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ACMA

64TH

ANNUAL SESSION

Fostering Self-reliance & Global Competitiveness in Mobility Components

COMPENDIUM OF PAPERS

September 09, 2024



ACMA

Automotive Component Manufacturers Association of India

64th Annual Session

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Fostering Self-reliance &
Global Competitiveness
in Mobility Components

Compendium of Papers

September 09, 2024
Taj Palace, New Delhi

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About ACMA

The Automotive Components Manufacturers Association of India (ACMA), with around 1000 members, is the premier organization representing India's automotive components manufacturing industry.

ACMA's mission is to drive industry growth, job creation, and economic prosperity. Committed to research and development, ACMA ensures that India remains a leader in global automotive components manufacturing.

ACMA supports its members through an expanding network, offering valuable resources, industry insights, and collaboration opportunities. The organization is also instrumental in shaping policies and regulations that foster sustainable and inclusive growth.

India's automotive sector is a vital part of its economy, contributing 49% to the country's manufacturing GDP and 6% to the overall GDP, while supporting over 30 million jobs. The auto industry in the country is valued at over $150 billion.

In FY 2023-24, the auto component industry grew to USD 74.1 billion, reflecting a 9.8% increase from USD 69.7 billion the previous fiscal year. Domestic OEM supply rose by 8.9% to USD 62.4 billion, with the electric vehicle (EV) sector contributing 6% to total production. Exports increased by 5.5% to USD 21.2 billion, while imports grew by 3% to USD 20.9 billion, resulting in a trade surplus of USD 300 million. The aftermarket sector also expanded by 10% to 11.45 billion.

Auto component exports grew by 5.5% to USD 21.2 billion in FY 2023-24, with North America accounting for 32% of exports (a 4.5% increase), Europe 33% (a 12% increase), and Asia 24% (stable performance). Key export items include drive transmission and steering, engine components, body and chassis, and suspension and braking systems.

Imports of auto components rose by 3.0% to USD 20.9 billion, with Asia contributing 66%, Europe 26%, and North America 8%. Key imports included engine components, body and chassis, suspension and braking, and drive transmission and steering systems.

The aftermarket sector, valued at USD 11.3 billion, saw growth due to increased vehicle usage and higher demand for used vehicles. This sector is experiencing greater e-commerce penetration and organization, particularly in rural areas.

ACMA plays a critical role in advancing India's automotive industry by promoting trade, enhancing technology, improving quality, and disseminating information. The association participates in international trade fairs, sends trade delegations abroad, and publishes industry materials.

ACMA also contributes to manufacturing excellence through skills training, mentoring programs, and initiatives like 'Asset Turnover Improvement,' 'Uptime Improvement,' 'Zero Defect Quality,' and 'Sustainable Manufacturing.' It is actively involved in various government panels, committees, and councils to influence policies and regulations.

ACMA has signed Memoranda of Understanding (MoUs) with over 30 counterpart organisations in several countries to facilitate information exchange and trade cooperation.

For more information about the Indian automotive industry, visit ACMA's website: www.acma.in.

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Automotive Component Manufacturers Association of India

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64th Annual Session

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Fostering Self-reliance &
Global Competitiveness
in Mobility Components

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Fostering Self-reliance &
Global Competitiveness
in Mobility Components

The Auto Component Industry in India:
Viksit Bharat - Fostering Self-reliance & Global competitiveness in Mobility components

An Introductory Note

The Indian Automotive Industry of India have shown significant growth over the past decade. The automotive industry is a vital engine of the Indian economy, employing over 5 million people and contributing 25 percent to manufacturing GDP. The auto component industry, with a compound annual growth rate (CAGR) of 7–8 percent since 2014, showed resilience and achieved a market size of $74 billion in 2024. It is poised to sustain this momentum over the next few years.

India's automotive components industry: A vision for 2030

By 2030, the auto components industry could reach a market size of $200 billion, fueled by rapid advancements in alternative powertrain technologies, rising demand for premium automotive features, and India's strategic position in the global supply chain. The industry could make this potential a reality by successfully riding these emerging trends, fostering innovation, and expanding manufacturing capabilities to meet domestic and international demand.

Facets to achieve growth

To achieve this growth, the industry could consider focusing on three key areas:

Domestic OEM sales

The auto component industry's sales to OEMs are projected to grow from $62 billion in 2024 to $89 billion by 2030. This is underpinned by strong growth in new vehicle sales as rising consumer incomes and urbanization boost demand for passenger vehicles (PVs) and light commercial vehicles (LCVs). The emergence of alternative powertrains such as electric vehicles (EVs) will further stimulate demand for specialized components. Additionally, advancements in automotive software and electronics will play a crucial role in enhancing vehicle functionality, with a significant shift anticipated towards zonal electrical/electronic (E/E) architectures.

Domestic aftermarket sales

The domestic auto-component market is set to grow substantially, driven by an expanding vehicle parc and increasing vehicle age. By 2030, the aftermarket is expected to reach $16 billion, with significant contributions from the PV, CV, and two-wheeler segments. Greater premiumization and the proliferation of digital sales channels could also fuel demand for high-quality, personalized automotive accessories and replacement parts. The shift towards organized service marketplaces and the rise of direct-to-consumer (D2C) sales models will further bolster the aftermarket sector.

Exports

These represent the most significant growth opportunity for the Indian auto component industry. Export revenues could soar from $21 billion in 2024 to $100 billion by 2030, at a CAGR of 30 percent. This growth will be driven by India's ability to capitalize on global supply chain disruptions and position itself as a reliable supplier of automotive components. Key markets include North America, Europe, and Latin America, where Indian manufacturers are well-positioned to fill gaps in demand, particularly for non-powertrain components.

Key considerations for auto component manufacturers

To unlock the full growth potential of the Indian auto component industry, manufacturers, government bodies, and industry organizations could collaborate on four steps:

1. Leveraging export tailwinds: Indian manufacturers could capture additional market share by leveraging developments like the transition to new powertrains or the increased diversification of supply chains from the region. Possible measures include moving closer to key export markets, building scale through collaboration, or leading the sustainability transition.

2. Building indigenous R&D and innovation muscle: Investment in research and development is essential to keep pace with global automotive trends. Establishing a dedicated infrastructure for R&D could facilitate innovation, supported by measures such as an accelerated tech push as well as the promotion of the "Made in India" and "Designed in India" brands.

3. Moving towards quality maturity: Digital tools and increased connectivity could help Indian OEMs improve operational efficiency and product quality. Technologies like the Internet of Things (IoT) and predictive analytics could be key to quality maturity.

4. Pursuing innovations in aftermarket accessibility: The growth of the domestic aftermarket offers opportunities for manufacturers to explore direct-to-consumer channels. Developing targeted strategies to engage with consumers through digital platforms could help capture this market.

An Update on the Indian Auto Component Industry FY 2023-24

by

ACMA

ACMA

Automotive Component Manufacturers Association Of India

An update on the Indian Auto Components Industry
FY 2024

Snapshot of Indian Auto Component Industry

Turnover:
USD 74.1 Billion
INR 614,670 Crore

Contribution to GDP :
2.7%



Exports :
USD 21.2 Billion
INR 175,960 Crore

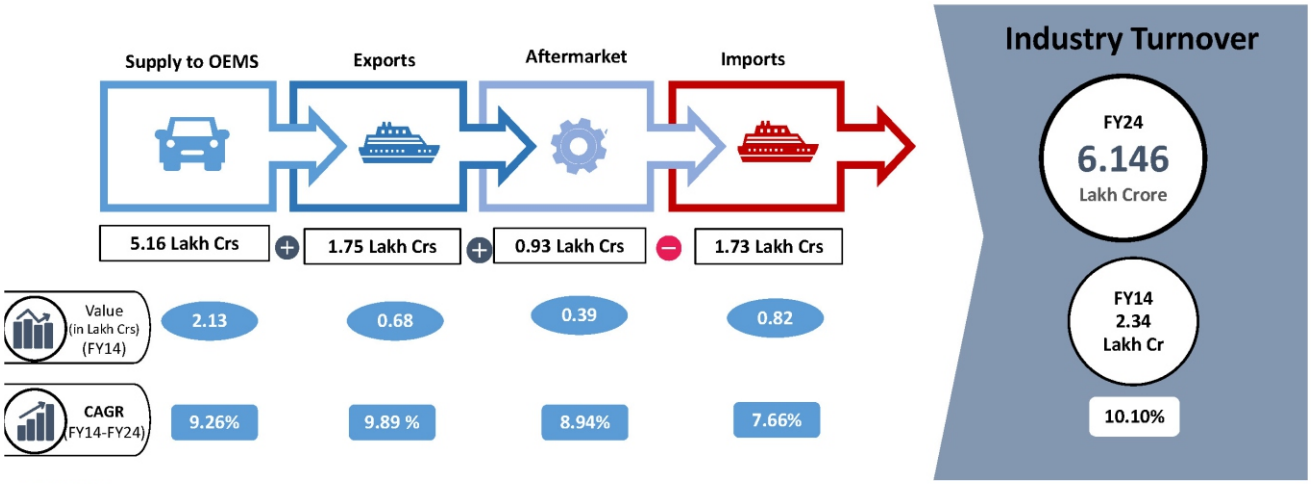
Share in India's Exports:
4.5%

Domestic Aftermarket:
USD 11.3 Billion
INR 93,866 Crore

Employment :
50 Lakh (Approx)

FY 14-24: Auto Components Industry grows to over 2.5X

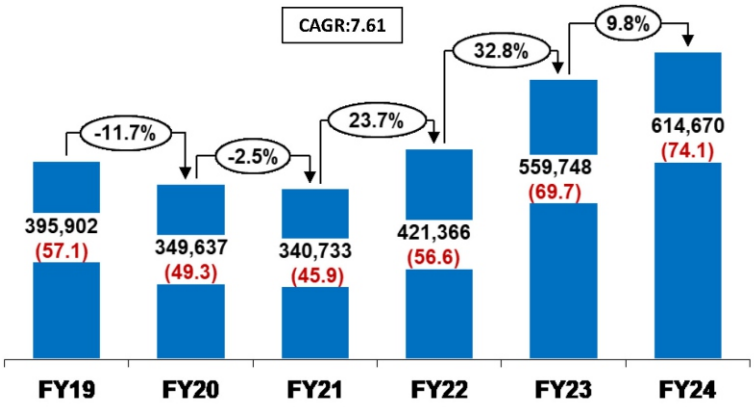
Auto Component Industry growth over last 10 years driven by robust domestic vehicles sales, strong aftermarket and increasing exports.



FY 2024: Auto Components Industry Performance

Size of industry | INR Cr (USD Bn)

Growth % taken against INR Values



The auto-components industry grew 10% y-o-y due to production growth and increase in value-addition per vehicle

Source: PwC research, CRISIL, SIAM, includes Tractors, Construction Equipment

FY24 – Auto components industry performance

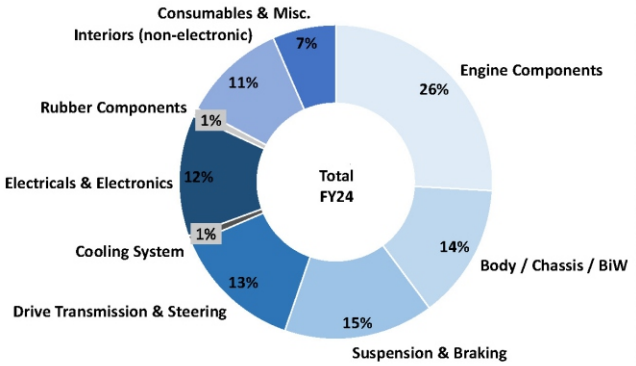
- Auto-components industry grew 10% in FY24, driven by 9% higher vehicle production and sales.
- Positive trade balance: Exports exceeded imports by $300 million (vs. $ -200 million in FY23).
- Two-wheeler production up 10%, with 350cc-500cc and >500cc segments growing 33% and 55%.
- Passenger vehicle production increased 7%, with Utility Vehicles (UVs) now at 56% of total production (up from 49%).
- Electric vehicles: contributing 6.0% to components sales value.

**EVs include only Li-ion battery operated vehicles. Cost of Li-ion battery excluded from component consumption calculations*

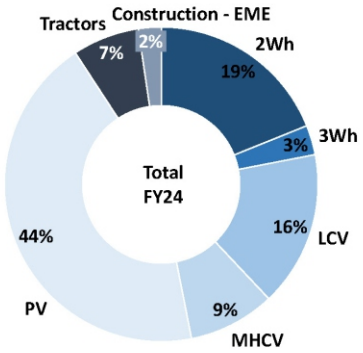
FY 2024: Sales by Category & Revenue from OEMs

Component Sales By Category:

Includes Sales to OEMs, Aftermarket, and Balance of Trade



Component Supply By OEM Segment:

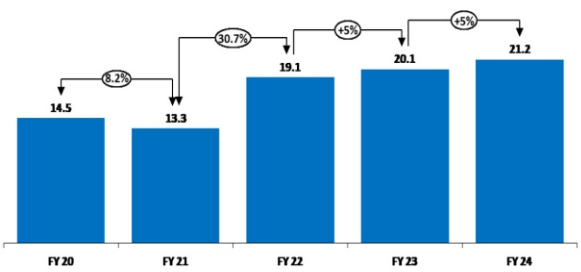


Source: PwC research, CRISIL, SIAM

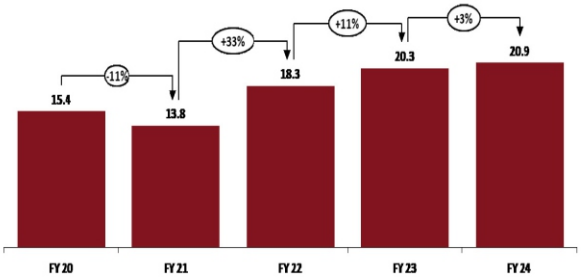
FY 2024: Exports & Imports - Balance of Trade

India had a **trade surplus of 300 Mn USD for auto components**- strong demand for exports

Exports ($ Bn)



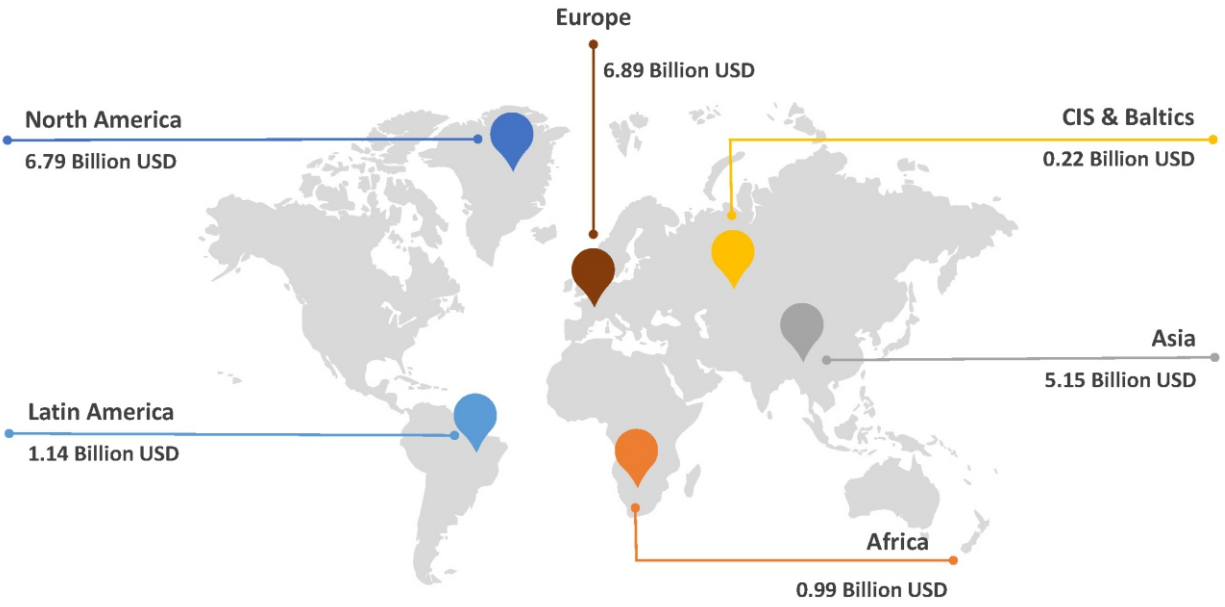
Imports ($ Bn)



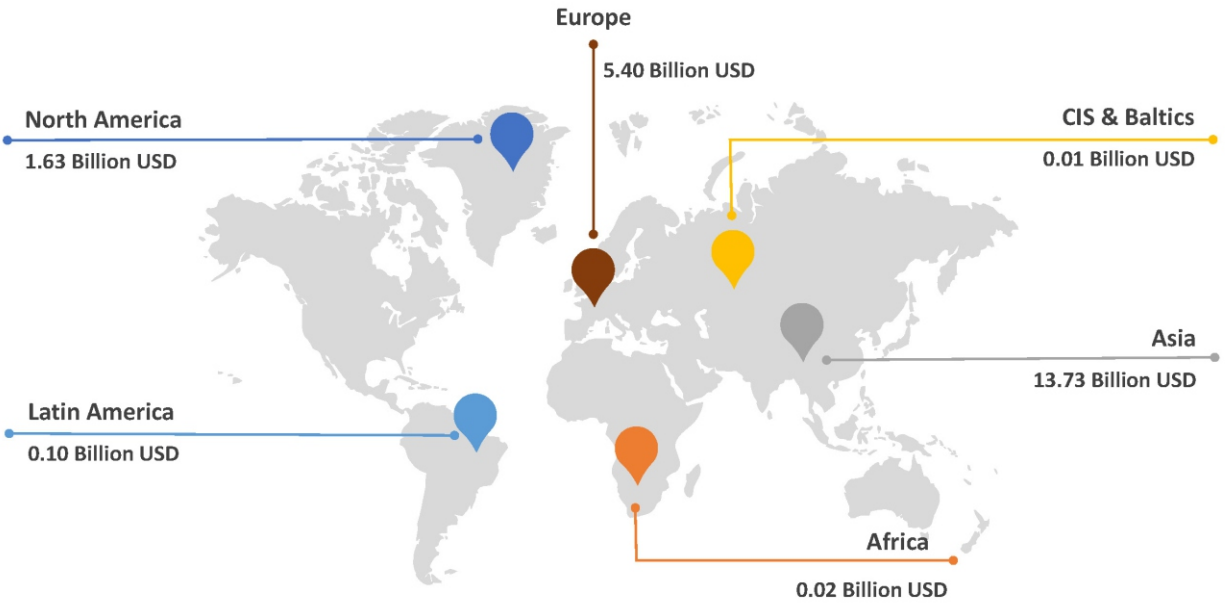
FY24 EXIM Performance

- Exports grew by **~5%** and imports surged by **3%** (vs. FY23)
- The trade surplus was $300 million
- **Exports: 'Engine components'** and **'Drive Transmission & Steering',** remain the dominant segment, accounting for more than half of exports.
- **Imports: 'Body/Chassis' & 'Steering'**, alongside **'Engine',** remain the 2 dominant segments, accounting for 41% of imports

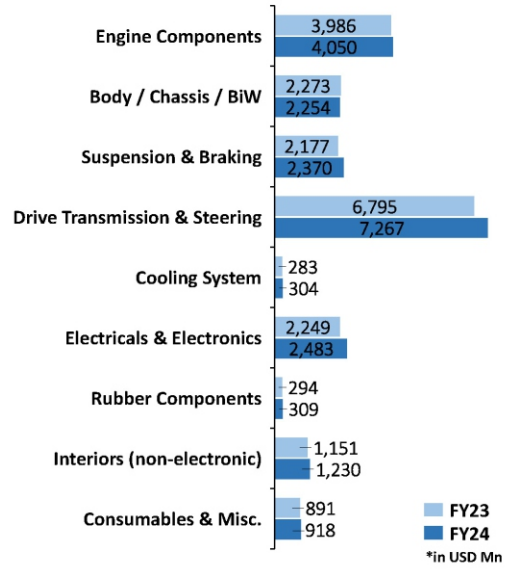
FY 2024: Region wise Exports

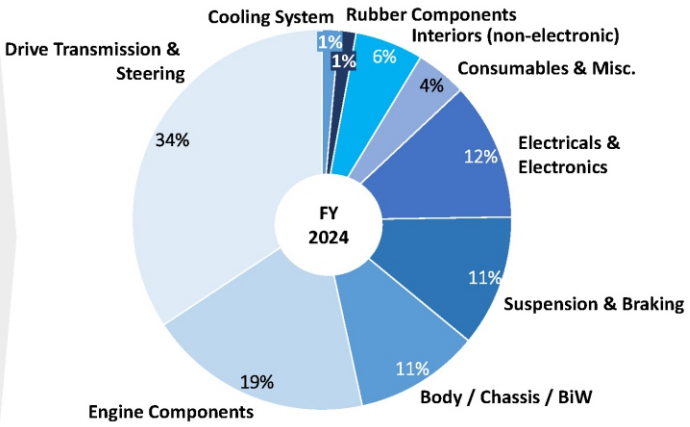


FY 2024: Region wise Imports

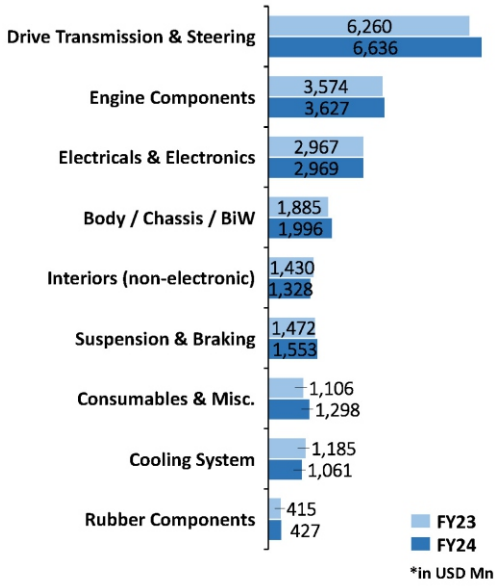


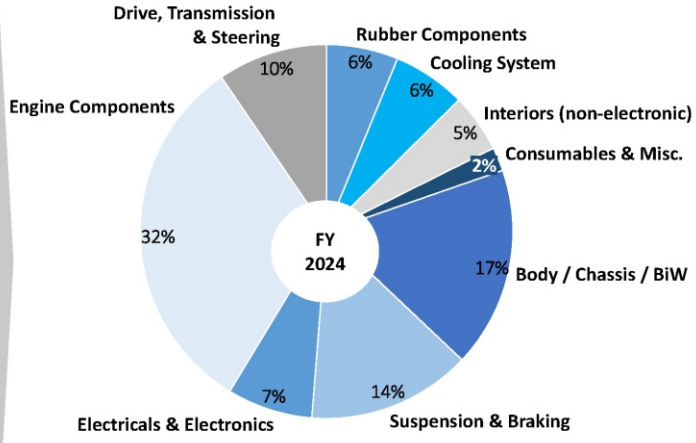
FY 2024: Exports Segmentation by Product Type





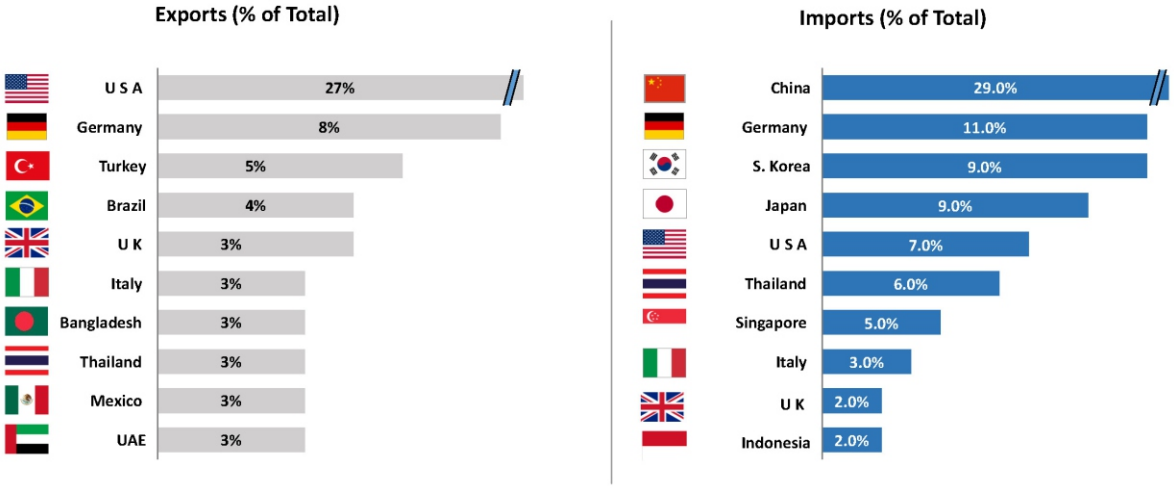
FY 2024: Imports Segmentation by Product Type





Top 10 Country wise Exports & Imports

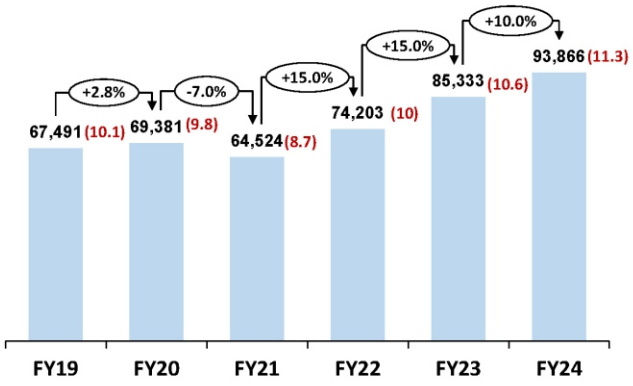
USA key destination for exports while China is key source of imports



FY 2024: Indian Auto Component Aftermarket

Aftermarket grew by 10% due to increase in vehicle parc and increasing formalization of the repair and maintenance market

Aftermarket | INR Cr (USD Bn)



FY24 Aftermarket

- Automotive aftermarket expansion driven by increased vehicle usage for personal and commercial purposes.
- Growth fueled by rural markets' demand for entry-level segments and a shift towards larger vehicles.

Summary: FY 2024 vs FY 2023

Figures in INR Crore	FY 2024	FY 2023	Growth Rate
Auto Components Supply to OEMs	518,313	476,022	8.9%
Aftermarket	93,866	85,333	10.0%
Exports	175,960	161,483	9.0%
Imports	173,470	163,090	6.4%
Industry Turnover	**614,670**	**559,748**	**9.8%**

Figures in USD Billion	FY 2024	FY 2023	Growth Rate
Auto Components Supply to OEMs	62.4	59.3	5.3%
Aftermarket	11.3	10.6	6.7%
Exports	21.2	20.1	5.5%
Imports	20.9	20.3	3.0%
Industry Turnover	**74.1**	**69.7**	**6.3%**



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State of the automobile industry: Macroeconomic overview of global and Indian economy

by

CRISIL

An S&P Global Company

Market Intelligence & Analytics

CRISIL An S&P Global Company

State of the automobile industry

Macroeconomic overview of global and Indian economy

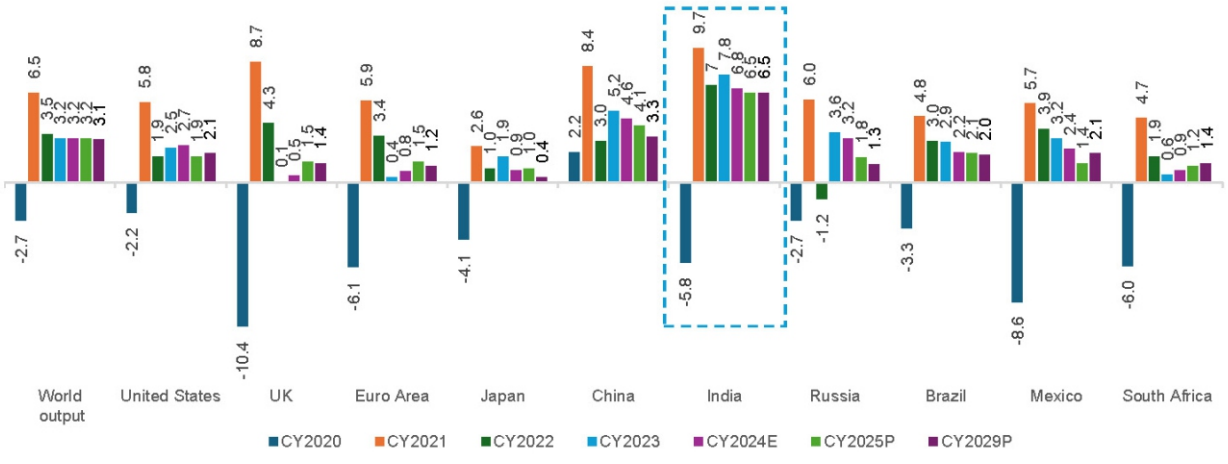
Review and outlook of global GDP growth

The International Monetary Fund (IMF) projects global gross domestic product (GDP) growth at 3.2% in 2024, unchanged from 2023. The projection is still below the historical annual average of 3.8%, reflecting restrictive monetary policies, withdrawal of fiscal support by major economies towards emerging markets, and low underlying productivity growth. Geopolitical uncertainties, considerable tightening of global monetary conditions to address elevated inflation, and long-term fallouts of the Covid-19 pandemic are holding back a steady recovery. Other cyclical factors include elevated central bank policy rates to control inflation in several large emerging markets and developed economies, withdrawal of fiscal support amid high debt levels, and extreme weather events.

For advanced economies, growth is forecasted to rise slightly to 1.7% in 2024 from 1.6% in 2023. An upward revision of 0.2 percentage point for 2024 reflects stronger growth in the United States (US), partly offset by weaker growth in the euro area.

In emerging market and developing economies, growth is expected to be stable at 4.2% in 2024 and 2025 compared to 4.3% in 2023, with a moderation in emerging and developing Asia offset mainly by rising growth for economies in the Middle East and Central Asia and for sub-Saharan Africa. An upward revision of 0.1 percentage point for 2024 from the October 2023 World Economic Outlook (WEO) reflects upgrades for several regions. Emerging market and developing economies are expected to experience stable growth through 2024 and 2025, with regional differences.

