availing an interest rate for loans that closely mirrors the rate offered to diesel vehicles can significantly affect the EMI and affordability of ZETs. **Exhibit 15** depicts the financing costs of two scenarios: one with a 16% interest rate and five-year lending term and the other with a more favourable 9% interest rate and seven-year term. Both scenarios maintain a loan-to-Value (LTV) ratio of 75%.

Exhibit 15 Total Financing Costs of an HDT ZET

	BAU Lending Conditions	More Favourable Lending Conditions
ZET purchase price*	₹15,59,29,712	₹15,59,29,712
Interest rate	16%	9%
Loan tenure	5 years	7 years
Down payment	₹38,98,243	₹38,98,243
Total interest over loan tenure	₹61,63,671	₹45,70,693
Total principle over loan tenure	₹1,16,94,729	₹1,16,94,729
Annual loan payment	₹35,71,680	₹23,23,632

* See **Appendix C** for more details

[vi] This implies loans taken on the books of business. In case of default, if the seized ZET is unable to cover losses, the lender can seize additional collateral dependent upon the terms.

Notably, long loan tenures present some complications to be carefully considered. First, long loans typically carry high interest rates. Second, it is essential to ensure that the vehicle does not depreciate to a value below the loan principal, as it results in negative equity and increased default risk. Such a concern is particularly significant in the emerging ZET market, where residual values are largely unknown. Despite these challenges, market research indicates borrowers prefer long loan terms for ZETs. This is especially true for small operators, for whom liquidity is critical. Short loan tenures increase equated monthly installment payments, which can strain liquidity. Moreover, large fleet operators and captive users typically prefer short tenures for ICE trucks because they benefit from selling used ICE trucks. However, as the residual value of ZETs is highly uncertain, short tenures do not have the same allure given the current market state. Thus, actors need to manage the risks and benefits of long-tenure loans to help borrowers reconcile revenue generation against loan repayments.

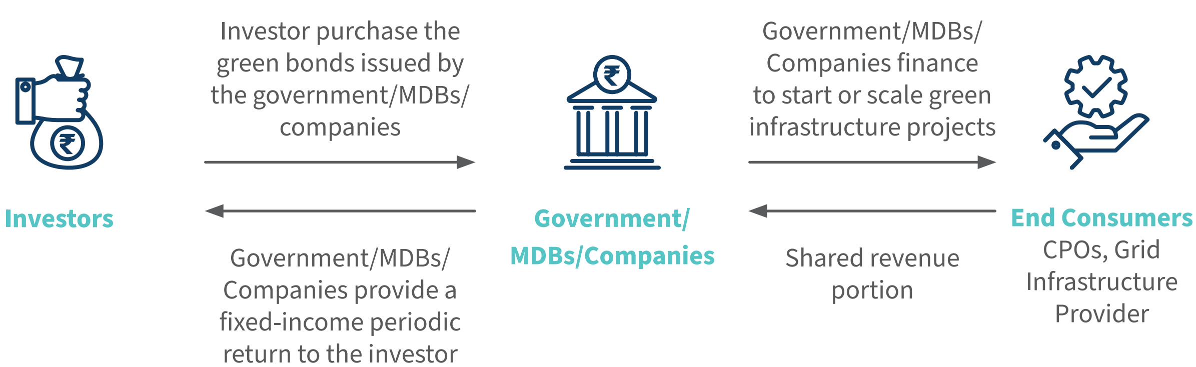
Green bonds: Green bonds, issued by governments, MDBs or companies, are investment vehicles that pay investors a fixed rate of return over a specified period and are utilised to finance or refinance green projects. Under India's Sovereign Green Bonds framework, this can include clean transportation and deploying charging infrastructure projects.[18] Companies can also explore corporate green bonds, which entail corporations issuing bonds to finance projects such as establishing charging infrastructure or acquiring a sizable zero-emission transport fleet.[19]

- **ZET purchase**: Corporate green bonds could be used by fleets to purchase several ZETs. Such practices are common in the aviation industry when purchasing eco-friendly aircraft.[20]

- **Charging infrastructure**: Corporate green bonds, a standard tool for renewable energy infrastructure development, can fund the development of a dedicated charging site.

- **Grid infrastructure**: The government or MDBs can issue green bonds to on-lend and provide funds for DISCOMs to invest in line extensions from substations to the transformers at charging stations. Such an investment framework is a viable mechanism to raise patient capital, and such projects would generate public benefit.

Exhibit 16 Green Bonds and Role of Different Stakeholders



Risk-sharing facilities

Ideal applications

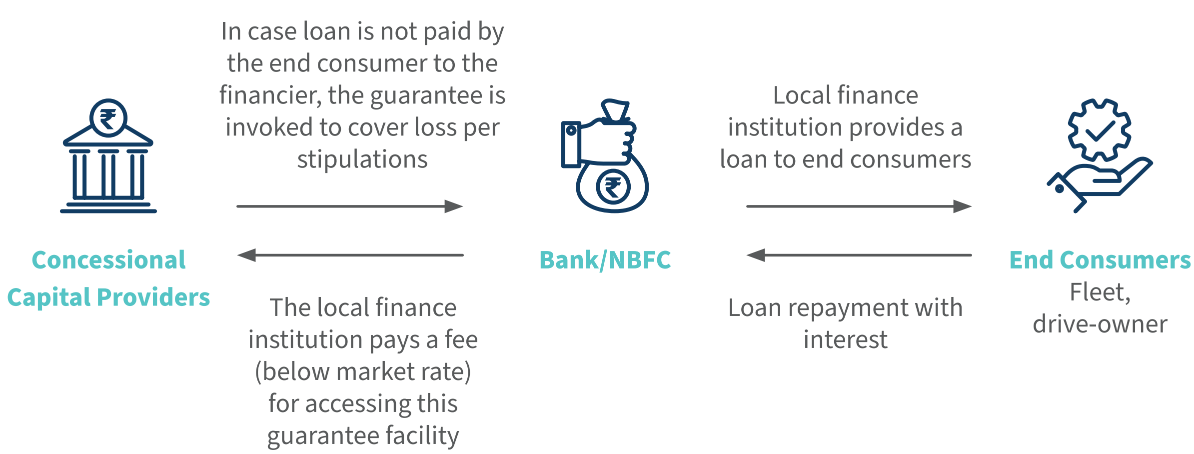
Purchase

In a guarantee arrangement, investors (often private investors) receive assurance that potential losses will be transferred, either entirely or partially, to a guarantor (often a public financier, DFI or MDB). This mechanism allows borrowers to access loans with potentially low interest rates as it reduces lenders' risks.

Loan guarantees: MDBs, governments or philanthropists can provide funds to DFIs or public finance institutions (PFIs) to develop risk-sharing facilities through credit guarantees to cover a share of the default lending risk for participating financial institutions.

- **ZET purchase:** Guarantees extend coverage for a set amount of loss on loans. The guarantor absorbs this loss, thus protecting investors. This can be structured as a partial risk-sharing guarantee where the borrower covers one portion of losses and the guarantor covers another; the mechanism can be structured to cover the first and/or second loss. The ZET ecosystem likely requires a first- and second-loss guarantee. First-loss guarantees are commonly deployed in high-risk markets to cover defaulted loans. A guarantor absorbs the initial portion of losses incurred by a lender or investor up to a predetermined percentage and specified amount. The second loss protects against large runaway losses, where the lender covers losses to a specified level, and the guarantor backstops a portion of losses beyond this. This is considered a measure to protect against substantial loss. Such a risk-sharing facility can be established by creating an escrow fund to cover instances of default. Contributions to the escrow fund can come from philanthropic organisations, MDBs and industry actors such as OEMs. The fund will then serve as a financial safety net for participating banks and NBFCs to leverage in case a ZET loan is defaulted upon. The funds would then be used to cover a share of losses of participating finance institutions.

Exhibit 17 Guarantees and Role of Differing Stakeholders



Equity

Ideal applications

Manufacturing

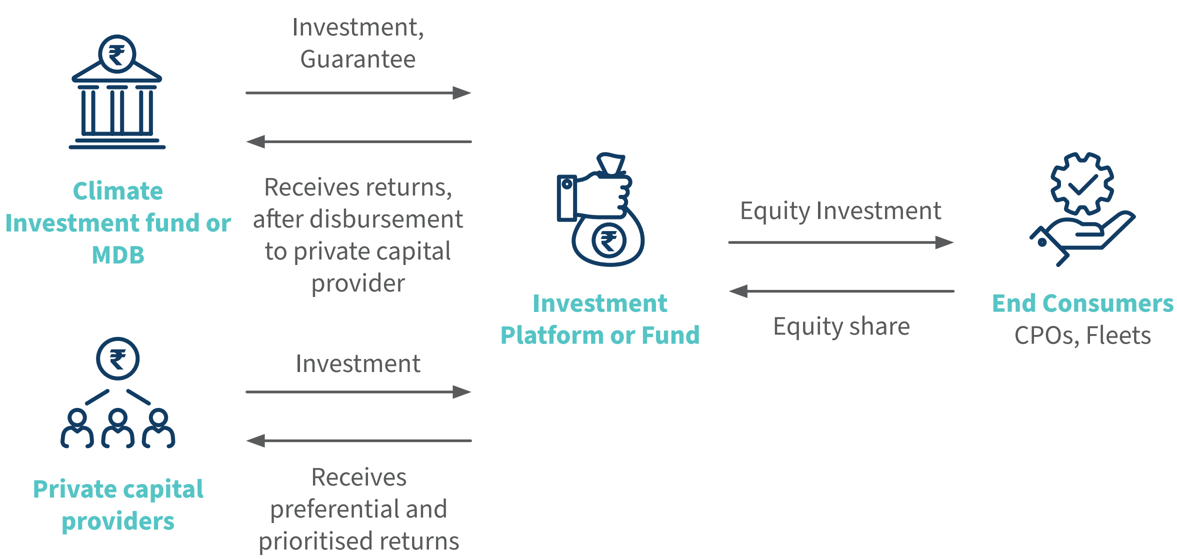
Charging Infrastructure

Equity is funding provided in exchange for ownership in a company or participation in a fund, with a return expectation. It is crucial for attracting private investment and particularly valuable for launching new business models.

Concessional equity: This refers to equity financing with lower return expectations than market investors typically require. It serves as an anchor investment to attract additional private equity in the ZET ecosystem. This type of financing requires an MDB or climate fund to make an initial investment alongside commercial funds through an intermediary platform.[21] Additionally, an MDB or climate fund provider may offer return guarantees to commercial investors, helping absorb initial losses and mitigate risks for private equity investors.[22]

- **ZET manufacturing**: Concessional equity can support OEMs and ZET startups by providing them access to capital without the burden of high debt and monthly repayments in the early stages of ZET production.[23] This financial mechanism enables stakeholders to expand ZET production operations without relying heavily on debt, thereby preserving cash flows.
- **Charging infrastructure**: International climate funds and MDBs can attract commercial investors by making initial equity investments or developing an investment fund or platform for charging infrastructure providers.

Exhibit 18 Concessional Equity and Role of Differing Stakeholders



Viability gap financing

Ideal applications

Purchase | **Manufacturing** | **Charging Infrastructure** | **Requisite Grid Infrastructure**

Viability gap financing in this report is defined as government budgetary allocations and other financial incentives designed to initiate market development and/or funding support needed to bridge the gap between commercially acceptable revenue and expected revenue inflows. The different structures of viability gap financing include (a) purchase incentives, (b) government waivers and tax incentives, (c) grants and (d) viability gap funding.

Purchase incentives: These include subsidies at the point of purchase to reduce the cost of procuring an asset. Such incentives can serve as an important lever to lower ZET TCO and the financial barriers fleet operators face, thus spurring ZET demand. Such subsidies can be reduced and removed as ZETs achieve cost parity with ICE trucks.

