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Building India's Electric Vehicle Supply Chains

A Case for Indo-German Cooperation

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Abbreviations

2W	Two-Wheeler
3W	Three-Wheeler
AAT	Advanced Automotive Technology
AC	Alternating Current
ACC	Advanced Chemistry Cell
ARAI	Automotive Research Association of India
BEV	Battery Electric Vehicle
BIK	Benefit-in-Kind
BIS	Bureau of Indian Standards
BMZ	German Federal Ministry for Economic Cooperation and Development
CAGR	Compound Annual Growth Rate
Capex	Capital Expenditure
CCS	Combined Charging System
CCS2	Combined Charging System 2
CPO	Charge Point Operator
CRM	Critical Raw Material
CRMA	Critical Raw Materials Act (EU)
CSEP	Centre for Social and Economic Progress
DC	Direct Current
DPI	Digital Public Infrastructure
DRC	Democratic Republic of Congo
E2W	Electric Two-Wheeler
E3W	Electric Three-Wheeler
E4W	Electric Four-Wheeler
ELV	End-of-Life Vehicle
EoL	End-of-Life
ESG	Environmental, Social, and Governance
EV	Electric Vehicle
FAME	Faster Adoption and Manufacturing of Hybrid and Electric Vehicles
FTA	Free Trade Agreement
FY	Financial Year
G2G	Government-to-Government
GB/T	Guobiao/Tui Jian
GDP	Gross Domestic Product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GSDP	Green and Sustainable Development Partnership

GVA	Gross Value Added
GW	Gigawatt
GWh	Gigawatt-hour
HEV	Hybrid Electric Vehicle
HQ	Headquarters
ICE	Internal Combustion Engine
IIT	Indian Institutes of Technology
IMEC	India–Middle East–Europe Economic Corridor
IP	Intellectual Property
ISI	Institute for Systems and Innovation Research
KABIL	Khanij Bidesh India Ltd.
kt	Kilotonnes
ktpa	Kilotonnes Per Annum
kWh	Kilowatt-hour
LCE	Lithium Carbonate Equivalent
LFP	Lithium–Iron–Phosphate
LIB	Lithium-ion Battery
MoEFCC	Ministry of Environment, Forest, and Climate Change
MOU	Memorandum of Understanding
mt	Million Tonnes
NCMM	National Critical Minerals Mission
NdFeB	Neodymium–Iron–Boron
NEMMP	National Electric Mobility Mission Plan
NMC	Nickel–Manganese–Cobalt
OEM	Original Equipment Manufacturer
PGE	Platinum Group Element
PSA	Office of the Principal Scientific Adviser
PHEV	Plug-in Hybrid Electric Vehicle
PLI	Production-Linked Incentive
PM E-DRIVE	PM Electric Drive Revolution in Innovative Vehicle Enhancement
REE	Rare Earth Element
REPM	Rare Earth Permanent Magnets
R&D	Research and Development
SME	Small and Medium-Sized Enterprise
SPMEPCI	Scheme to Promote Manufacturing of Electric Passenger Cars in India
TCO	Total Cost of Ownership
TTC	Trade and Technology Council

Executive Summary

Overview of Electric Vehicle Supply Chains and India's Need to Decarbonise

India is undergoing a structural transformation to address its climate vulnerabilities. It has committed to reaching 30% electrification of new vehicles by 2030 in the short term and net-zero emissions by 2070 in the long term. A key aspect of meeting these targets is creating resilient manufacturing value chains for the technologies needed to meet these ambitions. However, the global supply chains required to sustain the green mobility transition are fragile and concentrated—an issue affecting not just India, but many major economies globally. India currently has a 100% import dependency on the key minerals required to manufacture electric vehicle (EV) batteries, in both the ore and processed forms: lithium, cobalt, and nickel. Since much of the midstream processing of these battery minerals takes place in just one country—China—India faces a risk in its EV supply chains. Indian manufacturers have already faced challenges in acquiring requisite technologies, and without a strategy to mitigate these risks, domestic manufacturing will remain vulnerable to global and regional volatilities.

Strengthening India's EV Manufacturing Ecosystem

So far, India's domestic EV policy landscape has been driven by demand-side purchase subsidies (e.g., the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme) and downstream assembly incentives, through the Production-Linked Incentive (PLI) Scheme for Advanced Chemistry Cells (ACC). However, these schemes have not been able to address the supply risks in upstream mineral procurement and midstream processing, despite having domestic value-addition requirements, due to a lack of suitable local options. Furthermore, India's EV market is significantly different to those in the West; a large share of mobility electrification in India stems from two-wheelers (2Ws), three-wheelers (3Ws), and public transport, rather than passenger four-wheelers (4Ws). A resilient EV manufacturing strategy for India rests on improving mineral efficiency by minimising imported mineral needs per passenger-kilometre, and maximising local value addition in the midstream chemical processing and cell manufacturing.

The Need for International Strategic Cooperation

India cannot single-handedly overcome all the challenges it faces in the upstream and midstream segments of the value chain. State-backed enterprises like Khanij Bidesh India Ltd. (KABIL) have acquired mineral blocks abroad, though this alone is not enough if the raw ore needs to be sent to a different country for refining. India will need to develop capacities to mine critical minerals domestically and abroad, scale up processing capabilities, and begin manufacturing specialised components for EVs. However, there exist geological, technical, and financial challenges for India to resolve these alone domestically. Strategic alliances with like-minded partners can help de-risk investments, provide advanced technologies, and co-develop alternate supply chains.

Germany as a Complementary Partner

India needs to find partners for collaboration in developing resilient EV manufacturing capacities. While China currently leads in almost all aspects of these supply chains, equal-footing partnerships might be challenging given its use of critical mineral and technology exports as leverage. Other major battery manufacturers, like those in South Korea and the US, tend to prefer keeping the processing of intellectual property (IP) to themselves, particularly if there are vertically integrated plants. In contrast, Germany, projected to become the third-largest battery manufacturer by 2030, serves as a viable strategic partner. While it has a world-class automotive industry, it lacks the geological potential for battery minerals. Germany also faces higher energy and labour costs domestically, which provides an avenue for alignment with India's goals: Germany can provide its advanced technology IP and state financing for acquiring raw materials as well as processing and recycling plants, while India can provide lower operating costs, access to a vast pool of engineers, domestic market scale, and a stepping stone for German EV manufacturers to export from India.

Areas of Collaboration

Indo-German cooperation on EV supply chains can be operationalised in three areas. These will help de-risk investments, enhance bilateral market access, and create more resilient EV supply chains:

- ***Financing:*** The Indo-German Green and Sustainable Development Partnership (GSDP) and the KfW Raw Materials Fund (a state-backed initiative administered by Germany's development bank, KfW) must be leveraged for joint investments either in India or with Indian firms in third-party countries to acquire mining assets and set up processing and recycling plants. This de-risked mineral offtake can be used by both Indian and German manufacturers.
- ***Innovation and Standards:*** India has several challenges in domestic research and development (R&D), such as the lack of domestic battery testing laboratories. By partnering with German organisations, India can establish more testing infrastructure domestically that meets the local climatic requirements, while also being of a standard suitable to export to the European Union (EU). Additionally, German expertise in metallurgy and refining can be brought to India through joint ventures.
- ***Infrastructure Interoperability:*** India should align various EV standards with global good practices, such as charging protocols (Combined Charging System 2 (CCS2)). Additionally, aligning India's Battery Aadhaar with the EU's Battery Passport framework would open a larger market for secondary vehicle financing and battery recycling in both regions.

Table ES–1: Summary of Policy Recommendations

Pillar	Proposed Policy Action	Strategic Cooperation
Supply (Mining)	Expand reserves beyond rare earths to include battery minerals (lithium, cobalt, nickel).	Use G2G frameworks to de-risk private Indian bids for mining assets in third-party jurisdictions (Africa/South America).
Supply (Processing)	Provide incentives for domestic processing of imported ore, positioning India as a global processing hub.	Leverage the GSDP to transfer advanced processing IP to Indian refiners.
Circular Economy	Strengthen the enforcement of rules to restrict the export of black mass, ensuring critical minerals are recycled domestically.	Connect Indian recyclers with German SMEs (via TTC) to deploy the latest hydrometallurgical recovery technologies in India.
Manufacturing	Establish battery testing labs in India.	Set up certified joint testing facilities to validate Indian products for EU export.
Demand	Move from purchase subsidies to social leasing of EVs. Provide tax incentives for electric corporate fleets.	-
Digital	Implement the Battery Aadhaar framework to track the residual value of batteries to unlock secondary financing.	Align Indian data standards with the EU Battery Passport to ensure interoperability and market access.

Source: Authors' analysis.

Note: EU = European Union; EV = electric vehicle; G2G = government-to-government; SME = small and medium-sized enterprise; TTC = Trade and Technology Council.

India's green mobility transition cannot be managed in isolation. By operationalising existing India–Germany partnerships, India can move from the simple assembly of EV components to becoming a resilient player in the global EV value chain.

1. Introduction

India is at a critical stage in its mobility transition. While the country has committed to ambitious decarbonisation targets, including net-zero emissions by 2070 and 30% vehicle electrification by 2030 (Office of the Principal Scientific Adviser [PSA], Government of India, 2026), the supply chains required to achieve these goals are concentrated and fragile. The Indian EV market is projected to grow from US$3.21 billion in 2022 to over US$113 billion by 2029 (The Economic Times, 2025b). However, several structural vulnerabilities need to be overcome, particularly regarding the very high, or in some cases complete, import dependency for the critical minerals and materials that underpin this transition. India currently relies on imports for 100% of its lithium, cobalt, and nickel requirements. As the country transitions from internal combustion engines (ICEs) to EVs, it risks converting its energy dependence on West Asian oil to far more concentrated manufacturing dependencies on East Asian, primarily Chinese, supply chains. Such dependency is not only a theoretical risk, but one that Indian Original Equipment Manufacturers (OEMs) have faced. In July 2025, one of India's leading 2W OEMs, Bajaj Auto, was forced to cut electric scooter production by nearly 50% (Sengupta, 2025), triggered by a disruption in the supply of rare-earth permanent magnets (required for EV motors) following export controls from China. In early 2026, a report emerged that an Indian manufacturing company was unable to secure the requisite Chinese technology to manufacture battery cells (Reuters, 2026).

The challenge India faces is not only geological but also industrial. While extraction of EV-related critical minerals is concentrated in a few countries (including Australia, the Democratic Republic of Congo, China, and Chile), the processing and refining capacity is mostly controlled by a single country. China currently controls over 60% of global lithium and cobalt processing, over 70% of graphite, and nearly 90% of Rare Earth Elements (REEs) (International Energy Agency [IEA], 2025a). For India, as for the global economy, this midstream concentration creates a major supply chain risk. Without domestic capability to process raw ores or recycle the black mass from spent batteries, India remains a price-taker in a volatile global market. It will be exposed to the weaponisation of supply chains and trade shocks. Thus, India needs strong global partnerships with other countries that similarly aim to reduce mineral supply risks and build domestic capacity.

Recent years have seen a growing strategic alignment between India and the EU. Last year's landmark visit by European Commission President Ursula von der Leyen and the College of Commissioners to New Delhi and the second ministerial of the India–EU TTC deepened ties in clean tech and resilient supply chains. The *Towards 2030: India-EU Joint Comprehensive Strategic Agenda,* endorsed during the 16th India–EU Summit in January 2026, aims for joint action on global challenges such as climate change, digital transformation, and geopolitical stability. High-level EU leaders, including the European Council President António Costa and the European Commission President, served as chief guests for India's 77th Republic Day parade and co-chaired the 16th India–EU Summit. The signing of the landmark Free Trade Agreement (FTA), hailed as "the mother of all deals," unlocks increased potential for EV trade, investment, and market access opportunities, signalling growing trust. More recently, a battery recycling initiative was launched under the India–EU TTC, funded equally by both parties, to promote the localisation of advanced battery recycling technologies (Press and Information Team of the EU Delegation to India and Bhutan, 2026).

