

BUILDING INDIA AN ELECTRIC MOBILITY HUB FOR VIKSIT BHARAT

September 2024

**THE ASSOCIATED CHAMBERS OF
COMMERCE AND INDUSTRY OF INDIA**



BUILDING INDIA AN ELECTRIC MOBILITY

HUB FOR VIKSIT BHARAT

September 2024



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Foreword



Deepak Sood
Secretary-General
ASSOCHAM

Electric mobility is at the forefront of India's journey towards becoming a global leader in sustainable transportation. As the country envisions a developed India, electric vehicles play a crucial role in reducing carbon emissions, combating air pollution, and promoting energy independence. With rapid urbanization and a growing population, the demand for an efficient and eco-friendly transportation system has never been more urgent. The Indian government's ambitious initiatives, such as the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme, showcase a strong dedication to promoting the adoption of EVs nationwide. These efforts are laying the groundwork for India to establish itself as a hub for electric mobility.

Establishing a robust electric vehicle infrastructure is imperative to support the widespread adoption of electric mobility. This entails creating a comprehensive network of charging stations, promoting battery-swapping technology, and advancing energy storage solutions. Public-private partnerships will play a pivotal role in expediting the deployment of this infrastructure, ensuring that both urban and rural areas have access to reliable and cost-effective charging options. Additionally, investing in research and development to improve battery technology, extend vehicle range, and reduce costs will make EVs more accessible to the public, thus driving mass adoption.

As India continues its path toward becoming a Viksit Bharat, electric mobility will play a central role in shaping a sustainable and prosperous future for the nation. With its existing manufacturing capabilities, skilled workforce, and supportive policy environment, India has the potential to emerge as a leading global hub for electric vehicle production. The implementation of initiatives such as the Production-Linked Incentive (PLI) scheme for the automotive sector aims to attract both domestic and international players to establish manufacturing facilities in India. Furthermore, fostering innovation through startup ecosystems and partnerships with global technology companies will be essential in driving the next wave of advancements in electric mobility.

ASSOCHAM and NRI Consulting & Solutions India collaborated on a comprehensive study aimed at identifying key factors that will drive growth in the e-mobility sector and help achieve the planned targets. This study will be presented at the National Conference on 'Electric Mobility-Building India an Electric Mobility Hub for Viksit Bharat'. We

hope that the report will provide the desired information for policymakers, industry leaders, academia, and other stakeholders seeking to gain insights into the strategic roadmap for the future growth and development of the Electric Mobility sector in India.

Deepak Sood



Foreword



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Electric Mobility, together with other alternative powertrains, holds great promise for India in tackling rising emissions and reducing dependency on oil imports. In recent years, significant policy milestones have been achieved by both the Central and State governments through interventions like FAME, EMPS, PMP, PLI, and State EV policies. Industry players have embraced the potential of EVs in India, with OEMs, startups, and shared mobility providers exploring new products and business models.

The investment community recognizes EVs as a high-potential area, while academia and premier institutions like IITs, BITs are actively researching and refining EV technology for Indian use cases. This collective effort showcases a strong determination from the government, industry, and academia to kick-start the EV revolution in India.

However, the transition to EVs also presents challenges. The supply chain for critical components though developing is still import dependent, necessitating stable procurement of raw materials even with localization efforts. Prospective EV users have concerns now have higher charging anxiety than range anxiety, financing, and vehicle performance. Addressing these concerns while achieving the right value-price equation through unique business models is critical in a cost-conscious market.

In this report titled “Building India an Electric Mobility Hub for Viksit Bharat”, we present the current status, trends, and future potential of electric mobility in India while exploring the unique challenges towards making India as global hub for EV manufacturing aligning with government’s vision for 2047. Our research provides valuable insights for policy formulation and implementation based on the industry’s voice.

We extend our gratitude to all stakeholders, including the government, industry players, academia, and prospective users, whose collaboration has made this research possible. We hope this report serves as a valuable resource in advancing sustainable electric mobility in India and accelerates the nation’s journey towards a cleaner and greener transportation ecosystem.

1 NEED FOR ALTERNATE POWERTRAIN AND INDIA AS AUTO HUB



In terms of carbon emissions, India ranks as the fourth-largest emitter of CO₂ globally, with the transportation sector contributing roughly 13.5% of the nation's total emissions.

India's, sustained effort towards alternate powertrains is driven by 3 critical factors: - a) enhancing energy security b) reducing manufacturing import dependency and turning India into a global manufacturing hub and c) meeting carbon emissions targets. With a staggering 86% of oil being imported, resulting in an import bill of approximately \$170 billion in FY '24, the transportation sector alone consumes nearly 40% of this imported oil, significantly impacting energy security. Moreover, the import of raw materials and components for vehicle manufacturing, amounting to around \$18 billion in FY '24, signifies the strong import dependency. In terms of carbon emissions, India ranks as the fourth-largest emitter of CO₂ globally, with the transportation sector contributing roughly 13.5% of the nation's total emissions.

Thus, the adoption of alternative powertrain vehicles—including Hybrid Electric Vehicles (HEVs), Electric Vehicles (EVs), Natural Gas Vehicles (NGVs), Ethanol and Flex Fuel vehicles, and Hydrogen Fuel Cell-based vehicles—presents a viable solution to these challenges. Electric vehicles can substantially reduce overall greenhouse gas (GHG) emissions. Furthermore, coupling electric vehicles with renewable energy sources can create a greener and more sustainable mobility ecosystem.

As India envisions becoming a global automotive manufacturing hub under the “Viksit Bharat” initiative, focusing on alternative powertrains is crucial. The rapid adoption and local production of electric vehicles (EVs) and other green vehicles

can position India as a leader in the global automotive landscape. By investing in domestic R&D, fostering a robust supply chain for critical components like batteries, motors, and power electronics, and incentivizing the local production of EVs and alternative fuel vehicles, India can reduce import dependency and enhance energy security.

The government's policies, such as the Production-Linked Incentive (PLI) scheme for advanced chemistry cell battery manufacturing and the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme, are encouraging investments in EV manufacturing and infrastructure development. These initiatives are helping India emerge as a significant player in the global electric mobility market, attracting major automotive giants and startups to set up manufacturing and R&D centres in the country.

Additionally, promoting alternative fuel vehicles such as ethanol, hydrogen, and natural gas can further diversify India's transportation sector and reduce its environmental impact. By leveraging its large domestic market, skilled workforce, and growing technological capabilities, India is well-positioned to lead in the transition to sustainable mobility. This will not only help address critical issues related to energy security, import dependency, and carbon emissions but also create new opportunities for economic growth, employment, and technological innovation, cementing India's status as a global hub for automotive manufacturing.

2 POLICY OVERVIEW



In terms of carbon emissions, India ranks as the fourth-largest emitter of CO₂ globally, with the transportation sector contributing roughly 13.5% of the nation's total emissions.

2.1 Global EV Policies & Learnings

According to the International Energy Agency (IEA), a significant portion of global EV sales in Light Duty Vehicles (LDV), including both passenger and commercial vehicles, is influenced by EV-related policies, with approximately 90% of these sales covered by such regulations. Driven by Zero Emission Targets in regions like China, Europe, the US, and growing ambitions in markets like India, around 50% of global LDV sales are targeted to be Zero-Electric Vehicles by 2035. However, due to varying levels of EV penetration across different regions, policy directions now vary in their areas of focus.

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. In China, at the national level, subsidies are already phased-out; however, at the local level, vehicle subsidies are present, which are aligned towards govt targets of achieving ~50% New Energy Vehicles (NEV) vehicle share by 2030. In the case of Europe, countries like Norway, where penetration has already reached 80% of the new car sales, are reintroducing VAT for EV cars. In Germany, Plug-in Hybrid Vehicle (PHEV) subsidies are already phased out, and Battery Electric

Vehicle (BEV) subsidies are being reduced year-by-year till 2025. In countries with advanced EV penetration in cars, the push towards targets and incentives towards increasing EV penetration among heavy commercial vehicles (trucks & buses) is rising. Apart from direct incentive fuel economy targets, tighter emission norms Euro-7 is expected from 2025, which is likely to force the phasing out of ICE engines especially Diesel.

Countries like USA and Japan, which are still in the growth stages of EV penetration, are ramping up or continuing with existing levels of tax credits, including for private 4-wheelers. Other emerging ASEAN markets like Indonesia have also introduced purchase incentives especially targeting 2 Wheelers. India being in an emerging EV market, has policies in line with global cases with subsidies targeting 2W (personal + commercial use), 3W & 4W (commercial) and e-buses. Except in 3-wheelers, including e-rickshaws, India still needs to make a significant journey towards being a mature EV market. Hence, demand incentives need to be phased out strategically until desired penetration targets are achieved.

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 SHEV (strong hybrid electric vehicles) and PHEV (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. Other key aspect is that SHEVs are self charging vehicles (no range anxiety) and hence provide economies of scale for manufacturing of EV components such as batteries, motors & power electronics, thus catalysing 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 higher absolute tax on SHEV than 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	X

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

However, Indian government has taken right steps in giving due importance to hybrids, albeit push is more at state level at present. State government like UP have introduced policies to scrap road tax for strong hybrids, which would bring parity in acquisition of hybrids compared to EV.

PM Bus e-Seva

The Government of India launched the **“PM-eBus Sewa Scheme”** on August 16, 2023, to enhance bus services by deploying 10,000 electric buses under a Public-Private Partnership (PPP) model. The e-buses under this scheme will come with several accessibility features to accommodate passengers with reduced mobility.

These buses will comply with the Bus Code AIS 052 and Annexure V of AIS 153, ensuring features like steps, priority seats, and designated spaces for passengers with mobility challenges. Priority seats near the passenger door will have pictograms for easy identification, and standard symbols will indicate the location of wheelchair spaces inside and outside the bus. Additionally, handrails will be provided at the door entrance for added support.

About 25% of the buses, specifically the 12-meter and 9-meter variants, will be equipped with a hydraulic lift or ramp mechanism for wheelchair accessibility. The lifting platform will feature a safety restraint system, including safety belts, handrails,

push buttons, and stop request buttons, with built-in safety measures to prevent slippage. Furthermore, a Passenger Information System (PIS) will be available on the buses to provide essential travel information.

2.2 Manufacturing and Critical Raw Material Supply Chain:

Increasing localised production of EVs and critical components like batteries has been a rising priority across major economies. Currently, downstream material processing, battery manufacturing, and permanent magnets for motors are predominantly controlled by China. Coupled with the Ukraine-Russia war highlighting the vulnerability of critical minerals like nickel, major economies are increasingly looking into developing strategic stockpiles of critical minerals.

US has been pushing manufacturing localisation via IRA supply side Advanced Manufacturing Production Credits with up to US \$35 per kWh for battery production.

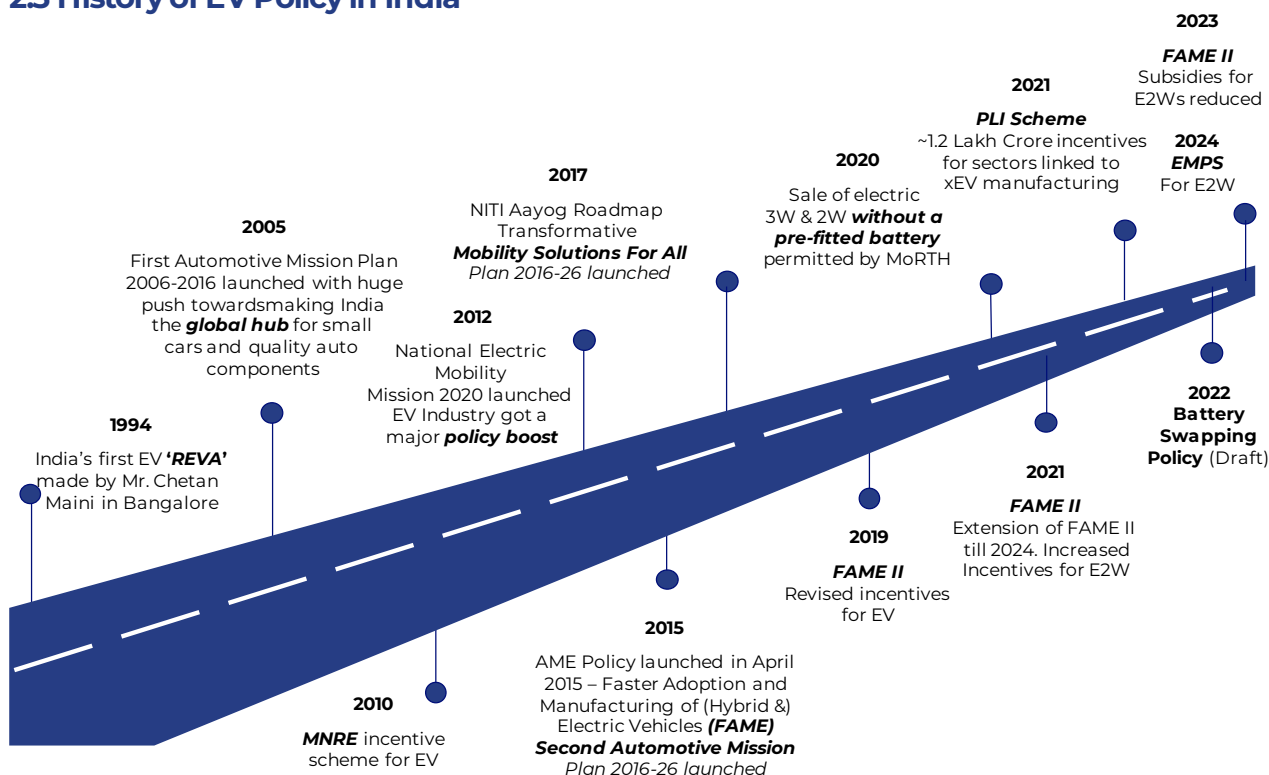
In addition to FTAs with major lithium-rich countries, the US has signed a MoU with the Democratic Republic of Congo and Zambia. European Union and the UK have also been strong proponents of manufacturing localisation, especially batteries. EU has proposed the Critical Raw Materials Act to secure the supply chain of materials for decarbonisation.

Amongst emerging EV markets, India's policy has given impetus to EV manufacturing localisation and local battery assembly & eventual localisation of sub-components. India is also a member of the Electric Vehicle Initiative by Clean Energy Ministerial allowing it to bolster its policy actions.

Additionally, India has launched policies around battery recycling for further strengthen circular economy and successful reuse of critical minerals. India is also successful in identifying 30 critical minerals via inter-ministerial consultation and setting up entities for the strategic acquisition of critical minerals.



