PHD CHAMBER
OF COMMERCE AND INDUSTRY
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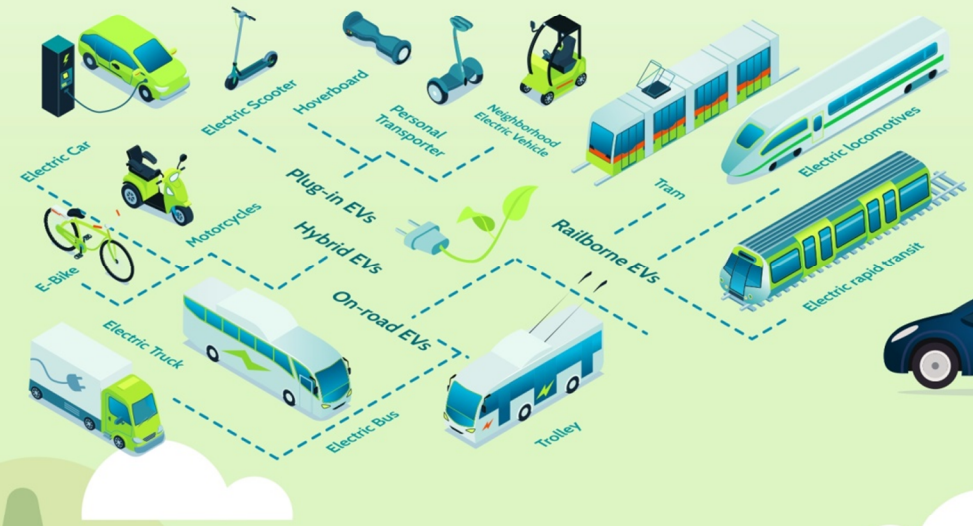
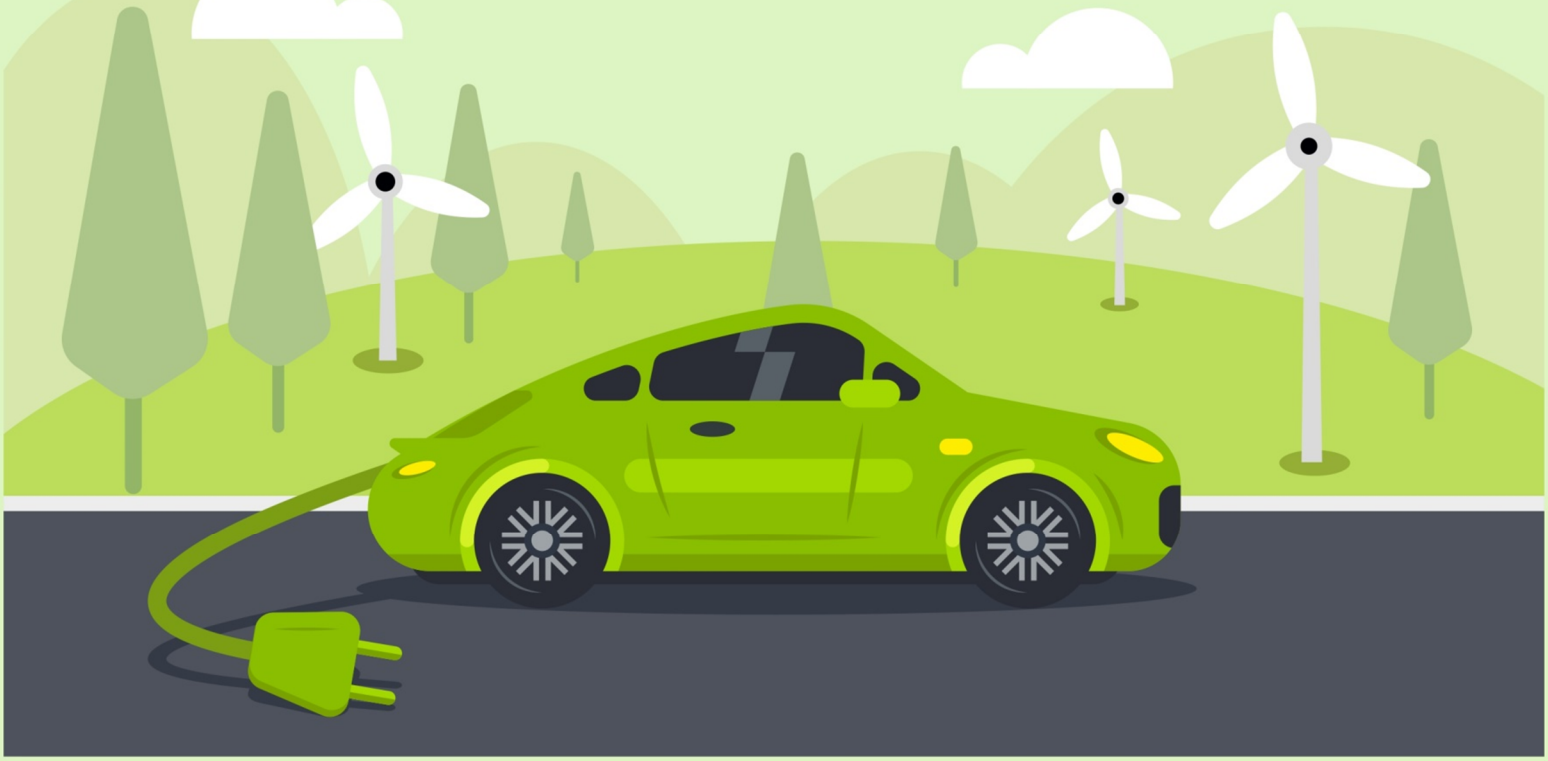
KNOWLEDGE REPORT

ELECTRIC MOBILITY ECOSYSTEM IN INDIA :

Roadmap for the future





Contents

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MESSAGE FROM PRESIDENT, PHDCCI

Sanjeev Agrawal
President, PHDCCI

It gives me immense pleasure to inform you that **PHD Chamber of Commerce and Industry** is organizing an **India Electric Vehicle Conclave- Roadmap for the Future on 12th & 13th February 2024** and that a Knowledge Report is being released on the occasion in collaboration with our **Knowledge Partner – NRI Consulting & Solutions India.**

As the world seeks to address the challenges posed by **climate change and environmental degradation**, the global transportation sector has been rapidly undergoing a significant shift towards electric mobility. The notable evolution in EV technology in the last decade has accelerated this shift, and so has government policy. India, like many other nations, is faced with the urgent need to address the challenges of climate change and reduce our dependence on fossil fuels. **Electric vehicles present a remarkable solution, offering not only a cleaner and greener mode of transportation but also the potential to revolutionize our energy security. By adopting electric vehicles on a large scale, we can significantly reduce carbon emissions, improve air quality, and create a more sustainable future for generations to come.**

Let us work together to address **challenges, leverage innovations, and create an ecosystem** that fosters sustainable and inclusive growth. Together, let us lay the foundation for a **cleaner, greener, and more prosperous India through the electrification of our mobility sector.**

Let us move forward with determination, unity, and a shared vision as we embark on this transformative journey towards a future powered by electric vehicles.

I wish the Conclave will be a successful one and will be able to bring experts from EV & Automobile Companies, Charging & Battery manufacturing companies, Startups, Automotive & EV Sector Service providers, Design & Development Solutions to decarbonize the Indian Transportation Sector.

Jai Hind!!

(Sanjeev Agrawal)

"Voice of Industry & Trade"

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MESSAGE FROM CHAIR- RENEWABLE ENERGY COMMITTEE

Devansh Jain
Chair- Renewable Energy Committee, PHDCCI

I am happy to note that the **Renewable Energy Committee of PHDCCI** is organising an **India Electric Vehicle Conclave - Roadmap for the Future** on **12th & 13th February 2024** and a Knowledge Report is being released on this occasion. The Conclave will deliberate on issues like- **Electric Vehicle Charging, Battery Manufacturing & Global Supply Chain Issues and Financing the EV Industry.**

The world is rapidly evolving, and we must adapt to meet the challenges of **climate change, rising pollution levels, and the need for sustainable transportation solutions.** Electric Vehicles offer us a unique opportunity to revolutionize our mobility sector, reduce our carbon footprint, and create a greener, cleaner future for our citizens. **India's transition to electric mobility is not just a vision; it is a reality that we must embrace wholeheartedly.**

A comprehensive policy framework is essential to provide a clear roadmap for the e-mobility transition. This includes regulations for **vehicle standards, charging infrastructure, and renewable energy integration.** The government's role in facilitating such policies, along with industry collaboration, will be crucial in creating an enabling environment for electric vehicles to thrive.

The roadmap to India's e- mobility journey is challenging, but it is also filled with immense opportunities. By working together, we can accelerate the transition towards electric vehicles and drive sustainable development. Let us embrace this revolution, where innovation and sustainability converge, and create a future where clean and efficient transportation is a reality for all.

Thank you and I look forward to the valuable insights and recommendations that will emerge from this Conclave.

Jai Hind!!

(Devansh Jain)

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MESSAGE FROM CO-CHAIR- RENEWABLE ENERGY COMMITTEE

Pawan Kumar Tibrawalla
Co-Chair- Renewable Energy Committee, PHDCCI

I am happy to inform you that the **Renewable Energy Committee of PHDCCI** is organizing an **India Electric Vehicle Conclave - Roadmap for the Future on 12th & 13th February 2024** and a **Knowledge Report** is being released on this occasion.

The growth of the electric vehicle market continues to play a pivotal role in the decarbonisation of the transport sector and in achieving the government's plan to get to nearly 1 million electric vehicles by 2030. The global demand for electric vehicles presents significant **opportunities for EV startups to develop innovative and sustainable electric vehicle technologies.**

Consumer awareness and education are pivotal in driving the adoption of electric vehicles. We must engage in extensive campaigns to highlight the **benefits of e-mobility, dispel any myths or misconceptions, and showcase the diverse range of electric vehicle models available. Incentives and subsidies** can also be instrumental in making electric vehicles more affordable and accessible to a wider population.

A **comprehensive policy framework** is essential to provide a **clear roadmap for the e-mobility transition**. This includes regulations for **vehicle standards, charging infrastructure, and renewable energy integration**. The government's role in facilitating such policies, along with industry collaboration, will be crucial in creating an enabling environment for electric vehicles to thrive.

India EV Conclave will be a monumental event that signifies our collective commitment to shaping the future of mobility in our great nation.

The roadmap to India's e-mobility journey is challenging, but it is also filled with immense opportunities. By working together, we can accelerate the transition towards electric vehicles and drive sustainable development. ***Let us embrace this revolution, where innovation and sustainability converge, and create a future where clean and efficient transportation is a reality for all.***

Thank you and I wish you all an enlightening and productive conclave.

Jai Hind!!

(Pawan Kumar Tibrawalla)

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MESSAGE FROM EXECUTIVE DIRECTOR, PHDCCI

Dr. Ranjeet Mehta
Executive Director, PHDCCI

I am glad to note that **PHDCCI which acts as the "Voice of Industry & Trade"** is organizing an **India Electric Vehicle Conclave- Roadmap for the Future on 12th &13th February 2024** and a **Knowledge Report** is being released on this occasion.

The India EV Conclave will serve as a crucible for forging a united vision—a vision that aligns with our national goals of sustainability, energy security, and economic growth. As we navigate the challenges and opportunities in this dynamic landscape, it is evident that the convergence of technology, policy, and industry collaboration is essential for the successful integration of electric vehicles into our daily lives and sustainable growth of the EV sector.

