Securing the supply chain

Preparing for the electric vehicle raw material challenge

December 2025

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Table of Contents

Executive summary (1/2)

India, the world's fourth-largest automobile producer[1], is at a defining moment in its transition toward electric mobility. Over the past five years, the electric vehicle (EV) market has evolved from early-stage adoption to a phase of accelerated growth, driven by strong government support, rapid infrastructure development, technological progress, and changing consumer preferences. EV penetration has risen sharply from just 0.5 per cent in FY20 to nearly 6 per cent in FY25, with sales reaching approximately 1.5 million units.[2]

EVs now offer total cost of ownership advantages over internal combustion engine vehicles in several categories, including scooters, three-wheelers, and intracity buses. For four-wheelers, cost parity has already been achieved for commercial usage and is expected for personal vehicles before the end of this decade. These economic benefits, combined with policy incentives and infrastructure expansion, position India for sustained growth in electric mobility. Looking ahead, EV sales are projected to reach 22 million units by 2035, with penetration crossing 50 per cent across most vehicle segments.[3]

A critical underpinning of this growth is the supply chain for raw materials, especially lithium, cobalt, nickel, manganese, and rare earth elements, that enable electric battery production and motor manufacturing. India currently depends heavily on imports of these critical minerals.[4]

Global reserves and processing capabilities for these materials are highly concentrated, creating vulnerabilities to geopolitical risks, supply disruptions, and price volatility. Lithium is primarily sourced from Australia, Chile, and Argentina, while cobalt and nickel come predominantly from the Democratic Republic of Congo and Indonesia.[5] China exerts overwhelming control over refining and processing, accounting for 70–80 per cent of lithium and cobalt refining, 30 per cent of nickel processing, and nearly 90 per cent of rare earth element separation.[5] This dominance extends to magnet production, making the EV value chain highly susceptible to supply shocks. Recent Chinese export restrictions on critical minerals and rare earths, underscore these risks and could disrupt global automotive production, delaying India's EV rollout and affecting cost competitiveness.

Price volatility adds another layer of complexity. Over the past five years, lithium, cobalt, and nickel prices have experienced sharp fluctuations due to geopolitical tensions, pandemic-related disruptions, and surging demand. Although prices have stabilised, the risk of future volatility remains high. Furthermore, mining of critical minerals raises environmental and ethical concerns, including high carbon footprints, water usage, and labor rights issues. Growing global awareness of these challenges is prompting stricter Environmental, Social, and Governance (ESG) compliance and sustainable sourcing initiatives.

To mitigate these risks, countries worldwide are pursuing strategies centered on supply chain diversification, recycling, and material innovation.

Countries such as U.S. and EU are focusing on expanding local mining operations, building refining and processing facilities, and incentivising investments through policy frameworks such as tax credits and subsidies. On the international front, strategic partnerships are being forged with resource-rich countries outside traditional supply hubs to diversify sourcing.

Private investments in recycling infrastructure are accelerating, with automakers, global recycling leaders, and emerging technology players actively expanding capacity and enhancing recovery efficiencies. These efforts are reinforced by regulatory frameworks that mandate stringent collection and recycling targets for EV batteries. At the same time, recycling of rare earth elements from electric motors is gaining prominence, as players experiment with innovative technologies aimed at reducing costs and simplifying complex processes.

Source: (1) India's Shift to Sustainable Mobility: Embracing Electric, Hybrid, and Alternative Fuel Vehicles – Economic Times news article dated 23 October 2025. (2) Vahan dashboard accessed on 1 November 2025, SMEV, and KPMG in India analysis. (3) KPMG in India Analysis basis primary and secondary research. (4) India needs to diversify its critical mineral sourcing strategy – Institute for Energy Economics and Financial Analysis news article dated 28 October 2024.

Executive summary (2/2)

Technological innovation is key to overcoming resource constraints. The surge of LFP batteries (Lithium Iron Phosphate) — from under 10 per cent market share in 2020 to nearly 50 per cent by 2024[5] —shows how material innovations address scarcity by reducing reliance on cobalt and nickel. Sodium-ion batteries, which eliminate lithium, are emerging as a viable option for low-cost EVs and grid storage, while solid-state batteries, offering higher safety and energy density, are expected to enter commercial production by 2027.[5] In motor technology, developments in magnet-free designs such as wound rotor synchronous motors, synchronous reluctance motors, and switched reluctance motors are likely to reduce dependence on rare earth elements.

India possesses mineral-bearing resources for lithium, cobalt, and nickel, but lacks proven reserves and large-scale processing capabilities.[6] Rare earth reserves are significant, yet production and refining remain minimal. Building a fully integrated supply chain from mining to battery pack or magnet manufacturing is a long-term endeavour, requiring 10–15 years on average. To achieve its EV ambitions, India must adopt a multi-pronged strategy combining short-term measures for supply security with medium- and long-term initiatives aimed at developing domestic capabilities and fostering technological leadership.

Signing trade deals with mineral-rich countries and fast-tracking approvals via Government-to-Government (G2G) agreements are critical in near-term to avoid supply disruptions. A dedicated company has been established under the Ministry of Mines to acquire overseas assets essential for energy transition. Strategic collaborations are underway with Argentina for lithium block development and with Australia's Critical Mineral Office to diversify supply chains and reduce concentration risks. Domestically, initiatives to discover and develop mineral deposits are gaining traction supported by technical exploration and policy backing. Medium-term priorities should focus on scaling processing capabilities for battery-grade materials and recycling, establishing mineral parks, and fostering academia-industry-government partnerships for research and development. Long-term success will depend on advancements in battery chemistries and motor technologies, supported by skill development programmes and integrated supply chains spanning mining, refining, manufacturing, and recycling.

Production Linked Incentive schemes are already catalysing investments in advanced chemistry cells and battery components, reducing import dependence and enhancing competitiveness. Battery Waste Management Rules and pilot recycling projects further strengthen India's circular economy initiatives. Investor interest in battery recycling is growing, with several players planning new capacities and expanding existing ones.

India's EV transition represents a historic opportunity to lead in sustainable mobility, reduce emissions, and enhance energy security. While challenges around raw material availability, supply chain vulnerabilities, and technological dependencies persist, proactive strategies and innovation can mitigate these risks. EVs remain the most practical and scalable pathway for India's clean mobility transition—outperforming hybrids and hydrogen fuel cell vehicles on cost, infrastructure readiness, and emissions reduction. By combining policy support, infrastructure development, domestic capability building, and global partnerships, India can establish a resilient and competitive EV ecosystem. The next decade will be decisive. Success will depend on India's ability to integrate supply chains, scale manufacturing, and foster technological leadership, ensuring that electric mobility becomes not just a transportation solution but a cornerstone of India's sustainable growth story.

Source: (5) Global Critical Minerals Outlook 2025 – International Energy Agency report dated May 2025. (6) India's efforts to step up domestic production of critical minerals remain crucial for our energy security – ICRA press release dated 22 May 2024.

1 EV growth story in India

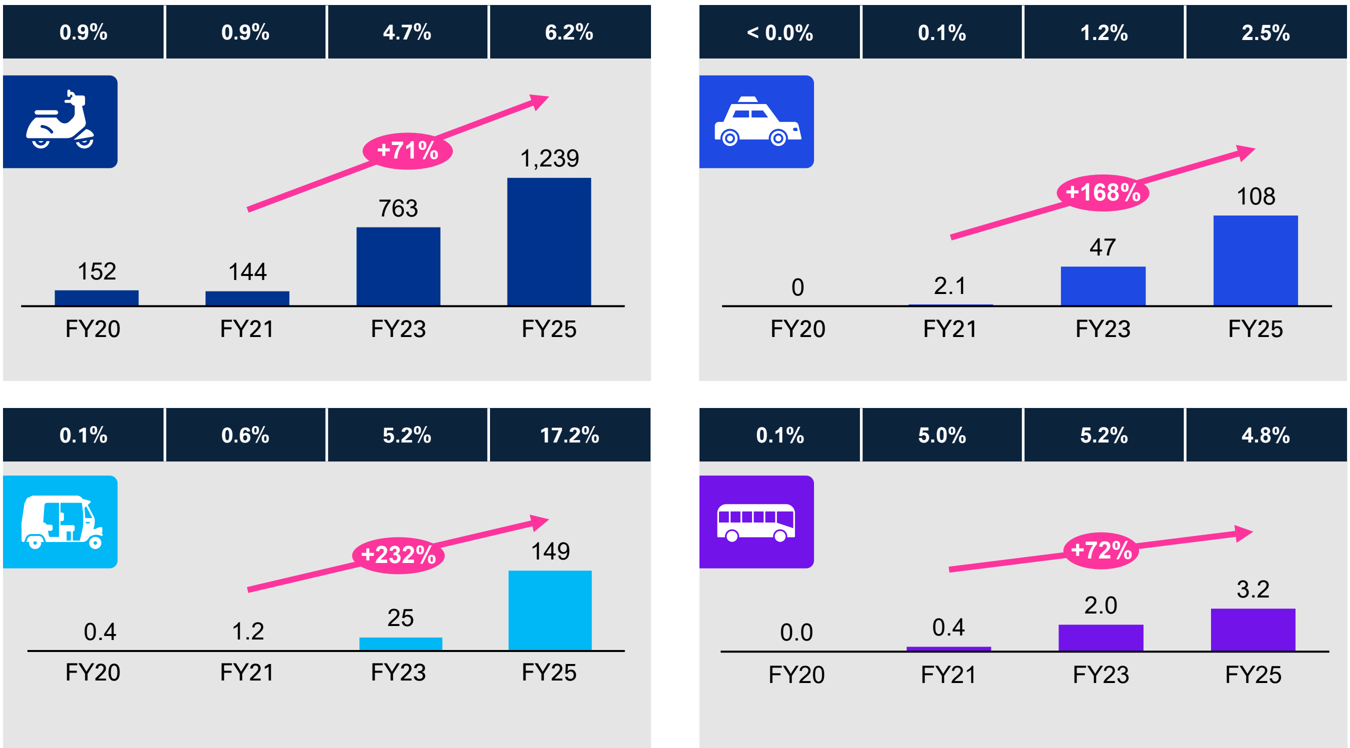
As the world's fourth-largest automobile producer,[1] India stands at a critical juncture in the evolution of its automotive industry. The country's electric vehicle (EV) market is transitioning from early-stage adoption to a period of accelerated growth, fueled by robust government policy support, expanding charging infrastructure, and shifting consumer preferences toward sustainable mobility solutions.