The partnership is anchored in a commitment to reach net-zero emissions by 2070 and 2050 by India and the EU, respectively. It is furthered by the ambition of both parties to shift towards a greater share of renewable energy to power the EVs. Notably, India reached its target to have 50% of its power generation from non-fossil sources five years early in 2025. Renewables make up 234 gigawatt (GW), and nuclear 8.7 GW (The Times of India, 2025). In the EU, nearly 49% of the electricity demand was met by renewables in 2025 (European Commission, 2025c). India has committed to 30% EV penetration across all new vehicle sales by 2030, while the EU has mandated 90% emissions reduction from 2021 baseline levels for new vehicles starting in 2035 (S&P Global, 2025a). The EU also reached a milestone in Battery Electric Vehicle (BEV) registrations in 2025; they accounted for close to 19% of new car registrations across Europe. This was a 31% increase compared to 2024 levels (International Council on Clean Transportation [ICCT], 2026). Germany and France led BEV registrations in Europe, reaching 30% and 27% registrations, respectively (ICCT, 2026).

EVs and green mobility represent one of the most concrete and rapidly advancing areas of India–EU strategic cooperation. Both partners face parallel challenges: India's imperative to electrify its burgeoning urban mobility amid rapid industrialisation and the EU's need to decarbonise its automotive heartland while securing alternative supply chains. The India–EU partnership in EV and green mobility emerges from a confluence of the shared needs to decarbonise, reduce fossil fuel import dependence, and secure critical minerals for resilient supply chains. This partnership can be bolstered by strategic imperatives, rooted in shared democratic values, commitment to a rules-based international order, and mutual recognition as "like-minded and trusted partners" in navigating a fragmented global landscape.

In Europe, Germany has been one of India's longest-standing partners, with diplomatic relations established in 1951 and a strategic partnership signed in 2000, allowing for cooperation across various sectors. In navigating the vulnerable critical mineral supply chains, the experiences of Germany can be a reference when determining India's strategy. Germany, in some ways, mirrors India's current industrial status: both nations are major automotive hubs that lack significant or readily exploitable domestic mineral reserves; both are facing the need to de-risk supply chains from dominant monopolies; and both are committed to democratic, rules-based trade. Like India, and unlike resource-rich countries, Germany is racing to secure raw materials to support its massive industrial base, employing state-backed instruments like the *KfW Rohstofffonds* (KfW Development Bank's raw materials fund) to secure equity in overseas mines. The convergence of the two countries' strategic interests forms a major component of this study. By examining Germany's response to these challenges, India can be better placed to respond to similar roadblocks it will face in localising EV supply chains. This paper draws on insights gained from high-level stakeholder consultations conducted in Berlin (July 2025) and New Delhi (November 2025). These engagements reveal that existing partnerships, especially the India–Germany GSDP with its €10 billion funding commitment by 2030, provide a foundation for increased industrial cooperation, such as through promoting technology transfer in mineral processing and for jointly acquiring assets in third-party countries.

In the present geopolitical context, the EU–India partnership serves as a stabilising force amid US–China tensions, Russia–Ukraine fallout, and Red Sea disruptions. For India, the EU collaboration diversifies dependencies beyond traditional partners like Russia for energy security. For the EU, India offers a democratic counterweight in the Indo-Pacific, aligning with its Global Gateway initiative. Germany, as the EU's industrial powerhouse, amplifies this, given that its auto sector (Volkswagen Group, BMW, and Mercedes) views India's US$500 billion EV market potential by 2030 as indispensable for global scaling. In turn, India gains access to advanced engineering prowess in batteries, powertrains, and software-defined vehicles. Creating established institutional mechanisms, significant financial commitments, and clear pathways for expansion across manufacturing, technology transfer, and market access will be key for both countries to emerge as global leaders in sustainable transport solutions.

This paper considers both the supply-side imperative of industrial resilience and the demand-side narrative of EV adoption. The paper draws on primary inputs from industry roundtables and bilateral consultations and finds that India's green mobility transition cannot rely solely on subsidies. It requires a comprehensive industrial strategy that accounts for India's unique market structure, which is dominated by 2Ws and 3Ws rather than cars and leverages its existing automotive manufacturing strengths to shift from ICE manufacturing to EV resilience.

This paper is structured as follows: Section 2 maps the global electric mobility supply chain, highlighting the bottleneck of midstream processing and India's vulnerabilities. Section 3 conducts a comparative supply-side analysis of India and Germany, examining domestic capabilities across raw materials, processing, manufacturing, and recycling. Section 4 evaluates demand-side dynamics, contrasting India's 2W-dominated market with Germany's passenger-car market. Section 5 outlines the strategic cooperation between India, Germany, and the EU, detailing three pillars (Institutional, Innovation, and Industrial) that serve as the framework for resilience. Finally, Section 6 brings together these insights into actionable policy recommendations.

2. Overview of Electric Vehicle Supply Chains

The global electric mobility supply chain has a bottleneck: While resource extraction is geographically concentrated in a few regions, mineral refining is monopolised by just one country. Such concentration creates bottlenecks in the supply chain, where raw materials from Africa, Australia, and South America must pass through China before manufacturers in India or Europe can use them.

Figure 1: Flows of Critical Minerals for Electric Vehicles

<table>
<tr><th>Mining</th><th>Processing</th><th>Manufacturing</th><th>Recycling</th></tr>
<tr><td>Lithium
Australia, Chile, China, and Zimbabwe</td><td rowspan="4">Lithium, cobalt, REE, and graphite
China</td><td>Battery cells
China, South Korea, Japan</td><td rowspan="4">Batteries
China, the United States, and the European Union</td></tr>
<tr><td>Cobalt
Democratic Republic of Congo</td><td>Cathodes/anodes
China, South Korea</td></tr>
<tr><td>Nickel
Indonesia and the Philippines</td><td rowspan="2">EV assembly
China, the European Union, the United States, and India</td></tr>
<tr><td>Rare earths
China, the United States, and Myanmar</td></tr>
</table>

Source: International Energy Agency (2025a).

Note: EV = electric vehicle; REE = rare earth element.

As shown in Figure 1, the major vulnerability in the EV supply chain is not in mining but in processing activities. Given this is an important distinction, India must focus on drafting policies to increase its supply chain resilience. To date, India has focused on acquiring equity in foreign mining assets through its state-run company, KABIL. However, if India were to obtain, say, a lithium mine in Argentina, it would not increase India's raw material security if the ore still had to be shipped to China for processing into battery-grade lithium hydroxide. Going further downstream to electric car production capacity, China leads with around a 70% share in global production in 2024, with the EU in second place with a 14% share of the 17.3 million cars manufactured (IEA, 2025b). Finally, battery recycling is also heavily concentrated in China, hosting over 70% of the global capacity, with the US and EU holding significantly smaller shares (IEA, 2024c).

While China leads in much of the EV supply chain scale, Germany possesses some technological advantages in power electronics, recycling processes, and leadership in new technologies such as magnet-free motor designs that bypass the need for concentrated rare earth supply chains. Strengthening India's EV manufacturing capacity would require long-term collaboration and partnership with other countries with battery manufacturing capacities. South Korea, Japan, and Germany are home to some of the leading automobile manufacturers in the world, like Hyundai, KIA, Toyota, BMW, and Mercedes-Benz. These companies are also some of the fastest-growing EV manufacturers in the country as they continue to increase their annual production and domestic investments (Table 1).

Table 1: India's Electric Vehicle Four-Wheeler Market Share

Companies	HQ Country	Vehicle Sales FY25	Market Share FY25 (%)	Vehicle Sales FY24	Market Share FY24 (%)
Tata Motors Passenger Vehicles Ltd	India	57,616	53.52%	64,530	70.52%
MG Motor India Pvt Ltd	China	30,162	28.02%	11,683	12.77%
Mahindra & Mahindra Limited	India	8,182	7.60%	6,119	6.69%
BYD India Private Limited	China	3,401	3.16%	1,787	1.95%
Hyundai Motor India Ltd	South Korea	2,410	2.24%	1,842	2.01%
PCA Automobiles India Pvt Ltd/ Stellantis	Netherlands	1,962	1.82%	2,034	2.22%
BMW India Pvt Ltd	Germany	1,550	1.44%	1,424	1.56%
Mercedes-Benz AG	Germany	1,133	1.05%	565	0.62%
Kia India Private Limited	South Korea	414	0.38%	432	0.47%
Volvo Auto India Pvt Ltd	Sweden	394	0.37%	606	0.66%
Others	-	421	0.39%	484	0.53%
Total		**1,07,645**	**100%**	**91,506**	**100%**

Source: Federation of Automobile Dealers Associations (2025).

Note: FY = financial year; HQ = headquarters.

Total EV sales in India have increased by 15% in FY 2025, with a few brands like MG Motors significantly increasing their market share. The growing share of Chinese EV companies like MG Motors and BYD, amounting to 31% of EV sales, has raised concerns for other manufacturers that must compete with Chinese technologies and performance. Sales of Indian EV company Tata Motors dropped by 17% in FY 2025, the lowest growth in sales for the market leader in the 4W segment. India must encourage EV manufacturers from other countries, especially the EU, to increase their investment in the sector to counter the increasing presence of Chinese manufacturers. It is important to counter the rapid growth of Chinese-owned companies to enable a healthy and competitive EV sector. European brands like BMW, Mercedes-Benz, Volvo, and the Stellantis Group, which manufacture luxury EVs, constitute close to 5% of total EV sales in 2025.

EU car manufacturers in the ICE vehicle category have managed to localise the majority of their supply chain in India, supporting technology transfer and employment (BMW Group, 2026a). The BMW group also intends to localise the manufacturing of its EV supply chains in India. Large sales volumes would encourage these companies to set up their manufacturing processes in India to support the expansion of the EV industry. The group is also vertically integrating its battery manufacturing capacity globally by investing in advanced battery cell production (BMW Group, 2026b). As part of its "local-for-local" policy, BMW aims to set up similar battery and EV manufacturing units locally in different countries to reduce its operational costs. Cooperation between India and leading German EV brands will act as a catalyst for India's EV battery industry. EV companies are currently some of the biggest investors in vertically integrating battery supply chains. German EV companies continue to invest locally to reduce their supply costs. India and Germany must leverage their strong history in automobile supply chains to increase investments in the EV sector.

The following table outlines the current risk exposures for India and Germany in the electric automobile sector.

Table 2: Supply of Key Electric Vehicle Components

Component	Key Global Player	Indian Context	German Context
Lithium hydroxide/ carbonate **Cathode active material**	China (~65%)	Highly import-dependent. No domestic mining or refining of lithium. Auctions of domestic lithium blocks are in the early stages of exploration.	Currently import-dependent. Potential for production in the Altmark deposits. The KfW Raw Materials fund can provide financing to get equity in overseas mines.
Cobalt sulphate **Cathode active material**	China (~75%)	No domestic mining or refining of high-purity cobalt needed for batteries.	Possesses technologies for processing high-purity cobalt (e.g., BASF).
Nickel sulphate **Cathode active material**	Indonesia (65% mining, 45% processing)	Highly import-dependent. Some domestic resources not yet operationalised.	Developing low-carbon technologies to extract nickel from low-grade ores.
Graphite anodes **Anode material**	China (~90%)	Emerging capacity with Epsilon Advanced Materials setting up domestic anode plants. Import dependent on needle coke required to produce anodes, though capacities are being developed.	Synthetic graphite production for high-performance cells (e.g., SGL Carbon).
Battery cells: nickel-cobalt-manganese (NMC) or LFP	China (~80%)	Cell assembly is growing (PLI scheme), but chemistry remains imported.	European hub of battery cell manufacturing driven by vehicle OEMs. R&D investments in pilot battery technologies (e.g., solid-state batteries).