This roadmap is not just a guide but a **commitment to shaping a future where electric vehicles play a central role in our transportation landscape.** PHD Chamber remains at the forefront of promoting sustainability & innovative technologies, processes & advocates for the related Government policies to help achieve better living & working environment for all the stakeholders. We are committed to championing the idea of "clean kilometers" especially through electric, solar, biofules & other innovative technologies.

PHDCCI's Renewable Energy Committee and Centre for Sustainability are geared up for assisting Indian businesses in reducing their carbon footprint and creating greener India. As we embark on this electrifying journey, ***let us continue to work together towards a greener and more sustainable future.***

I would like to thank our **Knowledge Partner –NRI Consulting & Solutions India Pvt. Ltd for supporting the Conclave.**

I am confident that the Conclave will be a successful initiative of PHDCCI and will become an annual feature

Jai Hind!!

(Dr Ranjeet Mehta)

Foreword

Vineet Jain
Partner & Group Head,
Automotive Industry
Consulting Group
NRI Consulting &
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The electric vehicle (EV) sector, along with alternative powertrains, represents a significant opportunity for India to address its growing emissions and reduce its dependency on imported oil and energy. In recent years, there has been notable progress in policy development from both the central and state governments, with initiatives such as the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME), Phased Manufacturing Programme (PMP), Production Linked Incentive (PLI) scheme, and various State EV policies. This policy support has catalyzed enthusiasm within the industry, with established automakers and new startups alike introducing innovative products and business models. The shift towards EVs is also gaining traction among shared mobility providers, investment circles, and asset financiers, all recognizing the sector's investment potential and its alignment with sustainable finance goals. This collective effort from the government, industry, and academia signals a strong commitment to advancing the EV landscape in India.

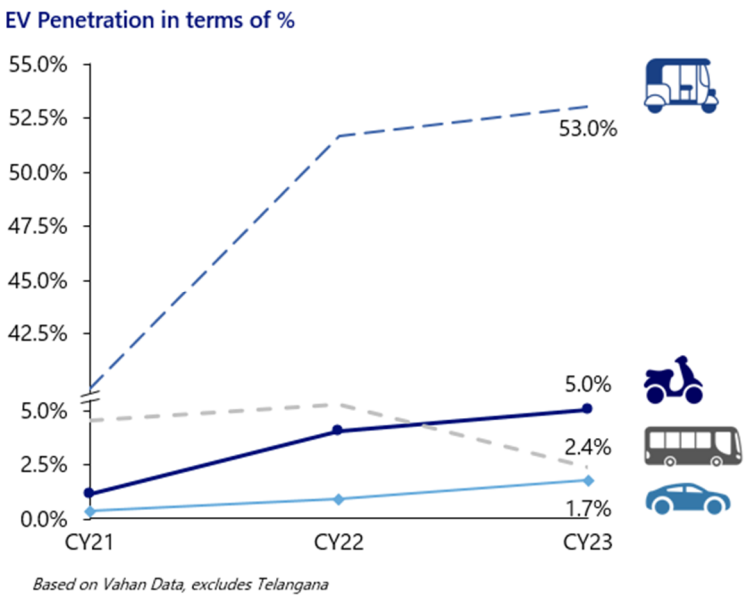
The EV supply chain in India is gradually evolving, transitioning from heavy reliance on imports to increasing efforts towards localizing the production of key components. Despite its nascent stage, there is a concerted push from both the public and private sectors to establish a more robust and self-sufficient EV ecosystem, addressing critical challenges such as raw material procurement and component manufacturing to support the growing electric mobility market.

Potential EV consumers, both individual and business clients, express apprehension about vehicle range, the availability of charging infrastructure, financing options, and vehicle performance. Additionally, in a market sensitive to cost, achieving a balance between value and price through innovative business models is essential. India is actively expanding its EV charging infrastructure, with both government and private initiatives aiming to increase accessibility and reduce range anxiety for EV users. Concurrently, the development of EV financing is witnessing innovation, with financial institutions exploring sustainable finance initiatives and tailored loan products to cater to the burgeoning demand for electric vehicles, thereby overcoming one of the significant barriers to EV adoption.

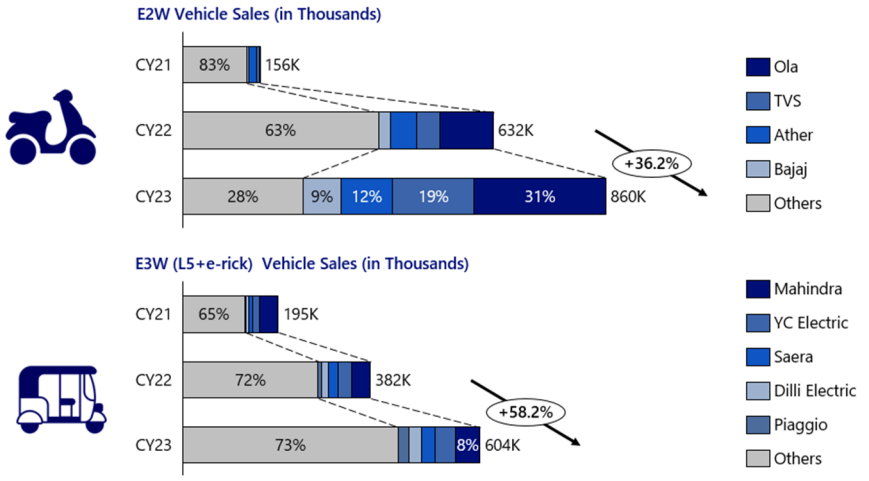
This report outlines the current state, emerging trends, and prospects of electric mobility in India, while also highlighting unique challenges to sustainability. It includes insights for policy development and implementation, reflecting the insights and concerns of the industry.

1. Current EV Landscape

Electric mobility in India is no longer a fringe issue and become central to the automotive industry

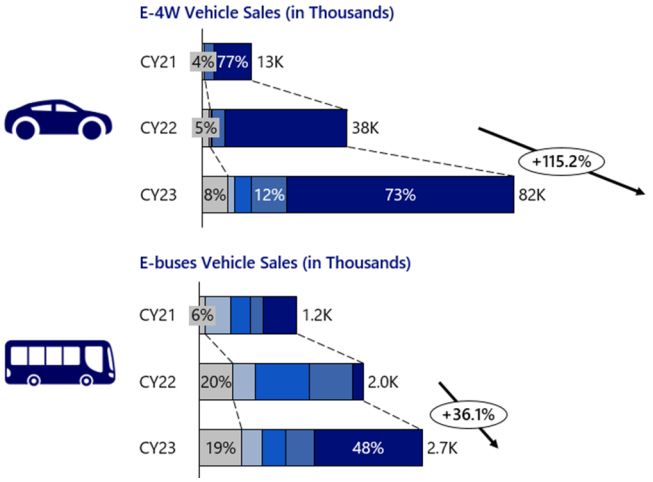


With a push from the government to improve energy security, reduce import dependency, and meet carbon emission norms, electric mobility has been a key focus area. Today, across all vehicle segments ranging from light forms like 2-wheelers, and 3-wheelers to passenger cars to trailers & tippers, there are offerings in the market by different OEMs with penetration accelerating towards the *"EV tipping point"* where EV sales start to cross a threshold to self-sustain rather than being driven by government incentives alone. Amongst 2-wheelers in calendar year (CY) 2023, penetration crossed 5% level



with sales reaching 0.86 million units (excluding Telangana sales) at a YoY increase of 36.2%. Even though sales are largely being driven by mopeds and are yet to witness EV motorbikes, 2-wheelers as an overall segment is on the cusp of reaching a tipping point. Coupled with increased penetration is the rising consolidation of 2-wheeler markets with the largest 4 players: Ola, TVS, Ather, and Bajaj occupying more than 70% of the market share in 2023 with Ola alone capturing 31% of the market. In 2022, the top 4 players occupied which included Hero Electric and Okinawa occupied 66% leaving 1/3rd of the market to other players. With issues around meeting targets, the market landscape has observed drastic changes with Ola and legacy OEMs like TVS and Bajaj gaining market share in a single year.

3-wheelers continue to be a fragmented and rapidly growing market driven by e-rickshaw growth. However, 2023 also observed rapid growth of L5 autos with both Piaggio and Mahindra Last Mile Mobility rapidly increasing their sales, leading to Mahindra becoming the leading e-3W player with both r-rickshaw & L5 autos 3-wheelers in its product portfolio.



Amongst 4-wheeler passenger vehicles, Tata Motors continues to be the dominant player with greater than 70% market share. E-4 wheeler segment has witnessed an exponential rise with a 115% Y-o-Y increase in 2023 reaching greater than 82K vehicles in India as per the Vahan database which excludes key EV states like Telangana which pegs EV sales at even higher numbers. Other 4-wheeler players like Mahindra, and BYD are strongly catching up in India and have taken a toll on Tata's market share which was greater than 80% in 2022.

Electric buses are a segment that even though observed growth in absolute numbers, decreased in terms of EV penetration. Tata Motors gained market share because of the delivery of buses under tenders in 2023, meanwhile, players like PMI, and Olectra with strong Chinese ties for technology had a dominant share in 2022. Electric buses are largely being ordered for State Transport Units (STUs) which depending on state form 2-16% of total buses, thus even with complete electrification of the state fleet, electrification will not rise in buses without the participation of private bus fleets. Delays in delivery of buses under CESL tenders for various states and surging diesel bus consumption at 67% Y-o-Y growth amongst private players are driving the penetration of e-buses down. The lack of adoption of e-buses amongst private players calls for policy impetus curbing diesel bus operation and better demand-side incentives for bulk-transport mediums like buses which would be crucial for overall sustainability and urban transportation.

1.1 Vehicle Purchase Support Policies:

Globally the purchase of EV Vehicles is focussed around i) Purchase Incentives/Vehicle Credits for Electric Vehicles and ii) Tighter emission norms coupled with EV sales targets/ban on ICE vehicles forcing the phasing out of ICE, especially diesel.

In advanced markets where EV penetration is in double digits in LDVs, Purchase incentives are being strategically phased out.

Apart from incentives for BEVs, there is a need to broaden the horizon as far as the electrification technologies for which incentives are being provided are concerned. BEVs are only one part of the electrification family, which also includes SHEVs (strong hybrid electric vehicles) and PHEVs (plug-in hybrid electric vehicles. In the Indian context especially, SHEVs can play a key role in the transition towards mobility electrification.

SHEVs provide multiple advantages. They have higher fuel efficiencies (up to 45%) and much lower emissions as compared to their ICE counterparts. Another key aspect is that SHEVs are self-charging vehicles (no range anxiety) and hence provide economies of scale for manufacturing EV components such as batteries, motors & power electronics, thus catalyzing BEV adoption as well.