- **ZET purchase**: To drive initial ZET adoption and close the capital cost gap between ZETs and diesel vehicles, the Ministry of Heavy Industries Electric Mobility Promotion could be extended to ZETs (as ZETs are currently not included). Additionally, a similar scheme modelling FAME II could be extended, providing purchase incentives for ZETs. Incentives can be extended to the first 10,000 ZETs, and funds can be capped at ₹33 lakh per vehicle allocated for e-HDTs and ₹14 lakh for e-MDTs (see **Appendix A** for more details).

Government waivers and tax incentives: These can be provided upfront or as credit to be reimbursed as subsidies. Tax incentives, toll waivers and concessional land rates can help defray initial costs for projects that seek to generate public benefits.

- **ZET purchase**: State governments can provide ZET operators with exemptions on road taxes, registration costs and toll waivers, reducing the operational costs of ZETs. Such incentives can be gradually phased out as ZET deployment increases.

- **Charging infrastructure**: Land concessions or more favourable lease structures that seek to structure lease payments based on revenue generation can reduce project capital liability.[24] Additional tax waivers can be provided to CPOs developing public charging infrastructure to defray initial project development costs.

Grants: These are funds provided by governments, MDBs or philanthropy to support specific projects and activities. Unlike loans, grants do not need to be repaid, making them an attractive form of financial assistance. They are often awarded based on criteria designed to achieve impact and generate public benefits. Grants are particularly beneficial in the pilot or initial deployment phases of ZETs and public infrastructure. Once a specified portion of funds has been allocated and designed to encourage private investment for continued market growth and development, they can be phased out.

- **ZET manufacturing**: Research grants can be offered to support OEMs in their ZET research and development efforts, with provisions made for small and medium enterprises (SMEs) to facilitate the development of new charging infrastructure and ZET technologies. These grants can provide a one-time grant for project expenses such as personnel, equipment and materials, stimulating innovation and fostering competitiveness and economic growth. Additionally, they can facilitate technology adoption, market expansion and skill development, which is essential for SMEs' growth and competitiveness in the ZET sector.

- **Grid infrastructure**: Central Financial Assistance (CFA) is essentially a grant from a nodal ministry to the implementing agency, such as a state government or DISCOM, to develop a desired project. To receive these funds, implementing bodies need to meet specific conditions or goals and adhere to reporting requirements set by the government.[25] Ministries such as the Ministry of Power and Ministry of New and Renewable Energy can offer CFA to state governments to cover the financial gap in project costs for distribution-level upgrades needed to accommodate ZET charging. Stipulations can also be made to pass benefits along to CPOs, such as demand charge holidays,[vii] where the CPO does not include demand charges for several years as utilisation stabilises.

Viability gap funding: This improves the financial viability of PPP projects that create social and economic infrastructure benefiting the public.[26] It is often an instrument designed to close the revenue gap between the cost of developing public infrastructure and revenue generated from its operations, and the investment is justified by creating a public good.[27] Viability gap funding can be adjusted based on project performance or other established criteria, and such funds can be reduced as favourable market growth takes shape.

- **Charging infrastructure**: The Ministry of Finance, Ministry of Heavy Industries or another government actor can issue bidding to develop public charging infrastructure assets. The CPO with the lowest bid for the project cost is selected and invited to create, maintain and operate ZET charging stations. The Ministry of Finance can then provide a one-time grant to the lowest bidder, offsetting the revenue-to-cost gap incurred by CPOs. Such assistance can be particularly impactful in covering the cost of on-site electrical equipment such as transformers. Additionally, the Ministry of Petroleum and Natural Gas (MoPNG) could establish targets for oil companies to convert a portion of their retail stations into charging hubs, offering fiscal incentives to aid the installation of initial chargers.

[vii] Demand charge holidays represent a viable pathway to distribute the benefits of grant funding for line extensions to CPOs. However, there are upstream ramifications of demand charge holidays for transmission and generation system cost recovery. As DISCOMs typically do not own transmission systems, the viability of demand charge holidays needs to be studied on case basis in terms of impact on transmission systems and use of peaker plants to meet daily power demands.

Blended implementation and impact

As mentioned, financial tools are the most effective when implemented jointly or through a blended financing approach. Each identified instrument requires different actors to negotiate specific terms and conditions. This process and how these measures work to directly or indirectly influence the TCO of ZETs will inherently differ. An evaluation framework is developed to capture these nuances and consider how a financial instrument affects the TCO of ZETs. It takes into account feasibility by examining the availability of relevant best practices from similar market segments or global standards. Finally, it evaluates the time horizon considering the duration needed to implement due diligence, refinement and negotiation processes among stakeholders.

Exhibit 19 Financial Instrument Evaluation of TCO Impact, Feasibility and Time to Deployment

Financial tool and Description	TCO Impact	Market Precedent	Deployment Readiness
Debt			
Concessional debt for ZETs	X (High)	X (High)	X (Moderate)
Debt for requisite grid infrastructure	X (Moderate)	X (High)	X (High)
Commercial debt for ZET assets	X (High)	X (Moderate)	X (Moderate)
Green bonds	X (Moderate)	X (High)	X (High)
Guarantees			
Loan guarantees	X (High)	X (High)	X (High)
Equity			
Concessional equity	X (Moderate)	X (Moderate)	X (Moderate)
Viability Gap Financing			
Purchase incentives	X (High)	X (High)	X (High)
Grants for requisite ZET grid infrastructure	X (Moderate)	X (Moderate)	X (High)
Viability gap funding	X (High)	X (Moderate)	X (Moderate)
Government waivers and tax incentives	X (High)	X (High)	X (Moderate)

X High X Moderate

Blended finance, i.e., the use of public and private sector funds, can facilitate significant commercial investment in the ZET ecosystem. Financing mechanisms such as concessional debt, equity and viability gap funding can kickstart the ZET market until the revenue generated from owning and operating ZETs and the necessary charging infrastructure can achieve adequate revenue flows to cover costs and become profitable. Initially, they can be utilised to galvanise the ZET transition and attract additional private capital to foster market growth. Upon market maturity, concessional measures and viability gap financing instruments can be rolled back, and private sector investment can and should be used to sustain market development.

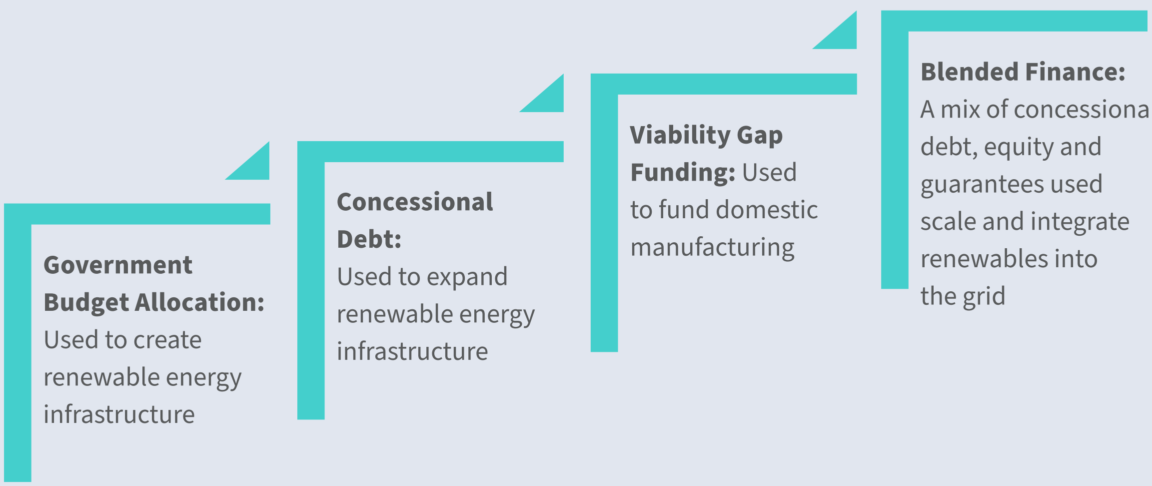
Learnings from other clean-tech sectors to leverage blended financial instruments

India ranks fourth globally in renewable energy capacity and actively pursues clean energy goals, including a 500 GW non-fossil-fuel capacity by 2030 and 50% energy from renewables. A series of financial tools are leveraged to increase investment in renewable energy projects.

Tax breaks such as accelerated depreciation schemes were first utilised to catalyse growth, followed by a transition to generation-based or performance-based schemes, such as promoting the continued use and operation of solar generation. Together, these measures significantly contributed to the growth and development of renewable energy in India. Funds such as the National Clean Energy Fund provided concessional interest rates to support the development of solar generation.

The government also used viability gap funding instruments; notable schemes include the Jawaharlal Nehru National Solar Mission and Central Public Sector Undertaking Scheme Phase-II, which gradually decrease funding as domestic production costs align with imports.[28,29] Recently, models such as the Green Energy Corridor Scheme and India E-Mobility Financing Program leveraged blended finance structures, combining debt, equity and guarantees.[30]

Exhibit 20 Evolution of Renewable Energy Development Funding



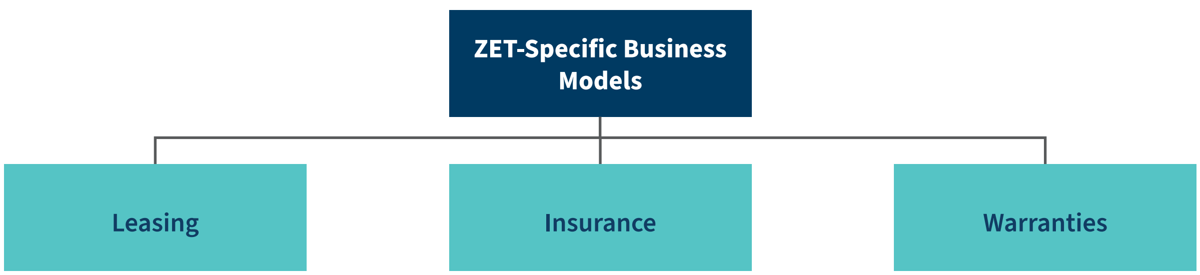
The incentives described and utilised in the renewable energy market can be replicated across the transport segment to spur ZET adoption. Accelerated depreciation tax benefits, concessional interest rates and purchase subsidies apply across ZET sectors. Viability gap financing allocations can support infrastructure development for OEMs, CPOs and grid providers. Over time, a blended financing approach leveraging public capital to scale private sector investment can emerge to drive market growth.

ZET-Specific Business Models

Private actors foster a supportive ecosystem by introducing new business models to drive the adoption of ZETs. For the ZET market to be a sustainable lending sector, it is essential that ZETs generate viable revenue streams and market actors develop business models to effectively manage the prevalent asset and technology risks. Without such interventions, the development of financial tools will struggle to gain traction, as even DFIs expect to see returns on their investments.

By tailoring their business models to address specific ZET technology and business risk fleets, OEMs, CPOs, lessors and insurance providers can drive market scale. These actors, particularly during the early stages of adoption, are better equipped to manage the risk of ZET and charging infrastructure deployment due to their market connections, allocation of dedicated resources and scale. Effective business models can transfer risk to create a more conducive lending environment to propel the ZET market. This section details how market actors can adopt four specific business models and offers opportunities to reallocate and more effectively manage risks.

Exhibit 21 ZET-specific Business Models



Truck leasing

The high upfront cost is a major barrier to ZET adoption. Leasing is a contractual agreement where a lessor grants a lessee the right to use a truck for a specified period in exchange for regular payments. Leasing is effective as it eliminates the residual value burden of ZET ownership, helps overcome market entry barriers and supports initial pilot growth. In addition to reducing fleet operators' liabilities, leasing lowers the technology risk of ZET ownership by allowing fleet operators to switch to new ZET models more regularly and thus supports the development of a ZET secondary market.

