Smart Freight Centre India

REPORT

DATA PARTNERSHIP FOR INDIAN ROAD FREIGHT

Driving Scale Up through Economic Analysis of Shipper Use Cases

By SMART FREIGHT CENTRE

About Smart Freight Centre

Smart Freight Centre is an international non-profit organization working on Freight Decarbonization to minimize the climate impact of the global freight and logistics sector. Smart Freight Centre has also undertaken a host of Freight Decarbonization initiatives in India under its India program, working in close collaboration with the India Freight Industry, Policy Offices (national and sub-national), Academia & Research and other ecosystem partners, targeting one of the world's largest freight markets with the urgent mission to address the projected 400% increase in CO_2 emissions by 2047. Smart Freight Centre, with its India program, is deeply engaged with NITI Aayog's e-Fast India program, collaboratively working with various knowledge partners to advance specific aspects of ZET ecosystem development, while also leading on Freight Emissions Guidance Development and Industry adoption in India. Through these strategic partnerships and a collaborative approach, SFC India envisions and works toward a freight and logistics sector that is sustainable, environmentally responsible, and actively engaged in mitigating climate impact, seeking commitments from logistics service providers and shippers to adopt emission reduction strategies for a more sustainable future.

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Acknowledgement

We extend our heartfelt gratitude to all the partners and contributors who played a vital role in shaping the Data Partnership Program. This initiative would not have been possible without the deep engagement and shared vision of organizations committed to accelerating the transition to zero-emission freight in India.

At the heart of the initiative is a simple but powerful insight: the economic viability of e-truck deployment depends on real-world use cases, shaped by factors such as vehicle duty cycles, load profiles, route conditions, and charging opportunities. This is why the program's unique **"Data Partnership"** framework—anchored in data voluntarily shared by partners across key industries—is so critical. We thank these partners for their openness and commitment, without which this analysis would not have been possible.

We are especially grateful to the **World Resources Institute (WRI)** - in particular **Pawan Mulukutla** and **Sharvari Patki** and to the **Shakti Sustainable Energy Foundation** for their valuable contributions and support. We also thank the **Centre for Excellence on Zero Emission Trucks (CoEZET),** especially **Ajithkumar TK, Selvarajan T** and **Ravi M.** We also want to extend special thanks to **UC Davis** for their continued thought leadership, technical expertise, and support throughout the design and execution of the program.

We would also like to sincerely thank **Mr. Vijay Jaiswal,** former Director of SFC India, for his valuable guidance and insights that helped shape the strategic direction of this initiative.

To all our partners—thank you for walking this path with us toward a more sustainable, inclusive, and low-emissions freight future.

Prof. Dr. Ing. Christoph Wolff
CEO, Smart Freight Centre

Foreword

India's commitment to sustainable growth is deeply intertwined with our ability to decarbonize the transport and logistics sector. Medium and heavy-duty trucks, though small in number, contribute a significant share of harmful emissions. The path to a zero-emission freight future requires an ecosystem approach, fixing bold ambitions by taking coordinated action, and evidence-based decision-making.

The Data Partnership Program, led by Smart Freight Centre (SFC), in collaboration with a diverse set of ecosystem partners, represents a pivotal step in advancing the zero-emission freight transition. What sets this initiative apart is its **use-case-driven approach**—recognizing that the successful adoption of electric trucks depends on specific operational characteristics such as route type, load profile, daily distance, and duty cycles. By harnessing granular operational data from shippers and logistics service providers, the program facilitates a **bottom-up assessment** to identify where and how zero-emission trucks (ZETs) can be deployed in a technically viable and economically sound manner.

This Report provides compelling use-case evidence, rigorous feasibility analysis, and a clear roadmap to transition from isolated pilots to corridor-scale implementation. Its focus on total cost of ownership, freight movement patterns, and deployment readiness reflects the kind of practical, in-depth insight that is essential for enabling inclusive and scalable adoption. The report also outlines the program's strategic approach, aligned with India's electrification drive under the PM E-DRIVE scheme.

NITI Aayog, through initiatives like the **e-FAST India**, has consistently championed collaborative approaches to freight electrification that puts data, innovation, and inclusivity at the core. We believe that India's freight transition should unfold a big scope as economic opportunity, equity, and resilience.

I commend the partners involved in this initiative for their commitment to this shared goal, and I encourage all stakeholders' industry, government, and civil society to build on this momentum. I take this opportunity to extend my compliments and congratulations to those who have put in sincere efforts to prepare this Report.

Shri Sudhendu J. Sinha
Adviser (E-Mobility), NITI Aayog

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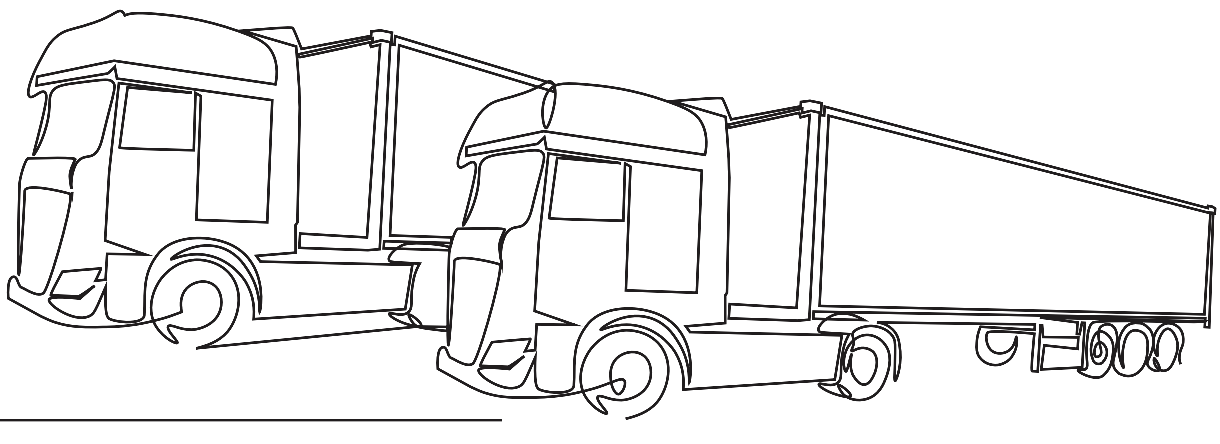


1 Executive Summary

1. EXECUTIVE SUMMARY

Smart Freight Centre's Data Partnership Program is laying the groundwork for accelerating the adoption of **Zero-Emission Trucks (ZETs)** through strategic collaboration with stakeholders such as shippers, logistics service providers (LSPs), policymakers, and financial institutions. This report outlines the program's rationale, methodology, and strategic alignment with India's broader electrification goals under the PM e-Drive scheme.

The program emphasizes **scale from the outset** moving beyond isolated pilots to unlocking corridor-level deployment across India's major freight highways. By leveraging real-world freight data and structured stakeholder collaboration, the program is identifying replicable, high-potential routes where demand aggregation, ecosystem readiness, and policy alignment can converge to enable scale.

This report presents **concrete outputs of the program, viable electrification of use cases, demand-aligned deployment strategies, and actionable insights for pilot and policy design.** These outputs are directly relevant to India's ZET ambitions, including those articulated under the proposed PM e-DRIVE scheme and the e-FAST India platform.

Through direct engagement with **over 20 shippers and LSPs,** the program has:

- Assessed **50+ use cases** across **50 freight routes for technical and economic feasibility**
- Identified **high-potential deployment clusters** in sectors like cement and containerized logistics,
- And **surfaced critical investment** and **infrastructure gaps** that must be addressed to enable scale.

Rather than offering a one-size-fits-all model, the program delivers **fit-for-purpose electrification strategies** tailored to real-world freight flows, operating conditions, and business models. The structured approach integrates **route-level data, stakeholder inputs**, and ecosystem constraints to prioritize scalable ZET adoption pathways.