2.3 History of EV Policy in India



Source: Secondary Research

The Government of India has introduced a set of fiscal and non-fiscal incentives to support the adoption of electric mobility. These incentives include tax breaks, subsidies, and access to dedicated lanes. The government has also set ambitious targets for the adoption of EVs, such as having 30% of all new vehicles sold in India be EVs by 2030. The road to transformation for electric mobility in India started in 1994 with India's first electric vehicle, the REVA. In 2010, the Ministry of New and Renewable Energy (MNRE) launched the Alternate Fuels for Surface Transportation Programme with a budget of INR 95 crore. This was the first step to promote electric vehicle penetration in India. A major policy boost followed in 2012 with the National Electric Mobility Mission 2020 (NEMMP 2020). The NEMMP 2020 set a target of having 6-7 million electric vehicles on the road by 2020. The movement towards electric mobility became stronger in 2015 with the announcement of the Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) scheme. The FAME

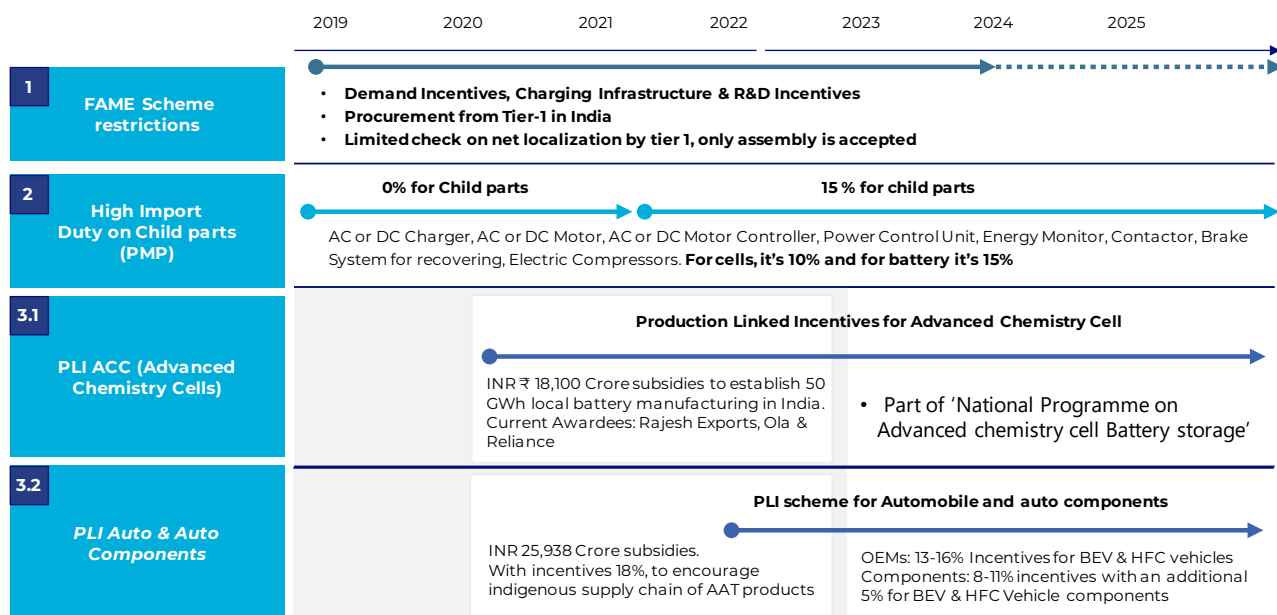
scheme provides subsidies for the purchase of electric vehicles and for the installation of charging infrastructure. The FAME scheme has been revised twice, in 2019 and 2022.

As the FAME scheme comes to a closure in FY24, the govt. launched a demand incentive scheme (EMPS) to provide a crucial 4-month transition period for the industry to stabilize. The government's efforts to promote the adoption of EVs have been successful in recent years.



2.4 Central Policy

Three Strategies through Four Initiatives to Promote Electrification



Currently, at national level, India has devised a 3 pillar strategy to promote local manufacturing ecosystem development for EVs – Faster Adoption & Manufacturing of (Hybrid&) Electric (FAME - 2) Vehicles restrictions (subsidies only for vehicles meeting local sourcing targets), Import Restrictions and localisation targets under Phased Manufacturing Program (PMP) and third, Fiscal Incentives or PLI 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. While PLI for Advanced Chemistry Cells (ACC) aims to facilitate the development of gigafactories for battery manufacturing capacity of 50 GWh.

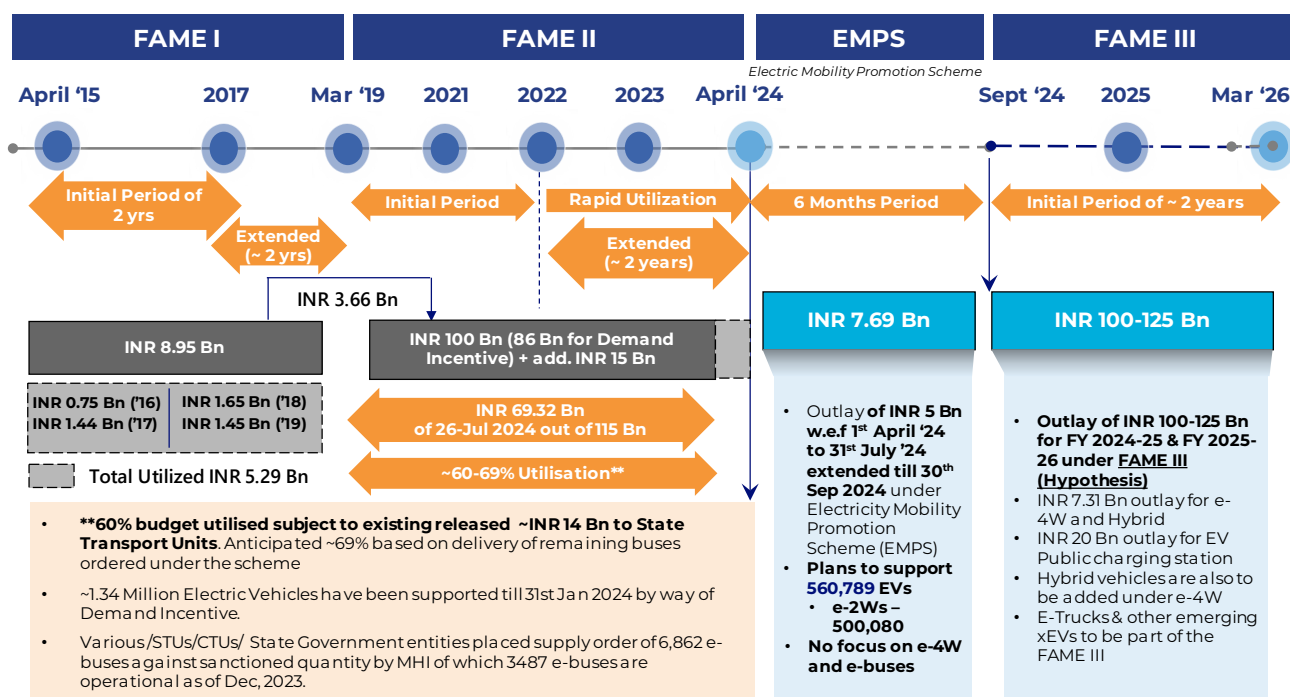
FAME, EMPS

As part of the National Electric Mobility Mission Plan (NEMMP) 2020, the Department of Heavy Industry (DHI) launched the FAME India Scheme in 2015

to promote electric and hybrid vehicle technology. Phase-I focused on creating demand through incentives, supporting around 2.78 lakh EVs. Phase-II, with a budget of INR 10,000 crore, targets 7,000 e-buses, 5 lakh e-3 wheelers, 55,000 e-4 wheelers, and 10 lakh e-2 wheelers.

As of July 2024 notifications, INR 6,932 Cr is utilised leading to ~60% utilisation. Utilisation rate anticipated to increase once the delivery of e-buses to various state-governments is realised along with select E-2W sales subsidy is also realised. Yet, it would be accurate to state that scheme hasn't been successful in utilising funds for vehicle category other than E-2W and E-buses. Especially, with other segments presently catching, sustenance of the scheme would be necessary.





Source: PIB Notifications

Post the FAME II scheme, Electric Mobility Promotion scheme was launched as a transition to a more elaborate FAME III scheme. Unlike FAME II, EMPS will allow EV makers to import parts temporarily while localising manufacturing. Although not rolled out, the FAME III scheme is expected to have an outlay of >INR 10,000 cr. with a focus on e-Bus, e-2W & e-3W. Allocation of ~INR 2000 cr. for charging infrastructure is also expected as part of FAME III.

Performance Linked Incentive (PLI) Scheme

PLI ACC: The Government of India approved the PLI scheme for ACC battery manufacturing in February 2022, with an 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. Eligible companies will receive a 25% incentive on incremental investments and sales, expected to attract over INR 60,000 crore investments and generate 50,000+ jobs, propelling India as an EV global leader.

In the initial round of allotment Rajesh Exports, Ola Electric, and Reliance New Energy emerged as winners with a combined capacity of 30 GWh. Seven companies: Reliance Industries, ACME Cleantech, JSW Neo Energy, Waree Energy, TVS Lucas, and Amara Raja have placed the bid for the second round of PLI for a total capacity of 10 GWh.

PLI Auto and Auto Components: The government approved the PLI scheme for auto and auto components in March 2022, offering financial incentives of up to 18% to boost domestic manufacturing of advanced automotive technology (AAT) products and attract investments in the automotive value chain. The scheme has well-defined targets for local domestic investments added with a 50% minimum localisation to be qualified for any incentive. With an INR 25,938 crore outlay over 2022-2027, eligible OEM Champions will 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. The scheme is anticipated to

draw over INR 80,000 crore investments and generate 7 lakhs+ jobs in the automotive industry.

India's EV export promotion will be driven by the Scheme to Promote Manufacturing of Electric Passenger Cars in India' (SPMEPCI) and the Production-Linked Incentive (PLI) scheme. SPMEPCI offers incentives up to 25% of project costs to enhance production and meet global standards, while the PLI scheme provides 4-6% rewards on incremental sales for achieving export targets. Together, these initiatives aim to boost India's EV exports by ₹30,000 crores (\$4 billion) by 2025, making Indian EVs more competitive in global markets.

Battery Reuse and Recycle Policy

The Government of India has launched initiatives like the Battery Waste Management Rules 2022 and the Vehicle Scrappage Policy to promote the reuse and recycling of Advanced Chemistry Cell (ACC) batteries. The Vehicle Scrappage Policy is designed to phase out old vehicles, reduce pollution, and recycle valuable materials, including batteries, contributing to environmental sustainability.

The Battery Waste Management Rules 2022 outline the government's vision for battery recycling in India, including the development of standards, financial incentives, and raising awareness about battery recycling. The current battery value chain involves raw material extraction, battery manufacturing, first application use, and disposal. However, by promoting recycling and reuse, India can significantly reduce its dependency on raw material imports. Battery reuse and recycling introduce alternate value chains, where batteries are repurposed for second-life applications in energy storage and, when they can no longer meet performance requirements, are recycled for extracting

valuable materials like Co, Ni, Al, and Cu. These initiatives aim to lower battery prices and improve the future availability of raw materials.

Charging and Swapping Infrastructure Policy

The Indian government is actively promoting charging infrastructure and battery swapping to support the EV industry's growth. This addresses the lack of charging infrastructure, a key barrier to EV adoption. The Bureau of Energy Efficiency (BEE) has prepared action plans for 9 major cities, targeting the installation of 46,397 Public Charging Stations (PCS) by 2030.

The government is promoting Battery Swapping Stations (BSS) alongside Battery Charging Stations (BCS) through a draft policy focusing on standardizing battery specifications and creating a phased battery swapping network, prioritizing cities with 4+ million population in the first phase. However, due to opposition from swapping players, the government is revising the standardization and interoperability terms.



		A Andhra Pradesh	B Delhi	C Karnataka	D Maha-rashtra	E Tamil Nadu	F Telangana	G Uttar Pradesh
Supply Side Incentives	Capital Subsidy	25% First 50 stations	✓	25% First 100 stations	25% First 250 stations	15% Eligibility criteria*	25% First 500 stations	25% First 100 stations
	Tax Exemption	100% SGST reimbursed	100% SGST reimbursed	100% SGST reimbursed		100% SGST reimbursed	100%/ 75% Public/ Private	✓
	Priority Power Supply	✓ within 48 hrs			✓ Within 15 days	✓	✓	✓ Within 15 days
	Land Subsidy			100% of Land Conversion Fee		R&D included in EFA		Up to 50%
	Discounted Power Tariff	✓ New tariff category	✓	✓		- No connection cost	✓ For up to 10 years	✓
	Registration& stamp Duty			100% stamp duty & Reg fee (₹1 per ₹1000)		100% exemption	100% exemption	100% stamp duty
Demand Side Incentives	Subsidy on Purchase		INR 30k		15% or INR 12k First 20,000 E-3W		✓	
	Loan Interest Subvention		5%				Only for Govt Employees	
	Tax Exemption	100% on road tax	100% on road tax		100% on road tax	100% on road tax	100% on road tax; 20k	75% on road tax; 100k
	Others	Mandatory charging station at Public parking	Additional tax on diesel and petrol vehicles	State will devise standards for battery swapping	Petrol pump freely allowed to setup charging station	10% parking reserved for EV in Commercial Bldgs	Free parking and high toll exemption till 2025	Single window for approval under CMO

In addition to central government policies, state governments have also been providing capital incentives, tax breaks, and subsidized electricity tariffs to accelerate

the development of charging infrastructure. Due to these transformative policies, India has experienced significant growth in the expansion of its charging infrastructure.