Component	Key Global Player	Indian Context	German Context
Permanent magnets (NdFeB) **EV motor**	China (~95%)	Lack of permanent magnets triggered production cuts in 2025. Reliance on China for rare earths and magnets. Rare earths corridor in the planning stage.	Innovations in magnet-free motors to reduce dependency on rare earths.
Charging power modules	China	Hidden risk—sub-components are largely imported.	Experience in power electronics and technical standards for CCS2 charging protocol.
Black mass **Recycling feedstock**	South Korea	Exports of black mass from India are restricted to encourage use by domestic recyclers.	EU Battery Regulations mandate lithium recovery.

Source: BASF (2026); Max-Planck-Gesellschaft (2026); Roschger (2022).

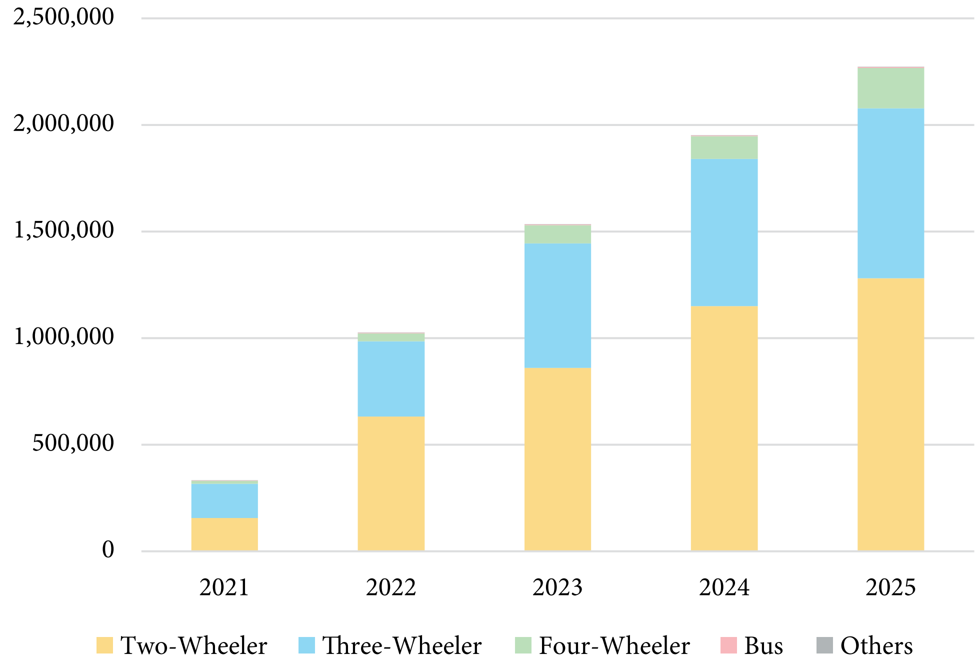
Note: CCS2 = combined charging system 2; EV = electric vehicle; NMC = nickel–manganese–cobalt; NdFeB = neodymium–iron–boron; OEM = original equipment manufacturer; PLI = production-linked incentive; LFP = lithium–iron–phosphate; R&D = research and development.

As Table 2 also shows, much of India's vulnerabilities rest in the midstream. While India's downstream industry is relatively capable, with its existing traditional industries able to assemble battery packs and EVs, the upstream and midstream sections of the supply chain are the most vulnerable due to the lack of a strong domestic presence. The following sections analyse the supply and demand factors in the EV sector and provide specific policy recommendations on collaboration towards resolving vulnerabilities.

3. Supply-Side Factors

India and Germany face similar supply-side constraints that directly impact their domestic EV manufacturing capacity. The Indian government has set a target of achieving 30% EV penetration by 2030 across all vehicle types. The target EV penetration is higher for certain vehicle categories: 80% of all 2Ws and 70% of all commercial vehicles to be electric by 2030. Private vehicles have the same target as the overarching goal, at 30% penetration (PSA Government of India, 2026). India's vision of becoming a developed economy by 2047, or "Viksit Bharat," also encompasses the establishment of an innovative, sustainable, and self-sustaining EV market and supply chain (PSA, Government of India, 2026). The EV market recently saw a 16.4% year-on-year growth rate, translating to 22,72,560 EVs sold in 2025, up from 19,50,767 vehicles the previous year (Figure 2). EVs accounted for 8% of the total vehicle units sold in India in 2025. Of this share, 56.4% were electric two-wheelers (E2W) and 25% electric three-wheelers (E3W). 4Ws accounted for only 8% of the total EV sales in 2025. The cumulative total of EVs sold in India reached 61.66 lakh by the end of that year (JMK Research & Analytics, 2025). The current national government's focus is on accelerating EV deployment in major urban areas, such as Delhi, Mumbai, and Bangalore (BDO India LLP, 2025).

Figure 2: Electric Vehicle Sales in India

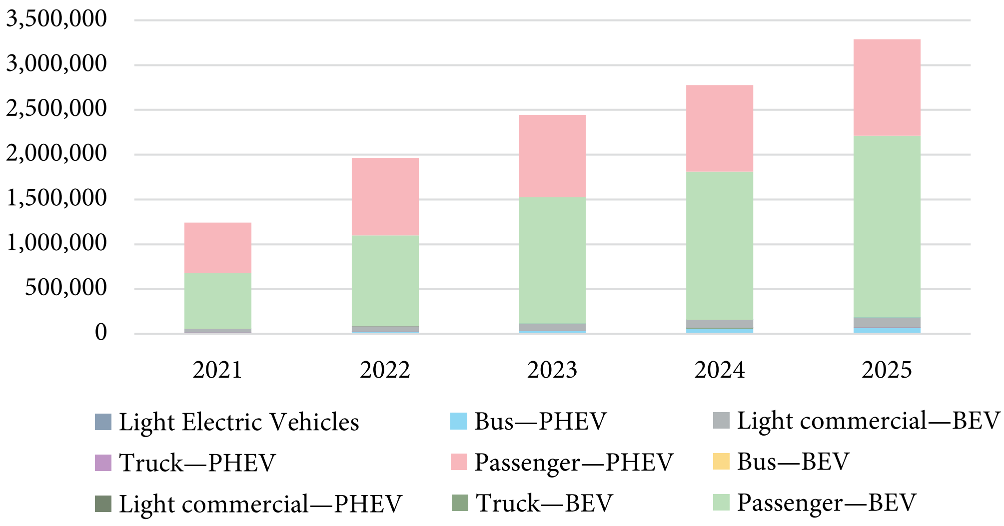


Source: Ministry of Road Transport & Highways, Government of India (2026).

India's first comprehensive framework for EV development was the National Electric Mobility Mission Plan 2020 (NEMMP), launched in 2013. This plan included policies and initiatives to deploy approximately 6 to 7 million electric or hybrid vehicles on Indian roads by 2020. The plan also focused on promoting India's expertise in certain vehicle segments and on ensuring the indigenisation of technologies related to the sector (Ministry of Heavy Industries, 2013). Specifically, the plan included demand- and supply-side incentives for EVs, promoted R&D initiatives for EV battery and motor technologies, incentivised charging infrastructure development, and the retrofit of vehicles on the road with hybrid kits (Ministry of Heavy Industries, 2013).

Figure 3 shows the trajectory of the German electric and hybrid vehicle market, which is dominated by passenger vehicles (both BEVs and Plug-in Hybrid Electric Vehicles [PHEVs]), with cumulative registrations exceeding 30 lakh vehicles in 2025. While Germany's mobility electrification is primarily in private 4Ws, India's volume is driven by cost-sensitive 2Ws and 3Ws. This divergence has an implication on battery supplies: German supply chains require high-energy-density cells for long-range cars, while India's ecosystem will need smaller and low-cost battery packs for light mobility and last-mile connectivity. In 2024, BEVs accounted for 13.5% of all new registered passenger cars in Germany, petrol cars formed the largest share, 35%, followed by Hybrid EVs (HEVs) (26.8%) and Diesel (17.2%). The total share of new registered ICE cars in Germany dropped by 11.4% in 2025 for petrol (27.2%) and Diesel (13.8%). The total share of BEV registrations was 19%, an increase of 5.6% from the previous year. HEVs (28.6%) held the largest share of new registered vehicles in 2025. A clear trend amongst passenger car consumers in Germany is a shift away from pure ICE vehicles to HEVs and BEVs.

Figure 3: Electric and Hybrid Vehicle Cumulative Registrations in Germany



Source: European Commission (2026).

The EV market has experienced a recent slump, which can be correlated with diminished investment in the EV sector. In 2023, India had passed Germany, capturing 4% of total global EV sector funding, making it the third-largest recipient of foreign funding (BDO India LLP, 2025). Whereas funding in 2022 reached US$934 million, in 2024 it dropped to US$586 million. Additionally, in India, numerous states' EV policies are approaching their expiration dates, eroding the confidence of some investors (S&P Global, 2025b). The deceleration in EV sales growth and plummeting funding suggest that the market's momentum is extremely sensitive to policy frameworks and investor confidence, despite ambitious targets. This demonstrates that the Indian EV market is still nascent and highly susceptible to shifts in government policy and investor sentiment. India needs a long-term and cohesive national strategy for EV deployment.

Globally, many countries face similar challenges as they rapidly increase their domestic EV capacity to meet ambitious green transition targets. Germany has the target to reduce transport emissions by 55% from 1990 levels by 2030 (European Parliament & Council of the European Union, 2019). In 2020, the German government set a target of having 15 million EVs on the road by 2030 and one million charge points in service across the nation (International Trade Administration, U.S. Department of Commerce, 2024). The targets were further amended in 2023 to include both pure EVs and HEVs, a shift from the earlier commitment of only pure EVs. In response, the EV and charging infrastructure market in Germany experienced rapid growth between 2020 and 2024, attaining a compound annual growth rate (CAGR) of 19.9% (GlobeNewswire Research and Markets, 2025). Although the growth rate is expected to decrease, forecasts still project a CAGR of 15.5% for the EV market between 2025 and 2034. This translates into an estimated US$21.32 billion market value in 2025, growing to US$78 billion in 2034. In 2025, Germany reached a total of 3.5 million registered BEVs (2.25 million) and PHEVs (1.25 million). It is highly unlikely for Germany to reach its targets at this rate; however, the ambitious targets have been a big boost to the EV sector in the country.

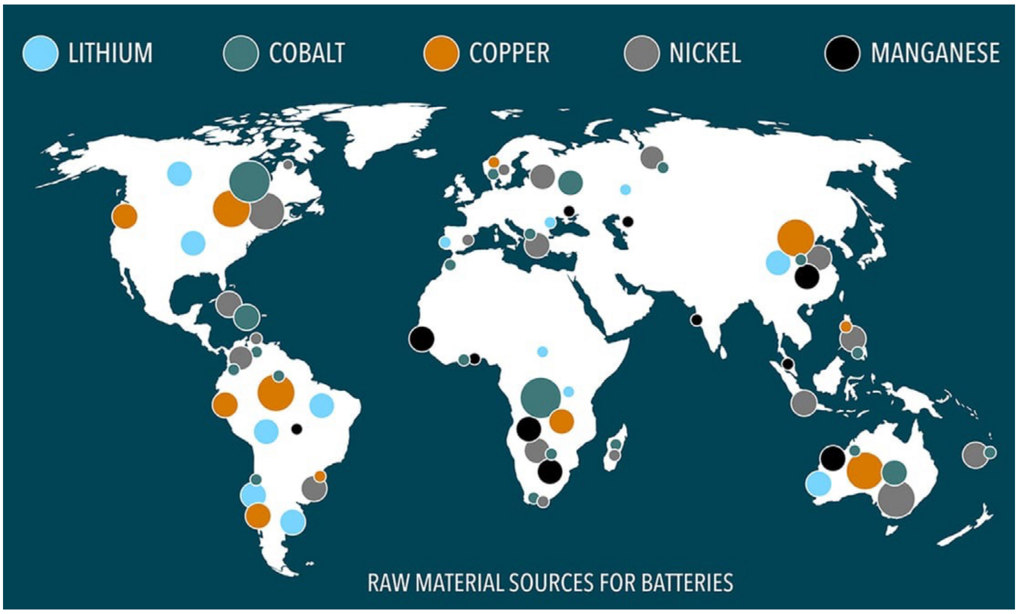
Despite this growth in market size, EV purchases have faced challenges in recent years due to the end of a comprehensive subsidy package offered by the German government until December 2023. Germany would require several policy incentives to achieve its 2030 EV targets. Germany has recently shifted its focus to EV policies and incentives. They are now further geared towards supporting company-owned EVs, charging infrastructure, and SMEs in the EV sector. For instance, Germany invested €210 million in 2017 in R&D for electric mobility, battery storage, value chain reinforcement, fleet and logistics strategies, digitalisation, grid integration, charging stations using smart metering technology, and infrastructure (Federal Ministry for Economic Affairs and Energy, 2017).