The leasing fee, i.e., the monthly fee or regular payment giving the lessor the right to use a truck, is the central element of the leasing agreement and drastically affects the economics of leasing. Agreements between the lessor and lessee determine details such as the lease term and inclusion of maintenance and insurance. At the lease end, operators can acquire the trucks outright or return them to the lessor. Moreover, since battery health is crucial for determining the truck's residual value, some leasing companies set a vehicle kilometre travelled (VKT) threshold for the predetermined monthly leasing fee, above which operators may have to pay additional fees.

Financial impact of leasing

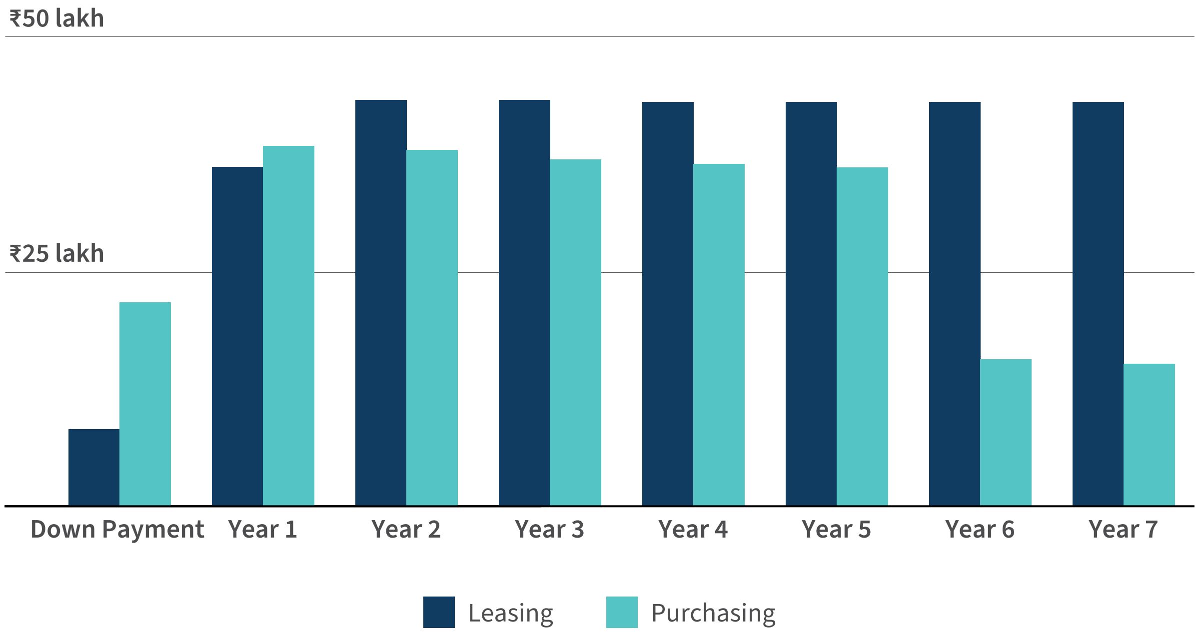
This section explores the economic feasibility of leasing by examining the annual expenses and TCO associated with leasing versus purchasing. The analysis focuses on a seven-year leasing agreement with monthly payment of 2.8% and no additional VKT charge compared to a five-year loan arrangement requiring 25% upfront payment and 16% interest for the purchase option. The analysis follows a capital lease structure because the residual value was not considered due to insufficient data.

Compared to purchasing, leasing reduces the initial down payment by approximately 68% for MDTs. It also lowers the down payment for HDTs at the same rate, as the modelled lease structure derived through field data is the same regardless of vehicle size.

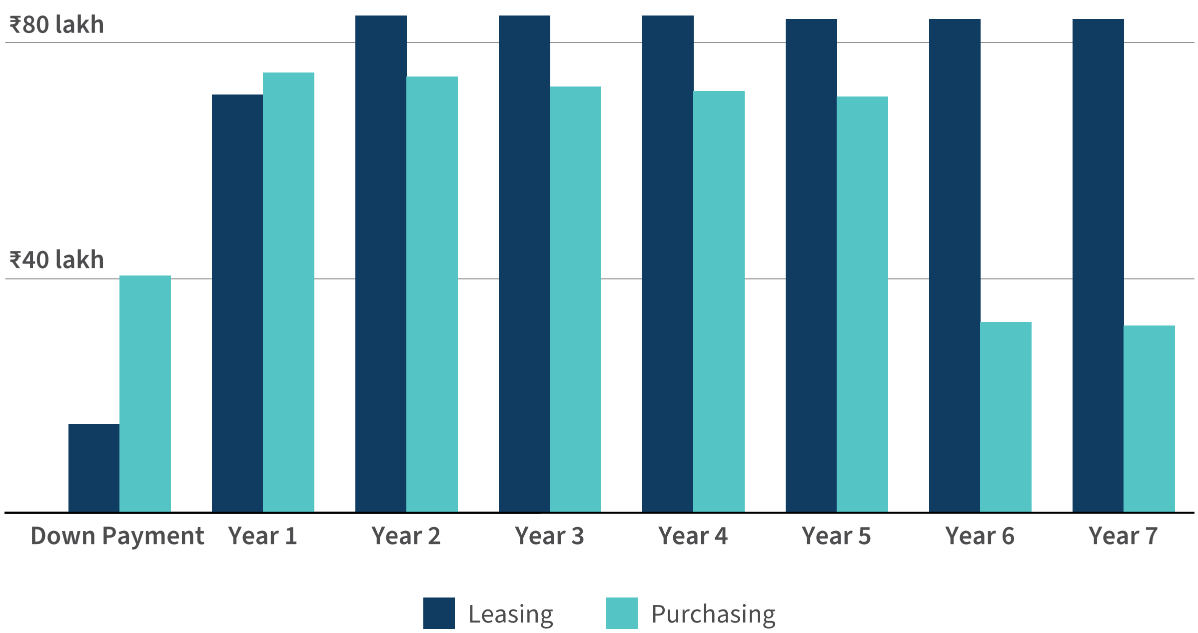
Additionally, leasing decreases the first year's cost by around 5% because the down payment on a lease is merely a hold and is returned after one year of use. As a result, while the annual lease payment remains the same each year, the first year's cost appears lower due to the return of the initial down payment. However, from the second to the fifth year, the non-amortised annual expense of leasing is 14%–19% higher than that of purchasing, as shown in **Exhibit 22** on the next page. Leasing is preferred by fleet operators seeking low costs in the near term.

Exhibit 22 Seven-year Non-amortised Annual Cost Comparison of Purchasing vs. Leasing a ZET

Seven-year Non-amortised Annual Cost Comparison of Purchasing and Leasing an MDT (₹ Lakh)

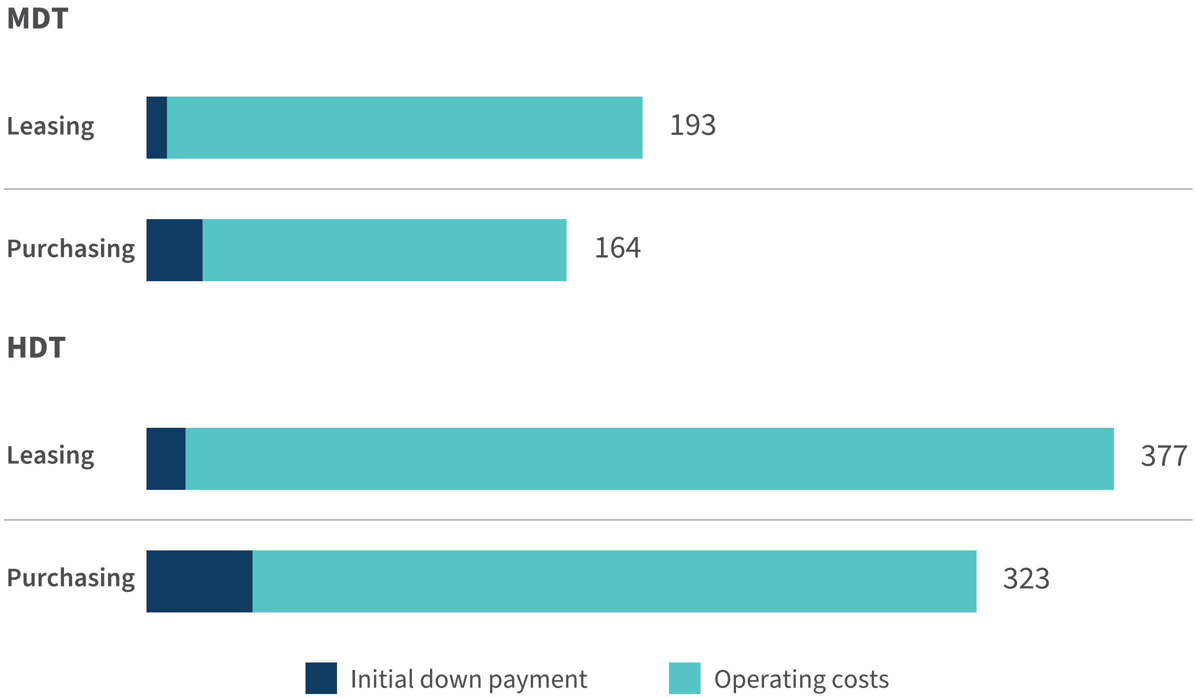


Seven-year Non-amortised Annual Cost Comparison of Purchasing and Leasing an HDT (₹ Lakh)



Note: 1. Leasing costs include both the capital and operational expenditures (i.e., maintenance and fuel costs) of vehicle use. 2. Purchasing includes both the capital and operational expenditures (i.e., maintenance and fuel costs) of vehicle use. 3. The costs in the sixth and seventh years in the purchasing scenario include only operational costs as the loan payment term concludes.

Exhibit 23 Seven-year TCO Comparison of Purchasing and Leasing a ZET



Although leasing reduces the initial capital outlay, the TCO results show that it ultimately increases the overall project cost by around 20%. The cost-effectiveness of leasing depends on the leasing fee, which is expressed as a percentage of the monthly leasing payment relative to a truck's upfront cost. Since no market data is available on ZET leasing arrangements in India, we derived the 2.8% monthly leasing fee based on a threshold of 15% internal rate of return (IRR) for the leasing company. However, by adjusting the leasing fees, leasing models can be structured to meet the specific requirements of purchasers and leasing companies, which would depend on the use case.

Leasing effectively distributes risk in the transportation sector by shifting residual value risk from the lessee or operator to the lessor. Additionally, depending on the terms, comprehensive lease structures can further shift the maintenance and repair responsibility to lessors. Fleet operators benefit from manageable monthly payments, while leasing companies use economies of scale and advanced analytics to effectively manage residual value risks and operational risks. However, not all leases are comprehensive; in nascent markets, lessors may transfer maintenance responsibilities to lessees to reduce their own risk. Additionally, as small operators pose financial risks to lessors, such as NBFCs, contracts should include clauses and guarantees to address these concerns.

Recommendations for implementation:

- Leasing companies can partner with ZET manufacturers to bridge the gap between ZET supply and demand.
- NBFCs and lessors can pilot ZET leasing, exploring term flexibility and monitoring how lease structures can best cater to the different needs of ZET drivers, including short lease periods and options to buy ZETs at the end of the lease.

Delivering Mobility as a Service

Mobility as a Service (MaaS) encompasses bundled offerings that extend beyond just truck leasing to include various essential services. Fleet operators lease trucks and benefit from integrated charging infrastructure provided under a quasi-lease contract. They can additionally access services such as electrification planning, parking depot management and maintenance. This bundled leasing approach alleviates the complexities and costs associated with infrastructure development and charging logistics, particularly benefiting small fleet operators. For truck leasing and charging service providers, this model effectively aggregates demand from individual operators for optimal utilisation of charging infrastructure.