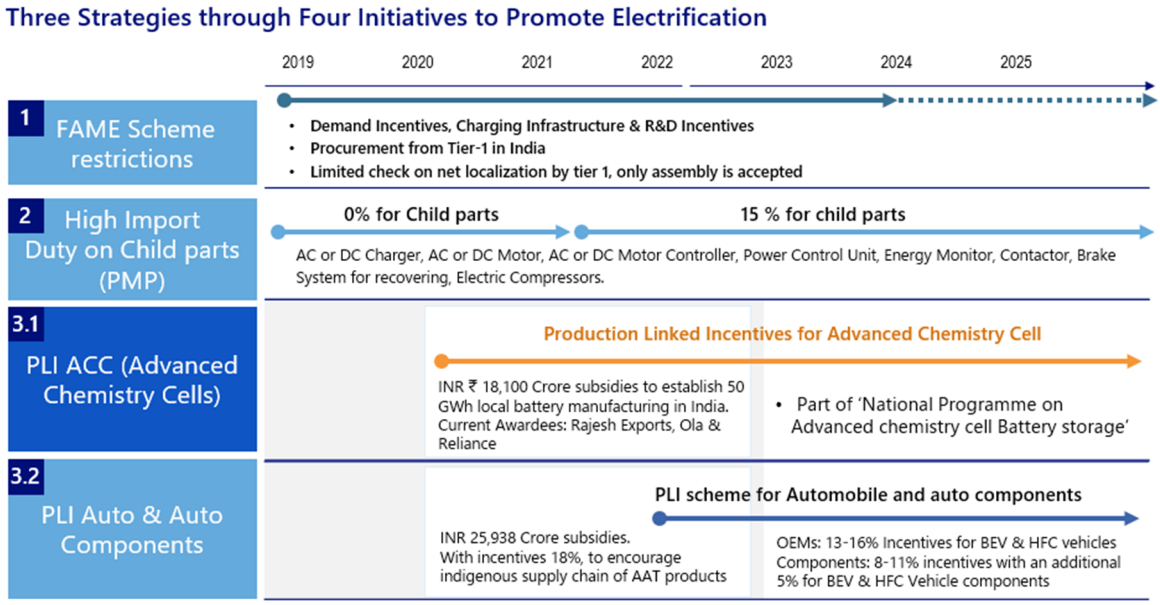
It is because of these reasons that in multiple countries across the world, SHEVs are taxed lower and provided incentives to ensure their attractiveness as compared to equivalent ICE vehicles. In contrast, India charges a higher absolute tax on SHEV than the ICE version.

S.No.	Country	Benefit for SHEVs over ICE (Federal Taxation + Federal Incentives) (in INR Lakhs)*	Lower absolute taxation for SHEVs
1	Netherlands	3.0	✓
2	Norway	1.4	✓
3	Germany	0.6	✓
4	Sweden	1.3	✓
5	France	3.1	✓
6	Ireland	1.7	✓
7	Thailand	2.4	✓
8	Indonesia	1.7	✓
9	Japan	2.8	✓
10	Brazil	7.5	✓
11	India	-1.2	×

** For easy reference figures are converted to a common base in INR*

To ensure the faster development of the electrification ecosystem in India, the rationalization of tax anomaly on SHEVs is critical, which will also help catalyze the vision of Electric mobility in the country.

1.2 EV Policy Status in India

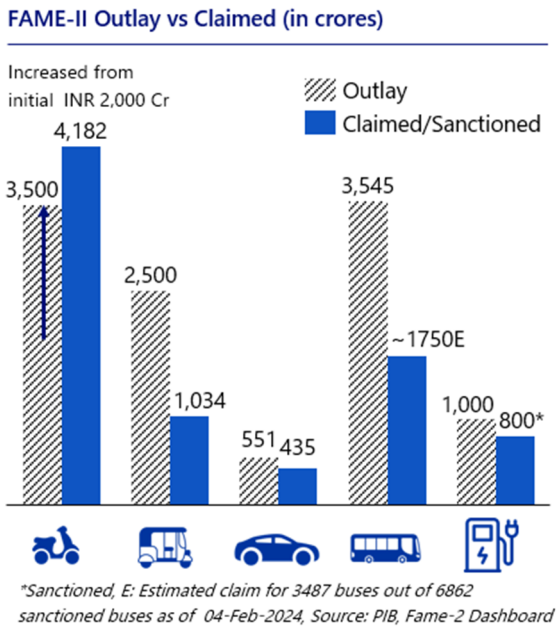


The government of India has devised a multi-faceted policy targeting green mobility including electric mobility, development, and mixing of bio-fuels and hydrogen into long-haul transportation. At the central level, there is a set of fiscal and non-fiscal incentives supporting EVs and a 3 pillar strategy to promote the entire EV ecosystem. These include – Faster Adoption & Manufacturing of Hybrid& Electric (FAME Phase - II) as a demand-side incentive, Import Restrictions and localization targets under the Phased Manufacturing Program (PMP) a supply-side policy curbing import dependency, and third, supply-side fiscal Incentives production linked incentives to support local manufacturers to develop the capacity to make and scale the EV components and battery production. PLI for Advanced Automobile and Auto Component Industry (Advanced Automotive Technology – AAT) is for boosting EV component manufacturers and OEMs based on sales of BEVs and Hybrids. At the same time, PLI for Advanced Chemistry Cells (ACC) aims to facilitate the development of giga-factories for a battery manufacturing capacity of 50 GWh.

While demand-side incentives have received significant allocation and utilization over the last 2-3 years, supply-side incentives and restrictions are slowly catching up in showing effects. Additionally, policies like Battery Waste Management Rules 2022 and amendments to the Mines and Minerals Act in 2023 are key policies that are targeting the recycling and upstream processing of critical minerals like lithium which are key for EV batteries. Apart from the centre, 27 of 36 states and union territories have notified EV policy which includes both supply and demand side incentives

1.2.1 FAME-II: Effects and Needs

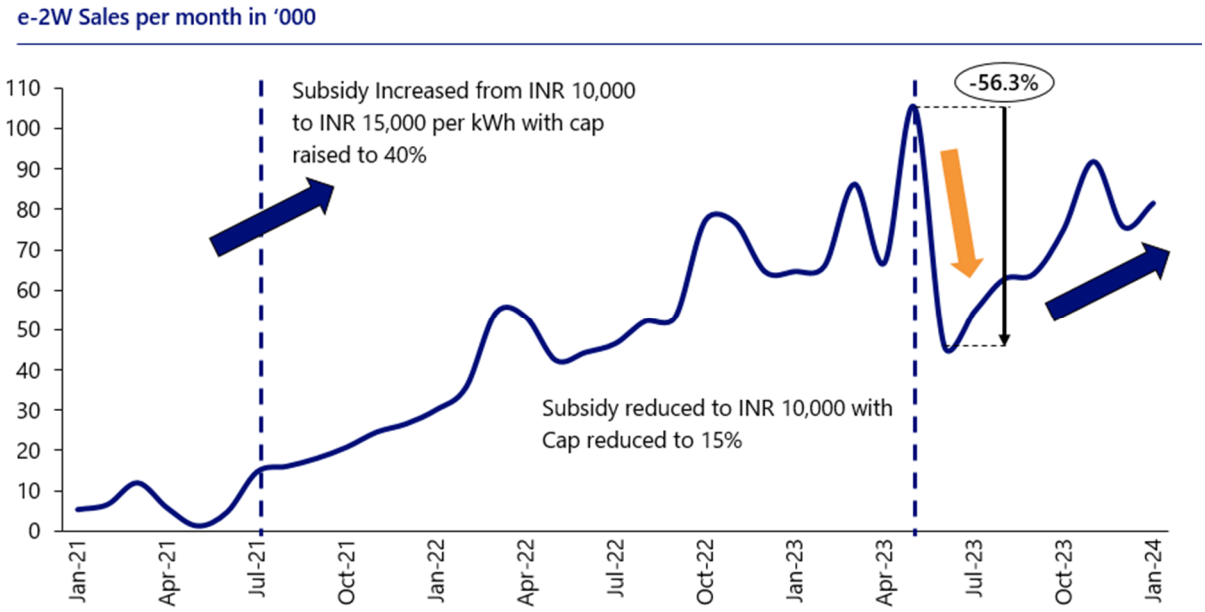
The FAME scheme in India was devised in 2015 with the first phase of the scheme catering to 0.278 million electric vehicles via demand incentives. Phase II of the scheme was initiated in 2019



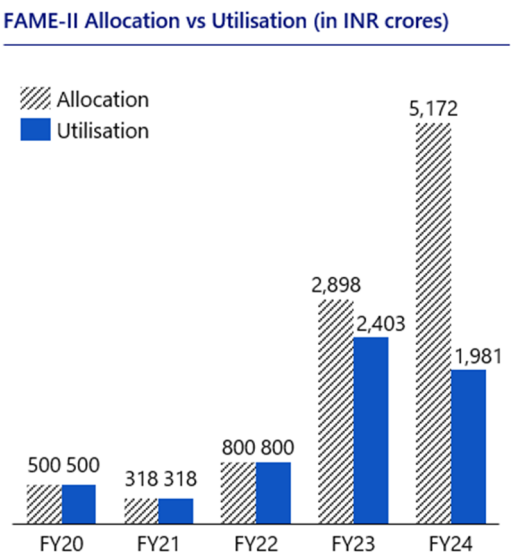
and was subsequently expected till the end of the financial year 2024. Under FAME-II a total of INR 10,000 Crore was outlawed for demand-side incentives on vehicles and the development of charging infrastructure. Subsequently, the total outlay budget was revised to INR 11,500 Crore to meet the increased demand in the 2-wheeler segment.

The 2-wheeler EV industry has been one of the biggest beneficiaries of FAME schemes with an initial outlay of INR 2,000 Cr being increased to INR 3,500 Cr and claims exceeding INR 4,180+ Cr by the end of Jan 2024. Claims for e-3W had been lagging without sufficient L5 models and are quickly catching up with major 3-wheeler OEMs expanding their electric 3-wheeler L5 category portfolio.

The effect of the importance of FAME in driving 2-wheelers can also be clearly understood from the sales rise and decrease followed by effective increase and decrease in incentive per kWh and cap on prices for 2-wheelers. With the subsidy amount increase in mid-2021 to INR15,000/kWh, sales of e-2W shot up for 2 years straight and observed the biggest drop of ~56% in July-23 when the subsidy was slashed back to INR 10,000 per kWh with a reduced cap.



However, despite a strong initial drop, the sales of 2-wheelers have slowly recovered and continue to rise indicating a stronger demand response. Yet a complete removal of subsidy for the 2-wheeler under future FAME phases may deter growth and a more phased–out smaller incentive per vehicle for 2-wheeler would be crucial for sustained transition in the 2-wheeler segment. Other vehicle categories like light commercial vehicles, medium-duty trucks, and tractors are segments that need to be introduced under the regime in the future. These segments are conventionally diesel guzzlers and OEMs are now able to successfully come up with EV products in their portfolio for consumers to select. With the slashing of budget allocated to FAME to INR 2671 Cr in FY24-25, it would be crucial to have a balanced outlay for different vehicle segments for sustaining growth beyond low-hanging targets like e-2W and drive penetration in the next set of vehicle segments like LCVs



Despite the claimed/sanctioned amount between eight to nine thousand crores, actual disbursal stands at around six thousand crores with the largest unutilized chunk remaining out of INR 5172 Cr allocated for FY23-24. Multiple factors may have led to this gap in disbursal with few select OEMs finding loopholes around meeting localization and billing targets and subsequent increased scrutiny and delay from the government end. An enhanced mechanism for more timely disbursal of claims would be crucial for the likely next phase of the scheme.