Figure 1: GDP growth of key economies (%)



Note: Euro area comprises 19 member countries of the European Union (EU); years mentioned in the graph are calendar years. Source: IMF (WEO – April 2024 update), CRISIL MI&A Consulting

India to post the fastest growth among large economies

India's growth trajectory continued throughout fiscal 2024 wherein India's GDP expanded at 7.8% in the first quarter, 7.6% in the second quarter and 8.4% in the third quarter. Core sector growth in February 2024 was the fastest in three months and manufacturing activity at five months high. Economic growth was encouraged by investment and manufacturing activity.

Consumer price index (CPI) inflation eased to five months low of 4.9% in March from 5.1% in February 2024. However, core inflation tapered to 3.2% in March 2024 from 3.3% in February 2024. Fuel inflation also tapered in March 2024 due to cut down in domestic fuel prices such as petrol and diesel. High food inflation at 8.5% in March 2024 due to higher cereals inflation, erratic vegetable inflation and elevated pulses inflation is a cause of concern given the Indian Meteorological Department's (IMD) prediction of higher-than-normal temperatures between April and June.

The Reserve Bank of India's (RBI) Monetary Policy Committee (MPC) voted to keep the policy rates unchanged with a 5-1 majority. The repo rate remained at 6.50% in April 2024. The MPC noted encouraging signs for food inflation easing on the back of an expected bumper rabi output in the current season and a normal monsoon. However, it will remain vigilant about unpredictable weather events, the frequency of which has increased in recent years. The MPC kept its consumer price index (CPI) inflation forecast unchanged at 4.5% for this fiscal.

The International Monetary Fund in its latest report indicated that India's gross investments as a percentage of GDP is expected to rise to 31.9% in fiscal 2025 from 31.7% in fiscal 2024. The National Statistical Office (NSO) reported that manufacturing output rose by 5% in February 2024 which is slightly lower as compared to 5.9% in February 2023. Industrial production expanded by 5.7% in February 2024. Mining production surged by 8% while power output grew by 5.7% in February 2024. India's merchandise trade deficit widened to USD 18.71 billion in February 2024 from USD 17.49 billion in January 2024, as imports surpassed exports in value terms against the backdrop of the Red Sea conflict.

The Indian economy is expected to grow at a higher than estimated 7.6% in fiscal 2024, with GDP growth in the third quarter of the fiscal at 8.4% on the back of lower base, tax collections and healthy growth in the manufacturing sector and construction activities. Data released by the NSO in February 2024 revealed that the economy is expected to grow by 7.6% in fiscal 2024 as against the previous estimate of 7.3%.

India's merchandise trade deficit widened to USD 18.71 billion in February 2024, from USD 17.49 billion in the previous month, as imports outstripped exports in value terms against the backdrop of the Red Sea conflict.

As per CRISIL MI&A, India's economy is expected to grow at 6.8% in fiscal 2025 up from 6.5% projected earlier. This will be driven by expected easing of domestic financial conditions, disinflation leading to increasing purchasing power of consumers and growth in private capital expenditure.

1.1 Overview of the Indian economy

Review of GDP growth over fiscals 2019-2024 and Outlook for fiscals 2024-2029

India ranks as the world's 5th largest economy and is the fastest growing among major economies. The Indian economy logged 4.3% CAGR between fiscals 2019 and 2024. This was a sharp deceleration from a robust 6.7% CAGR between fiscals 2017 and 2019, which was driven by rising consumer aspiration, rapid urbanization, the government's focus on infrastructure investment and growth of the domestic manufacturing sector. Economic growth was supported by benign crude oil prices, soft interest rates and low current account deficit. The Indian government also undertook key reforms and initiatives, such as implementation of the Goods and Services Tax (GST), Insolvency and Bankruptcy Code, Make in India, financial inclusion initiatives, and gradual opening of sectors such as retail, e-commerce, defense, railways, and insurance for foreign direct investments (FDIs).

A large part of the lower growth between fiscals 2018 and 2023 was because of the economy contracting 5.8% in fiscal 2021 owing to the fallout of Covid-19. The pandemic's impact was more pronounced on contact-sensitive services and social distancing norms-affected services such as entertainment, travel, and tourism, with many industries in the manufacturing sector also facing issues with shortage of raw materials/components as lockdown in various parts of the world upended supply chains.

Over the period, India's economic growth was led by services, followed by the industrial sector, while in part impacted by demonetization, the non-banking financial company (NBFC) crisis, slower global economic growth, and the pandemic.

As lockdowns were gradually lifted, economic activity revived in the second half of fiscal 2021. After a steep contraction in the first half, owing to rising number of Covid-19 cases, gross domestic product (GDP) moved into positive territory towards the end of fiscal 2021. Subsequently, in fiscal 2022, India's real GDP grew 9.7% from the low base of fiscal 2021.

India's GDP exceeded expectations during first three quarters of fiscal 2024. According to the National Statistics Office's (NSO) second advance estimates (SAE), real GDP growth accelerated to 8.4% year-on-year in the third quarter of fiscal 2024 from 8.1% in the second

quarter. Growth of the past two quarters were revised up (second quarter was revised to 8.1% from 7.6%, and first quarter to 8.2% from 7.8%)

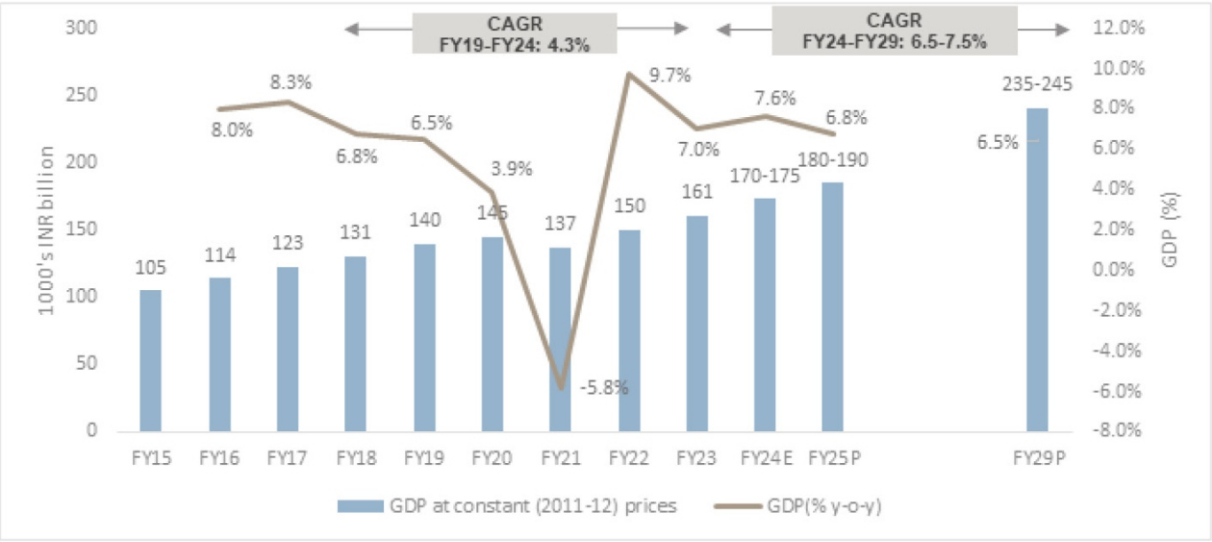
NSO now pegs GDP growth at 7.6% in fiscal 2024 compared with 7.3% as per the first advance estimates. Based on this second advance estimate, growth in the fourth quarter of this fiscal is estimated to slow to 5.9%. Additionally, the estimate for fiscal 2023 was revised to 7.0%, while for fiscal 2022 it was revised to 9.7%.

Growth surpassed forecasts in the second quarter of fiscal 2024, driven by strong government spending and a sharp rise in manufacturing and construction growth. Globally, growth in major economies such as the US and China beat estimates, contributing to better export earnings for India.

After a strong GDP estimate in the past three fiscals, CRISIL MI&A expects GDP growth to moderate to 6.8% in fiscal 2025. Fiscal consolidation will reduce the fiscal impulse to growth. Rising borrowing costs and increased regulatory measures could weigh on demand. Exports could be affected due to uneven growth in key trade partners and any escalation of the Red Sea crisis. On the other hand, another spell of normal monsoon and easing inflation could revive rural demand.

Reducing the fiscal 2024 deficit will reduce the government's direct support for economic growth, but investing in high-quality spending could still boost investment and rural incomes. CRISIL MI&A anticipates a return to normal levels of indirect tax impact on GDP. However, uneven economic growth in major trade partners like the US and EU, along with escalating tensions in the Red Sea, may hinder exports.

India's GDP growth trend and outlook



Note: P – projected

Source: National Statistical Office (NSO), IMF, CRISIL MI&A estimates

In the third quarter of fiscal 24, fixed investments posted year-on-year growth of 10.6% while private consumption (3.5%), despite a modest uptick, remained sluggish. The drag from net exports eased in the third quarter. From the supply side, growth was highest for manufacturing (11.6%), followed by construction (9.5%) and services (7.0%), while growth in agriculture contracted in the third quarter (-0.8%).

Similarly, growth in the fiscal year 2024 till Q3 has been driven by fixed investments (10.2% growth), while private consumption at 3.0% trailed overall GDP growth. On the supply side, industry grew the most (9%), followed by services (7.5%), while agriculture (0.7%) lagged.

Near-term Review and Outlook on GDP

Services sector is the key growth driver

In fiscal 2020, the services sector accounted for 55.3% of India's GDP compared with 52.4% in fiscal 2015. However, its share dipped to 53.6% in fiscal 2021 owing to the pandemic. Fiscal 2022 saw marginal improvement in the share of the services sector with gradual normalization of market operations.

The industrial sector, which is the second-largest contributor, maintained its share in GDP of ~31%, logging 7.1% CAGR between fiscals 2015 and 2019. Industrial contribution declined in fiscal 2020, with slowdown in economic development. Before overall economic activity slowed down in fiscal 2020, India's industrial sector output growth was supported by the Make in India initiative, rising domestic consumption and GST implementation. The initiatives improved India's position on the World Bank's Ease of Doing Business index to 63 in fiscal 2019 from 142 in fiscal 2014.

The pandemic and subsequent lockdown exacerbated the economic slowdown in fiscal 2021. The services segment was the worst affected and declined 8.2% year-on-year mainly due to the decline in Trade, Hotels, Transport, and Communication services (THTC) by 19.7% and decline in Public Administration, defense and other services by 7.6%, followed by industrial, which declined 0.9% year-on-year. Agriculture was the only sector that grew 4.1% year-on-year and restricted the fall in GDP.

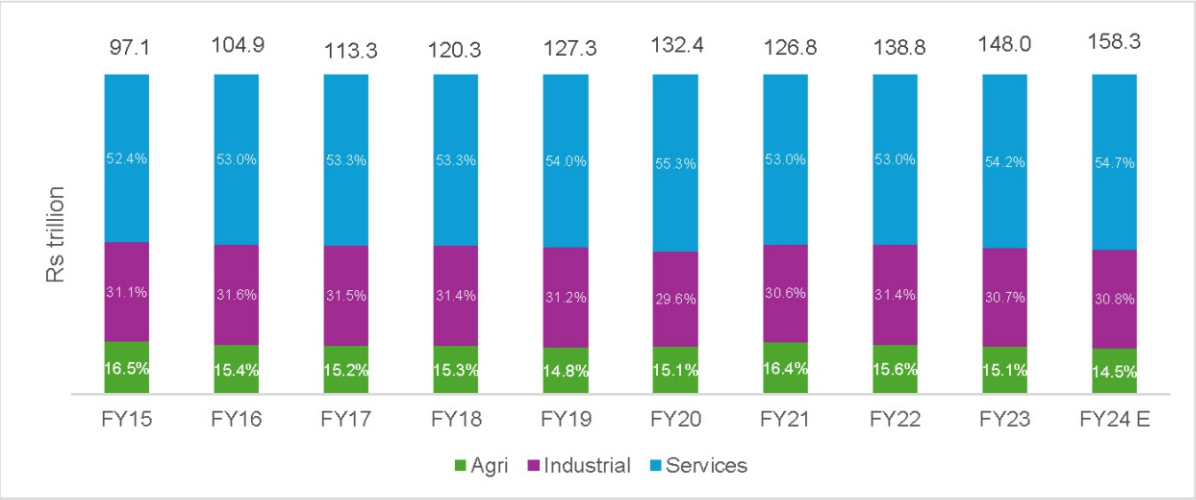
In fiscal 2021, the agriculture sector's share in Gross Value Added (GVA) at constant prices expanded, while the share of the services and industrial sectors contracted.

In fiscal 2022, agriculture GVA grew at a rate of 3.5% and the industrial sector grew by 12% on a low base of fiscal 2021. Whereas the service sector grew by 8.8% year-on-year. This helped GDP to grow by 9.1%

Agriculture GVA continued to grow at a steady 4.0% in fiscal 2023. Faster GDP growth in fiscal 2023 saw the share of agriculture increase in the fiscal. The share of industrial sector in GDP

grew 4% in fiscal 2023, mainly due to utility services with 8% growth, which was higher than all other industrial sectors. Mining grew by 5%, while manufacturing and construction added marginal growth momentum from a high base of fiscal 2022. The high base of fiscal 2022 led to moderate growth of the industrial sector in fiscal 2023. The services sector grew 9% in fiscal 2023. Trade, hotels, transport, and communication services (THTC) saw strong year-on-year growth of 14% in fiscal 2023.

Share of sector in GVA at constant prices



Source: RBI; CRISIL MI&A Consulting

Note: Data for FY24 is taken till the month of February

The Agri sector is expected to grow at ~0.7% year-on-year in fiscal 2024, thereby contributing to 14.5% of the GVA. The services sector is expected to provide a thrust to the economy with 7.5% growth and 54.7% GVA share while the industrial sector will maintain a share of 30.8%.

Outlook on GDP

For the fiscal 2025, India's GDP growth is expected to moderate to 6.8% after a better-than-expected 7.6% expansion in fiscal 2024, given that high interest rates and lower fiscal impulse (from reduction in fiscal deficit to 5.1% of GDP) would temper demand and the net tax impact would normalize.

Additionally, uneven economic growth of key trading partners and escalation of geopolitical uncertainties can lower exports. But there will be support from other areas. Continued disinflation will prop up the purchasing power of consumers. Healthy rabi sowing and good kharif output (assuming another spell of normal monsoon is ahead) will bolster agricultural incomes. Further, a gradual pick-up in private capital expenditure (capex) will make investment

growth more broad-based. The government has also provided budgetary support to rural incomes and infrastructure spending.

The lowering of fiscal deficit will mean curtailed fiscal impulse to growth, but good quality of spending would provide some support to the investment cycle and rural incomes. CRISIL also expects a normalization of the net indirect tax impact on GDP witnessed in the current fiscal. Uneven economic growth in key trade partners such as the United States (US) and the European Union, and an escalation of the ongoing Red Sea tensions can act as drag on exports.

Review of the Indian Domestic PV Industry (fiscals 2019 to fiscal 2024)

Between Fiscals 2019 and 2024, India's domestic PV sales volume rose at 5% CAGR. This growth was despite the sales contraction (at 10% CAGR) witnessed during Fiscals 2019 to 2021. From the low base of Fiscal 2021, PV sales bounced back and grew at a healthy pace to reach a high of 3.9 million vehicles in Fiscal 2023 and 4.2 million vehicles in Fiscal 2024.

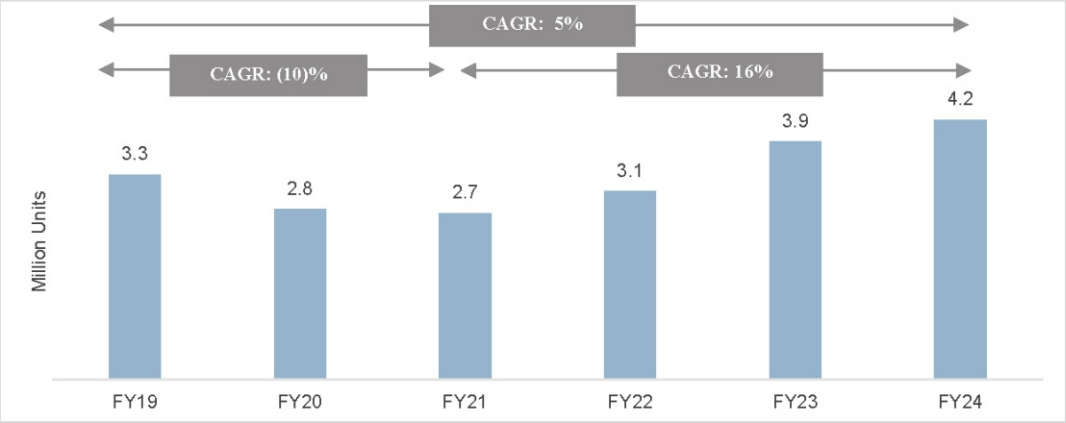
In Fiscal 2020, contraction of the economy put pressure on vehicle sales. Moreover, the Non-Banking Financial Company (NBFC) liquidity crisis and halting of BS-IV vehicle production amid mandatory implementation of BS-VI norms from Fiscal 2021 exerted added pressure during the year. The industry also lost nearly half a month's sales at fiscal year-end owing to outbreak of the COVID-19 pandemic and subsequent nationwide lockdown.

In Fiscal 2021, domestic sales volume continued to be impacted by the first wave of the pandemic. A nation-wide lockdown, reduced mobility, and supply chain constraints leading to production cuts weighed on annual sales. Despite some improvement in sales with the reopening of the economy and increased demand for personal mobility during the second half of the year, sales contracted approximately 2.2% year-on-year owing to the additional price hikes due to implementation of the BS-VI norms.

Fiscal 2022 began with a much severe second wave of COVID-19. State-imposed lockdowns, economic uncertainty, and a global shortage of semiconductor supply caused extended waiting periods that impacted sales, especially in the first half of the year. There was some improvement in the economic scenario with the reopening of markets in the second half of the fiscal. Pent-up vehicle demand, further increased need for personal mobility and improved supply scenario provided thrust to PV sales during the second half. After a two-year consecutive drop, PV sales rose 13% from a very low base of Fiscal 2021.

In Fiscal 2023, the PV industry grew at a rate of 27% y-o-y, which was more than double the rate of 13% y-o-y witnessed during Fiscal 2022, owing to the healthy pent-up demand created by two years of slump in sales volume. The orderbooks of auto OEMs were further supported by several new launches in the growing SUV category, which saw higher traction, along with multiple facelifts of existing models and easing supply of semiconductors. In fact, overall wholesale volume reached a historic high of 3.9 million units in the fiscal.

Fig: Review of the domestic PV sales volumes



Note:

1. Figures in bracket to be read as negative (Eg. (10) to be read as minus 10)

2. Passenger vehicles ("PVs") are four wheeled motor vehicles used for carriage of passengers comprising not more than eight seats in addition to the driver's seat. PVs include hatchbacks, sedans, SUV, MPV and vans under it.

Source: SIAM, CRISIL MI&A

During Fiscal 2024, growth momentum of the industry continued, albeit at a slower pace, backed by the continued traction for the SUV segment, intermittent launches and improvement in disposable income. Off the high base of Fiscal 2023, the industry grew by 8.4% in Fiscal 2024 to reach the historic high of 4.2 million units.

Segmental Shifts Amidst Premiumisation

The passenger vehicle industry can be broadly classified basis body types into hatchbacks, sedans, sports utility vehicles (SUVs), multipurpose vehicles (MPVs) and vans. Traditionally, Indian passenger vehicle buyers have been cost conscious, with mileage and initial vehicle buying cost being the two main pillars of decision-making. Thereby, the hatchbacks segment had been leading PV sales over the years primarily because of the lower ticket size and lower running costs, making them affordable to the average Indian customer.

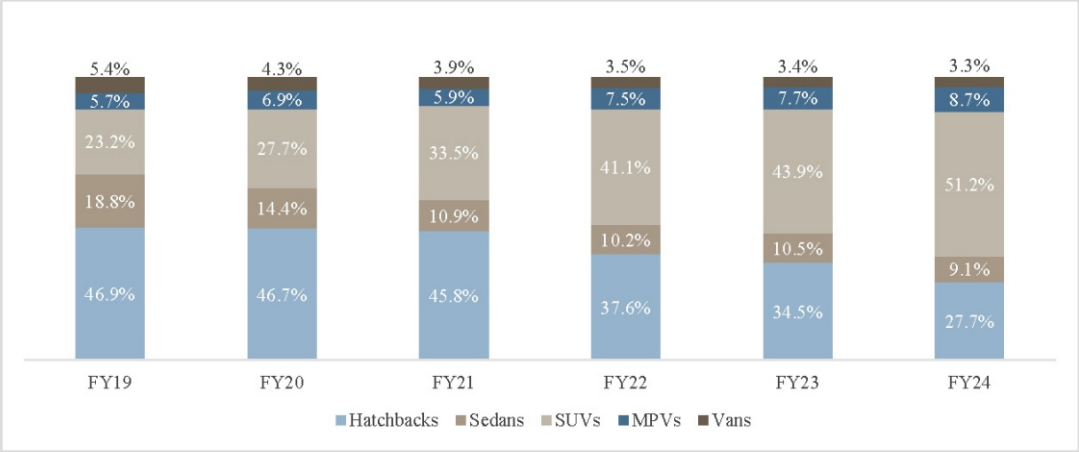
However, with a growing share of younger buyers in India, there is an increasing awareness and preference towards parameters other than price such as exterior and interior design, driving experience, safety, advanced features and aesthetics, resulting in inter-segmental shift towards SUVs as well as intra-segmental shifts towards the mid- to top-end variants. OEMs like Tata Motors & Hyundai Motor India have addressed this change by showcasing enhanced vehicle safety in their recent launches. Several OEMs have also gradually introduced advanced

features and trickled them down from their top variants to the mid variants. Furthermore, rising disposable incomes has also given an impetus to growth in the SUV segment.

Customer buying behaviour is also changing, wherein they are increasingly prioritising vehicle experience and technology over cost and are willing to pay a premium and are also ready to accept longer waiting time for the desired vehicle. More and more customers are now opting to buy mid to top level variants driving the intra-segmental shifts. This shift towards feature loaded vehicles is also driving the premiumisation trend.

The share of small cars (hatchbacks) reduced from 46.9% in Fiscal 2019 to 27.7% in Fiscal 2024. During the same period, share of SUVs increased from 23.2% in Fiscal 2019 to 51.2% in Fiscal 2024.

Fig: Segment-wise trends in the overall PV sales volumes in India



Source: SIAM, CRISIL MI&A

Rise of SUVs

The SUV segment, which traditionally appealed to customers valuing larger seating capacity and its ability to drive on rough terrain, has increasingly gained customer preference over the years. The compact SUV segment, especially, provided the much-desired SUV body styling at competitive rates bringing SUV segment within the reach of the common consumers.

Recognising the changing consumer preferences, OEMs also launched higher number of vehicles in the SUV segment compared to other segments providing a further fillip to the SUV share expansion. In the last 5 years, 30+ SUVs were launched by the OEMs versus 4 hatchbacks and 3 sedans.

Thus, the changing customer preference coupled with new vehicle launches provided the real thrust to the growth of the SUV segment. Prominent launches from players like Hyundai Motor India, Tata Motors, Mahindra & Mahindra, Maruti Suzuki aided the growth of this segment. Moreover, entry of global players like Kia and MG, with their SUV portfolios lent further support to the segment's growth.

All of this has led to the share of SUVs in overall domestic PV sales to more than double from 23.2% in Fiscal 2019 to 51.2% in Fiscal 2024. During the last 5 years, while industry witnessed a growth at 5% CAGR, the SUV segment grew at more than 4 times growth rate of 23% CAGR.

Within the SUV segment, compact SUVs (length <4m) grew in line (at 23% CAGR) with the overall SUV segment keeping its share steady within the SUV segment.

Launch of Ford EcoSport provided a real thrust to the compact SUV subsegment in India around Fiscal 2014. Over the years, introduction of vehicles like Maruti Suzuki Brezza (Fiscal 2016) and Tata Nexon (Fiscal 2018) aided the growth of entire SUV segment as well as helped compact SUVs gain sizeable share within the SUV segment, reaching 58% by Fiscal 2019 from 48% in Fiscal 2014. Moreover, launch of Hyundai Venue (Fiscal 2020), Kia Sonet (Fiscal 2021), Tata Punch (Fiscal 2022), Maruti Suzuki Fronx (Fiscal 2024) over and above the launch of facelifts of other popular models backed the healthy growth of the compact SUV subsegment.

Introduction of Hyundai Creta in Fiscal 2016, has propelled the mid-size SUVs (length 4 - 4.4 m) segment. The mid-size SUV segment (24% CAGR) outpaced the entire SUV segment and has grown its share within the mid-size SUV segment in the last 5 years. Continued traction for the high selling models like Hyundai Creta & Kia Seltos as well as successful recent additions including Maruti Suzuki Grand Vitara, Toyota Urban cruiser Hyryder, and Honda Elevate provided the thrust to the growth of mid-size SUVs. The intermittent upgrades of the vehicles provided an added fillip to the sub segment's growth.

Slowdown in hatchbacks

The hatchbacks segment, which was once the leading segment, has seen a loss in market share in recent years owing to lack of new model launches, frequent hikes in vehicle prices, increase in operating costs amid fuel price hikes, and an unfavourable macroeconomic environment that impacted the price sensitive entry-level customer base.

Lower demand for sedans

Shift towards the SUV segment, drop in demand from ride hailing commercial base and limited launches have restricted the sales of sedans during Fiscal 2019 to Fiscal 2024 period and their contribution to overall PV sales dropped from 18.8% in Fiscal 2019 to 9.1% by Fiscal 2024.

Segmental growth within the industry in the last 5 years

Segment	Fiscal 2019 Contribution	Fiscal 2024 Contribution	Fiscal 2019-Fiscal 2024 CAGR
Hatchbacks	**46.9%**	**27.7%**	**(6) %**
Compact Hatchbacks	*75.2%*	*66.7%*	(8) %
Premium Hatchbacks	*24.8%*	*33.3%*	0%
Sedans	**18.8%**	**9.1%**	**(9) %**
SUVs	**23.1%**	**51.2%**	**23%**
Compact SUVs	*57.7%*	*57.9%*	23%
Mid-Size SUVs	*23.7%*	*24.8%*	24%
Large SUVs	*18.6%*	*17.3%*	21%
MPVs	**5.7%**	**8.7%**	**14%**
Vans	**5.4%**	**3.3%**	**(5) %**
Total	**100.0%**	**100.0%**	**5%**

Source: SIAM, CRISIL MI&A

Changing Powertrain Mix in the Indian Passenger Vehicles Industry

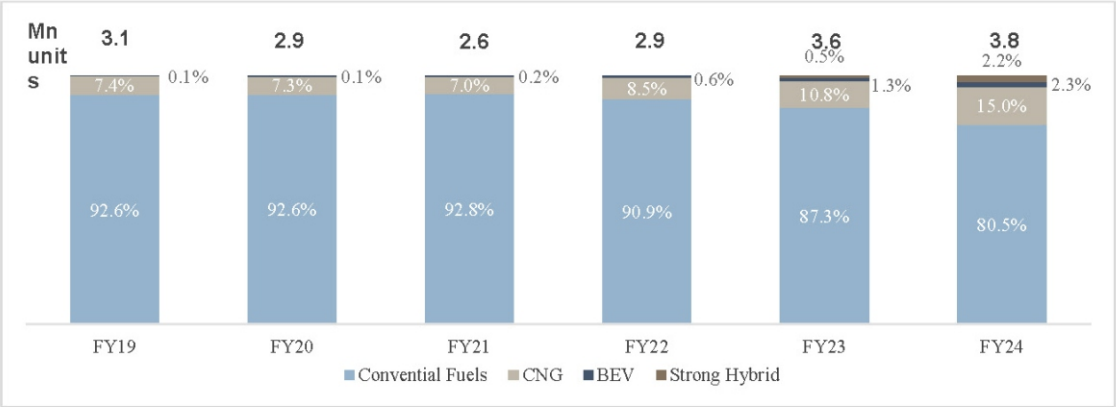
Conventional fuel powertrains (Petrol and Diesel) have dominated the Indian passenger vehicle industry for decades. Petrol vehicles were the preferred choice primarily due to low acquisition cost as compared to diesel vehicles. This was despite diesel being cheaper than petrol, however, during Fiscal 2012 to Fiscal 2014 period, there was an increasing preference for diesel vehicles due to rising petrol prices and further increase in the price gap with diesel. This was also supported by the fact that diesel vehicles gave better mileage, and there was only a slight difference in acquisition cost for a diesel vehicle.

However, considering the higher air pollution and environmental harm caused by diesel vehicles, the Supreme Court ordered a ban on diesel vehicles in the NCR region in order to reduce air pollution and improve the air quality. Moreover, higher price rise in diesel vehicles for the emission norms (BS-IV & BS-VI) implementation shifted consumer preference towards the petrol vehicles after Fiscal 2015. Subsequently, the share of diesel PV retails in the industry dropped from 48% in Fiscal 2015 to 37% in Fiscal 2019.

Moreover, the shift in OEM focus from diesel to petrol including discontinuation of diesel models by few OEMs like Maruti Suzuki with the onset of stricter BS-VI norms, exacerbated the

situation for diesel vehicles. In Fiscal 2024, the share of diesel powertrain in the industry retail slid to only 18%. On the other hand, the share of petrol variants expanded from 56% in Fiscal 2019 to 63% by Fiscal 2024.

Fig: Powertrain mix trend of PV industry retails



Note: Strong hybrid: Vehicles having a combustion engine as well as an electric motor. The vehicle can be powered by the engine, by the battery, or by both simultaneously. Battery of the vehicle is charged by the combustion engine and not by an external power source. Telangana & Lakshadweep retail data is not available on VAHAN.