E-Bus Mobility as a Service in India: In India, the MaaS concept was successfully implemented with e-buses, where comprehensive contracts include vehicle leasing, charging and maintenance services. For example, gross cost contracts (GCC) support Mobility as a Service (MaaS) in the Indian bus market by providing a structured framework for public-private partnerships that enhance operational efficiency and reduce financial risks for state transport authorities. Under the GCC model, private operators procure and maintain e-buses, allowing transport corporations to focus on service delivery without the burden of upfront capital investments. This model is particularly valuable in the context of India's growing demand for e-buses, as it facilitates the integration of new technologies and infrastructure.

Global Trends in ZET Leasing: In international markets where ZETs are more widely deployed, truck OEMs, rental firms and specialised third-party agencies commonly offer MaaS. These entities secure financing, acquire ZETs and may even establish the necessary charging infrastructure for fleet operators. In India, leading automotive companies — including ZET manufacturers, traditional truck leasing firms and EV leasing companies — are strategically positioned to best deploy MaaS business models to capture the nascent ZET market.

Warranties

Warranties serve as assurances or guarantees regarding a vehicle's performance, quality and lifespan. In the event of a breakdown or failure in a ZET, either the OEM or a third party assumes liability. The OEM then shoulders the costs associated with maintenance, labour and part replacement for the truck during a specified period. Warranties are typically provided by OEMs when consumers purchase ICE trucks. However, given the nascency of ZETs, standard warranties are often not offered and the warranty duration is short, which is a crucial concern. Warranties are essential for assuring fleet operators and encouraging the adoption of ZETs. OEMs should aim to standardise and strengthen warranty offerings for ZETs, providing the necessary support and protection to increase demand and ZET adoption.

Implementing ZET-specific warranties, particularly those aligned with battery life, can have a significant impact. Extended warranties, such as those spanning five years instead of the standard two years, hold several advantages. First, warranties that match the expected battery life ensure a fixed period of vehicle usage free from concerns about unexpected battery failure. Second, leasing companies and other stakeholders exhibit high confidence in investing in vehicles with extended warranties. This confidence stems from the assurance that potential issues will be covered for long, reducing the risk of unforeseen expenses. Consequently, this facilitates more favourable loan tenures or leasing terms for ZETs.

Extended warranties play a pivotal role in enhancing the residual value of vehicles. As warranties are extended, market actors gain more confidence in the vehicle's longevity and reliability. They also serve as a counterbalance to asset risks, particularly concerning battery performance and degradation in ZETs. From the perspective of fleets, warranties provide coverage against unforeseen maintenance expenses. Similarly, financiers benefit from offering warranties, as the coverage often extends through the lending period, mitigating the risk of default resulting from unforeseen failure. OEMs efficiently estimate the additional costs of extending warranties and, in the ICE market, often collaborate with insurance companies to manage their liability when offering such extensions. However, warranties primarily shift risk to OEMs. While they may have a deep understanding of a vehicle's lifespan, they bear the asset risk. Taking on this risk could ultimately lead to an increase in vehicle costs.

Recommendations for implementation: Manufacturers must provide data, while technology companies need to develop analytical capabilities to synthesise operational and battery performance data. This enables market actors to develop customisable warranties and depreciation schemes.

Insurance

Insurance provides financial protection for ZET customers. Liability insurance is legally required and covers bodily and property damage from accidents. Comprehensive insurance, although optional, offers broad protection beyond collisions, encompassing incidents such as product failure, theft and natural disasters. Insurers are essentially risk managers using statistical analysis to assess the likelihood of certain events and pricing premiums accordingly.

Developing customised insurance products for ZETs is an example of a business practice that distributes the risks of truck ownership and operations. Specific insurance products could cover battery damage, cargo protection during transportation, damages related to charging or refuelling and comprehensive coverage for repairing or replacing ZET-specific components.

Customised depreciation schedules can be developed specifically for batteries. By creating depreciation schedules using battery management data and shared metrics on battery health, insurers can depreciate these components in a manner that aligns with analytics rather than the common practice of assigning minimal, if any, value to used batteries. Such a product and assurance would offer ZET fleets and owner-operators a measurable recoverable value for their battery, reducing residual value risk.

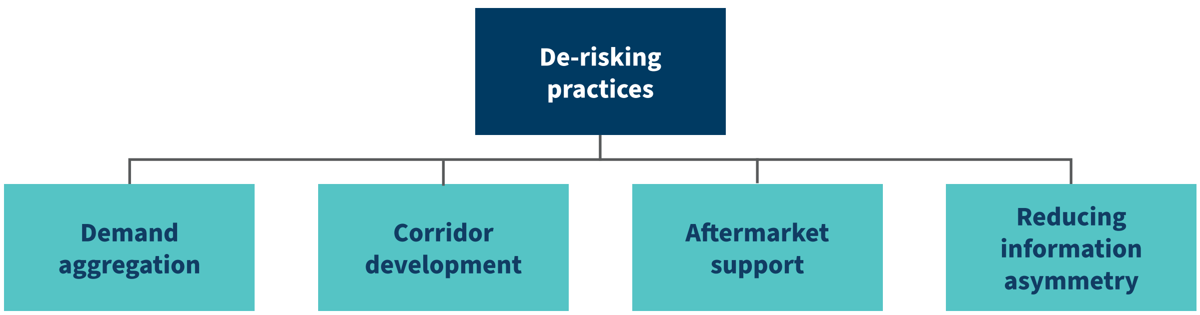
Recommendations for implementation: In collaboration, fleets, OEMs, banks and insurers can develop pilot programmes testing different insurance covers, such as adjusted depreciation covers and/or extended warranties, sharing relevant proof points with insurance companies regarding ZET performance.

Insurers can allocate dedicated resources to better understand the ZET market. By doing so, they can adjust premiums tailored to this specific technology type. This approach enables the development of insurance premiums that more accurately reflect the real asset and business model risks associated with ZETs.

De-risking Practices

Beyond implementing financial tools, de-risking practices are needed to expand the ZET ecosystem and represent a means for market actors to take proactive steps to mitigate asset, business and customer risks associated with ZET deployment and operation of ZET-related infrastructure. These measures are vital for boosting confidence among financiers and facilitating capital flow into the ZET ecosystem. Practical risk management tools can mitigate uncertainties from technology, regulations, market dynamics and operational challenges specific to ZETs. These strategies safeguard against potential losses and uncertainties, distribute liability and build market confidence. This section outlines ecosystem practices that can reduce ZET market risk.

Exhibit 24 Summary of De-risking Practices



Demand aggregation

Overview: Demand aggregation involves consolidating the demand for ZETs to capitalise on economies of scale. Low demand poses challenges for OEMs in achieving scale in ZET manufacturing. Demand aggregation frameworks address these by enabling OEMs to produce more trucks at low costs. As production costs decrease, demand ideally increases. By emphasising collective demand, this framework allows OEMs to streamline their production processes and manufacture ZETs on a large scale, thus achieving favourable economies of scale and attracting buyers and investors.

For example, demand aggregation is a valuable tool for e-bus procurement in India. Convergence Energy Services Limited, a public limited company under the administrative control of the Ministry of Power, aggregated the demand for e-buses across some cities. The financing model adopted was a gross cost contract, where CESL paid bus operators a specified amount to operate 5,450 e-buses over a specified time. CESL acted as the project administrator, working with OEMs and bus service providers to operate and maintain the buses for a predetermined per-kilometre rate and duration outlined in the contract.[31] Implementing this model in the ZET market may be challenging as private operators often own trucks, trips do not necessarily benefit the public and road freight duty cycles are less predictable. Therefore, demand aggregation may best suit public fleets, and it is essential to assess how contractual agreements can be curated for the ZET market.

Overall, demand aggregation drives down costs, minimises risk for financiers and ultimately facilitates the broad adoption of ZETs. Government bodies and large fleets can form stakeholder collations to purchase ZETs and create collective demand signals.

Exhibit 25 Market Impact and Risk Mapping of Demand Aggregation

Risk	Ability to Reduce Risk	Description
Business risk: Demand volatility	🟢	Demand aggregation can lead to economies of scale for ZET manufacturing, providing demand certainty to enable manufacturers to invest in ZET production capacities.
Customer risk	🟠	Aggregating demand from multiple sources provides a stable and predictable revenue stream for suppliers or service providers.

🟢 A measure has direct impact on risk. 🟠 A measure has indirect impact on risk.

Multi-party agreements for increased demand assurance

Collaboration between ZET market actors can drive early market confidence and initiate deployment. Multi-party agreements among OEMs, fleets, transporters and end consumers is an effective strategy to manage the deployment risk of ZETs and mobilise financing. Each stakeholder has a role:

- **End consumers**: Businesses can enter multi-year freight and shipment contracts, delineating detailed transport costs over a fixed period and along specific routes. This allows transporters and fleets to better utilise ZET assets and effectively manage their operational risks.
- **Transporters and fleets**: These should work with OEMs or leasing aggregators to procure products that meet their desired duty cycle, committing to ZET operation for a fixed minimum period.
- **OEMs**: Given the market nascency, these actors should and are best equipped to bear the asset risk, providing performance guarantees, warranties and, in some instances, buyback clauses.

With each key market actor at the exhibit, financiers will be better positioned to employ innovative financing mechanisms such as trailing loans and adapting to the unique needs of ZET transportation projects. Such partnerships can be a catalyst in managing risks and orchestrating a shared path for implementation.

Corridor development

Context: ZET corridors are highway segments equipped with the necessary charging or refuelling infrastructure to facilitate seamless ZET mobility.[32] Concentrating ZET fleets on these specific corridors can mitigate the challenges associated with low charging utilisation, unlock significant charging revenue potential and reduce grid infrastructure costs through concentrated and region-specific demand planning.

Pooling charging demand along designated corridors can foster better collaboration between CPOs and grid infrastructure providers for developing comprehensive, long-term resource planning. This joint effort involves exploring cost-sharing arrangements for deploying charging infrastructure. Such collaboration can also encourage grid capacity planning. Ideally, parties can work together to future-proof necessary electrical upgrades, minimising long-term costs and need for subsequent upgrades.

CPOs, fleets and DISCOMs can collaborate to strategically identify ZET corridors and cluster infrastructure on these routes to boost charging utilisation. This ensures that charging is readily available for fleets and assures CPOs of steady demand for power, providing a consistent revenue stream justifying investment.

Exhibit 26 Market Impact of Corridor Development

Risk	Ability to Reduce Risk	Description
Business risk: Utilisation	●	CPOs can scale their operations in accordance with the growth and deployment of ZETs on a particular corridor, leading to significant revenues from charging and more efficient cost recovery.

Coupling demand aggregation with corridor development

Aggregating demand for ZETs through corridor development is a powerful strategy that accelerates ZET adoption while minimising associated risks. Aggregating demand along specific corridors allows businesses to significantly reduce the risks associated with ZET utilisation. Concentrated and predictable ZET demand leads to predictable usage patterns, enabling charging operators to better plan and optimise their services. Additionally, demand aggregation allows CPOs to scale operations in sync with the growth of ZETs within a designated corridor. This scalability can result in increased revenue from charging services and efficient cost recovery.

Infrastructure development can, in turn, encourage market actors to participate in demand aggregation and scale ZET supply. For one, access to en-route charging along key corridors can boost transporters' confidence in committing to ZET deployment. Reliable charging infrastructure alleviates range anxiety, a key concern for ZET users, and supports the success of demand aggregation platforms. Additionally, developing corridors can build confidence, offering the assurance needed for OEMs to invest in and scale ZET production. Corridors can demonstrate the viability and functionality of ZETs to foster and support demand aggregation efforts. They can be used as testing grounds to identify best practices for justifying the implementation of ZETs

Coupling corridor development with demand aggregation synchronises the deployment of ZETs and charging infrastructure, effectively addressing the 'which comes first' market dilemma. This is an effective strategy to deploy ZETs and charging infrastructure together to ensure smooth operability of ZETs and optimal utilisation of chargers. Pairing ZET corridor development with demand aggregation can reduce risk, increase efficiency and accelerate ZET adoption.