India's e-mobility journey is on a fast track with significant traction witnessed over the last 5 years

EV sales reached approximately 1.5 million units in FY25, with penetration rising sharply from around 0.7 per cent in 2020 to nearly 5.9 per cent in 2025.[2] Early adoption was constrained by issues such as range anxiety, high upfront costs, and limited charging stations. However, strong government initiatives aimed at making India a global EV leader and achieving net-zero emissions by 2070[7] have been instrumental in driving progress. Technological advancements, declining global battery prices, increasing penetration in last-mile delivery, and heightened consumer awareness have further accelerated adoption. Public charging infrastructure, once a major bottleneck, has expanded significantly from roughly 5,000 stations in 2022 to over 26,000 by early 2025, alleviating range concerns for consumers.[8]

2W segment dominates EV market with 80-85 per cent of the EV sales[2] due to affordability and ease of usage in urban areas, making it the most convenient choice for cost-sensitive consumers. The passenger vehicle segment is also gaining momentum driven by advancements in vehicle performance and extended driving ranges. Notably, premium electric passenger vehicles with driving range exceeding 500 kilometers captured roughly 27 per cent of segment sales by mid-2025, reflecting increased consumer confidence in performance, range, and charging infrastructure.[9]

Figure 1: Electric vehicle sales volumes (in thousand units) and % share by vehicle segment



***Note:** Incase of 3W, only L5 category has been considered above.*

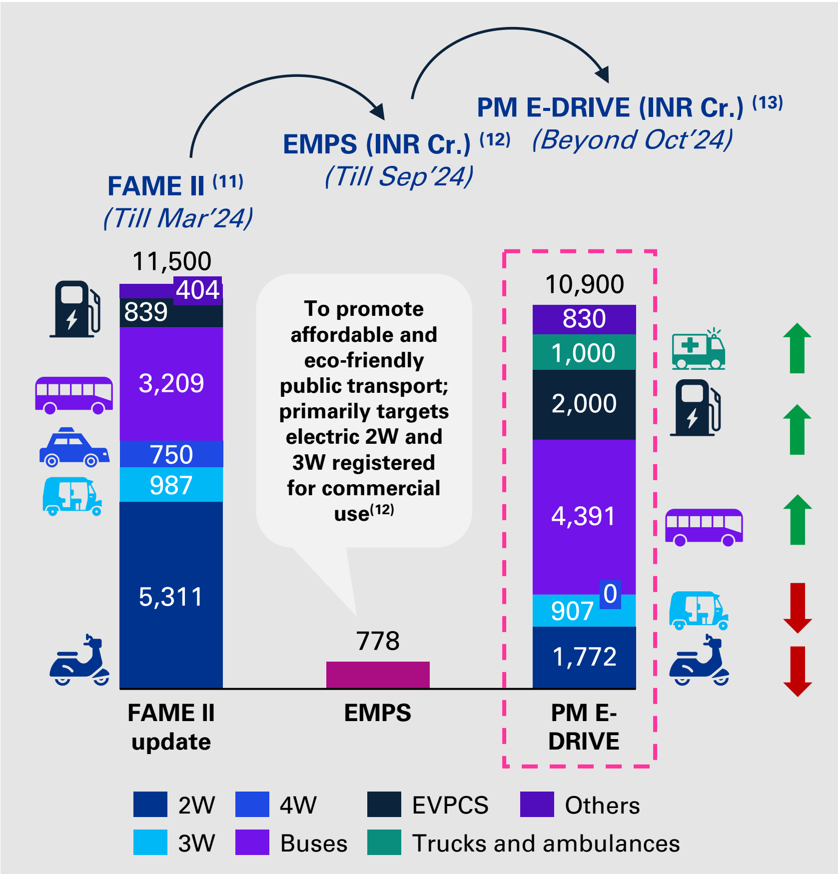
#% *EV penetration rates*

Source: (1) India's Shift to Sustainable Mobility: Embracing Electric, Hybrid, and Alternative Fuel Vehicles – Economic Times news article dated 23 October 2025. (2) Vahan dashboard accessed on 1 November 2025, SMEV, and KPMG in India analysis. (7) Net zero emissions target - Ministry of Environment, Forest and Climate Change press release dated 3 August 2023. (8) Target set for installing EV charging stations and implementation of FAME-III - Ministry of Heavy Industries press release dated 4 April 2025. (9) Range over price: India's EV market pivots to premium in H1 2025 - JATO news article dated 25 September 2025.

Government-led programs such as FAME and PM E-DRIVE have been the backbone of India’s rapid EV transition

PM E-DRIVE Scheme, launched in September 2024 with a INR10,900 crore funding,[10] reinforces India’s commitment to localise EV manufacturing and strengthen domestic supply chain. This initiative builds on FAME II’s success in driving adoption through purchase subsidies for electric two-wheelers (E2Ws) and public buses.·

Figure 2: Key government schemes for promoting EVs



Note: *Others include funding for testing agencies upgradation and administration expenses.*

E2W and E3W – INR 2,679 crore [13]

To incentivise 24.79 lakh e-2Ws, 3.16 lakh e-3Ws (commercial or privately owned vehicles).

Commercial Vehicles – INR 5,391 crore [13]

- To incentivise procurement of 14,028 e-buses by STUs/public transport agencies
- INR500 crore each for e-Ambulance and e-trucks.

Charging Infra – INR 5,391 crore [13]

Towards 72,300 Electric vehicle public charging stations (EVPCS) including 22,100 fast chargers for e-4Ws and 1,800 fast chargers for e-buses.

Table 1: Total cost of ownership comparison for ICE vs EV (14)

Segments	ICE TCO (INR per km)	EV TCO (INR per km)	Difference
2W Scooter	5.2	3.9	25%
2W Motorcycle	3.2	3.9	(22%)
3W - L5	11.1 (CNG) 12.3 (Diesel)	11.3	(2%) (CNG) 8% (Diesel)
4W Private	16.7	20.8	(25%)
4W Cabs	13.2	12.4	6%
LCV <2T	17.5	17.1	2%
Buses	93	63	32%

TCO parity by FY31-32

TCO parity by FY28-29

Currently, EV variants across most vehicle segments offer TCO savings over their ICE counterparts

Source: (10) PM E-DRIVE: Centre notifies Rs 10,900 crore EV subsidy scheme – Economic Times news article dated 30 September 2024. (11) Scheme outlay of FAME India Scheme Phase II enhanced from ₹10,000 crore to ₹11,500 crore - Ministry of Heavy Industries press release dated 9 February 2024. (12) Government extends duration of EMPS 2024 by two months i.e. upto 30th September, 2024 with enhancement of outlay to Rs. 778 crore - Ministry of Heavy Industries press release dated 26 July 2024. (13) PM E-DRIVE Scheme: Driving Towards a Greener Future – Research Unit – Press Information Bureau press release dated 9 October 2024. (14) KPMG in India Analysis basis primary and secondary research.

EV sales expected to reach 22 million units in 2035 as EV penetration crosses 50 per cent across most vehicle segments on back of favourable demand, supply and regulatory drivers [15]

Figure 3: EV penetration estimates (as per cent of annual vehicle sales)

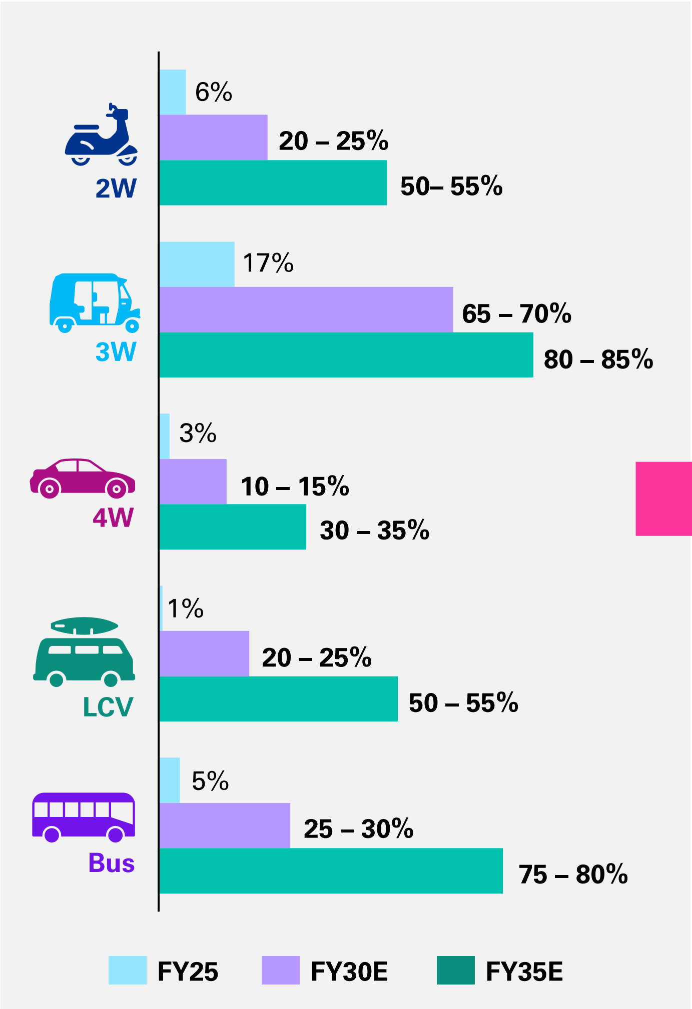
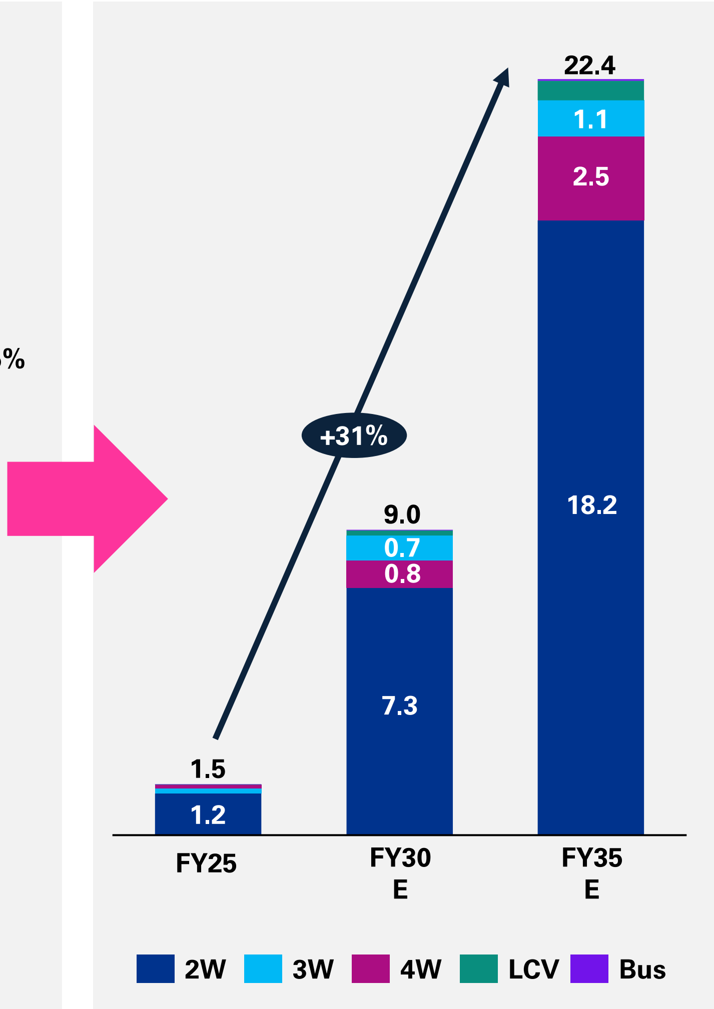