Source: VAHAN, CRISIL MI&A

Outlook on the Domestic Passenger Vehicle Industry

Going ahead, CRISIL MI&A expects the macroeconomic scenario to lend support to the industry growth with GDP projected to grow at a healthy pace between Fiscal 2024 to Fiscal 2029. India's GDP growth is expected to outperform other major geographies in the next 5 years with an expected growth rate of 6-8%. India's inflation levels are also expected to remain subdued in the 3-5% range, which is within the RBI's target band. CRISIL MI&A has assumed 3 years of normal monsoons within the 5-year outlook period and has considered positive momentum in rural demand. Fuel prices are also expected to remain near steady in the next 5 years. These favourable macro-economic factors are expected to aid the consumer disposable income levels.

Besides the macro-economic factors, continued support from government in terms of policies as well as continued expenditure and investments are expected to provide an added support. The favourable demographics is an added advantage for India which is also expected to help propel the passenger vehicle industry forward.

Additionally, OEMs are expected to continue with launches of feature rich competitively priced vehicles aiding the overall demand growth.

The changing consumer dynamics including younger consumer base, premiumisation, electrification, shorter replacement cycles (4-5 years currently versus 7-8 years a decade ago) will provide further impetus to the demand. Additionally, the government's push for scrapping of old vehicles is expected to help in shortening replacement cycles and hence aid demand.

Over and above these demand drivers, the capacity expansion by players like Maruti Suzuki, Hyundai Motor India, Tata Motors is expected to support the growing vehicle demand. Moreover, the expansion in the supporting infrastructure like EV charging stations and CNG pumps will also aid choices for customers across powertrains.

CRISIL MI&A expects the industry to clock 4.5-6.5% CAGR between Fiscal 2024 to Fiscal 2029 period to reach 5.2-5.7 million domestic vehicle sales.

CRISIL MI&A has considered 3 different GDP growth scenarios for the next 5 years. At a 6% CAGR GDP growth scenario, the PV industry is projected to reach approximately 5.2 million units by Fiscal 2029 growing at 4.5% CAGR in the next 5 years. Assuming a 7% CAGR GDP growth, 5.5% CAGR growth can be achieved for the PV industry. If India achieves 8% CAGR GDP growth in the next 5 years, the domestic passenger vehicle industry will clock approximately 6.5% CAGR growth and reach approximately 5.7 million vehicle levels by Fiscal 2029 according to CRISIL MI&A estimates.

Fig: Domestic PV Industry outlook (volumes)



Source: SIAM, CRISIL MI&A

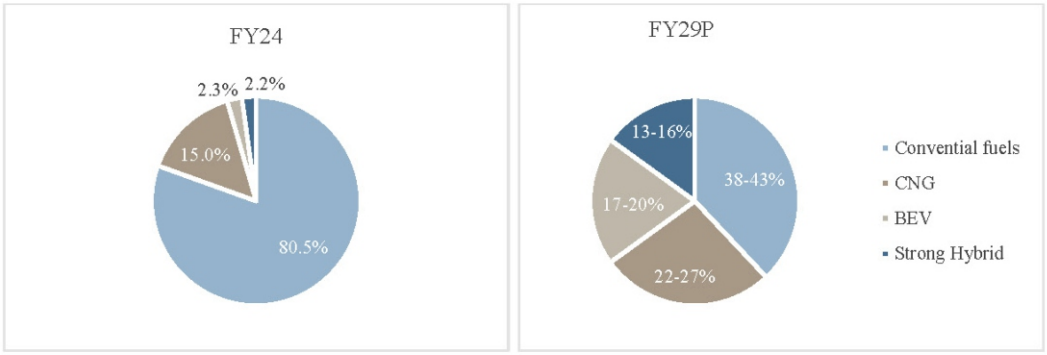
Outlook on the Powertrain mix of the industry

Indian domestic passenger vehicle industry, which was completely dominated by the conventional fuels, has witnessed fast acceptance of alternate fuels especially in the last 2 or 3

years. In fact, the share of CNG powertrain doubled to 15% while EV (2.3% share) and the latest addition, strong hybrids (2.2% share) expanded their presence in the vehicle retails.

Going forward, CRISIL MI&A expects the share of alternate fuel vehicles to witness a multi-fold growth while the conventional fuel vehicle's share will slide.

Fig: Powertrain wise Outlook of the industry



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Source: VAHAN, CRISIL MI&A

By Fiscal 2029, CRISIL MI&A projects the share of CNG variants to rise to 22-27% from the 15% share clocked in Fiscal 2024. Healthy growth in CNG station infrastructure will primarily thrust the growth of CNG vehicle share. Amidst the government's push coupled with the support of City Gas Distribution ("CGD") players, completion of commitments under the CGD rounds is expected to pick up pace. Thus, CNG station infrastructure is projected to rise at a healthy pace till 2030.

Electrification is another trend witnessed in the Indian domestic passenger vehicle market in the last 2 or 3 years. Plethora of vehicle launches, expanding charging infrastructure and continued government support will aid further growth of electrification in India going ahead. CRISIL MI&A expects the EV penetration to reach 17-20% (approximately 1 million units) by Fiscal 2029 from the 2.3% penetration (approximately 90 thousand units) seen in Fiscal 2024.

However, for EVs, range anxiety, limited charging infrastructure, import dependency on certain components, higher import duties and underdeveloped local supply chain are few bottlenecks.

The recent entry of strong hybrid vehicles such as Maruti Suzuki Grand Vitara, Maruti Suzuki Invicto, Toyota HyRyder, Toyota Hycross and Honda City have witnessed fast acceptance due improved mileage, environmental benefits coupled with absence of EV concerns like range

anxiety, limited charging infrastructure, etc. In the last 2 years, strong hybrid powertrains have grabbed approximately 2% share of the annual retails of the PV industry.

In the long-term horizon, CRISIL MI&A projects higher traction for strong hybrids, further buoyed by attractive hybrid offerings, OEM focus, infrastructure availability and government support. By Fiscal 2029, strong hybrids are projected to contribute about 13-16% to the industry retails.

Review of Indian Commercial vehicle industry

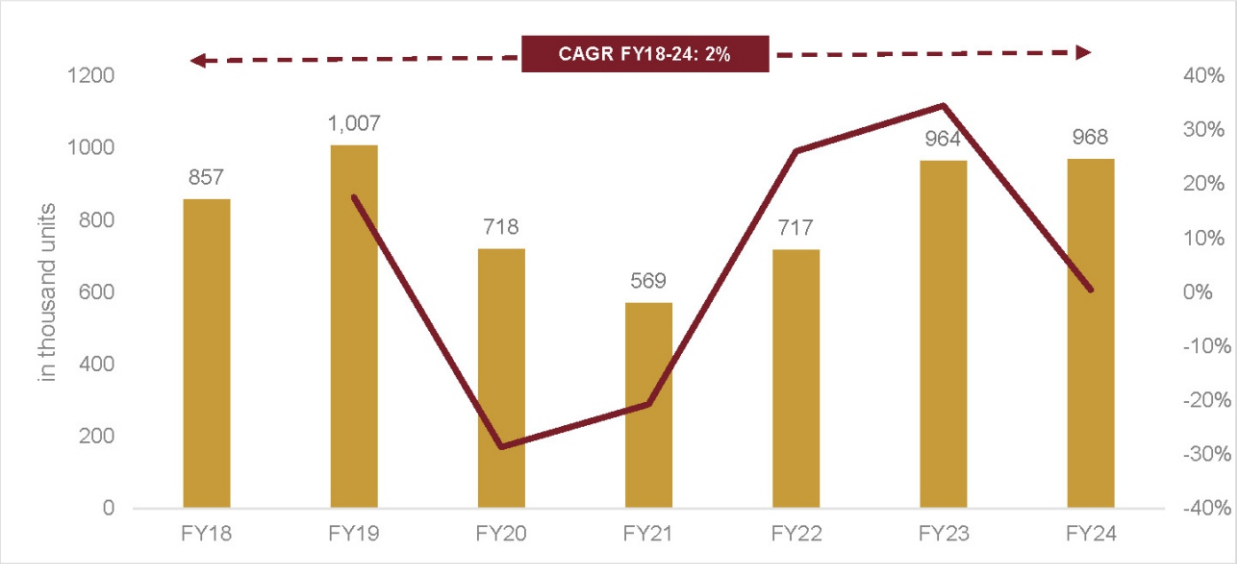
Historic domestic commercial vehicle industry

Between fiscals 2018 and 2024, domestic CV sales logged a CAGR of 2%. The CV industry exhibited a noteworthy recovery in fiscal year 2023, achieving a remarkable growth rate of 35% over fiscal 2022, albeit on a low base, and reaching 96% of the pre-pandemic levels observed in fiscal year 2019. This resurgence can be attributed to pent-up replacement demand, improved transporter profitability, and the pick-up in capex that had been hampered during the preceding 2-3 years due to economic stagnation and the disruptive impact of the pandemic.

In fiscals 2018 and 2019 witnessed strong recovery as compared to 2016-17 and a healthy 18-20% growth, supported by the government's focus on road and housing infrastructure development. In fiscal 2020, the industry witnessed a sharp de-growth of 28% on a high base of fiscal 2019, due to inventory adjustment on account of the transition to BS-VI emission norms. In fiscal 2020, demand for buses was impacted due to safety regulations (emergency exit doors, fire detection and suppression, escape hatches and emergency lighting).

The pandemic brought the entire economy to a grinding halt when a nationwide lockdown was declared to contain its spread, thus affecting the profitability and sustainability of transporters due to lack of availability of freight demand. The industry, however, gained momentum afterwards as consumption demand and industry activity started gaining pace.

Review of domestic commercial vehicle industry (in volume terms of sales)



Source: SIAM, CRISIL MI&A

Segmental Trends

Consulting

The commercial vehicle (CV) sales for fiscal year 2024 witnessed almost flat industry over fiscal 2023. This trajectory is underpinned by increased government spending and replacement demand. In FY2023, the CV industry exhibited remarkable recovery with a growth rate of 35% over fiscal 2022, reaching 96% of pre-pandemic levels

The Light Commercial Vehicle (LCV) witnessed a decrease of (3)% in fiscal year 2024, after an all-time high in sales in the previous fiscal. The lower utilization of vehicles coupled with the increase in asset costs led to a decline in sales. The Medium and Heavy Commercial Vehicle (MHCV) segment witnessed a stable outlook in the fiscal year 2024. In the fiscal year 2024, the bus sales sector witnessed substantial growth to 27% over fiscal 2023. This growth is anticipated to be bolstered by robust replacement demand; wherein older buses will be replaced with newer ones. In fiscal 2025, we expect CV sales to grow at a moderate rate of (2)-0% due to the impact of the upcoming union elections and the cyclical nature of the industry.

The demand from the key end-user segments coupled with the pent-up replacement demand helped the industry to mark the growth. The CV industry exhibited a strong recovery in the fiscal year 2023, achieving a remarkable growth rate of 35%, albeit on a low base, and reaching 96% of the pre-pandemic levels observed in the fiscal year 2019. This resurgence can be attributed to pent-up replacement demand, improved transporter profitability, and pick-up in capex that had been hampered during the preceding 2-3 years due to economic stagnation and the disruptive impact of the pandemic.

In the first half of fiscal 2024 the CNG prices dropped by ~4% and the diesel prices by ~3% respectively on-year. Consequently, in the LCV segment and the MHCV segment, the proportion of CNG vehicles decreased marginally by 1%. The CNG model availability was one of the major factors that lead to the drop as there were supply side constraints caused by OEMs transitioning to BS VI stage II emission standards leading to the unavailability of the LCV CNG models.

The adoption of Compressed Natural Gas (CNG) in the Light Commercial Vehicle (LCV) segment faced challenges in fiscal year 2023 due to a significant 57% increase in CNG prices relative to a minor 2% rise in diesel prices. As a result, the gap between CNG and diesel prices narrowed, leading to a reduction in the Total Cost of Ownership (TCO) benefits of CNG models. Consequently, the LCV segment observed a marginal decline in the share of CNG vehicles, indicating possible shifts in consumer preferences.

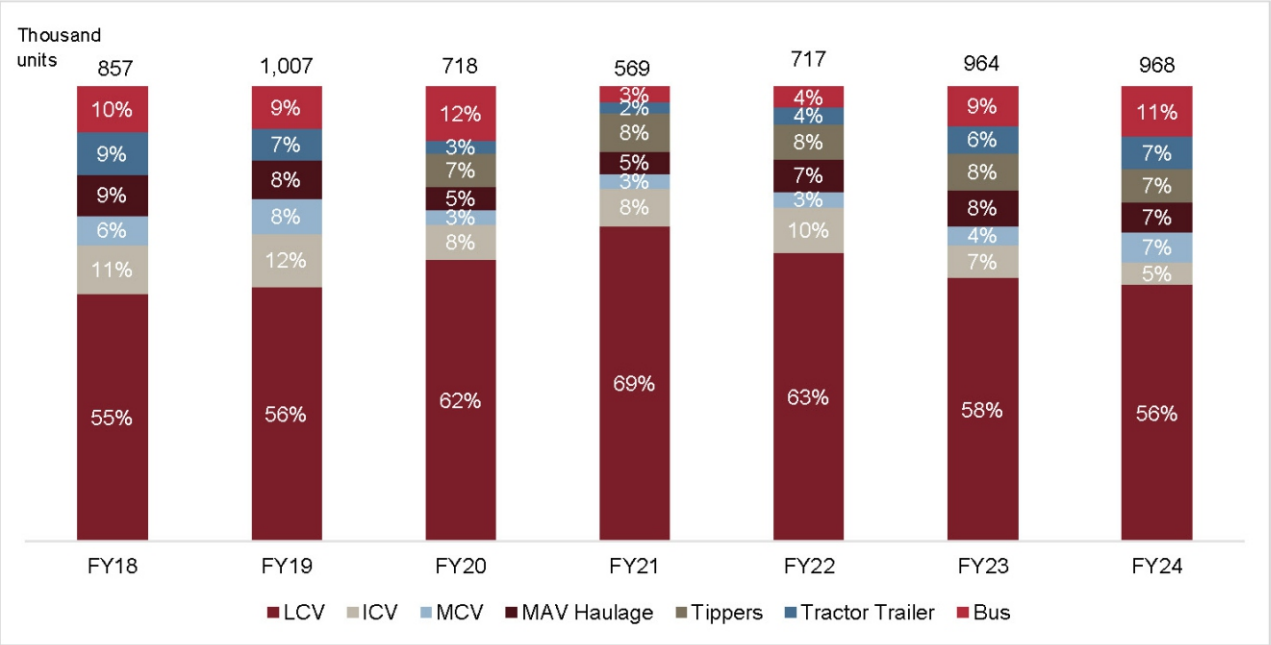
In fiscal 2024, the CNG penetration in LCV was 11% and in the Intermediate Medium and Heavy Goods Vehicle Category (IMHGV) increased to 11%. In FY 2023, the share of CNG models in the LCV market dropped from 15% in the previous fiscal year to 12%. Similarly, in the Intermediate Medium and Heavy Goods Vehicle (IMHGV) category, the share of CNG MHGV vehicles sold reduced from 11% in fiscal year 2022 to approximately 5% of total sales in FY 2023. The increased cost of CNG compared to diesel impacted demand, prompting consumers to opt for diesel-powered vehicles instead.

Consulting

Despite these challenges, the long-term prospects for CNG adoption remain promising. Fluctuating fuel prices and potential government incentives for eco-friendly alternatives could potentially reignite demand for CNG-powered vehicles. Moreover, advancements in CNG technology and the expansion of refueling infrastructure may enhance the appeal of CNG models, offering a greener and more sustainable solution for the transportation sector.

In fiscal 2024, domestic CV industry is dominated by the LCV goods segment contributing to more than half of the vehicle sales. The larger M&HCV segment which includes ICV, MCV, MAV Haulage, Tractor trailers and Tippers contributes to 33%. The rest is contributed by buses in the CV segment accounting for 11%.

Figure 2: Segment-wise share in domestic wholesale industry



Source: SIAM, CRISIL MI&A

Note: All percentages have been rounded off.

In fiscal 2024 the LCV sales declined by 3% after an all-time high in sales in the previous fiscal. The lower utilization of vehicles coupled with the increase in asset costs led to a decline in sales.

In fiscal year 2023, LCV sales recorded a growth of 23%, rebounding to 99% of pre-COVID heights. The surge in sales was attributed to robust replacement demand, particularly in the sub-one-ton category, which was deferred due to economic challenges and the pandemic.

Consulting

In fiscal year 2024, the MHCV segment exhibited a de-growth of 3% over the fiscal year 2023. In fiscal year 2023, MHCV sales recorded a growth of 40%, this recovery brought MHCV sales to approximately 90% of the level recorded in fiscal year 2019, a notable milestone. The resurgence in economic activities across various sectors played a pivotal role in driving this recovery.

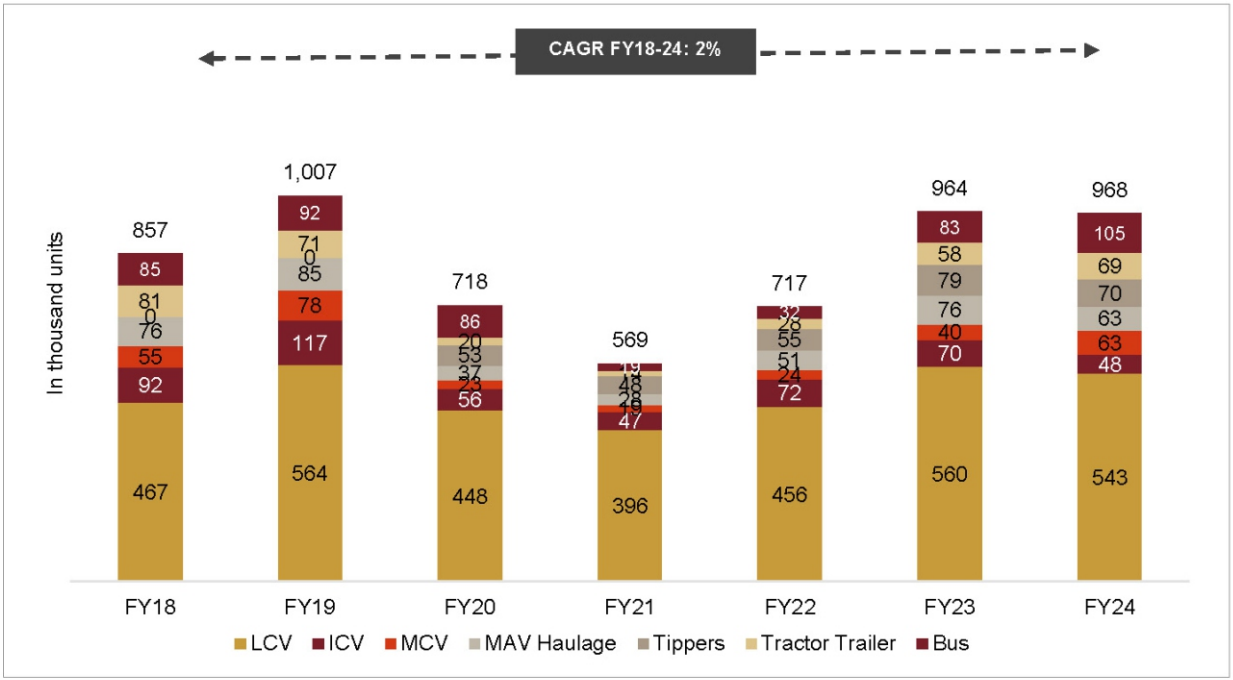
The bus sales sector witnessed an extraordinary CAGR of 75% during fiscal 2021-2024 period and in fiscal 2024, it witnessed a growth of 27% over fiscal 2023. However, it is essential to contextualize this growth as it was achieved on a low base, indicating a significant decline in bus sales during the previous fiscal year (fiscal 2023). The sharp growth in fiscal 2024 was primarily propelled by the resumption of schools and offices, along with a robust recovery in the tourism sector, contributing to a strong rebound in bus sales.

While bus sales more than doubled every fiscal off a very low base fuelled by robust replacement demand and urbanization trends. There has been unprecedented demand for buses. Buses are sold primarily to schools, corporates which use it to ferry staff and for tours & travel companies who use it for intercity and interstate travel. School demand has picked up after the pandemic. Schools have been apprehensive these last few years due to Covid and lockdowns, however now there seems to be no fears in this regard and schools are preponing purchases, there seems to be a lot of pent-up demand from schools. Corporates have also started to operate in full swing work from office mode with a few IT giants making work from office mandatory this has led to considerable demand for staff service buses as well.

Figure 3: Segmental sales trend

Market Intelligence & Analytics

CRISIL An S&P Global Company



Note: Domestic sales are exclusive of Bharat Benz sales as the same are not reported by SIAM

Source: SIAM, CRISIL MI&A

Outlook of the Indian Commercial Vehicle industry

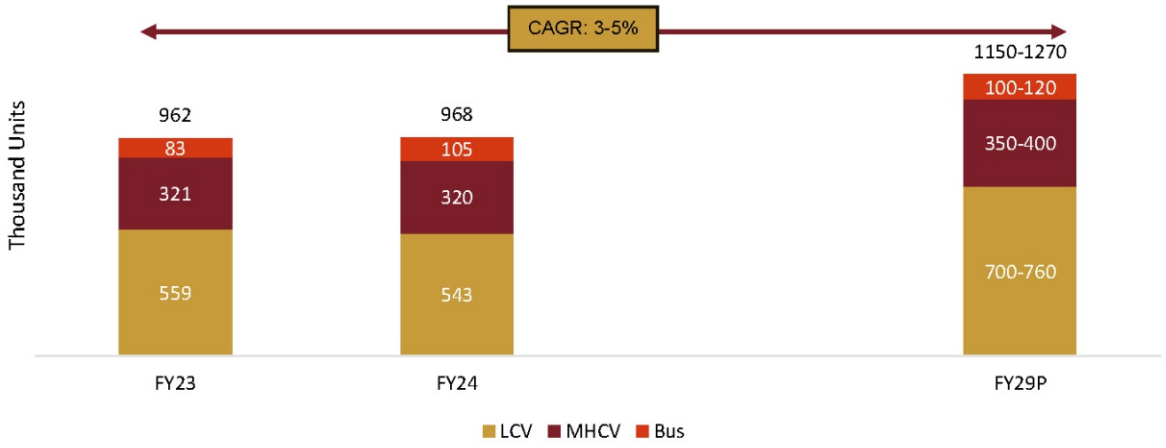
The CV industry recovered spectacularly in fiscal 2023, with a 34% growth rate and 0.6% in fiscal 2024, reaching 96% of pre-pandemic levels of fiscal 2019. Increased government spending, robust replacement demand, and strong end-user sectors such as construction and mining are expected to support growth.

Light commercial vehicle goods (LCV) sales derew by -3% in fiscal 2024, supported by sustained replacement demand with rising competition from electric three-wheelers, especially in the sub one tonne segment restricting further expansion. In fiscal 2023, LCV sales recorded impressive growth of 23%, rebounding to 99% of pre-pandemic levels. The surge in sales can be attributed to robust replacement demand, especially in the sub-one-tonne category, which was deferred due to economic challenges and the pandemic. However, LCV sales declined 9% in the first quarter of fiscal 2024 due to supply side constraints on account of OEMs transitioning to BS VI stage II emission standards. Despite this setback, the industry anticipates a revival in sales in the upcoming quarters, driven by a good monsoon season and an improved economic outlook with the easing of supply constraints.

Bus sales witnessed an increase of 26.8% in fiscal 2024, owing to strong replacement demand and urbanisation trends. CNG adoption has been hampered, affecting LCV sales. The CV industry, led by MHCVs, is expected to grow steadily over the next five years.

Over the long-term horizon, domestic CV sales are projected to record a 3-5% CAGR between fiscals 2024 and 2029, led by a 5-7% CAGR in the LCV segment, 2-4% CAGR in the M&HCV segment and 1-3% CAGR in the bus segment.

Figure 2: Commercial vehicle domestic sales outlook



P: Projected; E: Estimated,

Source: SIAM, CRISIL MI&A

Medium & Heavy Commercial Vehicles Set to Thrive in the Coming Five Years

The MHCV industry is expected to grow significantly, with a compound annual growth rate (CAGR) of approximately 2-4% projected from fiscal year 2024 to fiscal year 2029.

Long-term MHCV sales are likely to be driven by several factors, including the country's improving industrial activity, consistent agricultural output, and the government's continued emphasis on infrastructure development. However, volume growth may be limited due to efficiencies gained from the implementation of the Goods and Services Tax (GST), the development of improved road infrastructure, and the commissioning of the dedicated goods corridor (DFC). Nonetheless, the industry remains on a promising growth trajectory in the coming years.

Over the next five years (fiscal 2024-2029), industry GVA is expected to be robust, driven by the government's emphasis on "Make in India." Furthermore, infrastructure improvements and higher-than-expected corporate spending are expected to support the capex cycle after fiscal 2024.

LCV sales to grow at a modest pace in the long run.

Light commercial vehicle (LCV) demand is expected to grow at a 5-7% CAGR from fiscal 2024 to fiscal 2029, owing to increased private consumption, lower penetration, increased availability of redistribution goods, and improved financing. The industry grew at a 4% CAGR between fiscal 2018 and 2024.

Upper-end light commercial vehicles (ULCVs) provide lower returns to the transporter than ICVs and are best suited for captive use. Entry restrictions on ICV trucks and higher tonnage MHCVs are expected to keep demand from this segment buoyant. However, the higher toll on ULCV trucks versus pickups will limit segment growth.

SCV segment now offers a diverse range of products in various tonnages that cater to the needs of all types of customers. To fill tonnage gaps, players have launched a slew of new products, particularly in the last five years. In addition, the availability of CNG options is expected to keep volumes in this segment stable.

Bus demand is to witness strong growth over the next five years.

Domestic bus sales are expected to grow at a CAGR of 1-3% between fiscal years 2024 and 2029. Increased demand for inter-city/state travel, aided by improved road infrastructure, and higher personal disposable incomes will drive growth. The unregulated segment, which primarily serves demand from schools, businesses, and intercity travel by private operators, will continue to be the largest end-user. However, the implementation of metro-rail and monorail in several cities would have an impact on future bus sales growth. In terms of penetration (buses per 1,000 people), India ranks last among the countries studied, with 1 bus per 1,000 people and a 35% urbanization rate. These calls may have an upside if the scrappage policy is enforced, as well as increased urbanization and replacement of JNURM buses purchased between FY10 and FY13.

Review and outlook for electrification in commercial vehicles (fiscal 2018- 2029P)

Electrification in commercial vehicles

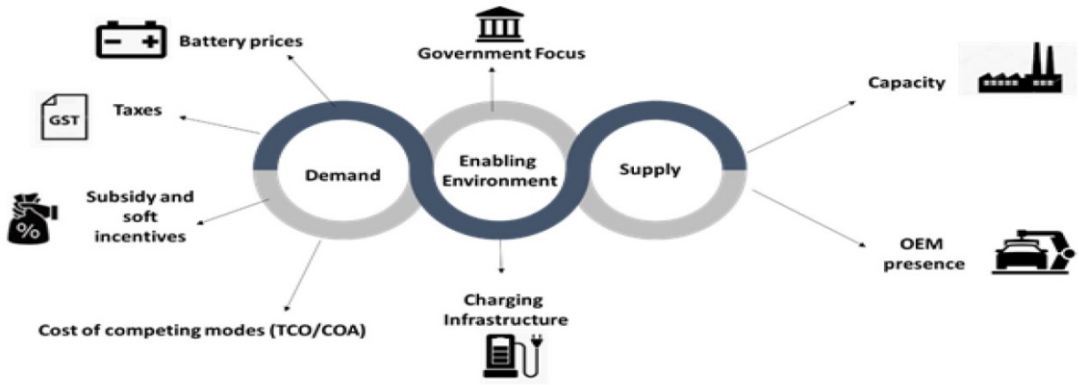
The Government of India has undertaken several steps to ensure proliferation of electric vehicles, such as Faster Adoption and Manufacturing of Hybrid & Electric Vehicles (FAME I & FAME II), Phased Manufacturing Program (PMP) and Production Linked Incentive (PLI) to name a few. The same has been supported by lucrative state EV policies, which a few progressive states have released.

Electric vehicles share of various vehicles segments such as two wheelers, three wheelers, passenger vehicles and buses are still in single digits despite multiple measure by the Government to support electric vehicle sales. EV penetration is low currently due to many issues such as limited presence of mainstream OEMs, model availability in certain segments like motorcycles, lack of charging infrastructure, financing availability etc.

Currently, most EVs used in the commercial segment as goods carries are three-wheelers and LCVs are picking pace. However, as the cost differential between electric and diesel vehicles start reducing, CRISIL expects new models to be launched, which will drive sales in the segment as the third-mile logistics and local distribution of goods are well suited applications for electric vehicles.

Due to the Government support through FAME and focus on quicker adoption of EVs in public transport, there has been significant increase in electric bus sales in the last couple of years. Further, through the introduction of PM eBus Sewa scheme government aims to augment the city bus operations using 10,000 e-buses through Public-Private Partnership (PPP) model across India. The Scheme will support bus operations for 10 years and would have an estimated cost of Rs.57,613 crore, out of which support of Rs.20,000 crore will be provided by the Central government. Operational profile of buses with fixed routes and regular stops makes them suitable for charging at pre-determined intervals and specific locations.