Aftermarket support

Aftermarket support includes maintenance, repairs, spare part availability and technical assistance provided after the initial sale. Aftermarket services encompass a network of businesses that offer repair services, routine maintenance and replacement of specific parts and specialised accessories after the ZET is purchased. These include:

- **Subscription-based services**: Monthly or annual charges paid by trucking companies for maintenance, repairs and updates.
- **Performance-based contracts with OEMs**: Contracts between operators and OEMs or dealerships tied to predefined performance benchmarks detailed by OEMs.
- **Integration with roadside assistance services**: ZET repair services are integrated into roadside assistance operations.
- **Training programmes for ZET servicing**: Development of certification programmes for ZET maintenance and repair technicians.

- **Dedicated charging infrastructure repair contracts**: Given the technicalities and high-voltage wiring of charging, dedicated maintenance and repair agreements from third parties may be an effective strategy to service assets more efficiently and reduce downtime. Such agreements cover regularly scheduled maintenance, charger upkeep and emergency repair services.

- **Emergency services**: Specialised training, equipment and protocols are essential to safely manage battery fires, including coordination with manufacturers, containment of hazardous materials and standard practices for ambulances and hospitals to attend and manage responses.

The following measures can be implemented by third-party organisations and OEMs and bundled as part of annual maintenance contracts. Such contracts guarantee ongoing maintenance and assistance for EVs beyond the warranty period, ensuring long-term reliability and performance.

The existence of robust aftermarket support increases the likelihood of the product retaining its value over time and remaining operational, attracting prospective buyers in the secondary market. Essentially, potential buyers are inclined to invest in a product if they can easily access support services and spare parts and ensure the longevity and reliability of their purchase. Therefore, strong aftermarket support enhances the perceived value of a product and stimulates demand in the secondary market by instilling confidence in potential buyers.

Exhibit 27 Market Impact of Aftermarket Support

Risk	Ability to Reduce Risk	Description
Asset risk: Residual value	● (green)	Preventative maintenance and charging a ZET per manufacturer specifications can prolong the vehicle's life, ultimately contributing to high resale value and reduced residual value risk.
Business risk: Utilisation and uptime	● (orange)	Aftermarket ensures a ZET can be fixed, reducing revenue disruptions.

Reducing technology asymmetry with telemetric data

Overview: Information asymmetry remains a persistent challenge in the ZET market, where actors do not have access to information regarding truck performance, including vehicle utilisation data, downtime, range and battery performance.

Access to insights on battery performance is particularly valuable for market actors. The battery is the most expensive element of a ZET and significantly affects the asset's residual value. Battery performance also directly influences vehicle range and overall performance. Market actors gain confidence in buying and selling used ZETs by accessing granular data on battery health and performance. Such data can improve decision-making, enabling fleets, financiers and other actors to evaluate ZET purchasing decisions based on performance, efficiency and overall value proposition. Increased transparency can foster trust among consumers and contribute to the continued growth of the secondary ZET market.

From a financier's perspective, it is crucial to collaborate with technology companies, OEMs and other stakeholders to gain a deep understanding of battery health and longevity. For instance, a significant risk of default arises if a loan is set for five years but the battery degrades to a point at which the vehicle range becomes inadequate for the intended use before the loan term ends. Therefore, accessing such data can help determine the appropriate loan term and enable financiers to assess battery longevity accurately.

Exhibit 28 Market Impact of Reducing Information Asymmetry with Telemetric Data

Risk	Ability to Reduce Risk	Description
Asset risk: Residual value	●	Telemetric data provides comprehensive insights into the performance of ZET technologies, such as battery health, charging patterns and overall operational efficiency, enabling actors to prescribe a residual value to an asset more confidently.

Impact of battery state of health on ZET secondary market

The residual value of ZET vehicles is highly dependent on the retained value of batteries, constituting over 70% of the capital cost. Transparent data on battery performance, including the number of charge cycles before obsolescence for a use case and state of health (SOH) metrics — the retained battery capacity compared to design specifications expressed as a ratio — are crucial indicators of residual value and secondary uses for batteries. Such indicators can inform stakeholders about the battery's performance and vehicle ranges.

A battery's SOH deteriorates as the number of charge cycles increases. However, determining this value poses challenges primarily due to information asymmetry and SOH dependence on factors such as usage patterns, temperature and charging parameters. Increased transparency on battery operation and design specifications facilitates value determination and convergence among market participants around a universally recognised SOH value.

Economic Assessment of ZETs Across Use Cases

The preceding sections detailed the need for capital infusion and financial instruments to support the ZET market. However, ZET financial support can only be justified in case of a sustainable business rationale, wherein the unit economics align to incentivise business entities to transition. Hence, it becomes crucial to scrutinise the business viability and pinpoint early adoptable use cases for ZETs. The following section presents a series of case studies offering a real-world perspective on the economic viability of ZET technologies in specific trucking use cases.

Case studies

Three prominent ZET use cases are analysed: port, petroleum and e-commerce. These use cases cover key market segments and represent various duty cycles, daily distances travelled and vehicle classes. **Exhibit 29** provides an overview of the key vehicle characteristics for these selected use cases. The port e-truck case study draws on real-world data obtained from the deployment of BYD Q1R terminal tractors at Katupalli Port in 2023 as part of a pilot initiative. Meanwhile, assumptions about battery characteristics for petroleum and e-commerce ZETs are based on typical duty cycles for their respective applications.

Exhibit 29 Summary of Use Cases Selected for Unit Economics Analysis

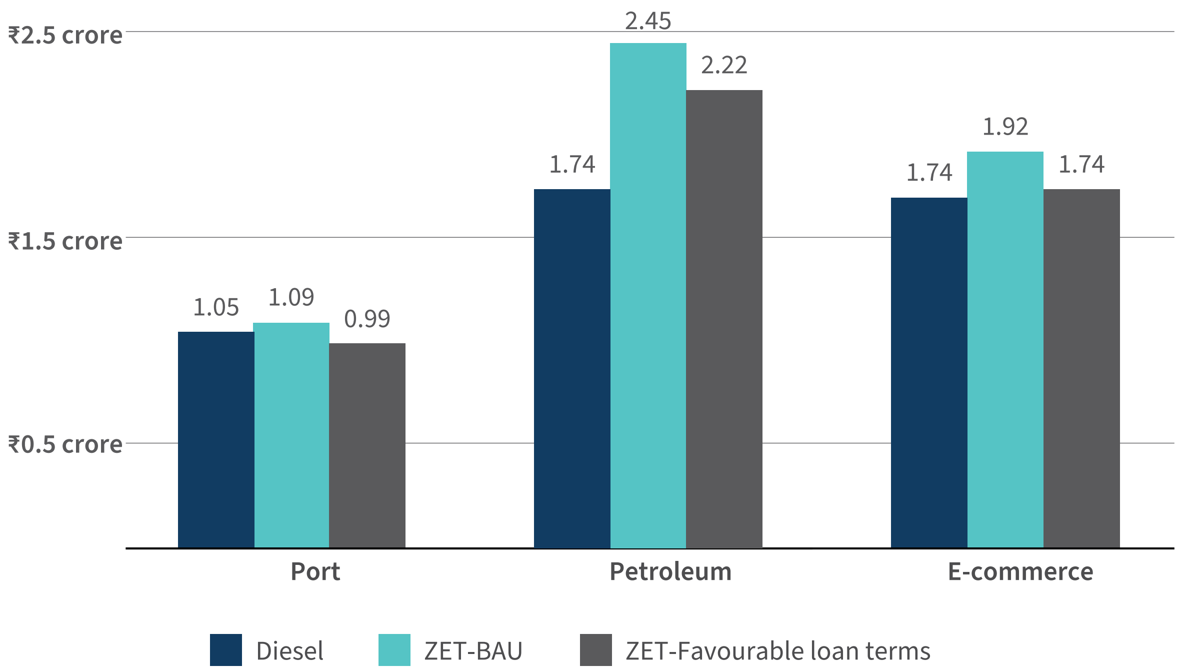
Case 1: Port[33]	Case 2: Petroleum[34]	Case 3: e-commerce[35]
		
• GVWR: 55 tonne • Battery size: 255 kWh • Battery range: 120 km • Annual VKT: 24,000 km	• GVWR: 28 tonne • Battery size: 459 kWh • Battery range: 376 km • Annual VKT: 1,20,000 km	• GVWR: 19 tonne • Battery size: 200 kWh • Battery range: 220 km • Annual VKT: 79,200 km

Note: 1. The inputs are derived from an extensive literature review and industry interviews. 2. Approval is required to transport petroleum products using ZETs, as there are potential risks associated with carrying fuel via these vehicles. These risks need to be examined to ensure compliance with all required safety approvals.

The unit economics analysis compares the TCO of diesel vehicles with ZET under two different financing scenarios: ZET-BAU and ZET-favourable loan terms. The above analysis depicts only cost considerations for enhanced accuracy, as there is significant variability in freight rates across each scenario. For a comprehensive overview of revenue data and net present value of ZETs, please refer to **Appendix C**.

The BAU scenario reflects current lending terms derived from stakeholder interviews. It assumes the purchase of ZETs through a five-year loan with 25% down payment and 16% interest. In contrast, the favourable loan terms scenario presents a seven-year loan structure with 9% interest rate. The results of this analysis are illustrated in **Exhibit 30** below.

Exhibit 30 Summary of Seven-year TCO of Three ZET Use Cases



These case studies provide insights into the use cases most suitable for being the first mover in trucking electrification in India as well as the role of favourable financing in improving the unit economics of ZETs compared to diesel trucks. Of the three identified use cases, petroleum tanker trucks exhibit the largest cost differential between ZET and ICE vehicles, primarily due to the high upfront cost associated with large battery size and specialised ZET trucks. The port terminal tractor emerges as the use case demonstrating the greatest economic feasibility for ZETs, achieving a 4% TCO superiority over diesel trucks for a seven-year lifespan. Such favourable economics led to actualised market momentum for ZET adoption in this use case; the Jawaharlal Nehru Port Authority announced its intent to transition to ZETs, deploying pilots as early as the end of 2024.[36]

The favourable seven-year loan with 9% interest rate effectively narrows the cost gap between ZET and ICE trucks. Both port and e-commerce ZETs exhibit a competitive seven-year TCO with their diesel counterparts in this scenario. Although the favourable loan structure reduces the TCO of petroleum ZET by around 10%, the overall TCO still remains 28% higher than diesel trucks, necessitating the exploration of other innovative financial instruments to ensure the economic viability of this use case.

These TCO results offer broad estimates regarding the unit economics of ZETs within a particular operational scenario. It is crucial to acknowledge that a range of dynamic factors, such as duty cycle and battery attributes, shape the practical feasibility of ZETs. In addition, policy and finance sector actors can improve the unit economics of ZETs through a series of favourable regulations and incentives, summarised in the exhibit below.

Exhibit 31 **Impact of Policy Measures and Financial Tools on ZET Economics**

Policy	Description
Favourable EV electricity tariff	Favourable EV tariffs reduce the overall charging cost and improve unit economics.
Purchase incentives for ZETs	Purchase incentives for ZETs, as direct subsidies or tax benefits, reduce the upfront cost. Thus, the interest and principal are paid over the load period.
High freight rates	High green freight rates paid to transporters or revenue subsidies can increase revenue flows and make ZET ownership more profitable.
Concessional financing rates	Providing ZETs favourable lending can reduce interest payments paid on loans and improve the attractiveness of ZETs.

ZETs exhibit economic competitiveness, particularly in specific closed-loop use cases with fixed routes, such as ports and e-commerce. Swift support to and exploration of these promising use cases are crucial. Nevertheless, additional funding and financial instruments are imperative in the near- and-long terms to bridge the cost disparity of ZETs, especially for use cases such as petroleum tanker trucks. This commitment is essential to ensure sustained and widespread adoption of ZETs across diverse applications.