2.5 State-wise Policies

State/UT (Top 10)	E2W % CY23	Policy Validity	Demand-side Subsidy for E-2Ws
Goa	16%	Nov 2021-Nov 2026	Phased decline from INR 10,000/kWh in FY21 to INR 2,000/kWh in FY26 (cap of 3,000 E2W)
Kerala	13%	Mar 2019 – Mar 2024	Road Tax Exemption till FY22. Charging infra capex Max INR 1 Mn for AC chargers (100 stations)
Karnataka	11%	Sep 2017 – Sep 2022 (Existing policy continued till launch of new policy)	Road Tax exempted Mandates for adoption of E-2W in e-commerce deliveries by 2030
Chandigarh	10%	Jan 2022 – Jan 2027	INR 5,000/kWh up to INR 30,000 (for first 10,000 E2W). Road Tax waived
Maharashtra	9%	Jul 2021 – Jul 2025	Subsidy of INR 5,000/kWh up to INR 10,000 for the first 100,000 E-2Ws
Delhi	9%	Aug 2020 – Jun 2024 3yr plan extended	Updated policy expected in CY2024 Subsidy of INR 5,000/kWh up to INR 30,000 50% of the 2W fleet to be electric by '25
Odisha	7%	Feb 2021 – Feb 2025	Subsidy as 15% of vehicle cost capped at INR 5,000 (No Cap specified)
Gujarat	6%	Jun 2021 – Jun 2025	Subsidy of INR 10,000/kWh for E-2Ws priced under INR 150k
Chhattisgarh	6%	Aug 2022 – Aug 2032 on gov discretion	Subsidy of 10% of vehicle cost, capped at INR 150k till 2026-27
Tamil Nadu	6%	Feb 2023 – Feb 2028	Road Tax exempt till 2022

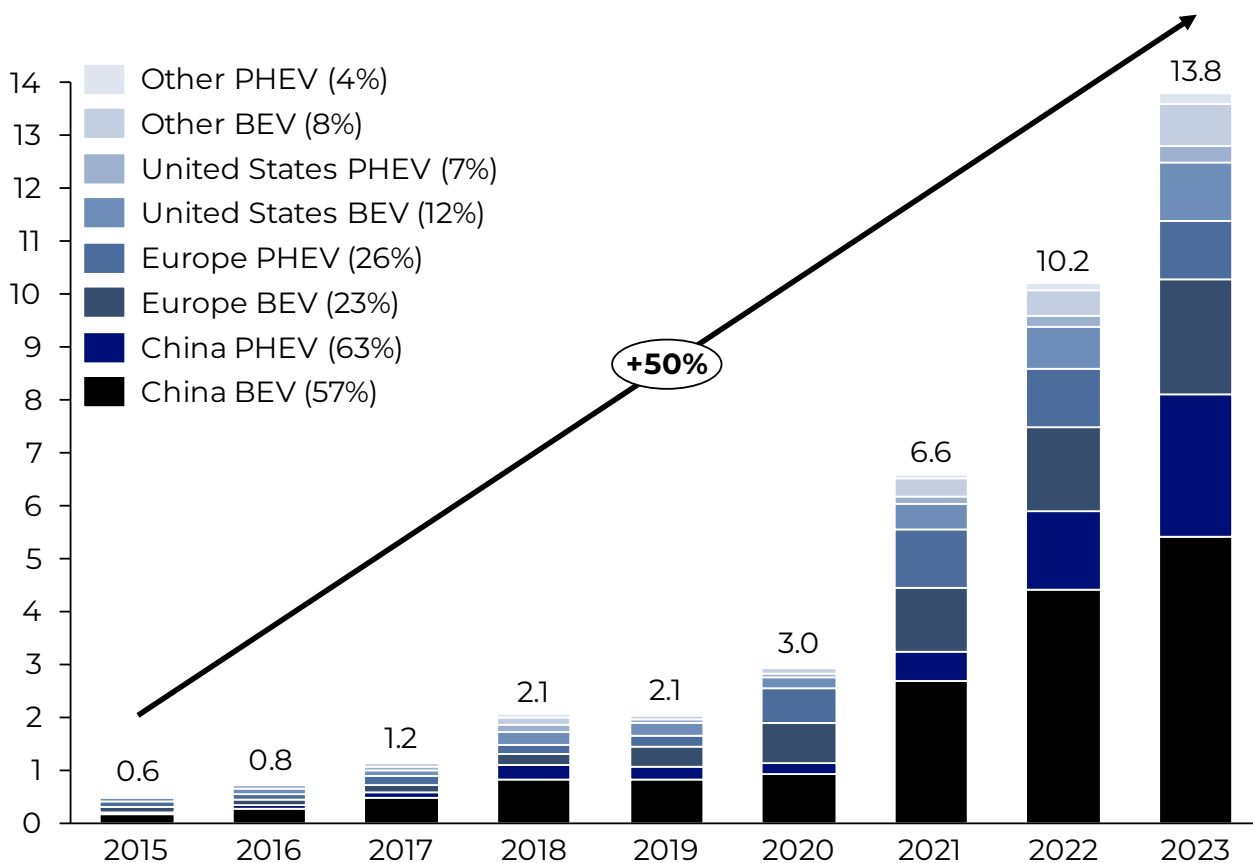
Source: Individual State Policy Notification, Vahan

State wise demand incentives have critical role in determining EV sales locally. In Goa and Maharashtra lead in driving E2W adoption with significant subsidies, enhancing penetration in their respective regions. Delhi's focus on both direct incentives and pollution cess has further promoted EV uptake, while Kerala and Odisha's emphasis on road tax exemptions and charging infrastructure has provided a favourable environment for

EV growth. Gujarat and Chhattisgarh are pushing for adoption through subsidies and manufacturing activities, with policies supporting broader market penetration. Karnataka and Tamil Nadu's focus on manufacturing hubs is contributing to steady E2W adoption, particularly in urban centres. Overall, the states are leveraging a combination of subsidies, infrastructure support, and manufacturing incentives to accelerate E2W growth.

2.6 Global EV Sales Trends

Annual Electric Cars Sales (millions)



Electric vehicle (EV) sales continued their upward trajectory in 2023, with global sales reaching a record 13.8 million units. China remained the frontrunner, contributing to over half of the global sales with 7.9 million EVs sold. However, the growth rate slowed down from the previous year due to

the discontinuation of national subsidies, indicating a shift towards a more market-driven approach. Despite this, China's dominance in the EV market persisted, driven by strong domestic demand and advancements in battery technology.

In the United States, EV sales grew by 40%, fuelled by the entry of new OEMs and the expanding variety of electric models. The anticipation of the Inflation Reduction Act's incentives, set to take full effect in 2024, also contributed to the market's momentum. While the U.S. continues to ramp up its EV infrastructure, challenges such as inflation and supply chain issues have moderated the growth pace compared to the previous year.

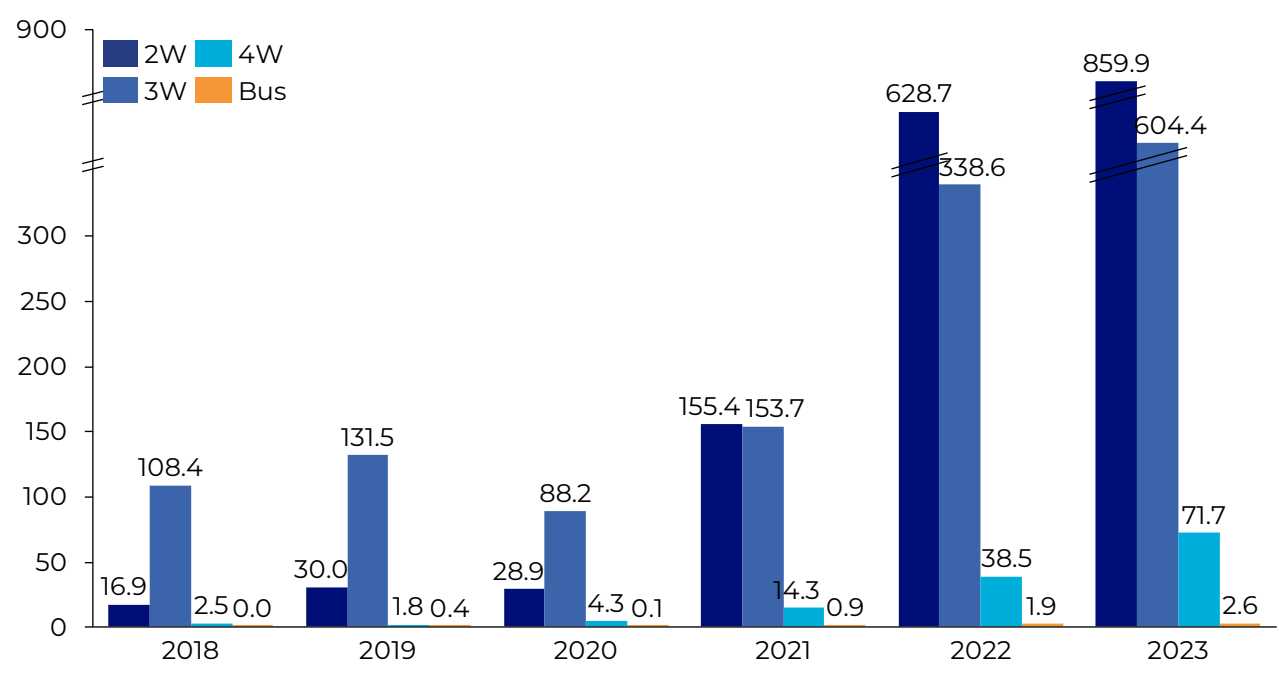
Europe, on the other hand, faced slower growth in EV sales, attributed largely to the ongoing geopolitical crisis in Ukraine and the resultant high energy prices. The region, which once led the global EV market, is now grappling with economic challenges and the gradual phasing out of subsidies, impacting overall consumer demand. Nevertheless, the European market continues to invest in

long-term sustainability goals, which may stabilize and boost EV sales in the future.

Emerging markets, particularly India and Indonesia, exhibited significant growth in EV adoption. India maintained its momentum, with monthly EV sales consistently exceeding 100,000 units, driven by government incentives and growing consumer awareness of electric mobility. Indonesia also saw a surge in EV sales, surpassing 60,000 units, largely due to favourable tax policies and a growing market for electric two-wheelers and small cars. As more countries in Asia and other regions embrace electrification, the global EV market is expected to see sustained growth, albeit at varying paces depending on local economic conditions and policy frameworks.

2.7 Electric Vehicle Sales Growth - India

Annual Electric Vehicle Sales (in '000 units)



Electric vehicle (EV) sales in India continued their remarkable growth trajectory into 2023, building on the strong momentum from previous years. The market, which had already seen significant advancements

between 2018 and 2022, reached new heights with sales of two-wheelers nearing 860,000 units and three-wheelers surpassing 600,000 units. This growth reflects the ongoing commitment of the Indian

government towards promoting electric mobility, supported by policy incentives and growing consumer acceptance.

Two-wheelers remain the dominant segment, driven by their affordability and suitability for urban commuting. However, the recent reduction in incentives for this category has led to a noticeable dip in sales, highlighting the need for a more phased approach to policy changes. In contrast, the four-wheeler segment saw substantial growth, supported by the introduction of new models and increasing consumer interest in sustainable transportation options.

The bus segment, although still small in absolute numbers, also witnessed a gradual increase, indicating the slow but steady adoption of electric buses in public transportation. Three-wheelers continued to be a niche market but showed potential for growth as urban logistics and last-mile connectivity needs expand.

Despite these successes, challenges persist, particularly in the areas of supply chain localization and the development of a robust domestic manufacturing ecosystem. India's reliance on imported components for EVs remains a concern, and efforts to build a self-reliant supply chain are crucial for sustaining long-term growth.

In conclusion, the period from 2018 to 2023 highlights India's increasing commitment to electric mobility, with significant growth across all EV segments. However, careful management of incentives, coupled with ongoing government support and strategic investments, will be crucial to ensuring that this growth trajectory continues. India's journey towards a sustainable transportation future is well underway, and with the right policies in place, the country is poised to become a global leader in electric mobility.

2.8 Market Players

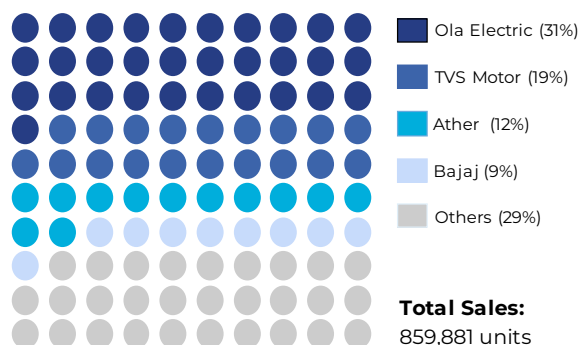
India's EV growth has been primarily fuelled by the emergence of new OEMs and startups, which have led the market with innovative offerings. Traditional vehicle manufacturers are now catching up, investing in portfolio diversification to capitalize on the growing EV demand. Meanwhile, new OEMs and startups continue to introduce advanced EV models, leveraging both in-house R&D and global partnerships. This momentum is further supported by dedicated EV fleet operators, who are playing a crucial role in boosting acceptance and driving the demand for electric vehicles across the country.

Electric Two-Wheelers (E2W)

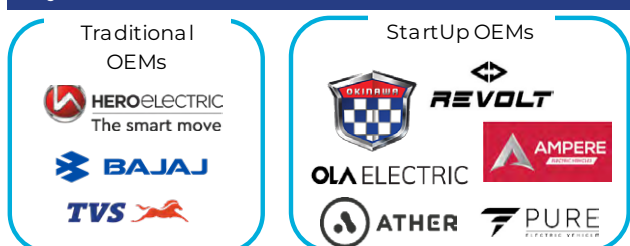
India's electric two-wheeler market is led by prominent players like Ola Electric, TVS, and Ather Energy. Although Hero Electric was one of the early adopters in the E-2W space, newer entrants such as Ola Electric and Ather Energy have quickly secured significant market share. This growth has been largely driven by strong government support, which has enabled emerging companies to introduce new models and establish themselves in the market. Additionally, there has been considerable focus on expanding charging infrastructure and implementing battery swapping solutions in major metropolitan areas across the country.



Sales Distribution (CY 2023)



Key OEMs



Key Industry Developments

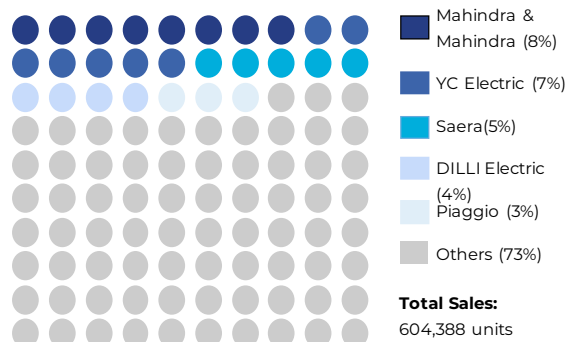
- 2014** - Go Green BoV launched e-bike
- 2018** - Many new vehicles launched in the market including models from traditional OEMs like TVS and also new entrants like Ather Energy, E2O, Bixie (E-bikes for women), Ceeon India etc
- 2019** - Saw introduction of more new players like Ultraviolette, Li-Ions, Okinawa Autotech, Ola Electric etc. Big traditional OEMs like Piaggio & Bajaj also introduced Electric 2W
- 2019** - 2W space dominated 90% by lead acid battery models
- 2020-21** - FAME II gave subsidies to LiB models, companies like Ather Energy, Okinawa, Tork Motors etc grew rapidly in this market
- 2022** - Focus growing on charging infrastructure and swappable battery packs (stations established by Renon India, Honda)
- 2023-24** - Slash in prices with falling LiB Prices, Economic models from Ather (Rizta) and Bajaj (Urbane)
- 2024** - Ola launches motorcycles Roadster

Electric Three-Wheelers (E3W)

India's electric three-wheeler market is primarily driven by E-Rickshaws, with key players like Mahindra, YC Electric, and SAERA leading the segment. Despite this, a significant portion of the market is fragmented among hundreds of

local companies operating in specific regions. Over 200 brands have collectively produced more than 2 million E-rickshaws. Additionally, new E-Auto (L-5 category) models are being introduced by both OEMs and startups, leveraging subsidies provided under the FAME-II scheme to boost their presence in the market.