1.2.2 Performance Linked Incentive (PLI) Scheme: ACC and AAT

Performance-linked incentives for the automotive industry have been centered around the i) ACC: Advanced Cell Chemistry with INR 18,100 crore outlay over five years (2023-2028) to establish 50 GWh local battery production, encouraging domestic manufacturing of ACC batteries and components for the EV industry and ii) AAT: advanced automotive technology (AAT) targeting localized manufacturing of auto and auto components. With an INR 25,938 crore outlay over 2022-2027, eligible OEM Champions under PLI AAT receive incentives ranging from 13-16% of determined sales value for BEV & FCEV vehicles. For Component Champion, 8-11% of determined sales along with an additional 5% for BEV & FCEV vehicle components.

Under PLI ACC, in the initial round of allotment Rajesh Exports, Ola Electric, and Reliance New Energy emerged as winners with a combined capacity of 30 GWh. Govt has now announced a bid for a 10 GWh tranche expecting previous bidders who were not allocated to come forward.

In the interim budget for 2024, the allocation for PLI ATT has been increased to INR 3,500 Cr, and PLI ACC has been increased to INR 250 Cr indicating a strong commitment from the government end to boost the supply side ecosystem of electric mobility.

1.2.3 Mines and Minerals Act, 2023

Another important piece of legislation affecting the EV ecosystem and supply chain is the Mines and Minerals amendments in 2023. With the amendment of the Mines and Minerals Act, lithium was removed from atomic minerals, and a composite license (single license for exploration and earning revenue) is being put for auction for lithium blocks in J&K. With PLI ACC government targeted the downstream cell & battery manufacturing process and amendments to minerals act targets opening up avenues in upstream mining and processing for material for cell manufacturing.

2. EV Supply Chain in India

Indian EV industry has boomed post-pandemic with e-2W and e-3W sales skyrocketing. Passenger cars and EV buses have also observed significant growth in numbers. On the policy front, the demand-side incentives are strongly coupled with supply-side incentives and import restrictions on components from China and completely built vehicle units which favors localization. The impetus behind this localization encompasses multiple objectives ranging from eliminating fragility from the supply chain, and indigenization of the growing sector to fuel national growth and reduce costs. From a consumer demand side, there is an increasing call for a wider product range at competitive prices. Thirdly EVs are no longer a game of start-up. Both conventional OEMs and tier-1 auto suppliers have placed strong EV bets. This pertains to increased product portfolio and competitiveness in the market which calls for localized manufacturing as a key to survive in the market in India.

Critical EV Component	Net Localization* (%)	Approx. Value Addition in India
Battery Pack	10-20%	• Local Pack Assembly: Bus Bar, Connector, Cooling, Enclosure, Fuses, Side plate
Power and control wiring harness along with connectors	25-30%	• Wiring Harness made in India • Connector Imported & assembled
AC Charging Inlet- Type 2	40-50%	• Inlet, Connector Import • Assm. with Cable/Connector in India
DC-DC Converter	5-10%	• 100% Hardware imported • Testing, CAN Integration support
Vehicle Control Unit	4-5%	• Only Enclosures are made in India • Software dev. Testing
On Board Charger	10%	• Hardware imported • Mechanical components made locally
MCB, Circuit Breakers, Electric Safety device (Power Electronics)	40-45%	• Some Child parts made in India • System Assembly & Testing
Electric Compressor	0-10%	• System Import • Some OEMs planned Assm. Line in India
DC Charging Inlet	0-10%	• Majority part is imported from China *Currently most cars have 1 charger only
Traction Motor & Controller	15-20%	• Majority import, assembly lines being setup in India

Lower range Higher range

Note- Net Localization = Value of Raw Material/ Child Part Sourced from India + Assembly Value Addition done in India

**Indicative figures for > 25 KWh vehicle*

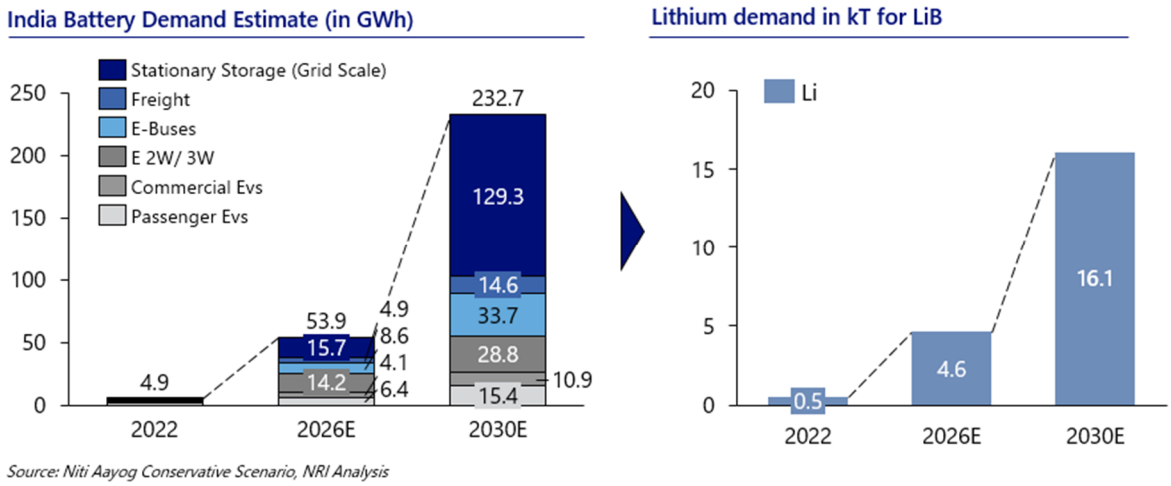
Largely it is the batteries, motors + invertors DC-DC convertors, and OBCs that encompass the costliest components in EV vehicles covering 70% of the cost of a 30kW battery size EV in the Indian market. Thus, the ecosystem around these components is central to understanding to EV supply chain in India

As of 2023, the Battery pack which remains to be the most critical component is still largely import-driven due to the import of cells and localisation limited to assembly-level operations including welding of bus bars, enclosures, etc. Traction motors coupled with invertors and transmission going by names like e-axles are also largely imported with a knock-down version of the component being imported for the large form factor of vehicles. A more detailed analysis of these components however leads to an understanding that India has reached sufficient volumes and

capacity is being lined up for attaining a much higher percentage of localisation in the next 2-3 years.

2.1 EV batteries

2.1.1 Demand for LiB Batteries & Raw Materials



EV batteries specifically Lithium-ion batteries play a pivotal role not just in the EV segment, but also address the stationary grid applications related to renewable energy. Considering India's commitment to achieving 50% of its cumulative power generation from non-fossil-based sources, building a reliable local supply chain of batteries. This commitment has propelled the growth of solar and wind energy, and battery-based energy systems hold great potential for grid management and creating renewable energy-storage solutions. This, combined with the burgeoning electric mobility sector, is a key driver of the surging demand for batteries in India. According to estimates by Niti Aayog, electric vehicles alone are poised to account for approximately 64% of the cumulative new battery demand in India between 2022 and 2030, with grid storage applications following closely behind considering that grid storage will also utilise repurposed batteries to meet the requirement.

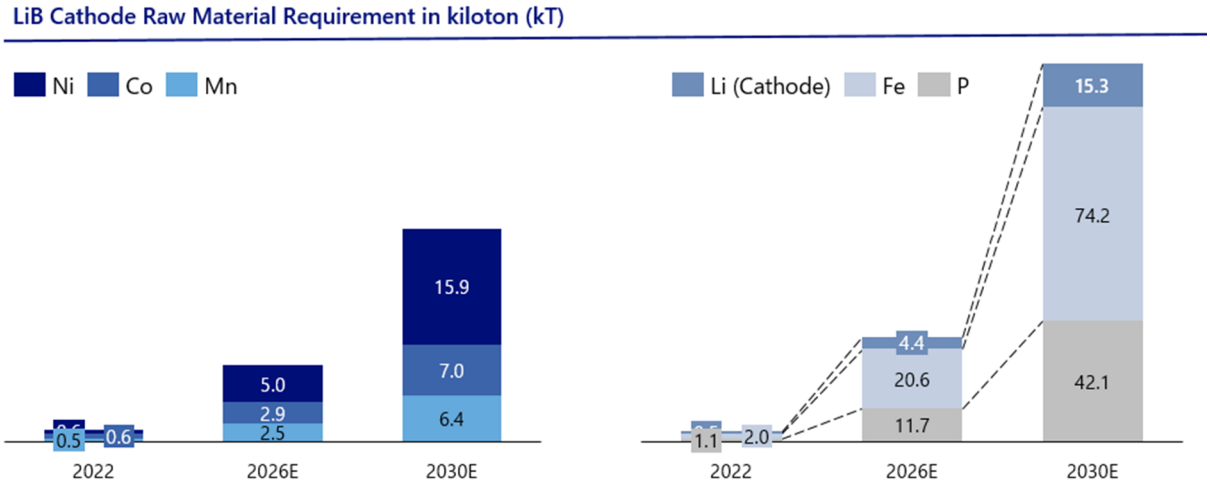
Demand for new batteries alone is expected to generate an annual demand of 16 kilotons for Lithium by 2030, an even higher quantity when lithium carbonate or lithium hydroxide is considered.

As per the IEA estimate, total global lithium demand is expected to reach ~319 kT implying that India would constitute a conservative number of 5% of global demand which presents an opportunity for both domestic and global players to have a presence in the battery manufacturing ecosystem in India.

Raw materials are the lifeblood of lithium-ion battery (LiB) localization. Securing a stable and domestic supply of essential elements such as lithium, cobalt, nickel, graphite, and other critical components is paramount to reducing dependence on imports and achieving self-sufficiency in LiB production. Developing a robust supply chain for these raw materials is not only economically strategic but also vital for the long-term sustainability and competitiveness of the electric vehicle industry in a rapidly evolving global landscape.

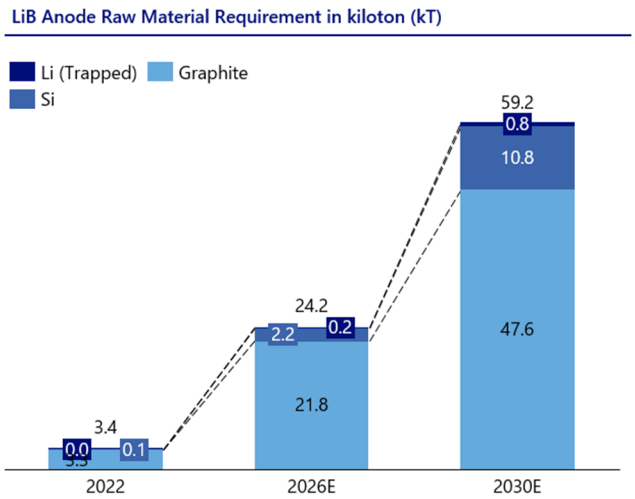
2.1.1.1 Cathode Materials Scenario

Demand for critical elements is expected to exhibit moderate growth by 2030, with LFP chemistry taking center stage and advanced NMC variants gaining traction. Nickel and cobalt demand is projected to increase, but at a slower pace, due to the shift towards advanced NMC



(811) formulations that utilize less nickel. Iron and phosphorus will emerge as pivotal raw materials, with an estimated demand of 74 kilotons and 42 kilotons, respectively. These insights underscore India's strategic trajectory in LiB battery manufacturing, with a focus on optimizing raw material usage, fostering sustainable chemistry choices, and aligning with the nation's commitment to eco-friendly mobility solutions.