The report also outlines a **forward-looking scaling roadmap** including **demand aggregation, blended finance models, and policy levers, to build corridor-level e-mobility ecosystems.** These solutions are designed to **reduce emissions, improve fleet economics, and enhance** the **resilience of India's freight sector.**

2 Background

2. INTRODUCTION AND CONTEXT

India's freight sector is a cornerstone of the national economy, contributing 13–14% to GDP and supporting over 22 million [1] livelihoods. Yet, medium and heavy-duty trucks, just 3%[2] of India's vehicle stock, contribute approximately 34% of total road transport CO_2 emissions. This disproportionate impact makes their electrification not only an environmental imperative but a strategic priority for sustainable growth.

While India has seen notable progress in electrifying two, three and four-wheelers supported by the FAME and PLI schemes, Zero-Emission Trucks (ZETs) have lagged. Key barriers include low production volumes, limited technology maturity, and insufficient policy support. However, momentum is building. The government led initiatives such as NITI Aayog's Report "**Unlocking a $200 Billion Opportunity: Electric Vehicles in India**[3]", e-FAST coalition, the PSA's Technical Roadmap for ZET Deployment, and the Ministry of Heavy Industries' e-Truck Task Force are generating momentum. Together, these developments mark a shift from pilots to planning forlarge-scale deployment.

The recently notified PM e-Drive[4] scheme, with an initial subsidy outlay of INR 500 crore, represents a significant policy commitment to the adoption of ZETs. This formal policy backing strengthens the relevance of the "Data Partnership Program's" outputs, particularly its identification of viable use cases, ecosystem gaps, and investment triggers, as inputs for effective implementation and scaling under e-DRIVE.

Smart Freight Centre's **Data Partnership Program** responds directly to this need by turning policy ambition into commercially viable action. By harnessing real-world operational data from shippers and logistics providers, the program identifies and validates use cases where ZETs can achieve both economic viability and emissions reduction. Importantly, it is designed for scale from the outset — moving beyond isolated trials to a 10X, corridor-level approach that aggregates demand, aligns stakeholders, and accelerates zero-emission freight adoption across India's priority highways.

Figure 2.1 summarizes the key motivations driving the Data Partnership Program, underscoring the critical need for a data-driven, collaborative approach to unlock ZET adoption in India's freight sector.

1. https://www.niti.gov.in/sites/default/files/2021-06/FreightReportNationalLevel.pdf
2. https://www.niti.gov.in/sites/default/files/2021-06/FreightReportNationalLevel.pdf
3. https://niti.gov.in/sites/default/files/2025-08/Electric-Vehicles-WEB-LOW-Report.pdf
4. https://pmedrive.heavyindustries.gov.in/policy_document

Supportive Policies

- INR 500 Cr allocation under PM E-DRIVE
- INR 2000 Cr allocation for charging infrastructure

Economic Viability

- New-age fleet leasing, pay-per-use, and blended finance solutions are lowering entry barriers for smaller fleets
- Declining battery prices, repurposing and recycling

Emission & Net Zero

- Focus on scope 3 emission reduction
- Corporate Net Zero commitments & global freight decarbonization push

Digital Logistics & Fleet Optimization

- Smart routing, telematics, and digital freight platforms enhance efficiency, further supporting ZET viability

FIGURE 2.1 DRIVING THE DATA PARTNERSHIP PROGRAM

2.1 ZET OPPORTUNITIES: INDIA'S EARLY ADOPTERS

The transition to Zero-Emission Trucks (ZETs) in India's freight sector will be uneven, advancing first in sectors and use cases where **operational viability, commercial benefits,** and **supportive policy measures converge.**

Smart Freight Centre (SFC) fact-based "Data Partnership" approach has identified the following criteria for priority ZET adoption:

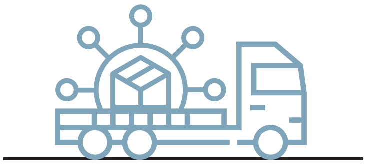
- **Predictable, high-frequency routes** that fit current ZET range and charging capabilities
- **Centralized fleet operations** or hub-and-spoke models that allow for controlled pilot deployments
- **Strong Environmental Social Governance (ESG) and net-zero commitments** from shippers and multinational customers
- **Existing or planned infrastructure** for depot-based charging
- **Regulatory and policy incentives** targeted at high-impact sectors

The combination of these factors will ensure steady stream of revenues and increased margins, establish operational viability and the offering of finance at more conducive terms (i.e.: Longer tenure, lower interest, less requirements collateral, lower seniority).

Based on real-world freight data and extensive industry consultations, our analysis highlights the sectors most likely to adopt ZETs early:

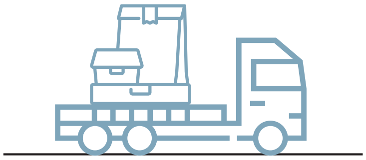
E-Commerce and Retail Distribution

E-commerce giants and organized retail chains operate high-frequency, time-sensitive routes between warehouses, fulfilment centres, and urban delivery hubs. Their predictable, closed-loop or regional movement patterns allow centralized charging and efficient vehicle utilization. Additionally, these companies are under strong ESG and customer pressure to decarbonize their supply chains, making them naturally the first movers for ZET pilots.



FMCG and Food & Beverage

Fast-moving consumer goods (FMCG) and food & beverage logistics depend on regional distribution networks with consistent daily volumes and short-to-medium haul distances. These routes are well-suited for current ZET range capabilities. The sector's emphasis on reliability and brand reputation further incentivizes early adoption, especially as shippers seek to meet Scope 3 emission targets.