Both India and Germany have observed growing government and private-sector incentives and investments in EV supply chains. The two countries also face similar supply chain challenges; a deeper analysis of the current scenario would foster cross-border learning of each other's experiences. This section analyses the supply-side challenges faced by manufacturers in India and Germany across different stages of the supply chain—raw material procurement, mineral processing, manufacturing, and recycling.

3.1 Raw Materials

A major barrier is India's reliance on imports for critical minerals and EV components. Currently, India's EV market primarily focuses on the 2W and 3W classes (BDO India LLP, 2025). The country relies heavily on imports of minerals and components, making it particularly vulnerable to any price jumps, supply disruptions, geopolitical tensions, or trade disruptions (International Institute of Sustainable Development [IISD], 2024). Specifically, regarding critical minerals, India has a 100% import dependency on lithium, cobalt, and nickel, three key components used in EV batteries (Institute for Energy Economics and Financial Analysis, 2024). Most countries globally are dependent on China for their import of these minerals. China does not domestically mine most of these battery minerals; it imports them from other countries for processing (Figure 4).

Figure 4: Global Battery Mineral Resources



Source: Karamitros (2021).

Furthermore, with China maintaining a dominant position in the manufacturing of EV components and the extraction of critical minerals, the EV supply chain is extremely sensitive to any geopolitical changes or moves by the country (Murali, 2025). In January 2025, the government introduced the National Critical Minerals Mission (NCMM), an extensive critical minerals strategy for India with several targets to be achieved by 2031. The primary focus of the mission is to secure India's critical mineral supply chains and strengthen its domestic value chains. The budget outlay for the mission is ₹16,300 crore (approximately US$1.9 billion) with an additional expected investment of ₹18,000 crore (~US$2.1 billion) from public sector companies (Ministry of Heavy Industries, 2025). The budget outlay is significantly large as it provides direct subsidies to mining companies for exploration, and it aims to reduce the financial risks associated with mining in the region. Other countries like Australia and the USA have provided similar tax incentives for mining companies for domestically producing critical minerals.

The majority of the budget is dedicated to mineral exploration and securing foreign mineral assets (₹12,600 crore, approximately US$1.4 billion), with the NCMM aiming to support 1,200 exploration projects and acquire 50 foreign mines. Mineral recycling is also an important component of the mission, with ₹1,500 crore (~US$170 million) in incentives expected to result in the recycling of 400 kilotonnes (kt) of critical minerals by 2031. Mineral processing has received a more limited budgetary allocation of ₹500 crore (~US$57 million) to set up four critical mineral processing parks across India.

However, achieving the mission's objectives would require significant changes to domestic policies that currently impede the growth of the domestic mineral sector. Currently, mining companies cannot apply for mineral reconnaissance or prospecting in India. This reduces the investment in mineral exploration as companies do not get to undertake green-field mineral projects. The exploration licenses only apply to already discovered minerals (Chadha, Sivamani, & Bansal, 2023).

The lack of exploration is heightened when considering the challenges in production. Five tranches of critical mineral auctions have been concluded, during which the government put out 78 critical mineral blocks for auction, and 46 of them were successfully auctioned (Government of India, 2026). Many winning bidders placed irrationally high bids, such as three graphite blocks auctioned at 752%, 190%, and 151%. High bids would require the leaseholder to pay a higher share of their mineral sale value (equal to the bid percentage) to the government as auction premiums. There have already been instances of leaseholders returning their auctioned mining blocks due to the project's financial viability, likely resulting from the high bids. These issues with exploration and allocation of mineral lands slow down the creation of stable domestic supply chains. It also makes the domestic mineral sector unfavourable for foreign investment and competition. Global mining companies cannot compete against such irrationally high bids with low returns on investment due to the high costs.

Like India, Germany is also dependent on imports of critical minerals, as it does not domestically mine or process many of the essential minerals. Germany is entirely import-dependent on key battery minerals like lithium, nickel, and cobalt. There have been recent discoveries of lithium deposits in the Altmark region of Saxony-Anhalt, Germany, with up to 43 million tonnes (mt) of lithium carbonate equivalent (LCE) (Metal.com, 2025). This is one of the world's largest estimated lithium deposits, likely to boost Germany's lithium production and reduce its import dependence.

Part of the cost issues for OEMs can be attributed to Germany's import dependencies across the entire EV supply chain. Due to the need to import essential minerals, Germany may be in a fragile position amid supply bottlenecks, price volatility, and geopolitical tensions. The volatility was further exacerbated by recent crises such as the COVID-19 pandemic and Russia's war in Ukraine. Critical minerals are key for the manufacturing sector, as goods containing copper account for approximately 30% of gross value added (GVA), lithium-bearing products constitute 10%, and products utilising rare earth minerals form 22% (KfW Focus on Economics, 2024). This means that these critical raw minerals account for over half of the GVA of manufactured goods in Germany.

Furthermore, OEMs may soon face critical mineral shortages, which can, in turn, further hike mineral prices or cause supply chain disruptions (Euractiv, 2025). To reduce its import dependency, Germany is introducing a variety of measures to diversify its domestic supply of critical minerals and to increase recycling and end-of-life (EoL) re-use. Measures include the July 2025 announcement to distribute government grants to support Germany's critical raw minerals supply chain recipients (Reuters, 2025). Recipients, for instance, include Vulcan Energy, which has received €104 million to progress its clean lithium production initiative. This falls in line with the goals of the EU Critical Raw Materials Act (CRMA), for which the targets are to locally extract at least 10% of the total annual consumption of the EU's critical raw minerals by 2030. Further goals include processing at least 40% of those materials and recycling a share greater than 25% (European Commission, 2023).

3.2 Processing

The concentration of mineral processing in China is the main cause for bottlenecks in the global mineral supply chains. India is 100% import dependent on processed minerals that are essential for EV manufacturing, like lithium, nickel, and cobalt (Bansal & Chadha, 2025). India has identified mineral deposits of a few critical minerals domestically, but these resources have not yet been converted into mineable reserves. The majority of the auctioned blocks are under a composite license that requires further exploration of the deposits before converting them into mineable resources. This increases the lead time for the development of these minerals. In the absence of a domestic mineral supply, the processing sector in India would have to rely on imports in the short term. The prescribed time without any delays for operationalisation of a composite license block is seven years; however, long delays are very common in obtaining clearances and acquiring land in India (Ministry of Mines, 2025a).

Countries like China and Indonesia are currently oversupplying processed minerals, making it extremely hard for any other country to compete on such a low cost of production. High import reliance for raw materials drastically increases the cost of production, and the possibility of scaling up domestic mineral production would require long-term supply agreements with global mining companies (IEA, 2025a).

NCMM has laid out a strategy to build processing parks in India and support investors through various other incentives focused on mineral processing. After China's recent export restrictions on REEs, the government has introduced a PLI for the manufacturing of Rare Earth Permanent Magnets (REPM) with a budget outlay of ₹7,280 crore. This is likely to boost rare earth mineral processing in India (Government of India, 2025). The Union budget 2026–2027 announced the government initiative to build a rare earth mineral corridor in Odisha, Kerala, Andhra Pradesh, and Tamil Nadu that would integrate the complete value chain for REPM production in India (Press Information Bureau [PIB], 2026a). India requires more such dedicated mineral strategies that prioritise the development of the entire value chain for minerals with rich domestic resources.

Germany displays similar vulnerabilities for critical mineral processing, as it has very limited primary mineral sources. Currently, Germany processes negligible amounts of critical minerals and REEs essential to the production of EVs. Mineral processing infrastructure in Germany is not developed, making it commercially unviable for projects to scale (Hidayat, 2025). In 2022, Germany imported a total value of US$8.5 billion of raw or unprocessed minerals compared to US$25 billion of processed materials (Centre on Global Energy Policy, Columbia University, 2024). The European Commission has committed that the EU's domestic mineral demand by 2030 shall be met from 10% extraction, 40% processing and 25% recycling within the EU (European Commission, 2025). Germany is increasing its domestic mineral production and processing capacity to meet these targets.

The KfW Development Bank, which is state-owned, introduced the raw materials fund in 2024. Financial support for critical mineral processing projects will also be covered under this fund. The total amount of funding available is €1.1 billion, with individual projects or firms receiving between €50–150 million (KfW Development Bank, 2024). The processing level for 40% of the total resources consumed by 2030 is an ambitious target set under the CRMA. EU members face significant challenges in meeting these targets due to the high labour and energy costs associated with mineral processing, making it a less competitive market than other countries for low-cost production (Payne, 2026).

RESourceEU aims to invest US$3.5 billion under the CRMA in certain strategic mineral projects across the EU, in addition to banning the waste of certain recyclable black mass waste(Payne, 2025). EU initiatives supported the upskilling of labour forces for raw mineral processing, as it requires very high precision, quality, and well-trained technical experts. The European Battery Alliance is one such initiative that has led to investments in technologies and skills for this sector (EITI, 2025).

Another challenge for the EU is the negative public perception in many member countries towards mineral processing plants and the opposition due to labour and environmental concerns. Building facilities that meet higher sustainability standards and commitments to providing transparency in the supply chain would help provide more push for such facilities to come up (Breitsching, 2025). Despite high import dependence for raw and processed critical materials, both countries managed to increase their domestic EV manufacturing capacity.

3.3 Manufacturing

EV sales across India are growing, but at a slower rate than in prior years. In 2024, 1.9 million EVs were sold in the nation, up from 1.5 million in 2023. This 24.5% year-over-year growth is slower than the 50% increase in EV sales growth between 2022 and 2023 (Ministry of Road Transport & Highways, Government of India, 2026). The automotive sector in India represents 7.1% of Gross Domestic Product (GDP) and contributes 49% to the country's manufacturing GDP (NITI Aayog, 2025a). The growth of the EV sector will significantly contribute to expanding the automotive industry as more consumers shift away from traditional ICE vehicles. India aims to achieve a US$7 trillion economy by 2030. If such a share is maintained, the automotive industry can capture up to US$500 billion, with a large share of this amount going to EVs as the nation pushes for electrification targets (BDO India LLP, 2025).

India's import dependency, particularly for EV batteries, is particularly concerning, as it has a near-total lack of domestic battery manufacturing. This is due to its lack of infrastructure for EV battery manufacturing, accounting for less than 1% of global battery manufacturing (ORF America, 2024). Manufacturing includes producing key components like cathode and anode materials, electrolytes, separators, and the capacity to combine these components to produce battery cells. Even with major improvements to its infrastructure, India would still lag behind lithium-ion battery manufacturers in Germany or the US, for instance, mainly due to innovation capacity and Environmental, Social, and Governance (ESG) issues throughout the supply chain (Harvard Kennedy School, 2024). For OEMs, there is also a lack of demand and off-take assurances, making investments in the domestic market riskier and thereby delaying larger-scale funding. India would be most advanced in the domestic manufacturing chain at the battery module and pack assembly stage, in the last steps of EV battery manufacturing (Harvard Kennedy School, 2024).