Figure 4: EV annual sales (million units)



EVs deliver significant cost savings compared to ICE vehicles in scooters, 3Ws and intracity buses - segments that currently lead in EV maturity within the Indian market. For 4W cars, cost parity already exists for commercial usage and the same is expected for personal usage before the end of this decade.

Improving economics, coupled with continued government focus, rapid expansion of charging infrastructure, increasing availability of models across segments and technological advancements, India's EV growth momentum is likely to accelerate over the next decade.

Source: (15) KPMG in India analysis based on primary and secondary research.

2 Mineral dependence for EV transition

EV transition rests on a foundation of specialised materials - many of which are limited in supply and difficult to access

The transition to electric vehicles is heavily dependent on the availability of critical raw materials required for battery and motor production. On average, EVs require six times more mineral inputs than conventional internal combustion engine (ICE) vehicles, primarily due to the complexity and size of their battery systems.[16]

Minerals such as lithium, nickel, cobalt, manganese, and graphite are critical to EV batteries, directly influencing energy density, stability and overall performance. These minerals enable high-capacity storage and long driving ranges, which are critical for EV adoption.

In addition to batteries, electric motors rely on rare earth elements, particularly neodymium and dysprosium to manufacture high-strength permanent magnets. These magnets are essential for delivering compact, efficient, and powerful motors, making them a critical part of the modern EV propulsion systems.[16]

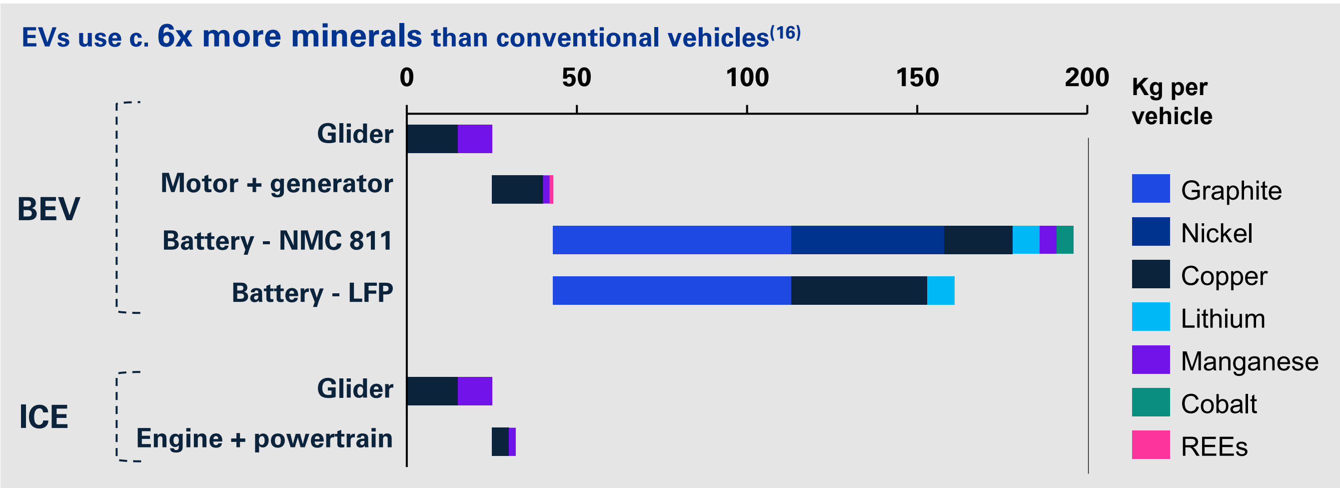
Table 2: Key raw materials in critical EV components

EV components	Prominent technologies	Key raw materials
Battery	Lithium–ion based (NMC, LFP)	LFP battery • Lithium • Iron NMC battery • Nickel • Manganese • Cobalt
Motor	Permanent Magnet Synchronous Motor (PMSM), AC Induction Motor (ACIM), and Brushless Direct Current (BLDC)	• Copper • Iron • Aluminium • Rare Earth Elements (REE) • Resins • Ceramics

Focus minerals for EV transition with supply chain risk

Global demand for these minerals is surging as EV adoption accelerates

Figure 5: Comparison of mineral usage in EV and ICE vehicles



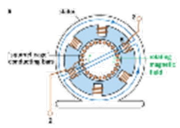
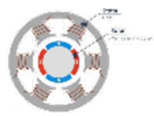
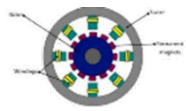
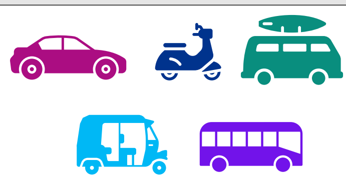
Notes: Considering PMSM EV motor and 75kWh battery with graphite anodes

Source: (16) The Role of Critical World Energy Outlook Special Report Minerals in Clean Energy - International Energy Agency report dated March 2022.

PMSM is the dominant EV motor technology globally that offers the highest efficiency and power density. However, its reliance on REE makes it costlier than its alternatives

Electric vehicles rely on advanced motor technologies to convert electrical energy into mechanical motion efficiently. Among the most widely adopted designs are Permanent Magnet Synchronous Motors (PMSM), AC Induction Motors (ACIM), and Brushless DC (BLDC) motors, each offering distinct advantages in terms of efficiency, cost, and material requirements.

Table 3: Comparison between existing EV motor technologies[17]

	AC Induction Motor (ACIM)	Brushless Direct Current (BLDC)	Permanent Magnet Synchronous Motor (PMSM)
			
	• 3 Phase ACIM works on the principle of a **rotating magnetic field** caused **when a 3-phase alternating current (AC) is passed through coil windings** within the motor • The **electric current is inducted into the rotor**, which causes it to rotate • The **speed of the rotor is controlled** by controlling the **frequency of input power.**	• BLDC motors **induce a rotating magnetic field on a permanent magnet** using a 3-coil winding setup, which is **powered by a direct current** • Unlike AC motors, where continuous current flows through all the windings, in BLDC motors, winding is either **powered 100** per cent **or 0** per cent **at a given time**, which can lead **moment of jerks** when power is switched.	• Converts DC power from the battery to AC using an **inverter**, and the motor controller adjusts speed by changing AC frequency • **Permanent magnets** in the rotor interact with the rotating magnetic field from the stator to generate torque • During braking, **converts mechanical energy into electrical** to recharge the battery.
AC/ DC:	*AC*	*DC*	*AC*
Magnet usage:	×	✓	✓
Cost:	*0.7 x*	*0.9 x*	*1.0 x*
Efficiency:	*75-85%*	*85-90%*	*92-95%*
Reliability:	*0.9 x*	*0.8 x*	*1.0 x*
Torque and power density:	*0.5 x*	*0.7 x*	*1.0 x*
Torque ripple:	◔	●	◔
Maintenance:	◔	◑	◑
Controller complexity	◑	◔	◑
Vehicle applications:			

Legend >>> ◔ **Low** ◑ **Medium** ● **High**

Notes: *Basis a study conducted on BEV motors by International Journal of Science and Research in December 2023*
Assumptions: 1. Electrical and mechanical loading of each motors under comparison are kept the same | 2. The same machine design and construction is considered | 3. The size, rating, power factor, and efficiency of each motor drive are considered to be the same
Power density is measured in Watt / Volume, Specific power is measured in watt / kg

Source: (17) KPMG in India analysis based on primary and secondary research.

