From Demonstration to Deployment at Scale

A Strategic Framework for Zero-Emission Freight Corridor Development

India's freight sector is entering a critical transition phase. While heavy-duty trucks represent only a small share (3%) of the total vehicle population, their contribution to greenhouse gas emissions (34%), fuel consumption, and air pollution is disproportionately large. Decarbonising freight therefore is no longer solely an environmental concern; it is an economic, energy security, and industrial competitiveness imperative.

Over the past two years, India has sold over 1,500 electric trucks (Figure 1), mainly as electric-truck pilot demonstrations across the logistics, mining, and industrial sectors. While these pilots have successfully validated vehicle performance and operational feasibility, most deployments remain fragmented, small scale, and

geographically isolated. **The sector now faces a larger challenge: how to move from demonstration to deployment on a scale.**

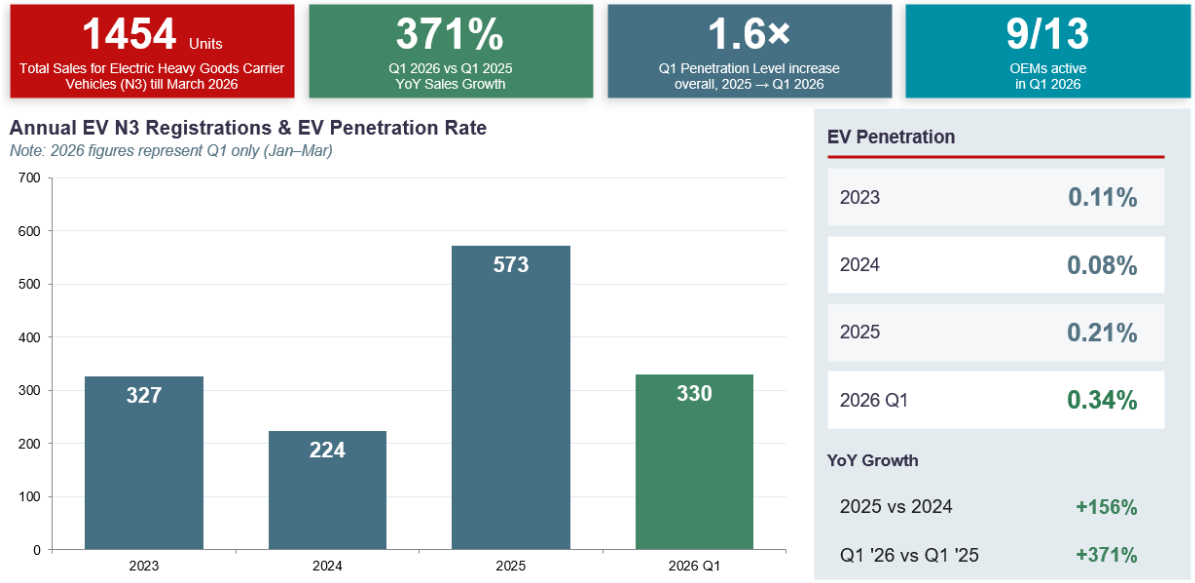

Figure 1: Smart Freight Centre (SFC) Analysis Based on Vahan Portal (Excludes Telangana)

Scaling up zero-emission freight requires more than vehicle adoption; it calls for coordinated action across the ecosystem that includes shippers, carriers (or transport operators), charging providers, power utilities, energy regulators, and renewable energy (RE) providers.

To address this challenge, Smart Freight Centre (SFC), in collaboration with the Center for Study of Science, Technology and Policy (CSTEP), has launched a strategic corridor-electrification initiative focused on the Bengaluru–Mumbai corridor. The initiative aims to develop a scalable framework for zero-emission freight deployment by integrating demand aggregation, charging infrastructure planning, RE integration, and ecosystem coordination. It positions corridor electrification not merely as a transport intervention, but as the foundational step towards an **integrated freight and energy transition strategy** for India.

This technical note is the first in a series examining how India can scale zero-emission freight through corridor-based ecosystem development. It focuses on **demand aggregation as the starting point for scaling up** and presents a framework to identify and prioritise freight corridors for large-scale electric truck deployment, using the Bengaluru-Mumbai corridor as a case study.

The subsequent notes will build on this foundation to examine charging infrastructure readiness, grid integration, RE opportunities, and deployment pathways for corridor-level freight electrification.