Roadmap and Conclusion

Developing a comprehensive ZET financing strategy is essential to identify financial tools, evaluate outcomes and adapt to market demands through iterative processes. Tailoring financial tools to meet the evolving needs of the ZET market can ensure adequate funding for scaled development and appropriate distribution of risks among stakeholders. The exhibit below delineates the pivotal role of government and financiers and how their expertise can drive the development of a robust ZET market.

Exhibit 32 Role of Government and Differing Financiers in Mobilising and Scaling ZET Investment

	Near-term actions to finance the first 10,000 ZETs	Market sustaining actions to reach 15% ZET sales penetration
Government	• Extend grants to fund high-tension line extensions from substations to transformers • Provide incentives to defray ZET purchasing costs for the first 10,000 ZETs • Create a viability gap funding arm for public charging development	• Work with public sector undertakings to extend concessional debt to DISCOMs for line extensions and transformer installations for charging • Issue green bonds to support required grid-infrastructure development for ZETs
Philanthropists, multilateral and development finance institutions	• Develop risk-sharing facilities to cover ZET market losses • Provide concessional finance to be further on lent to local financiers	• Develop funding platforms to attract equity investment in the ZET ecosystem
Local finance institutions and banks	• Dedicate internal capacity to assess the financing intricacies of ZETs and invest in ZET pilots • Utilise and apply for the use of loan guarantees and increase lending to ZETs	• Develop tailored lending products for ZETs and charge point operators, elongating loan tenure • Insurance providers and other market actors initiate the creation of extended ZET warranties and depreciation schedules

The government plays a crucial role in building confidence and encouraging the shift to ZETs through financial incentives and customised fiscal measures. MDBs and DFIs can partner with governments to provide concessional financing and minimise private-sector investment risks with loan guarantees. Additionally, commercial investors can help create specialised lending products and develop in-house expertise regarding the risk and operations of low- and zero-carbon freight operations.

Market actors, including fleets, insurance companies, OEMs and technology startups, also support a conducive ZET financing ecosystem. These entities are instrumental in helping financial institutions comprehend the operational intricacies of the ZET market and have a key role in forming partnerships with banks and NBFCs to finance ZET projects. Market actors play a crucial role in implementing de-risking practices and developing conducive ZET business models to manage risks effectively. The exhibit below highlights specific actions by stakeholder type.

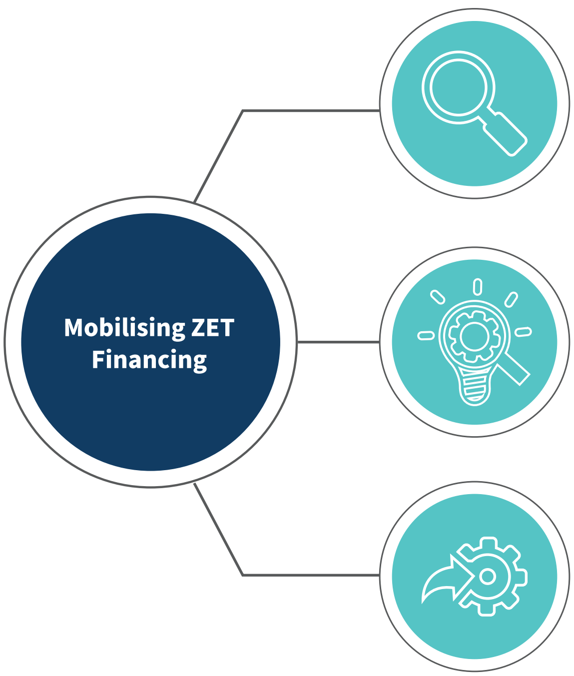
Exhibit 33 Actionable Opportunities for Market Actors

	Near-term actions (6 months to 1 year)	Market sustaining actions (1 year to 5 years)
Fleets	• Work with financial institutions to reach the financing terms mutually agreed upon for ZETs • Formulate demand aggregation tie-ups	• Explore leasing to spur near-term ZET adoption
OEMs	• Produce and sell timely, high-quality, safe and reliable ZETs and share proof points about ZET performance to create market confidence	• Provide after-sales support and maintenance services to ZET end-consumers • Introduce warranties and buyback schemes for ZETs to build market confidence
CPOs	• Deploy high-power capacity chargers along corridors	• Offer charging-as-a-service. • Work with financiers to better understand the risks of debt and equity investment in charging infrastructure development
Technology	• Develop battery state-of-health diagnostics systems to provide market actors battery operation and performance data	• Support actors in analysing ZET freight flows to synthesis operational data
Insurance	• Evaluate the unique risks of operating and owning ZETs	• Develop tailored compressive insurance products for ZETs
DISCOMS	• Develop capacity maps and power availability data within and along specific corridors • Work with state regulatory agencies, CPOs and fleets to plan for ZET charging demands	• Develop and invest in grid readiness strategies for ZETs

Conclusion

Finance is a critical growth catalyst in ZET market segments, including ZET manufacturing, ZET purchase, charging infrastructure deployment and requisite grid upgrades. Financing the ZET transition requires a blend of financial instruments and risk management measures. Concessional financing instruments, such as low-cost loans and guarantees, can play a crucial role in increasing capital flows and redistributing financial liability. Viability gap financing through the deployment of grants and other incentives is also important, as it sends a clear market signal and ideally attracts more significant private investment in the emergent ZET ecosystem. In addition to financial tools, the development of specific business models represents a pathway for market actors to distribute risk more efficiently, and de-risking practices implemented by several sectoral actors can reduce risk within the sector. The combination of these levers can mobilise funding and facilitate better access to affordable finance for end consumers. To attract funding and mitigate lending risks, all stakeholders within the ecosystem must collaborate to identify how financial tools can be piloted and scaled. Through joint efforts, stakeholders can combine resources, share expertise and formulate collective strategies.

Exhibit 34: Interrelationship of Financing Tools, De-risking Practices and Business Models



Identify a blend of financing tools to spur ZET market development:
Debt, equity, risk-sharing facilities, viability gap financing

Develop business models to more effectively manage and distribute ZET risk:
Leasing, insurance, warranties

Implement de-risking practices to reduce market risk:
Demand aggregation, corridor development, reducing information asymmetry, aftermarket support

Adopting ZETs in India can align with the nation's vision of self-reliance and position it as a global leader in clean freight technology. The potential for sustained fuel cost savings, along with substantial reduction in logistics expenses, emissions and improved air quality, underscores the transformative impact of ZETs on the transportation sector. The enhanced energy security resulting from this shift to zero-emission vehicles contributes to India's resilience and sustainable development. By mobilising finance, India can transform its trucking sector and pave the way towards a clean and sustainable future.

Appendices

Appendix A: Monetised Impact of Financial Tools on ZET TCO

Financial instruments are essential to kickstart the adoption of ZETs. These interventions bridge the ZET TCO gap, which is crucial for encouraging actors to transition to ZETs. This appendix details the process used to determine how finance tools lead to a monetised impact and work to close the TCO gap.

A ZET TCO baseline was established per a bottoms-up analysis of the capital and operational cost of running a ZET (see **Appendix C** for specific assumptions regarding ZET cost). The analysis then sought to understand how financial tools could be applied to achieve 3% TCO superiority compared to diesel vehicles (see **Appendix C** for details on diesel vehicle prices). Based on market interviews, 3% TCO superiority was established as a viable point at which logical market actors would consider making the switch to ZETs, as freight actors are highly sensitive to TCO, and recover some additional savings from switching to ZETs. Hence, 3% was established as the benchmark.

The exhibit below outlines the financial tools modelled and how they affected ZET TCO.

Exhibit 35 Finance Tools' Impact on ZET TCO

Impact on ZET TCO	Financial Intervention	Modelling
Low loan and interest payments	Concessional debt for ZET purchase	Modelled as the difference between a 9% and 16% interest rate.
Low electricity price during charging	CFA, grants for line-extensions and on-site electrical	Modelled as line-extension costs not borne by the CPO and demand chargers for charging providers at industry average of ₹110/kVA.
	Viability gap financing to close CPO operational cost and revenue gap	Modelled as the amount to close CPOs' operational cost and revenue gap for 10 years, assuming CPOs pass along a ₹1.25/kWh reduction in electricity price to end consumers.
	Concessional debt/equity for CPOs	Modelled as the ability of CPOs to raise low-cost capital at 9%, with a debt ratio of 80% over a 15-year term.
Low purchase price	**Viability gap financing:** Purchase incentives	Modelled as a purchase incentive needed to achieve the targeted 3% TCO after all other ZET financial tools above are implemented.

1. Modelling the use of concessional debt

The impact of concessional debt was monitored by deriving the difference between the two, the baseline scenario with a 16% interest rate and post-intervention where the interest rate is assumed to fall to 9%, the same recorded interest rate for ICE truck lending. The loan tenure and LTV were held constant at five years.

The BAU lending terms rate was derived from a series of stakeholder interviews and represents the market average. While interest rates can vary depending on the customer and their balance sheets, the following rates provide a broad market perspective. As it is crucial to understand the distinction between ICE and ZET interest rates, market average interest rates were derived and compared across the two. Additionally, regardless of creditworthiness, ZET interest rates are consistently higher for borrowers compared to ICE interest rates. The concessional rate represents the average rate of ICE loans. This is the target rate where we aim for convergence to help offset the cost penalty associated with ZET technology.

Exhibit 36 Differing Loan Terms for ZET Loans

	Interest Rate	Tenure	LTV
BAU loan terms	16%	5 years	75%
Concessional loan terms	9%	5 years*	75%

Note: While market actors prefer a seven-year loan tenure, this model focuses only on the impact of interest rate changes, to show the impact of concessional loan terms for ZETs.

2. Impact of financial tools on electricity prices for charging includes the effect of CFA, viability gap funding, and concessional equity provided to charging operators, which can help reduce the electricity prices passed on to end consumers.

Incentives for CPOs and requisite grid infrastructure, such as access to affordable debt and grants or green bonds for line extensions, indirectly support ZETs by facilitating the development of necessary charging infrastructure. Without these tools, the entire cost of infrastructure development and grid upgrades would be passed on to ZETs through high electricity prices.

To assess the impact of available financing on TCO, a bottom-up cash flow statement was created to forecast charging infrastructure providers' financials. The analysis modelled infrastructure development costs based on utilisation rates, determining the charging prices needed for operators to recover costs and achieve 15% IRR profitability threshold over 15 years.

Notably, this was a national-level approximation of the cost to develop a charging station. It was derived by approximating the number of chargers needed to meet ZET deployment demand over the next 15 years (see **Appendix B** for more details).[37]

a. Modelling the cost of charging infrastructure development: Two scenarios were compared: (1) business as usual (BAU), which is without financial tools and where the cost of debt and equity is high, and (2) wherein financial tools cover some of the detailed costs. Three key costs were derived to understand the total cost burden of CPOs: capital costs, operational expense, and electricity fees.

Capital costs: The capital costs are assumed to remain the same across the two scenarios. However, since the lending rates applied to the two scenarios differ, the annual interest and the principal also vary, as shown in **Exhibit 37** below.

Exhibit 37 Differing Lending Rates Applied Against the Two Scenarios for CPOs

Type of Support	BAU	Financial Intervention
Concessional debt for CPOs	16% interest rate, 15 years, 80% debt ratio	9% interest rate, 15 years, 80% debt ratio
Concessional equity for CPOs	NA	15 years, 15% equity

The capital cost also includes ancillary electrical costs, which is the cost of requisite line extensions from the substation, and the distribution transformer (DT) cost per kVA rated capacity to provide requisite power to charging stations based on the number of chargers deployed year over year to meet ZET demand.