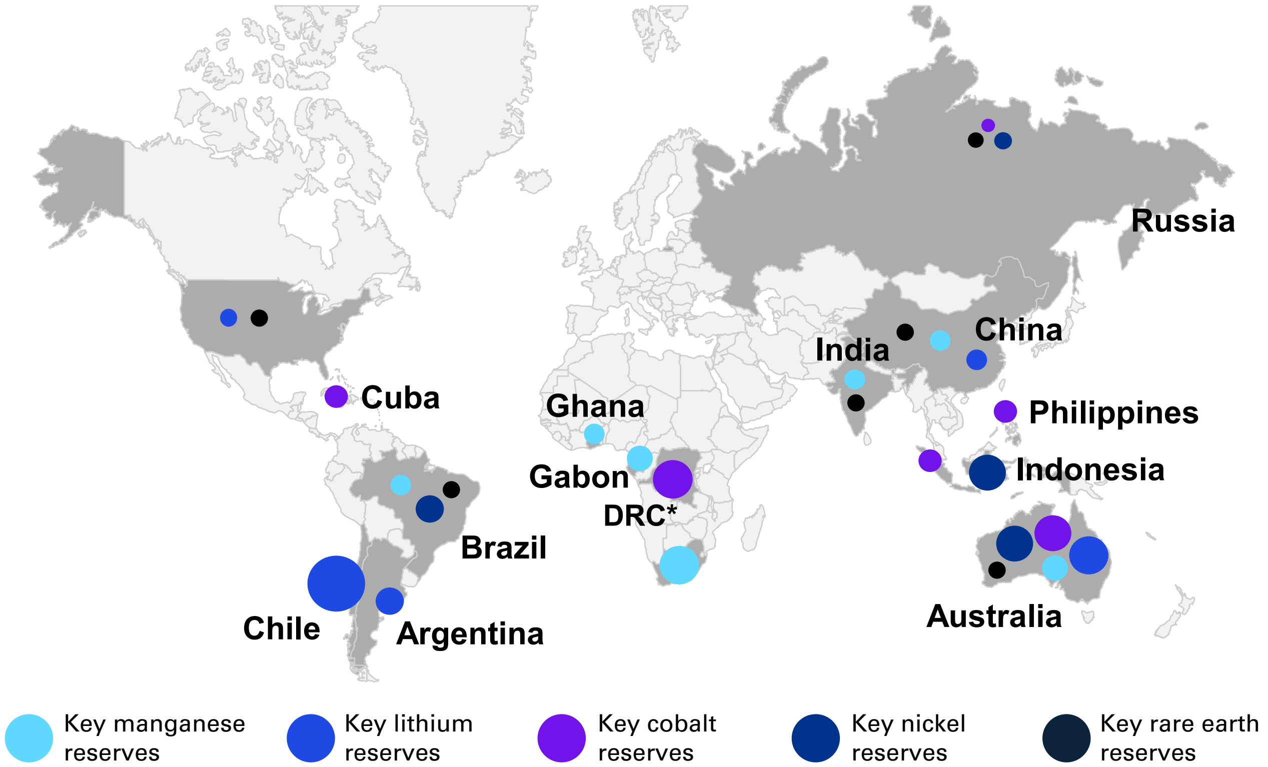
3 Supply chain risks

As India pushes forward with its ambitious EV agenda, several critical risks are inherent within the supply chain for raw materials vital to EV production. These risks are multifaceted, spanning geopolitical dependencies, price volatility and ESG challenges.

High level of geographical concentration of critical battery materials and rare earth elements makes the EV value chain quite vulnerable to supply shocks and price volatility

The global reserves of key battery minerals and rare earth elements are highly geographically concentrated, with a few countries dominating extraction and refining. While lithium is largely sourced from Australia, Chile, and Argentina; cobalt and nickel are sourced from the Democratic Republic of Congo and Indonesia, respectively. China, meanwhile, controls over 80 per cent of global refining capacity and rare earth magnet production.[5]

Figure 6: Global reserves of key raw materials – Top countries 2024 [18]



Note: ** Democratic Republic of the Congo; REE reserves account for all the rare earth minerals*

Manganese c.1.7bn MT – **South Africa and Australia** hold **~62** per cent **of world's** Manganese reserves

Rare earth (REE) c.90+mn MT – **China** holds **c.50** per cent **of world's** REE reserves

Nickel c.130+mn MT – Indonesia's Nickel production constitutes ~60 per cent of the world production

Cobalt c.11mn MT – **Democratic Republic of the Congo (DRC)** produces **c.76** per cent of the world's mined **Cobalt**

Lithium c.30mn MT – **Chile**, **Australia**, **Argentina** and **China** account for **c.78 per cent** of **global Lithium reserves**

This concentration creates vulnerabilities in the EV value chain, with exposure to supply shocks, price volatility, and geopolitical risks. India's domestic reserves of these minerals remain limited and largely underexplored and hence relies on these countries for key minerals.

Source: (5) Global Critical Minerals Outlook 2025 – International Energy Agency report dated May 2025. (18) Mineral Commodities Summaries 2025 report by USGS dated March 2025, KPMG in India Analysis.

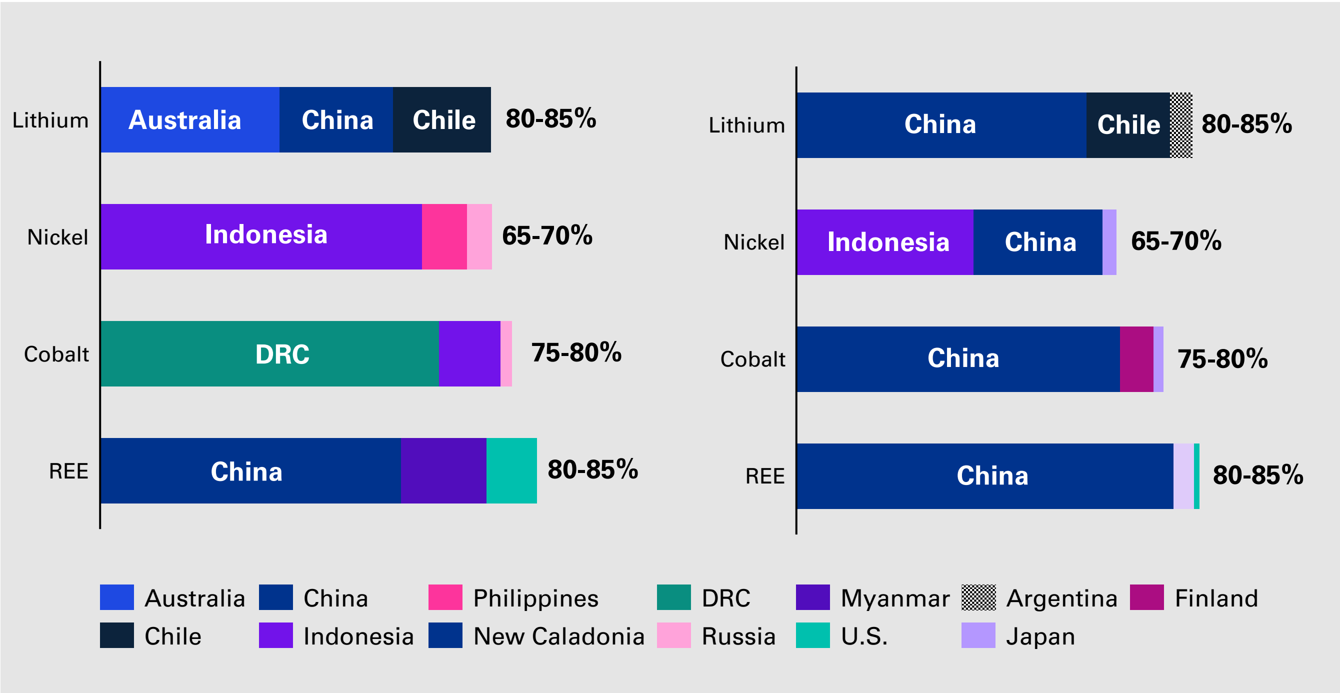
For lithium, cobalt and REE, top three producing nations control over 75% of global production. Processing operations are even more concentrated, with China dominating across the value chain

Figure 7: Share of top 3 countries in mined or raw material production (2024)

The key minerals have a single dominant producer contributing more than 50 per cent of global production, highlighting the supply chain concentration risk.[5]

Figure 8: Share of top 3 countries in refined material production (2024)

Similarly, for refined materials, China dominates production for majority of the key minerals with a global market share of at least 70 per cent.[5]



China's major influence on global critical mineral supply chains

- In 2025, China accounted for ~30 per cent of global nickel processing, 70–80 per cent of lithium and cobalt refining, and ~ 90 per cent of rare earth element separation[5]
- Furthermore, Chinese firms have invested extensively in overseas mining operations located in Australia, Chile, the Democratic Republic of Congo, and Indonesia
- Recently, China implemented export controls measures on critical minerals[5]:
  - **December 2024:** Banned exports of gallium, germanium, and antimony to the U.S. and imposed stricter end-use based restrictions on graphite exports;
  - **February 2025:** Expanded controls to include tungsten, tellurium, bismuth, indium, and molybdenum;
  - **April 2025:** Introduced export controls on seven rare earth elements. Additionally, China strengthened domestic oversight through Rare Earth Management Regulations effective October 2024.[19][20]

Such supply chain vulnerabilities stemming from China's market concentration could disrupt and delay global automotive production operations.[21]

Given ongoing global supply chain uncertainties, India may experience ripple effects that could influence EV production timelines and model roll-outs, potentially affecting its competitive positioning and investment outlook.

Source: (5) Global Critical Minerals Outlook 2025 – International Energy Agency report dated May 2025. (19) How Indian EV makers are racing to go rare earth-free amid China's chokehold – The Indian Express news article dated 12 November 2025. (20) China expands rare earths restrictions, targets defense and chips users – Reuters news article dated 10 October 2025. (21) China's Rare Earth Clampdown Threatens Global EV Supply Chain – Report - Forbes news article dated 9 June 2025.

Raw material prices for EV batteries and motors saw sharp fluctuations in the recent years due to global supply shocks induced by geopolitical tensions, rising demand and pandemic-related disruptions. Although they have stabilised now, the risk of future volatility remains high

Over the past five years, lithium prices have soared during periods of high demand and supply uncertainty. Cobalt and nickel have shown similar trends, driven by rapid EV adoption, pandemic-related disruptions, and geopolitical tensions such as the Russia-Ukraine war.