2.1.1.2 Anode Materials Demand



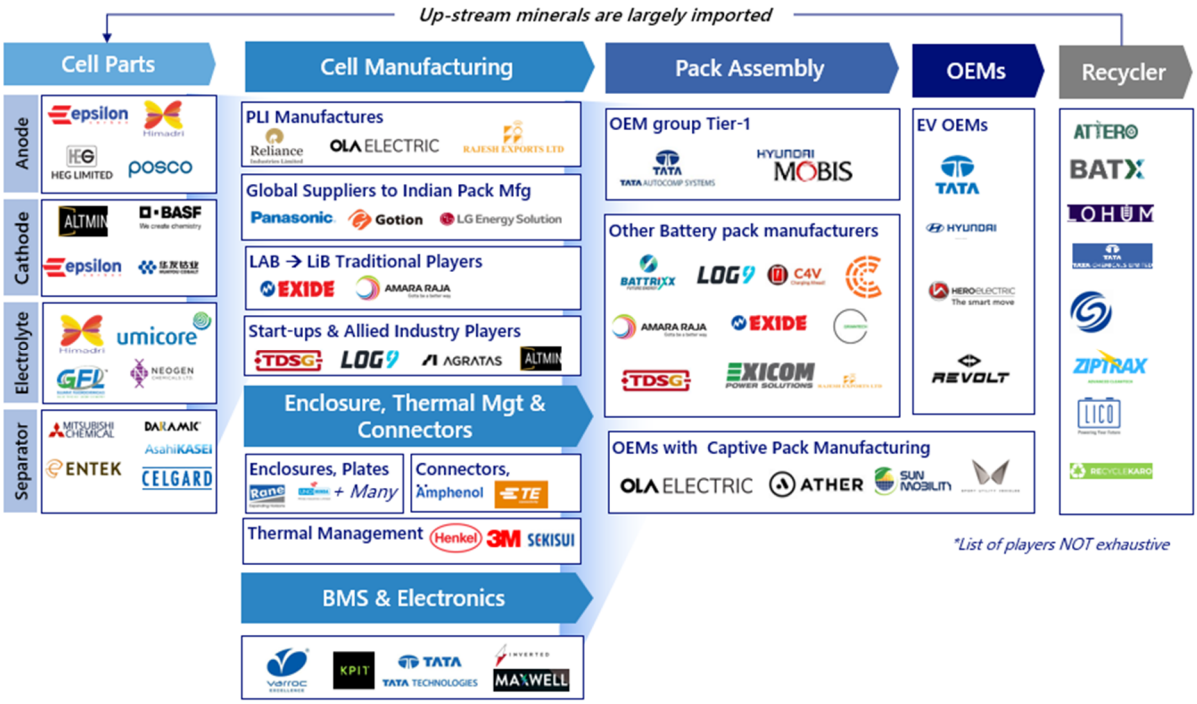
Graphite, the cornerstone of anodes for LiB cells, is expected to witness a steady rise in demand, but silicon-doped graphite is poised to be a game-changer, reducing the demand per kWh of energy produced.

Anodes in LiB cells are primarily graphite-based, but silicon-doped graphite is gaining traction, projected to increase its share from the current

30%. This transition is significant as Si-Gr anodes consume less graphite while offering improved efficiency.

As new battery technologies like solid-state batteries emerge, they are set to increase the lithium content in anodes. Conversely, sodium-based chemistries will usher in reductions in lithium content.

2.1.2 Battery Supply Chain and Key Players



India's LiB manufacturing industry is booming, with several key players investing in new facilities to support the growing electric vehicle (EV) market. Ola Electric, Reliance, and Rajesh Export have been selected under the PLI scheme to receive incentives for cell manufacturing, and are expected to start production by 2024. Traditional battery manufacturers such as Tata AutoComp Systems, Exide Industries, and Amara Raja Batteries are also expanding their LiB presence, while non-traditional players like Mahindra & Mahindra and Larsen & Toubro are entering the market. Additionally, startups and players from allied sectors serving telecom, and consumer electronics with a presence in pack manufacturing are considering investments in cell manufacturing. Among startups for example Godi Energy has announced to expand production of NMC in 2 phases with first phase capacity 2.5 GWh. Log9 another startup pioneering LTO chemistry is also enhancing production upto 1 GWh

Upcoming Li-ion Gigafactories in India

Manufacturer	Chemistry	Capacity (GWh)
Ola	NMC	20
Reliance	LFP	5 (under PLI) -20
Rajesh Exports	LiB	5
Exide	NMC, LFP, LTO	12
Amara Raja	NMC, (LFP likely)	16
Tata Group	LFP	10-20
TDSG	LTO	6
Godi India	NMC	2.5
Lucas TVS-24M	-	10
Log9	LTO	1
Nsure Power	_	1

**List is NOT exhaustive .Additional 10 GWh under PLI to be awarded soon*
Source: Public Announcements

These companies are also partnering with research institutes to develop new LiB technologies. For example, Exide Industries has signed an MoU with IIT Chennai, and Amara Raja Batteries has partnered with the Andhra Pradesh Economic Development Board.

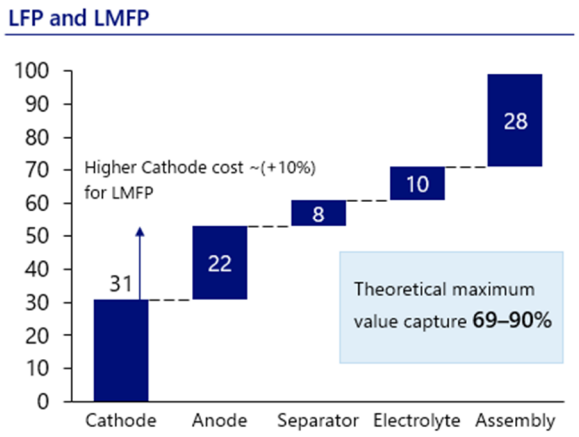
The development of domestic LiB manufacturing is expected to reduce battery costs, create jobs, and boost EV adoption in India. It will also reduce India's reliance on imported batteries and promote self-reliance in the EV sector.

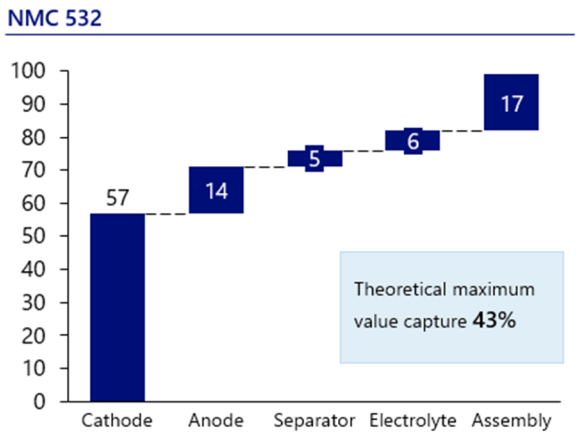
2.1.3 Cell Cost Breakdown and Localization Potential

A cost breakdown of these batteries into cell and pack components is done above. Remarkably, the pack components and pack assembly together constitute approximately 30% of the battery component's overall value.

The cell can be further disassembled into a Cathode, Anode, Separator, and Electrolytes. Among these, the Cell Cathode emerges as the primary cost contributor, commanding a significant 21% in LFP batteries and a substantial 42% in NMC batteries.

Yet, the downstream supply chain for these critical components, encompassing cathode, anode, separator, and electrolyte, finds itself in a fledgling state in India. This fragility is primarily attributed to the scarcity of raw materials, a limited number of manufacturers, and the inherent uncertainty regarding demand security.





Nevertheless, despite the formidable challenges concerning the procurement of raw materials for cathode and anode production, India remains poised to unlock a substantial portion of the battery's value chain. The potential includes harnessing more than 90% of the packing component's value, achieving between 70% to 90% of the LFP cell's value, and realizing up to 43%

of the NMC cell's value. To embark on this journey, India must prioritize the development of domestic cell manufacturing capacity.

2.1.4 Cell Components Key Activities in India

There is a critical need to localize the cell supply chain. The cell materials constitute around 40% of its cost, and India has minimal availability of cell raw materials. If India targets to achieve 60% of the value addition (as mandated by the PLI), it needs to localise the manufacturing of anode, cathode, electrolyte, and separator.

2.1.4.1 Anode

The landscape of anode manufacturing in India is evolving with a dual focus on securing global demand and preparing for future domestic needs. Anode manufacturers in India are actively seeking approval from global battery manufacturers, as this collaboration ensures a steady demand for domestically produced anode materials. Export-oriented strategies are being adopted, as it is anticipated that domestic demand from local cell manufacturing companies will take more than three years to materialize.

Indian-made anodes are poised to be competitively priced, making them attractive to battery manufacturers seeking supply chain diversification, aligning with the "China+1" approach. Key players like Epsilon Carbon, HEG, and Himadri are investing substantially to expand their production capacities, with targets ranging from 20,000 to 100,000 MT by 2030. These efforts underscore the growing significance of anode manufacturing in India's thriving electric vehicle and battery industries.

2.1.4.2 Cathode

Cathode manufacturing in India is poised for growth, with companies preparing to enter the sector as demand matures and long-term supply contracts materialize. However, several challenges need to be addressed. The lack of clarity on battery chemistry poses a significant hurdle, as cathode production is closely tied to cell chemistry, making it challenging for manufacturers to estimate demand accurately. Additionally, the absence of government incentives or schemes specifically targeting cathode manufacturing, coupled with the substantial investment required, presents a barrier to entry. Moreover, the limited technical expertise within Indian companies necessitates technology transfer agreements with overseas players to bridge the knowledge gap, while securing a stable supply of raw materials remains a pressing challenge.

In this evolving landscape, key companies are making strides. Altmin, in collaboration with ARCI, has set up a pilot plant for cathode materials in Hyderabad, Telangana. Altmin has also partnered with the Telangana government to initiate C-LFP active battery material production. Altmin has also raised investments in tune for setting up cathode active material (CAM) plant catering to 3 GWh capacity.

BASF India, with its extensive chemical manufacturing experience, is keen on expanding its presence in India, tapping into its global technical expertise in cathode active materials (CAM) manufacturing through collaborations like Umicore.

2.1.4.3 Electrolyte

Electrolyte manufacturing in India for Lithium-Ion Battery (LiB) cells is currently in its nascent stages, but it has been attracting increasing interest from both domestic and international companies. One notable aspect in favor of electrolyte production in India is the local availability of salt, a key component in electrolyte formulation. However, despite the accessibility of salt, procuring it from local sources may present challenges due to stiff competition within the domestic market.

On the flip side, the manufacturing of battery-grade solvents such as Ethylene Carbonate (EC), Ethyl Methyl Carbonate (EMC), and Dimethyl Carbonate (DMC) remains a hurdle, as these solvents are not produced locally in India and must be imported. Currently, only commercial-grade solvents are readily available within the country. Similarly, the production of additives, another crucial component of electrolytes, faces the same challenge of limited local manufacturing capabilities, necessitating their importation. As the LiB industry in India continues to evolve, addressing these challenges and establishing a robust supply chain for electrolyte production will be pivotal in supporting the growth of the electric vehicle and energy storage sectors.

2.1.4.4 Separator

The separator manufacturing landscape in India has attracted investments from global manufacturers, but there are several key considerations at play. To ensure demand security, long-term contracts with established non-startup companies are crucial. This is because the domestic market is still relatively underdeveloped. Raw material supply remains another critical factor, and companies are actively scrutinizing potential suppliers to establish a reliable local supply chain.