India has taken measures to expand this manufacturing capability through the PLI Scheme for ACC. The scheme was introduced in 2021 by the Ministry of Heavy Industries. This scheme is expected to establish advanced battery manufacturing capacity of 50 gigawatt-hour (GWh). Currently, this capacity is close to negligible. The policy is technology-agnostic and is likely to boost EV battery manufacturing in India. This, however, is dependent on sourcing critical minerals, such as lithium, cobalt, nickel, and manganese. An estimated US$5.11 billion will be required for critical mineral imports, which can, in turn, help reach this battery production capacity (ENS Economic Bureau, 2025). The investment scheme has a budget of ₹18,100 crore, incentivising the production of battery cells and aiming to reduce the current high cost of batteries produced within India (Ministry of Heavy Industries, 2024c). Any OEM receiving incentives will need to provide a domestic value addition of 25% and increase this to 60% within 5 years. Furthermore, the beneficiary will be required to invest ₹225 crore/GWh within 2 years of receiving the incentive (Ministry of Heavy Industries, 2026a). As of 2026, a total of 40 GWh capacity for batteries was awarded to 4 companies, and they have only managed to reach an installed capacity of 1 GWh. (Ministry of Heavy Industries, 2026b). The battery PLI scheme has not resulted in the desired outcomes, and the growth of the sector has been slow. One of the major reasons is the availability of easily accessible, cheap battery supply from China and the limited technology advancement in the domestic cell manufacturing process.

To help mitigate import dependency, the Indian government rolled out the PM Electric Drive Revolution in Innovative Vehicle Enhancement (PM E-DRIVE) Scheme. The main purpose of the scheme is to promote EV adoption and the development of EV and battery technologies. This scheme is ongoing until the end of March 2026. It provides demand-side incentives, namely ₹3,679 crore in funding for 2W and 3W vehicles, electric trucks, ambulances, and buses (Ministry of Heavy Industries, 2025). It also provides ₹2,000 crore in grants and incentives for charging stations. With an initial focus on major urban areas, the scheme is also being rolled out in rural areas (Ministry of Heavy Industries, 2025). Furthermore, ₹4,391 crore has been allocated for 14,028 e-buses. The scheme has resulted in greater adoption of EVs, especially in the 2W and 3W segments. The government has credited this scheme for the surge in the sale of 5.7 lakh 2Ws in 2024–2025 and 72,000 3Ws (Ministry of Heavy Industries, 2024b).

This scheme contains localisation mandates, specifically a 50% domestic value-addition requirement for production lines that benefit from the incentive, to promote the domestic manufacturing of EV components, such as charger enclosures and panels, internal wiring, connection controllers, and other main vehicle components (Ministry of Heavy Industries, 2025). The scheme contains an incentive package for the manufacturing of "Advanced Automotive Technology" (AAT) products, ranging from an incremental 13–18% incentives for OEMs producing AAT vehicles, and 7.2–13% for OEMs producing AAT components (Ministry of Heavy Industries, 2025). Cumulatively, through March 2025, this incentive is deemed to have invested ₹29,576 crore and created 44,987 new jobs (Ministry of Heavy Industries, 2025).

Various states have also enacted EV policies, such as Delhi, Maharashtra, Tamil Nadu, Karnataka, and Uttar Pradesh. These states provide a wide range of initiatives, including tax exemptions, fee waivers, and subsidies for EV procurement (eMobility Careers, 2025).

Under this plan, the FAME scheme was launched in 2015. The first phase proceeded until March 2019, with an actual spending of ₹529 crore to push the market for domestic production and early adoption of EVs (PIB, 2015). The second phase was subsequently launched, under FAME II and lasted into 2024. The framework was launched with a supporting budget of ₹11,500 crore to subsidise EV procurements and charging infrastructure deployment, and to invest in e-buses for public transport (Kohli, 2024; PIB, 2025a). Following the end of these schemes, the Electric Mobility Promotion Scheme was rolled out in 2024, but with a particular focus on the manufacturing process for 2W and 3W EVs. This promotion scheme lasted six months and had a budget of ₹778 crore for incentives (Ministry of Heavy Industries, 2024a). India's FAME II framework for E2W, E3W and electric four-wheelers (E4W) requires that over half of an EV's value must be manufactured domestically. This is presenting challenges for OEMs, as some lack the preparedness to manufacture EV components amid current low EV demand (IISD, 2024).

The major OEMs in India are Tata Motors, Mahindra & Mahindra, and MG Motors India. Tata Motors dominates the sector with an approximately 53% market share for EVs (Entrepreneur Staff, 2025). The EV sales of these OEMs primarily focus on cities with higher per capita income, such as Mumbai, Delhi, Pune, Kolkata, and Bangalore (BDO India LLP, 2025). The EV manufacturing industry is primarily geared towards 2Ws and 3Ws. There are several challenges the development of this market faces, despite India's push to ramp up its EV manufacturing. The barriers include a heavy reliance on imports for critical minerals, a negligible EV battery manufacturing industry, gaps in labour skills, and a fragmented EV supply chain with high production costs.

Germany holds a key position in EV manufacturing, accounting for approximately 50% of the EU's EV production in 2023 (IEA, 2024b). This equated to 955,000 BEVs and 315,000 hybrid vehicles, representing 30.9% of the total vehicle production in Germany. Germany's key OEM firms, for example, Volkswagen or BMW, have a strong market presence with a 5% year-on-year increase in EV sales, a more positive trend than any other EU member counterparts (IEA, 2025b). Germany's domestic car sales have nonetheless been in decline, from 30% increase in 2022 to a 25% increase in 2023. Notably, German manufacturers face several barriers to domestic EV adoption. This includes cost pressures compared to cheaper Chinese EV brands, import dependencies on critical minerals, shortages of skilled workers, and a lack of EoL recycling infrastructure for EV components.

Low-price competition with Chinese EVs and components has been one of the biggest challenges for both India and Germany. The average German-made EV costs 20% more than the average Chinese one. Two-thirds of all Chinese-produced EVs in 2024 were priced lower than equivalents in other nations, after accounting for subsidies (IEA, 2025b). To counter this, the European Commission placed countervailing duties on imports of Chinese battery EVs, starting in October 2024 (European Commission, 2024). The measures are imposed for five years on leading Chinese EV brands, including BYD Group (17% duty), Geely Group (18.8% duty), SAIC Group (35.3%), and Tesla–Shanghai Co. Ltd (7.8%). These measures resulted from an EU research study, which found that the Chinese government is providing unjustified subsidies throughout its EV supply chain, causing damage to the EU battery EV manufacturing sector and threatening its own supply chain (European Commission, 2024).

To further reduce its import dependency, Germany is making strides to localise EV battery manufacturing and invest in R&D in the EV industry. EV battery production will see a rapid increase over the next decade, of up to 1.5 terawatt hours. The EU has had a similar expansion in battery production already, from 7.8 GWh in 2021 to 77.3 GWh in 2025. Europe is aiming for a tenfold increase in manufacturing by 2030 to reach 750 GWh (SolarPower Europe, 2025). Germany plays a major role in Europe's EV battery manufacturing process, set to account for 400 GWh, which is over a quarter of the EU's output. For example, Volkswagen is building its first EV battery cell manufacturing plant in Salzgitter. Manufacturing capacity is projected to reach 40 GWh (Volkswagen Group, 2022). Farasis Energy, backed by Mercedes-Benz, intends to scale its solid-state EV battery manufacturing to GWh outputs in 2026 (CarNewsChina.com, 2025). The aggressive targets and investments in battery cell manufacturing are a direct response to the critical importance of batteries in the EV value chain and represent a strategic move to mitigate risks of raw material dependency. By developing significant domestic battery production capacity, Germany directly addresses a key supply-side bottleneck, reduces its vulnerability to external battery suppliers, and gains control over a crucial part of the EV value chain.

Export Opportunities to European Markets for Indian Companies

The development of the EV manufacturing sector in India also means that the country has increased capacity to export to the EU and third countries. India's EV exports have grown exponentially, with exports to France showing remarkable growth from ₹168.47 lakh (US$185,000) in 2022 to ₹2,367.27 lakh (US$2.61 million) in 2023, and Germany increasing from ₹85.35 lakh (US$94,000) to ₹343.28 lakh (US$378,000). The Government of India has announced a goal to export EVs to over 100 countries, including European markets, which positions the partnership for significant trade expansion. Indian manufacturers like Maruti Suzuki and Hero MotoCorp are targeting exporting to the EU, especially for 2Ws and affordable EVs, by capitalising on India's 30–40% lower production costs compared to Europe (The Economic Times, 2024). Increasing investments in the EV sector from German and European OEMs—such as BMW, Mercedes-Benz, Volkswagen, and the Stellantis Group—have led to these brands localising more of the supply chains within the country to reduce the cost of production. India can become the manufacturing hub for these brands in Asia, enhancing EV exports to different countries in the region. Germany's partnership with India would lead to an increase in access to low-cost EVs for its own domestic consumers. Additionally, India can benefit from technology transfers in battery cell manufacturing and investments in the domestic value chain through vertical integration.

3.4 Recycling

NCMM has a budget outlay of ₹1,500 crore (2025–2031) to incentivise the recycling of critical minerals. The mission identifies key minerals, such as lithium, nickel, cobalt, graphite, Platinum Group Elements (PGEs), and REEs, that would be covered under such incentive schemes. In September 2025, the government introduced the Incentive Scheme for Promotion of Critical Minerals Recycling (Ministry of Mines, 2025c). The scheme provides a 20% capital expenditure (Capex) subsidy for new recycling capacity or fresh expansion of existing capacity. It also provides opex subsidies of 40% and 60% in two tranches over the first five years. The scheme covers various recycling systems, including E-waste, lithium-ion battery (LIB) scrap, and other recycling. The objective of the scheme is to develop 270 kt of annual recycling capacity, leading to ₹25 crore in investments from companies and the creation of close to 70,000 jobs.

Currently, there are about 322 registered e-waste recyclers in India, with a total capacity to process 2.2 mt of e-waste. These processes involve mostly basic methods of recycling, such as collection, dismantling, crushing, and sorting, which do not allow for efficient mineral recovery from EoL technologies like batteries. Recycling of batteries in India has only reached the R2 level (black mass production). It has very limited capacity in R3 (black mass to metal) or R4 (end-to-end battery scrap to metal) levels of recycling. The government estimates that India will require an annual recycling capacity of 400 kt by 2030 to utilise the domestically available EoL battery feedstock efficiently (Ministry of Mines, 2025b). The incentive scheme would help increase India's capacity for battery recycling, as there are currently 10–12 recyclers with a combined capacity of 100 kt per annum (ktpa) for the extraction of critical minerals from EoL technologies.

Mineral recovery and processing from recycling EoL technologies have attracted large investments in India. Domestic companies are recovering and processing minerals such as cobalt, nickel, and lithium from EoL batteries. These recycling companies are also looking to further invest upstream in acquiring mining assets and manufacturing green technologies through domestically integrated supply chains. One such domestic company is Lohum Cleantech, which currently holds a 70% share in domestic lithium-ion battery recycling. It processes 10,000 tonnes of batteries annually; the company also invests in the manufacturing of 2W and 3W EV batteries, which account for 20% of its revenue. It has also secured strategic partnerships with leading mineral developers such as Glencore (Mobility Outlook Bureau, 2022) and some of the largest global vehicle manufacturers, including Mercedes-Benz (Mukherjee, 2023), for mineral recovery and battery recycling.