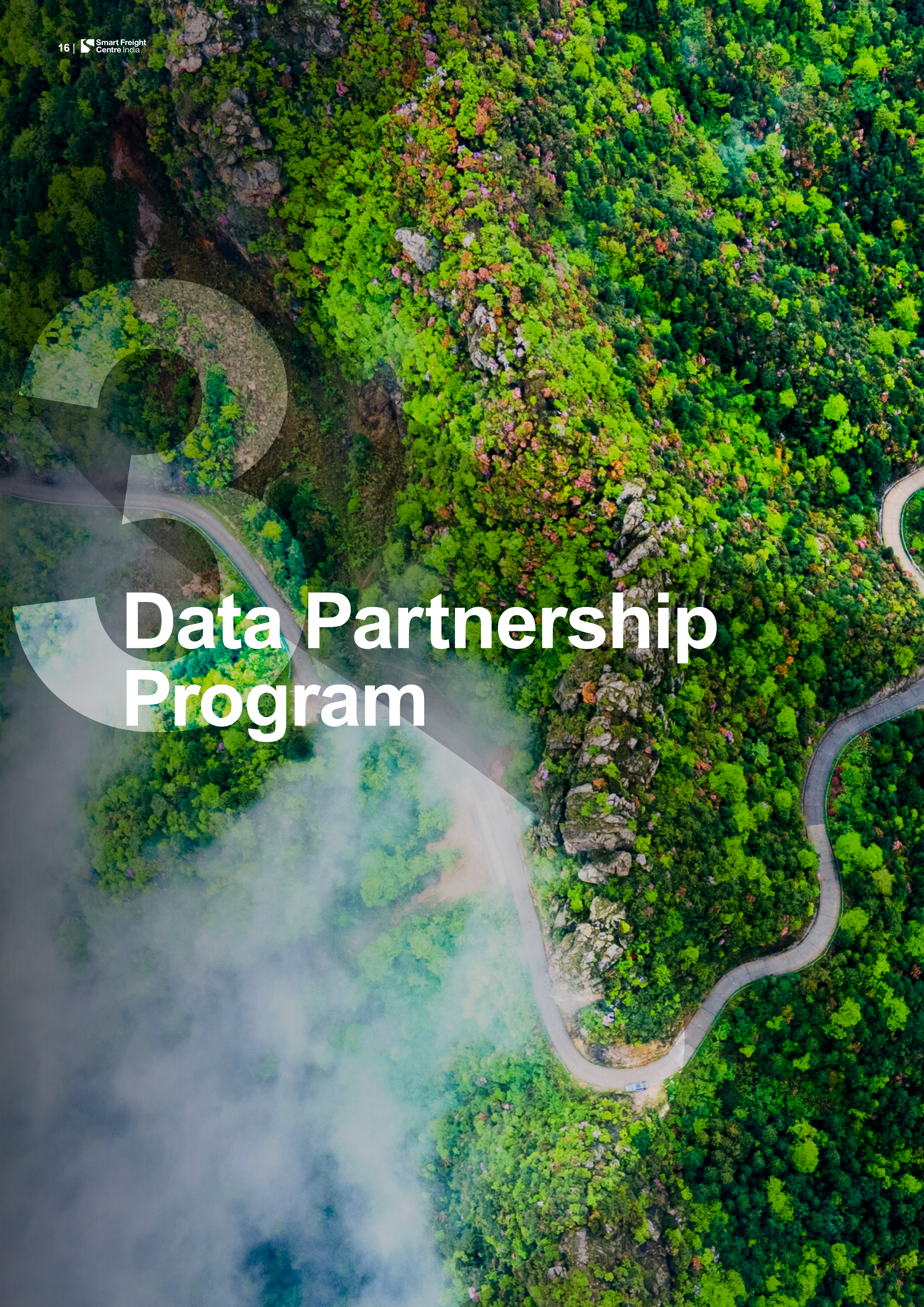
Cement and Building Materials

The cement sector has already demonstrated early technical and economic viability for ZETs. Large, predictable point-to-point movements between plants, depots, and construction sites often on fixed, repeatable routes make this sector ideal for electrification. The centralized fleet management and the potential for on-site charging infrastructure further strengthen the business case.

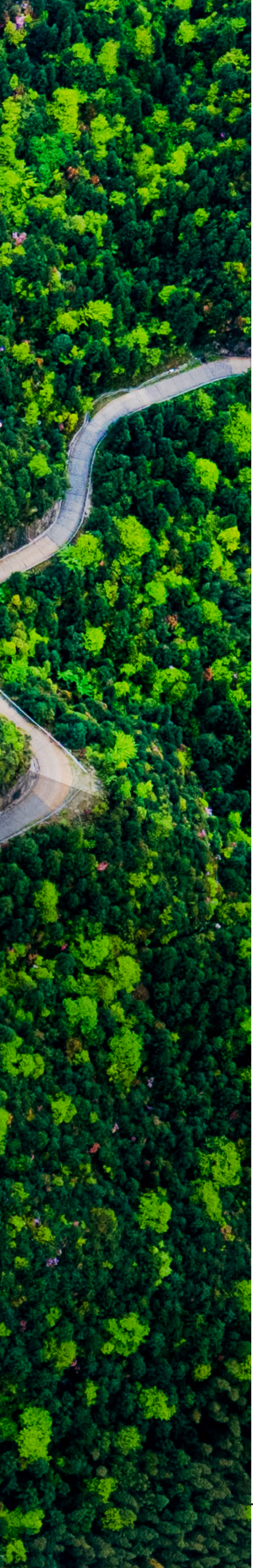
Ports and Inland Container Depots (ICDs)

Port-to-warehouse and ICD shuttle operations are characterized by high asset utilization, short-haul, and repetitive movements conditions that maximize ZET efficiency. The potential for dedicated charging infrastructure at port and depot locations, combined with regulatory support for green logistics corridors, positions this sector as a key early adopter.

By focusing on these sectors, the **"Data Partnership Program"** aims to showcase successful business models and operational strategies that can be scaled across the broader freight ecosystem. Early wins in these segments will not only build market and investors' confidence, but also generate the data and learnings needed to accelerate ZET adoption in more challenging, long-haul, and fragmented market segments.



3 Data Partnership Program



3. ABOUT DATA PARTNERSHIP PROGRAM

At its core, the "Data Partnership Program" leverages operational and economic data from industry partners to identify, validate, and scale use cases, where ZETs can deliver both environmental and business benefits. The program's phased methodology - **Identify, Qualify, Develop,** and **Apply & Scale Up,** ensures that each step is grounded in real-world freight operations and market realities.

While the initial phases focuses on building technical and economic proof points through targeted pilots, the next phase marks a critical inflection point. The program is now advancing toward commercial deployment at scale, driven by **demand aggregation, corridor-level implementation, and ecosystem-wide readiness.**

This scale-up effort aims to unlock a 10X expansion in ZET deployment by focusing on **replicable use cases, viable financing pathways, and shared infrastructure across** India's priority freight corridors. These objectives are further illustrated in Figure 7.1, which outlines the transition from pilots to full-scale market enablement

Start Up	**Scale Up**
Establish use case level economic viability for ZET adoption	Enable large scale ZET deployment by aggregating scale and system readiness
Focus on individual shipper demand on select use cases	Broaden use case and shipper base for demand aggregation
Lane-level feasibility, duty cycle validation for pilots	Phased corridor-wide deployment for broader operational validation
Focused on single/multiple specific duty cycles	Expand across multiple duty cycles-clinker, cement, inbound materials, construction
Limited number of trucks (10-50) in pilots	Scale to 1,000+ trucks across corridors and diversified applications
Select Pilot Routes	Broadened to regional, inter-state, and multi-site networks based on feasibility

FIGURE 3.1 START UP TO SCALE UP TRANSITION GOALS

3.1 PROGRAM OPERATING MODEL

The 'Data Partnership' program follows a structured, four-phase approach:

Data Partnership: Translating Vision into Action
A phased process to identify and qualify freight use case for planned deployment of e-trucks at pilot scale

Identify	Qualify	Develop	Apply & Scale Up
Identify Use Cases	Establish Feasibility and Economic Viability	Develop Business case for ZET pilot for Viable use cases	Implement ZETs Pilots at scale

FIGURE 3.2 DATA PARTNERSHIP SUMMARY

Identify: Relevant use cases are pinpointed across freight-intensive sectors such as e-commerce, FMCG, food & beverage, retail, mining, coal, steel, cement, and ports. The focus is on operational profiles, where ZETs can offer the greatest value.

Qualify: Shortlisted use cases undergo rigorous evaluation for technical and economic feasibility. This includes **product matching** (mapping the use case with the right EV vehicle), **operational feasibility** (mapping of charging infrastructure along the route) and **economic viability** (through comparative analysis of total cost of ownership (TCO) for diesel versus ZETs).

Furthermore, each use case accounts for utilization rates and charging downtimes and is customized to align with the unique operational patterns of individual shippers, thus ensuring both relevance and precision. Achieving total cost of ownership (TCO) at or near cost parity is critical for economic viability. Equally important is the analysis of charging requirements, which plays a central role in ensuring operational feasibility through the timely and strategically planned deployment of charging infrastructure.

Develop: During the development phase, Smart Freight Centre (SFC) builds or selects robust business cases for qualified use cases, ensuring both technical and financial viability. This involves assessing **lane-level constraints, analysing duty cycles** and **utilization patterns,** and **engaging key stakeholders** including OEMs, fleet operators, financiers, and charge point operators—to align on deployment needs and co-design tailored solutions.

These solutions consider **asset configurations, ownership models, the integration of renewable energy, charging demand, energy requirements,** and **financing options, such as leasing or battery -as-a-service**. The Total Cost of Ownership (TCO) is modelled across varied usage and policy scenarios to assess economic feasibility. Potential risks are identified, and mitigation strategies are co-developed with logistics service providers (LSPs), non-banking financial companies (NBFCs), and aggregators to support smaller fleets and promote inclusive business models.