Figure 9: Historical price deviations of key raw materials and minerals (Jan 2020 to Mar 2025) (5)

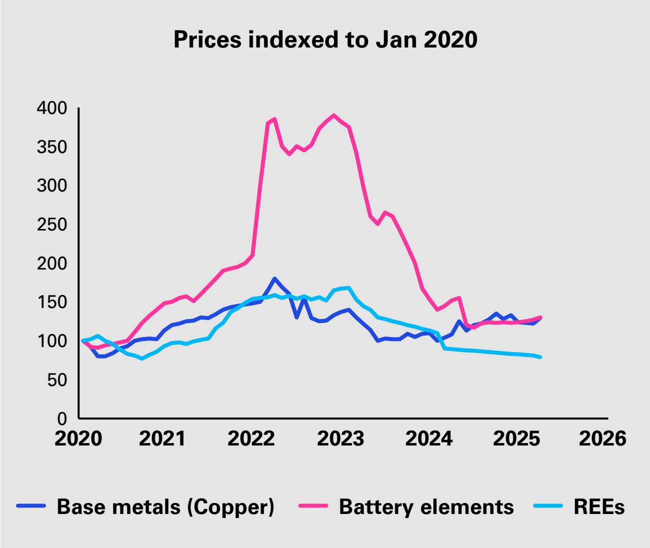
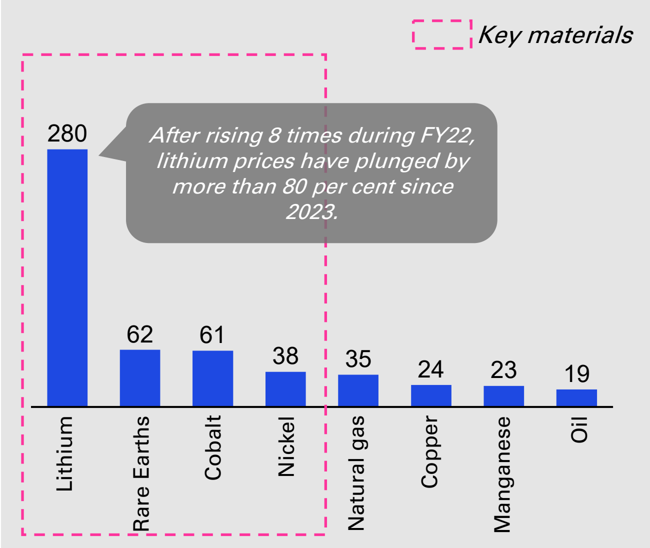


Figure 10: Monthly volatility (standard deviation) for selected materials (Jan 2014 - Mar 2025 (5))



A surge in battery mineral prices (10x increase in price of either Lithium or Nickel) could raise global battery pack costs by 40–50 per cent, driving up consumer prices and reducing manufacturing competitiveness. This could widen the manufacturing cost gap with China from 40-50 per cent to about 70 per cent for Europe and the U.S.[5]

Managing price volatility is key for Indian EV OEMs to ensure predictability and maintain competitiveness.

Global awareness of the environmental and ethical challenges in critical mineral mining has been rising

Table 4: Top countries with Lithium reserves

Key countries	% of Li reserves (22)	Drought risk
Chile	31%	✓
Australia	23%	
Argentina	13%	✓
China	10%	✓
U.S.	6%	

Amount of water for extracting 1 ton of Lithium = **2.2 Mn. Litres (23)**

ESG concerns

- The extraction and processing of these minerals pose significant **environmental and social challenges**
- Lithium mining, which **demands substantial water resources**, frequently occurs in **water-scarce regions** such as Chile's Atacama Desert that is home to **more than half of the world's lithium reserves** [24]
- **Cobalt production**, concentrated in parts of Central Africa, has been associated with **human rights violations**, including **child labor** and **hazardous working conditions.**[25]

Source: (5) Global Critical Minerals Outlook 2025 – International Energy Agency report dated May 2025. (22) Mineral Commodities Summaries 2025 report by USGS dated March 2025, KPMG in India Analysis. (23) South America's 'lithium fields' reveal the dark side of our electric future - Euro news article dated 21 November 2022. (24) Lithium mining leaves severe impacts in Chile, but new methods exist: Report - Mongabay news article dated 10 September 2025. (25) The current state of child labour in cobalt mines in the Democratic Republic of the Congo – Humanium new article dated 27 May 2025.

4 Global mitigation strategies

Countries and regions across the globe are stepping up efforts to ensure reliable and sustainable supply through 3 key strategies:

Supply chain diversification	Recycling and re-use initiatives	Material innovation

4.1 Supply chain diversification

To reduce dependency on concentrated supply chains, governments and companies are implementing multi-pronged strategies that focus on domestic production and strategic international partnerships.

Domestic production initiatives include expanding local mining operations, building refining and processing facilities, and incentivising investments through policy frameworks such as tax credits and subsidies. For example, the United States has introduced measures under the Inflation Reduction Act to boost domestic extraction and processing of lithium, nickel, and cobalt. Similarly, the European Union's Critical Raw Materials Act aims to strengthen local supply capabilities and reduce reliance on imports and Australia's Critical Minerals Strategy focuses on enabling diversified global supply chains and value-added downstream capabilities.

On the international front, strategic partnerships are being forged with resource-rich countries outside traditional supply hubs to diversify sourcing. These partnerships often involve long-term offtake agreements, joint ventures, and technology-sharing arrangements. For instance, automakers and battery manufacturers are collaborating with countries such as Australia, Canada, and Indonesia to secure stable supplies of lithium and nickel, reducing dependence on China's dominant position in refining and processing.

Example 1: U.S. is building domestic supply chains and partnerships with allies, with funding support from government to ensure a secure supply chain

Category	Key strategic initiatives	
Battery materials	Domestic source recognition	• Canada designated as a "domestic source" under the U.S. Inflation Reduction Act for lithium, nickel, and cobalt [26] • Bipartisan Infrastructure Law promotes battery recycling, circularity, and local manufacturing.[27]
	Grants and funds	• Department of Energy grants for high-purity manganese sulfate, nickel sulfate, and cobalt hydroxide [28] • Support for battery supply chain development (cathode, anode, electrolyte, cell manufacturing).[29]
	Industry investments	• ESG-compliant nickel extraction and refining projects in Indonesia[30] • Trade discussions and technology transfers with Vietnam and Australia for lithium and manganese, respectively.[31]
Rare earth elements	International partnerships	• Collaborations with Australia, Canada, and Japan for domestic mining, refining infrastructure, and research in recycling and alternative materials.[32]
	Key investments	• Funding for mineral separation and magnet manufacturing[33] • USD22 million investment in Canadian rare earth firms under the Defense Production Act.[34]
	Processing and supply chain development	• Canadian firms are advancing rare earth processing in the U.S.; firms are also partnering with German players for permanent magnets • Feedstock sourcing from South Carolina, Brazil, and Canada • Rare earth processing technology agreements with Canadian and German firms.

Source: (26) Canada eyes cash for critical minerals in Biden's big new climate bill - CBC news article dated 16 August 2022. (27) Funding Selections: Bipartisan Infrastructure Law Battery Recycling, Reprocessing, and Battery Collection Funding Opportunity - U.S. Department of Energy report dated January 2025. (28) Battery Materials Processing Grants - U.S. Department of Energy website (29) DOE Announces Over $3 Billion to Support U.S. Battery Manufacturing Sector - American Public Power Association news article dated 20 September 2024. (30) US approaches Indonesia for multinational critical mineral partnership – Reuters news article dated 16 July 2024. (31) US seeks cooperation with Việt Nam in semiconductor, essential mineral & nuclear energy R&D - Viet Nam news article dated 13 March 2025. (32) Minerals Security Partnership press release on U.S. Department of State website.(33) Energy Department Announces $60 Million to Secure Domestic Critical Mineral Supply and Strengthen Magnet Manufacturing - ARPAE news article dated 25 August 2025. (34) Rare Earth Elements: 7 numbers that illustrate the global state of play—and Canada's potential role - RBC Bank press release dated 20 May 2025.

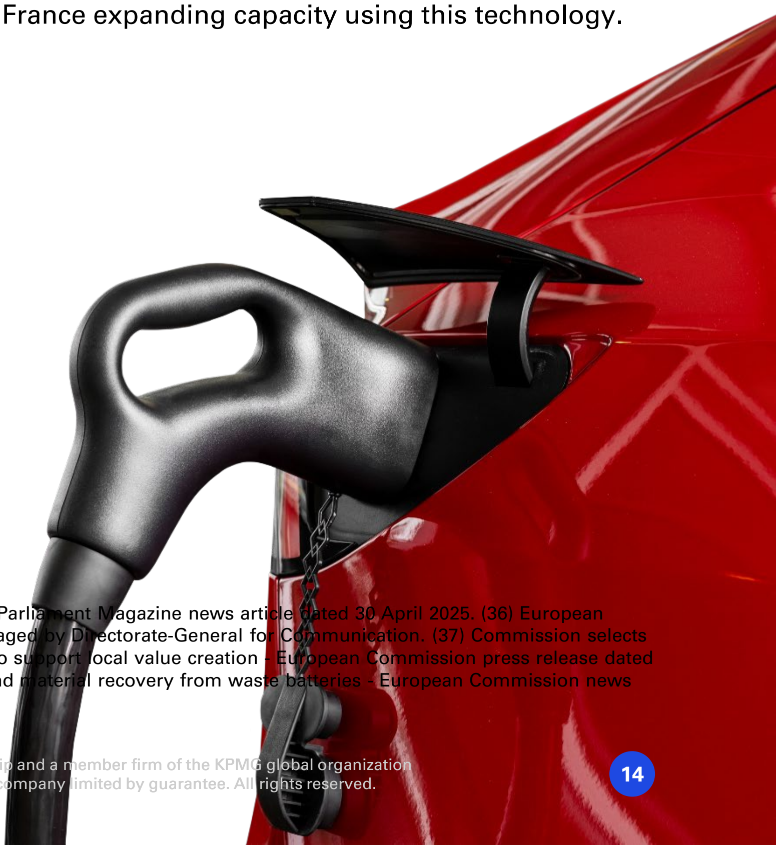
Example 2: EU government is diversifying sourcing, reducing reliance, and building resilient value chains through global collaboration across upstream and downstream partners

Category	Key strategic initiatives	
Battery materials	**EU mineral agreements**	• Signed 10+ critical mineral deals with resource-rich countries, reducing reliance on China/Russia.[35]
	Critical Raw Materials Act (CRMA 2030 Targets)[36]	• 10 per cent of annual consumption from EU mining • 40 per cent from EU-based processing • 25 per cent from recycling • Max 65 per cent from any one non-EU country.
	Funding and industry initiatives	• Mid/downstream value chains with countries across Africa, Latin America, Asia, Greenland. *Countries participating: DRC, China, Greenland, Indonesia, Kazakhstan, Morocco, Namibia, Rwanda, Serbia, South Africa, Tanzania, Ukraine, Uzbekistan, Zambia*
Rare earth elements	**CRMA targets (same as Battery materials)**	
	New material projects	• In January 2024, EU announces 13 new material projects focused both inside and outside EU (notably in Canada, Australia, Vietnam, parts of Africa) – extraction and processing.
	Trade partnerships	• In June 2025, the bloc announced 13 new raw material projects outside EU borders (Canada, Australia, Vietnam, and parts of Africa), focusing on both extraction and processing capabilities[37] • Trade deals with Mercosur countries (e.g. Brazil, Argentina) are in progress to secure long-term feedstock.