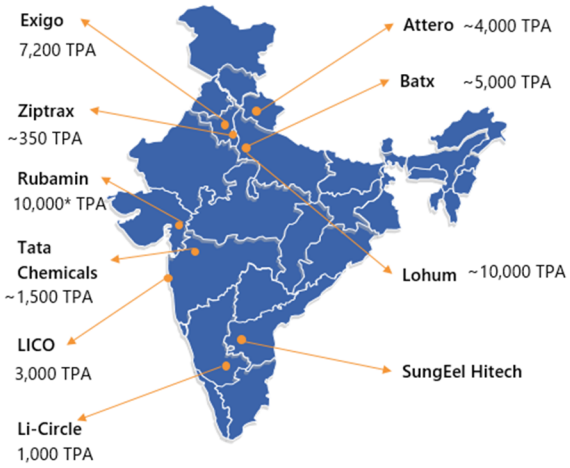
Separator manufacturing is agnostic of cell chemistry, but it varies depending on the specific lithium-ion battery (LiB) application. For instance, separators used in Energy Storage Systems (ESS) applications do not require coating. Another key consideration lies in the choice between wet and dry process separators. Wet process separators cater to the surging demand for Electric Vehicle (EV) batteries, while dry process separators are well-suited for the growing demand in ESS, driven by increasing Renewable Energy (RE) penetration.

Some key players in the emerging Indian separator manufacturing landscape include Neogen, Daramic, and ENTEK. Neogen is actively planning to establish a manufacturing capacity ranging from 1200 to 2400 tons per year. Daramic, an Asahi Kasei Group company, currently manufactures Polyethylene (PE) separators in India for Lead Acid Batteries and is prepared to transition to Li-ion

battery separators in the future. ENTEK, a global player, is exploring the establishment of a manufacturing plant for Absorbent Glass Mat (AGM) battery separators in India.

The rising prominence of separator manufacturing in India's burgeoning energy storage and electric vehicle industries is underscored by these investments from leading players.

2.1.5 Battery Recycling



*Indicates Planned capacity Source: Niti Aayog, Company Websites, Capacity evaluation as of 2022, List is Non-exhaustive and includes players with capability of producing only black mass Map indicated may not present accurate boundaries

Battery recycling plays a pivotal role in the battery supply chain, ensuring circularity and the recovery of lithium metals. Given the absence of a robust upstream mining and material processing infrastructure and considering the extended timeline of 5-7 years for establishing upstream refinement, the critical need to scale up Lithium-ion Battery (LiB) recycling becomes evident to meet the demands of mid and downstream production. Both black production and mineral extraction through hydrometallurgy/pyro-metallurgy contribute to India's capacity of 35,000 tons per annum (TPA) across various players involved in processing LiB plants. However, approximately 10,000 TPA is limited to mechanical processing, involving pre-treatment and battery shredding to generate black mass. To align with the recycling/repurposing potential projected for 2030, the current capacity must increase by approximately nine times. In comparison to global players, China boasts a total capacity of around 230,000 TPA in 2022, contributing to the global capacity of approximately 0.4-0.45 million TPA in the same year. Consequently, India represents less than 5% of the global total in this rapidly evolving segment. Presently, key players in India's recycling ecosystem comprise a diverse mix of start-ups, e-waste recyclers expanding horizontally, and companies with a focus on battery materials or critical battery minerals processing. Notable entities include Lohum, Exigo, Ziptrax, Attero, Batx, Tata Chemicals, LICO, and SungEel Hitech, among others.

2.2 Prospect of EV supply chain in India

The prospective development of India's Electric Vehicle (EV) supply chain is filled with both promise and challenges, particularly in the localization of critical components. In the battery sector, achieving localization for the anode seems feasible due to the availability of raw materials within the country. However, complete localization for the cathode, separator, and electrolyte faces constraints due to limited raw materials and reliance on imports. Despite these challenges, there is an opportunity for domestic manufacturing of essential components like the Battery Management System (BMS) and Thermal Pads, which could strengthen the overall EV supply chain domestically.

Shifting the focus to the motor segment, localization encounters unique obstacles. Currently, domestic procurement of the magnetic core is impractical as China dominates the mining of approximately 79% of the world's rare earth metals, including those crucial for motor cores. Consequently, a significant 92% of India's imports in this sector are from China, creating a notable dependency. Achieving full localization of the magnetic core requires exploring alternative sources or advancing technologies that do not rely on rare earth metals.

On a positive note, the localization of the copper coil used in EV motors holds promise for India. Despite limited reserves of copper ore, the country possesses a competitive copper industry with substantial smelting and refining plants that process copper concentrates into pure metal, copper cathodes. This favorable scenario positions India to enhance the localization of copper coil production, contributing to the domestic growth of the EV supply chain.

Another potential avenue for localization lies in the production of metal sheets of the required thickness for the motor's MG core. With collaborative efforts from Indian companies to initiate such production, the domestic sourcing of MG cores could become a tangible reality.

In conclusion, the future potential of the Electric Vehicle supply chain in India depends on strategic localization efforts and a concerted resolve to overcome raw material dependencies.

3. Charging Infrastructure Evolution

Establishing infrastructure for Electric Vehicle (EV) charging serves as a pivotal driver in promoting widespread EV adoption across various vehicle segments. While 2-wheelers currently lead in EV penetration, largely relying on slower home-charging units, expanding adoption among high-performance 2-wheelers, 3-wheelers, 4-wheelers, buses, and commercial vehicles calls for the development of "Faster, Wider & Discoverable Charging Networks," alongside alternative solutions such as Battery Swapping.

The public charging infrastructure value chain involves numerous stakeholders, encompassing Charge Point Operators (CPOs) and Power Utility Companies (DISCOMs). In various charging infrastructure models, CPOs are tasked with deploying and managing charging points or Electric Vehicle Supply Equipment (EVSE). Government-affiliated CPOs include EESL, REIL, BESCOM, other State Nodal Agencies (SNAs), and the retail arms of government oil companies transitioning their fuel stations to electric. Private entities like Tata Power, Statiq, Fortum, JBM Group, Kazam, Magenta Mobility, Ather Grid, Zeon, and others contribute to the charging infrastructure landscape. All CPOs establish partnerships with Network Service Providers (NSPs) for essential data transfer, enabling real-time monitoring of EVSE status.

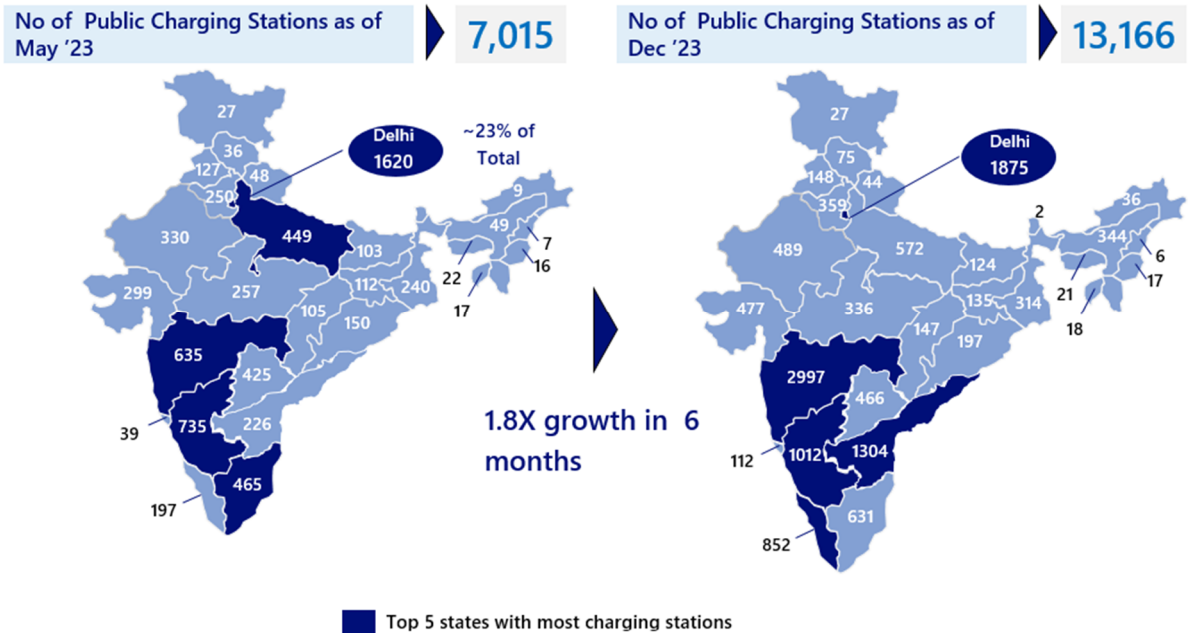
The presence of multiple CPOs in the market necessitates users to install various apps and possess multiple cards, leading to inconvenience. This inconvenience is compounded by differing charging plug types, particularly noticeable in fast-charging 2-wheelers, where plug-in standardization is less prevalent compared to EV 4-wheelers in India. Resolving this challenge entails achieving charger interoperability and the rise of e-Mobility Service Providers (e-MSPs) capable of accessing multiple charging point operators through a unified interface or app. In India, e-MSPs are gradually emerging, with players such as ElectricPe, Numocity, and ElectricFL gaining traction.

Distribution Companies (DISCOMs) play a crucial role by offering essential support for establishing electric infrastructure and supplying power to charging stations. In certain instances, DISCOMs also function as charge point operators, as evidenced in Bengaluru, where BESCOM operates its charging stations within the city.

Presently, India's charging infrastructure value chain boasts a diverse array of players, particularly among CPOs. While the lack of interoperability isn't a significant hindrance given current EV penetration levels and the number of CPOs in operation, it is expected to pose a challenge in the future. Addressing this requires ongoing collaboration among existing players and more decisive policy interventions.

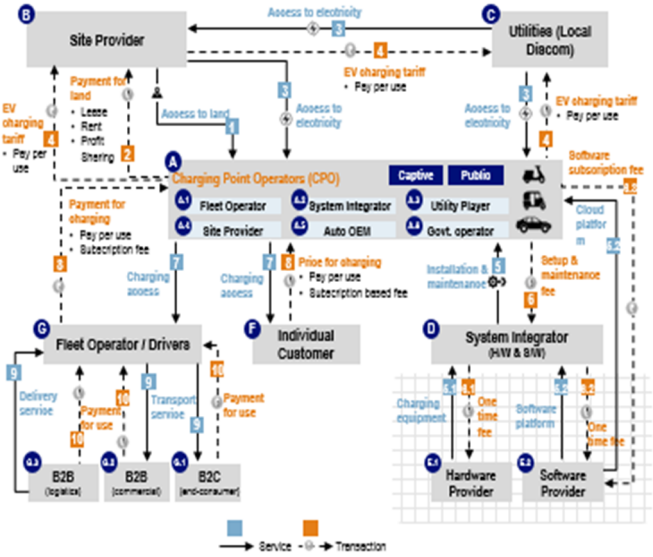
3.1 Growth and Geographical Coverage

In terms of coverage and absolute numbers, India has observed exponential growth. As per Bureau of Energy Efficiency (BEE) data, as of May 2023, there were more nearly 7000 chargers spread across the country with Delhi accounting for nearly 1 out of every 5 chargers. Within nearly 6 months, the numbers have almost doubled with states like Maharashtra having 4X growth and Andhra Pradesh having 5X growth in the number of charging stations during the period



Cities like Pune in Maharashtra had the highest numbers of chargers including both slow AC and fast DC chargers being set up with numbers rising from ~130 to over 1800 in the second half of 2023 as per data available with BEE.