Sales Distribution (CY 2023)



Key OEMs

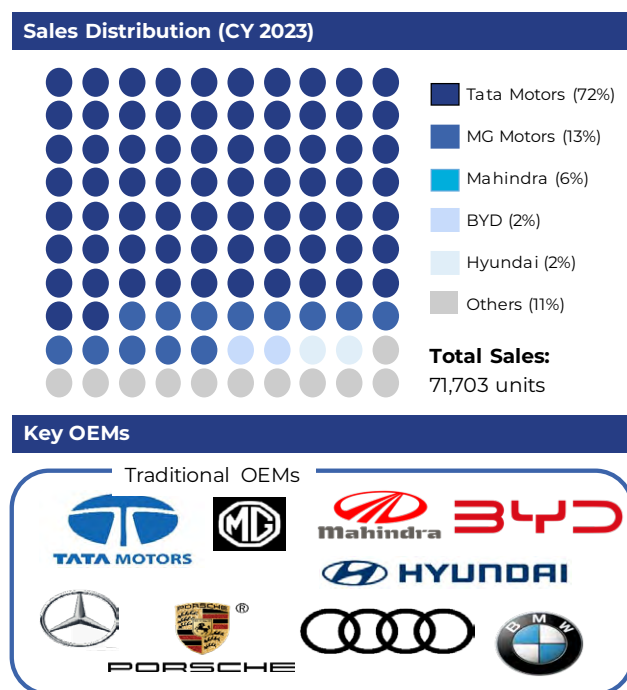


Key Industry Developments

- 2011** - The first product to gain popularity in the e-3 Wheeler segment were electric Rickshaws in major metro cities across India
- 2014** - First laws around E-rickshaws discussed in Delhi High-Court
- 2015** - Legalized e-rickshaws by amending the Motor Vehicles Bill
- 2018** - The e-3W market saw many new players who produce only e-rickshaws like Goenka, ETO Motors, Sun Mobility while traditional OEMs like Mahindra Electric also entered this segment
- 2019** - E-3W gained traction for delivery application driven by giants like Blue Dart, IKEA, Grofers while more traditional OEMs like Bajaj, Piaggio launched vehicles in this segment
- 2019** - Over 2mn+ Rickshaws by 200+ brands, largely lead acid based
- 2020-22** - E-Autos (L-5 category) upcoming through OEMs and startups. FAME II gave subsidies to LiB models of companies like YC, Kinetic, Mahindra
- 2022-23** - Launch of wide body Large PAX autos by Altigreen, OSM, mushrooming of E3W Cargo

Electric Four-Wheelers (E4W)

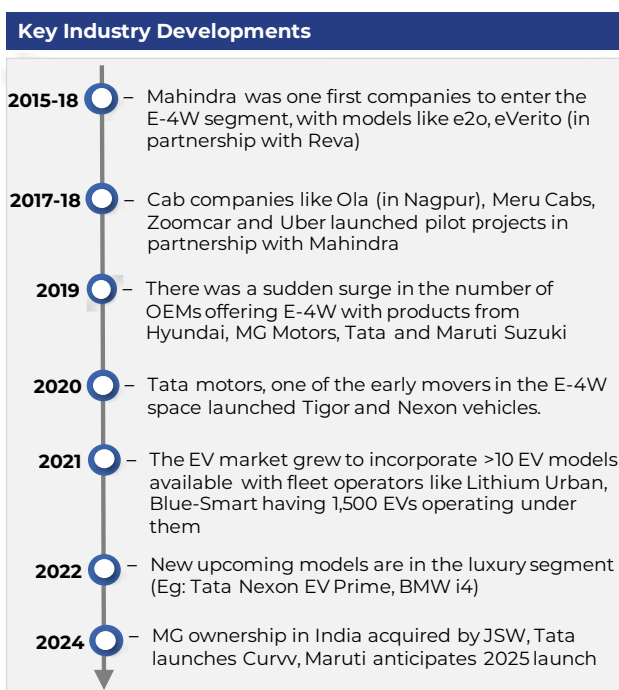
India's electric four-wheeler market has experienced significant growth in recent years, largely driven by advancements in vehicle technology and the expansion of charging infrastructure. Leading the segment are major automakers like TATA, MG Motors, Hyundai, and Mahindra, who have established a strong foothold in the market. The growth has been particularly pronounced in the B2C segment, where consumer interest in electric vehicles has surged. However, the B2B segment is also gaining traction, with fleet operators like Blue-Smart fully electrifying their fleets. Larger operators such as Ola, Uber, and Meru Cabs are actively exploring or piloting partial electrification, attracted by the lower total cost of ownership that electric vehicles offer.



Electric Buses

India's electric bus market has seen rapid expansion over the past two years, propelled by demand aggregation, product advancements, standardization, and better charging infrastructure. Leading players

The market's expansion is further underscored by the availability of more than 20 passenger vehicle models, catering to a diverse range of consumers. This variety is set to increase as several automakers have announced plans to launch new models, particularly in the luxury segment, signalling a broadening of the market's appeal. The convergence of government incentives, consumer demand, and technological advancements suggests that India's electric four-wheeler market is poised for continued robust growth, both in the consumer and commercial sectors. As the market evolves, it is likely to see further innovation and competition, particularly as infrastructure continues to improve and more models become available to meet the needs of different segments of the population.

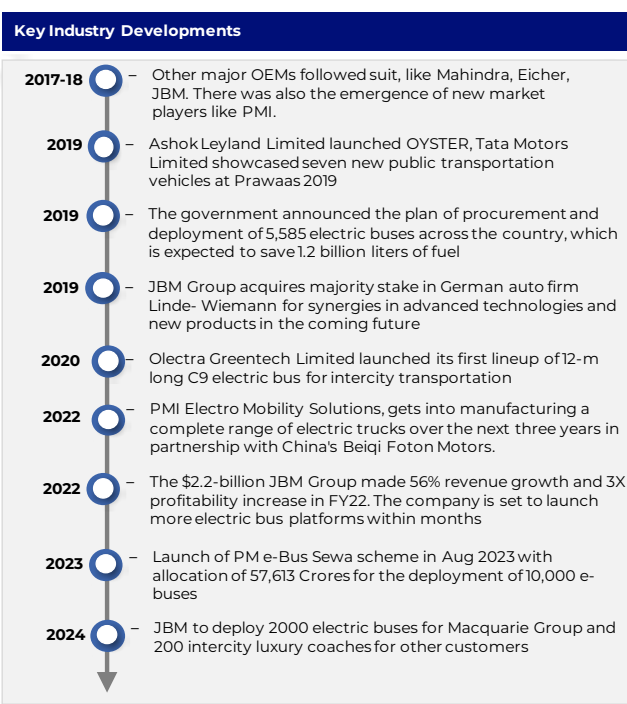
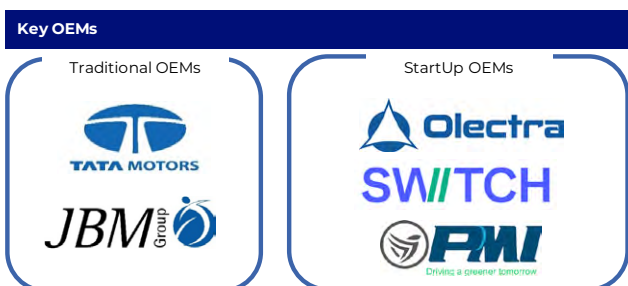


like JBM, PMI Mobility, and Olectra have significantly contributed to this growth. The government's push for fleet electrification and efforts by OEMs like JBM Group to develop integrated EV ecosystems have been key drivers.

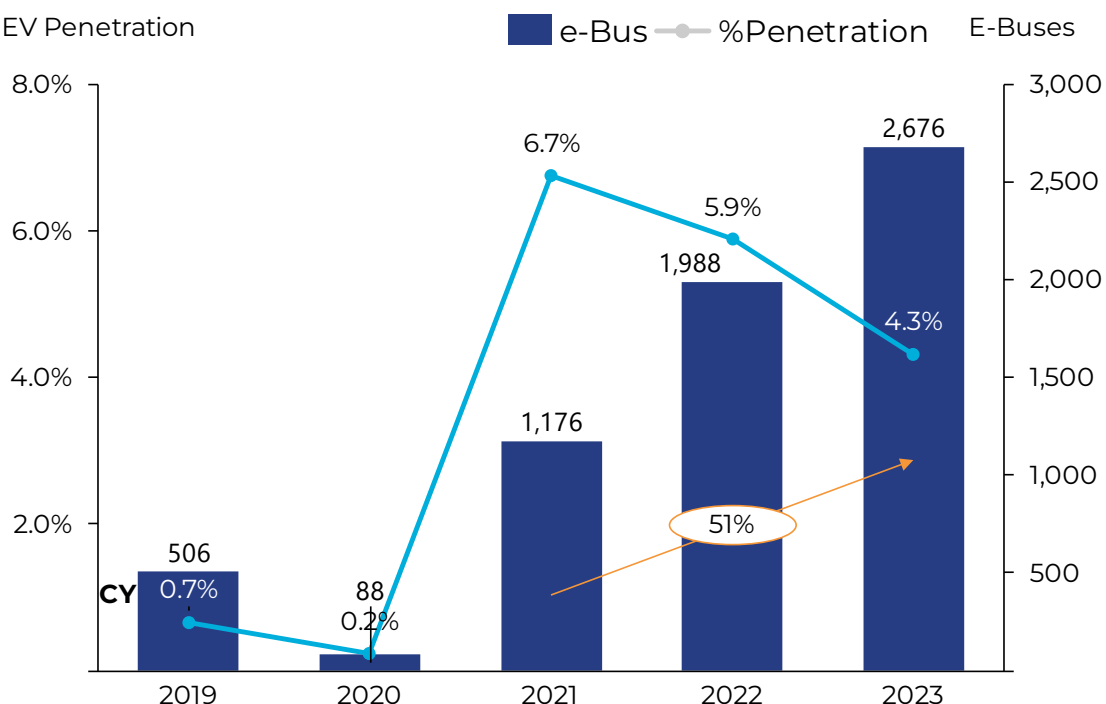
Local businesses are also collaborating with international players to meet rising domestic demand. Cities are adopting various cost-reduction strategies, including upfront subsidies, to lower electrification expenses. As demand aggregation leads to economies

of scale, the electric bus market is expected to achieve over 70% penetration by 2030 across various applications, including city transit, intercity travel, staff transportation, airport tarmac operations, and school buses.

States	Total
AP	23
Assam	178
Delhi	1327
Goa	58
Gujarat	243
HP	35
Haryana	20
Jharkhand	2
J&K	165
Karnataka	596
Kerala	95
Ladakh	9
Maharashtra	664
Madhya Pradesh	62
Odisha	72
Punjab	12
Rajasthan	9
Tamil Nadu	118
West Bengal	16
Total	3704



EV Penetration



In August 2023, under the PM e-Bus Sewa scheme, the Central Government further allocated Rs. 57,613 Crores for the deployment of 10,000 e-buses across 169 cities, thus ensuring that e-mobility will be taken to the grassroots across India.

The India-USA Strategic Partnership for expanding electric mobility in India is working on a payment security mechanism to accelerate the procurement of 10,000 electric buses under the PM e-Bus Sewa programme.

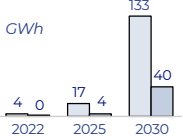


The traction for zero emission public transportation is attracting multiple sovereign funds, DFIs, PEs, global FIIs, local PSUs and other financial institutions for funding and investments on a significant scale.

2.9 Impact Drivers in India

Vehicle Categories	Impact of Drivers of Growth	Impact
 E-Two wheeler	FAME II Extension – Expected to continue till 2024, but the incentive has been decreased to 10,000 INR/kWh with a max cap of 15% of ex factory cost, this is expected to slow growth in the short term	
	Alternate Business Model – Emergence of Battery-as-a-Service, its standardization in pipeline and Mobility-as-a-Service can cater to a wider range of audience compared to conventional ownership	
	Startups and New Products – Higher innovation and emergence of high speed EV 2W which are yet to be experimented by major OEMs	
 E-Three wheeler	High penetration of L3 rickshaws – E-3W rickshaws have a smaller capex, and perform better on a TCO analysis and are much more favourable	
	Better financing mechanisms – New players acts as guarantor and partners with public banks to provide loans at a cheaper rate	
	Swappable E3W – which offer both a higher uptime and better TCO compared to traditional EVs and CNG vehicles as battery cost reduces further	
 E-Four wheeler	Development of fast charging infra – Current 7,000+ charging stations are expected to grow exponentially due to investments	
	Continued R&D – Better battery chemistries offering higher range and performance at lower costs, making EV adoption attractive	
	Tax Incentives – Several states that offer or plan to offer road tax reductions which can reduce on-road prices and thereby TCOs for electric cars	
 E-Bus	Electric corridors – Private players, and potentially e-commerce players soon, are investing in electric corridors for commercial vehicles to run long distances to meet decarbonisation targets	
	Cost Savings and Operational Benefits - While the upfront cost of electric buses is higher than conventional diesel buses, they offer significant operational cost savings over the long term.	
	Gross-cost Contract – Helps reduce burden on cash strapped State Road Transport Undertaking while increasing private participation	

2.10 Sustaining EV Adoption in India

RAW MATERIAL	COMPONENT MAUFACTURING	FINANCING	CHARGING INFRASTRUCTURE	SKILL AND SERVICE DEVELOPMENT	RECYCLING & REUSE												
 - While China is increasing its hold over global Lithium reserves, India has discovered 5.9 MT of Li deposit (6th after Bolivia) in 2023 in J&K and an additional deposit in Rajasthan - However, the transition from exploratory phase to usage of domestic lithium may materialize post 2030, until which, India may continue to rely on imports of cells and packs	 Lithium ion Battery  Power electronics  Electric motor  Charging system 60-65% of EV cost is Lithium -ion battery pack, motor and power electronics, majority of which is imported - Currently only pack assembly is happening in India with targets for cell manufacturing	Purchasing cost of EVs/lack of EV financing availability due to low confidence of financial institutions Models of EV financing include: - Purchase - Retail Loans - Equity/Personal funds - Debt - Bulk procurement - Lease - All - Dry Lease - OPEX - Battery Separation - Battery Swapping - Battery Leasing	Total number of community charging stations in India presently as per BEE: 25,000+ - Ratio of EV to Charging stations in India currently stands at ~100:1 compared to the optimal 6:1 ratio observed in China and mature markets required for strong adoption - Land and SLD related subsidies can significantly reduce CAPEX for a faster adoption	 Increased electronic component s in EVs - India currently lacks suppliers and skills for EV components - Share of upstream component manufacturing can be as high as 60% which will require strong technical capabilities and know-hows	New Battery Capacity Retiring Battery Capacity GWh <table><thead><tr><th>Year</th><th>New Battery Capacity (GWh)</th><th>Retiring Battery Capacity (GWh)</th></tr></thead><tbody><tr><td>2022</td><td>4</td><td>0</td></tr><tr><td>2025</td><td>17</td><td>4</td></tr><tr><td>2030</td><td>133</td><td>40</td></tr></tbody></table> 40GWh worth of batteries are set to retire by 2030 - A lack of proper collection system will result in toxic buildup at landfills and a wasted potential at second life use cases such as Energy Storage Systems	Year	New Battery Capacity (GWh)	Retiring Battery Capacity (GWh)	2022	4	0	2025	17	4	2030	133	40
Year	New Battery Capacity (GWh)	Retiring Battery Capacity (GWh)															
2022	4	0															
2025	17	4															
2030	133	40															
Fast-track localization of raw material supply leveraging new local deposits	For TRUE Make in India, manufacturing of EV components to be indigenised	Govt. push & incentives to financial institutions to promote EV financing	CAPEX easing subsidies for rapid charging infra development	Need dedicated focus on skill development of large workforce	Enforcement of Producer Responsibility and Collection System												

To sustain electric mobility in India, several critical challenges need to be addressed. One major issue is the availability of raw materials, particularly as China's control over global lithium reserves tightens. Although India has discovered significant lithium deposits, these resources are unlikely to be utilized before 2030, meaning the country will continue to rely heavily on importing cells and battery packs in the near term. Addressing these supply chain vulnerabilities is essential for the long-term success of India's electric mobility ambitions.