EV demand drivers



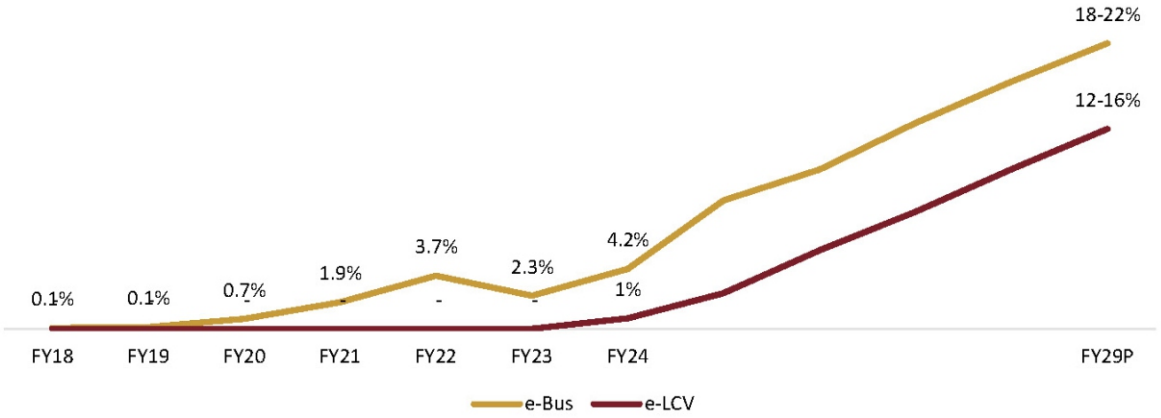
Source: CRISIL MI&A

- **Lesser environmental impact**: Compared to ICE vehicles, limited impact of EVs on the environment is the primary reason for increasing focus on electric vehicles globally. It is expected to drive the demand going ahead.
- **Government Focus**: Central as well as state government are focussing on promoting electric vehicles to the consumers. Governments are incentivising customers in the form of subsidies, tax breaks, waiver on registration certificates (RC) and renewal of RC for EVs etc. The Government incentives will remain the major driving force for the EV adoption. For commercial vehicle segment, government is also supporting EV usage through STUs by committing to convert a significant portion of the public transport infrastructure fully electric in the next few years.

- **Lower operating costs**: One of the primary advantages of an EV for the customer is its lower operating cost. The recent rise in fuel costs has provided an added impetus to the EV adoption. Although the cost of acquisition is still one of the major hurdles for EVs, lower operating cost is expected to remain a significant incentive for customers. The lower battery cost, reduced GST rate of 5% and FAME-II demand incentive are expected to improve the cost of ownership and hence viability of EVs.
- **Charging infrastructure**: Availability of charging infrastructure remains a key determinant in EV adoption. Government, power distribution companies, OEMs are focussing on expanding the supplementary infrastructure including the charging infrastructure which will surely aid the EV adoption in the longer run. For instance, The Ministry of Road Transport and Highways announced plans to set up EV charging kiosk at each of India's 69,000 petrol pumps across the country. State government of Andhra Pradesh has decided to set up ~400 EV charging stations along the National and State Highways. Delhi government has announced to set up charging stations within every 3 kms distance in the city. Besides, large corporate such as MG Motor and Tata Motors installed 60 kW Super-fast EV charging station in Mangalore.
- **Increased OEM presence**: Most of the mainstream players are planning to launch an electric vehicle offering which is expected to boost the sales in the longer horizon.
- **Capacity expansion:** Most OEMs are expanding EV capacity to address the expected rise in electric vehicles. Moreover, government push in the form of mandatory localisation, PLI schemes will also provide an additional support to the capacity expansion.
- **Competitive pricing**: Battery is the primary contributor to the high electric vehicle prices. Through R&D, manufacturers are trying to lower the battery pricing while increasing the vehicle range. Companies are trying to achieve a golden mean between pricing and the range. This improvement in the customer offering will provide an impetus to the EV demand.

Batteries account for ~40-50% of the total EV cost. Prices of batteries have been falling moderately. The fall is expected to continue over the next five years. India is highly dependent on imports of batteries due to lack of manufacturing facilities for battery cells (ACC). However, the Government announced initiatives for reducing battery prices further by localization of electric vehicle battery manufacturing. As part of the production-linked incentive scheme, the Union Cabinet earmarked ~Rs. 18,100 crores for setting up 50 giga watt hour (GWh) of advanced chemistry cell (ACC) manufacturing facility and 5 GWh of niche ACC capacity.

EV penetration in CVs (FY2018-FY2029P)



Note: FY21 and FY22 were COVID impacted years and hence the overall sales of buses were low which leads to low base effect in FY21 and FY22

Source: CRISIL MI&A, VAHAN

Electrification in passenger vehicles (buses)

EV bus registrations skyrocketed in the last 3 years backed by adoption by STU as well as government incentives. During fiscal 2019-2023 period, EV bus registration increased at a breakneck pace of 133% CAGR with more than 600% on year growth clocked in fiscal 2020. EV penetration was insignificant till fiscal 2019, it gained some pace during fiscal 2020 and received a real boost during fiscal 2022 to reach more than 1,100 units and reached 3.7% of overall registrations. Growth momentum continued in fiscal 2023 with y-o-y growth of 61% reaching more than 1,900 units.

Due to the government support through FAME and focus on quicker adoption of EVs in public transport, there has been a significant increase in electric bus sales in the last couple of years. Operational profiles of buses with fixed routes and regular stops make them suitable for charging at pre-determined intervals and specific locations. However, sales of electric buses are unlikely to meet the target in fiscal 2021 due to the pandemic and hence we expect the subsidy amount to get carried over to the coming years.

The price of an electric bus is electric bus is considerably higher than the cost of a bus running on diesel. Thus, subsidy would be a key driving factor that would drive EV adoption in STU buses. We expect a large part of the STU intra city buses to be electric by fiscal 2028. However other segments are unlikely to see a meaningful penetration of electric buses owing to their high cost of acquisition and limited range limiting their ability for intercity travel.

CRISIL expects FAME subsidies to be extended for buses as the policy period ends in fiscal 2024. With other incentives from the central and state governments, the sales of electric bus penetration is expected to reach 18%-22% by fiscal 2029.

Electrification in LCV goods vehicles

Currently, most of the EVs used in the commercial segment as goods carries are three-wheelers. However, as the cost differential between electric and diesel vehicles start reducing, we expect new models to be launched. This will drive sales in the segment as the third-mile logistics and local distribution of goods are well suited applications for EVs. Tata Ace EV is the only e-SCV currently in the market.

Consequently, as depicted in the chart above, EV sales in the LCV goods segment can rise to 81,000-82,000 vehicles by fiscal 2028. This would be about 12-13% of the total LCV goods vehicle market, as CNG offers better TCO in near future and will be preferred over electric variants. Further EV penetration is expected to grow and reach 12-16% by fiscal 2029.

Electrification in HCV goods vehicles

EV adoption in the HCV segment is expected to be negligible in the near future as operational profile makes them highly expensive. Further, the current charging infrastructure is not suitable for larger HCV batteries, which will make electric adoption unviable for some time.

Review of domestic tractor industry

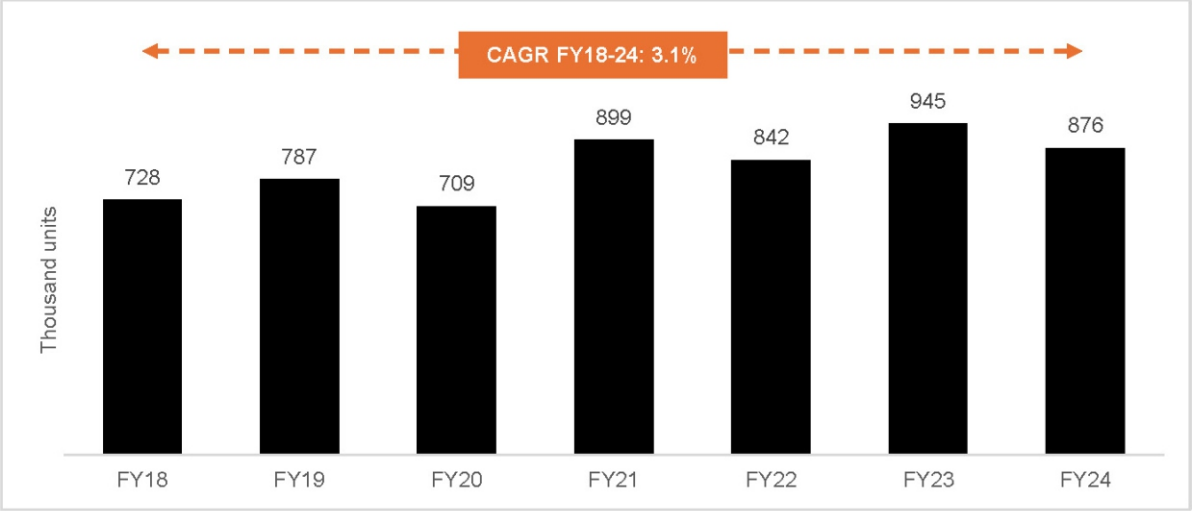
Domestic tractor demand dropped 6.4% on-year in fiscal 2022 after growing 26.9% in fiscal 2021. Rising tractor prices amid price hikes taken by OEMs, higher inventory at dealerships, lower commercial demand, negative farmer sentiment due to rising cultivation cost, low fertilizer availability, and increase in other expenditure (such as marriages and other social occasions) hampered demand.

In fiscal 2023, tractor sales grew 12.2% on-year to an all-time high of ~945,000 units. Healthy crop prices, sound reservoir levels owing to above-normal monsoon, higher MSPs announced by the government and better rabi acreage, all led to positive farmer sentiment. Healthy festival demand because of various schemes and discounts supported the retail growth momentum. Commercial demand during the fiscal, however, remained rangebound in fiscal 2023 owing to slower retail momentum in eastern states and a complete ban on sandmining. In the last fiscals, the governments in states such as Bihar, Jharkhand and Uttar Pradesh had clamped down on illegal sand mining, negatively impacting commercial demand for tractors.

In fiscal 2024, domestic tractor sales dropped by 7.4% on-year to ~875,724 units, on account of lower reservoir levels and negative farmer sentiments. Negative farmer sentiments also impacted the festive demand, with sales in the festive months September, October, and November for fiscal 2024 - being lower by 5.8% on-year as compared to the same period last fiscal. Uneven rainfall distribution with monsoon being 6% below normal for the season has led to slower pick-up in the retail market. Barring north-west and central India, remaining regions reported deficit rainfall over normal impacting tractor demand. Erratic monsoon, lower reservoir levels, anticipated decline in rabi acreage contributed towards a 7.4% on-year decline in tractor sales for fiscal 2024.

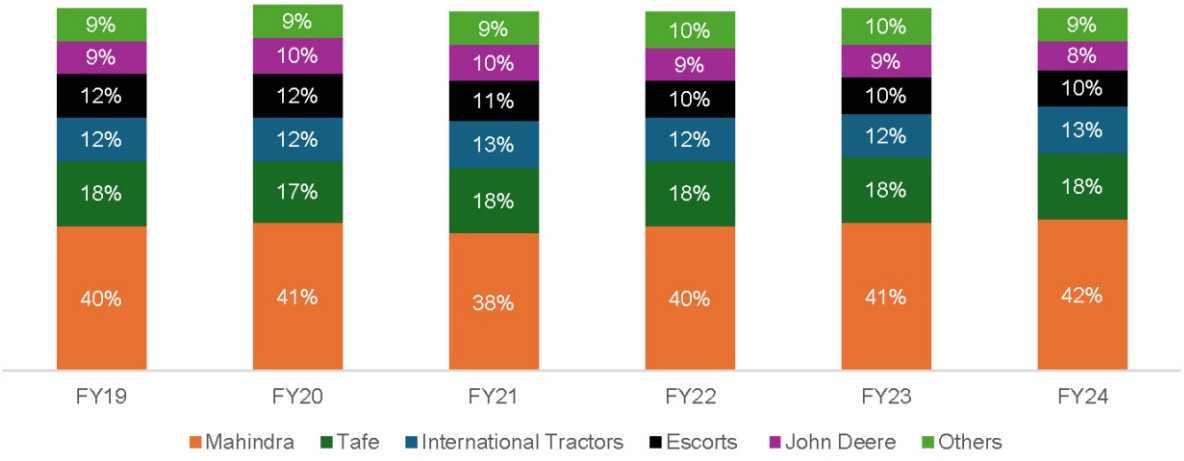
A large part of domestic tractor sales is driven by replacement demand. The typical holding period for a tractor is 6-9 years. Most of the tractors in the country is replaced within 7-8 years. Of the domestic demand, 50-60% constitute replacement demand. In states with high penetration of tractors, such as Punjab and Haryana, the replacement demand accounts for 70-80% of total sales. On the other hand, states with lower farmer incomes than that in Punjab and Haryana have a lengthier replacement cycle (higher age tractors) vs industry average.

Figure 3: Domestic tractor industry logged 3.1% CAGR between fiscals 2018 and 2024



Source: TMA, CRISIL MI&A CONSULTING

Figure 4: Player-wise domestic market share (volume-wise): M&M gained significant market share last fiscal



Source: CRISIL MI&A CONSULTING

Going forward, CRISIL Consulting expects the competition in the industry to intensify further. However, the top five players will continue to account for 85-90% of the industry by volume. A strong distribution network, brand recall, captive financiers and diverse product range are critical to maintain market position in the tractor industry.

Consulting

Outlook of Indian tractor industry

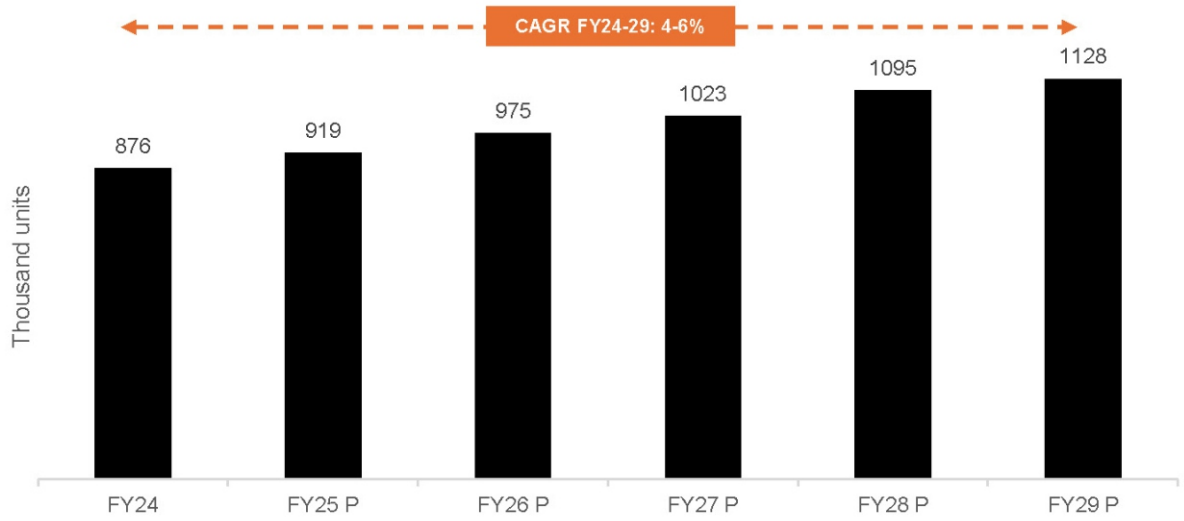
CRISIL MI&A Consulting projects domestic tractor sales to increase at a steady pace over fiscals 2024 to 2029, factoring 1-2 years of erratic monsoon, with healthy sales forecast for the remaining years. To be sure, the tractor segment is cyclical. Also, historically, whenever there is a downturn in the industry, it takes 4-5 quarters for sales to recover. Thus, assuming that the industry will be impacted by weak monsoon for 1-2 years between fiscals 2024 and 2029, with the industry taking 4-5 quarters to recover, our long-term growth projection of the tractor industry is 4-6% CAGR.

During fiscals 2019 to 2024, the industry had registered a 2% CAGR, owing to healthy sales in fiscals 2021 and 2023.

Growth up to fiscal 2029 will be on the back of low tractor penetration in the country (three tractors per 100-hectare area), government's focus on improving farm incomes through various schemes, promotion of farm mechanisation, and investments to improve rural infrastructure.

In fiscal 2025, with IMD's (Indian Meteorological Department) prediction of a normal monsoon season, aiding farmer sentiments, domestic tractor sales are expected to grow by 4-6% on-year in volume terms reaching ~910,000-930,000 units. An 8-10% on-year increase in volumes up for replacement to further support growth in the fiscal. Anticipated healthy rainfall is expected to lead to higher festive demand in the second and third quarters while healthy reservoir levels would also boost kharif acreage and thereby crop profitability which, in turn, is expected to aid tractors sales in the last quarter of the fiscal.

Figure 5: Tractor industry sales expected to increase 4-6% between fiscals 2024 and 2029



Note: P- Projected

Consulting

Source: CRISIL MI&A Consulting

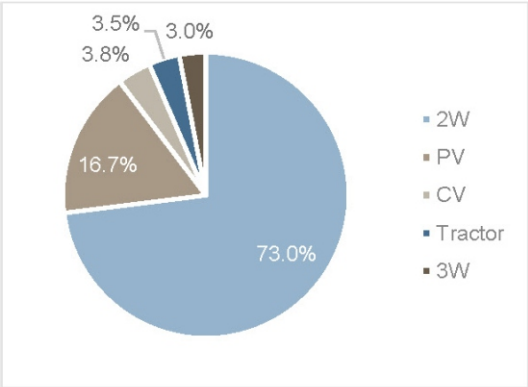
A large part of domestic sales is driven by replacement demand. Typical holding period for a tractor is around 6 to 9 years with most of the tractors being replaced in the country within 7-8 years. Of the overall domestic demand, 50-60% of the sales are replacement demand. For states having high penetration of tractors such as Punjab and Haryana, the replacement demand accounts for about 70-80% of the total sales. While states where farmer incomes are lower as compared to Punjab and Haryana have a lower replacement cycle (higher age tractors) compared to the industry average.

Replacement demand is expected to be higher by 8-10% on-year in fiscal 2025 with healthy sales registered in fiscals 2017 and 2018.

Review of the Indian two-wheeler industry

India is the largest motorised two-wheeler market by volume in the world, with domestic sales of 18.4 million units in fiscal 2024. Indian automobile segment primarily consists of two-wheelers (2W), passenger vehicles (PV), commercial vehicles (CV), three wheelers (3W) and tractors. Two-wheeler is the largest segment and contributed 73% to the total auto market by volume followed by the passenger vehicle segment which contributed 16.7%.

Fig: Segment wise split of the Indian Automobile market by volumes (fiscal 2024)



Source: SIAM, VAHAN, CRISIL MI&A

The two-wheeler segment sees a healthy demand in India and is preferred over four wheelers by majority of the Indian population especially for their regular commute. This is primarily due to the lower acquisition cost, higher mileage, lower maintenance costs, ease of navigation especially during the traffic hours, hassle free parking and suitability of two-wheelers on rugged roads.

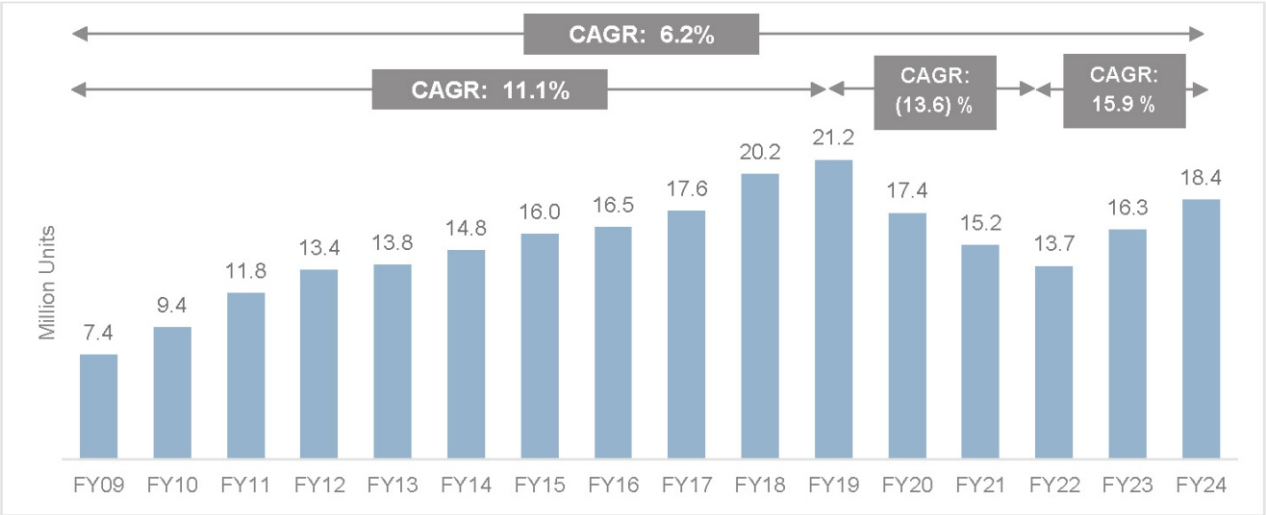
In the last 15 years (fiscal 2009 to fiscal 2024), domestic two-wheeler industry has grown at a CAGR of 6.2% and reached a volume of 18.4 million in fiscal 2024. Within this period, the industry accelerated at a much faster pace of 11.1% CAGR over the 10-year period from fiscal 2009 to fiscal 2019 and reached a historic high of volumes of 21.2 million in fiscal 2019.

During fiscal 2009 to fiscal 2019, India's GDP as well as private final consumption expenditure grew at a healthy pace of 7% CAGR. Moreover, inflation levels were on a tapering trend reaching ~3% levels in fiscal 2019. This favourable macro-economic environment led to a rise in disposable incomes and provided a thrust to the industry growth during the decade. Additionally, expansion in vehicle portfolio by OEMs, accelerated growth in scooters segment and a healthy growth of higher cc motorcycles (>=125 cc) provided additional support to the industry growth during the decade. Moreover, vehicle prices rose at a nominal level of 3-5% during the period

which limited the rise in acquisition costs for the customers. The continued support from financers provided an additional support to the industry growth.

These favourable factors helped the two-wheeler industry reach a historic high of 21.2 million volumes in fiscal 2019. These record sales were achieved despite the higher-than-normal price rise due to BS IV emission standard implementation in fiscal 2018, GST implementation in fiscal 2018 and demonetization in fiscal 2019 that restricted 2W purchases.

Fig: Domestic two-wheeler sales volume trend – fiscal 2009 to fiscal 2024

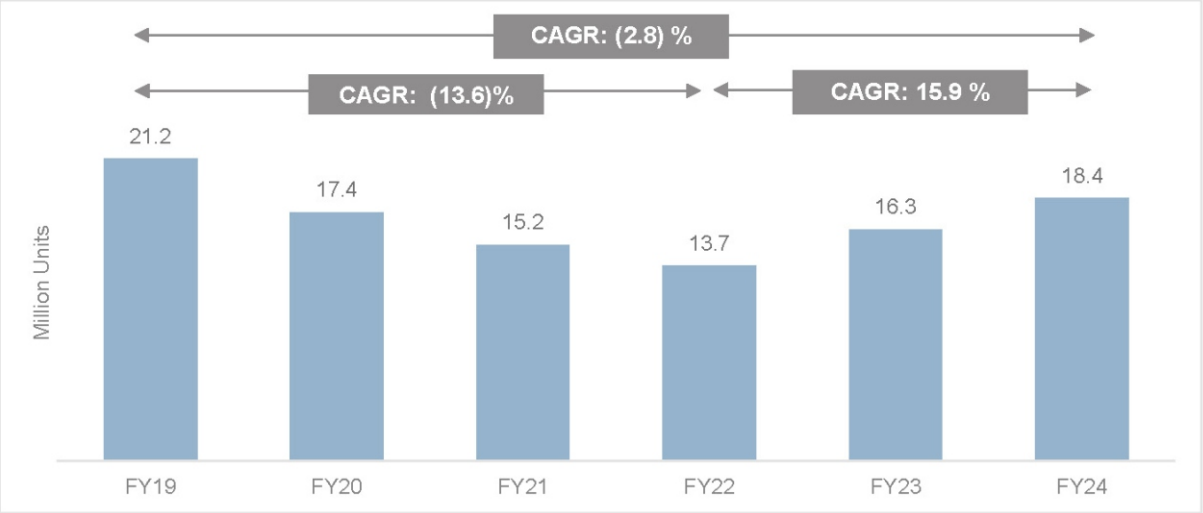


Note: Figures in bracket to be read as negative (Eg. (10) to be read as minus 10)

Source: SIAM, VAHAN, CRISIL MI&A

However, in the next 4 years, fiscal 2019- fiscal 2022, the industry witnessed contraction at 13.6% CAGR amidst the pandemic, nationwide lockdowns, reduced mobility, unfavourable macroeconomic scenario, closure of schools, colleges and offices, and work from home impacting the demand for two-wheelers.

Fig: Domestic two-wheeler sales volume trend – fiscals 2019 to fiscals 2024



Note: Figures in bracket to be read as negative (Eg. (10) to be read as minus 10), Data for ICE and EVs; EV retail data from VAHAN has been considered.

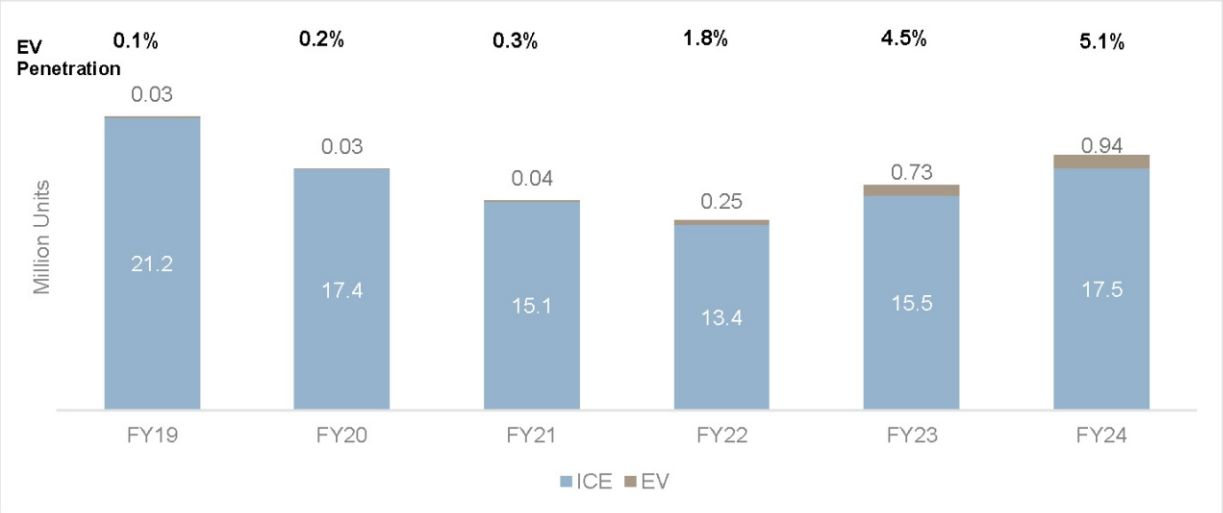
Source: SIAM, VAHAN, CRISIL MI&A

On the reduced base of fiscal 2022, two-wheeler sales rebounded in fiscal 2023 and recorded a healthy growth of 19%, driven by improving demand sentiments and the normalization of economic activities and increased mobility. The pent-up demand, because of the postponement of purchases during the pandemic period and sharp rise in scooters demand with restarting of colleges and offices provided thrust to the industry demand. Despite normalization of public transport, improved frequency of intracity bus and railway services, the demand for last mile mobility and in turn the demand for two-wheelers remained buoyant during the year.

Over and above this, the EV segment retail sales nearly tripled during the year giving an added fillip to the overall sales in fiscal 2023. However, the increased interest rates amidst higher repo rates and further increase in vehicle prices restricted the growth of two-wheeler industry sales during fiscal 2023.

2W industry sales further increased by 13% during fiscal 2024 backed by improvement in macro-economic scenario, rural support, continued traction for >=125cc motorcycles as well as scooters. Furthermore, continued demand for electric two-wheelers despite the subsidy cut supported the growth in fiscal 2024. New launches especially in the premium segments provided an added support to the demand. Additionally, <=110 cc motorcycles subsegment witnessed some improvement during the year after consecutive contractions, aided by limited rise in ownership costs as well as increased customer incentives. Moreover, continued support from financers also aided the overall industry growth in fiscal 2024.

Fig: Domestic two-wheeler sales volume trend (ICE vs EV)



Source: SIAM, VAHAN, CRISIL MI&A

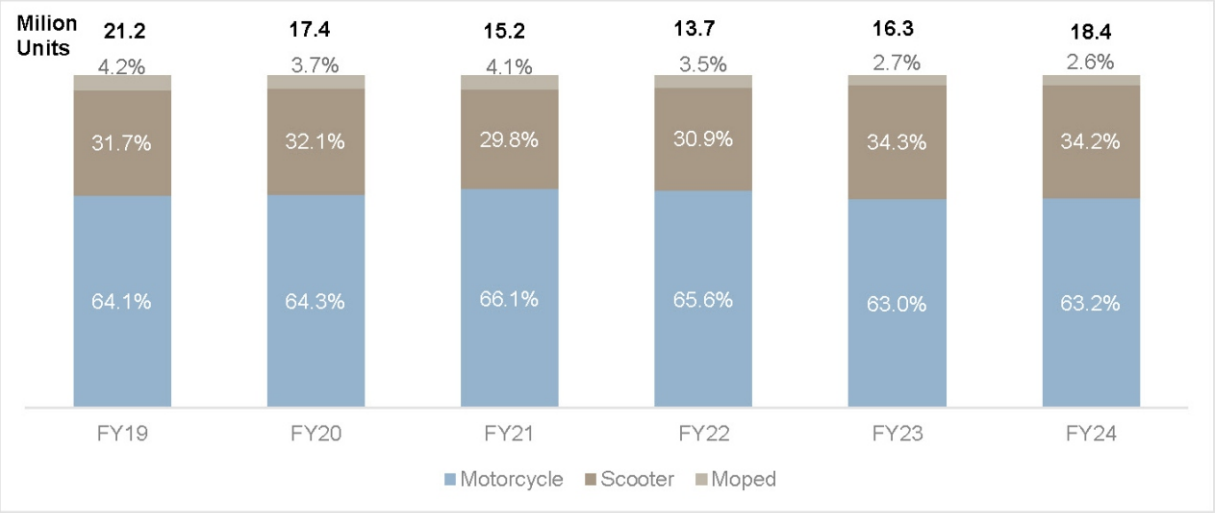
In the last 5 years, the electrification within the industry has helped grow the industry sales. Even during the years, when the ICE vehicle sales slid, the sharp rise in EV retails restricted the drop in the overall 2w sales volumes. During fiscal 2019 to fiscal 2024 period, ICE segment contracted at 3.7% CAGR and EV retails skyrocketed with a 101.7% CAGR, albeit from a lower base.