3.2 Evolving business models and charging ecosystem



The present EV charging ecosystem encompasses a variety of stakeholders, each with distinct roles and functions. In the realm of electric vehicle (EV) charging infrastructure, charging point operators (CPOs) are categorized based on ownership, operational methods, and business models. The following are common classifications of CPOs:

1. **Fleet Operator:** Entities managing a fleet of electric vehicles, constructing and overseeing charging infrastructure to fulfill their fleet's charging requirements.
2. **System Integrator:** CPOs specialized in integrating various EV charging infrastructure components, overseeing the creation, construction, and management of the entire charging system, including stations, software platforms, and network connectivity.
3. **Utility Player:** Utility corporations operating as CPOs, utilize existing energy distribution infrastructure to deliver EV charging services. They establish and run charging stations, often in collaboration with other stakeholders, and may offer specialized EV charging fee structures.
4. **Site Provider:** Entities offering locations for charging station installation and operation, including commercial establishments, parking lots, shopping malls, and other public areas.
5. **Auto OEM:** Original Equipment Manufacturers (OEMs) rapidly transitioning into CPOs, developing charging networks and solutions to meet the needs of electric vehicle users. They may install charging stations at their dealerships or collaborate with other CPOs to expand their charging infrastructure.

6. **Government Operator:** Public entities such as public transport agencies or local governments can function as CPOs by developing and managing public charging infrastructure. They play a crucial role in promoting EV adoption by ensuring the availability of charging stations in public spaces, along highways, and within government-owned facilities.

As we move towards the future of EV charging infrastructure, several key business models have emerged:

- **Franchise Model of Charging Infrastructure Deployment:** This model involves a franchise agreement between a franchisor and a franchisee to establish a network of charging stations. The franchisor, typically an established charging infrastructure provider or Charge Point Operator (CPO), partners with individuals or organizations interested in operating and managing stations under their brand and guidelines. This model benefits both parties, allowing the franchisor to expand its network and brand visibility while enabling the franchisee to enter the industry with the support and expertise of an established player.
- **Energy Storage as a Service (ESaaS):** ESaaS offers energy storage devices as a service to consumers, eliminating the need for ownership and control. Third-party companies, usually energy storage providers or service providers, install, own, and maintain the equipment at the customer's location. Customers pay a regular fee for using the energy storage system and its associated benefits. This model simplifies the adoption of energy storage technology, enabling users to enjoy its benefits while entrusting financial, technical, and operational responsibilities to specialized service providers.
- **IoT Enabled Charging Station Aggregation & Remote Performance Management:** This approach utilizes Internet of Things (IoT) technology to connect and manage multiple charging stations efficiently. It allows for real-time monitoring, control, and optimization of stations, enhancing performance, reliability, and user experience. IoT-enabled aggregation and remote management optimize charging infrastructure efficiency, reliability, and user experience by centrally monitoring, controlling, and optimizing multiple stations. It facilitates proactive maintenance and fault management, leading to increased uptime and customer satisfaction.

The future of charging infrastructure in India presents significant business opportunities. Increasing EV adoption and the government's focus on reducing fossil fuel dependency create a promising landscape for entrepreneurs and investors. Opportunities exist for companies involved in manufacturing, installing, and operating charging stations. Innovative solutions like fast-charging technologies, battery-swapping stations, and smart grid integration offer avenues for growth.

Private players can collaborate with automakers, real estate developers, and government agencies to establish stations at strategic locations such as highways, residential complexes, commercial

hubs, and parking lots. The market also offers opportunities for software development, data analytics, and cloud-based solutions to optimize charging networks and enhance user experiences.

To succeed in this evolving landscape, businesses must stay updated on technological advancements, government policies, and consumer preferences while providing reliable, affordable, and user-friendly charging solutions.

3.3 Types of Chargers & Interoperability

Apart from the proprietary charger types. Public Charging Infra in India is largely limited to standards shown in the table.

Type of compatible charger	Diagram	Level	Power (kW)	Type of Vehicle
Type 1, Bharat AC-001		AC (Level 1)	<=3.5 kW	2/3/4-Wheeler
Bharat DC-001		DC (Level 1)	<=15 kW	2/3/4-Wheeler
Type 2,		AC (Level 2)	<=22 kW	2/3/4-Wheeler
CHAdeMO, CCS2		DC (Level 3)	Up to 400 kW	4-Wheeler

Amongst the charger types, Bharat AC-001 is by far the most commonly available plug type. Amongst 4-wheelers, variants holding greater than 90% market share combined (Tata Nexon, Tigor, MG ZS) support CCS-2. However, there is variation amongst 2-wheelers in fast charging, including some OEMs not supporting fast charging and few others having their proprietary plug designs.

When it comes to non-interoperable charging network challenges exist along 3-fronts:

- **Discoverability:** Ease of finding charging stations with empty/available charging points that are compatible with the vehicle
- **Access**: Need to maintain multiple mobile apps, accounts & credentials for access
- **Payments:** Most Charging points may force you to pay via captive wallets, lack multiple payment options, and payment-charging orchestration issues

To address these three kinds of interoperability address these issues:

- **Network-to-Network inter-operability**: Implementation of a protocol for B2B connectivity that facilitates customer roaming between CPO networks, including seamless pricing and payments

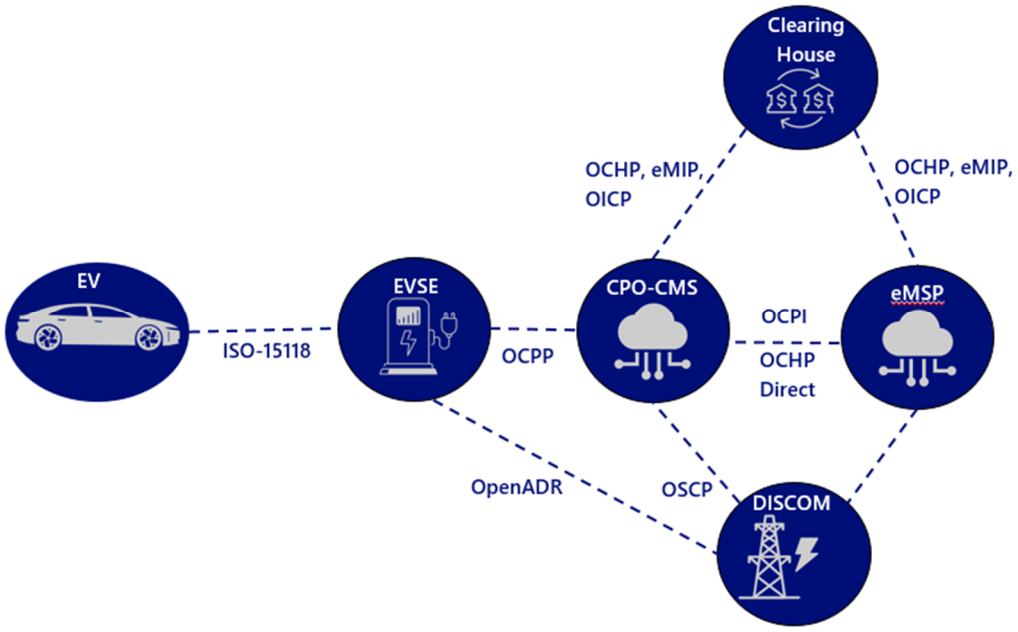
- **EVSE-to-network inter-operability:** Implementation of open, non-proprietary protocols enabling interchangeable services and operations between charge stations (EVSE) and charge point management software deployed by CPOs.

- **Hardware interface inter-operability**: adoption of appropriate DC charging protocol and interface, which facilitates interoperability, especially for light-duty EVs. Regarding battery swapping and hardware interoperability via standardization of packs, India is reconsidering standardization in the new draft of the Battery Swap Policy. With increasing consolidation of players, the need for standardization would emerge organically if not accelerated via policies.

Apart from these V2G interoperability is another crucial aspect for reducing energy costs and, more importantly, managing grid stability as EV penetration increases.

3.3.1 Protocols for Operability

Effective communication protocols are essential for enabling interoperability among various stakeholders. ISO 15118 stands out as a protocol facilitating communication between Electric Vehicles (EVs) and Electric Vehicle Supply Equipment (EVSE), enabling functionalities like "plug and charge" and Vehicle-to-Grid (V2G) for smart charging. However, existing technical challenges, particularly in hardware (especially for low-duty vehicles like 2-wheelers and 3-wheelers), as well as software implementation, need to be addressed before widespread adoption can occur.



OCPP (Open Charge Point Protocol) serves as an open-source standard for communication between EVSE and Charge Point Management Software, maintained by Charge Point Operators (CPOs). It encompasses features such as device management, transaction handling, security, and smart charging, fostering interoperability among diverse charging equipment.

OCPI (Open Charge Point Interface) represents a standard for communication between CPOs and e-Mobility Service Providers (e-MSPs) as well as between different CPOs. It supports functionalities including charge point information exchange, charging session authorization, tariff management, reservation systems, and roaming capabilities.

OpenADR functions as a communication protocol connecting EVSE, Charge Point Management Systems (CMS), and Distributed Energy Resource Management Systems (DERMS) to power utilities. It serves as a facilitator for energy demand management by controlling the power drawn by EVs during peak load periods.

4. EV Financing

The retail vehicle finance sector in India has experienced sustainable growth, currently reaching an estimated outstanding portfolio value of INR 5.9 lakh crore as of June 2023. Economic liberalization and the maturation of the automotive market have been instrumental in fueling this growth, making automotive finance the second-largest loan segment, trailing only home loans.

Constituting about 12% of total personal finance lending by banks in the past three years, auto loans have become a significant player in the financial landscape. HDFC Bank leads the Indian auto finance sector, securing a market share of 44.84% in FY23. Two-wheeler loans, with an outstanding

portfolio of INR 1.06 lakh crore, are predominantly dominated by NBFCs in both value and volume, followed by private banks.

Financing penetration, indicating the share of vehicles financed through organized sector loans, varies across sectors. It ranges from 35 to 50% for all two-wheelers, 90% for all three-wheelers, 80 to 90% for all four-wheeler PVs, and 99% for new light-, medium-, and heavy-duty CVs.

During COP 26, India revised its climate commitments, pledging to achieve Net Zero by 2070 among four other specific targets. As India is poised to become the world's third-largest automotive market by 2030, the government is intensifying efforts to transition to electric mobility to realize its Net Zero ambitions and mitigate the adverse impact of automobiles, such as air pollution and escalating oil import expenses.

The government's decarbonization goals include achieving 80% penetration of electric vehicles in the two-wheeler segment and 30% in four-wheeler PVs. The Indian electric vehicle market is projected to grow at a CAGR of 45.5%, reaching 10 million units by 2030, with a cumulative capital cost estimated at INR 19.7 lakh crore (USD 266 billion). NITI Aayog suggests that the electric vehicle financing industry could reach a market size of INR 3.7 lakh crore by 2030.