Apply & Scale Up: In this phase, the program shifts from analysis to implementation—translating validated business cases into real-world deployment strategies. The focus is on advancing from pilot planning to commercial-scale adoption, with a clear emphasis on unlocking **10X growth in ZET deployment.** This includes moving beyond isolated pilots to aggregated **use cases across high-traffic freight corridors,** where demand concentration, infrastructure planning, and financing alignment can be leveraged to drive scale.

Focus Areas

Sectors

E-commerce, FMCG, F&B, Retail, Pharma, Mining, Coal, Steel, Cement, Ports

Use Case

Retail and Wholesale distribution, Cyclic movement for mining, Port, Cement, Steel and manufacturing

Freight Movement Profile

- Closed Loop
- Regional
- High-Density Corridor Network

FIGURE 3.3 FOCUSED SECTORS AND USE CASE TAXONOMY

The framework is designed not only to validate pilots, but to serve as a scaling engine, **bridging the gap between policy ambition and market adoption**. By embedding risk mapping, financing readiness, and monitoring from the outset, it builds confidence for shippers, operators, and financiers alike laying the foundation for sustained ZET deployment across India's freight corridors.

A critical function of the "Data Partnership Program" is to move beyond theoretical models and use real-world operational data to identify where and when ZETs can achieve cost competitiveness. By analysing actual trip-level patterns from partner fleets, the program is able to **assess both vehicle utilization (number of trips) and economic performance (TCO per ton-km) across different haul lengths**.

Please find the elements of the TCO model utilized in the annex.

The analysis highlights a distinct S-curve relationship between trip length and TCO viability. On shorter hauls, ZETs underperform because high upfront capital costs are spread over limited kilometres, and charging downtime further impacts utilization. As trip lengths increase, however, utilization improves, and operating cost savings (lower fuel and maintenance) begin to outweigh the higher CapEx. This creates an **inflection zone typically around 200–300 km, where ZETs move towards parity** with diesel. Beyond this range, longer hauls and consistent daily cycles reinforce the economic case, making deployment increasingly attractive.

The chart below, based on real-world use cases captured through the Data Partnership, illustrates this relationship. It shows how TCO per ton-km trends downward with longer trips while trip frequency stabilizes, highlighting the operational "sweet spot" for viable ZET deployment. These insights are critical for selecting priority use cases and scaling solutions across freight corridors. HIGH-DENSITY CORRIDOR NETWORK FOCUS AREAS "sweet spot" for viable ZET deployment. These insights are critical for selecting priority use cases and scaling solutions across freight corridors.

By mapping this relationship, the program is able to select viable use cases routes and operations, where ZETs can deliver both cost savings and emissions reductions.

These insights form the **basis for scaling strategies**, ensuring that pilots are not one-off demonstrations but stepping stones toward corridor-level deployment.

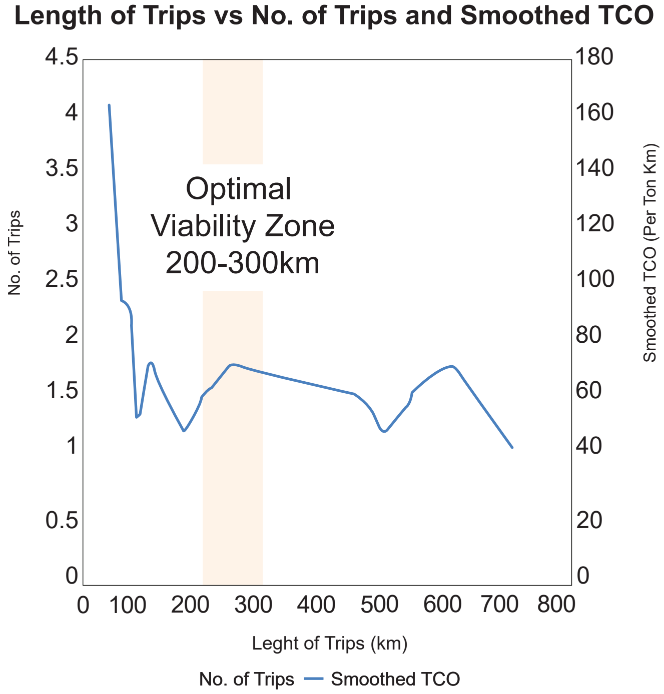
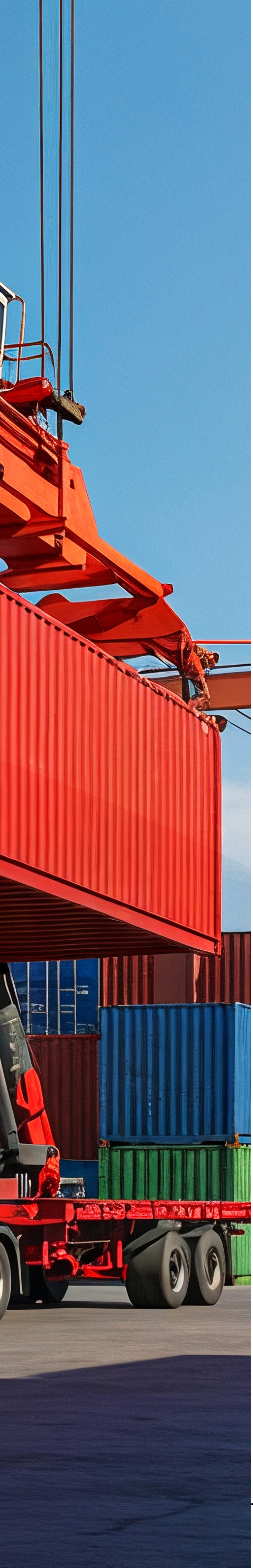


FIGURE 3.4 OPTIMAL VIABILITY FOR E-TRUCK CONVERSION

This analysis demonstrates how **real-world operational data** can guide the identification of viable ZET use cases, ensuring that deployment decisions are rooted in both cost competitiveness and operational feasibility. However, numbers alone cannot capture the full picture. To translate these insights into action, it is important to examine how they play out in practice across different industries and freight corridors.

The following case studies build on these findings, illustrating how shippers, LSPs, fleet operators, and ecosystem partners are applying the "Data Partnership framework" to test and scale zero-emission truck deployment in real-world operations.

4 Case Studies



4. CASE STUDIES

The two case studies highlighted below showcase the technical viability and Total Cost of Ownership (TCO) feasibility achieved for two distinct industry segments: Cement Manufacturing and Inter Carting Operations at an Inland Container Depot (ICD) of a large Logistics service provider. Together, they clearly demonstrate how a data driven partnership approach can identify, validate, and prioritize the most promising use cases for scaling up Zero Emission Truck (ZET) adoption

4.1 CEMENT CASE STUDY

Client Context

The client is one of India's largest integrated cement producers with a panIndia footprint and a high throughput supply chain. They operate multiple cement plants and dispatch hubs serving a vast dealer network and industrial customers.

Freight Scale:

Several thousand tonnes of cement moved daily across inbound (raw material) and outbound (finished goods) legs.

Network Complexity:

High frequency short hauls between plants, warehouses, and customer locations, combined with long-haul movements to regional hubs.

Business Priority:

Reducing logistics emissions while maintaining cost competitiveness in a diesel intensive sector.

Our Approach & Methodology

Using the program's structured Identify–Qualify–Develop–Apply framework, we collaborated with the client and ecosystem stakeholders (OEMs, CPOs, LSPs, and financial institutions) to map freight flows, assess technical and operational feasibility, and model economic outcomes

Step 1:
Identify Phase - Use Case Mapping

- Mapped plant-to-warehouse, plant-to-plant, and plant-to-customer routes, analysing distance (80–600 km), trip frequency, and payload patterns.
- Identified below listed five high-density, repetitive movement routes as the strongest candidates for ZET adoption.