4.2 Recycling and re-use initiatives

As EV ownership scales, so does the volume of spent lithium-ion batteries reaching end-of-life. Recycling introduces a critical alternative source of raw materials, reducing the pressure on primary mining and import dependence. Developed economies including the EU, Japan, and U.S. have instituted regulatory frameworks mandating high collection and recycling rates of EV batteries. For instance, the EU's Battery Regulation (2023) requires a minimum recovery rate of 70 per cent for lithium and 95 per cent for cobalt, nickel, and copper by 2031.[38] Similarly, U.S. supports recycling through initiatives under the Inflation Reduction Act. Private investments in recycling infrastructure are gaining momentum with auto makers, global recycling majors and emerging tech players focusing on capacity expansion and improving recovery efficiencies.

Beyond batteries, recycling of rare earth elements from electric motors is also emerging as a priority. Traditional rare-earth magnet recycling relies on "long-loop" processes, breaking magnets into oxides, converting them back to metals, and reforming alloys—a method that is effective but energy-intensive and costly. A new approach, short-loop recycling, is gaining traction by reprocessing magnets directly, reducing steps, energy use, and costs, with companies in UK and France expanding capacity using this technology.



Source: (35) Europe's quest for critical raw minerals gains new urgency - The Parliament Magazine news article dated 30 April 2025. (36) European Critical Raw Materials Act topic section – European Commission website managed by Directorate-General for Communication. (37) Commission selects 13 Strategic Projects in third countries to secure access to raw materials and to support local value creation - European Commission press release dated 4 June 2025. (38) Circular Economy: New rules to boost recycling efficiency and material recovery from waste batteries - European Commission news article dated 4 July 2025.

Battery recycling industry, though currently small, is set for exponential growth post 2030 as the influx of spent batteries enter the recycling market. Rare-earth recycling, on the other hand, is still in experimental stage

Table 5: Comparison of battery recycling and rare earth recycling

Parameter	Li-ion battery recycling	Rare earth elements recycling
EV component	Battery pack	Motor
Main materials recovered	Lithium, cobalt, nickel, graphite, manganese, copper, aluminum	Neodymium, praseodymium, dysprosium, terbium (used in permanent magnets in motors)
Industry maturity	Relatively mature, commercial operations established and are scaling rapidly	Nascent stage, limited commercial activity with mostly lab-scale or pilot efforts
Recycling rate	5-10% [39]	<1% [40]
Challenges	• Battery chemistries vary (e.g., LFP vs NMC) • Need for safe dismantling • Cost of logistics and processing	• Complex, multi-step dismantling with low REE content • High cost and low scalability
Policy and regulation focus	• Strong mandates (e.g. EU Battery Regulation, Responsible Battery Recycling Act of 2022) • EPR and recycled content laws emerging across countries including India Battery Waste Management Rules (2022, amended 2025)	• Still emerging • European Critical Raw Materials Act (CRMA 2030 Targets) specifies recycling targets for strategic raw materials which includes rare earth elements
Future outlook	Rapidly expanding due to large battery volumes and policy support	Growing interest but needs significant innovation and investment to scale

4.3 Material innovation

Globally, automakers and battery manufacturers are accelerating efforts to develop alternative battery chemistries to reduce dependence on critical minerals such as lithium, cobalt, and nickel.

Resurgence of LFP batteries:

- In 2020, nickel-based lithium-ion batteries, mainly NMC accounted for over 90 per cent of global[5] EV battery market, while LFP held less than 10 per cent share.[5] By 2024, LFP batteries surged to nearly half of the market, displacing nickel-based chemistries.[5] This shift began during 2021–2022 spike in nickel and cobalt prices and continued even after the slump in prices, driven by improvements in LFP energy density and growing price competition in EV sector.

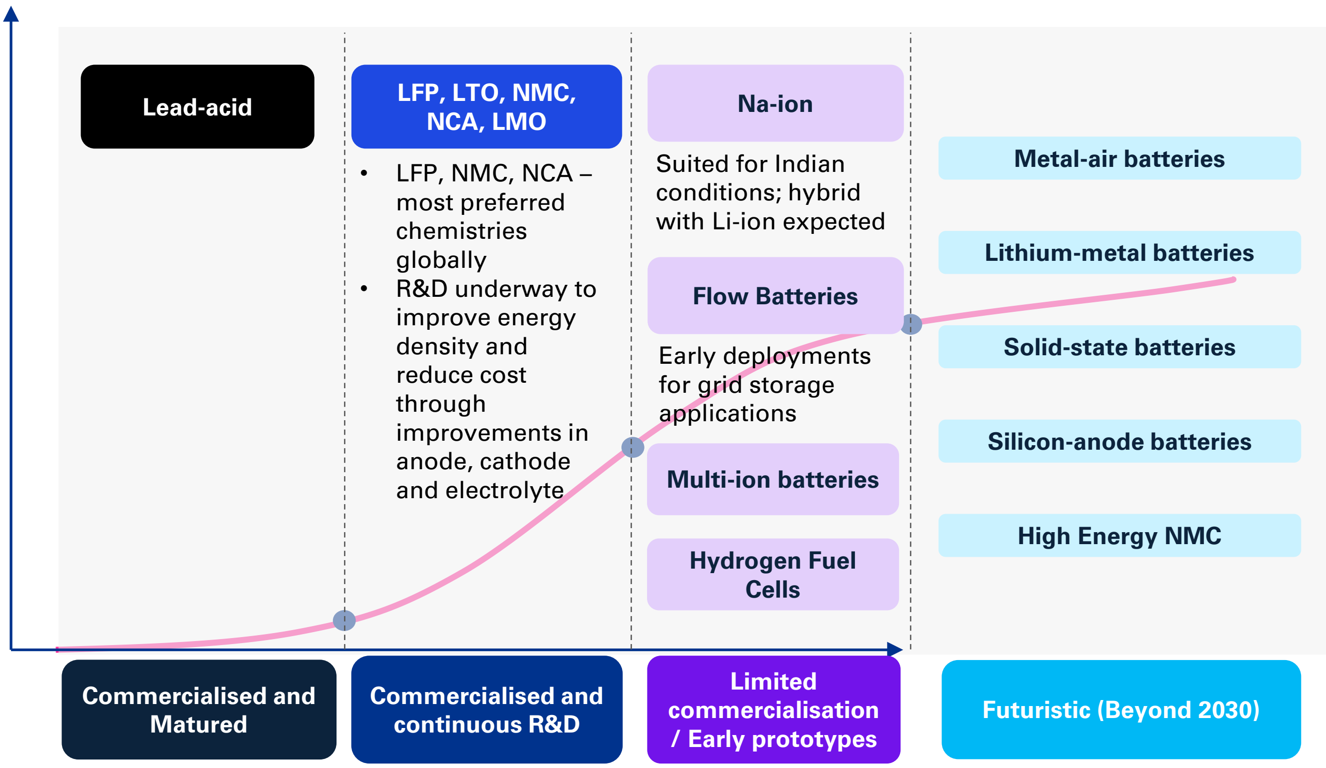
Emerging battery technologies:

- Sodium-ion batteries are currently the only commercial EV battery chemistry that does not contain lithium. Leading battery manufacturers have announced large-scale sodium-ion production lines, targeting low-cost EVs and grid storage. While energy density is lower than lithium-ion, sodium-ion offers strong performance in cold climates and abundant raw material availability.
- Advancements are being made in solid-state batteries, with leading Korean and Chinese battery majors targeting commercial production by 2027.[5]

Source: (39) What Statistics Indicate Lithium Recycling Rates - Sustainability Directory press release dated 30 April 2025. (40) The Future of REE Recycling - The Economist Global news article dated 26 August 2024. (20) IEA report on 'Global Critical Minerals Outlook 2025. (5) Global Critical Minerals Outlook 2025 – International Energy Agency report dated May 2025.

Notable developments have been made in alternative battery chemistries over the recent years, particularly sodium-ion and solid-state technology

Figure 11: Expected roadmap of EV battery technologies (41)



Motor design innovation

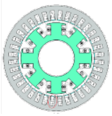
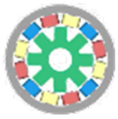
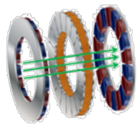
Automotive OEMs are exploring with alternative motor designs which deliver torque through magnetic field alignment rather than permanent magnets, reducing reliance on rare earth elements. Technologies like wound rotor synchronous motors (WRSMs), synchronous reluctance motors (SynRMs), and switched reluctance motors eliminate the need for scarce rare earth elements, while features such as axial flux orientation enable lighter, more compact motors with reduced material intensity.

A notable case study is Japan's rapid advancement in magnet-free motor technologies following China's rare earth export restrictions in 2010, which catalysed significant R&D investment and supply chain diversification.

Source:(41) KPMG in India analysis based on primary and secondary research.

Automotive OEMs are experimenting with alternative motor architectures to reduce dependence on rare-earth magnets

Table 6: Comparison of emerging motor technologies [42]

Particulars	Wound Rotor Synchronous Motor / Externally Excited Synchronous Motor	Syn Reluctance Motor	Switched Reluctance Motor	Axial Flux
Process/ working principle				
	The **rotor** has windings connected **via slip rings and brushes**. When current is supplied to the rotor windings, it creates a magnetic field **that interacts with the stator's rotating magnetic field** to produce torque.	• The **stator windings** create a rotating magnetic field when AC power is applied. The rotor, designed with regions of high and low magnetic permeability, aligns with this rotating field to produce torque. • The rotor **has no windings or permanent magnets**, which reduces manufacturing and maintenance costs.	• The stator windings create a magnetic field when energised. The rotor, **made of soft magnetic material with salient poles,** aligns with the magnetic field to minimise reluctance, producing torque. • The **absence of permanent magnets** and the **simple rotor design** reduce material and manufacturing costs.	• The magnetic flux **is parallel to the axis of the rotor movement**, making these motors compact and lighter. • **Moving the magnet's position** to the axis of the motor can increase/decrease the torque of the motor.
AC/ DC	*AC*	*AC*	*AC*	*AC*
Magnet usage	×	×	×	✓
Efficiency	*87-90%*	*90-92%*	*87-90%*	*> 96%*
Power density	*Lower than PMSM*	*Lower to PMSM (0.55X)*	*Lower than PMSM*	*Higher than PMSM*
Reliability	◑	●	●	◑
Torque ripple	◕	◑	●	◔
Design complexity	◕	◑	● *(complex controller)*	◕ *(complex motor)*
Vehicle types *(existing/future)*	*E: Mass e4W*	*F: e3W and eLCV*	*F: e3W and eLCV*	*F: e2W and e4W (high end) and M&HCV*

Legend >>>	◔	Low	◑	Medium	●	High

Notes: *Basis a study conducted on BEV motors by International Journal of Science and Research in December 2023*
Assumptions: 1. Electrical and mechanical loading of each motors under comparison are kept the same | 2. The same machine design and construction is considered | 3. The size, rating, power factor, and efficiency of each motor drive are considered to be the same
Power density is measured in Watt / Volume, Specific power is measured in watt / kg

Source: (42) KPMG in India analysis based on primary and secondary research.