Component manufacturing is vital, as 60-65% of EV costs depend on imported lithium-ion battery packs, motors, and power electronics. While localizing pack assembly is progressing, the focus should now shift to establishing domestic cell manufacturing to reduce import dependency and build a stronger EV supply chain.

Financing remains a challenge due to the high cost of EVs and limited financing options. Encouraging models like retail

loans, bulk procurement, and battery leasing is essential to boost adoption.

However, Financing for Electric buses in India has seen a significant transformation in recent years. Initially, Non-Banking Financial Companies (NBFCs) were the primary financiers for E-bus concessions. This has evolved with Public Sector Units (PSUs) like the State Bank of India (SBI) stepping in to support the EV Concession Business. The recent interest from diverse financial institutions, including Development Finance Institutions (DFIs), private equity firms (PEs), and global financial institutions, have started a new era in the funding of E-bus projects. These institutions are offering competitive interest rates, extended repayment periods, and longer moratoriums, making the lending terms more favourable for operators.

Further, Payment Security Mechanism (PSM) is announced by Indian Government for the concession business like security being given by SECI in renewable business. PSM is giving further comfort to lenders and ensuring that

their investments are secure, which in turn encourages more funding. Moreover, the entry of funds like Macquarie, which have established platforms to finance E-buses for operators on a leasing model is going to be another financing method. This not only will ease the financial burden on operators but also will support in creating private market for E-buses.

Charging infrastructure is crucial for EV adoption, with India lagging behind mature markets like China in the ratio of EVs per charging station. Providing subsidies for land and SLD can greatly reduce CAPEX, accelerating infrastructure development and adoption.

Addressing the shortage of skilled suppliers and service capabilities is essential, as India currently lacks technical expertise in upstream component manufacturing. Building strong technical know-how is vital.

Recycling and reusing batteries are key to sustainable electric mobility. Implementing robust battery recycling programs can minimize environmental impact and extend battery lifecycles.

By focusing on these areas, India can establish a solid foundation for sustainable electric mobility, fostering a greener transportation ecosystem.

2.11 India’s EV Export Potential

India’s Leverage	Free Trade Agreements will form the bread and butter for enabling foreign trade and will play a major role for export batteries and EV as well going forward. In a tense global environment, India is expanding its hold over international trade through FTAs. India has 13 FTAs at place including major 2W and 3W markets of ASEAN and South Asia which will significantly reduce export barriers.
	A strong self-reliance push has enabled an overall Industrial GVA rise of 3.7% in H1F23 as PLIs unlock further local manufacturing potential.
Way Forward	Additional FTAs – EU, a top market for 2W export additionally with high electrification potential, is yet to be covered by a FTA (in pipeline)
	Enhance Productivity – Even as GVA rose, overall productivity is much lower than in China due to high logistics costs. This can hamper cost-competitiveness in global markets.

Multiple OEMs are exploring or are in implementation stages for export of EVs. Piaggio has deployed its locally made e-Ape in Philippines. Hero MotoCorp eyes Europe

for its maiden e2W by 2023 and TVS targets exports of certain models within its e2W range to ASEAN and mature markets by FY24.

2.12 International Trade Agreements in the Auto Sector

Free Trade Agreements Overview		Impact	
		China not the part of FTA with India	
Countries / Regions	Status		
South Asia (Pakistan, Nepal, Sri Lanka, Bangladesh, Bhutan, Maldives, Afghanistan)	At place	20.75%	↑ Increase in overall exports with countries on FTA from 2015-20
ASEAN (Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam)		25.30%	↑ Increase in exports to ASEAN from 2015-20 reaching USD 31B
East Asia (Japan, South Korea)		18.70%	↑ Increase in exports in South Asia from 2015-20 reaching USD 22B
GCC (Gulf) (CEPA with UAE in place)	Final round of talks	32.90%	↑ Increase in exports to South Korea from 2015-20 reaching USD 4B
UK		Apple's India Growth Story - India now accounts for 7% of the world's iPhones, increasing from 1% in 2021, assembling more than USD 7B worth of iPhones - iPhone exports surged 4 times, reaching USD 5B in FY23, accounting for 50% of overall smartphone exports from India which is now dominated by Apple and Samsung - Foxconn, Wistron and Pegatron, the company's suppliers from India are set to further expand its production lines to cater to the world	
Canada*			
Australia (ECTA in place)			
EU	Next round of talks in Sept. 2024		
USA	A larger agreement will be designed		

India's automotive industry is witnessing a transformative shift, driven in part by the country's proactive pursuit of Free Trade Agreements (FTAs) and other international trade deals. These agreements are critical for India as it seeks to establish itself as a global hub for the production and export of automotive components, particularly in the electric vehicle (EV) sector. By strategically engaging with key regions around the world, India aims to secure the necessary raw materials and open markets for its burgeoning EV industry, especially for high-demand components like batteries.

India has successfully established FTAs with a range of regions including South Asia, the Association of Southeast Asian Nations (ASEAN), East Asia (encompassing Japan and South Korea), and the Gulf Cooperation Council (GCC). The impact of these agreements has been significant, with India's overall exports to these FTA partners increasing by ~25% between 2015 and 2024. Notably, exports to ASEAN countries surged by ~30%, reaching a substantial USD 40 billion. Similarly, exports to South Asia and South Korea grew by ~20% and ~35%, respectively, bringing in USD 24 billion and USD 5 billion. These agreements have helped India to strengthen its trade

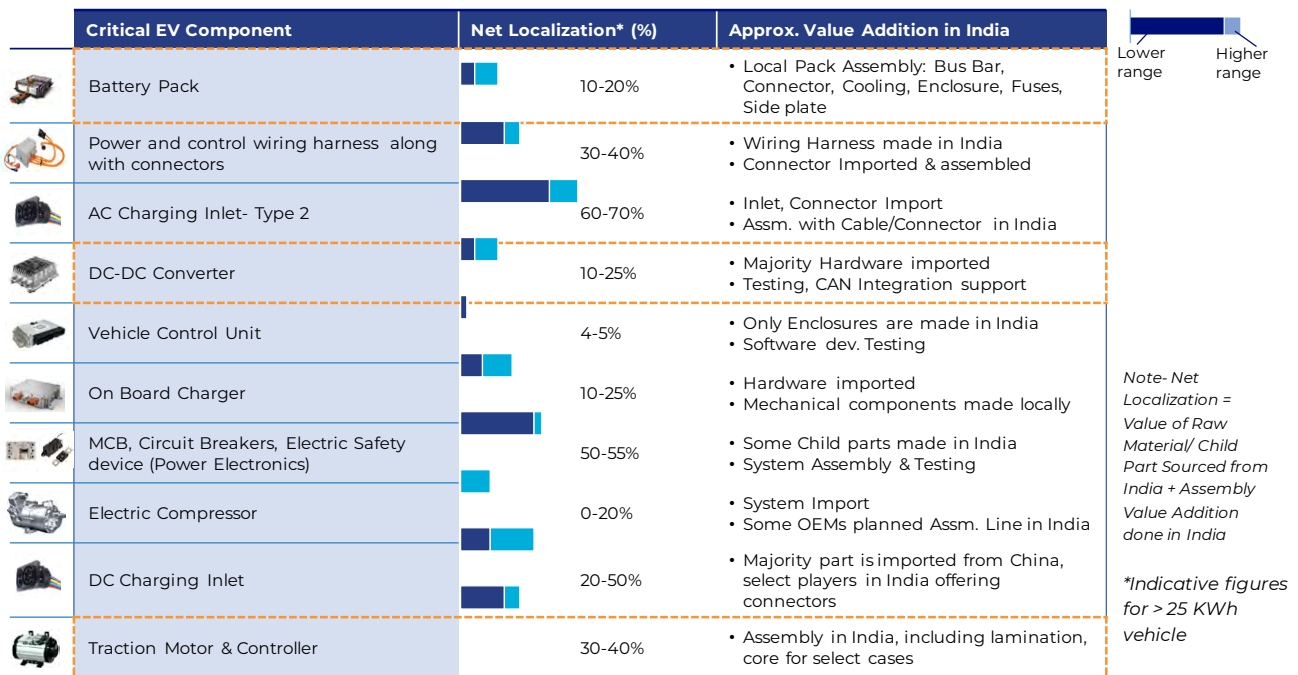
relationships and economic ties, although it is worth noting that China remains outside of these FTAs due to ongoing geopolitical tensions, limiting trade possibilities with one of the world's largest markets.

In addition to boosting trade through FTAs, India's role in the global supply chain is exemplified by its growing contribution to Apple's production ecosystem. Over recent years, India has rapidly increased its share in global iPhone production from 1% to 7%, with the country now assembling more than USD 7 billion worth of iPhones. This growth is underscored by a fourfold increase in iPhone exports in FY23, which reached USD 5 billion, accounting for 50% of India's smartphone exports. Apple's key suppliers in India, including Foxconn, Wistron, and Pegatron, are responding to this surge by expanding their production capacities to meet global demand. As India continues to negotiate new FTAs with countries such as the UK, Canada, Australia, the EU, and the USA, the automotive industry, particularly the EV sector, stands to gain immensely. These agreements will likely open new avenues for export growth, attract foreign investments, and position India as a pivotal player in the global automotive supply chain, especially in the rapidly evolving EV market.

3 EV SUPPLY CHAIN STATUS IN INDIA



Power electronics are vital for managing and regulating the flow of electricity between the battery and motor, while the charging system provides convenient recharging options for the battery pack from external power sources.



Indian policymakers have long recognized the importance of localizing the EV supply chain, a topic that has been discussed since the early stages of the National Electric Mobility Mission Plan 2020. The push for localization is motivated by several factors, such as reducing costs, enhancing domestic manufacturing, and supporting sustainable mobility solutions. Electric vehicles (EVs) depend on several essential components to function effectively and sustainably, including the battery pack, electric motor, power electronics, and charging system. Among these, the battery and traction motor account for the largest share of the vehicle's cost. Power electronics are vital for managing and regulating the flow of electricity between the battery and

motor, while the charging system provides convenient recharging options for the battery pack from external power sources.

Currently, the level of localization for these key components in India is quite low. For instance, battery packs are only 10-20% localized, with domestic production limited to pack assembly, while lithium-ion (LiB) cells are entirely imported. Similarly, while traction motors are assembled in India, many key components are still imported. However, as discussed in the following sections, there is potential for greater localization of these sub-components in India, provided there is collaborative effort from both the industry and the government.

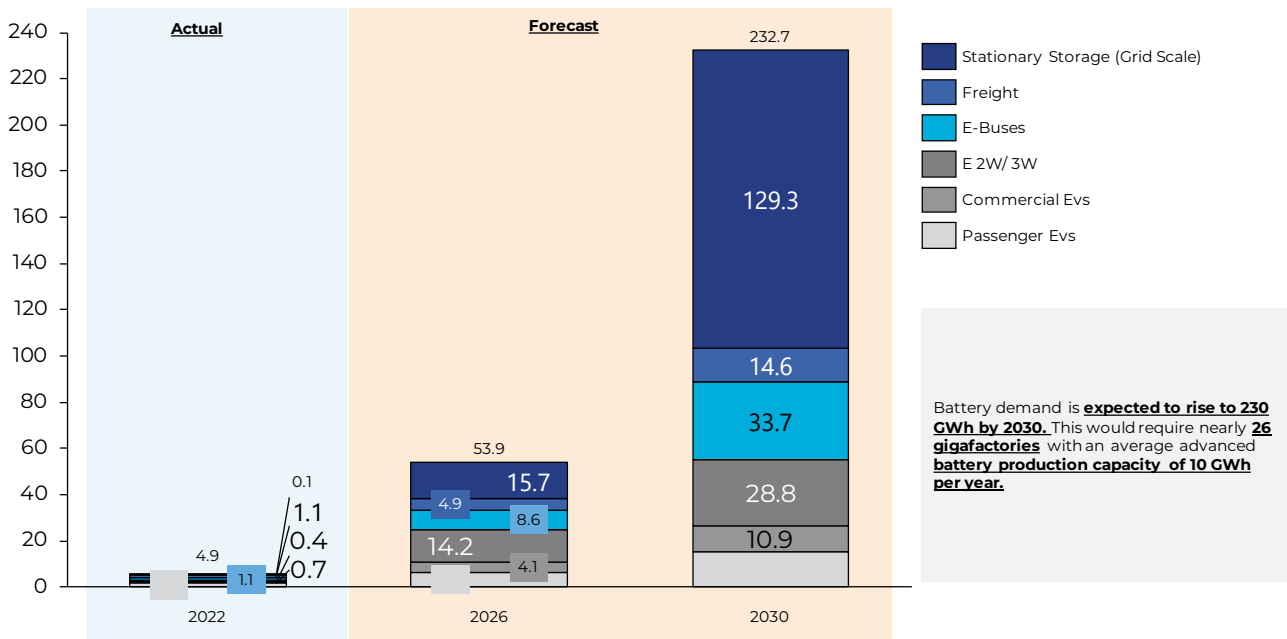
Increasing the localization of these subcomponents will promote self-reliance, reduce dependency on imports, and strengthen the domestic manufacturing ecosystem of India. Localizing these components will foster technological

advancements, drives innovation, and create job opportunities. In the long term, it will drive cost reduction, improve supply chain efficiency, and support the government's vision of promoting electric mobility, sustainability, and a greener future.