Government incentives have been the key driving factor for battery recycling within the EU, with all member states adopting regulations that support and incentivise domestic mineral recovery from EoL technologies. To also help alleviate some of Germany's import dependency burden and reduce the volume of new critical minerals to be imported, there is a push to improve the circularity of EV components. Germany still has much room for progress in its recycling infrastructure. More than three million vehicles are permanently deregistered in Germany annually; of these, approximately 300,000 to 500,000 are End-of-Life Vehicles (ELVs) (Federal Ministry for the Environment, Climate Action, Nature Conservation and Nuclear Safety, 2024). In April of 2025, the Environment Council meeting of the EU members unanimously voted in favour of a new ELV regulation (Federal Ministry for the Environment, Climate Action, Nature Conservation and Nuclear Safety, 2025). The focus of the regulation would be to ease ELV recycling and re-use by discouraging illegal scrapping and supporting approved recyclers. The regulation introduces stricter norms for the use of recycled material in new vehicle manufacturing. It mandates that manufacturers use 15% recycled plastic in the first six years and 25% recycled plastic within ten years of the regulation's passage (European Parliament, 2025). Such targets for minimum recycled content are likely to be set for recycled steel, aluminium, and critical raw materials (CRMs). In order to facilitate the recycling of EoL batteries used in EVs, the legislation requires EV manufacturers to ease and standardise the process for batteries and e-drive motors to be removable and replaceable.

The EU CRMA has set the target that by 2030, at least 25% of the Union's annual consumption of CRMs must be met by domestic recycling capacity (European Commission, 2023). Currently, the EU has a very low recycling rate for green technology minerals like lithium and neodymium. The EU does not recycle 10 out of the 26 critical minerals identified, including lithium. Seven of the critical minerals have a recycling rate lower than 5% (European Court of Auditors, 2026). The new regulation on ELVs would help member countries achieve the recycling rate targets by 2030. An insight from a policy expert in Germany is the goal of retaining as many raw materials as possible in the EU.

The EU Batteries Regulation was introduced in 2023 to reduce emissions from new battery manufacturing by increasing the number of batteries recycled, improving and standardising battery designs, and incentivising mineral recovery from EoL batteries. Efficiency in battery traceability and recyclability has been ensured through the introduction of performance standards, battery passports, and labelling requirements. The regulation further incentivises members to produce batteries with cleaner materials and with designs that lead to higher recycling rates (IEA, 2024b). Table 3 provides the minimum material recovery rates from batteries across the EU. Germany has also observed increasing investment in battery recycling to recover minerals from EoL EV batteries. Vehicle manufacturers, including Porsche and Mercedes-Benz, are investing in battery recycling to support their e-mobility and emission-reduction targets. Cylib, backed by Porsche, is one of Germany's leading battery recycling companies and aims to operationalise its largest recycling facility by 2027, with a capacity to recycle 60,000 tonnes of EoL batteries (Cylib, 2025).

Table 3: EU Batteries Regulation—Minimum Recovery Rate

Minerals	By December 31, 2027 (%)	By December 31, 2031 (%)
Cobalt	90	95
Copper	90	95
Lithium	50	80
Nickel	90	95

Source: European Union Batteries Regulation; International Energy Agency.

India and Germany are both at the nascent stage of battery and mineral recycling. While governments have set targets and introduced incentive schemes to support recycling, there is still a need to scale up recycling capacity. This would require incentivising recycling companies to invest in direct processing of mineral concentrates. Vertical integration is key to securing investments for mineral processing and recycling. Globally competitive EV manufacturers have shown interest in such vertical integration.

India and the EU have recently announced a ₹169 crore joint initiative to promote the recycling of EV batteries under the TTC (Press and Information Team of the EU Delegation to India and Bhutan, 2026). This call for proposals looks to develop advanced metallurgical processes capable of extracting battery minerals at high recovery rates and from mixed chemistries.

4. Demand-Side Factors

4.1 Role of Consumer Demand

The structure of India's EV supply chain needs to be examined alongside the unique character of the country's electric mobility demand. Unlike the European market, which is driven by long-range passenger cars, India's transition is led by cost-sensitive 2Ws and 3Ws. This divergence in vehicle types and uses informs the OEMs' strategy. Indian consumers demand affordability and range over raw performance, which drives the industry toward specific technological choices, such as a preference for LFP chemistries (which are cheaper and safer at high temperatures) over NMC variants. Consequently, demand-side interventions must go beyond purchase subsidies to address other financing frictions, charging infrastructure, and asset utilisation.

The Indian vehicle market operates on different financial fundamentals than the German counterpart. During stakeholder consultations, European policy observers noted that while EV leasing has provided some stability to EV adoption in the EU, India's demand will likely be driven by e-buses. In both cases, demand certainty rises. There are also major divergences in consumer patterns—Germans look for performance and range while Indians are more price-sensitive—which suggests that cooperation should focus less on selling German cars in India, and more on co-developing engineering solutions for developing countries. Furthermore, German industry experts highlighted that while passenger cars are considered "emotional" purchases in Germany, electric trucks and buses are more "rational" purchases. This suggests that India's export potential to Germany is stronger in the commercial vehicle segment, where India's cost advantage outweighs the lack of legacy brand loyalty.

4.2 Cost Competitiveness of Electric Vehicles Versus Internal Combustion Engine Vehicles

Despite the Total Cost of Ownership (TCO) advantages of EVs, the Indian market remains stuck by the sticker-price shock of initial acquisition costs. As of FY24–25, the EV market is overwhelmingly dominated by 2Ws and 3Ws, which account for nearly two-thirds of total sales of units. E2W sales grew by 18.8% in FY25, while electric car sales grew by a relatively modest 11% year-on-year (Entrepreneur Staff, 2025). However, adoption is highly skewed geographically, concentrated in wealthier parts of the country, like Bengaluru, Delhi, and Pune, leaving the broader mass market untapped (BDO India LLP, 2025). While E2Ws and E3Ws make up the larger share of India's EV transition, the E4W segment has a relatively higher asset value and mineral requirement.

The primary issue is the upfront capital cost: an entry-level EV in India costs approximately 1.5 to 1.8 times more than a comparable ICE model (NITI Aayog, 2025b). For a highly price-sensitive economy where vehicle financing penetration is high, this capital gap, mainly driven by the cost of the battery (40% of vehicle value), leaves the TCO argument less relevant for the average consumer who cannot afford the down payment.

To bridge this gap, India has relied on demand incentives such as FAME II and the subsequent PM E-DRIVE scheme, which provide direct cash subsidies to lower EV purchase prices. The initial subsidies were more aggressive, with discounts as much as 15%, before tapering down to under 10% as the market matured. However, the German experience offers a lesson on incentivising purchases through subsidies. Between 2020 and 2023, Germany's *Umweltbonus* (Environmental Bonus) boosted EV market share from under 2% to 18% by offering purchase incentives of up to €6,000. However, when fiscal constraints forced the termination of these subsidies in December 2023, the market faced a sharp impact: battery EV registrations in Germany fell by 27.4% in 2024 (European Alternative Fuels Observatory, 2024).

There exists a risk for Indian policymakers: industrial capacity does not guarantee demand. Even with Germany's leading manufacturing base, consumer confidence vanished once the subsidy was removed. For India, the lesson should be that subsidies are a temporary bridge and not a permanent mainstay, and an EV market built on government subsidies may crash the moment the incentives are removed. Supply-side stimuli, as well as demand, must be reconciled, potentially through alternative, less direct incentives or by ensuring the market is truly self-sustaining before withdrawing support. This illustrates the importance of long-term policy stability, not just for investment but also for maintaining consumer confidence. One successful case is Norway, which gradually phased out its EV incentives once a majority of new cars sold were electric. This ensured that the market had matured enough to absorb increasing costs (Haug, 2024).

Stakeholders in Berlin mentioned the success of "social leasing" programmes for EVs, where leasing rates were subsidised for low-income workers. This may be a more sustainable alternative to purchase subsidies. India could adapt this for the e-3W sector, subsidising the lease rather than the asset. Since gig workers focus on daily operating costs rather than asset ownership, a subsidised leasing model reduces the entry barrier more effectively than a purchase subsidy in the commercial vehicle sector.

To avoid the German boom-and-bust cycle, India must pivot from subsidising the asset to financing the transition. The shift from FAME II to PM E-DRIVE reflects a strategic correction, moving subsidies away from private cars toward commercial assets (e-buses, trucks, commercial 3Ws) where utilisation rates would justify the cost. Some financing issues also need to be reconciled. While around 80% of ICE vehicles are purchased using bank loans, only about 60% of EVs secure financing and also face higher interest rates. This is because lenders lack data on residual battery value. Implementing the Battery Aadhaar (as seen with the EU Battery Passport) would allow banks to underwrite the asset risk more accurately, lowering the cost of capital. By tracking a battery's health and usage history in a digital and locked ledger, lenders can more accurately calculate the residual value of the battery. This data makes the battery a bankable asset, which can help lower interest rates and unlock a secondary market. Finally, India must look to de-risk ownership of EVs. German tax data suggests that corporate fleet incentives (Benefit-in-Kind (BIK) tax breaks) are more durable than retail subsidies—the tax rate for EVs is 0.25–0.50% compared to 1.0% for combustion vehicles (European Alternative Fuels Observatory, 2025). For India, incentivising corporate fleet electrification offers a pathway to build volume without direct cash handouts to individuals.

4.3 Charging Infrastructure

For Indian consumers, the barrier to adoption is not only range anxiety, but also reliability anxiety—i.e., the fear that a charging station, even if found, will be non-functional. Current market data indicate that approximately 25% of public fast chargers in India frequently experience technical interruptions, making them unreliable for daily use (Autocar Professional Bureau, 2024). Unlike global standards, where fast charging typically takes 30 to 60 minutes, the average charge time in India is nearly two hours due to lower power outputs and thermal throttling. Consequently, nearly 90% of Indian EV users rely exclusively on home charging to avoid the pains of public infrastructure. This behaviour creates an additional challenge on the grid, as it clusters electricity demand during evening peak hours.

A fragmented charging ecosystem exacerbates this operational issue. India currently lacks a unified connector standard, resulting in a fragmented market (including Combined Charging System (CCS), Bharat AC-001, Guobiao/Tui Jian (GB/T), and proprietary connectors). This fragmentation means that not every vehicle is compatible with every plug, lowering utilisation rates for Charge Point Operators (CPOs) and making it difficult to justify the business case for new installations.

In contrast, Germany's approach offers a lesson in state-led infrastructure planning. Recognising that the private sector would not voluntarily build chargers in economically unviable rural areas, the German government intervened with the Fast Charging Act (SchnellLG) and the *Deutschlandnetz* (Germany Network) initiative. Rather than relying on private sector-led growth, the government tendered specific search areas to ensure a fast charger is available every 10 minutes on motorways, backed by a US$6.7 billion investment. Furthermore, under the Master Plan Charging Infrastructure II, the government mandated that petrol stations install charging points at a minimum of 75% of their franchise locations. This strategy successfully leveraged existing real estate to penetrate underserved communities, addressing a persistent gap where nearly half of German municipalities previously lacked infrastructure.

However, the German experience also illustrates the limits of infrastructure deployment. Despite having the second-highest number of charging stations in the EU, Germany is projected to fall short of its 2030 target of 1 million charging points. Moreover, utilisation data suggest a mismatch between deployment and actual need;

with average daily driving distances of only 40–50 km, the sheer volume of public chargers may be less critical than their speed and reliability.

For India to replicate a Deutschlandnetz-style rollout, it must first address an upstream vulnerability. A Direct Current (DC) Fast Charger relies primarily on power modules (Alternating Current (AC)-to-DC converters). Currently, Indian charger manufacturers function largely as system integrators, packaging imported power modules, primarily imported from China and Taiwan, into local enclosures. Scaling up the network from 30,000 to 300,000 chargers would create a massive import dependency on these critical components. The global semiconductor shortage in 2021 also affected CPOs, as charging stations require microcontrollers (Paul, 2021). Without a targeted incentive to localise the semiconductor packaging and power electronics required for these modules, India's charging network will remain dependent on external supply chains and susceptible to the same geopolitical risks as the battery sector. Thus, the strategic imperative for India is to pivot from a focus on quantity to quality, prioritise mandated uptime guarantees set by CPOs, ensure strict connector standardisation, and localise the power electronics supply chain for charging infrastructure.