Demand Aggregation: The Starting Point for Scale-up

Industry today broadly understands the operational benefits of electric trucks, such as lower operating costs, reduced emissions, and improved energy efficiency. However, large-scale deployment continues to face three fundamental barriers.

- First, the sector struggles with high vehicle costs and limited vehicle supply. Electric trucks still involve a significantly higher upfront investment compared to diesel vehicles, making adoption difficult for many fleet operators, especially the small and medium carriers.
- Second, charging infrastructure availability remains limited. Freight operations require high-capacity charging systems, reliable grid connectivity, and strategically located charging hubs that are aligned with freight movement patterns. The absence of corridor-scale charging infrastructure creates operational uncertainty for fleet operators.
- Third, carrier-entry barriers abound. Most transport operators operate on thin margins and are hesitant to adopt new technologies without assured utilisation, stable freight demand, and long-term commercial viability.

This is where SFC's Freight Electrification Coalition becomes critical.

The coalition focuses on one of the most important missing links in freight electrification: demand aggregation. Instead of individual fleets adopting electric trucks independently, the coalition brings together shippers, logistics providers, carriers, infrastructure players, and ecosystem stakeholders to create a consolidated freight demand.

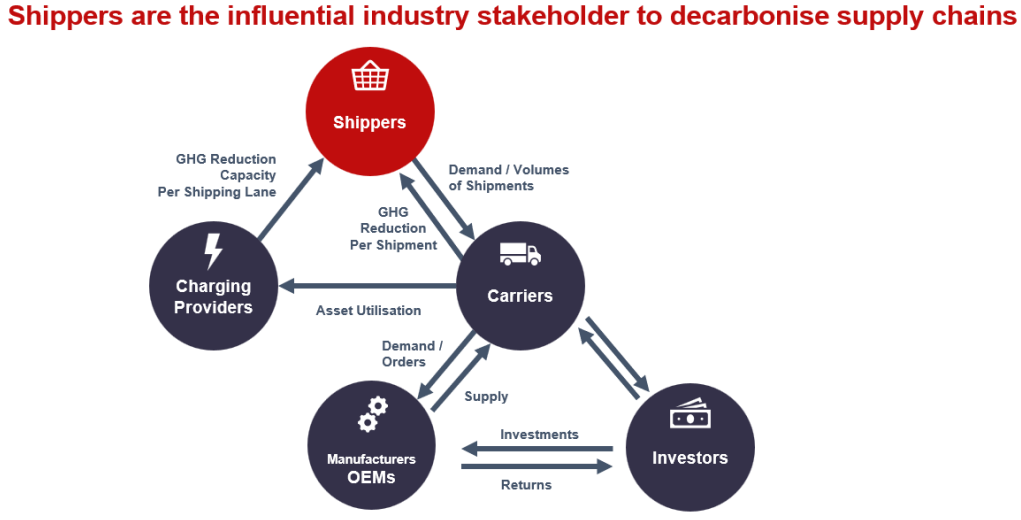

Figure 2: Role of Shippers in Freight Decarbonisation

Demand Aggregation Fundamentally Changes the Economics of Freight Electrification.

When multiple shippers commit freight volumes together (or aggregate demand) for electric trucks, carriers gain confidence to invest in electric trucks because vehicle utilisation becomes predictable. Higher utilisation improves the total cost of ownership and reduces commercial risks.

At the same time, aggregated demand sends strong market signals to manufacturers to increase the scale of production and reduce costs. Further, by replacing speculative investments with investments that are aligned with the existing freight demand, it enables charging providers to deploy the infrastructure more efficiently.

This creates a scalable ecosystem where demand simultaneously drives vehicle adoption, infrastructure development, financing, and ecosystem coordination. **Globally successful freight electrification programmes like those in Europe, China, and North America, and the i10 corridor in the United States, rely on corridor- and cluster-based demand aggregation strategies.** Such high-density freight corridors enable shared infrastructure, coordinated charging deployment, improved utilisation, and stronger commercial viability.

Thus, a zero-emission freight scale-up in India cannot be driven by isolated pilots. It requires collaborative freight electrification coalitions where aggregated demand becomes the foundation for accelerating large-scale deployment.

Corridor-based Demand Aggregation

High-density freight corridors create ideal conditions for large-scale zero-emission freight deployment because they concentrate on freight movement, operational predictability, and infrastructure utilisation within a defined geography.