Case study: Japan's strategic response when China halted rare earth exports in 2010

China's decision to halt rare earth shipments to Japan in 2010 triggered a supply shock with far-reaching implications for technology-intensive industries. Japan's subsequent proactive policy response is a notable case study that focuses on strategic resilience and diversification approach.

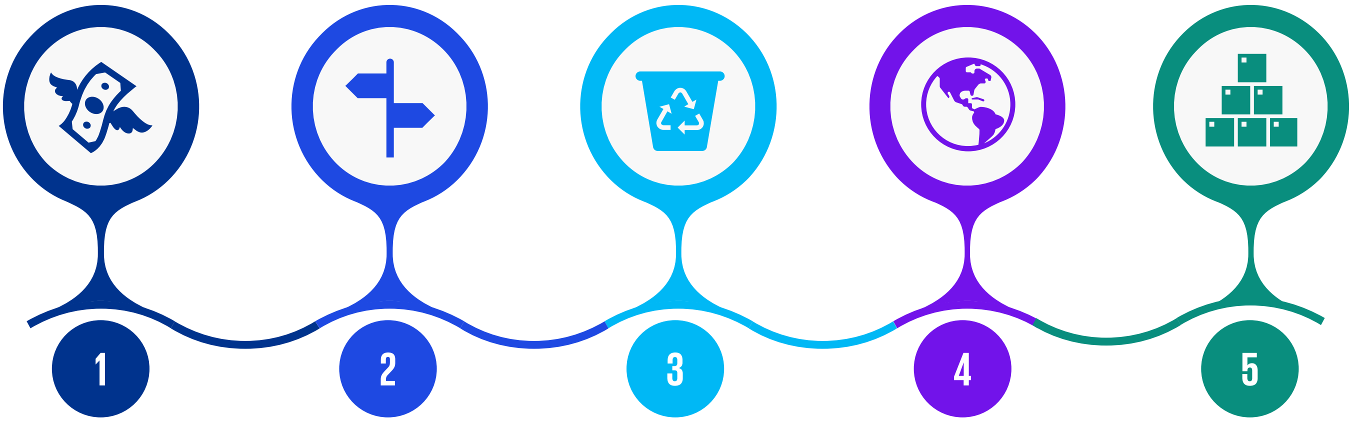
Background [43]

- On September 7, 2010, a Chinese fishing boat collided with 2 Japanese Coast Guard vessels near the Senkaku Islands (Southwest Japan), leading to the Chinese captain's arrest
- In retaliation, China halted air route negotiations, reduced tourist flows to Japan, and most significantly, **suspended rare earth exports**
- This event led to the **rare earth prices surge of 10x over the following year.**

Government measures [44]

✓ A supplemental budget of JPY100 billion (equivalent back then to about USD1.2 billion) was set aside by the Japanese Government in October 2010. The package had **five main pillars:**

Key pillars



1. Encourage technology development and capital investment to lower rare earth consumption
2. Develop technologies to use alternative materials
3. Supporting investments in recycling facilities and development of efficient recycling technologies
4. Expand mining and investments in rare earth assets outside China
5. Stockpiling rare earths in addition to policy framework to ensure reserves of critical minerals

Outcomes

Supply diversification

Japan expanded its supplier base by forging strategic partnerships with countries holding untapped rare earth reserves (with Australia, Myanmar and Vietnam).

Reduced import dependence

Japan's reliance on Chinese rare earths has fallen from 90 per cent, at the time of the incident, to 60 per cent today, accompanied by a 50 per cent reduction in overall consumption.[44]

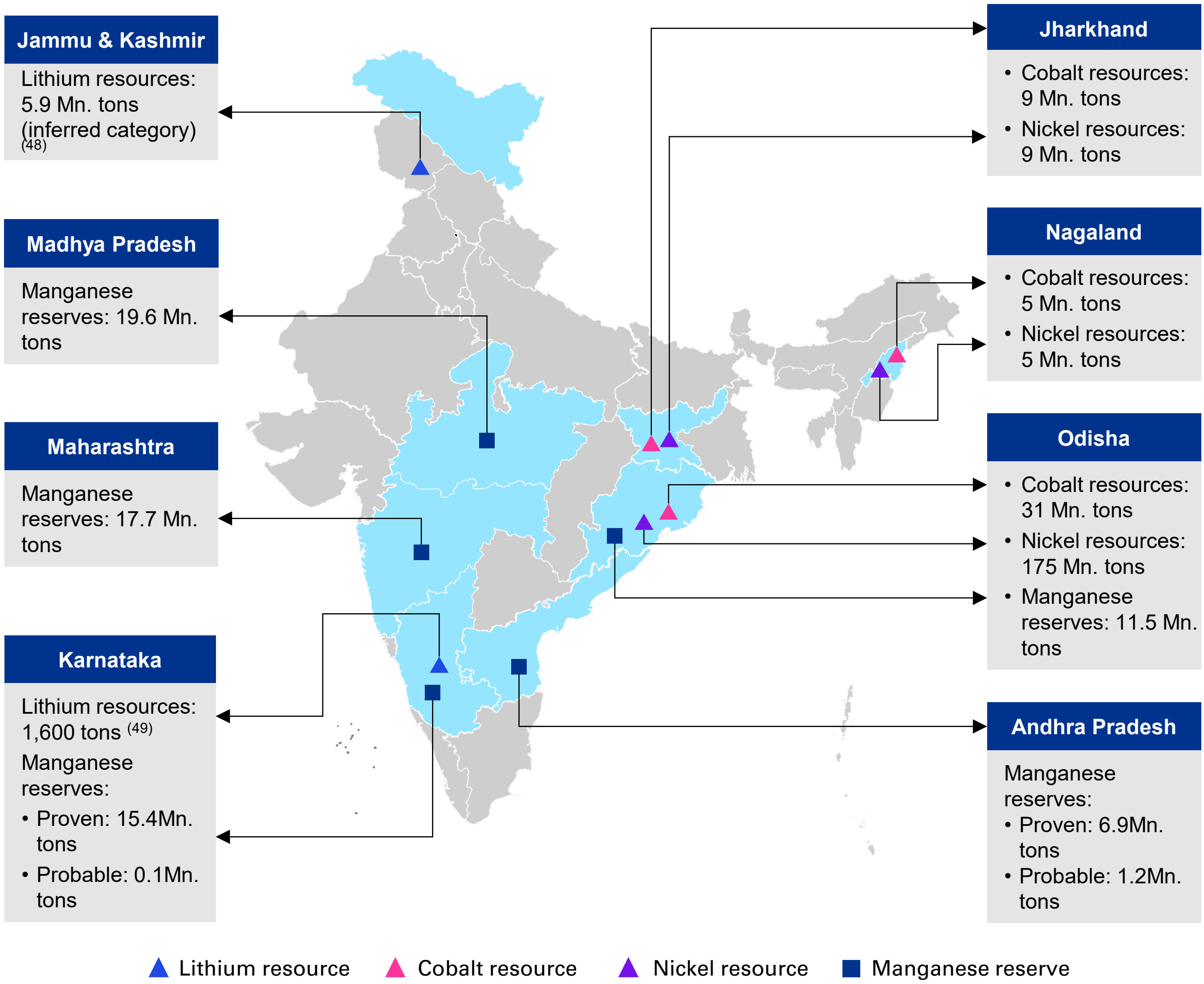
Source: (43) How Japan solved its rare earth minerals dependency issue - World Economic Forum news article dated 13 October 2023. (44) A lesson for the West ?- Japan was better prepared than most for China's rare-earth mineral squeeze - CNBC news article dated 20 June 2025.

5 India's readiness for the EV RM challenge

Although India possesses mineral bearing resources for Lithium, Cobalt and Nickel, none have yet been confirmed as proven reserves which can be mined in economically feasible and sustainable manner. Even for manganese, where India has significant reserves,[45] it does not yet produce battery-grade manganese (High Purity Manganese Sulfate Monohydrate - HPMSM) at scale and continues to rely on imports.

Similarly, for rare earth elements, India holds third largest reserves globally after China and Brazil.[46] But production accounts for less than 1 per cent of global output,[46] and processing capacity is minimal. Most rare earth oxides and magnets are imported, primarily from China.

Figure 12: Statewise distribution of India's reserves for key battery minerals[47]



***Note:** Unless specifically mentioned, all details have been considered from Indian Minerals Yearbook 2023 published in January 2025.*

Source: (45) Manganese Reserves by Country (2025) - World Population Review website. (46) India Plans To Counter China's Global Grip On REE Exports - Details Here - Times Now news article dated 13 June 2025. (47) Indian Minerals Yearbook 2023 - Indian Bureau of Mines publication dated January 2025. (48) Lithium discovery in Jammu and Kashmir - Ministry of Mines press release dated 31 July 2023. (49) Discovery of Lithium Resources in Mandya and Yadgiri districts Karnataka by Atomic Minerals Directorate for Exploration and Research - Department of Atomic Energy press release dated 25 July 2024.