Route	Movement Type	Route Length	Trips per Day	Mileage per day (Km)	Daily Truck Movement	Trip Type
1	Plant-Warehouse	250 km	2	500	10-12	Round
2	Plant-Plant	600 km	0.4	240	1-2	One Way
3	Plant-Customer	120 km	2	240	8-10	One Way
4	IU-GU plant	80 km	2	160	2-3	Round
5	Supplier-Plant	170 km	1.4	238	20-22	One Way

Table 4.1 IDENTIFIED TRUCK USE CASES

Step 2: Qualify Phase – Technical & Operational Feasibility

Technical Fit

- Matched operational needs rated payload, daily mileage, turnaround times with available electric truck models in the market.
- Verified battery capacities and drive cycles for heavy haul cement applications.
- **Identified two optimal models** (Table 2), each with a Gross Vehicle Weight (GVW) of 55 tons and a payload capacity of 40 tons, as the best technical fit for the client's operational profile.

Make	Model	Body	GVW (Kgs)	Payload	Battery capacity	Range (Kms)	Availability
Ashok Leyland	AVTR 55T 4X2	Tractor-trailer	55,000	40 Ton	301 kWh	180	Launched
IPLT Electric	Rhino 5536e	Tractor-trailer	55,000	40 Ton	258 kWh	185	Launched
Tata Motors	Prima E.55s	Tractor-trailer	55,000	38 Ton	438 kWh	350–500	Launched
BYD	Q1R	Tractor-trailer	41,830	34 Ton	217 kWh	100	To be Imported
Volvo	FH Aero Electric	Tractor-trailer	44,000	36 Ton	360 kWh	Upto 300	To be Imported
Volvo	FH Aero Electric	Tractor-trailer	44,000	36 Ton	540 kWh	Upto 300	To be Imported
Volvo	FH Aero Electric	Rigid	40,000	32 Ton	360 kWh	Upto 300	To be Imported
Volvo	FH Aero Electric	Rigid	40,000	32 Ton	540 kWh	Upto 300	To be Imported

Table 4.2 PRODUCT MATCHING BASED ON AVAILABLE E-TRUCKS

Operational Side

- **Evaluated depot-based charging opportunities** at cement plants and warehouses, complemented by the emerging public charging networks along key corridors.
- **Assessed both near-term solutions** (temporary fast charging infrastructure) **and long-term investments** in permanent charging facilities.
- **Qualified four priority routes/use cases** (Table 3), that met the technical and operational criteria and were subsequently advanced for economic viability analysis.

Route	Route Length (in Km)	No of en-route Charging Station	DC Fast Charger (60 kWh)	Ultra Fast Chargers (>120 kWh)	Upcoming Fast / Ultra Fast Charger	Cost per Unit (INR / Unit)	Feasibility
1	250 km	10+	>10	0	0	20-22	Feasible
2	600 km	10	10	0	1	15	Feasible in long run
3	120 km	10+	10	0	0	20-22	Feasible
4	80 km	50+	60	0	3	20-22	Most Feasible
5	170 km	10+	0	1	2	20-22	Feasible

Table 4.3 EVALUATING CHARGER AVAILABILITY ACROSS ROUTES

Step 3:
Qualify Phase - Economic Viability

- For the **four shortlisted use cases,** a detailed **Total Cost of Ownership (TCO) analysis** was conducted, comparing the cost of operating an ICE truck versus a ZET over a 10 year operating horizon.
- The analysis covered:
  - **Fuel and energy cost profiles** to capture operational savings.
  - **Maintenance requirements and expected downtime** to assess lifecycle efficiency.
  - **OEM financing options and battery warranty structures** to reflect realistic market terms.
- Multiple scenarios were **modelled,** including:
- With and without applicable **subsidies and incentives.**
- **Optimistic operating scenarios,** factoring in improved energy consumption and evolving incentive frameworks.
- The modelling **identified cost competitive routes** (Table 5), where ZETs are projected to achieve **TCO parity within five years,** providing a clear business case for transition

Route	Monthly Running Distance	TCO - ICE	Base Case Subsidy*	Base Case W/o Subsidy	Optimistic Case Subsidy*	Optimistic Case W/o Subsidy
			EV	EV	EV	EV
Route 1	7000 Km	69.58	68.20	76.66	53.97	73.99
Route 2	3360 km	80.02	86.51	85.05	83.07	88.31
Route3	6000 km	72.65	70.87	72.12	63.21	67.46
Route 4	4760 km	74.43	76.48	84.41	53.08	57.72

Table 4.4 TOTAL COST OF OPERATIONS IN INR/ KM, CONSIDERING VEHICLE LIFE 10 YEARS

Facilitated joint discussions with OEMs, CPOs, and financiers to develop a commercially viable pilot framework for the Route 1 & Route 4 (Most economically favourable case)

- Delivered a phased deployment plan with operational parameters, enabling the client to move toward trial runs.

Conclusion:

Switching to electric trucks for cement use-case offers long-term benefits as follows:

- **CO_2 Reduction:** High-frequency routes offer the greatest emission reduction potential due to daily truck movement approx. Annual Tailpipe emissions abated ~ 50 Ton CO2e for a route length between (180-230km)
- **Economic Viability:** Total Cost of Ownership (TCO) modelling shows cost parity within 5 years on routes under 250 km, which dominate cement outbound logistics. Operational cost savings of approx. 40%.
- **Business Continuity:** With key cement dispatch hubs located near industrial zones, early electrification ensures continued access to low-emission transport corridors.

4.2 INTER-CARTING OPERATIONS AT AN ICD

Client Context

The client is a leading terminal operator managing one of India's busiest Inland Container Depots (ICDs), which handles high volume transshipment of EXIM and domestic containers.

- **Scale of Operations:** 31 heavy duty trailers under contract, operating **24/7 year-round** for container shuttling between rail sidings, stacking areas, and warehouses.

- **Movement Profile:** Average round trip distance of **1.5 km,** with **~80 trips per day per trailer,** resulting in **~120 km of daily usage per vehicle.**

- **Commercial Structure:** Trailers are operated under a fixed rate contract with periodic diesel escalation adjustments. Current diesel consumption averages **32–35 litres per trailer per day.**

Step 1:
Identify Phase: Use Case Mapping

- **Mapped internal freight flows** between rail siding, stacking areas, and warehouses (Table 1), analysing trip frequency, payload patterns, and operational parameters such as average vehicle speed limits (e.g., 15 km/h) and turnaround requirements.

- **Confirmed that all movements are confined** within depot premises, eliminating external road dependencies and simplifying route planning and operational control.