Unlike fragmented deployments that are spread across disconnected regions, corridors allow stakeholders to aggregate freight demand from multiple shippers operating along similar routes and logistics clusters, assuring utilisation, cost reductions, and efficient infrastructure planning. Freight movement patterns become easier to map, allowing for strategic deployment of charging infrastructure at logistics hubs, industrial clusters, warehouses, and truck-driver dwell points along the route. This reduces operational disruption while improving charging efficiency and uptime.

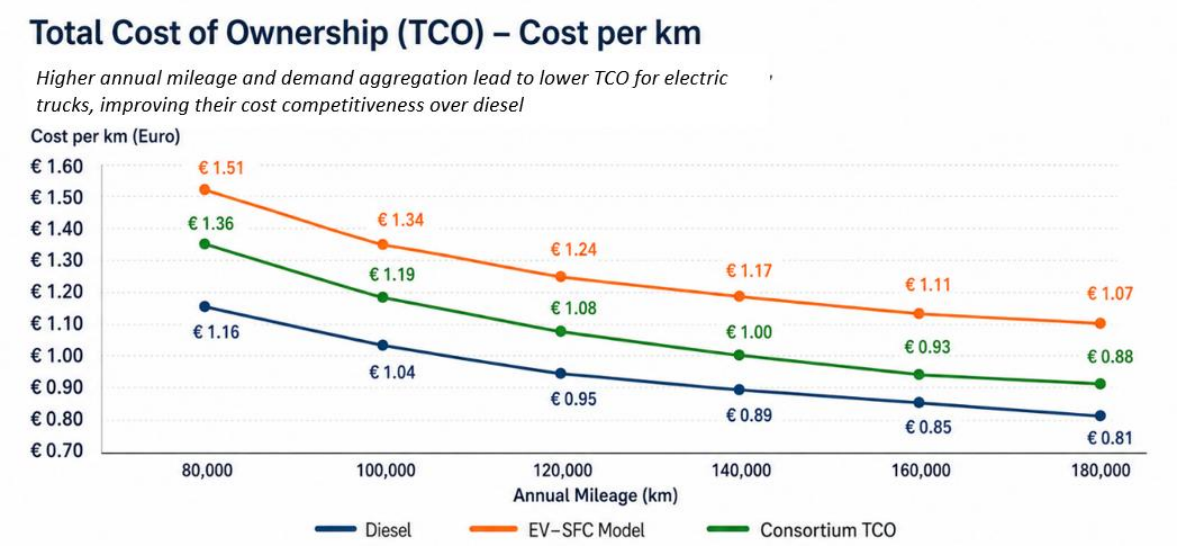

Figure 3: SFC Analysis- Indicative TCO Model for Illustration (2024)

Similar to the global initiatives, corridor-based demand aggregation offers a practical and scalable pathway for India to transition from pilot projects to large-scale deployment. Corridors such as the Bengaluru–Mumbai one creates an opportunity to build integrated freight-energy ecosystems where shippers, carriers, original equipment manufacturers (OEMs), charging providers, financiers, and policymakers collectively enable the transition towards zero-emission freight at scale.

Framework for Identifying the Right Freight Corridor

Not every corridor is suitable for early-stage freight electrification. Corridor prioritisation therefore requires a structured qualification framework.