Exhibit 38 Charger Hardware Costs Modelled by Size

Input	Value	Assumption
100 kW charger hardware cost considered appropriate for MDT charging	₹16 lakh	Based on market research and interviews with charging operators in India.
500 kW charger hardware cost considered appropriate for HDT charging	₹54 lakh	Extrapolated from market interviews and derived per market rate price decline.
Installation cost	20% of hardware	As per market research, installation costs include civil works (trenching and wiring, installation, and commissioning).
Incremental cost decline	2%	Hardware cost per charger-by-charger size was modelled to decline through 2039 to account for economies of scale and convergence in price.

Exhibit 39 Assumptions Detailed for Electrical Equipment

Type of Support	BAU	Financial Intervention
Line extensions and on-site electrical upgrades such as addition of transformers	The requisite grid infrastructure costs, such as line extensions and transformer installation, are borne by the CPO. This cost was calculated by deriving the total cost of electricity upgrades outlined in **Appendix B**, following which a ratio based on the expected on-site costs was assumed.	DISCOMs cover these costs through access to grants, green bonds, and concessional equity. It is modelled that the CPO does not bear this cost.

Operational costs: Remain constant across the two modelled scenarios.

Exhibit 40 Operational Cost Component Modelled Assumptions

Operational Cost Component	Description
Maintenance	5% each year from the first year of each charger's installation.
Labour	Labour costs are 10% of the maintenance costs.
Electricity tariff	Electricity tariff of ₹6.5/kWh is derived by averaging tariffs across states in India. The average demand charges utilised was ₹110/kVA per month.
Land	Yearly land costs are derived based on the technology assessment of ZET along the Delhi-Jaipur corridor, where the average land cost for charging use is derived as an expected cost approximation. Land costs are then shown as lease, per market interviews, with the annual leasing amount proportional to recouping the original land cost in 15 years.

Electricity fees: A national market average tariff was derived by assessing the industrial tariff; this reflected the energy charges of ₹6.5/kWh and was utilised for both the scenarios.

Demand charges included a ₹110/kVA fee; notably, these chargers are highly dependent on the region.[38] The demand charges were assumed to remain constant in both the modelled scenarios and the demand modelled was considered to represent the national average. However, as some regions in India have double the assumed demand charges, tariffs may be more substantial depending on the region. An additional intervention that becomes highly relevant is demand charge holidays, where the CPO does not include demand chargers for several years as utilisation stabilises.

In addition, the analysis also included an interconnection fee, which is the fee paid at the connection point and is included in the total grid cost (see **Appendix B** for details on how grid costs were derived).

b. Assessing the profit margin of ZET charging and electricity prices charged to ZET operators: A cash flow statement is derived from the outlined cost for the two scenarios based on a fixed utilisation of charging equipment; the model then arrives at the revenue needed to be profitable to derive the electricity price for charging. The model aims to achieve 15% IRR in 15 years by adjusting the charging electricity price based on standards utilised and published by the State Bank of India.

This model assumes that chargers are deployed incrementally based on the number of ZETs. Thus, an ultra-fast charger, which can fully charge an HDT in around two hours, is utilised for two hours a day or 8%. As truck sales increase, utilisation of each charger is expected to increase. For fast chargers, which can fully charge an MDT in roughly three hours, the utilisation is eight hours or 33%. Utilisation of fast and ultra-fast chargers increased 3% yearly over 15 years. For example, if ultra-fast charger utilisation rises 3% each year, utilisation would climb to about three hours or 13% per day by the end of its 15-year lifespan. The model calculates the electricity demand by considering the number of trucks, battery size and typical ZET operating parameters. The model uses this derived demand to achieve 15% IRR by adjusting the electricity price accordingly.

The model depicts two price structures for ZET consumers, as the high peak loads from ultra-fast charging led to additive costs and are priced accordingly. Thus, using ultra-fast (500 kW) public chargers cost nearly 25% more than (100 kW) depot fast chargers on kWh basis. Based on the modelled parameters, charging operators can price electricity at the following rates listed in **Exhibit 41** to achieve the desired 15% IRR.

Exhibit 41 Prices CPOs Need to Sell Electricity at to Meet IRR Targets

	BAU	Financial Intervention
Fast charging	₹12/kWh	₹9.6/kWh
Ultra-fast charging	₹14.4/kWh	₹12/kWh

3. Impact of purchase incentives

This is modelled as a purchase incentive needed to achieve the targeted 3% TCO superiority by 2026 after implementing other ZET financial tools above and is based on the bottom-up cost of ZETs in **Appendix C**.

The purchase incentive is expressed as a three-year average purchase incentive. For MDTs, the average incentive was ₹14 lakh derived from the TCO between 2024 and 2026, when purchase subsidies are needed to completely close the TCO gap. The subsidy would be ₹7.6 lakh in 2026, which is needed to reach 3% TCO superiority. For HDTs, the average incentive amount was ₹33 lakh derived based on the TCO from 2024 to 2027, with a subsidy of ₹12.9 lakh, which is needed to reach 3% TCO superiority in 2026.

Appendix B: Market Size

The total investment required across the four segments will include ZET purchase, ZET manufacturing, charging infrastructure and requisite grid upgrades. Such investment costs are derived based on ZET sales. The ZET asset costs are derived based on cost assessment of the balance of truck cost, cost of batteries and profit multiplier to account for manufacturing costs.[viii] The costs associated with charging infrastructure and grid upgrades were determined by estimating the charging and power demand, along with the cost of charging infrastructure and necessary ancillary electrical equipment upgrades.

ZET cumulative cost: This denotes the capital required for the majority share of the truck stock to transition to ZETs by 2050, based on the optimistic adoption scenario outlined in the Truck Emission Projects Mapping 2050 report.[39] In this scenario, ZETs are projected to constitute over 50% of the total stock.[40] To obtain this figure, the cost of ZETs was derived as outlined in **Appendix C**. The cost of the truck was then multiplied by a profit multiplier to account for the manufacturer's margins. This value was taken as 10%. Given this practice, the ZET cost depicts the cost of ZET procurement and manufacturing as manufacturers will pass along their costs in the truck price.

Charging infrastructure cumulative cost: As outlined in **Appendix A**, the total cost of the charging deployment was determined by analysing capital and operational expenses. The cost per charger was multiplied by the required number of chargers to meet the forecast ZET charging demand over the next 15 years. The charging demand was estimated based on the number of ZETs sold as mentioned above and an assumed 4:1 ratio of trucks to chargers. This ratio was modelled as a conservative estimate based on the need for en route charging along several major corridors to accommodate a range of routes and will remain low as ZET adoption increases. As a result, the initial utilisation rates will start out low and gradually increase with time. The average utilisation rate, when calculated based on charging time, is approximately 8% and grows over time.

Grid costs: The cost of upgrading the grid is closely linked to the projected number of ZET charging stations throughout India and the anticipated peak load demands at each station. To accurately assess these costs, the previously mentioned number of chargers were allocated to an assumed number of charging stations, based on the assumed maximum peak load that charging stations can take. The detailed approach is explained below.

First, based on stakeholder interviews, the peak load at all charging stations is assumed not to exceed 100 MW to avoid the high cost associated with transmission-level grid upgrade. Therefore, we capped the peak load at 100 MW across charging stations and maximised the number of chargers within each station. Additionally, two types of charging stations were assumed for simplicity: overnight charging depots that only include 100 kW slow chargers and en route fast charging stations that only include 500 kW chargers. Based on these two assumptions, we calculated the number of fast and slow charging stations needed every year between 2024 and 2040.

The next step is to calculate the total grid upgrade cost for each slow and fast charging station based on the type and quantity of the required electrical infrastructure. Fast-charging 500 kW chargers need substations and lines to be constructed to lower the 220 kV power at the transmission level to 33 kV at the charger level. Slow-charging 100 kW chargers need the 220kV power to be further stepped down to 11 kV. The key cost components for upgrading the grid infrastructure are summarised in **Exhibit 42**.

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viii. Profit multiplier refers to the additional mark-up manufacturers apply on a vehicle to recoup a profit.

Exhibit 42 Key Grid Upgrade Cost Items for Slow and Fast Charging Stations

Charging Station Type	Main Cost Items
Fast charging stations	220/132/33 kV substation; 10 km 33 kV lines; Labour costs, Processing fee
Slow charging stations	220/132/33/11 kV substation; 10 km 11 kV lines; Labour costs, Processing fee

Finally, the total grid upgrade costs were calculated based on the electrical equipment unit cost in DISCOM cost databooks. The data sources are summarised in the exhibit below.

Exhibit 43 Summary of Grid Upgrade Cost Input

Electrical Equipment	Cost (₹ per unit)	Data Source
220/66/33/11 kV substation	67,70,73,000	Dakshin Haryana Bijli Vitran Nigam Ltd. (DHBVN) 22–23 Cost Databook[41]
220/132/33 kV substation	51,89,89,000	DHBVN 22–23 Cost Databook
132/33 kV substation	20,03,93,000	DHBVN 22–23 Cost Databook
66/11 kV substation	11,68,26,000	DHBVN 22–23 Cost Databook
33 kV line (per km cost)	40,66,582	DHBVN 22–23 Cost Databook
11 kV line (per km cost)	6,62,297	DHBVN 22–23 Cost Databook
Processing fee 3–10 MW	15,000	UP Cost Databook[42]
Processing fee >10 MW	25,000	UP Cost Databook
33/11 kV transformer	63,83,075	DHBVN 22–23 Cost Databook
11 kV panel	28,34,118	DHBVN 22–23 Cost Databook
11 kV automatically switched capacitor	10,48,069	DHBVN 22–23 Cost Databook

Appendix C: Cost of ZETs

The purchase cost of a fully loaded truck is the sum of the battery cost and the balance of the truck. The battery cost is the product of battery size (kWh) and battery per unit cost (₹/kWh). The model assumes a decline in per unit battery cost from ₹1.9 lakh in 2024 to ₹0.8 lakh in 2033—the primary reason for the decrease in purchase cost. The cost of ZETs is calculated in the five steps explained below:

Step 1 Calculate the Capital Cost Components

Cost Component	Metrics	Assumptions
Down payment	25%* purchase cost	Based on the market average of 75% loan to value (LTV) of ZETs*, our model used the remaining 25% LTV to calculate the down payment.
Interest + Principal	**Nominal interest rate:** 16% per annum	Based on the market interviews, 16% is the initial interest rate for ZET fleet loans. The interest rate is higher than the diesel interest rate because ZET technology is still nascent and has technology risk.
	Loan term: 5 years	Based on the market standards for diesel trucks, five years is used as the loan term for ZETs.
	Lifespan: 7 years	For more details, refer to Technology Assessment of Office of the Principal Scientific Adviser report on Zero-Emission Trucking on the Delhi-Jaipur Corridor, November 2023.
Balance of the truck cost	₹19 lakh for MDT and ₹44 lakh for HDT	Based on the cost of the truck chassis, power electronics, onboard charger, and thermal management system. For more details, refer to the Technology Assessment of Office of the Principal Scientific Adviser report on Zero-Emission Trucking on the Delhi-Jaipur Corridor, November 2023.

Note: LTV of 75% is different than the market ICE average as lenders expect ZET consumers provide more capital upfront as a guarantee or added incentive not to default or abandon the asset.