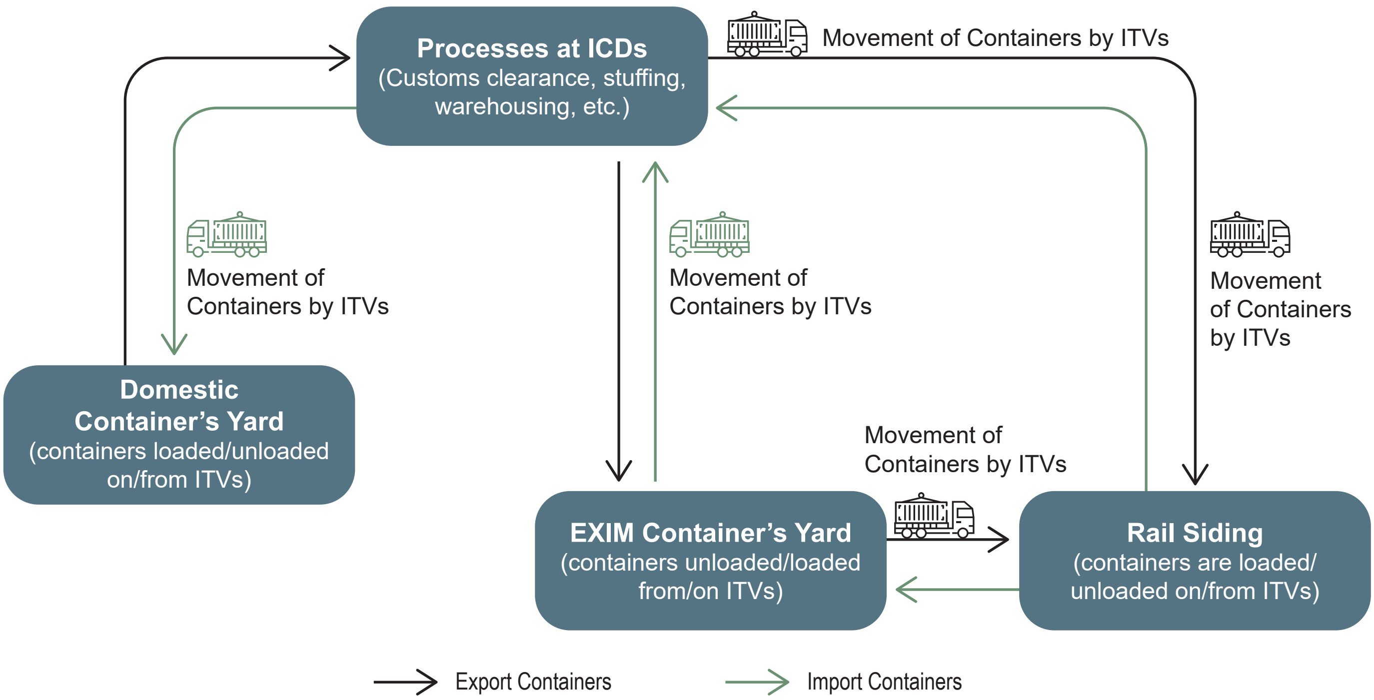


Table 4.5 INTER-CARTING OPERATIONS AT AN ICD USE CASE MAPPING

Step 2:
Qualify Phase Technical & Operational Feasibility

The current Inter-carting operations leveraged 18-wheeler (55-tonne) trailers to transport 20/40 ft containers. These trucks operate 24/7, year-round, shuttling between the rail siding, stacking area, and domestic/EXIM warehouse. The average round-trip distance between the rail siding and stacking location is 1.5 km, with approximately 80 trips made per day resulting in a daily usage of around 120 km per truck.

Technical Fit:

- Matched operational requirements rated payload, daily mileage, and turnaround times with available electric truck models.
- Verified battery capacities and drive cycles against high frequency short-haul operations.
- **Identified optimal models:** 55 tonne GVW, 18/22 wheeler electric trucks with at least **120 km range,** fully meeting load and movement profiles.

Operational Fit:

- External charging network mapping was **not required** as all movements are within the facility.
- Confirmed **on site charging capability** supported by the depot's internal electricity substation.
- No route planning constraints, enabling continuous 24/7 operations with planned charging intervals.

Step 3:
Qualify Phase - Economic Viability

- A detailed **Total Cost of Ownership (TCO) analysis** was conducted, comparing the cost of operating an ICE truck versus a ZET over a 10 year operating horizon
- Additionally, a detailed **10 year cash flow analysis** was carried out for two procurement models:
  - **Scenario 1:** Leasing model (current practice)
  - **Scenario 2:** Upfront purchase by client
- The analysis covered
  - Fuel vs. energy cost profiles.
  - Maintenance costs, downtime, and AMC assumptions.
  - OEM financing terms and battery warranty structures.
  - Sensitivity tests with & without policy subsidies, plus optimistic energy efficiency scenarios.
- Both leasing and upfront purchase models show **competitive cash outflows**
  - **Leasing option (Table 4.5):** EV cash outflow in base case is INR 3.44 Cr vs. ICE at INR 3.01 Cr, with significant improvement in optimistic scenarios (down to INR 2.84 Cr).
  - **Upfront purchase option (Table 4.6):** EV cash outflow in base case is INR 3.07 Cr vs. ICE at INR 3.01 Cr, again improving in optimistic scenarios (INR 2.82 Cr) when incentives and better energy consumption are factored in.

Scenarios	Cashflow - ICE	Base Case W/o Subsidy	Optimistic Case - With Subsidy*
		EV	EV
Upfront Procurement	301,67,075	3,07,95,529	2,82,86,274
Leasing Procurement		3,44,45,504	2,84,14,735

Table 4.6 CASHFLOW (EXCLUDING REVENUE) FOR 10 YEAR PERIOD IN INR

Step 4:
Develop Phase – Business Case Development & Transition Plan

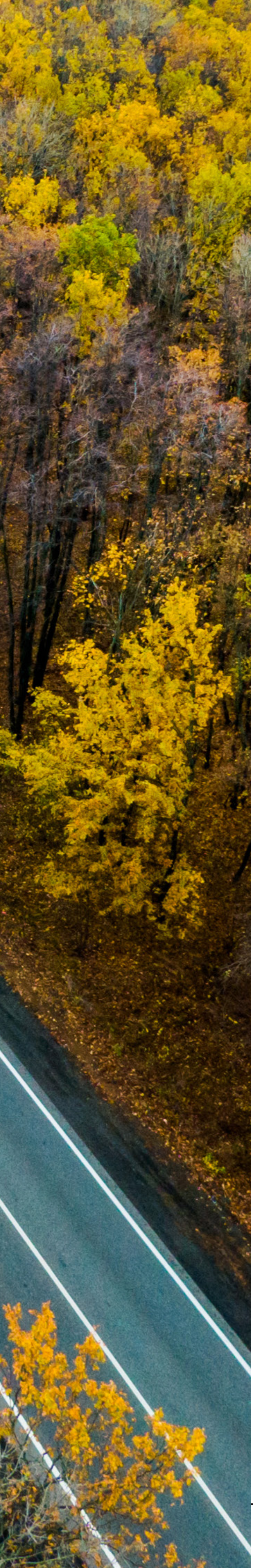
- **Facilitated joint discussions** with OEMs, Charge Point Operators (CPOs), and financiers to define the most **commercially viable operating conditions** for the inter-carting operation.
- **Delivered a phased deployment roadmap** outlining key operational parameters, financing structures, and risk-sharing mechanisms, enabling the client to confidently proceed with **pilot runs and phased ZET implementation.**

Conclusion:

Switching to electric trucks for inter-carting at ICD TKD offers long-term benefits as follows:

- **CO_2 Reduction Potential:** Significant emissions savings (1,061 tCO_2/year) by replacing diesel inter carting movements with electric trucks, directly supporting the client's sustainability targets.
- **TCO Feasibility:** Both leasing and upfront purchase models show competitive cash outflows, with optimistic scenarios delivering cost advantages within the 10 year period.
- **Business Continuity:** Uninterrupted operations at ICD even with progressive tightening of environmental regulations for urban centres.

5 Outcomes



5. OUTCOMES FROM THE DATA PARTNERSHIP PROGRAM AND KEY LEARNINGS

The program has received a strong response from the industry and is progressing well, with over 50 use case evaluations completed across more than 20 participating shipper and LSP organizations.

As part of its focus, the program is evaluating key freight corridors and national highways—assessing the current share of Zero-Emission Trucks (ZETs) and identifying high-traffic routes. These findings highlight priority corridors that offer the greatest opportunities for targeted infrastructure development and policy support.

Sectoral and corridor-wise distribution insights are detailed below.

Key corridors / National Highways across the routes evaluated

Highways	% E-truck Share
NH 44	15%
NH 48	21%
NH 27	5%
NH 16	4%
NH 4	31%

Corridors with Max Traffic
BLR - Chennai
Mumbai - BLR
Delhi - Mumbai
Mumbai - Pune Exp

FIGURE 5.1 KEY CORRIDOR TRAFFIC EVALUATION

From the evaluations conducted, the program made crucial observations about the route movements of trucks and infrastructure. The findings include:

- 50% of evaluated route movements happen on NH 44 & NE 4 (refer to the image above)
- Limited infrastructure has led to shippers focusing on short stretches of <300 km on the highlighted highways.