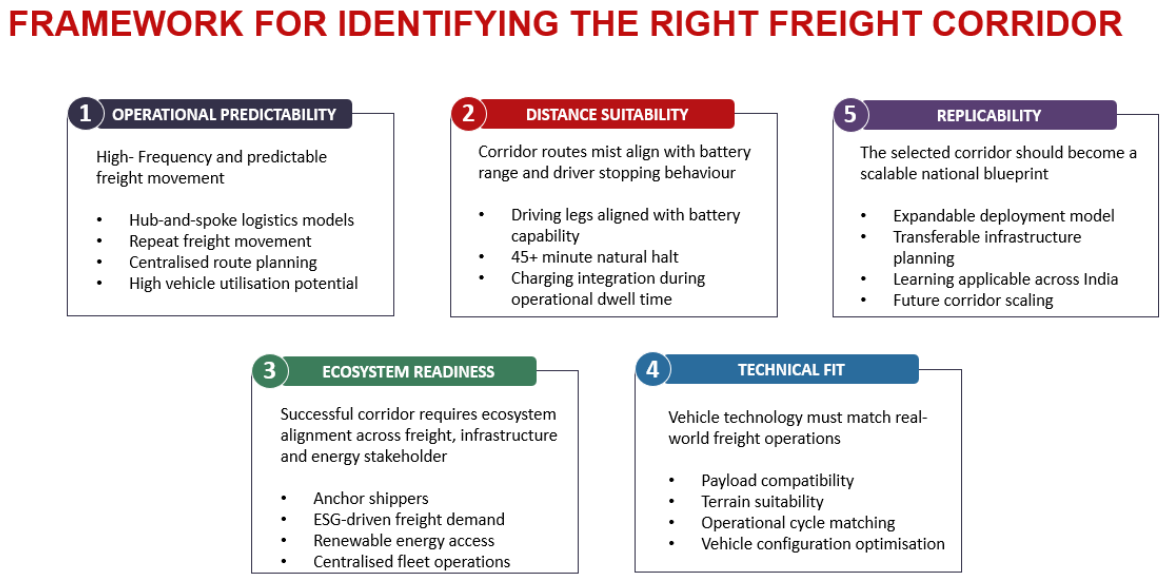

Figure 4: Five Pillars for Selecting Scalable Zero-Emissions Freight Corridor

Reasons for Choosing the Bengaluru-Mumbai Corridor

The Bengaluru–Mumbai corridor emerges as one of the strongest candidates for large-scale freight electrification in India due to its unique combination of freight density, industrial activity, RE availability, infrastructure readiness, and policy support. The corridor demonstrates many of the characteristics globally recognised as critical for successful zero-emission freight deployment.

1. High Freight Density and Strategic Economic Importance

The Bengaluru–Mumbai corridor is one of India's busiest freight movement arteries, connecting major industrial, manufacturing, logistics, and consumption centres across Karnataka and Maharashtra.

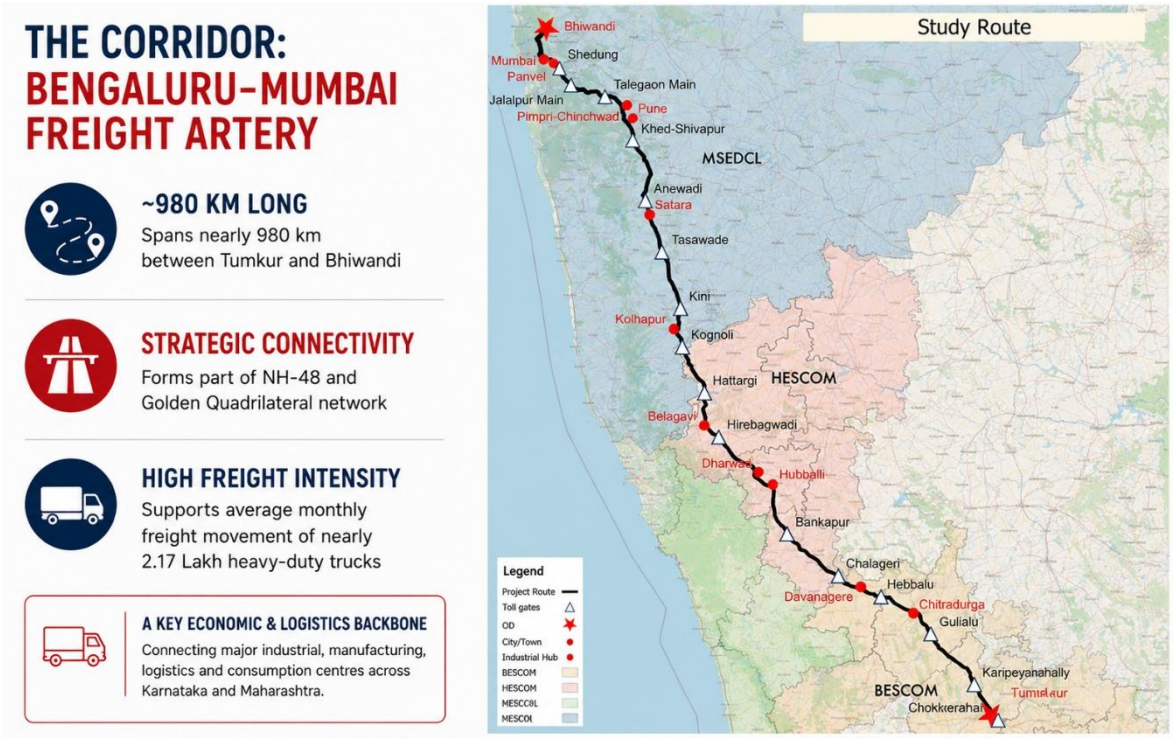

Figure 5: Key Characteristics of Bengaluru - Mumbai Corridor

Its strategic connectivity with the Jawaharlal Nehru Port Trust (JNPT) port, Pune–Mumbai expressway, and industrial manufacturing clusters, along with dedicated freight corridor (DFC) linkages, ensures a stable and predictable freight demand throughout the year.