4.4 Resource Efficiency

From a strategic perspective, one effective way to de-risk a supply chain is to reduce the aggregate demand for the scarce or concentrated resource itself. While much of the discussion has focused on securing more lithium and other critical minerals, a resilient policy must also focus on optimising the resources we consume. One way to do so is to consider shifting the metric from the number of EVs sold to minerals per passenger-kilometre. The current Western model of electrification, where private ICE cars are replaced by private electric cars, is inefficient when resources are constrained. A typical electric passenger SUV requires a battery pack with approximately 60 kilowatt-hours (kWh) of capacity. In contrast, an E2W operates on a 2–3 kWh battery pack.

The critical minerals required to build one private electric car, which typically transports an average of 1.5 people, could instead be used to manufacture nearly 30 electric scooters, providing mobility to 30 individuals. In a market where 2Ws and 3Ws already constitute 80% of vehicle sales, India has a unique opportunity to avoid the bloated mineral intensity of Western markets. By prioritising the electrification of 2Ws and 3Ws, India can achieve mass fleet electrification with a fraction of the critical battery minerals required for a car-centric transition. While India seems to have missed the intermediate transition to hybrid vehicles (perhaps due to unfavourable pricing structures and lack of public incentives), they have the potential to serve as an in-between, given that they are relatively more resource-efficient than their electric counterparts and can also reduce pressure on the grid.

The efficiency argument is even more relevant when considering public transport. An electric bus equipped with a 250 kWh battery can transport up to 1,000 passengers daily in larger cities. In contrast, an electric car with a 60-kWh battery may move only 2–3 people, if a private car, or 20–30 people, if a shared taxi, in the same period. Consequently, the return on investment for every gram of imported lithium is much higher when allocated to an e-bus than to a private vehicle. The Indian government's PM E-DRIVE scheme (October 2024) implicitly recognises this by excluding private electric cars from subsidies and channelling funds instead to e-buses, e-ambulances, and commercial 3Ws. This is an efficient supply chain strategy, where state resources are used to maximise public mobility per unit of imported mineral.

5. Indo-German Strategic Cooperation

To jumpstart the local EV ecosystem, India needs to engage its domestic policy on both the supply and demand sides. Yet, this would be insufficient to overcome the vulnerabilities within the global supply chains. To increase resilience, India needs more active international cooperation. While China currently leads in almost all aspects of these supply chains, equal-footing partnerships might be challenging given its use of critical mineral and technology exports as leverage. Other major battery manufacturers, like those in South Korea and the US, tend to prefer keeping processing IP to themselves, particularly if there are vertically integrated plants.

One avenue is to potentially align its goal of strategic autonomy with Germany's agenda of de-risking. High-level consultations with stakeholders in Berlin revealed that Germany possesses the IP and the capital for green financing but lacks the economics for large-scale mineral processing. On the other hand, India offers the potential to become a processing hub but requires technology transfer to move downstream from mineral extraction. This section outlines three pillars to operationalise the synergy: institutional, innovation, and industrial.

5.1 Institutional Pillar: Financing and Standards

Indo-German Green and Sustainable Development Partnership

Germany represents the most advanced bilateral EV partnership within the EU framework. The Indo-German GSDP includes a €10 billion commitment by 2030, with a specific focus on electric mobility and low-emission vehicles. During a December 2025 meeting, Germany furthered its commitment to India within the framework of the GSDP by providing €1.3 billion of additional investment through loans across different topics of climate, energy, sustainable development, and urban mobility (ANI, 2025). This section will showcase Germany's GSDP as the bilateral blueprint for urban EV infrastructure and OEM partnerships, offering a scalable model for broader EU–India collaboration. As part of the GSDP, Germany and India committed to the Indo-German Green Urban Mobility Partnership. This scheme aims to develop green transport infrastructure in urban areas across India and to increase transport electrification and access to transit systems (German Cooperation, n.d.).

Through the development of low-emission transport infrastructure, Germany and India are contributing to a number of Sustainable Development Goals. These include affordable and clean energy, supporting industry, innovation, and infrastructure, making cities sustainable, mitigating the effects of climate change, and improving public health outcomes (German Cooperation, n.d.). By 2050, close to 50% of India's population is expected to live in urban centres; given this context, this collaboration comes at a key time for cities in need of growth in transport electrification (PIB Delhi, 2024). Projects across this program are co-administered by the German Federal Ministry for Economic Cooperation and Development (BMZ) and a variety of ministries in India. Examples of Indian support bodies include the Ministry of Finance, the Small Industries Development Bank of India, and REC Ltd (German Cooperation, n.d.).

Projects include KfW-funded e-bus depots in 20 cities; Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) training for 50,000 EV technicians; and Fraunhofer-Automotive Research Association of India (ARAI) pre-competitive R&D on solid-state batteries. German OEMs dominate the Scheme to Promote Manufacturing of Electric Passenger Cars in India (SPMEPCI) responses. For instance, Volkswagen's Pune plant, positioned to start operation in 2026, will localise production. During Chancellor Friedrich Merz's January 2026 visit to India, Germany pledged new commitments under the GSDP, which would support various projects, including the Prime Minister's e-bus Sewa scheme (PIB Delhi, 2026b). India and Germany also launched a battery storage working group under the India–Germany Platform for Investments in Renewable Energy Worldwide (PIB Delhi, 2026b).

Germany's bilateral leadership creates scalable pathways for cooperation across EU member states. The GSDP framework can provide a blueprint to be modelled across the EU.

India–EU Trade and Technology Council

Playing a key role in this collaboration is the establishment of the India–EU TTC. This council was announced jointly by the Indian Prime Minister and the European Commission's President and formally launched in February 2023. The partnership seeks to use technology to promote sustainable development and foster economic growth and prosperity (European Commission, 2025b). There are three working groups on (1) digital governance and connectivity, (2) clean energy technologies, and (3) resilient value chains, which foster structured dialogue at the intersection of trade, technology, and security (European Commission, 2025b).

The TTC's second working group on clean energy technologies is led by the Indian Government Office of the Principal Scientific Adviser and the EU Directorate-General for Research and Innovation. It drives EV-specific outcomes and has established workstreams to promote collaboration and growth in the sector. These workstreams include (1) a €60 million joint investment fund for EV battery recycling, emphasising "flexible, low-cost, easy-to-recycle" designs; (2) harmonisation of EV charging infrastructure policies and standards; and (3) development of comprehensive EV norms (European Commission, 2025). Working Group 2 convened its first workshop in February 2025 in Pune on Electric Vehicle Charging Technology (Joint Research Centre, 2025). This workshop allowed for a dialogue led by the ARAI and the EU's Joint Research Centre to make strategic decisions on standards and technological improvements for EV charging infrastructure. Interoperability was a major theme of the workshop, seeking to achieve market cross-compatibility for India's CCS2 and the European charging infrastructure (Joint Research Centre, 2025). Other discussions included the future market growth of India and the EU's sustainable mobility, as well as industry perspectives for areas helping the EV economy scale up. The workshop also provided EU partners with insights into Indian electromobility testing laboratories through a visit to the ARAI laboratory (Joint Research Centre, 2025).

Indo-German cooperation must also extend to battery testing facilities. Berlin stakeholders highlighted that the lack of global-standard testing labs in India forces Indian start-ups to ship prototypes to Europe for validation, increasing costs and delays. Establishing more testing facilities within India would allow domestic manufacturers to validate products against Indian standards, as well as against EU standards, to help accelerate exports.

The Digital Governance Working Group 1 indirectly bolsters EVs through interoperability in Digital Public Infrastructure (DPI). Although less pertinent for manufacturing, this working group can help identify key areas of cooperation. These could include co-developed EV technologies and charging processes, as well as digital payments for e-mobility services. For instance, harmonisation could occur for digital standards of software and telematics, where EVs manufactured in both geographies could access similar data spaces. This could help with data exchanges, where each one can learn best practices and ensure compatibility for software updates and system modifications.

5.2 Innovation Pillar: Linking German Intellectual Property With Indian Scale

Beyond institutional frameworks, the partnership is being operationalised through industrial integration. As European OEMs face rising energy costs and geopolitical risks, India is emerging as a strategic export base. This China+1 diversification strategy includes European OEMs localising production in India to de-risk their supply chains, and Indian OEMs leveraging the manufacturing to export to the European market.

The comparative advantages of Germany and India are emerging in the value chain. While German OEMs possess IP in cell chemistry, Berlin stakeholders have indicated that there is a willingness to offshore pack assembly and testing to Indian partners. This presents an opportunity for Indian manufacturers to partner with

Germany's SMEs (*Mittelstand*), who possess the requisite technologies but lack scalability.

The TTC held a matchmaking initiative for European and Indian SMEs in the EV battery recycling industry (Press and Information Team of the EU Delegation to India and Bhutan, 2024). The event hosted 12 selected SMEs—six from India and six from the EU—who could pitch their start-up ideas around EV battery recycling technologies to Indian and European venture capitalists, investors, and solution adopters (Press and Information Team of the EU Delegation to India and Bhutan, 2024). From the ideas pitched, three European SMEs and three Indian counterparts were given the possibility to conduct cross-immersion visits to collaborate and further promote their technological advances (Press and Information Team of the EU Delegation to India and Bhutan, 2024). This promoted the visibility of novel ideas in the EV battery recycling space, as well as strengthening collaboration between the Indian and EU battery recycling sectors' available resources and technologies. This also allowed for smaller firms to gain potential access to capital and thus develop and scale their ideas (Press and information team of the EU Delegation to India and Bhutan, 2024). Indian standouts like BatX Energies (hydrometallurgical recovery), Evergreen Lithium Recycling, LW3 Pvt Ltd, and Lohum (direct recycling) partnered with EU peers such as Ecomet Refining and Eneris, unlocking capital, market access, and tech synergies. This initiative addresses a dual imperative: (a) India's 2030 target to recycle 90% of EV batteries (amid 1.5 mt annual e-waste by 2030) and (b) the EU's Battery Regulation mandating 16% recycled content by 2031, rising to 26% lithium by 2036.

Cross-immersion fosters scalable models. This could help smaller Indian industry players to develop modular plants to adapt EU circular designs for India's informal recycling sector. At the same time, this also helps universities amplify R&D and collaborate across geographies. Various Indian Institutes of Technology (IITs) have Memoranda of Understanding (MoUs) with Fraunhofer Institute for Systems and Innovation Research (ISI) and Technical University (TU) of Munich in the fields of circular economy and sustainable development.

July 2025 witnessed a significant outcome from this TTC event when BatX Energies and Germany's Rocklink GmbH announced the setting up of India's first integrated rare earth magnet recycling and refining ecosystem (The Economic Times, 2025a).

Broader SME ecosystem benefits could allow Horizon Europe grants and India's Startup India seed funds to now prioritise joint bids, creating a virtuous cycle of innovation-commercialisation.

As showcased, the TTC workstreams, SME battery hubs, and the potential for development of the India–Middle East–Europe Economic Corridor (IMEC)'s intercontinental EV network demonstrate how India–EU diplomatic and political frameworks convert geopolitical alignment into tangible green mobility infrastructure and innovation outcomes.

5.3 Industrial Pillar: India–Middle East–Europe Economic Corridor

The IMEC, announced at the 2023 G20 New Delhi Summit, elevates green mobility to a geoeconomic scale, spanning India–Gulf–Europe via ports, rail, and highways. Partners include India, the EU (via Germany, France, and Italy), the US, Saudi Arabia, the UAE, and Jordan. It integrates three pillars: (1) transportation through rail and maritime networks, (2) energy, and (3) digital interconnectivity. While primarily a trade and logistics initiative, the IMEC architecture provides potential avenues of cooperation between India and the EU on priority issues such as critical minerals supply chains and green mobility.