3.1 Current Supply Chain Status in India

Battery

India Battery Demand Estimation (GWh/Year)



Source: Niti Aayog

India's commitment to achieving 50% of cumulative power installed through non-fossil-based sources is strongly pushing solar and wind energy. In order to aid grid management, there is a strong potential for the usage of battery-based energy systems for creating RE + storage systems to ensure a smooth load curve. This, coupled with rising E-mobility, is among the drivers of battery demand in India. Based on Niti Aayog estimates, electric vehicles alone will account for ~64% of the cumulative (2022–30) battery potential in India, followed by grid storage applications.

Among electric vehicles, E4W passenger vehicles alone are expected to generate a potential annual demand of 35.3 GWh in

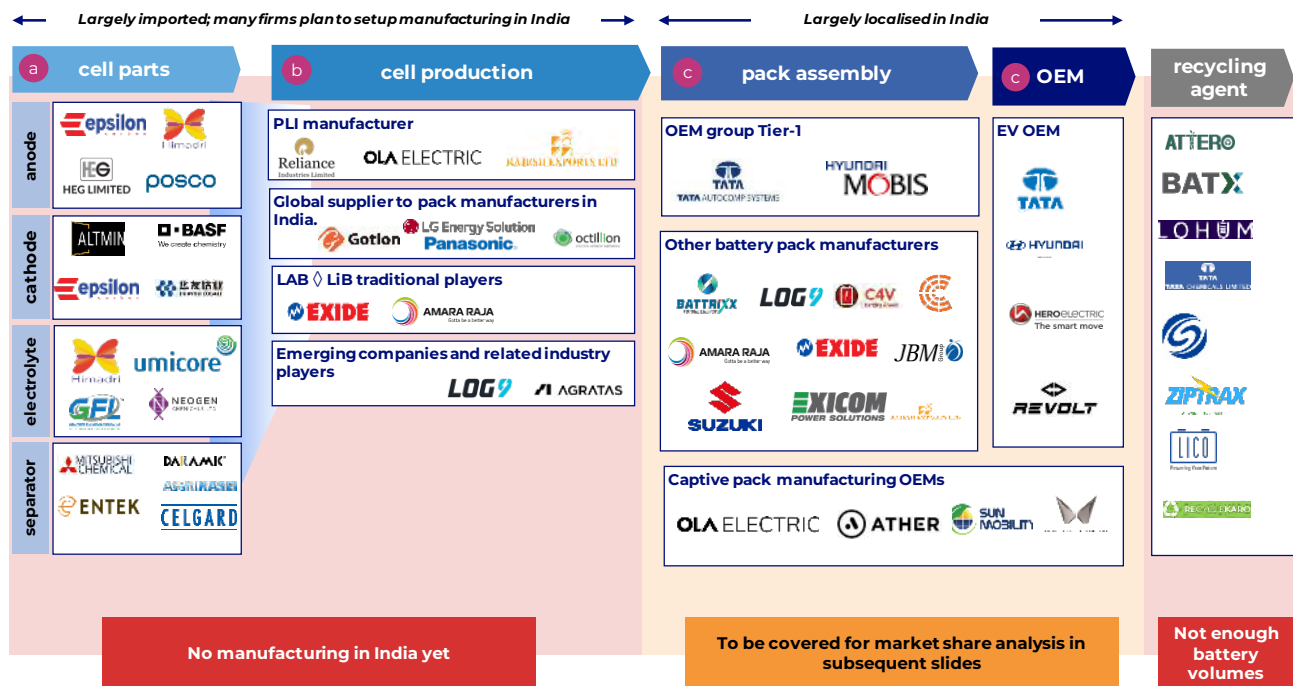
2030, driven by estimates of E4W vehicle volumes increasing exponentially in the coming decade. Average battery sizes are expected to reach between 40 and 50 GWh, with Li-ion technology having >95% market share among various battery technologies. This is followed by E2W, which will generate an annual demand of 33.3 GWh in 2030. The annual potential battery energy demand in 2030 due to EVs itself is expected to be ~102 GWh, which would demand at least 10 gigafactories each of 10 GWh just to meet EV demand.

With a dynamically growing EV market, battery chemistry is expected to evolve to meet the changing needs of consumers and manufacturers. Currently, the battery

trend is dominated by LFP and NMC, with LFP being preferred by E4W and NMC being predominantly used by E2W.

In electric buses and trucks, battery technology is extremely critical considering the safety, performance parameters and high asset utilisation basis which majority of

the manufacturers using NMC batteries have not had any safety or performance concerns which have been observed in multiple bus and truck manufacturers using other chemistries. Therefore, creating value with such technologies is always preferable rather than reducing cost.



Several key players are investing in setting up lithium-ion battery (LiB) manufacturing facilities in India to promote the adoption of electric vehicles (EVs) in the country.

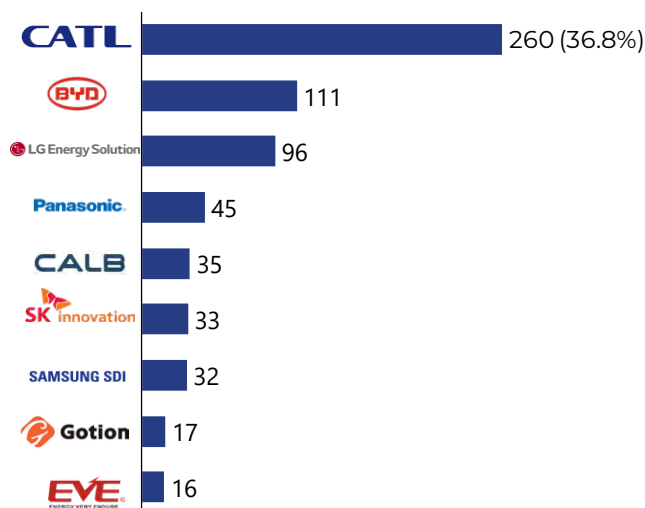
Ola Electric, Reliance, and Rajesh Export have been selected under the PLI scheme for receiving incentives for cell manufacturing and are expected to start cell manufacturing at the latest by 2024. Traditional battery manufacturers' presence is inevitable in lithium-ion battery manufacturing. These companies have an excellent understanding of the automotive industry and have long-term experience working with OEMs. Companies such as Mahindra, JBM Green Energy, India Power, Thermax, Tata, and startup companies are looking to enter the pack manufacturing business, with some plans to explore cell manufacturing in the future.

Tata Group has announced in July its plans to set up a global Lithium-ion cell manufacturing plant in UK with a target of 40GW annual capacity. With an investment of over 4 billion GBP, Tata plans to produce high quality, high performance sustainable cells and packs for applications including both electric vehicles and renewable energy sector. Production is planned to start from 2026. Additionally, Tata also plans to maximise clean energy utilization with a target of 100% down the line and set up recycling and reuse facilities to deliver a circular economy ecosystem.

With a dynamically growing EV market, battery chemistry is expected to evolve to meet the changing needs of consumers and manufacturers. Currently, the battery trend is dominated by LFP and NMC, with LFP being preferred by E4W and NMC being predominantly used by E2W.

Major Players operating in Indian Battery Space

Global Cell Production in 2023 (in GWh)



The top 6 cell manufacturers account for ~82% of Li-ion production in 2023. CATL, LG & BYD all made significant strides in terms of expanding their production capacity

India Manufacturing Capacity (Non-Exclusive)

Upcoming Li-ion Gigafactories in India

Manufacturer	Chemistry	Capacity (GWh)
Ola	NMC	20
Reliance	LiB	5
Rajesh Exports	LiB	5
Exide	NMC, LFP, LTO	12
Amara Raja	LiB	12
Tata Group	LFP	20
TDSG	LiB	3
JBM	NMC, LFP	5

Gigafactories totaling >50 GWh is expected in India

Indicative List of Battery Manufacturers

Source: Volta Foundation, News Articles, Company Websites

Several key players in India are investing in setting up lithium-ion battery (LiB) manufacturing facilities in India.

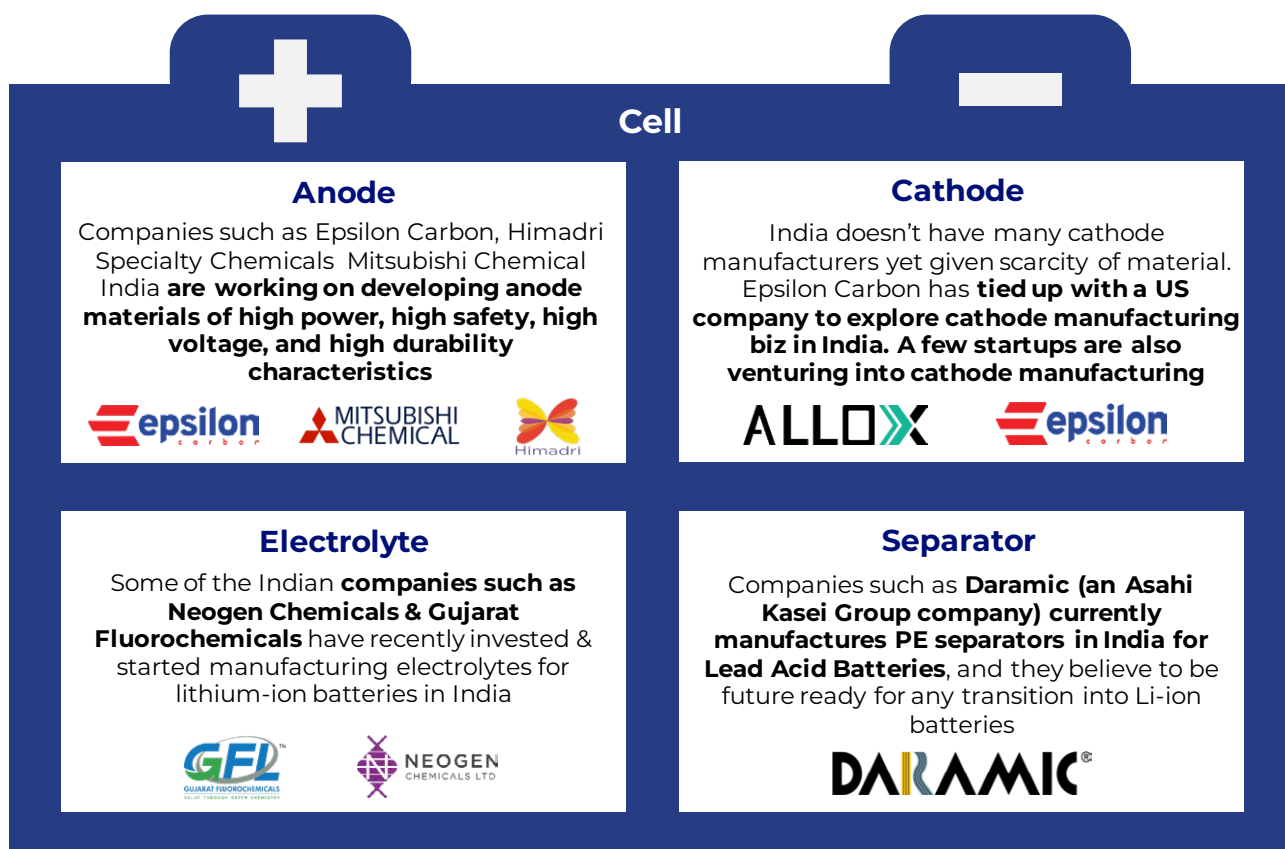
Government intends to take fresh bids for the allotment of the remaining 20 GWh under the second phase of the PLI-ACC scheme.

India aims to develop cell manufacturing capabilities and establish itself as one of the major cell manufacturing hubs.

Battery Localization Potential in India

There is a critical need to localise 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.

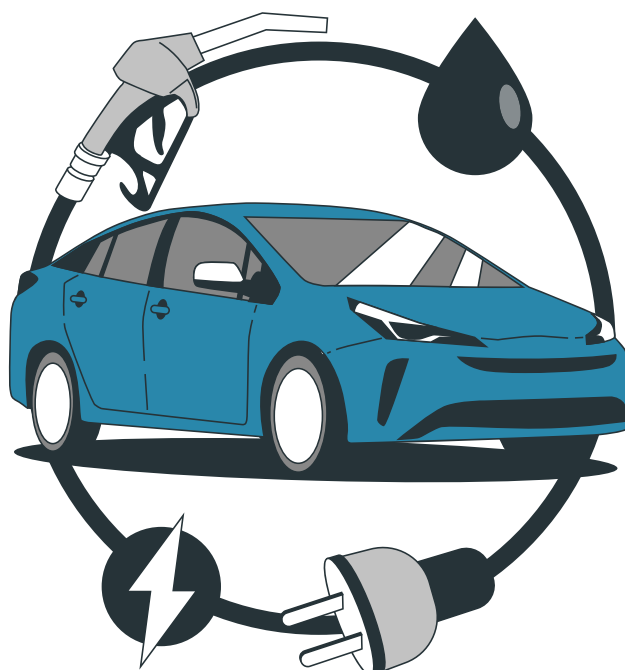




Cell Components Localisation

- **Anode:** Companies such as Epsilon, Himadri, HEG etc. are exploring and taking steps to manufacture anode locally.
- **Cathode:** India doesn't have many cathode manufacturers yet given the scarcity of raw materials. Epsilon Carbon has tied up with a US company to explore cathode manufacturing business in India. A few startups are also venturing into cathode manufacturing.
- **Electrolyte:** Some of the Indian companies, such as Neogen Chemicals and Gujarat Fluorochemicals, have recently invested in and started manufacturing electrolytes for lithium-ion batteries in India.
- **Separators:** Companies such as Daramic (an Asahi Kasei Group company) currently manufacture PE separators

in India for lead acid batteries, and they believe they are future ready for any transition into Li-ion batteries.



Raw Material

India's Treaties with the world

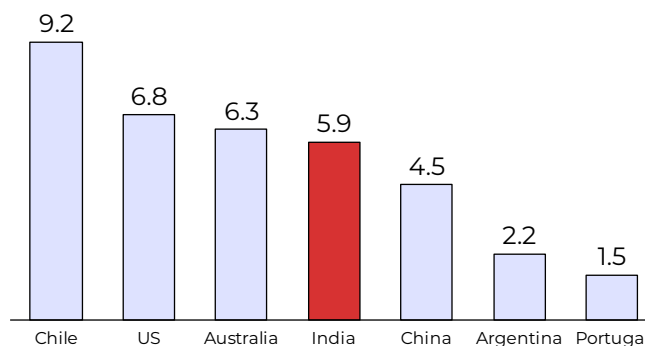
KABIL	NMDC
	
- Joint Venture with , Khanij Bidesh India (KABIL) Ltd., created by Ministry of Mines National Aluminium Company (NALCO), Hindustan Copper (HCL), and Mineral Exploration Corporation (MECL) are three companies that are the main components of this Joint venture. - MOUs signed with many countries including Argentinian organizations, Australia, etc.	- State-owned NMDC (National Mineral Development Corp.) is looking to mine lithium, cobalt and nickel through Legacy Iron Ore Ltd in Australia. NMDC owns 90 per cent share in Legacy Iron Ore Limited. - NMDC is also looking for cobalt, nickel and gold mines in various geographies, including Africa.