Despite the positive trajectory driven by declining battery prices, favorable electric vehicle economics, and government incentives, the high upfront cost of EVs remains a barrier. This challenge is expected to persist until technology advancements and increased scale lead to cost reductions. To meet growth targets for electric vehicles, there is a need for attractive financing options to make EV adoption sustainable and capitalize on the vast opportunity in the market.

4.1 Business Models in EV Financing

Within the automotive sector, financing penetration across various segments is diverse, influenced by factors such as Total Cost of Ownership (TCO), asset size, creditworthiness, and vehicle use case. Multiple stakeholders contribute to the vehicle finance industry, including PSU Banks, Private Banks, NBFCs (Captive, Non-captive, and Fintech) for financing, state-owned and privately owned insurance companies, and insurance agents or brokers for motor insurance. Additionally, long-term investors, such as VC Funds, National Development Banks, and Multilateral Institutions, are significant players.

These stakeholders collectively play a vital role in the sustainable evolution of the electric vehicle (EV) finance sector. Notably, NBFCs stand out for their crucial role in providing flexible repayment options, particularly when compared to traditional banks. Moreover, the larger risk appetite of NBFCs, including the emergence of new fintech-based NBFCs, has contributed to expanding EV adoption in tier 2 and 3 cities.

Regarding existing business models in India, the EV financing landscape encompasses various models with distinct benefits and drawbacks. Broadly classified into three categories based on asset ownership – Vehicle upfront purchase, Leasing, and Battery separation. The first category involves loans for upfront vehicle purchases by individuals or fleet owners. Demand aggregation, a volume-dependent solution, involves a third party securing bulk loans for leveraging economies of scale. In the second category, leasing options include a dry lease, where the lessor manages repair and maintenance with flat monthly payments, and a wet lease, where the borrower handles repair and maintenance while the lessor retains operational control. The third category has gained traction with the rising discussion about decoupling batteries from vehicles. Under battery swapping or leasing operations, the vehicle is financed separately, and the battery is provided by an Original Equipment Manufacturer (OEM) or a third party.

Private investor sentiment in the Indian EV sector has seen an increase, with over USD 780 million raised in 2023, compared to USD 758 million in the previous year. Investors are showing a preference for allied sectors like batteries, EV infrastructure development, and other segments due to longer gestation periods associated with Original Equipment Manufacturer (OEM) investments, increasing competition, and significant capital requirements. This shift in funding focus is expected to strengthen the overall electric mobility R&D ecosystem and supply chain in India, reducing dependence on imports. Consequently, this positive change is likely to enhance financier confidence on the product side and reduce asset side risk.

4.2 Key challenges in EV financing in India

Vehicle finance encompasses two primary risks: Asset Risk and Credit Risk. Asset Risk pertains to risks associated with vehicle performance, maintenance, and resale value, while Credit Risk assesses the creditworthiness of the customer. Currently, in the personal two-wheeler segment, banks and NBFCs charge 1-4% higher interest rates for Electric Vehicles (EVs) compared to Internal Combustion Engine (ICE) vehicles, leading to higher down payments and Equated Monthly Installments (EMIs) due to perceived higher asset risk. Conversely, terms are nearly identical in the personal four-wheeler segment. In the commercial usage sector, determining loan terms is more complex as creditworthiness depends on asset utilization and business viability, leading to worse credit terms for EVs compared to ICE vehicles across all commercial segments due to elevated asset side risk.

Customer pain points in EV financing include higher initial down payments, increased interest rates and EMIs, limited financing options, and elevated insurance rates. Limited specialized products for EVs force operators in India to opt for loans with high-interest rates, low Loan-to-Value (LTV) ratios, and shorter repayment periods. Banks and NBFCs often demand collateral for EV loans, adding to the challenges faced by aspiring EV operators and owners. Higher insurance rates for EVs are attributed to their upfront cost, contributing to larger insurance premiums.

The underlying causes of these pain points include the unestablished resale value of both the vehicle and battery, evolving battery technology, challenges in evaluating creditworthiness, and operational and maintenance risks associated with battery replacement. Challenges in determining the State of Health (SoH) of batteries and the absence of historical data on product performance contribute to difficulties in assessing Loan-to-Value (LTV). Operational and maintenance risks arise from the need to replace batteries after 4-5 years, constituting a significant portion of the vehicle cost. The lack of established end-of-life pricing for batteries further burdens buyers with additional capital expenditure.

Addressing these challenges requires outcome-focused and technology-driven business model innovations in the retail financing sector, coupled with systemic policy support, to enhance accessibility and affordability for customers looking to purchase EVs in India.

4.3 Government policies and potential solutions

Policy-supported mechanisms, including down payment subsidies, interest subventions, low-interest loans, and extended repayment periods, have the potential to make electric vehicle (EV) financing more accessible and affordable. Apart from demand-side incentives like FAME subsidizing EV vehicles at the end-consumer level and supply-side incentives like PLI supporting manufacturing and OEMs, there are additional policy interventions that can accelerate the EV transition. Some of these include:

Income Tax Rebate: Individuals opting for EV loans are eligible for a tax deduction of Rs 1.5 lakh on the interest paid, as per Section 80EEB. Salaried professionals find this tax benefit appealing, making EV acquisition an attractive option. This tax exemption is a one-time benefit for each individual.

Interest-free Loan: The government, in the interim budget for FY25, has earmarked INR 1 lakh crores as a 50-year interest-free loan for the sunrise sector, including green energy and green mobility.

Other Measures: Initiatives such as reducing the Goods and Services Tax (GST) on EVs to 5% and waiving road taxes contribute to lowering the initial costs associated with EV ownership.

In addition to these central government initiatives, certain state governments have also taken steps to ease EV financing challenges by offering incentives for purchases, as well as exemptions on road taxes and registration fees. The challenges outlined around EV financing can also be addressed through innovative solutions facilitated by collaboration among various stakeholders. These solutions can be broadly categorized into four major groups:

4.3.1 Risk Absorption (Green Bonds)

Green bonds are fixed-income assets issued to fund projects that have environmental or climate benefits. Through green asset-backed securities, auto financiers can free up their balance sheets for further lending. Also, OEMs can utilize their overall creditworthiness based on their performance track record to issue green bonds.

Another possible solution to reduce credit risk can be guarantor-backed auto loans, in which the guarantor shares underlying assets and credit risks with the OEM, helping to improve the credit rating of their loans.

4.3.2 Technology Interventions

Vehicle state tracking through the use of IoT devices coupled with data analytics can help in mitigating the lender's asset side risk making loans cheaper. This solution finds its application in large fleet sizes with each vehicle fitted with tracking devices. Revfin, a Delhi-based financier for commercial use EVs and fleets is already employing this solution. Developments in the area of battery certification and safety standards also help in reducing asset risk.

On the credit risk front, the application of AI & ML in credit assessments can simplify the consumer onboarding experience and help in gauging creditworthiness.

4.3.3 Second life price discovery

Evolution and stabilization at the end-of-life value chain of EV batteries will help in creating a price discovery for both second-use applications and metal retrieval. This will help in creating new business models such as buy-back models by OEMs and will reduce the battery replacement cost for vehicles, reducing the overall capex burden for the buyer as well as LTV establishment for electric vehicles

4.4 EV-specific finance products

Financial products specifically tailored according to the unique nature of EV ownership are likely to emerge. Here the role of emerging fintech institutions takes centre stage as they can leverage the abundance of data generated by EVs into data-driven models for risk assessment and credit pricing

5. Way Forward

FAME Scheme:

1. Establish a long-term FAME scheme with clear EV penetration targets and timelines.
2. Ensure incentives cover EV lifecycle stages: manufacturing, infrastructure, and recycling.
3. Regularly update FAME to align with tech advancements and market dynamics.
4. Collaborate with stakeholders for ongoing evaluation and improvement.

PLI Scheme:

1. Design a PLI scheme to boost domestic manufacturing and supply chain.
2. Ensure fair distribution of incentives and simplify application processes.
3. Target high-potential EV segments for maximum impact.

EV Financing:

1. Engage with banks and NBFCs to develop tailored financing solutions.
2. Introduce innovative models like leasing and BaaS to lower upfront costs.
3. Establish a platform to negotiate favorable terms and fast-track approvals.
4. Promote financial literacy to debunk myths and showcase long-term savings.

Charging Infrastructure:

1. Assess and prioritize charging infrastructure in key areas.
2. Standardize protocols and interoperability for user convenience.
3. Foster innovation in fast charging and smart grid integration.
4. Move towards one app for all to onboard all CPOs on the same app.
5. Standardise charging rates across geographies & CPOs for a uniform customer experience.

R&D Investment:

1. Increase public-private R&D in battery tech, materials, and V2G integration.
2. Establish R&D clusters to facilitate collaboration and tech transfer.
3. Provide incentives for companies investing in EV-related R&D.
4. Encourage cross-sector collaboration for breakthrough innovations.

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- The industry opinions presented are based on a comprehensive survey conducted by ASSOCHAM & Nomura Research Institute India, gathering insights from veteran industry experts representing various segments of the electric vehicle value chain, including OEMs, Suppliers, Academia, R&D Institutes, and Think Tanks. The responses have been categorized to provide a coherent representation of the industry's perspectives.

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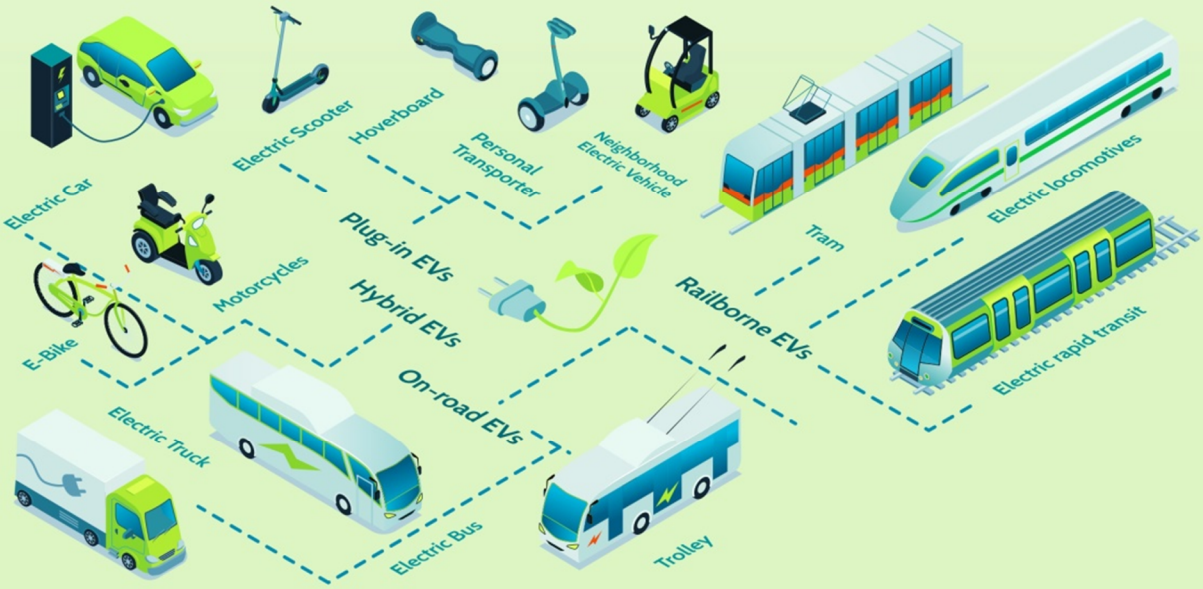

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