Segment wise domestic sales trend

Motorcycles dominate the domestic two-wheeler industry sales with more than 60% contribution to the annual domestic sales volumes. However, their contribution has gradually contracted over the years, from 78% in fiscal 2009 to 63% by fiscal 2024.

On the other hand, the scooters segment expanded its presence over the long-term horizon; from 15% in fiscal 2009 to 34% in fiscal 2024. The mopeds segment also lost some ground to scooters over the years, from ~ 6% share in fiscal 2009 to ~3% in fiscal 2024.

Fig: Domestic two-wheeler sales segmental trend – fiscals 2019 to 2024



Note: Data includes ICE and EVs; EV retail data from VAHAN has been considered.

Source: SIAM, VAHAN, CRISIL MI&A

Table: Segmental growth within the industry in the last 5 years

Segment	FY19-FY24 CAGR	FY19 share	FY24 share
Motorcycles	**(3.0) %**	**64.1%**	**63.2%**
ICE	(3.1) %	64.1%	63.1%
EV	NM	0.0%	0.1%
Scooters	**(1.3) %**	**31.7%**	**34.2%**
ICE	(4.3) %	31.6%	29.2%
EV	101.3%	0.1%	5.0%
Mopeds	**(11.4) %**	**4.2%**	**2.6%**
Total	**(2.8) %**	**100%**	**100%**

Note: NM: Not meaningful; Figures in bracket to be read as negative (Eg. (10) to be read as minus 10), EV retail data from VAHAN has been considered.

Source: SIAM, CRISIL MI&A

Electrification in the 2W industry

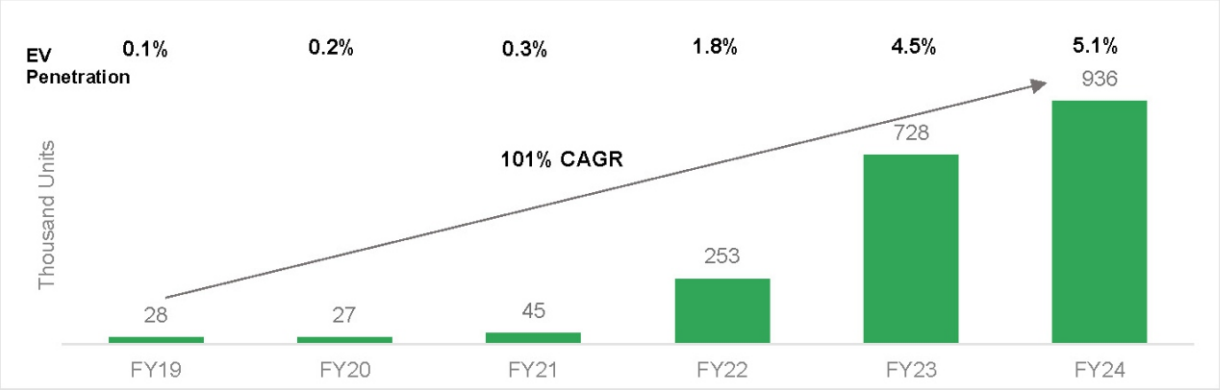
EVs are gaining global interest amidst the need to curb pollution. In India, too, EVs are gaining popularity, as the government is extending support via Faster Adoption and Manufacturing of Hybrid and Electric vehicles (FAME II) and tax rate cuts to encourage EV adoption. Further, growing awareness and concerns about environmental issues are likely to drive electrification in India.

EV sales have skyrocketed, especially post pandemic aided by the rising awareness, government support and expanding EV portfolio of the industry. The entry of the new age non-traditional OEMs like OLA, Ather, Okinawa provided an additional boost to the EV segment in India.

While the ICE two-wheeler sales contracted at 3.7% CAGR between fiscal 2019-2024, EV sales accelerated at 101% CAGR, thus restricting the drop in overall industry sales.

Even going ahead, the furthering electrification is estimated to provide the much needed thrust to the industry growth over the long term horizon. (EVs have been covered in detail in the next chapter)

e2W retail sales trend in India



Note: VAHAN data does not include Telangana & Lakshadweep retails

Source: VAHAN, CRISIL MI&A

Shrinking replacement cycles

The vehicle replacement cycles have been shrinking amidst the expanding vehicle portfolios by OEMs, entry of newer players into the industry - global & non- traditional, increasing number of attractive, feature rich and competitively priced vehicle launches, shortening duration of new vehicle launches by OEMs, continuous technological advancement in vehicles, younger buyer demographic, expanding financing coverage and rising awareness. The increasing share of scooters with a relatively lower ownership holding period is another factor contributing to the

shortening of the replacement cycle in the overall 2W industry. Rising premiumization as well as electrification is also aiding this trend as growing number of customers make their switch from ICE to EV or to products with premium features.

From an average 10-12 years replacement cycle a decade ago, the replacement cycles have come down to 7-8 years. The shortened replacement cycle for the average customer is an added boost for the two-wheeler industry sales.

R&D support

The young customer base of the two-wheeler industry today are tech savvy gen Z customers who appreciate and prefer the latest advanced features, connected technology as well as hi tech accessories for their new vehicles. This customer base sees the vehicle as an extension of their personality. Moreover, the replacement cycles have also shortened. Therefore, intermittent new vehicle launches are a must to ensure continued demand.

Thus, all the OEMs spend a notable amount on Research and Development (R&D) for the latest tech, design, and features for their upcoming vehicles. R&D has also become a necessity to enhance the safety of the two-wheeler riders.

In the last 6 years, two-wheeler industry OEMs have spent 1% - 2% of their total revenues on their Research and Development expenditure.

Advancement in Vehicle Technology

Over the years, there has been a significant advancement in vehicle technology as well as addition of latest features in ICE as well as EVs, making the vehicles more appealing to the customers, especially the younger buyers. EV segment has revolutionised the industry in terms of latest technological designs as well as offerings, and ICE vehicles are following with notable advancements. The latest new age vehicles offer a wide range of features and innovations to cater to different consumer needs offering safer, more efficient, and environmentally friendly transportation.

In recent two-wheelers, features such as digital instrument cluster (around 2010), navigation (around 2017), USB charging port (2017), Bluetooth connectivity (2018), cruise control have been added over the years. Over and above these basic features, premium vehicles including EVs offer much advanced features like full colour TFT displays, gear shift indicators, real time mileage, fuel efficiency metrics, music, calls on vehicle display, riding modes, traction control, keyless ignition, smart helmets with built in communication, heads up display etc.

As technology continues to advance, two-wheeler industry will witness more innovations in the coming years, making the ride safer and more enjoyable for the customer, thereby supporting the growth of industry over the long-term horizon.

Domestic Two-Wheeler Industry Outlook (fiscals 2025-2031)

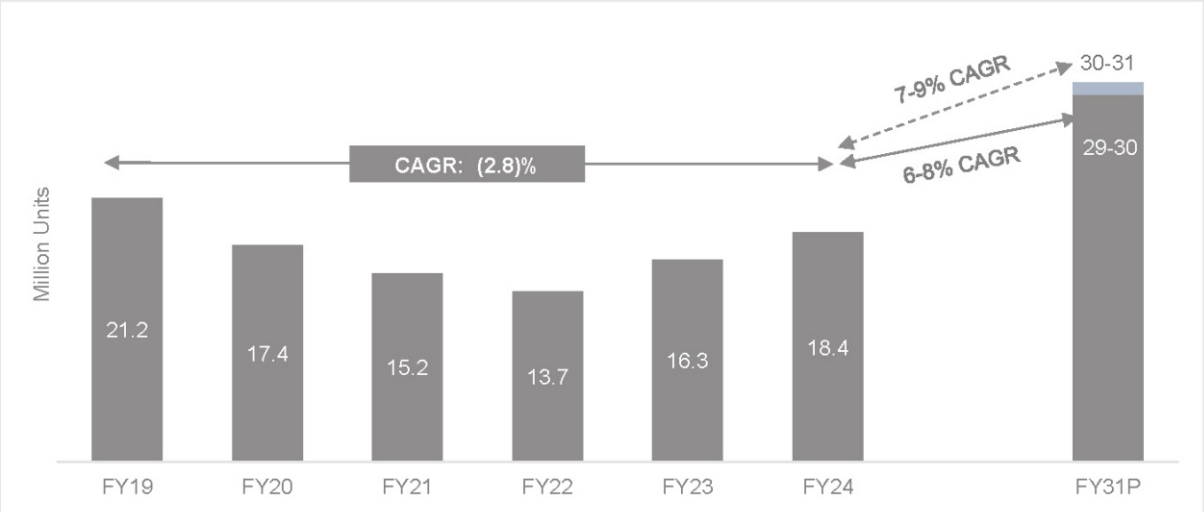
The industry is expected to continue its growth momentum over the long-term horizon led by the positive microeconomic and macroeconomic environment, favourable rural demand, premiumization, intermittent launches, shrinking replacement cycle and continued support from financers. Moreover, continued R&D investments by the OEMs and the technological advancements in the industry to provide an added support to the growth of the industry over the long-term horizon.

Additionally, the fast-rising EV segment, with EV portfolio expansion by legacy players, capacity expansion by new age players will accelerate the industry growth.

Introduction of CNG powertrain, which will offer lower operating costs compared to petrol variants, will push the two-wheeler industry growth further.

Led by these positive industry drivers, the two-wheeler industry sales are projected to grow at 6-8% CAGR and reach volumes of 29-30 million by fiscal 2031.

Fig: Domestic two-wheeler industry outlook – till fiscal 2031



Note: The numbers indicated by the dotted arrow represent the optimistic case

Source: SIAM, CRISIL MI&A

Industry growth will be driven by the EV segment which is projected to clock a healthy CAGR of 40-42% over the long term. While the ICE vehicle segment will grow at a subdued pace of 1-3% CAGR.

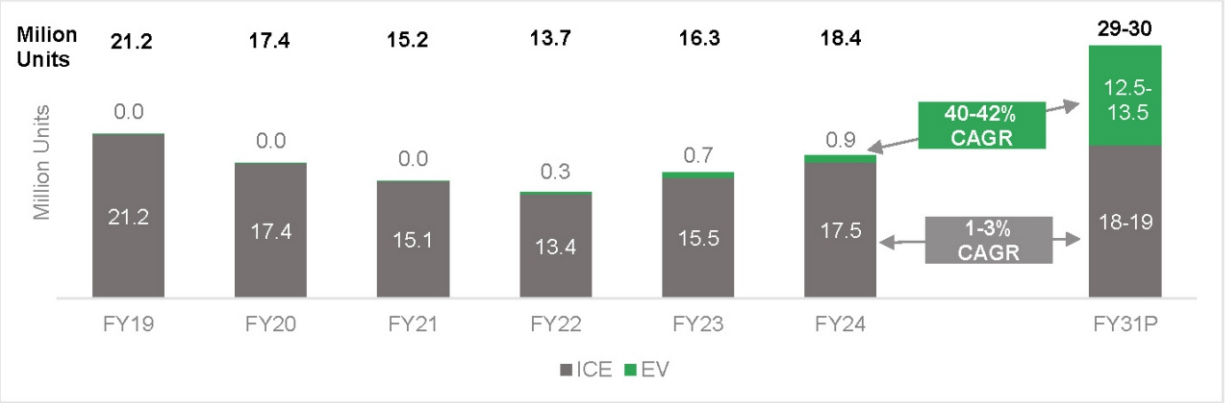
The faster growth in EVs will help the EV penetration to reach 33-37% of the industry sales by fiscal 2031. (EV subsegment outlook is covered in detail in the later section)

In an optimistic scenario, supported by increased EV launches, favourable government support, faster momentum in infrastructure development, reduced battery prices, easing supply chain

constraints, localized value chain and faster consumer shift towards electrification, the industry sales are projected to grow at a faster pace of 7-9% CAGR to reach volumes of 30-31 million by fiscal 2031. In the optimistic scenario, EV penetration is expected to reach 38-42% compared to 33-37% estimated for the base case.

Domestic two-wheeler industry powertrain wise outlook

Fig: Powertrain wise sales trend



Note: Figures above the graph showcase the total sales, outlook is for the base case scenario

Source: SIAM, CRISIL MI&A

Going ahead, over the long term horizon, CRISIL MI&A expects the scooter segment to grow at a much faster pace off the relatively lower base, backed by expected sharp rise in e-scooter demand, ubiquitous usage of scooters, rising share of women in workforce, projected growth of e commerce segment coupled with continued focus of OEMs on the scooters segment. The strong launch pipeline, especially for e-scooters and faster replacement cycles of the scooters segment will also back the faster growth of the scooters segment. Further, the improvement in supporting charging infrastructure is expected to provide added impetus to the segment's growth.

CRISIL MI&A projects the scooters segment to grow at a faster pace of 8-10% CAGR over the long-term horizon. However, the ICE scooters segment is expected to contract amidst the shift towards the EV segment. Sizeable portion of the ICE scooter replacement demand will shift towards the electric variants.

Market Intelligence & Analytics

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Powering India's Future: Unleashing the Potential of the EV value chain

by

EY Parthenon
Building a better working world



Foreword

At COP26, India pledged to reduce its carbon emission by one billion tons by 2030 and committed to reducing its carbon intensity by 45% by 2030 levels over 2005 levels. Further, India has pledged to achieve net zero emissions by 2070. To achieve these targets, India must shift its power generation towards renewable sources of energy and distance itself from fossil fuel-based transportation. The rise in automobile adoption over the past decade has made the Indian transport sector the third-largest user of oil world-wide, with road transportation contributing 80% to the consumption. To achieve the GHG emission target committed under NDC, the transition towards greener mobility technologies in the sector plays a crucial role.

Even though avenues for clean mobility are gaining momentum in India, there is a visible need for large-scale adoption to make a considerable impact on reducing the import bill, GHG emissions and ensuring future energy security. EVs have emerged as a promising alternative that could help drastically reduce the adverse environmental impacts caused by conventional vehicles. The Government of India's National Electric Mobility Mission Plan 2020, which seeks to enhance national energy security, alleviate adverse environmental impacts from road transport vehicles and boost domestic manufacturing capabilities for Electric Vehicles, is a step in the right direction.

A key aspect of the mass adoption of EVs is the production of EV vehicle and battery components in India. Currently, battery manufacturers primarily assemble battery packs from cells manufactured outside India. To promote production, the GoI has instituted several schemes as such as the Production Linked Incentive (PLI) program for component manufacturing and for Advanced Cell Chemistry. These policies aim to increase indigenous value addition to EV-related components and application-agonistic batteries to 60% by 2026.

In parallel, the growth of EV charging infrastructure, including the development of new standardized charging port for India's two-wheeler and three-wheeler fleets, will also aid the EV proliferation. The evolution of the electric mobility ecosystem in India may follow a different growth trajectory compared to other developed or economically varied global EV markets. In India, the transition is currently driven by the two-wheeler and three-wheeler segments, with the four-wheeler industry and other commercial transport catching up. Further, business models such as battery swapping and Battery-as-a-Service (BaaS) are being extensively explored in India, as they significantly reduce upfront EV cost. Growth in this part of the ecosystem has also seen the GoI release of the Draft Battery Swapping Policy in 2022.

Envisioning the growth of electric mobility, I hope that this thought leadership will serve as a reference point for stakeholders aiming to accelerate electric mobility and manufacturing. It would undoubtedly help new entrants make a head start by understanding the fundamentals of electric mobility, while those at advanced stages will benefit from insights on various value pools within the EV ecosystem.



Som Kapoor
Partner and EY India Automotive, Future of Mobility and Network Leader

Executive summary

India has committed to reducing carbon emissions by one billion metric tons by the end of this decade. A major source of this commitment is the reduction in emissions from the transportation sector. At present, the sector accounts for nearly 13.5% of the country's energy-related emission, of which 90% can be attributed to road transportation across India. To alleviate this, the GoI has identified green mobility as a key driver for decarbonization.

The focus of this report is to highlight the EV value chain, and the necessity for component manufacturers to align strategic goals to meet the growing EV demand. The electric vehicle sector in India has registered a healthy growth, with over 16.8 lakh registered vehicles by the end of FY24. We touch upon several drivers outside of the conventional demand-side policies and technologies and highlight value pools that can be used as reference points to drive the supply side acceleration for EV component manufacturers. The report focuses on the several components of the EV value pool framework by EY, a comprehensive end-to-end recognition of the EV value chain, from battery mineral mining to end-of-life vehicle.

Within battery technology, India currently has built capabilities and capacities for battery pack assembly and BMS integration, while the components, cells and module manufacturing are largely conducted offshore. However, with new lithium deposits found in Jammu and Kashmir and Rajasthan, streamlined mining regulations and optimum cell chemistry choice, a robust domestic lithium industry can help reduce battery costs, while making India self-reliant in batter manufacturing.

The EV manufacturing industry is also on a headway with focus on costs and indigenization, and newer dedicated EV platforms paving the way to increased production in India. Similarly, the Indian component manufacturing has grown over the last few years, deriving over 28% of its revenue from the global market. However, greater emphasis on opportunities presented by vehicle electrification is the need of the hour. Enhancing R&D and the production of EV components will result in an expanded global market share, necessary to support the industry during a domestic downturn. To keep pace with the industry, several key regulations for safety, such as the AIS 156 for L-category and AIS 038 for M/N categories batteries have been introduced.

From a demand perspective, several major sectors are making a commitment to EV100, a movement aimed at 100% fleet electrification for goods/freight, in accordance with a policy towards carbon neutrality. Public transport fleets, especially the three-wheeler industry, have seen fast paced growth in electrification, including autos and rickshaws, for last mile connectivity. EV adoption in the passenger vehicle segment is led by the intermediate public transport sector, focusing on decarbonization.

To facilitate the transition to electric fleets, large-scale charging infrastructure must also be deployed. Currently, India has ~140 EVs per charging points. To remedy and facilitate demand, the Indian standards for charging require at least one charger in a 3x3 grid and every 25 km of highway for passenger vehicles. The introduction and future ratification of the Battery Swapping policy will also foster growth in the e2/3W segments, particularly for commercial applications, such as e-commerce and the last mile delivery industries.

While the overall EV ecosystem is still at a nascent stage in India, it is accelerating with a strong momentum. The spike in fuel prices is providing a compelling business case for the transition towards EVs and alternate powertrain vehicles across personal and commercial segments alike. To support this transition, different aspects of the EV value pool will need to evolve in conjunction as we look into the future.

Acknowledgements

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List of abbreviations

Abbreviation	Meaning
ACC	Advanced Chemistry Cell
ACMA	Automotive Component Manufacturers Association
ARAI	Automotive Research Association of India
BEV	Battery Electric Vehicle
BIS	Buruea of Indian Standards
BLDC	Brushless Direct Current
BMS	Battery Management System
CBU	Completely Built-Up
CCS	Combined Charging System
CECRI	Central Electro Chemical Research Institute
CSIR	Council of Scientific and Industrial Research
DISCOM	Distribution Company
EOL	End of Life
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
FAME	Faster Adoption and Manufacturing of Electric Vehicle
FMCG	Fast Moving Consumer Goods
HV	High-Voltage
ICE	Internal Combustion Engine
IEC	International Electrotechnical Commission
IRDAI	Insurance Regulatory and Development Authority
LCV	Light Commercial Vehicle
LFP	Lithium Iron Phosphate

Abbreviation	Meaning
LTV	Loan-to-Value Ratio
MCV	Medium Commercial Vehicle
NBFC	Non-Banking Financial Company
NDC	Nationally Determined Contribution
NITI	National Institution for Transforming India
NMC	Nickel-Manganese-Cobalt
OCPP	Open Charge Point Protocol
OEM	Original Equipment Manufacturer
OMC	Oil Marketing Companies
PDU	Power Distribution Unit
PLI	Production Linked Incentive
PMSM	Permanent Magnet Synchronous Motor
PPP	Public-Private Partnerships
PSL	Priority Sector Lending
SCV	Small Commercial Vehicle
SIAM	Society of Indian Automobile Manufacturers
SLB	Second Life-of-Battery
SMEV	Society of Manufacturers of Electric Vehicles
SRM	Switched Reluctance Motor
TCO	Total Cost of Ownership
UPI	Unified Payments Interface
WTW	Well to Wheel
ZEV	Zero Emission Vehicle

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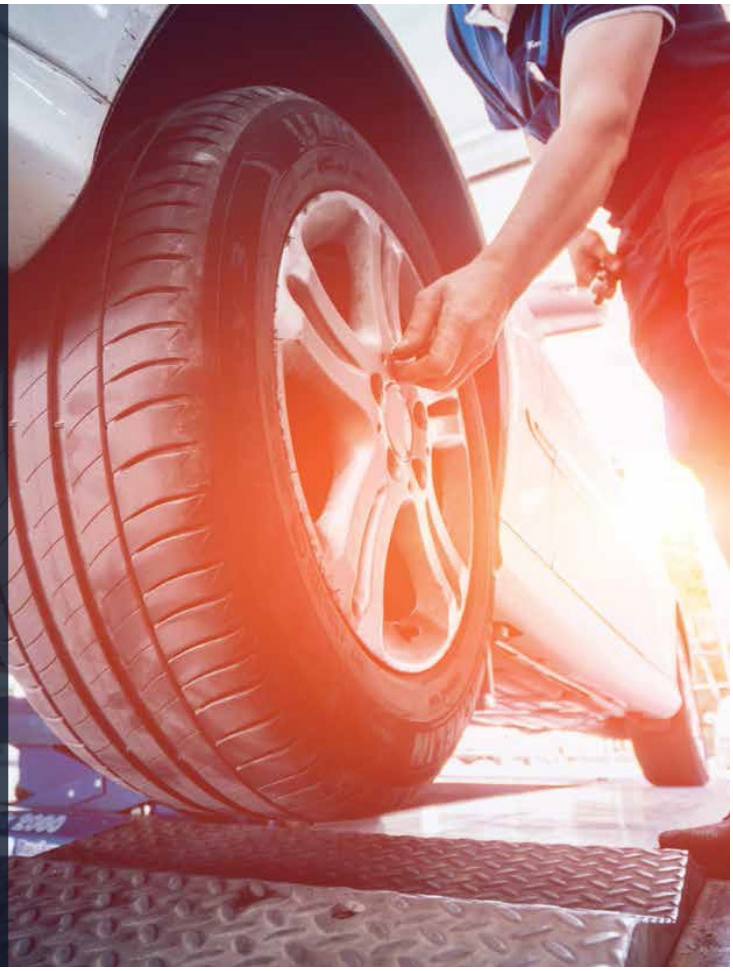

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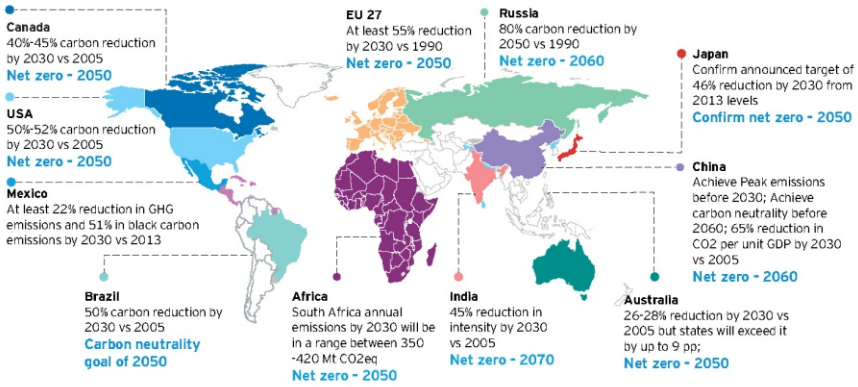
01 Introduction

With a population of over 1.4 billion, India imports approximately 84% of its crude oil needs, making it the third-largest oil consumer in the world. A marked increase in oil prices, rising imports, and a decline in domestic oil production have driven India's crude oil import bills upward. In FY22, India crossed the $100 billion mark in oil imports.[1] In February 2022, oil prices exceeded $100 per barrel, pushing the import bill to $120 billion by the end of FY22[2]. The Russia-Ukraine War and discounted crude from Russia have given slight reprieve to India's import bills in FY24, bringing them down by ~16% from $157 billion in FY23 to $132 billion in FY24.[3]

Pledges made at COP26 in Glasgow have accelerated momentum towards reducing fossil fuel needs as more countries set carbon reduction targets. Clean transport incentives and other policy initiatives will drive a rapid increase in electric vehicles, renewables, and energy storage (Figure 1). At the COP26, Prime Minister Narendra Modi announced India's aim of achieving net zero emissions by 2070. This was followed swiftly by submitting its Long-Term Low Emissions Growth Strategy, indicating low carbon transition pathways in key economic sectors, and updating their Nationally Determined Contributions in August 2022. The PM also said that India has embarked on far-reaching new initiatives in renewable energy, e-mobility, ethanol-blended fuels, and green hydrogen as an alternate energy source. The ambitious announcements are more than the 2016 NDCs, which included reducing carbon intensity of the economy by 30% to 35% below 2005 levels, having 40% installed capacity of renewable energy, and creating a carbon sink capable of absorbing 2.5 to 3 billion tons of carbon dioxide by 2030[4]. At the COP27 in Egypt, the Indian delegation focused on reaffirmation of Climate Finance and a "Just Energy Transition", looking at the COP26 ambitions from an implementation lens.

Figure 1: COP26 pledges across the globe



With the transport sector accounting for greater than 70% of diesel consumption, 95% of the petrol consumption and approximately 14% of the CO2 emissions in India, it becomes critical to decarbonize the automotive industry to achieve the target set by the government[5]. To do so, alternate fuel and electric powertrains are the need of the hour depending on the use case, cost of ownership and availability of an ecosystem to drive adoption. EVs are emerging out as a promising alternative that could help in drastically reducing the adverse environmental impacts caused by conventional vehicles when compared to traditional fossil fuels.

1 Petroleum Planning and Analysis Cell (PPAC)
2 Economic Times, March 2022
3 Business Standard, April 2024
4 Paris Climate Accords, 2015-16
5 Ministry of Petroleum and Natural Gas, 2014



02 Global EV market across vehicle segments

2.1 Passenger vehicle segment

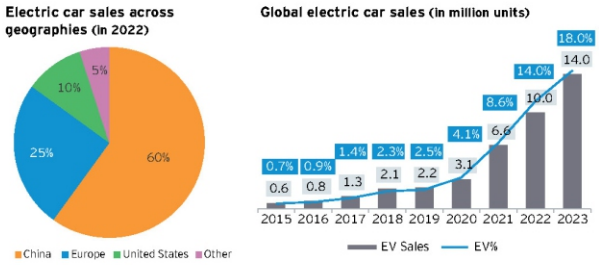
Almost 14 million new electric cars were registered globally in 2023, bringing their total number on the roads to 40 million. Electric car sales in 2023 were 3.5 million higher than in 2022, a 35% year-on-year increase. In 2023, there were over 250 000 new registrations per week, which is more than the annual total in 2013, ten years earlier. Electric cars accounted for around 18% of all cars sold in 2023, up from 14% in 2022 and only 2% five years earlier, in 2018. These trends indicate that growth remains robust as electric car markets mature. Battery electric cars accounted for 70% of the electric car stock in 2023[6]. The global electric car market (including passenger and light duty commercial vehicles) has witnessed a strong uptake especially over the last three years, even as the global pandemic shrank the market for conventional cars as OEMs were hit with supply chain bottlenecks, production restrictions and lockdowns. The incremental growth opportunity worth 25 million[7] units between 2022 and 2027, which translates to around 391% of the market size in 2022 is a lucrative growth opportunity for vendors.

China has become the global leader in electric vehicle sales. In 2022, 6.2 million EVs were sold in the People's Republic, making it the largest market for electric vehicles for the eighth consecutive year. Furthermore, Chinese manufacturers exported 679,000 EVs in 2022, a 120% increase YoY.[8] The Chinese government had also extended electric car subsidies for two years after the pandemic with a reduction of 10% in 2021, and 30% in 2022. In addition to financial support, the Chinese EV industry gained significant advantages from large procurement contracts with public transportation companies, which ordered electric taxis, vans, and buses. In the industry's early days, these orders were vital for Chinese automakers, serving both financial and public relations purposes. Public procurement provided EV manufacturers with security and predictability, while also showcasing their products to the public, thereby shifting perceptions about electric vehicles and speeding up their acceptance.

The growth suggests China's EV market is starting to mature, driven by the combined effects of consumer preferences for the new model offerings such as entry level mini EVs, residual national subsidies and continued preferential treatment for EVs at the local level (e.g., local subsidies, exclusion from city-level purchase limitations) etc.

In the EU, sales of new battery electric vehicles continued to grow even though the overall car market declined in 2022. In Europe, EV sales grew by ~70% in 2021 to 2.3 million, with >50% being plug-in hybrids. While the overall car sales in 2021 were 25% less than in 2019, the spurt in EV volumes was partially driven by new CO2 emissions standards and the increase and expansion of EV purchase subsidies to most major European markets. The European Commission (EC) wants there to be at least 30 million EVs in the EU by 2030 and at least one million electric and hydrogen vehicle charging stations across Europe by 2025.

Figure 2: Historical trend in global electric car sales and adoption across geographies[6]



6 Global EV Outlook 2024,IEA
7 Global EV Market 2023-2027, Technavio, 2024
8 Global EV industry at a glance, EMIS, 2023

2.2 Other vehicle segment

In 2023, the sales share of electric 2Ws and 3Ws was just 13% globally, while in terms of stock shares, 2Ws and 3Ws represent the most electrified road transport segment, with about 8% of 2Ws and 3Ws being electric. China sold the most electric 2Ws and 3Ws in 2023, with over 30% of the 2W and 3W sales being electric (decreasing from about 50% in 2022), followed by India (8%) and ASEAN countries (3%)[9].