5.1 APPLYING AND SCALE UP: THE PATH FORWARD

To date, the Data Partnership Program has focused on targeted pilot projects driven by individual shipper demand, typically involving a limited number of electric trucks (10–50 units). These efforts have provided critical insights into operational feasibility, vehicle performance, and early Total Cost of Ownership (TCO) dynamics.

The next phase marks a transition from proof-of-concept pilots to the commercial deployment of Zero-Emission Trucks (ZETs). This involves moving beyond isolated use cases to aggregated demand, optimized freight corridors, and coordinated ecosystem readiness.

The Program is structured as a phased journey to accelerate ZET adoption at scale. It began with technology and data demonstrations that established proof of concept and allowed stakeholders to test electric truck deployment in real-world conditions. Building on this foundation, the transition phase has focused on validating deployment strategies across different fleet profiles, geographies, and freight applications.

These initial stages have laid the groundwork for scale. As the Program enters its next phase, the focus shifts to realizing both economic and environmental value. Key scale-up levers include expanding operational use cases, increasing the electric truck population, broadening route coverage, and aggregating freight volumes to create predictable demand.

To enable a 10X scale-up, the Program is supporting interventions that improve TCO, strengthen business case viability, promote innovative operating models, and mobilize institutional capital. These efforts aim to reduce perceived risks and establish a strong foundation for commercial financing, making ZETs more accessible to fleets of all sizes.

Through active stakeholder engagement, detailed feasibility and TCO assessments, and a structured pilot-to-scale approach, the Program is helping the freight sector move from ambition to action. Beyond demonstrating economic viability, this transition supports broader sustainability goals reducing CO_2 emissions, lowering dependence on fossil fuels, and improving public health.

The lessons, tools, and value drivers emerging from this work offer a replicable blueprint for decarbonizing freight not only in India but also in other emerging markets.

As we move into this next phase of scale-up, we invite logistics partners, ecosystem enablers, and industry stakeholders to collaborate with Smart Freight Centre in accelerating the adoption of zero-emission trucks and shaping a cleaner, more resilient freight future.

6 Institutionalizing Data Partnerships

6. INSTITUTIONALIZING DATA PARTNERSHIPS

Partnerships are the cornerstone of the "**Data Partnership Program**". The transition to zero-emission freight cannot be achieved by any single actor; it requires **dynamic and systematic collaboration** across the entire value chain. For ZET adoption to move from pilots to large-scale deployment, relationships among stakeholders must go beyond transactional engagements and evolve into a framework of **continuous data sharing, joint problem-solving, and aligned incentives.**

The **business case development phase,** a core pillar of the program methodology, has been made possible only through trusted partnerships that enable operational data sharing, co-design of pilots, and joint development of deployment blueprints. These collaborations are not transactional; they represent a shared commitment to shaping the market architecture for zero-emission freight in India.

6.1 A SYSTEMS APPROACH TO PARTNERSHIP

The Data Partnership Program takes a systems approach, aligning stakeholders across three primary collaboration areas:

- **Commercial Viability:** Shippers and LSPs contribute real-world freight movement data, enabling granular route analysis and tailored TCO Model.
- **Technology Enablement:** OEMs, CPOs, and digital solution providers support vehicle-product mapping, charging infrastructure co-design, and deployment readiness.
- **Financial Innovation:** Financiers, including SIDBI, NBFCs, and leasing partners, inform risk mitigation strategies. The selection of viable cases in the pre-lending phase enables financiers to offer more conducive lending terms.

This integrated, multi-stakeholder structure enables the program to move beyond theoretical modelling and develop practical, implementation-focused deployment plans that reflect real-world operating conditions and partner priorities.

6.2 TOWARDS A "DATA PARTNERSHIP INNOVATION HUB"

The **Data Partnership Program** institutionalises collaboration across the EV freight ecosystem by aligning **demand, supply, and enabling actors** into a single framework.

- On the **demand side**, shippers and LSPs aggregate freight demand and share operational data; fleet operators provide route-level viability and ground-level operating insights; and platform/asset companies (e.g., Transvolt, BillionE /SwitchLabs) enable leasing and pay-as-you-go models.
- On the **supply side**, OEMs deliver ZET models designed for India's freightoperations, while charge point operators and utilities ensure depot and corridorlevel charging readiness, grid capacity, and renewable integration.
- At the **enabler level**, financing institutions, banks, and NBFCs provide riskmitigated capital and innovative models such as leasing and blended finance. Policy offices (NITI Aayog, PSA, MoRTH, MHI, and state governments) provide the enabling environment through incentives, regulatory clarity, and infrastructure planning.

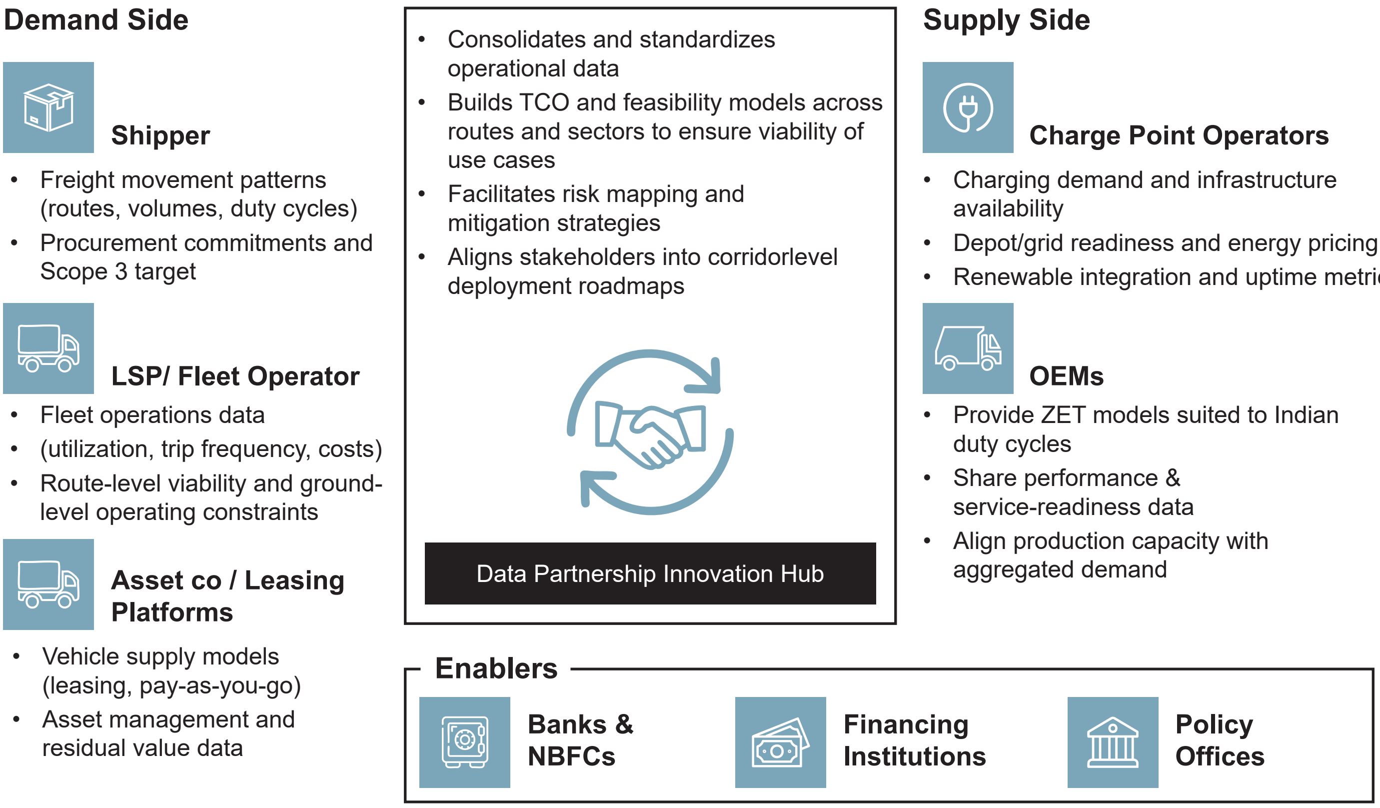


Table 6.1 DATA PARTNERSHIP: ECOSYSTEM COLLABORATION

As India moves from pilot projects to corridor-scale deployment, the need is no longer for isolated partnerships but for **systematic and institutionalized collaboration.** The next phase of scaling ZET adoption will require a mechanism that enables stakeholders not only to share insights, but to **jointly validate, prioritize, and act on the most viable opportunities.**