This high freight intensity is a critical factor because freight electrification economics turns significantly favourable under high-utilisation conditions.

2. Strong Operational Predictability

The corridor supports highly repetitive and structured freight movement patterns in the fast-moving consumer goods (FMCG), e-commerce, automotive, and industrial goods sectors.

The route operates largely under hub-and-spoke logistics models, where fleet movement is predictable and operationally controlled. Such operational predictability is one of the most important enablers for electric truck deployment because it allows

- planned charging schedules
- optimised route mapping
- improved vehicle utilisation.

Additionally, the corridor includes operational halt-points across logistics hubs, toll plazas, industrial clusters, and driver rest locations, creating opportunities for integrating the charging infrastructure with the existing freight movement behaviour.

3. Existing Freight and Energy Infrastructure Advantage

One of the strongest advantages of the Bengaluru–Mumbai corridor is the simultaneous availability of both freight and energy infrastructure. The corridor already includes logistics parks, transport hubs, fuel stations, repair centres, *dhabas* and hotels, and the existing charging infrastructure. Simultaneously, the route is supported by major utility jurisdictions including those of Bengaluru Electricity Supply Company Limited (BESCOM), Hubli Electricity Supply Company Limited (HESCOM), and Maharashtra State Electricity Distribution Company Limited (MSEDCL).

This creates an important advantage for freight electrification as grid connectivity, transmission infrastructure, and substations are already present across several high-demand nodes.

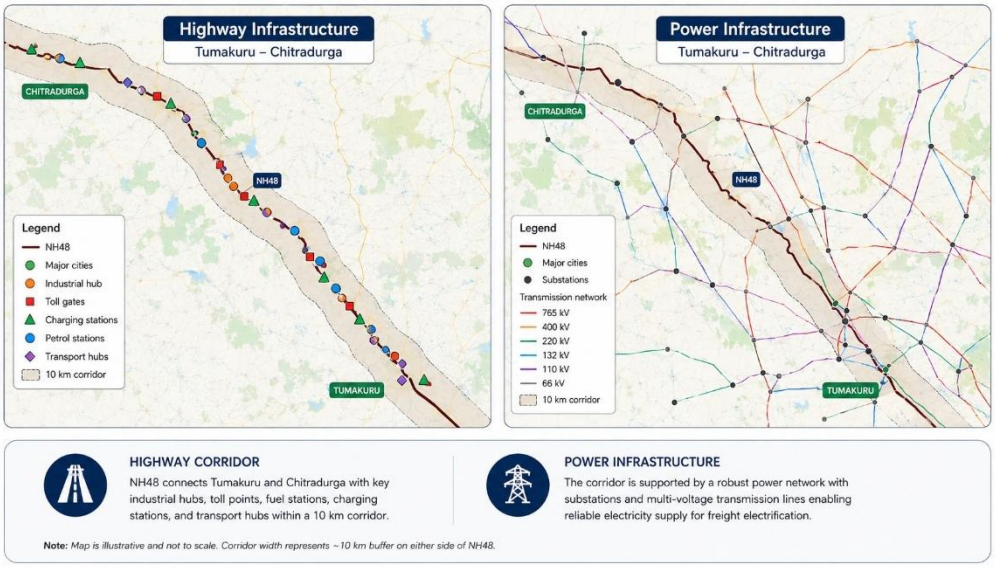

Figure 6: Highway and Power Infrastructure Along the Tumakuru–Chitradurga Corridor

4. RE Ecosystem Readiness

The corridor is uniquely positioned within some of India's largest RE clusters.

The RE hotspots include

- Tumkur and the surrounding regions with strong solar potential
- Chitradurga with major wind energy development
- Satara–Kolhapur regions with both wind and solar energy assets.

As of August 2025, the broader corridor region includes

- nearly 19 GW of solar energy capacity
- nearly 13 GW of wind energy capacity.

This makes the corridor a strong candidate for developing RE-powered freight charging ecosystems, which can enable significantly higher reductions in lifecycle emissions as compared to grid-only charging.