For the lighter 2W segment, China accounts for ~78% of the global market by clocking a domestic sale of six million in 2023. For the heavier electric buses and trucks, the volumes have stagnated over the last few years with China accounting for ~94% and 90%, respectively[10].

Sales of electric buses, comprising all medium- and large-sized buses, are far ahead of those of other heavy-duty vehicle (HDV) segments (including medium- and heavy-duty trucks). Several European countries (such as Belgium, Norway and Switzerland) and the People's Republic of China (hereafter "China") achieved sales shares above 50% in 2023, and more than one-fifth of bus sales were electric in Canada, Chile, Finland, the Netherlands, Poland, Portugal and Sweden. Globally, almost 50,000 electric buses were sold in 2023, equating to 3% of total bus sales and bringing the global stock to approximately 635,000 in total. Over the last few years, many governments and OEMs alike have set targets to phase out internal combustion engine vehicles within the next 20 years. The US government announced a 50% electrification target for new cars by 2030 enabled with the installation of over five lakh charging points. At the same time, several automakers announced electrification targets.

Table 1: Overview of EV policy and regulations across the globe[11]

Policy / incentive	Canada	China	EU	India	Japan	USA
ZEV mandate*	🔵	🔵	***🔴	🔴	🔴	🔵
Fuel economy standards**	🟢	🟢	🟢	🟢	🟢	🟢
Vehicle incentives	🟢	🟢	🟢	🟢	🟢	🟢
Charger incentives	🟢	🟢	🟢	🟢	🟢	🔵
Charger H/W standards	🟢	🟢	🟢	🟢	🟢	🟢
Building regulations	🔵	🔵	🟢	🟢	🔴	🔵

🟢 Announced at a country level, 🔵 Announced at a state / provincial / regional level to reach a target, 🔴 NA
*Varying EV credits offered, **Varying fuel economy standards across countries *** EU does not have a mandate but individual countries have the certain mandates

9 Global EV outlook 2024, IEA
10 Global EV data explorer, IEA
11 Assessment of EV policy, IEA, EY analysis

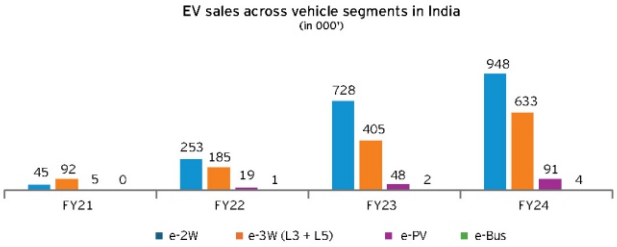




03 EV market in India

Over the past few years, the India EV industry has witnessed rapid uptake. In FY24, registered EV sales stood at, 16.86 lakh units with the e-2W segment accounting for over 56% of the market. The e-3W market has also shown strong growth on the back of rising penetration of e-commerce and last mile delivery. The e-bus and e-4W segments have also witnessed a healthy growth in sales with a low baseline.[12]

Table 2: EV sales in India (excluding the low-speed 2W segment)[13]



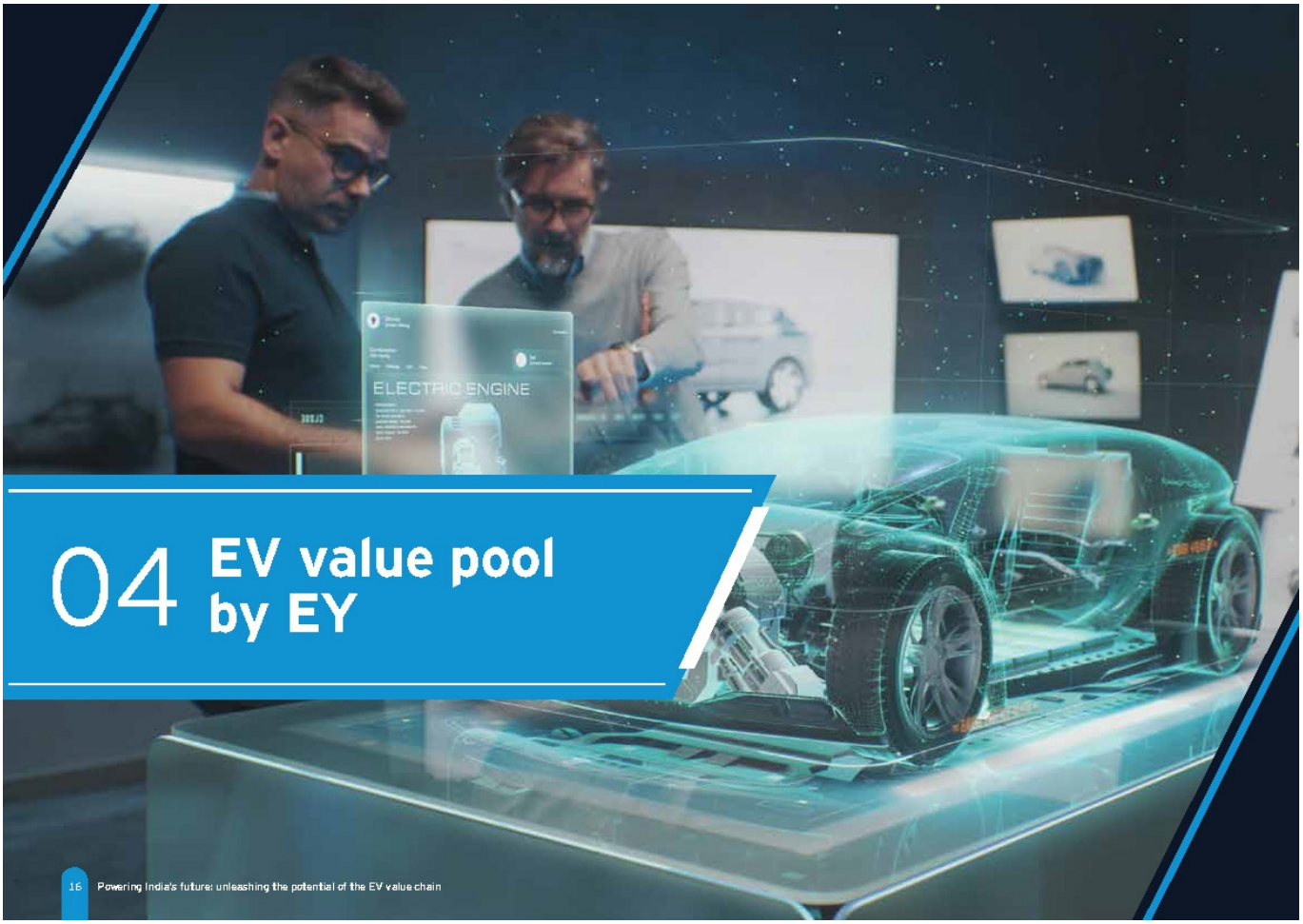
EY point of view:

The growth of India's electric mobility ecosystem is likely to follow a unique trajectory, distinct from that of developed or other global EV markets. In India, the shift towards electric vehicles is expected to be led primarily by private two-wheelers and public three-wheelers, which dominate the shared mobility sector. These segments have a favorable total cost of ownership (TCO) for electric powertrains, making them early adopters.

As two-wheelers account for over 60% of India's petrol consumption, electrifying this segment could significantly reduce crude oil imports. Additionally, the battery swapping model is particularly suited to India, as it lowers the upfront cost of EVs and increases the operational time for commercial vehicles. To drive EV growth, supportive policies, declining battery prices, charging infrastructure development and localized supply chains are essential, ensuring that solutions are tailored to the Indian market.

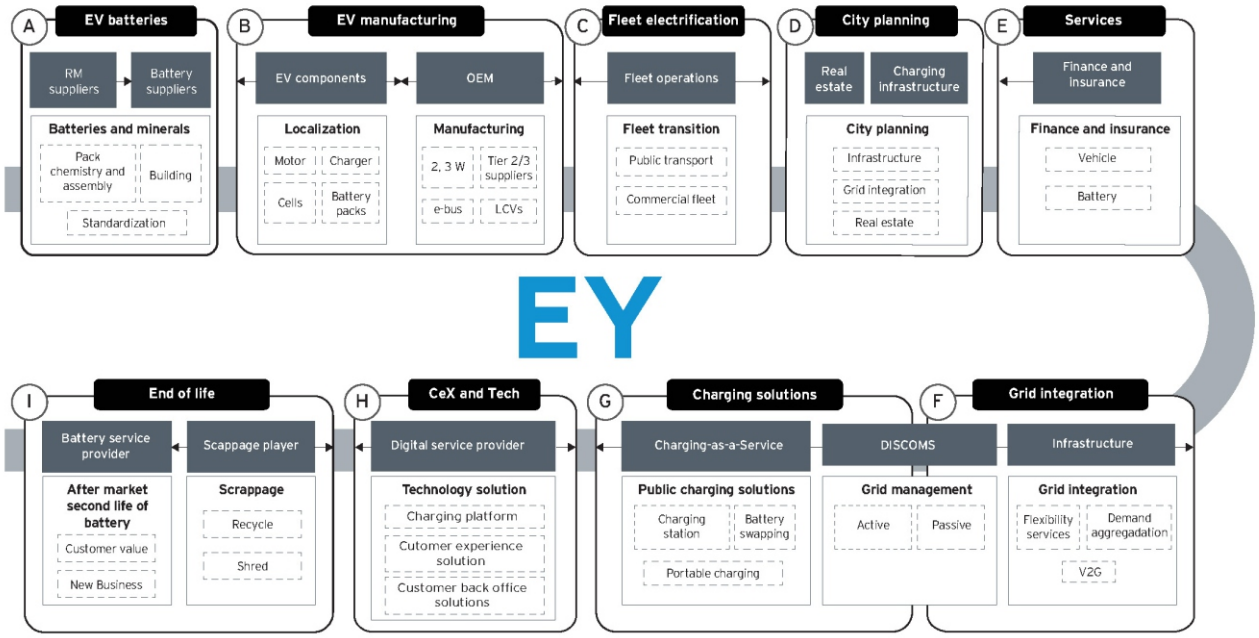
While rising fuel prices are resulting in a shift towards EVs, especially for the lighter vehicle segments, this is to be accompanied with adequate charging infrastructure to support the ecosystem. As of April 2024, India has a total of ~16,344 operational public EV chargers, of which three states - Karnataka, Maharashtra, and Delhi-NCR account for > 50%[14]. The implementation of GoI initiatives, such as affordable EV tariffs, residential charging, technical standards, revenue sharing models and a rapid increase in charging infrastructure by OMCs, becomes vital for India to support the growth in EVs.

12 SMEV, EY analysis
13 SMEV, JMK Research
14 JMK Research, EY analysis



04 EV value pool by EY

Figure 3: EV value pool - opportunities from emerging EV ecosystem players



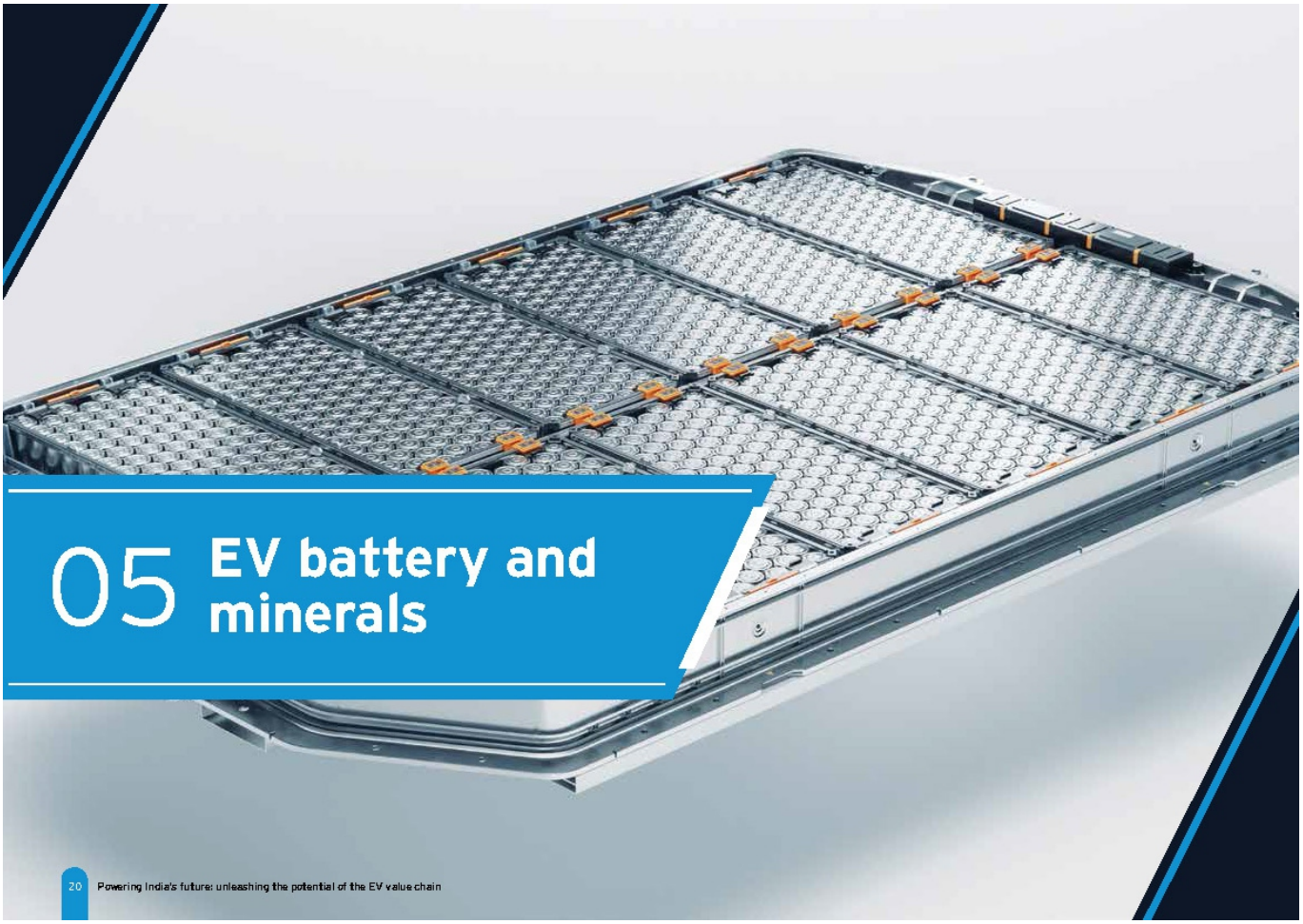
EY has conducted extensive research and defined the EV value pool, which describes the various intricacies of the EV ecosystem. We examine the EV ecosystem from the manufacturing of battery packs to the end-of-life processes for discarded batteries. The EV value pool as defined by EY comprises nine different individual ecosystems, all interlinked and performing towards a sustainable future for EVs in India. For the EV industry to replicate the success of the Indian auto market sector, this value pool must be developed, and the market be mature for indigenous production with support from policies developed by national, state, and local government entities.

EV battery manufacturers should develop capabilities that include building and recycling battery materials once they reach their end of life. The value pools further recommend indigenous manufacturing of EV components, such as motors and chassis components, as well as capacity building for major sectors of road transportation - 2W, 3W 4W, LCVs and e-buses. The development of fleets for public use - e-3W and e-buses, and the development of private fleets using electric vehicles should be encouraged through policy support from national and local agencies. Innovative models need to be developed for financing EV for consumers, as the current model does not consider challenges specific to electric vehicles such as the residual value of vehicle at the end of life, or that a single component– the battery– accounts for nearly 40% of the cost of the vehicle.

In addition to EVs, stakeholders should also focus on the development of the charging infrastructure. With ambitious EV targets for the upcoming decade, it is necessary to address challenges such as range anxiety and the develop a robust grid network to meet the growing energy needs of the country. Development of DISCOMs should facilitate wider charging infrastructure deployment, as well as the development of specific rate structure to deploy retail charging outlets for EVs. Additionally, charging solutions such as battery swapping need to be encouraged, at least at the fleet level, to ensure faster turnaround for vehicles and higher utilization of the fleets.

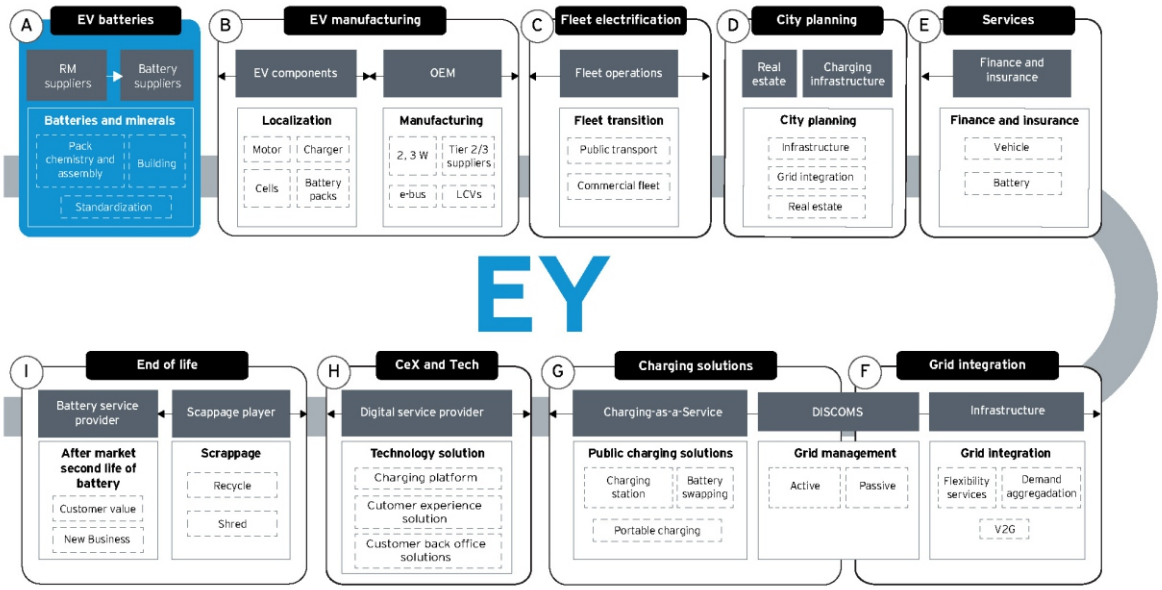
To ensure an integrated approach to the EV ecosystem, the EV value pool by EY also emphasizes the need for a unified battery charging solution for consumers, providing resources such as charger locations, estimated wait time, digital payment methods and an overall consumer experience like that of a retail petrol outlet, but in an online application instead. Moreover, electric vehicles have been successfully sold through online portals than their ICE counterpart. New start-ups in electric mobility have also shunned the dealership method and made their products, especially e-scooters, available through various web portals. These examples, coupled with the digital marketplace growth during the COVID-19 pandemic, prove that EVs will have a higher digital presence compared to ICE vehicles. Lastly, the EV value chain focuses on the need to recycle batteries at the vehicle's end of life and scrap the vehicle components sustainably. All values pools have been discussed in the subsequent chapters of this report.





05 EV battery and minerals

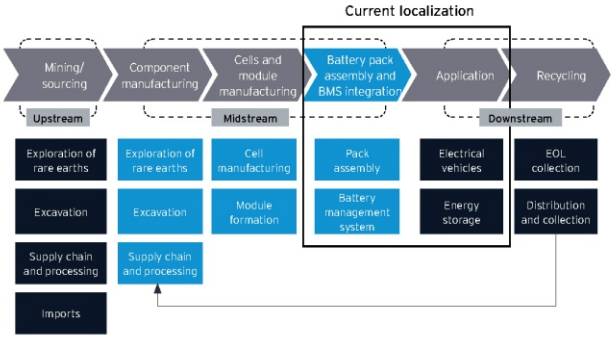
Figure 4: EV battery and minerals with EV value pool by EY



5.1 EV battery ecosystem in India

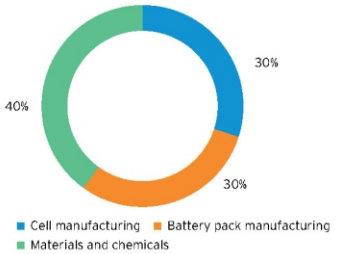
Battery ecosystems consist of various stages critical for automotive application. From sourcing of minerals to packing the active materials into the cell to recycling the used batteries, the battery ecosystem has an integrated supply chain.[15]

Figure 5: EV battery value chain



India participates in certain stages of the ecosystem due to increasing application in electric vehicles. Currently, manufactured cells are imported from China, Japan and South Korea and assembled into modules and battery packs. This has led to higher costs of batteries and a consequential increase in EV prices in India, and keeps India exposed to volatility of the global supply chain.[16]

Figure 6: Cost breakdown of EV battery



India has a local ecosystem for sub-components of battery packs, including battery pack housing and BMS systems. However, lower volume and lack of standardization has led to an increase in the cost of such components.

Nonetheless, India's EV battery ecosystem is evolving rapidly, with a growing emphasis on domestic cell manufacturing. Some Li-ion cell manufacturing start-ups are establishing indigenous production facilities, focusing on advanced chemistries, rapid charging, and safety. This localization is expected to reduce costs, create jobs, and strengthen India's position in the global EV market.

EV OEMs are also contributing to this shift. For instance, a major EV OEM is building a giga factory with a projected initial capacity of 1 GWh, expandable to 20 GWh when completely operational. This facility will focus on producing advanced cell formats, marking a significant stride in India's self-reliance on EV battery production.[17]

15 Department of Industry, innovation and science, Australia - 2018
16 A guidance document on accelerating electric mobility in India, WRI
17 Secondary Research

5.2 Cell chemistry roadmap for India

One of the most critical components in an electric vehicle is the battery pack and its cells. Within the cell, cathode chemistry plays an important role in deciding the performance of the battery pack. There are multiple cell chemistries that are being researched and explored for battery manufacturing. However, NMC and LFP cell chemistries have witnessed the highest adoption for EV application. Lithium-based cell chemistries have higher adoption due to mature technology and production processes to meet cost economics for vehicle application. However, they also face significant challenges in the long term due to supply side constraints, high energy consumption and environmental concerns raised during the mining and processing of active cathode materials. Intensive research on multiple chemistries needs to be undertaken to develop advanced cell chemistries for future requirement.

Figure 7: Cell chemistry performance comparison[18]

Battery Cell Types	Units	LFP	LMO	NMC	NCA	LiS	Li-Air	NiMH	NaS (Sodium Ion)	Solid State
Nominal cell voltage	V	2.5-3.65	3.0-4.2	3.0-4.2	3.0-4.2	2	2.91	1.2	2	5
Energy density	Wh/litre	160	130	400-700	500-730	140-270	Up to 2,000*	140-300	151	>1500
Specific energy incentives	Wh/kg	90-120	100-150	150-220	200-300	160-300	1000*	85	75-150	>500
Specific power incentives	W/kg	2,000-3,000	1500-3,000	600-1,500	500-1,500	590-1,300	400-1,000*	250-1,000	200	374.7
Charge rate (continuous)	c	1-2C	0.7-1 C	0.7-1 C	0.7-1 C	N/A	N/A			1-4C
Discharge rate (peak)	c	2C	10C	2C	1C	1C	N/A	0.2-0.5C	1C	1C
Lifecycle	-	3,500-5,000	300-700	1,000-2,000	1,000-2,000	110-1,000	<100 (under dev)	>2,000	>4,200	>800
Safety[1]	-	High	Med	Low-Med	Low-Med	Very high	Med	Med	Low	Med

1 Inherent thermal stability of chemistry Note: All values for cell level, not considering packed battery systems.

Source: Published Data - various Journals

18 Electric Vehicles charging towards future

In the near term, to meet the immediate demand for lithium-ion batteries, battery manufacturing companies must focus on the production of lithium-based cell chemistries. However, within the lithium-ion cell chemistries, focus should be on LFP chemistry over the NMC categories, as India faces challenges in the supply chain and environmental conditions for NMC chemistry. Figure 8 explains why LFP might be the preferred cell chemistry for the Indian EV industry.

Figure 8: Advantages of LFP Cell Chemistry

1. **Performance advantage**
   LFP has a more efficient heat dissipation that provides better thermal stability, which is ideal for the hot-tropical climate in India. LFP cells also have a life span of up to 3000 cycles, which is estimated to last five years.
2. **Supply chain advantage**
   Apart from lithium, all active material such as iron oxide, phosphate and graphite can be sourced domestically. Compared to NMC, where active materials are sourced from foreign reserves, LFP would offer a short, stable supply chain.
3. **Price advantage**
   Critical minerals such as Nickle and Cobalt experience significant volatility in their prices, creating a significant business risk for cell manufacturers. Nickel prices have grown over 107% over the last two years, reaching record levels in March 2022.

In the long-term, Indian cell manufactures should focus on more advanced cell chemistries including metal air batteries, sodium ion batteries and solid-state batteries. These technologies are currently being tested and will take some development cycles before they are commercially viable. For example, one of the world's leading cell manufacturers announced advancement in Sodium ion cells and expects to have commercial deployment soon. These second-generation cells are expected to have an energy density of 200 Wh/kg which is similar to that provided by LFP cells.[19]

India's lithium exploration is still in its early stages, with most reserves in Jammu and Kashmir, Rajasthan, and Jharkhand currently classified under preliminary exploration (G3). Full-scale mining will require further exploration and development, which may take upto several years. The government is actively working to streamline mining regulations and provide incentives to attract investment in the sector, aiming for a robust domestic lithium industry to support its ambitious EV targets and energy security goals.[20]

5.3 Battery pack assembly

1. India has established local capacities for battery pack assembly to serve the local demand from electric vehicles. However, there is a lack of standardization in battery pack design, which leads to an increase in related to tooling and assembly. Multiple battery pack suppliers with low capacities further add to increased overhead cost for battery assembly.
2. India has varied climate condition across different regions and different time of the year which impacts the overall performance of the battery pack. Cells have an optimal thermal operating range for safe and efficient performance. Therefore, thermal management of the cells become critical for safer and longer life of the vehicles. Battery pack suppliers need to build modules and packs with integrated thermal management for vehicles based on their area of application.

5.4 Battery management system

1. Battery management system, which is considered the brain of battery pack, is required for safer and optimal performance of electric vehicle batteries. Battery management system requires advanced algorithms for monitoring individual cell and take required actions based on inputs on voltage, current and temperature from each cell.
2. To ensure the battery pack operates safely and for a longer duration in Indian conditions, it is necessary to extensively test and fine-tune the Battery Management System (BMS). Therefore, battery pack suppliers must establish complete local design and manufacturing capabilities in their offerings.

5.5 Battery standardization

Battery standardization can play a major role in the development of the EV sector in India. The focus should be on low-speed application as well as towards public fleet vehicles such as e-3W and e-buses. With a market that is highly sensitive to price changes, any cost reduction achieved through standardization will be applicable to the consumer, allowing for faster adoption of EVs.

Advantages of battery standardization are

- **Lower cost for the consumer**: With all OEMs using the same battery technology, it will be easier to achieve economies of scale and thus lower production costs which can be passed onto the consumer.
- **Lower cost for OEMs**: With standardization, the cost for battery chemistry development and deployment will be shared among OEMs, reducing overall cost for research and development for an individual OEM.
- **Easier recycling**: With a single type of manufacturing, the process for recycling battery material can be streamlined. This will reduce costs for OEMs, who are legally responsible for the safe disposable of batteries after their end-of-life.
- **Second life applications**: With a similar type of battery, determining use cases for the second life of batteries that have reached their EV end-of life is easier due to less technical requirements.

19 PV Magazine, July 2021

20 India faces uphill battle in lithium mining and exploration, Economic Times

Disadvantages of battery standardization are

- **Stifling innovation**: With the market at its nascent stage, the development of EVs is driven by market growth. Design flexibility and innovation in the market will be removed, as battery standardization does not allow OEMs to use their initiative to build better EVs.
- **Reluctance from early adopters:** Early adopters of EVs, who have already invested heavily in the then-unknown market of EV might be reluctant to hand over the fruits of their research and development over the past years to other OEMs without reaping the rewards of a larger market share. With performance tied heavily to battery technology, similar performing vehicles can be expected from battery standardization, which will further increase competition for early adopters.

In an effort to the boost interoperability of batteries in India, the GoI released the Draft Battery Swapping Policy in February 2022. The policy aims at standardizing battery charging and discharging rates, connectors, battery types and battery charging stations (BCS) to be used across primarily 2W and 3W applications. The draft policy is under review to avoid adverse impact on technological innovation and is being guided through an inter-agency effort.

Battery standardization: a look at China's model

Battery standardization has already been implemented in China, as they announced standards for EV swappable batteries in March 2022. This move was made to address the rising cost of electric vehicles. With swappable batteries, the vehicle's cost can be reduced by up to 40%, as the battery is owned by the operator and not the EV consumer. It is worth noting that not all vehicle owners will be able to participate in the program, as their existing EVs may not be compatible. However, China has demonstrated that battery standardization can significantly impact the upfront cost of the vehicle. Given the early stage of EVs in India, the Indian auto-market should closely examine the battery swapping model to provide potential EV owners with more affordable upfront costs.