Step 2 Calculate the Operational Cost Components

Cost Component	Metrics	Assumptions
Maintenance cost	120%* diesel maintenance cost (years 2024–26) 80%* diesel maintenance cost (years 2027–29) 60%* diesel maintenance cost (year 2030 onwards)	Based on the market average diesel maintenance costs, the ZET maintenance cost declines from 120% to 60% during its lifespan. The decline in ZET maintenance costs is due to an increase in available resources for repairs, enhanced technical expertise, and a growing number of skilled service technicians. These improvements are expected to bring ZET maintenance costs in line with diesel maintenance costs by 2027, with further reductions anticipated in the future.
Fuel cost	Total fuel cost per year = fuel cost (₹/kWh) * efficiency (kWh/km) * vehicle kilometre travelled (km/year)	Based on the average cost of electricity tariff, average vehicle efficiency and annual kilometres travelled.
	Fuel costs: • **For fast charging:** ₹8.7/kWh • **For ultra-fast charging:** ₹11.2/kWh	Based on the type of charging requirement for fast and ultra-fast charging. The model assumes 15% IRR in 15 years for CPOs to continue operating profitably, without overburdening ZET operators with fuel costs (see **Appendix A** for more details).
	Efficiency: 80% or 0.80 (kWh/km)	Based on a conservative estimate of 80%, it is the lowest technical threshold below which the batteries become inefficient for trucking applications.
	Vehicle kilometre travelled = kilometres travelled per day * number of operating days per year = 1,05,000 km/year	Based on the 300 km travelled per day and 350 operating days per year.
Insurance cost	3%* depreciated value	Based on the depreciated value
Depreciated value	Straight line depreciation = (purchase cost – estimated salvage value) / lifespan	The depreciation value is calculated using the straight-line depreciation (SLD) method with the assumption that the salvage value is 0. SLD is applied to long-term assets and uniformly reduces the value of the asset over its lifespan.

Step 2 Calculate the Operational Cost Components (Continued)

Cost Component	Metrics	Assumptions
Battery replacement cost	Battery replacement cost	Battery cost * battery size
	Battery life (km) = Battery life (cycle) * kilometres travelled per day (km)	The battery life (cycle) is the number of charging cycles before the efficiency of a battery reduces to less than 80%. The model assumes that battery life (cycles) will gradually increase over the years because of advancements in battery technology. In 2024, the battery life is 2,533 cycles and grows 4% on average every year compared to that in the last year.
	The number of batteries required over a lifetime: (VKT* lifespan)/(battery life*range)	Based on the range of 300 km per day
	Battery replacement timeline = Lifespan of truck (years)/ battery size (kWh)	The battery replacement timeline increases gradually based on a derived expected factor for technology improvement.

Step 3 Calculate the Residual Value

Cost Component	Assumptions
Residual value	15% of the purchase cost of ZET

Note: Residual value is a positive inflow at the end of the truck life. The net present value (NPV) of this value was subtracted from that of all other cost components.

Step 4 Calculate the NPV of the Cost Components

The NPV of the capital cost, operational costs and residual value are calculated. To assess when ZETs become profitable the net present value of the capital cost, operational cost, and remaining residual value was derived assuming a fixed discount rate.

Cost Component	Metrics	Assumptions
Discount rate	**Real discount rate:** 13%	The discount rate for new products or industries is generally higher at 12% to 20% due to the risk returns on investments.

Step 5 Calculate the TCO

Cost Component	Metrics	Assumptions
TCO	TCO = Capital cost + operation cost – residual value	Based on the above assumptions on capital cost, operation cost and residual value.

Appendix D: Unit Economics

The unit economics case study analysed the seven-year TCO and revenues for three prominent trucking use cases: port, petroleum and e-commerce. Due to limited data availability and variations in revenue numbers, only the TCO results were included in the main report. Despite data quality concerns, showing the revenue data collected through literature review and stakeholder interviews is meaningful, reflected as freight rates paid to fleet operators. **Exhibit 44** summarises the revenue data of the three use cases and their data sources. Analysing revenues along with the TCO can effectively show the economic viability of ZET's operation. More granular stakeholder interviews that cover different regions, truck VKT, commodity types, etc., can potentially solve the data availability challenges.

Exhibit 44 Summary of Revenue Data of Selected Use Cases

	Port (55 tonnes)	Petroleum (28 tonnes)	E-commerce (19 tonnes)
Freight rates	₹56/km	₹3.36/kl–km or ₹67.2/km with a 20 kL tank	₹3–7/tonne-km or ₹21–35/tonne-km with 7-tonne payload*
Sources	Research and Reporting of Internal Transfer Vehicles in Ports and ICDs (EY, Nov 2023)	Research and Reporting of Outbound Truck Tanker Logistics in PSU Refineries (Deloitte, Oct 2023)	Expert interviews

Note: A 19-tonne e-commerce truck typically has a maximum payload of 11–12 tonnes. However, interviews indicate that trucks are usually not fully loaded for this particular use case and tend to only have 7–8 tonnes of real payload.

The TCO analysis utilises a similar approach to the vehicle cost calculations outlined in **Appendix C**. This means that the TCO is also the sum of capital costs and operational costs minus the residual value, which is 15% of the vehicle capital cost at the end of the seventh year. These TCO calculations also use a 13% discount rate. However, in the unit economics study, we customised the input assumptions for each use case to account for their unique operational conditions. **Exhibit 45** summarises the key assumptions for the three use cases. The analysis relies on the data points provided in existing publications from EY and Deloitte for ports and petroleum use cases, and interviews were conducted for e-commerce where existing publications were unavailable.

Exhibit 45 Summary of Key Input in TCO Calculations

	Port (55 tonnes)		Petroleum (28 tonnes)		E-commerce (19 tonnes)	
	ICE	ZET	ICE	ZET	ICE	ZET
Capital costs (₹)	39,00,000 (EY[ix])	1,20,00,000 (EY)	30,92,000 (Deloitte[x])	1,57,96,984 (Deloitte[xi])	32,01,489 (RMI)	1,26,44,923 (RMI)
Payload	Not used in the calculation		20 kl		7 tonnes	
Battery capacity (kWh)	-	255 (EY)	-	459 (Deloitte[xii])	-	220 (Expert interview)
Battery efficiency (kWh/km)	-	2.1 (EY)	-	1.22 (Deloitte)	-	0.91 (Expert interview)
Fuel efficiency (L/km)	0.6 (EY)	-	0.31 (Deloitte)	-	0.38 (RMI)	-
Maintenance costs (₹/km)	6 (EY)	8 (EY)	3 (Expert interview)	4.5 (Expert interview)	3 (Expert interview)	5.5 (Expert interview)
Electricity cost (₹/kWh)	-	13.5 (Expert interview)	-	12.5 (Deloitte)	-	12.5 (RMI)
Diesel cost (₹/L)	100 (RMI)	-	100 (RMI)	-	100 (RMI)	-
Monthly VKT (km)	2,000 (EY)		8,500 (Expert interview)		6,600 (Expert interview)	
Battery replacement schedule	Battery replaced in the fifth year of the ownership (EY)		No battery replacement during the seven-year ownership (RMI)		No battery replacement during the seven-year ownership (RMI)	

The re-charging or electricity cost modelled for e-commerce use case was ₹12.5/kWh, see **Appendix A** for a more detailed justification of the cost derivation, and the battery replacement modelled at 2,533 charge cycles as detailed in **Appendix C**. For the port use case, modelled inputs were derived from the **Research and Reporting of Internal Transfer Vehicles in Ports and ICDs** report which obtained data from extensive stakeholder interviews.

Two differing scenarios, the BAU and favourable lending scenario, are then modelled to depict the impact of financing terms on the ZET TCO. The BAU scenario reflects the projected ZET lending rates acquired through market interviews and reflects the perceived risks related to ZET ownership. In contrast, the favourable loan term scenario depicts a mature market where ZET loan terms and interest converge to ICE rates today, and ZETs are not charged an interest rate premium.

ix. Data obtained from ***Research and Reporting of Internal Transfer Vehicles in Ports and ICDs***.

x. Data obtained from ***Research and Reporting of Outbound Truck Tanker Logistics in PSU Refineries***.

xi. Data obtained from ***Research and Reporting of Outbound Truck Tanker Logistics in PSU Refineries***.

xii. Data obtained from ***Research and Reporting of Outbound Truck Tanker Logistics in PSU Refineries***.

Exhibit 46 Loan Terms

	Loan Term	Down Payment	Interest Rate
BAU	5 years	25%	16%
Favourable loan terms	7 years	25%	9%

Appendix E: Leasing

The leasing section compares the seven-year cost of leasing versus purchasing a ZET. The key characteristics of the selected MDT and HDT are summarised below.

Exhibit 47 Leasing Operational Parameters

	MDT	HDT
Annual VKT (km)	1,05,000	1,05,000
GVWR (tonne)	15	44
Battery size (kWh)	353	618
Pre-tax cost in 2024 (₹)	86,78,854	1,63,08,514

Given that there is no commercial-level ZET leasing programme in India, the key assumptions in the leasing TCO calculation largely rely on stakeholder interviews and future market projections. We utilise the approach described in **Appendix C** for purchasing cost calculations. **Exhibit 48** summarises the assumptions behind key cost components in TCO calculations.

Exhibit 48 Summary of Key Cost Components in the Purchasing and Leasing TCO Calculations

Cost Components	Purchasing	Leasing
Upfront payment	**Loan down payment:** 25% of the vehicle market price	**Processing fee:** 1% of vehicle market price **Deposit:** Three months of the monthly leasing fee, returned at the end of the first year
Annual capital costs	**Interest and principal:** 16% interest rate, five-year loan term	**Monthly leasing fee:** 2.8% of the vehicle market price and insurance
Fuel cost	Paid by fleet operators, calculated using the same approach as the bridge funding section	Paid by fleet operators, calculated using the same approach as the bridge funding section
Maintenance cost	Paid by fleet operators, same as fuel cost assumptions in the bridge funding section	Not paid by fleet operators
Insurance cost	Paid by fleet operators, same as fuel cost assumptions in the bridge funding section	Not paid by fleet operators on annual basis but included in the monthly leasing fee calculation
Residual value	15% of the truck market price at the end of the seventh year	Not included in the TCO calculation for fleet operators

The primary determinant influencing the economic viability of leasing lies in the monthly leasing fee, which is calculated based on the expected 15% IRR of the leasing company. In this financial analysis, we assume that the leasing company's revenue stems from the monthly leasing payments and one-time processing fee, while costs include vehicle capital cost (financed through a loan), insurance and maintenance.

Several factors, including specific lending terms, corporate income tax, maintenance costs and residual value, can impact the monthly leasing fee necessary to attain the target IRR. **Exhibit 49** presents two scenarios outlined in the main report, both capable of achieving the 15% IRR threshold.

Notably, the actual IRR is influenced by various factors related to loans, leasing arrangements and taxes. If the leasing company efficiently manages tax liability distribution, benefits from reduced maintenance costs, secures favourable loan terms and realises a higher residual value at the conclusion of the lease term, the same 15% IRR can be achieved with a much lower monthly leasing fee. This makes leasing more economically attractive. For example, with a marginal reduction in corporate income tax, a 10% decrease in maintenance costs, a seven-year loan with a 9% interest rate and a 20% residual value at the lease term's end, the leasing company can achieve an equivalent IRR by charging a leasing fee of just 2.3%. This results in a TCO for leasing that is only 4% higher than purchasing over seven years.

Should leasing companies secure favourable loan terms, reduce truck maintenance costs relative to fleet operators, optimise tax expenditures and realise greater residual value at the conclusion of the vehicle's lifespan, they can offer consumers a more appealing monthly leasing fee. This would potentially render leasing a more economically viable option compared to purchasing in the long term.

Exhibit 49 Summary of Leasing Sensitivity Analysis Assumptions

	Scenario 1	Scenario 2
Monthly leasing fee	2.8%	2.3%
Loan interest rate	14.25%	9%
Loan tenure	3 years	7 years
Tax (as a % of the collected leasing fee)	25%	20%
Residual value (as a % of the vehicle capital cost)	15%	20%
Maintenance cost	Same as the maintenance cost in the bridge funding section	90% of Scenario 1 maintenance cost

These findings underscore significant uncertainties surrounding the TCO of leasing, primarily due to the lack of real-world ZET leasing data in the Indian context. The economic feasibility of leasing hinges on how leasing companies minimise capital and operational expenditures and pass these costs on to consumers through the leasing fee.

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