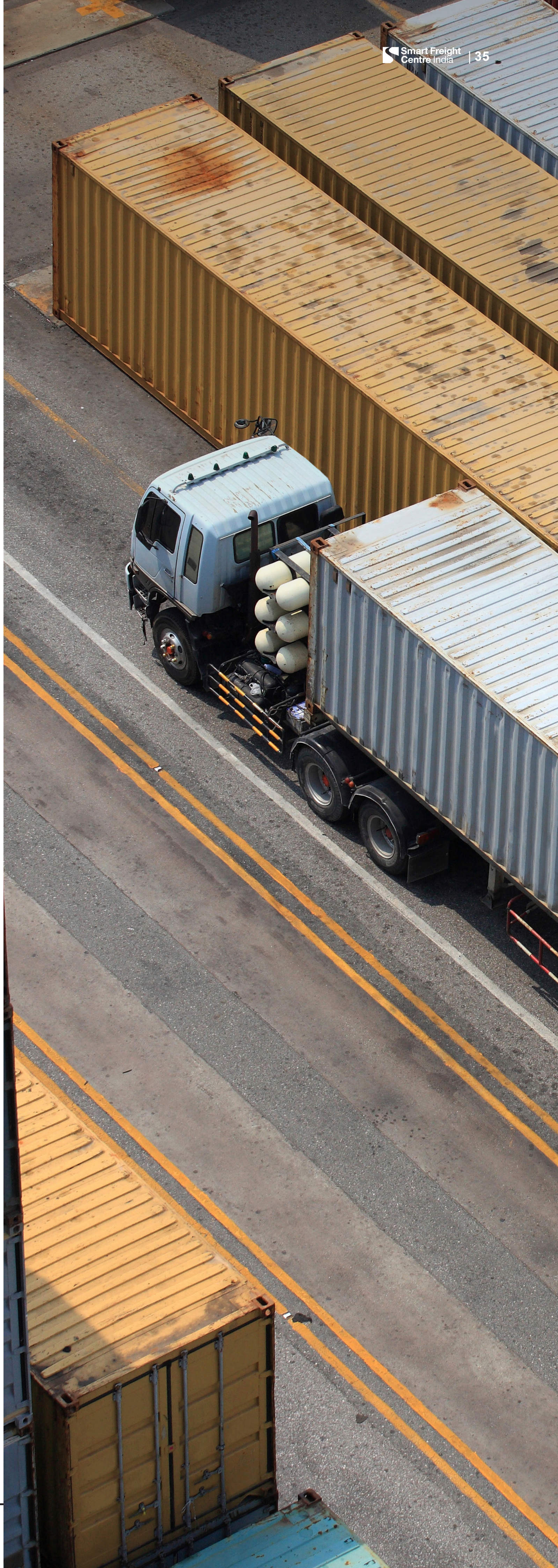
One forward-looking idea is a "**Data Partnership Innovation Hub.**" a proposed resource that could strengthen the scale-up process by:

- **Providing access to anonymized, aggregated datasets from the ground** - giving shippers, LSPs, OEMs, financiers, and policymakers the ability to plan with confidence while ensuring data security.
- **Validating the importance of specific use cases and geographies**, enabling industry and government to focus efforts where ZET deployment is both operationally and economically viable.

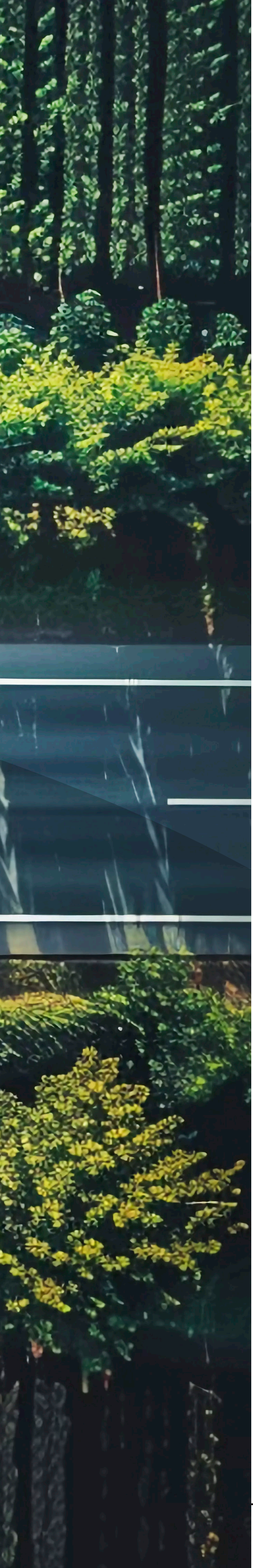
- **Bringing the ecosystem together** around shared priorities, moving from fragmented pilots toward collective, corridor-level deployment strategies.
- **Creating feedback loops** on how policy measures, financing instruments, and infrastructure planning are enabling or constraining adoption, so stakeholders can adapt and refine their approaches.
- **Supporting ecosystem matchmaking**, helping shippers, fleet operators, financiers, and technology providers find the right partners to de-risk and accelerate adoption.

While still at the **concept stage**, such a hub would help institutionalize data partnerships across the freight ecosystem — fostering transparency, building trust, and accelerating the journey from pilots to scale. It positions data not as an isolated asset but as a **shared resource** that unlocks coordinated action.

Going forward, **institutionalizing such data partnerships** across the many efforts already underway in the ecosystem will be essential for moving from fragmented pilots to coordinated, corridor-level deployment.



7 Annexures



7. ANNEXURES

Economic Feasibility: Building the Business Case for ZETs

The TCO analysis incorporates all relevant cost drivers including vehicle acquisition, energy and fuel costs, maintenance, charging infrastructure, and utilization rates across diverse operational profiles. Special attention is given to the interplay between high capital expenditure and low operating costs, a dynamic that makes utilization and route optimization critical for achieving cost competitiveness.

Grounded in Total Cost of Ownership (TCO) the Data Partnership analysis is structured around two primary components: Capital Expenditure (CapEx) and Operating Expenditure (OpEx). CapEx represents the initial investment required for procuring and financing the electric truck. This cost is influenced by key technical specifications such as battery capacity, vehicle body type, payload requirement, and the range needed to support the intended use case.

OpEx encompasses the recurring costs associated with operating the vehicle over its lifecycle. This includes expenditures on maintenance, tolls, charging infrastructure, energy costs, and other operational expenses. Together, CapEx and OpEx provide a holistic view of the long-term economic feasibility of electric truck deployment.

Vehicle

- GWW & Payload
- Vehicle Body
- Battery Capacity
- Range

Operational

- Contract Term
- Vehicle Running (In km)
- No of Trips per Day
- Kms per Trip
- Days of Operations
- Energy Consumption
- Resale / Residual Value

Finance

- Loan Term
- Interest Rate
- Debt: Equity Ratio
- Insurance

Cost

- Vehicle + Battery+ Trailer Cost
- Registration Fee
- Road Tax
- Charger Cost (Setup & Running
- Energy Cost / Fuel Cost
- AMC & Repair Cost
- Manpower Cost

Others

- State of Registration
- Toll Cost
- Green Tax
- YOY Inflation %
- Permit Fee / Fitness Fee
- Revenue per Trip / Km

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