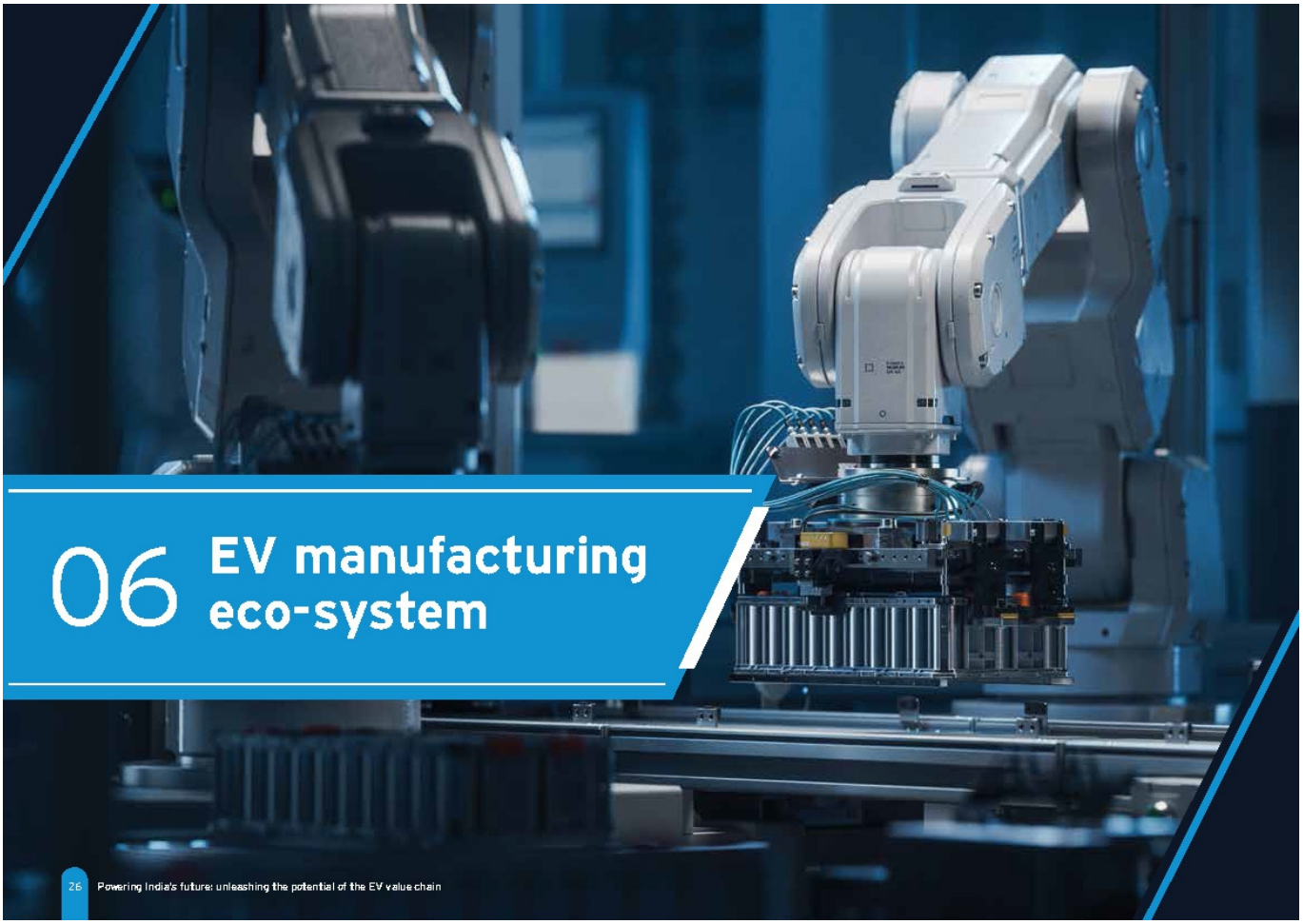
Our understanding

With the announcement of organizations nominated under PLI, a phased manufacturing and technology roadmap should be followed.

Battery cell manufacturing may be key to achieving the ambitious EV targets set forth in India. Focus must be put on acquiring capital goods required for building production lines, rather than importing the necessary cells and repacking them as battery packs. Scaling manufacturing capacity to achieve economies of scale will be important in bringing down costs for consumers and manufactures alike.

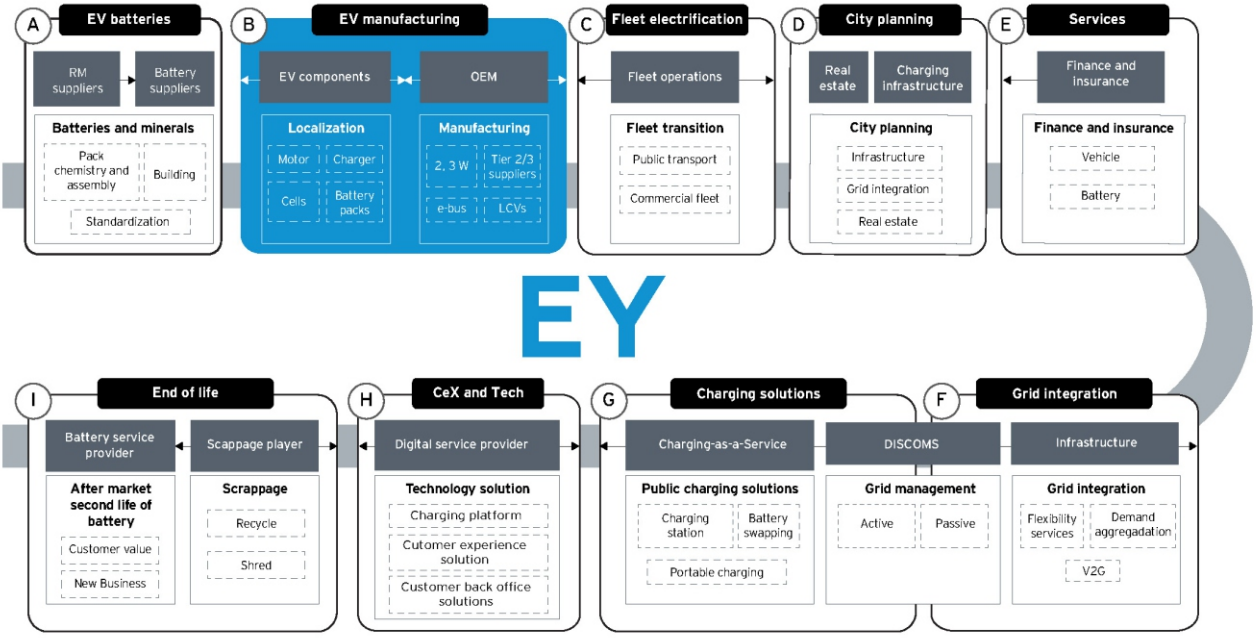
It is important that stakeholders prioritize integrating Tier 2 and 3 suppliers within a consortium to purchase raw materials at cheaper prices from the global market and ensure a robust supply chain. In addition, stakeholders must choose the right cell chemistry and build capacity for raw material production, rather than repackage imported cells.

A domestic supply chain, along with reducing supply costs, will also provide strategic benefits, with battery prices not being linked to international market volatility. Battery standardization, especially for low speed and fleet-based applications, should also be given consideration as they would enable companies to develop a single technology resource for battery recycling and allow for easier deployment of charging solutions such as battery swapping.



06 EV manufacturing eco-system

Figure 9: EV Manufacturing within EV Value Pool



The automotive industry in India contributes up to 7.1% to GDP[21], including vehicles manufacturing, auto component manufacturing and dealer distribution. With the global and domestic automotive industry transitioning from ICE vehicles to electric vehicles, the industry could be at risk of reducing employment opportunities and GDP contribution. Therefore, setting up local EV manufacturing and supporting supply chains should be of strategic importance to India. Since the launch of the FAME scheme, which incentivized adoption of electric vehicles, India has witnessed an increase in domestic manufacturing of electric vehicles. Policies focusing on localization and increasing import duties for CBUs have led automotive players to set up local assembly lines in India. However, lower production volumes and lack of technology and manufacturing capabilities for major components have led to OEMs relying on imported components.

The FAME II scheme, launched in 2019 with a budget of INR10,000 crore, aimed to support the adoption of electric vehicles by providing subsidies for various categories, including 7,000 e-buses, five lakh e-3 wheelers, 55,000 e-passenger cars, and 10 lakh e-2 wheelers. The next iteration of the FAME scheme, FAME III, is expected to be announced soon. This new phase aims to continue supporting the adoption and manufacturing of electric vehicles, particularly e-2 and e-3 wheelers.[22]

6.1 EV vehicle manufacturing

As of 2024, there are over 232 FAME-approved EV models for sale in India[23]. Sales figures reveal that India has sold upwards of 39 lakh EV units till April 2024. Sales have picked up pace after a pandemic-induced slowdown in the earlier fiscals. A state-wise analysis of sales data for FY24 reveals that the top states for e-4W sales were Maharashtra, Karnataka and Kerala, with upwards of 10,000 units. In the case of high-speed e-2Ws, Maharashtra and Karnataka again led the pack with 1.8 and 1.5 lakh units sold in FY24. Increasing adoption and localization value add conditions will require OEMs to invest in setting up additional design and manufacturing capacities.

6.1.1 Focus areas for EV manufacturers

With increasing production capacities and platform numbers for each OEM, vehicle manufacturers will need to focus on strategies that **improve vehicle efficiency and range, reduce overall costs, and increase profitability for EV manufacturing**. OEMs will need to address existing gaps and challenges to meet their strategic goals, focusing on the following areas.

Figure 10: Strategic goals for EV manufacturing



1. **Build technology capabilities**: To build new platforms for electric vehicles, OEMs will need new technologies, processes and manufacturing operations to reduce development cost. Thus, OEMs should focus on establishing best-in-class technology competencies and manufacturing expertise to ensure components provide value to end users and can also create a benchmark for global markets.
2. **Develop new dedicated platforms**: Most current electric vehicles rely on ICE vehicle designs, so OEMs and component suppliers must work towards dedicated EV platforms to increase vehicle range, efficiency and performance to meet end-user expectations.

21 Invest India, 2024
22 Economic Times, 2024
23 Ministry of Heavy Industries, GoI

Figure 11: Make-or-buy situation for OEMs

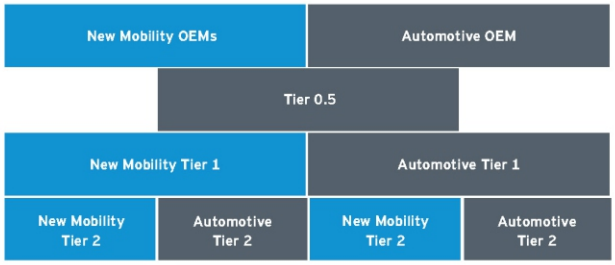
	Case 1	Case 2	Case 3	Case 4	Case 5
Cells	Make	Make	Make	Make	Buy
Battery pack	Make	Make	Make	Make	Buy
Motor	Make	Make	Make	Buy	Buy
Electronics	Make	Make	Buy	Buy	Buy
Charger	Make	Buy	Buy	Buy	Buy

3. **Make-or-buy decision**: Due to limited component manufacturing capabilities, many organizations have adopted vertically integrated manufacturing strategies with in-house design and capabilities from vehicle assembly to component manufacturing. OEMs will need to evaluate the make-or-buy strategies for components to reduce vehicle development and manufacturing costs.
4. **Build a repair and service network**: Even though electric vehicles experience limited wear and tear compared to ICE vehicles, service requirements for electric vehicles differ. Thus, to provide end users with a seamless EV experience, manufacturers should build an extensive network for repairs and services of components.

6.2 New models for EV ecosystem

1. The global electric vehicle industry has seen participation from new players, industry incumbents, tech companies, mobility players and auto-component players. The entry of new players will impact vehicle manufacturing and create new relationships between OEMs, Tier 1 suppliers, Tier 2 suppliers, thereby creating a more integrated manufacturing value chain.
2. This will require industry bodies such as SIAM, ACMA, SMEV to increase collaboration among players in the ecosystem.

Figure 12: How automakers can master new mobility



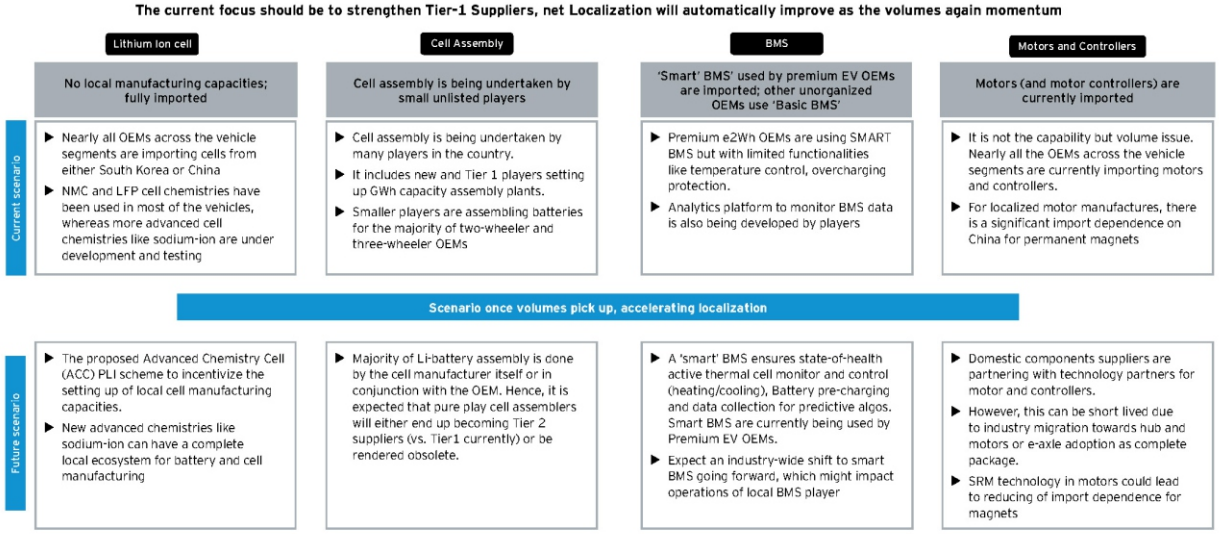
6.3 EV component manufacturing

1. Indian auto component players can leverage the EV opportunity to safeguard and grow in important export markets. As per ACMA, the Indian auto component industry derives 28%[24] of its revenues from the global market, with Europe and North America accounting for 65%[25] of exports from India.
2. These markets will undergo significant development or modification with electrification. Hence, the industry must be future-ready and take a closer look at the opportunities presented by electrification to retain and expand its share in the global market, which has supported the industry during domestic downturns.
3. Many segments of the ICE auto component industry can be carried forward to EVs with some modification, while many other capabilities can be leveraged to enter the EV-specific segment with new products. Further, with relatively low entry barriers in the EV industry, many component manufacturers are finding it easier to move up the value chain.
4. With new components and technologies driving EVs (cells, powertrain and electronics, telematics, etc.), various OEM-supplier engagement models are emerging with a higher degree of collaboration over the traditional transactional approach. Besides existing parameters of cost, time, and quality, other parameters such as technology strength, R&D capabilities, development and design validation, performance and level of value chain integration will gain more importance.



24 ACMA | ACMA Indian auto components performance review - FY24
25 ACMA Indian auto components performance review - FY24

Figure 13: EV manufacturing ecosystem

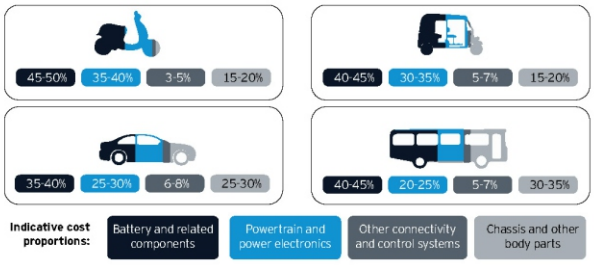


Electric vehicles require new components that are not present in ICE vehicles and thereby require the establishment of dedicated EV ecosystem. This new technology requirement will allow new component manufacturers to build design and manufacturing capabilities.

6.3.1 Segment-wise EV technology and component value composition

1. e-2 Wheelers - BLDC motor, PMSM hub/mid-mount (48-72 V)
2. e-3 Wheelers - BLDC motor, PMSM, AC Induction Axle (48-72 V)
3. e-4 Wheelers - PMSM, AC Induction Axle (96-300+ V)
4. e-Bus - AC Induction, PMSM Axle (350-800 V)

Figure 14: Component manufacturing by percentage[26]



6.3.2 Tier 2 and 3 component manufacturing

1. Tier-2 firms feed subcomponents to Tier-1 companies; these are typically medium- to small-scale firms
2. Tier-3 companies constitute raw material suppliers and could range from very large to very small companies constituting job shops offering specific services like welding, soldering, heating, grinding, etc.
3. Typically, Tier 2 and Tier 3 are in the form of an umbrella of micro, medium and small enterprises around the vehicle manufacturers, who are their primary consumer
4. Tier 2 and Tier 3 supply auto parts worth 60% to 70%[27] of the total cost of an ICE car
5. The value chain of a conventional vehicle in India comprises OEMs and the auto component suppliers in Tiers 1, 2, and 3 of the auto industries, who work in tight symbiosis with the OEMs
6. Changes in-vehicle platform design and components used in electric vehicles will push Tier 2 and Tier 3 component suppliers to adapt to the new design and technology requirement

6.4 Safety standards for battery manufacturing

With the recent concerns over EV vehicles catching fire dominating the news, it is important that EV manufacturers focus on the safety of battery technologies and the development of battery management systems. More rigorous testing needs to be conducted, specifically in the two-wheeler market segment, where the instances of vehicle safety being compromised have spanned various manufacturers and top selling models. With the ambitious targets of EV adoption is India, it is important that manufacturers take the safety standards laid forth by ARAI and in BIS regulations seriously, lest they undermine consumer confidence in this growing automotive sector.

On the other hand, regulators need to ensure that manufacturers meet battery standards and that safety standards align with India's hot tropical climate. They must thoroughly investigate vehicle fire issues to prevent scepticism in consumer adoption. ARAI has introduced standards AIS 156 and AIS 038 (Rev 2) for testing of EV batteries and ensuring their safety. AIS 156 caters to the e2W and e3W category while AIS 038 (Rev 2) deals with the e4W and above categories. The regulations treat the vehicle and battery as a single unit and have clearly defined requirements and series of tests that the battery and the vehicle must pass to obtain approval. These requirements have been outlined in Figure 15[28].

26 EY| Yes Bank Analysis
27 WRI Report
28 ARAI, Financial Express 2022, EY analysis

Figure 15: Battery testing requirements in India

AIS 156	AIS 038 (Rev 2)
L category (e2W, e3W)	M, N category (e4W, eBus)
Vibration test	Vibration test
Thermal shock and cycling test	Thermal shock and cycling test
Mechanical drop test for removable REESS	Mechanical shock test
	Mechanical integrity test
Fire resistance	Fire resistance
External short circuit protection	External short circuit protection
Over charge protection	Over charge protection
Over-discharge protection	Over-discharge protection
Over temperature protection	Over temperature protection
Hydrogen emission test	Hydrogen emission test
	Over current protection
	Thermal propagation test

Battery safety standards: Europe vs. India

India has developed the Automotive Indian Standards (AIS) 156, that covers vehicle category L and provides substantial testing requirements for vehicles. Similarly, AIS 038 Rev 2, published in September 2020, covers testing requirements for vehicles in the M and N category of vehicles. These standards have since been revised and implemented and made mandatory for battery and EV OEMs in the country from 2023. Both these standards are based on UN regulations (UN R136 and UN R100 Rev3 respectively). Europe also follows the same set of regulations, but the challenges faced by the Indian EV market are that these regulations do not consider the variations in ambient temperature present in India.

EY point of view

Domestic manufacturing potential across EV components in the short, medium and long-term.

Table 3: EY analysis on domestic manufacturing potential

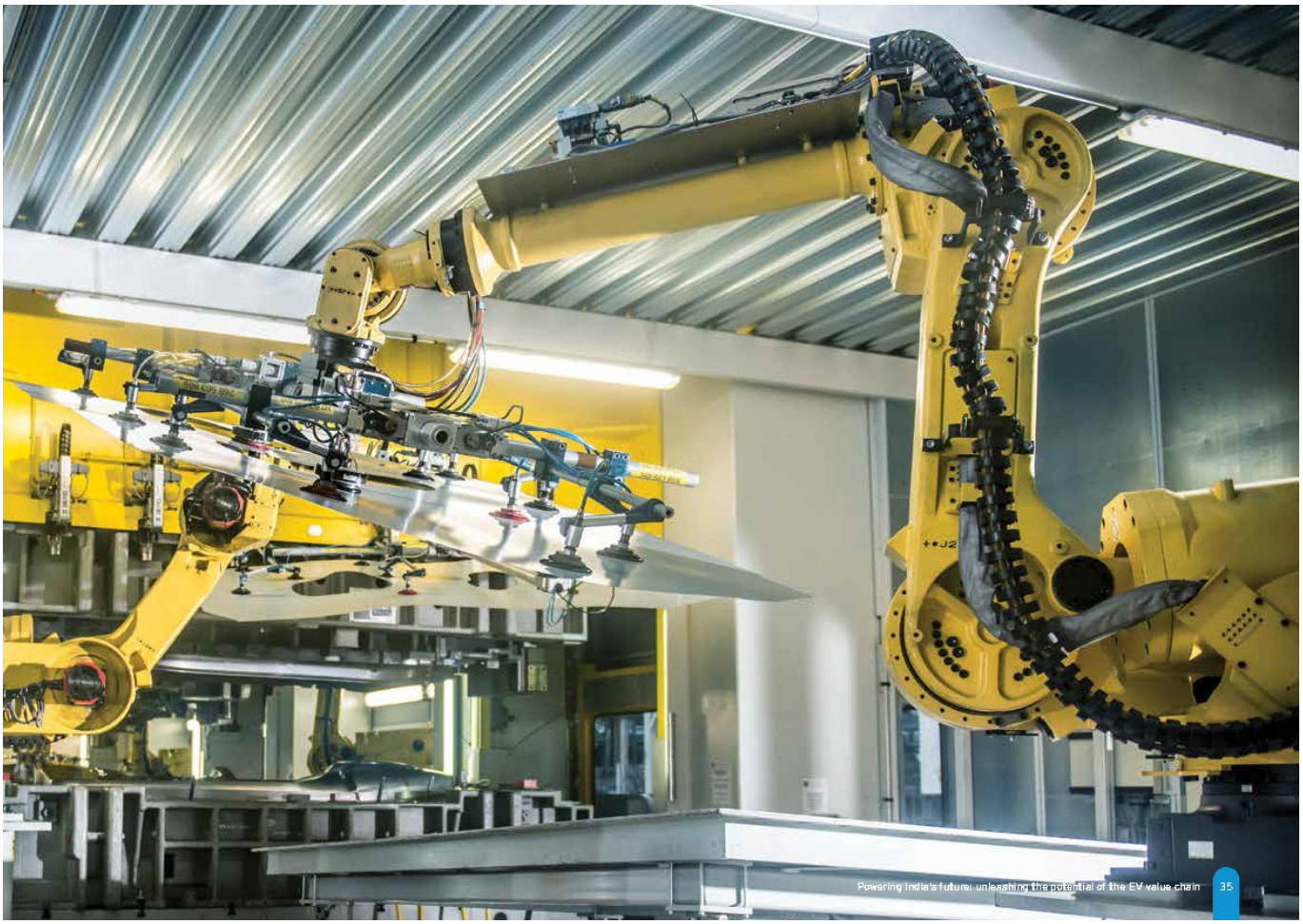
	E-motor	EV power electronics	Power converters	On-board connectivity and electronics	Body frame/chassis-related components	Battery systems
Short-term	Software capabilities can be leveraged for EV Industrial motor capabilities need to be upgraded for auto application Transmission and gear manufacturing capabilities need to be upgraded	Electronic hardware design and software capabilities can be leveraged to develop solutions for EV application		Existing auto capabilities can be leveraged for EVs with no minor tweaks	Designing components suitable for dedicated BEV platforms Enhancement of material used for component manufacturing (focus on lightweight and durable components) Sealants and cooling systems to be adapted for EV application	Battery packs BMS
Medium-term		Complete hardware and manufacturing capabilities for motor controllers and vehicle control units HV connectors used for EV	Components such as AC/DC - DC/DC converter, on-board charger, PDU have low manufacturing complexities and can be localized efficiently			Cells
Long-Term	Completely indigenous technology for motors, Ex- SRM motors Integrated systems to reduce costs	Semiconductor manufacturing for microcontrollers and MOSFETs	Designing integrated units for battery economics		Lightweight manufacturing capabilities	Minerals

Redesign parts to improve applicability

1. **Focus on bundled solutions:** Manufacturers focus on providing integrated solutions to OEMs. Additionally, combining components helps in an easier vehicle integration.
2. **Growing start-up ecosystem:** The start-up ecosystem for auto components and battery technologies recieved $1.4 billion in 2023 globally[29 30]. OEMs, as well as Tier-1 suppliers, are actively investing in start-ups that are working towards revolutionizing the EV component space.
3. **Dynamic manufacturing:** Dynamic manufacturing is highly flexible and is designed with a high degree of adaptability. High automation results in lowered labor costs.
4. **JV and tech partnerships:** Partnerships and JVs across the value chain to harness partner capabilities and technology. Additionally, major component manufacturers acquire smaller players to increase product and service offerings.



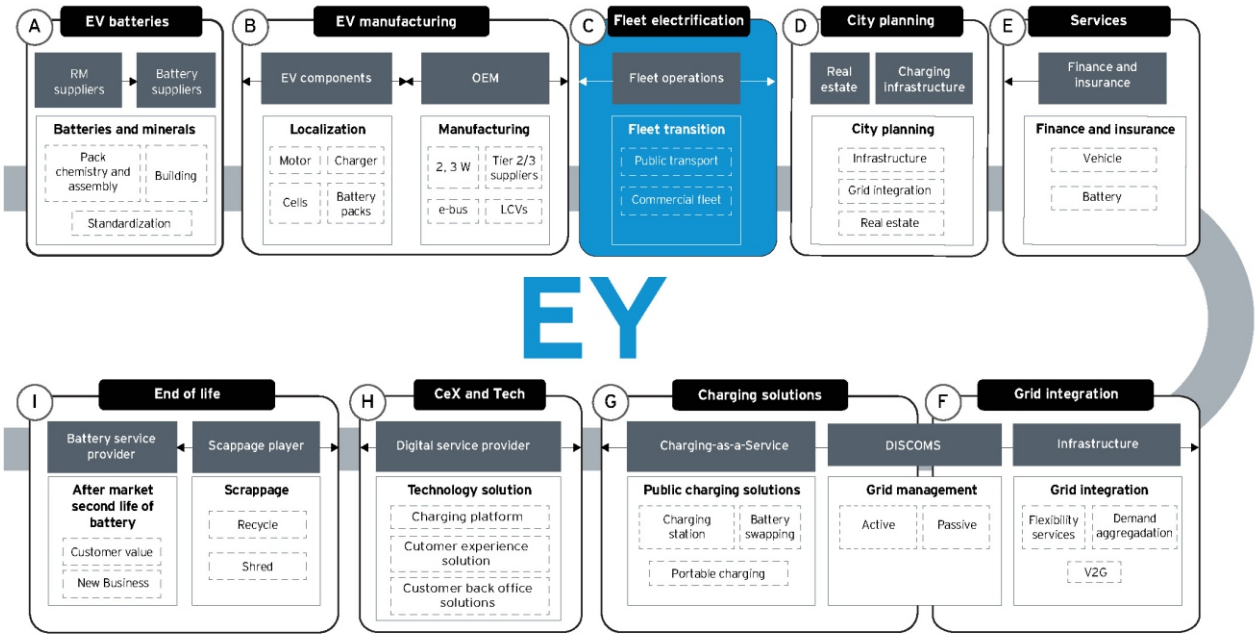
29 & 30 International Energy Agency





07 Fleet electrification

Figure 16: Fleet Electrification within EV Value Pool



India's cumulative energy consumption from freight transport between 2020 and 2050 under a business-as-usual (BAU) scenario is expected to be around ~5.5 billion to 6 billion tons of oil equivalent (TOE)[31]. India, however, can reduce this consumption by up to ~50% under an efficient scenario[32] through efficient and optimal truck usage, use of alternate powertrain, and fuel-efficient vehicles.

Limited fuel saving technologies and lack of awareness reduces profitability of Indian fleet operators. With low availability of capital, fleet operators are hesitant on investing in fuel-saving technologies, EVs, and other alternate powertrain vehicles owing to their higher upfront acquisition costs and limited access to finance. At present, internal combustion engine vehicles dominate India's on-road freight activity, while EV penetration in commercial vehicle sales is less than 1 percent[33]. Additionally, commercial vehicles in India have a low fuel mileage, impacting operational costs. Fuel costs account for more than half of the total cost of vehicle ownership (TCO)[34]. This leads to an unfavorable TCO scenario for the fleet operator. Alternate powertrains with low fuel costs and high efficiency will lead to long-term benefits and positive economic returns for the fleet operators. Following are the TCO scenarios for different vehicle segments: :

1. EV 2-wheeler segment is ~50%[35] more efficient compared to ICE
2. EV 3-wheeler segment is ~60%[36] more efficient compared to ICE
3. EV 4-wheeler segment is ~10%[37] more efficient compared to ICE
4. E-Bus segment is ~5%[38] more efficient compared to ICE
5. E-LCV segment is ~40%[39] more efficient compared to ICE
6. E-MCV segment is ~20%[40] more efficient compared to ICE

The announcement of the national vehicle scrappage policy will also require fleet operators and other freight management organizations to consider alternate powertrain options or powertrain retro fitment to replace their existing fleet. According to the policy, ICE commercial vehicles can ply on roads for eight years after which they need to apply for a vehicle fitment certification (additional cost to the owners) every year until 15 years of age after which they will be deemed unfit for application and will be scrapped. After eight years, fleet operators/freight management players can choose to either sell their existing vehicle and purchase a new vehicle, upgrade to a new alternate powertrain vehicle, or select the option of retrofitting their current vehicle with a new alternate powertrain.

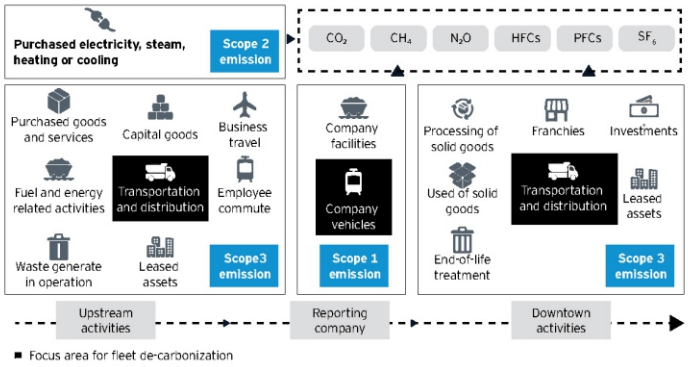
In addition, major sectors are making commitments to EV100, a movement aimed at ensuring 100% fleet electrification for goods freight. Players in major sectors such as e-commerce, automotive, steel, cement, food delivery, FMCG/retail, and logistics have announced plans for complete fleet electrification and a stronger commitment toward carbon neutrality in India.