To ensure a steady supply of raw materials for lithium-ion battery production in the country, India will be obtaining lithium and cobalt from countries like Australia, Argentina, Bolivia, and Chile. A joint venture company, Khanij Bidesh India (KABIL) Ltd., has been created by the Ministry of Mines with the National Aluminium Company (NALCO), Hindustan Copper (HCL), and Mineral Exploration Corporation (MECL). State-owned NMDC (National Mineral Development Corp.) is looking to mine lithium, cobalt, and nickel through Legacy Iron Ore Ltd. in Australia. NMDC owns a 90% share in Legacy Iron Ore Limited. NMDC is also looking for cobalt, nickel, and gold mines in various geographies, including Africa. Hence, once these G2G collaborations pick up, India will solve major challenges with respect to raw materials access for cell manufacturing.

Recycling Status in India

Lithium-based battery chemistries are rising exponentially in India with the

Lithium Deposits per Country



Indian-Lithium Reserve findings

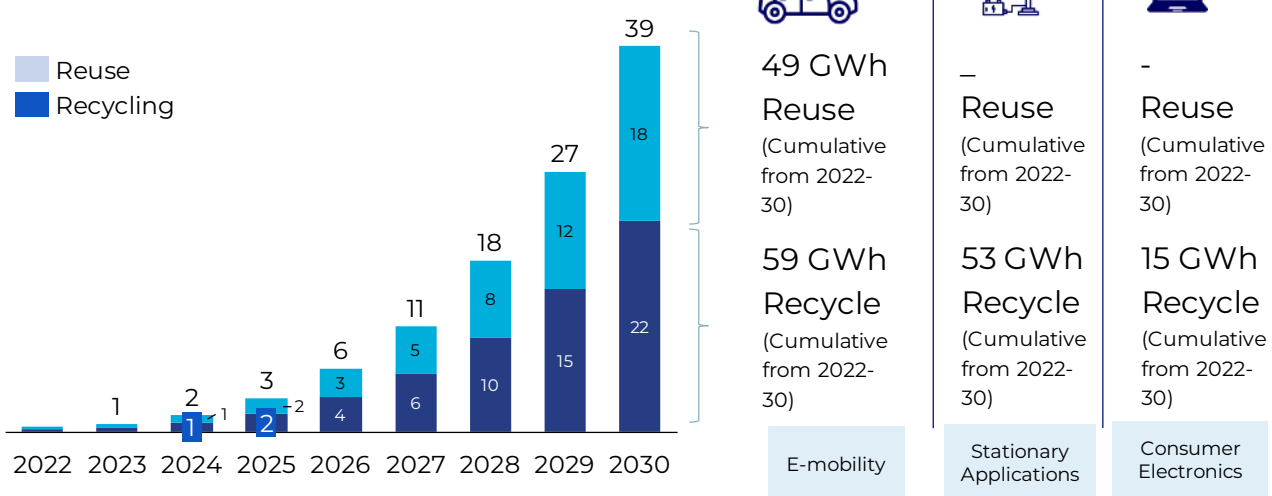
Lithium deposits found in J&K: Is India's EV drive now set to take the fast lane?

Govt To Auction Newly Discovered Lithium Reserves In J&K By June: Report

Earlier this month, the government said that 5.9 million tonnes of lithium reserves have been found in Jammu and Kashmir

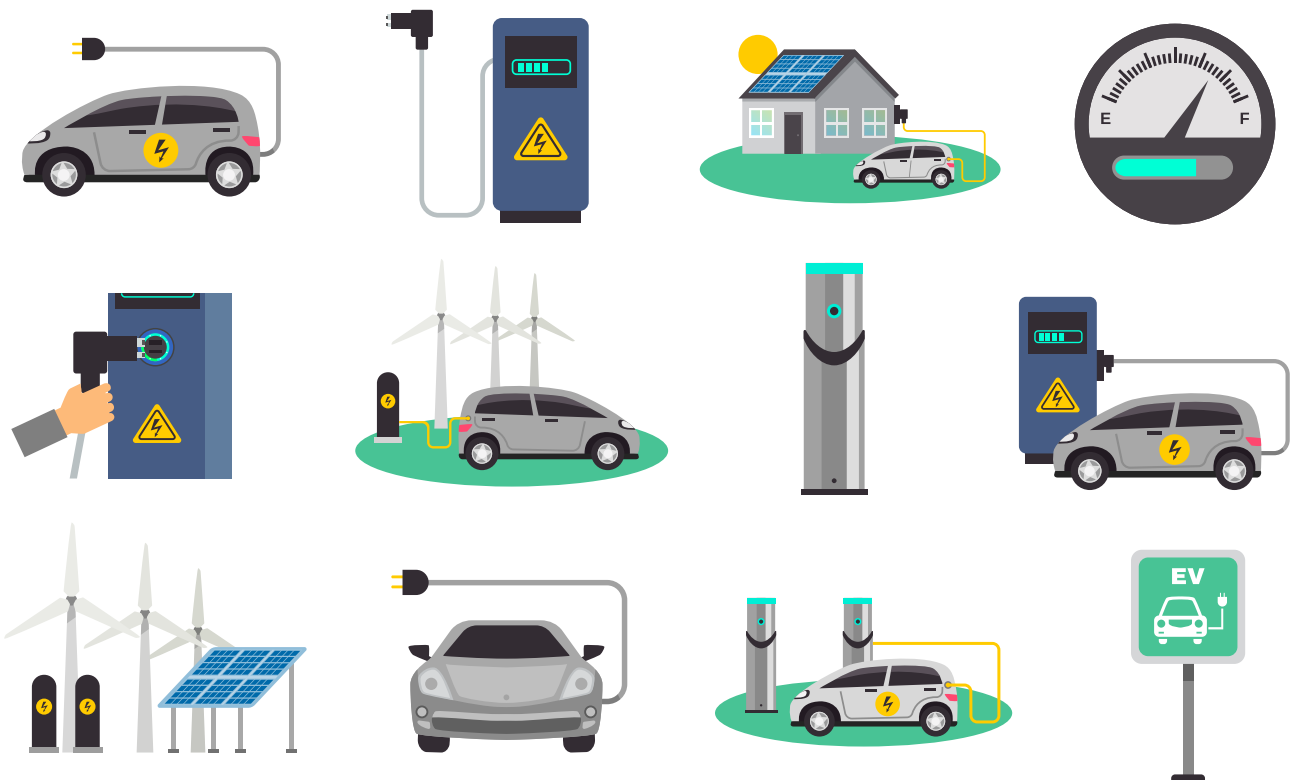
indispensable growth of EV automotive and Stationary Applications, including renewable integration with the grid, data centres and telecom, moving beyond the historical usage in consumer appliances. The total demand for Lithium-ion Batteries (LiB) in India is expected to cross 230 GWh by 2030 from a mere ~5 GWh in 2020. The rising LiB is coupled with a need for a robust LiB recycling ecosystem primarily driven by the need to hedge 1) geopolitical supply chain risk associated with critical minerals like lithium, cobalt and nickel in batteries, 2) managing environmental hazards with untreated batteries and meeting sustainability goals with recycled material resulting in 55% GHG emission than using virgin materials from ores and 3) improved price discovery for LiB batteries. To fully evaluate the recycling potential of the Li-ion battery (LiB) value chain, it is important to analyse both stationary applications and electric vehicle (EV) batteries, which are expected to be the primary consumers of manufactured cells in the future.

Annual LiB recycle and reuse volume from EV in GWh



EV batteries, once used, can either be repurposed or sent for recycling, depending on the level of recovery. Larger form factor EV batteries, such as those used in four-wheelers (4Ws) and buses, are generally more suitable for repurposing compared to those used in two- and three-wheelers. According to NITI Aayog, only about 30% of batteries from two- and three-wheelers

are viable for repurposing due to their frequent usage cycles and the chemistries involved, whereas this figure can reach up to 60% for private four-wheelers. Typically, EV batteries have a lifespan of 3-5 years, after which they can be repurposed for stationary applications for a similar duration before eventually being recycled.



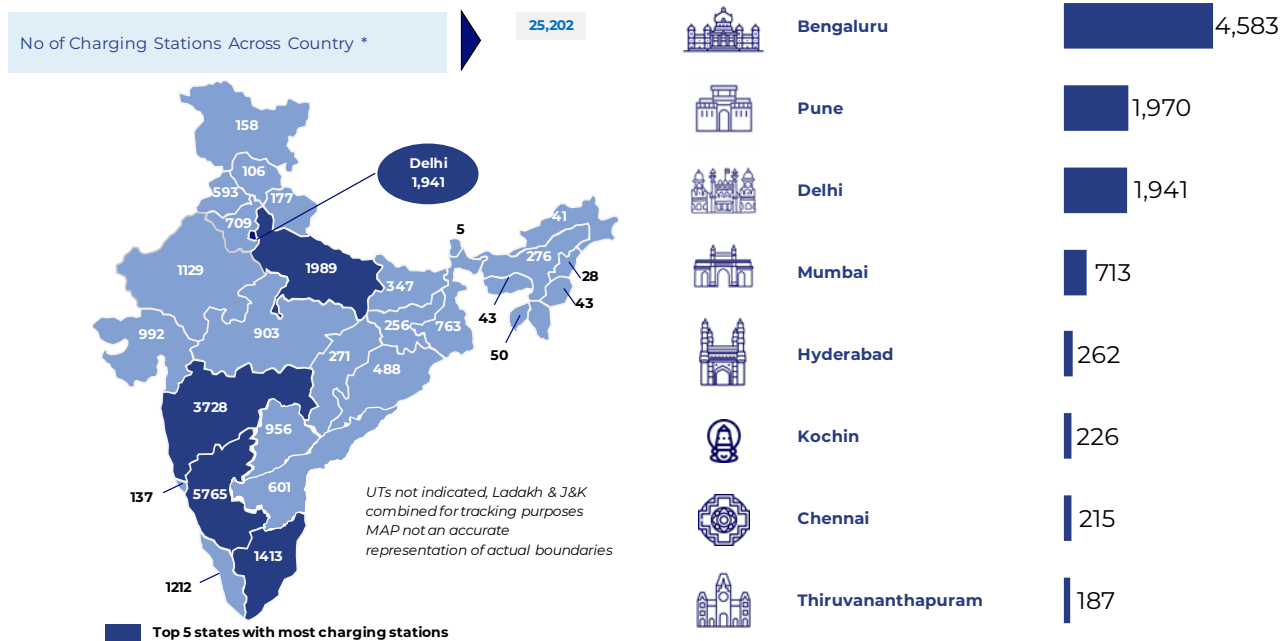
4 CHARGING INFRASTRUCTURE IN INDIA



Some estimates suggest that the actual number could be closer to 32,000, as many private players have not yet registered their chargers on the BEE portal.

India's EV charging ecosystem has experienced significant growth over the past 2-3 years, with rapid expansion in both plug-in charging stations and battery swapping stations (BSS). Concurrently, EV sales have surged from around 160,000 vehicles in 2019 to over 1.5 million in 2023, representing a 9-10x increase over the past four years. The growth in public charging infrastructure has

been equally impressive. In 2021, there were only 451 public chargers; by end of August 2024, this number had soared to over 25,202 according to the Bureau of Energy Efficiency (BEE). Some estimates suggest that the actual number could be closer to 32,000, as many private players have not yet registered their chargers on the BEE portal.



Source: *As per BEE, September 2024 ** Map of India shown is only Indicative and may not accurately represent boundaries. UT PCS not indicated on map

Mumbai includes city, suburb & Thane, Bengaluru includes both urban& rural, Delhi limited to state boundary

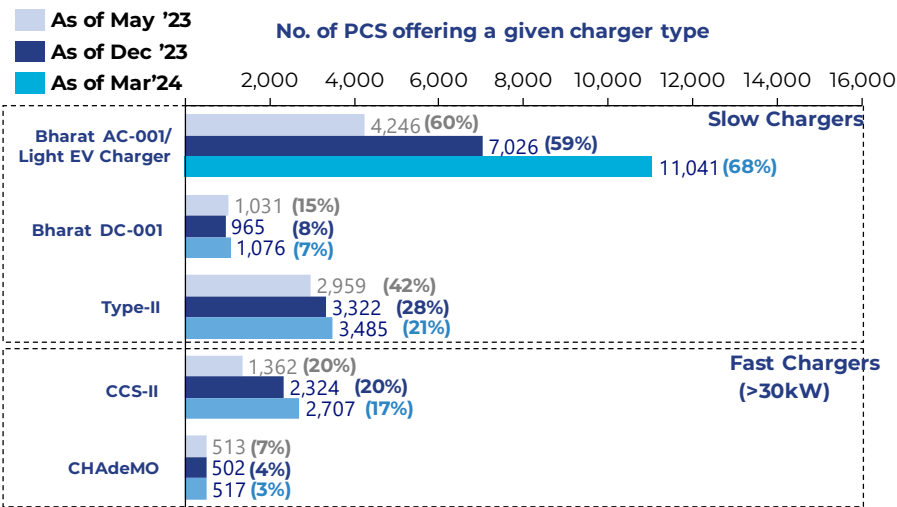
Despite the rise in charging stations, their distribution remains uneven. Delhi (excluding NCR regions of Gurugram, Noida), which has been proactive in adopting charging infrastructure to combat air pollution, now has 1,941 public charging stations. As of March 2024, India has a total

of 16,344 charging stations, with Bengaluru leading at 4,583 stations, followed by Pune (1,970), Delhi (1,941), and Mumbai (713). States like Maharashtra, Karnataka, Tamil Nadu, UP and Kerala have a more substantial presence of charging stations, indicating a concentration in the southern & western regions of India.