This corridor is set to improve trade logistics between all countries along the corridor and to promote the development of sustainable infrastructure projects along this route (IMEC, n.d.). The corridor has the potential to provide an effective platform for critical mineral refining and supply chains, alongside advanced manufacturing zones and other strategic components. Under the energy pillar, the feasibility of leveraging green hydrogen along IMEC remains an unclear prospect, but with high potential (Hussain & Shafer, 2025).

The Indo-German partnership is well-positioned to shape how these opportunities are realised. Germany's strengths in industrial electrification and hydrogen technology can be leveraged for IMEC's energy and transport pillars, while India's manufacturing scale and renewable energy ambitions provide the demand-side pull. However, success is not guaranteed as geopolitical sensitivities such as conflicts in West Asia, disruptions in the Red Sea, and limited connectivity amongst South Asian neighbours pose potential implementation challenges that demand diplomatic agility and routing contingencies (India's World, 2025). Additionally, political and regulatory uncertainty in the region makes investments difficult. For India and the EU, the IMEC's industrial potential for green mobility is real but hinges on their dexterity to navigate geopolitics and ensure a much deeper level of cooperation that has so far been elusive (International Chamber of Shipping, 2026).

6. Policy Recommendations and the Way Forward

This paper argues that India's current EV strategy has thus far been skewed towards demand subsidies (including FAME and PM E-DRIVE) and assembly incentives (PLI) and must now move towards technology industrialisation. The following recommendations are synthesised from literature reviews, various high-level stakeholder consultations in Berlin, as well as an Industry Roundtable with Indian OEMs and component manufacturers in New Delhi. The recommendations are categorised into three strategic pillars: Supply, Manufacturing, and Demand.

Table 4: Policy Recommendations

Recommendations	Context and Rationale
Supply	
Establish a strategic mineral stockpile for various critical minerals, beyond REEs.	Current stockpiling efforts are narrowly focused on REEs. India must expand its strategic reserves to include battery minerals (lithium, cobalt, and nickel) to buffer against trade shocks.
Incentivise merchant refining capacity.	Mining is capital-intensive, while refining is technology-intensive. Germany expressed a lack of economic viability for domestic processing, but it does have the technical know-how. India should position itself as a refining hub to standalone refineries that process ore from third countries (e.g., those in Africa), even if they do not own the mines.
Encourage refinement of black mass within the country to support the policy objectives of developing autonomy and resilience in the supply of minerals of interest.	India currently leaks valuable recovered minerals to other countries for recycling. By operationalising the MoEFCC's hazardous waste classification, India can limit the export of black mass. This can be combined with Viability Gap Funding to make local processing cost-competitive for domestic recyclers.
Fast-track the licensing process for recyclers to bring the urban mining sector into the formal economy.	Currently, obtaining environmental clearances for recycling facilities can take up to two years. This regulatory delay leads to leakage of battery waste into the informal sector or to exports to nations with faster approvals. Establishing a smoother clearance mechanism for certified recyclers will accelerate formal capacity creation. Formalisation is critical to shifting from black-market production to high-purity mineral recovery, ensuring that critical materials are retained within the country.

Recommendations	Context and Rationale
Leverage KABIL and G2G talks to de-risk private sector acquisition of mining assets in Africa and South America.	While state-run KABIL provides diplomatic security, its acquisition pace has been slower than that of private sector players. However, private Indian firms face geopolitical risks when operating in jurisdictions like the DRC. The government should utilise G2G frameworks to provide support for private Indian firms. This hybrid model combines private-sector efficiency with state-level diplomatic security, thereby lowering the risk of overseas asset acquisition.
Jointly acquire lithium, cobalt, and nickel mining rights with Germany in a trilateral framework.	KABIL and the KfW Raw Materials Fund can jointly invest in acquiring mining rights in third countries as a trilateral partnership, which will reduce risks in the investment.
Utilise G2G partnerships (e.g., Indo-German GSDP) to facilitate technology transfer for midstream processing, helping reduce prohibitively high licensing costs for domestic firms.	As noted in stakeholder consultations, Germany possesses advanced chemical processing IP but lacks the economic viability (due to high energy costs) to scale midstream operations domestically. India possesses the chemical engineering capability but lacks specific IP. Schemes like GSDP can be used to transfer German technology to India to process minerals cost-effectively.
Support R&D in developing advanced battery technologies and efficient recycling techniques.	India relies on imported cell chemistries. Continued reliance on standard lithium-ion chemistries risks shifting to another type of dependency. The Indian government should direct grants towards R&D that promotes the development of indigenous IP in emerging battery technologies, to secure technological sovereignty and insulate the sector from future supply shocks.
Manufacturing	
Build more battery testing and validation facilities.	Stakeholders highlighted that localised testing facilities are critical to reducing R&D cycles. India should establish more testing labs. Relying on foreign certification risks IP leakage and delays product launches. These labs should offer subsidised testing for Indian start-ups.

Recommendations	Context and Rationale
Localise the power electronics supply chain for charging infrastructure.	The charging network is vulnerable due to 90% import dependency on Power Modules. The Indian government can consider either creating a new scheme or extending an existing one to specifically incentivise the manufacturing of high-power EV charger modules (AC-to-DC converters).
Provide EV technician certification.	India faces a shortage of skilled labour in EV maintenance. A GIZ vocational training partnership can help create an Indian certification standard for EV mechanics.
Demand	
Component and EV manufacturers, recyclers, financiers, and other market players to collaborate on data sharing to help realise multiple objectives, including cost-effective financing.	Germany is implementing the Battery Passport to track the carbon footprint and durability of batteries. India needs a Battery Aadhaar for financing. By digitising the battery health metrics, banks can price residual value, unlocking secondary markets and lowering interest rates for new buyers.
Industry bodies to lead the creation of voluntary or minimum interoperable charging standards for light EVs (2W/3W) to de-risk infrastructure investment.	The fragmented charging market (CCS2, GB/T, Bharat AC-001) lowers utilisation. The BIS may mandate minimum interoperable standards for 4W and a unified form factor for 2W battery swapping to enable interoperability.
Shift subsidies towards electrifying public transport.	Private electric cars are less resource-efficient than buses. Future subsidy plans should consider excluding private 4W EVs. Capital should be redirected to e-buses and shared 3Ws, which deliver much greater passenger mobility per kWh of battery.

Source: Authors' compilation based on an internal roundtable.

Note: 2W = two-wheeler; 3W = three-wheeler; 4W = four-wheeler; AC = alternating current; BIS = Bureau of Indian Standards; DC = direct current; DRC = Democratic Republic of Congo; G2G = government-to-government; GB/T = Guobiao/Tui Jian; GIZ = Deutsche Gesellschaft für Internationale Zusammenarbeit; IP = intellectual property; KABIL = Khanij Bidesh India Ltd.; MoEFCC = Ministry of Environment, Forest, and Climate Change; PLI = production-linked incentive; REE = rare earth element; R&D = research and development.

India's electric mobility transition is set to take off. As demand-side subsidies are gradually withdrawn, a key challenge of the transition will be about resilience. This paper has argued that India cannot navigate this transition in isolation. Germany serves both as a mirror from which Indian policymakers can learn and a critical partner in bridging the technology gap and developing domestic supply chains. Through cooperation, Indian companies can leverage German capital to de-risk mining assets in Africa, utilise German IP to kickstart Indian midstream processing, and harmonise digital standards (such as the Battery Passport) to ensure market access. By deepening industrial partnership and green mobility cooperation, India and Germany can de-risk their respective supply chains.

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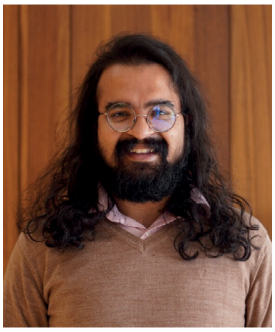

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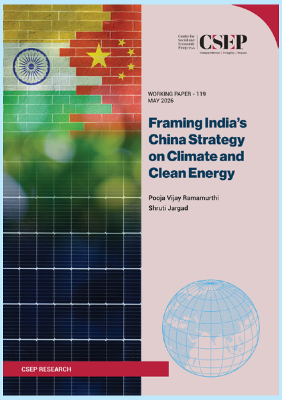
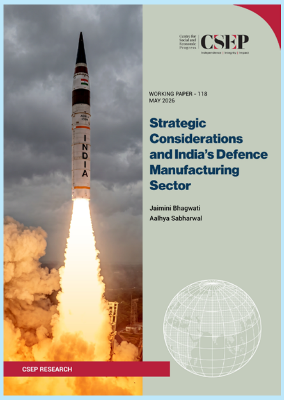
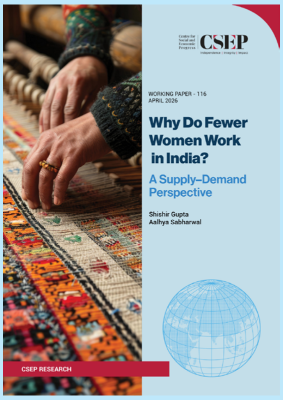
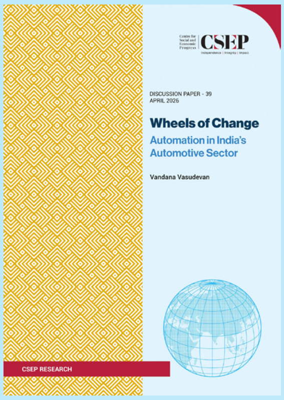
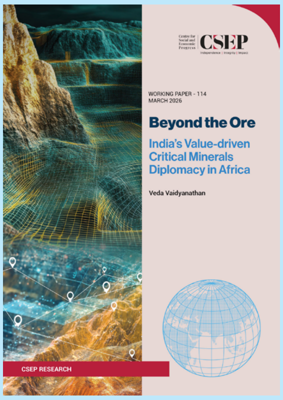
Other publications

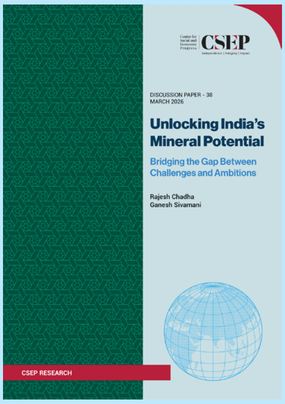


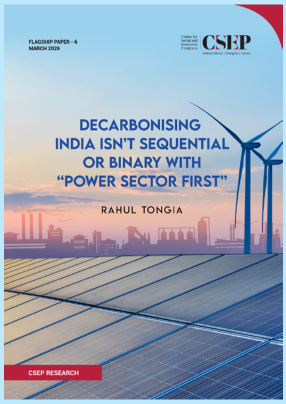


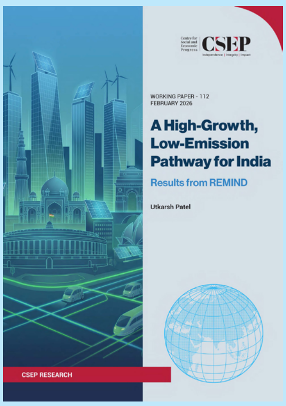


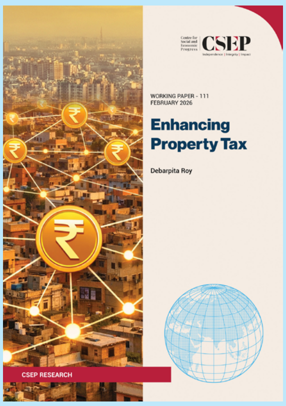


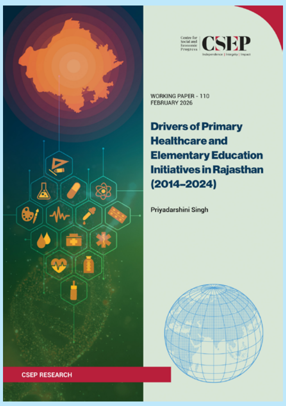












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