Several initiatives are being undertaken by public and private mining companies to explore primary and secondary raw material sources. However, building a mine-to-battery pack or mine-to-magnet supply chain is a lengthy process with average lead times of 10-15 years

Table 7: Current status of key metals and future outlook

Lithium (Li)	Cobalt (Co)	Nickel (Ni)	Manganese (Mn)	Rare earth elements
Reserves of natural resources				
~5.9 Mn tons Mineral bearing resources in inferred category recently discovered in Reasi district of J&K.[48]	~45Mn tons Estimated mineral bearing resources. [47]	~189Mn tons Estimated mineral bearing resources. [47]	Reserves: ~75Mn tons.[47]	Probable reserves: c.6.9 to 8.5 Mn tons.[49]
Production				
• No mining and refining capacity	• No mining capacity • Refining capacity: ~2,060 tons.[47]	• No mining capacity • Production capacity: ~7,000 tons.[47]	• Total production: ~3.4Mn tons.[50]	• Total production: ~4,200 tons.[47]
Future outlook				
• Geological Survey of India conducting exploration in J&K, Meghalaya and Chhattisgarh [51] • Auction of J&K's resources failed due to lack of bidder interest, re-auction planned in the near future[52] • Exploration required to confirm the resource as proved reserve • Infrastructure and expertise for mining and refining lithium needed.	• Union Budget FY26 removed customs duties on cobalt powder encouraging domestic processing[53] • Ongoing R&D on 2 potential secondary sources [54] • Startups piloting low-heat, high-recovery recycling of cobalt from li-ion batteries via magnetism and solubility techniques.	• India is dependent on imports until a commercial-scale technology for recovering Ni from the overburden of chromite ore in Odisha is established [54] • Exploring nickel recovery from copper tailings and e-waste [47]	• Ministry of Mines auctioning low-grade manganese blocks with incentives for beneficiation and value addition. • Gap between demand and domestic production likely to be filled by imports from Australia and South Africa in the medium term	• Export ban on rare earth elements imposed in Jun 2025 [55] • Atomic Minerals Directorate for Exploration and Research (AMD) carrying out exploration projects for monazite and xenotime[56] • Partnership potential being explored by Indian companies to setup permanent magnet facility

Source: (48) GSI confirms an inferred resource (G3) of 5.9 million tonne Lithium ore in Reasi District, J&K - Ministry of Mines press release dated 26 July 2023. (47) Indian Minerals Yearbook 2023 - Indian Bureau of Mines publication dated January 2025. (49) India's growth hinges on rare earths, but China holds the key - Deccan Herald news article dated 14 October 2025. (50) Contribution of MOIL - Ministry of Steel press release dated 18 March 2025. (51) One-third of annual exploration projects are for critical, strategic minerals: GSI - Economic Times news article dated 7 May 2023. (52) J&K's 5.9 mn tonne lithium reserve to be re-explored after failed auction - Business Standard news article dated 17 October 2024. (53) Union Budget 2025-26 proposes to remove seven customs tariff rates for industrial goods - Ministry of Finance press release dated 1 February 2025. (54) Mine to market: critical minerals supply chain for domestic value addition in lithium-ion battery manufacturing - NITI Aayog report dated June 2023.
(55) Exclusive: India moves to conserve its rare earths, seeks halt to Japan exports, sources say – Reuters news article dated 16 June 2023. (56) Parliament Question: National Rare Earths Policy - Department of Atomic Energy press release dated 3 April 2025.

Despite the raw material challenges, EVs represent the most practical and scalable solution for India's transition to clean mobility — outperforming hybrids and hydrogen fuel cell vehicles in terms of cost, infrastructure readiness, and emissions reduction

Table 8: Factors in favor of EVs vs alternative technologies

Parameter	Description
Strategic policy alignment and commitments	• **Net-zero goals:** India has committed to net-zero by 2070 and intermediate 2030 targets for reducing carbon intensity.[57] Given these targets, EVs are the fastest path to meet the decarbonisation goals in urban segments. • **Avoiding technology lock-in:** Hybrids still depend on petrol/diesel, locking in oil imports and emissions. Focus on EVs avoids creating a "midway" dependency.
Technology and market alignment	• **Global technology convergence:** Global auto leaders are moving towards full electrification. Most domestic and foreign OEMs have already committed large capex into EV lines for India. • **Supply chain establishment:** Investments in charging infrastructure, battery manufacturing, assembly, and R&D centres already are ongoing with strong policy push. • **Export potential:** EVs align with market export opportunities, with major auto markets phasing out ICE sales and moving towards EVs.
Cost and adoption dynamics	• **Strong momentum** - With more than 1.5 million EVs sold in FY25, EV market in India has built a strong momentum and is witnessing emergence of scale economies. • **Total cost of ownership (TCO)** – EVs already beat ICEs in certain segments and the cost advantage is likely to further improve driven by falling battery costs • **Faster adoption curve** – EV infrastructure can scale faster for urban commute compared to hydrogen refuelling networks. With a solid ecosystem of about 30,000 public charging stations,[58] each additional rupee fuels utilisation of existing network.
Limitations of alternatives	**Hybrids** : • Offer incremental fuel efficiency improvements but deliver GHG savings compared to battery EVs, especially in India's coal-heavy power grid, where the benefit of electrification is diluted. • India's EV roadmap and incentive structures do not prioritise hybrids, making them less attractive for OEMs and consumers. Global trends also indicate hybrids as a short-term bridge rather than a long-term solution. **Hydrogen:** • Still in R&D phase for light-duty vehicles; infrastructure costs are massive and safety standards are still evolving. • Best suited for heavy-duty, long-haul, shipping, and industrial use cases, not mass passenger cars yet.

Source: (57) The Solar Surge: India's Bold Leap Toward a Net Zero Future - Ministry of Energy & Environment press release dated 19 August 2025. (58) EV Charging in India: Ecosystem Perspectives and Skilling Opportunities - The Energy and Resources Institute (TERI) report dated 3 September 2025.

India's four-pronged strategy for a future-ready EV supply chain

India's ambition to lead electric mobility market relies on securing and stabilising critical material supply chains amid global volatility and resource constraints. To achieve this, India's comprehensive strategy should combine immediate measures for supply security with medium to long-term initiatives aimed at developing domestic capabilities and advancing technological leadership.

Signing trade deals with mineral rich nations is critical in the short term, while building domestic processing and recycling capabilities and fostering R&D in alternative technologies needs to be prioritised for building a sustainable domestic EV ecosystem

Table 9: Strategic focus areas towards development of EV supply chain [59]

Strategic Pillar	Way forward
Secure Short-Term Supply of raw materials	• Prioritise trade deals with mineral-rich countries (Australia, Argentina, Chile, Vietnam) • Fast-track customs/import approvals via G2G agreements • Monitor global materials supply market trends for early warnings • Development of Light RE (LRE) magnets as an alternative to High RE (HRE) magnets.
Build domestic supply chain	• FDI/PLI-backed investments in mineral processing and battery manufacturing to support upstream mining and downstream recycling • Develop industrial parks for establishment of battery value chain • Support development of domestic recycling/re-use ecosystem via mandates to reduce dependence on imports • Incentivise global partnerships for recycling technology.
Technology innovation and future-proofing	• "Moonshot" funding initiatives in R&D for non-Lithium technologies such as sodium-ion, solid-state batteries and non-magnetic motors WRSM, SynRM, SRM and Axial Flux • Promote industry-academia consortia for prototyping innovations • Benchmark against global innovation models to adopt best global practices.
Systemic policy and collaboration enablers	• Launch of PLI and state incentives in an efficient and time-effective manner • Stable, investor friendly public-private R&D policies • Industry consortia driven collaboration and bulk procurement to secure favorable terms from global suppliers while ensuring ESG compliance and cost efficiency • Establishment of skill alliances between industry and academic / research institutes to accelerate innovation.

Production Linked Incentive (PLI) schemes are already driving significant investments towards domestic manufacturing of advanced chemistry cells, and battery components, reducing import dependence while fostering employment, technology development, and export competitiveness.

At the same time, the development of battery recycling infrastructure, guided by Battery Waste Management Rules 2022 and supported by pilot projects for recovering lithium, cobalt, and rare earth elements, is strengthening the circular economy approach. Investor interest in battery recycling is growing, with several players planning new capacities and expanding existing ones. Domestic OEMs are also investing in experimental R&D for ferrite magnets and magnet-free motor technologies such as switched reluctance motors to reduce reliance on rare earths.

Source: (59) KPMG in India analysis based on primary and secondary research.

Figure 13: Key recent government initiatives for supply chain resilience

- Formation of separate company under Ministry of Mines to identify and acquire global mineral assets essential for India's energy transition, including lithium and cobalt.
- Collaboration with Argentina to explore and develop five lithium blocks, ongoing talks with Australia's Critical Mineral Office.

Launch of National Critical Mineral Mission (NCMM) allocating INR16,300 crore (~USD1.9 billion) and expecting INR18,000 crore (~USD2 billion) in public sector investment to build domestic value chain for FY25 - FY31 period.[60]

The first tranche of e-auction conducted in November 2023 covered 20 blocks of critical and strategic minerals, including Lithium, Rare Earth Elements, Platinum Group Minerals, Nickel, and Potash.[61]

INR1,500 crore incentive scheme planned to boost domestic recycling of rare earth minerals critical for EVs and defense technologies.[62]

Battery Waste Management Rules, 2022 defined critical aspects of battery management and recycling in India and set mandatory targets for collection, recovery and recycling.[63]

India–U.S. Initiative on Critical and Emerging Technology (iCET) includes rare earth collaboration as a core pillar.

For India's long-term success, it is essential to establish a fully integrated EV supply chain that spans mining, refining, manufacturing, and recycling. This should be supported by mineral parks that co-locate these activities to minimise logistics costs and improve operational efficiency.

Scaling domestic refining and chemical processing capabilities for nickel, lithium, manganese and rare earths will reduce import dependency and create significant domestic value addition. Complementing these efforts, advanced R&D in battery chemistries, beneficiation processes, and motor technologies—driven by academia-industry-government partnerships and supported by skill development programs—will be critical in sustaining innovation and competitiveness in India's EV ecosystem.

Source: (60) Cabinet Approves 'National Critical Mineral Mission' to build a resilient Value Chain for critical mineral resources vital to Green Technologies, with an outlay of Rs.34,300 crore over seven years - Ministry of Mines press release dated 29 January 2025. (61) Mines Ministry Launches First Ever Auction of Critical and Strategic Minerals - Ministry of Mines press release dated 29 November 2023. (62) Cabinet approves Rs.1,500 crore Incentive Scheme to promote Critical Mineral Recycling in the country - PIB press release dated 3 September 2025. (63) Government notifies Battery Waste Management Rules, 2022 - Ministry of Environment, Forest and Climate Change press release dated 25 August 2022.

Conclusion

EVs represent a transformational shift in mobility — but securing their future will require equal focus on raw materials as on technology and policy. As the global supply chain becomes more contested, India must act decisively to reduce dependencies, secure access, and build circular systems. A resilient, localised, and sustainable raw material strategy is no longer optional — it is imperative for meeting India's energy transition goals.

Acknowledgements

We are sincerely grateful to the following people from the ecosystem who have helped in the preparation of this report.

M&A Consulting:

Shruti Chadha

Akshat Khare

Alekhya Ganti

Compliance and Design:

Nisha Fernandes

Pooja Patel

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