Charger Types in India

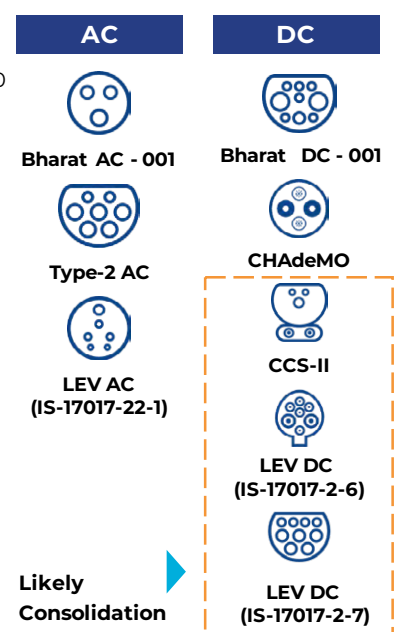
AC			DC				
Bharat AC - 001	Type-2AC	LEV AC (IS-17017-22-1)	Bharat DC - 001	CHAdMo	CCS-II	LEV DC (IS-17017-2-6)	LEV DC (IS-17017-2-7)
							
Power Output	Power Output	Power Output	Power Output	Power Output	Power Output	Power Output	Power Output
3.3 kW	3/7/11/22 kW	3.3 kW	15/30 kW	25/50/100/250/500 kW	25/50/100/250/500 kW	Up to 12 kW	Up to 12kW
Rated Voltage	Rated Voltage	Rated Voltage	Rated Voltage	Rated Voltage	Rated Voltage	Rated Voltage	Rated Voltage
230 V (1-phase)	230 V (1-φ) - 415 V (3-φ)	230 V (1-φ)	48 V - 72 V	500 V - 1000 V & Above	500 V - 1000 V & Above	120 V	120 V
							

Status of Charger Types offered at PCS in India



Source: *BEE, PCS: Public Charging Stations

- EV market is expected to **converge towards CCS-II and new LEV DC protocols**; CHAdMo may phase out due to low acceptance by OEMs
- LEV chargers are rapidly increasing and will be the future of charger consolidation



India's diverse range of EV chargers includes both AC and DC types. AC chargers, such as Bharat AC - 001, Type-2 AC, and LEV AC (IS-17017-22-1), offer power outputs from 3.3 kW to 22 kW and support voltages from 230V single-phase to 415V three-phase. On the DC side, chargers like Bharat DC - 001,

CHAdMo, CCS-II, and two LEV DC versions (IS-17017-2-6 and IS-17017-2-7) provide power outputs between 12 kW and 500 kW with voltages ranging from 48V to over 1000V. Recently, the Indian government approved LEV charger types, further enhancing the charging infrastructure. These chargers are

compatible with various vehicle categories, including electric two-wheelers, three-wheelers, cars, and buses, demonstrating India's comprehensive approach to EV infrastructure development.

Bharat AC-001/Light EV chargers dominate India's public EV charging landscape, with 68% of public charging stations equipped with at least one of these chargers, up from 59% in December 2023. These chargers are primarily designed for smaller vehicles like E-2Ws and E-3Ws but can also serve passenger cars and light commercial vehicles (LCVs). However, due to longer charging times, they are best suited for E-2Ws and E-3Ws.

Type-II AC chargers, offering power outputs from 7.2 to 22 kW, are gaining popularity for their ability to charge both E-3Ws and E-4Ws. In the fast-charging sector, the CCS-II standard has been widely adopted by automakers across India. While around 20% of public charging stations had at least one CCS-II charging gun in May 2023, this figure remained consistent through December 2023 but dropped to 17% by March 2024. This decline, despite a significant increase in the absolute number of CCS-II chargers, is attributed to the rapid growth of LEV chargers, reflecting efforts by OEMs and charging point operators (CPOs) to standardize and adopt interoperable chargers for 4-wheeler passenger cars.



5 WAY FORWARD — INDUSTRY PERSPECTIVE



The government should present a long-term roadmap with specific targets for penetration and localization, providing industry players with a clear timeline for incentives.

5.1 FAME, EMPS and PLI-ACC Scheme



**EV (CV) After
Sales Service
Provider**

Providing cash subsidies for vehicles is unlikely to achieve the desired outcomes. Instead, we should focus on subsidizing modern, high-tech, smart batteries and carefully monitor these subsidies in collaboration with battery manufacturers and assemblers.



E-bus OEM

Continuing the Electric Mobility Promotion Scheme (EMPS) and introducing FAME III are key to advancing India's EV ecosystem. These initiatives will boost EV adoption, reduce emissions, and support sustainable transportation. Developing shared charging infrastructure for electric buses in the private sector is essential. The local content requirement should be optional, allowing OEMs to focus on cost efficiency. Since electric buses are not mandated by law, choosing between electric or BSVI (Diesel/CNG) buses should be at the discretion of the authority or operator.



EV 4W OEM

Continuing EMPS and launching FAME III are vital for advancing electric mobility and reducing environmental impact. Enhancing these initiatives involves broadening EV incentives, expanding charging infrastructure, streamlining subsidies, boosting R&D, supporting local manufacturing, and improving consumer incentives.



**Battery
Swapping
CPO**

PLI will undoubtedly boost the sector, but it lacks support for charging and swapping infrastructure, BMS, battery packs, and R&D. A separate PLI for startups and MSMEs in this space, along with expedited ACC PLI output, would further benefit the sector.



EV CV OEM

The Production-Linked Incentive (PLI) scheme for Advanced Chemistry Cell (ACC) battery manufacturing is a major step in enhancing India's battery production, reducing import reliance, and supporting the EV and renewable energy sectors. However, selecting the appropriate battery chemistry for optimal performance under Indian city conditions remains a challenge.



EV CV OEM

PLI for EVs could be more effective, and PLI for ACC projects could be transformative. However, success largely depends on securing critical minerals and maintaining geopolitical stability internationally

Industry experts in the Indian EV sector emphasize the importance of extending the FAME scheme beyond March 2024, recommending a three to five-year extension to provide stability and long-term policy clarity. This is crucial for businesses to effectively plan their investments. The scheme's focus should expand to include support for public transport and heavy-duty vehicles, with incentives for quality control investments in lithium cell and pack manufacturing to ensure global competitiveness. A strategic approach with well-defined sunset clauses is vital to sustainably aid the EV ecosystem. The government should present a long-term roadmap with specific targets for penetration and localization, providing industry players with a clear timeline for incentives.

The PLI scheme is recognized as a significant step towards battery localization but requires adjustments. Experts suggest that incentives should be more inclusive, extending to both large and small players. Securing a stable supply chain for critical raw materials is essential for giga scale battery production. The PLI ACC scheme should not only focus on cell manufacturing but also support the entire upstream supply chain, including Tier-2 suppliers, CAM, pre-CAM producers, and battery recyclers. Additionally, the scheme needs to address issues related to raw material procurement and processing, aiming for self-sufficiency in critical mineral availability to strengthen India's battery production capabilities.

5.2 Strengthening the EV supply chain



Battery Swapping CPO

To enhance the manufacturing capabilities for critical EV components like motors and inverters in India, a comprehensive strategy should be adopted that integrates policy support, investment in R&D, skill development, and collaboration within the ecosystem.



EV Component Manufacturer

Funding is limited in the sub-component sector, as investments and subsidies are primarily directed toward OEMs, leaving sub-component manufacturers struggling to invest without clear revenue prospects. As a result, OEMs tend to produce as many sub-components in-house as possible to secure better margins and optimize the use of raised funds. Although financing sub-component manufacturers is challenging, providing low-cost test and validation facilities—the major bottleneck for launching products—could significantly reduce the barriers for many industry players.



E-bus OEM

Strengthening the manufacturing capabilities for key EV components like motors and inverters in India is crucial for building a strong domestic supply chain, reducing reliance on imports, and supporting the EV industry's growth. However, the industry must address the challenge of optimizing production costs despite low volumes.



EV Component Manufacturer

Reducing GST and taxes on technology transfer agreements, enforcing strict requirements for EV manufacturers to purchase Made-in-India components, and ensuring the availability of high-quality labs to certify Indian-made products are essential steps.

The manufacturing and supply chain for electric vehicles in India require a multifaceted approach to ensure growth and sustainability. A comprehensive strategy is needed to enhance the production capabilities of critical EV components like motors and inverters. This involves integrating policy support, R&D investment, skill development, and collaboration within the ecosystem. The supply chain, particularly in the sub-component sector, faces challenges due to limited funding and a focus on OEMs.

To address these issues, it is crucial to provide low-cost test and validation facilities, reduce taxes on technology transfer agreements, and enforce strict requirements for EV manufacturers to prioritize Made-in-India components. Additionally, promoting a stable supply chain through incentives for precursor manufacturing, recycling, and repurposing is essential. This strategic focus will not only strengthen domestic production but also reduce reliance on imports, ultimately supporting the broader growth of India's EV industry.

5.3 Priority Lending for EVs



MaaS Provider

Currently, access to financing is limited, with very high IRRs, especially in the 2- and 3-wheeler segments, which are crucial for driving the EV transition. This challenge is largely due to the evolving nature of these products and the fact that many users, particularly in the supply chain, have little to no credit history. Therefore, priority lending will be crucial to spur market growth.



Battery Swapping CPO

Priority lending can be effective in stimulating the electric vehicle market in India, but its impact may be limited if cost parity with existing ICE vehicles isn't achieved. To enhance market growth, the government should prioritize battery swapping technology, as it could bring the total cost of ownership (TCO) to levels comparable with or lower than ICE vehicles.



**EV
Component
Manufacturer**

Priority lending for EVs in the price range of 15 lakhs will be effective. However, special pricing and a single-window loan disbursement system are necessary for both BEVs and FCEVs to maximize the impact.



OEM

Priority lending will be highly effective, as it can help offset the higher initial cost of the vehicle by spreading the cost difference over its usage. Additionally, there should be incentives to maximize the distance these vehicles are driven.

Priority lending is essential for boosting electric vehicle adoption, especially in the 2- and 3-wheeler segments, where financing is limited due to high IRRs and users with limited credit history. While priority lending can drive market growth, its impact may be limited without achieving cost parity with ICE vehicles. To enhance effectiveness,

the government should prioritize battery swapping technology to lower the total cost of ownership (TCO). Additionally, streamlined loan processes, special pricing, and usage incentives are crucial strategies to maximize the benefits of priority lending in the EV sector.

5.4 Battery Recycling



**Battery
Recycler**

The recycling industry in India is still in its infancy, lacking world-class technology. To develop indigenous technologies, we need to encourage R&D in this sector. However, two urgent requirements must be addressed:

- Access to raw materials, which India currently lacks, necessitating the import of used lithium batteries
- Incentives and funding support through public and private participation.



**MaaS
Provider**

The current recycling capacity is minimal and urgently needs to improve. When a battery is said to be no longer working, it just means it's not fit for its original purpose anymore. I see potential in repurposing these batteries, first for different mobility applications and then gradually for stationary energy storage solutions.



**EV (CV)
OEM**

The recycling process is gaining momentum due to strict EPR guidelines and regulations. However, recyclers should go beyond just reaching the Black Mass stage and complete the full recycling process to recover essential critical minerals.



**Battery
Recycler**

Recyclers in India need raw materials and R&D investment to expand capacities, unlike China and Korea, which are advancing by importing lithium-ion batteries. To improve, India requires more R&D labs, closed-loop recycling, material manufacturing standards, and better collaboration between recyclers and OEMs. Given the high capital requirements, access to funding and international partnerships will be essential

India's recycling sector is in the early stages and urgently requires advancements to develop competitive domestic capabilities. The industry needs better access to essential materials, such as used batteries, and increased investment from both public and private sectors to scale effectively. Current recycling capacity is limited, and there is a significant need to focus on reusing batteries for alternative applications like energy storage.

While regulations are driving some progress, the industry must push beyond basic recycling processes to fully recover valuable resources. To keep pace with global advancements, India should prioritize expanding R&D, implementing comprehensive recycling systems, and encouraging stronger partnerships between recyclers and manufacturers. Addressing financial and technical barriers will be crucial for the sector's growth and sustainability.

5.5 Charging Infrastructure



EV OEM

We are entering the early adoption phase for commercial EVs in India, driven by depot charging at select locations. As costs decrease, efficiency improves, and localization advances, broader adoption will require significant charging infrastructure development. Promoting high-power chargers (>100 kW to megawatt) and ensuring a reliable power supply are essential, with FAME III subsidies playing a key role.



**EV 4W
OEM**

To enhance EV charging infrastructure in India, offer investment incentives, standardize charging technology, expand public and private charger networks, support home and workplace installations, promote public-private partnerships, integrate smart grid technology, and raise public awareness



**EV
Component
Manufacturer**

Independent off-grid green charging stations should be encouraged, especially those generating electricity from the city's biowaste, allowing city waste to power its vehicles



EV 4W OEM

To reduce the high costs of public charging infrastructure while ensuring scalability and accessibility, we can focus on:

- **Public-Private Partnerships:** Collaborate to share costs and responsibilities.
- **Modular and Smart Charging:** Implement scalable designs and optimize energy use.
- **Incentives and Standardization:** Provide financial support and ensure uniform technology.

As India enters the early adoption phase for commercial EVs, primarily through depot charging, broader adoption will hinge on significant charging infrastructure development. Promoting high-power chargers and ensuring a reliable power supply, supported by FAME III subsidies, will be crucial. To enhance EV charging infrastructure, the focus should be on investment incentives, standardized technology, expanded charger networks, and smart grid integration. Encouraging independent off-grid green charging stations powered by city biowaste could further support this transition. Reducing costs through public-private partnerships, modular and smart charging solutions, and

financial incentives will be key to making public charging infrastructure scalable and accessible.

Charger standardization and battery swapping are crucial for accelerating EV adoption, especially in areas with developing infrastructure. While some advocate for organic evolution, a top-down approach is necessary for rapid progress. However, standardization must focus on safety without stifling innovation or limiting options. India's adoption of CCS2 and Bharat Stage 1&2 standards is a positive step, but challenges remain with DC chargers and extending battery swapping beyond 2W and 3W vehicles.



MaaS
Provider

Charger standardization and battery swapping are crucial for the rapid adoption of EVs, especially given the limited infrastructure penetration in our country. While some might believe that standardization should evolve organically from the customer side, driving it from the top down is essential for achieving swift and widespread adoption in the industry.



Battery
Swapping
CPO

Standardizing beyond safety could hinder innovation and create safety issues, especially with battery swapping across different OEMs. It may also commoditize the market, limiting user options, as seen with delayed standardization in other industries.

Globally, no country has set battery swapping standards beyond safety. Allowing multiple standards and letting the market decide is more effective. Users should have the flexibility to switch service providers with minor, low-cost adjustments in battery documentation.



EV (CV)
OEM

Charger standardization is progressing, with most companies adopting CCS2 and Bharat Stage 1&2. AC chargers face no significant issues, but DC chargers still need some time for streamlining. The swapping model is highly successful for 2W and 3W, but it presents challenges for 4W and heavy-duty vehicles like e-trucks and e-buses.

In conclusion, a balanced approach that prioritizes safety, supports innovation, and involves proactive government initiatives will be key to successfully advancing electric mobility in India.

5.6 Key Recommendations

- The FAME Scheme must continue for three to five years more to ensure EV market matures
- Benefits for both EV & HEVs need to be continued. For EVs benefits may be linked to battery size. Road tax exemption for strong HEVs needs to be encouraged in parallel to EVs
- A new PLI scheme should be introduced to incentivize the charging infrastructure, upstream battery process with separate tranche for small and medium enterprises
- Subsidies schemes targetted towards testing & validation of EV components to accelerate launch of quality products
- India should target to expand its exports of EV vehicles and components to smaller fast developing economies like South East Asia, LATAM and MENA.
- Enhanced support from urban infrastructure development boards to CPOs for identification of appropriate sport for setting up charging stations.
- No push from government for forced standardisation for fast charging protocols or swapping in next 3 years



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