The presence of RE infrastructure also creates opportunities for green, open-access, RE-linked charging tariffs, energy storage integration, and long-term low-carbon charging ecosystems.

5. Supportive State-Level Policy Environment

The Bengaluru–Mumbai corridor benefits from a relatively supportive and evolving policy ecosystem in Karnataka and Maharashtra, creating favourable conditions for freight electrification deployment.

Maharashtra has introduced several enabling measures, including purchase subsidies for electric heavy-duty vehicles, charging-infrastructure support mechanisms, and long-term fleet electrification targets. Karnataka, while more focused on infrastructure enablement, has introduced electric vehicle (EV) infrastructure deployment incentives and special electricity tariffs for EV charging.

The presence of proactive policy frameworks at both ends of the corridor strengthens long-term investor confidence, improves commercial viability for infrastructure developers and fleet operators, and supports the development of a scalable zero-emission freight ecosystem.

6. Strong Replicability Potential

Besides its immediate deployment potential, the Bengaluru–Mumbai corridor also offers strong replicability value for future freight electrification efforts across India. The corridor has many of the characteristics expected across future high-volume freight routes, including long-haul, heavy-duty freight movement, industrial demand concentration, RE integration potential, and multi-state logistics operations. As a result, the learnings emerging from the corridor on operational, infrastructural,

energy, and policy aspects can be utilised to replicate similar efforts across other strategic freight routes such as Delhi–Jaipur, Mumbai–Pune, Chennai–Bengaluru, and the Golden Quadrilateral freight corridor. The Bengaluru–Mumbai corridor therefore represents more than a regional deployment opportunity. It serves as a strategic national blueprint for demonstrating how integrated freight–energy ecosystems can enable a scalable zero-emission freight transition across India.

The next critical step after corridor identification and demand aggregation involves understanding and aligning the supporting energy infrastructure ecosystem. The subsequent technical notes in this series will focus on charging infrastructure readiness, energy system integration, grid preparedness, and RE-powered freight charging systems.

Conclusion

India's freight sector is approaching a critical transition point. While pilot demonstrations across the country have successfully established the technical feasibility and operational viability of electric trucks, the next phase of adoption requires moving from fragmented deployments to coordinated ecosystem-scale implementation. The future of freight electrification will depend not only on advancements in vehicle technology, but also on the ability to align freight demand, charging infrastructure, RE integration, financing mechanisms, utility readiness, and supportive policy frameworks within a unified deployment strategy.

The Bengaluru–Mumbai corridor particularly stands out due to its strong combination of high freight density, industrial demand concentration, RE readiness, existing freight and power infrastructure, operational predictability, and supportive policy ecosystems across both Karnataka and Maharashtra. More importantly, the corridor represents a scalable national blueprint for zero-emission freight deployment across India. The operational, infrastructure, energy, and policy learnings emerging from the Bengaluru–Mumbai corridor can support replication across other strategic freight routes such as Delhi–Jaipur, Mumbai–Pune, Chennai–Bengaluru, and the Golden Quadrilateral corridor.

About the Bengaluru–Mumbai Corridor Initiative by SFC and CSTEP

Smart Freight Centre (SFC), in collaboration with the Center for Study of Science, Technology and Policy (CSTEP), has undertaken a strategic initiative focused on enabling large-scale freight electrification along the Bengaluru–Mumbai corridor. The initiative combines freight demand analysis, charging infrastructure planning, energy system integration, RE assessment, and stakeholder engagement to develop a corridor-scale deployment blueprint for medium- and heavy-duty electric trucks.

It focuses on identifying freight demand clusters, aggregating shipper and fleet demand, assessing charging and grid infrastructure requirements, mapping logistics

and industrial hubs, and evaluating RE integration opportunities. It also integrates freight and energy system planning by assessing corridor-level electricity demand, transmission and distribution readiness, charging-load patterns, RE availability, and opportunities for managed charging and energy optimisation.

The initiative also seeks to strengthen collaboration among shippers, carriers, OEMs, charging providers, utilities, policymakers, financiers, and research institutions. By combining demand aggregation with infrastructure and energy planning, the SFC–CSTEP initiative aims to demonstrate how freight corridors can transition from fragmented pilots to commercially scalable deployment ecosystems.

Join the Initiative

Click here or scan the QR code to join the Bengaluru–Mumbai corridor initiative.

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