31 RMI Analysis
32 IBID
33 RMI Analysis
34 RMI Analysis
35 WRI TCO Evaluator: 2-wheeler
36 WRI TCO Evaluator: 3-wheeler
37 WRI TCO Evaluator: 4-wheeler
38 WRI TCO Evaluator: Bus
39 WRI TCO Evaluator: LCV
40 COP 26

Figure 17: Focus on fleet decarbonization

The focus of fleet decarbonization is on the reduction of scope 1 and 3 emissions related to movement of goods by adopting alternate powertrains such as EVs, NGVs, biofuels...

For the fleet decarbonization journey, the focus segments will include the eompany-owned fleets which fall under the scope 1 emissions bucket and the fleets owned by the 3PL service providers for in-bound, out-bound and in-plant movement of goods which fall under the scope 3 emissions



To ensure that targets for clean and sustainable mobility are met, the government is taking key initiatives, such as:

1. **Choosing a sustainable way forward**: India has committed to be carbon negative by 2070[41] under the Paris agreement 2021. Currently, 22 of the top 30[42] most polluting cities globally are in India.
2. **Harboring strategic advantages**: India can save ~ $14 billion[43] through decreased dependence on crude while factoring in increased EV penetration by 2030.
3. **Leverage the paradigm shift**: Promoting local battery and EV manufacturing will result in reduction in unemployment and up-skilling of semi-skilled workers.
4. **Take advantage of the falling battery prices**: Battery prices are expected to fall from the current of ~$140 to ~60[44] by 2030 through the onset of economies of scale, making EVs even more affordable for mass fleet adoption.

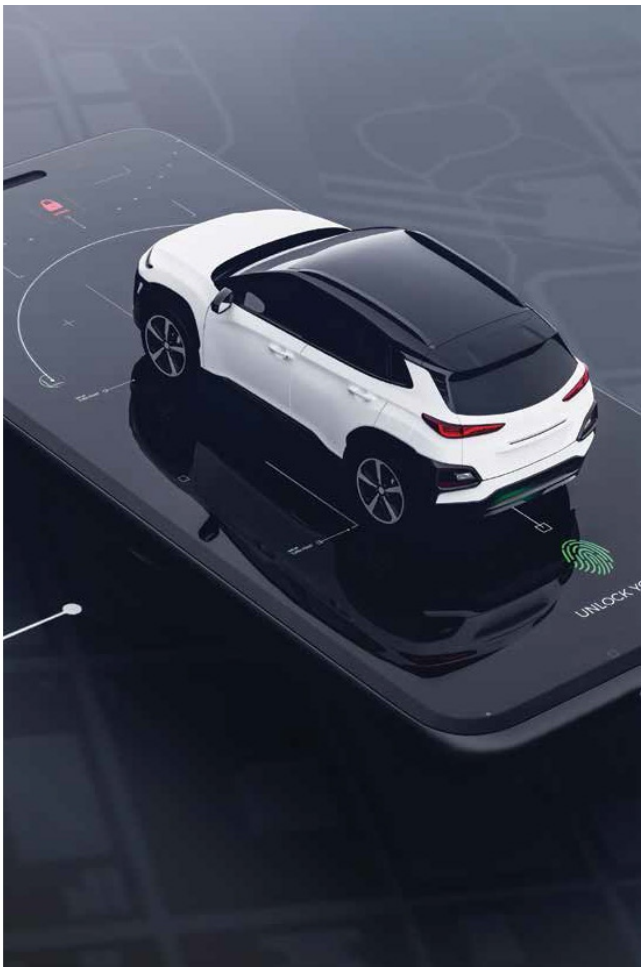
41 COP 26
42 The Weather Channel
43 CEEW (Council of Energy, Environment and Water)
44 Niti Ayog

7.1 Fleet electrification roadmap

Figure 18: EY Analysis - Fleet Electrification Roadmap

Lane assessment	Roadmap development	Supplier assessment
Detailed assessment of each lane for inbound, outbound and passenger transport	Iterative discussions with key functions of the target organization	Supplier reachout and finalization
Fuel consumption, distance, carbon footprint, LSPs, vehicle specs, load, duty cycle, infrastructure etc.	Vision, boundary conditions, preferences, impact, barriers, enablers etc.	Selection of suppliers to collaborate with LSPs to enable a transition towards alternate powertrains
Selection of key lanes to focus on	Design thinking workshop	Route selection for pilot study
Future state assessment for focus lanes	To arrive at a organization wide consensus on the way forward for de-carbonization	Route shortlisting basis - Feasibility of alternative powertrain, Availability of LSPs and infrastructure, Criticality in terms of volume, frequency, load value etc.
Industry best practices, cost comparison and availability of alternative powertrains, carbon footprint reduction potential.	Roadmap for de-carbonization	
	▶ Selection of alternate powertrains acros select lanes ▶ Assessment of carbon reduction potential and cost	

Pilot study and roadmap finalization	Vehicle procurement for Pilot	Stakeholder alignment
Development and implementation of a pilot study framework	Selection of the procurement rout by the target organization	Business case development for select lanes
To monitor the key performance indicators during vehicle operations (specifications, cost, re-fuelling infrastructure)	Procurement via: Leasing Retrofitment Gross Cost Contract Outright purchase	Assessing the costs for transitioning and operation of alternate powertrains and developing a comparison
Analysing results & updating the roadmap		Alignment of LSPs & suppliers on a common platform
Basis deviations in vehicle specifications, TCO, risks and hidden expenses, user feedback, real world carbon reduction potential	Alternate powertrain vehicle procurement	Present the business case and formalize the business relation (commercials, investments and roles of each party)



Public transport fleets will also play a key role in the adoption of electric vehicles. The 3W market has the highest penetration in terms of sales, with the majority of share being attributed to e-3W rickshaws. There has also been a push to include electric three wheelers in the autorickshaw fleets, such as in Delhi, Kochi and Amritsar. Additionally, states have designed ambitious targets for the development of their e-bus fleets, all of which would be funded through the state transportation departments. Adoption of EVs in these sectors will provide opportunities for the robust manufacturing capabilities and development of infrastructure will be critical for growth of these auto sectors.

Our understanding

Fleet operators need to be actively engaged in the developing their charging infrastructure. Route planning should consider the existing infrastructure, ensuring fleet deployment is modeled around charging needs, managing the vehicle's range expectations, and scheduling drivers around necessary charging requirements.

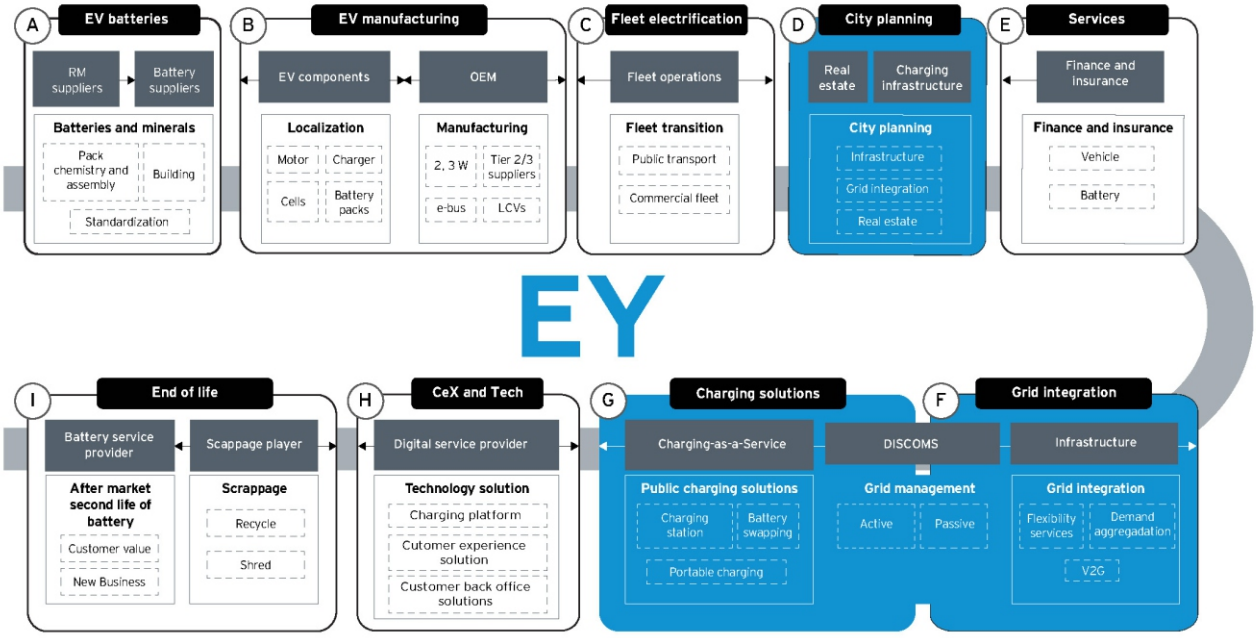
Companies should pursue electrification in a phased, pilot-driven model. This approach ensures vehicle profitability through the pilot program, while a staggered approach will reduce the upfront capital required. Carefully investigating the total cost of ownership when exploring new vehicle purchases versus retrofitting is crucial to minimize profit loss. A successful strategy could involve initially replacing short-range vehicles and conducting a pilot study to understand real-world performance before achieving 100% electrification.

Depending on vehicle expectations and needs, some industry sectors will be able to achieve their electrification targets earlier. Considering state and local policies, fleet managers should strive for the low-hanging fruit before approaching more ambitious targets.



08 EV infrastructure development

Figure 19: Infrastructure development within EV value pool



8.1 EV charging ecosystem

The transportation sector is in a transformational phase undergoing electrification. Electric vehicle adoption has gained strong traction due to government initiatives and national policy support programs. Further, the development of charging infrastructure is essential to support EV adoption as a mainstream mode of transportation. Electric vehicle charging infrastructure can be divided into two broad categories i.e. charging infrastructure (using electricity to charge the battery pack within the vehicle) and battery swapping (replacing a used battery pack with charged battery pack).

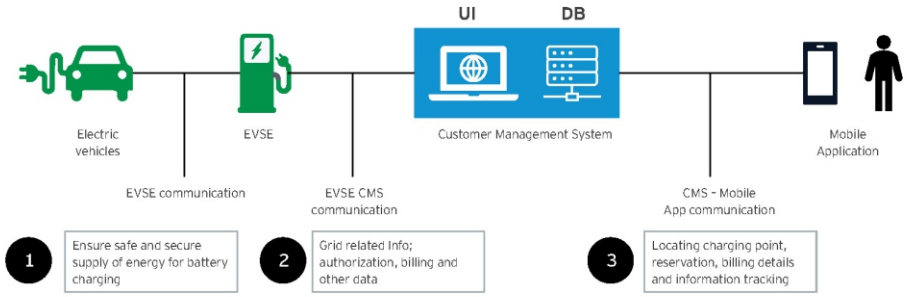
Key factors for planning and developing charging infrastructure include:

- the availability of charging stations
- the safety of operation
- the type of vehicle (time to charge)

8.1.1 EV charging systems

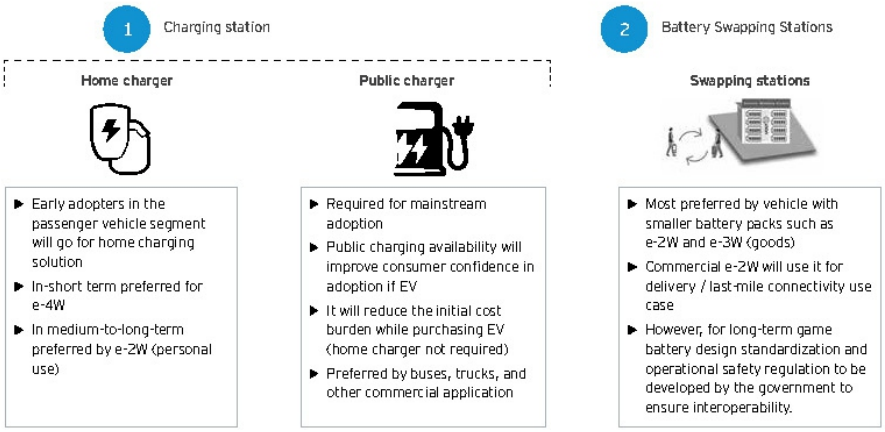
Electric vehicle supply equipment (EVSE) is a fundamental component required to set up an EV charging infrastructure. The control system enables operations such as authentication, authorization, data capture, networking, and data privacy and security.

Figure 20: Architecture of EV charging ecosystem



The charging can be done in two ways, i.e., wired and wireless. The wireless mode requires additional inputs from the supply-side for technology upgrades and addition. The wired mode is the most preferred globally. It is highly efficient in terms of energy consumed for charging and can be easily controlled as well in case of an emergency. The EV charging ecosystem can be divided into two broad categories, as shown in the Figure 21.

Figure 21: Types of charging infrastructure



8.1.2 Charging technology in India

The charging technology is defined by the type of connectors. Some of the connectors are mentioned in Table 4.

Table 4: Common charging standards in India

Charging Type	Connector	Power Rating	Additional Information
Fast Charger	Combined Charging System (CCS) 2	50kW - 150 kW	DC rapid charging of 50kW or more
	CHAdeMO	3 kW - 150 kW	Bi-directional charger being used by 400 members and 50 charging companies. CHAdeMO is the original DC charger for fast charging
	Type 2 Charge	Up to 43 kW	The maximum voltage is 500 V AC., and can be used for charging electric 2W, 3W and 4W.
Slow/Moderate Charging2	AC-DC LEV Charger	Up to: 12kW (DC) 7.7 kW (AC)	Based on Ather's IP, this connector is now part of AIS 17017 (Part 2 Sec 3). Capable of charging in both AC and DC configuration, this charger is built for LEVs (2W, 3W etc.).
	Bharat DC-001	Up to 15kW	Based on the GB/T connector, the Bharat DC001 standard can deliver up to 200A of current and operate at 48V/60V/72V.
	Bharat AC-001	Up to 3.3 kW	The connector is IEC 60309, and it also has OCPP 1.5. AC-001 is mainly a low power charging delivering up to 15A.

45 Department of Heavy Industries, JMK Research, EY Analysis

EV adoption will be driven by the light vehicle segment, particularly in the commercial sector such as warehouse management (inventory), last-mile delivery and connectivity, and the e-commerce industry. Electric 2W and 3W are the highest gainers in the e-commerce ecosystem. The intermediate public transport sector, focusing on decarbonization, leads EV adoption in the passenger vehicle segment.

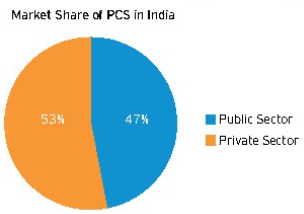
8.1.3 Current scenario of India's EV charging infrastructure

The national electric mobility mission plan was envisioned to bring electric vehicles into the mainstream transportation sector with an intent of reducing carbon emissions and import crude oil. Under the mission, the FAME initiative captured the attention of the industry players. The sanctioned public charging stations were 520 (FAME Phase 1), 2,877 (FAME Phase 2), and 1,576 (FAME Phase 2 across nine expressways and 16 highways).

Currently, there are over 16,000 operational charging stations with ~28,000 total charging points across the country. A state wise study shows that Karnataka, Maharashtra and Delhi are the top three regions with the highest number of charging stations. There are ~80 charge point operators in the Indian ecosystem currently and their network is serving the EV parc at ~140 EVs per charging point. This shows that there is ample scope for growth of the charging infrastructure in India.[45]

The EV charging station growth will be driven by the OMCs in this decade, as they plan to leverage their existing refueling station network for setting up EV charging options. Currently, India has around 90,000 ICE refueling stations across the country.

Table 5 - Share of Public Charging Station Operators in India



8.1.4 Swapping stations business models

Battery swapping charging solutions have seen a keen interest from the Indian start-up industry, with innovative business models offering to target a wide range of customers. Some of the models are:

1. Energy-as-a-service: is a concept where the battery is separated from the vehicle purchase. Instead, customers can lease the battery pack and pay for its usage (Pay-as-you-go model). This approach significantly reduces the upfront cost of the vehicle because the battery, which is the most expensive component of an electric vehicle (EV), is not included in the purchase price. As a result, this becomes an affordable option for customers who need a low-to-moderate range EV.
2. Battery-as-a-service: is a concept where a new fully charged battery is rented in exchange for a discharged one. This model can be further elaborated as:
   - Subscription: a monthly/annual subscription contract for the specified number of battery swaps with small per swap fees to accommodate for administrative expense
   - Actual utilization in real-time: no subscription required, direct access to compatible battery pack exchanged against a discharged battery. The consumer's cost may include charges based on the cost per kWh, a fee per swap, and a monthly subscription charge
   - Connected battery: digitalizing the service with IoT-enabled tech helps monitor battery function, the storm left capacity, battery location tracking, and energy utilization behavior basis energy expense
   - The battery is not a part of the vehicle, which brings down upfront cost and makes it affordable owing to the battery swapping option

Figure 22: Swapping stations business models "Battery-as-a-Service"

Business model 1	Monthly subscription fees	Utilization fees
▶ Subscription fees is an assurance of enrollment of a customer on the service with the company; ▶ Utilization fees would be by kWh or per swap;		
Business model 2	**Monthly / annual subscription fees**	
▶ For fixed number of swaps in the subscribed period; ▶ It is inclusive of utilization of battery as well, all cost is bundled into one subscription amount;		
Business model 3	**Utilization fees**	
Pay-as-you-go model no upfront cost/subscription required only pay when using the service and for the amount of use		

The projection considers various variables impacting the adoption of battery swapping vehicles. A smaller battery that is easy to switch, along with the best use case for a quick switch at the swapping stations, was the primary consideration for the required battery pack size for the vehicle function. The battery swapping technology is a promising option for last-mile delivery and connectivity application for 2W and 3W.

8.1.5 Battery swapping vs fixed battery[46]

Advantages of battery swapping

1. Reduction in EV acquisition cost: Battery accounts for a significant cost, nearly 30% to 40% of the total cost in an EV. In the battery swapping model, the battery is not part of the total cost of the vehicle, as it is owned by the operator.
2. Reduction of risk associated with batteries: With the battery owned by the operator, mishaps caused by battery would be under the purview of the manufacturer/operator and not the consumer, allowing for lower risk to insurance companies.
3. Low financing cost: Reduction in the battery cost would in turn reduce the finance amount which the consumer would like to avail to purchase an electric vehicle.
4. Longer vehicle life: Low finance and insurance costs would increase the adoption of electric vehicles over ICE vehicles.

Challenges of battery swapping

1. Standardization of battery packs: The battery packs need to be standardized across all vehicle segments to successfully execute this model. This standardization would snatch away the OEMs' freedom of designing vehicles as per their needs.
2. Reliability of the battery pack: The battery packs available to the user should be of the same specifications and quality. Any disparity in the functioning of the battery packs would result in damage to the vehicle.
3. Private ownership: A private owner will also be unwilling to use batteries that they have not purchased, or can guarantee chain of command of, as can be viewed as a potential risk to their vehicles. Also, with lower adoption rates in the country for private vehicles, battery swapping is not commercially viable currently, as owners would prefer to charge at home.



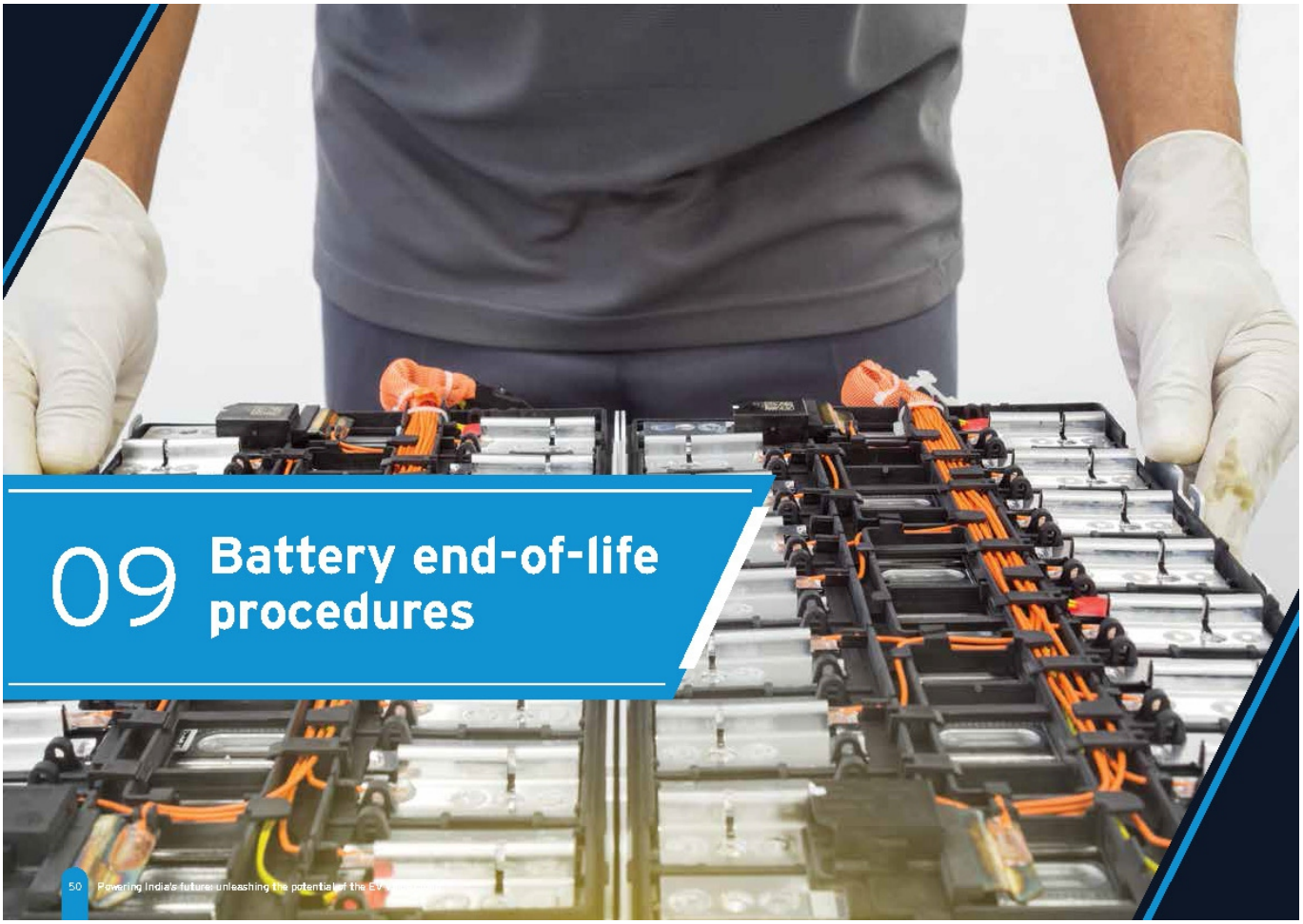
Our understanding

The Indian EV policy should focus on building a robust supply chain, ensuring component availability, and localizing production. It should also standardize EVSE for better interoperability and implement regulatory frameworks in phases to simplify business operations. States should offer incentives for off-peak electric tariffs to stabilize the grid, while battery swapping should be prioritized for commercial fleets until battery technology improves.

Fast charging will remain essential for heavy-duty vehicles and commercial fleets, while battery swapping can optimize last-mile delivery for two- and three-wheelers. Private owners will likely depend on home or office charging, driving demand for related infrastructure. A strategic nationwide deployment of fast chargers, supported by grid analysis and smart metering, will manage power demand effectively and enhance grid management.

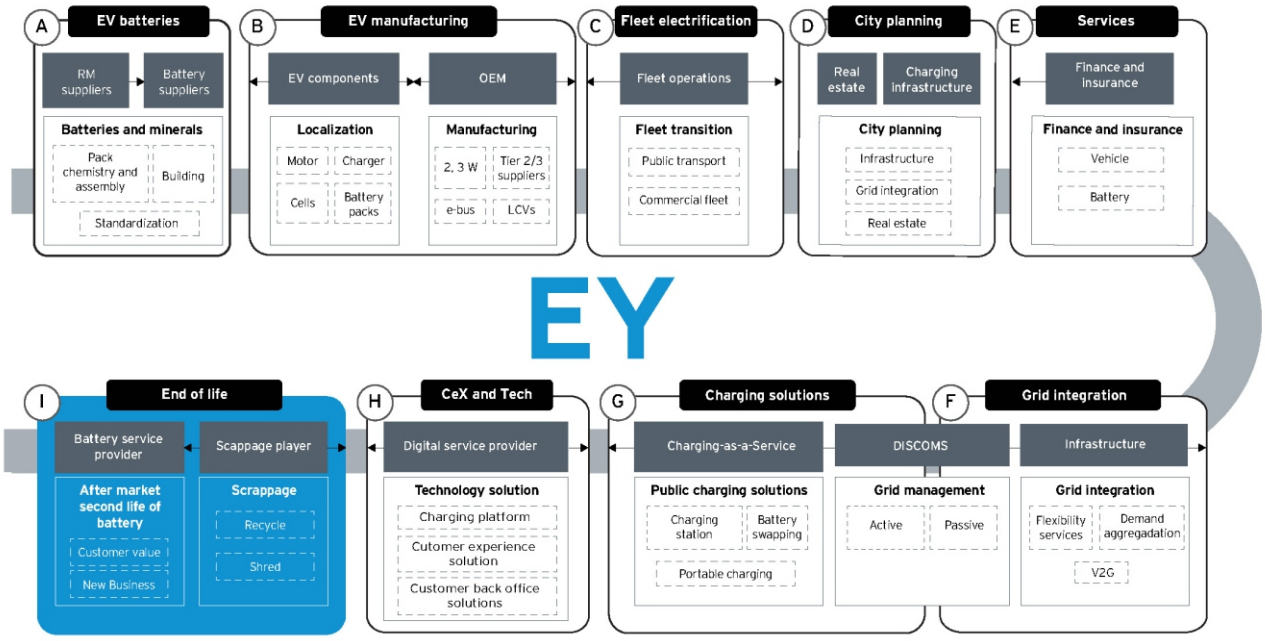
46 https://www.financialexpress.com/auto/electric-vehicles/rechargeable-battery-vs-battery-swapping-in-electric-vehicles/2467989/





09 Battery end-of-life procedures

Figure 23: Battery End-of-life Procedures



9.1 Scrapping and recycling

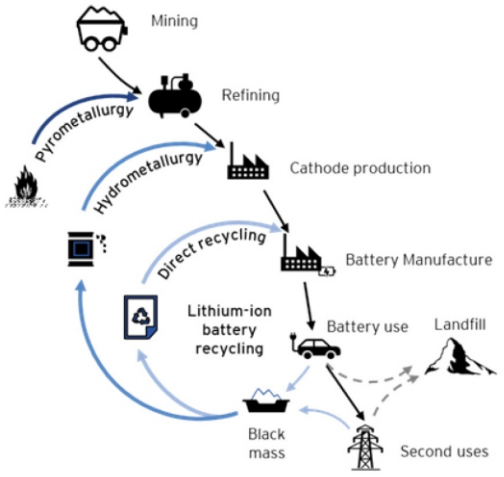
The Indian government has introduced the Battery Waste Management Rules, 2022, to regulate the management of waste batteries. These rules apply to producers, dealers, sellers, and entities involved in the collection, segregation, transportation, or recycling of waste batteries. The rules aim to ensure sound management of waste batteries and promote recycling of battery materials. They introduce a system of Extended Producer Responsibility (EPR) where producers are responsible for managing the end-of-life of their products.

The rules set targets for the collection and recycling of waste batteries, as well as the use of recycled materials in new batteries. Producers, battery manufacturers, and recyclers will need to register with the state and central pollution control boards and comply with the EPR regulations. Compliance with EPR rules can be monitored through a system of EPR certificates, which can be traded among industry players to meet targets. These measures are expected to promote innovation and growth in the battery recycling sector while ensuring the sustainable management of waste batteries.

9.2 Second life of battery (SLB)

Electric vehicle batteries typically operate for up to 3000 to 5000 cycles before they are deemed inefficient for direct use in the vehicle. These batteries retain 70% to 80% of their original battery capacity, with only a 5% expected self-discharge rate over a 24-hour period, making it extremely viable for non-transportation related secondary application. A second life battery (SLB) can improve the value proposition of electric vehicles, making them even more attractive by using the full potential of the battery value chain.

Figure 24: Battery Recycling Lifecycle



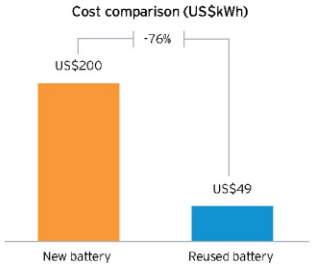
industry drivers creating the need for recycling:

- Growing recycling industry due to increased EV adoption and Giga plant rollout: Before 2020, less than 5% of Li-ion batteries were recycled[47]. This has scaled up rapidly with the introduction of battery waste management rules, growth in production scrap, warranty cells and EOL batteries.
- Increased economic benefit from recycling: Typically comprising up to 70% of the value at the battery cell level, the Bill of Materials presents the single-most significant value driver in securing a competitive price for battery materials .
- Increased regulations and mandates: Regional governments have put forward more ambitious recycling targets, labeling and threshold requirements to maximize the content of recycled materials at the end of life.
- Stricter CO2 and recycled content guidelines: Batteries manufactured and sold will face mandatory CO2 declarations, recycled content obligations, collection targets and material recovery targets.
- Increased pressure on the supply of critical materials: Battery recycling will be a key lever to secure cost reduction and mitigate the risk of consolidated global raw materials supply and subsequent upward price risks.
- Reduced reliance on Asian supply chains and retaining ownership of materials locally: Europe and the US are exploring options to mine and retain materials locally. Recycling will act as a critical enabler in the battery supply chain.
- Reduced environmental impact: Manufacturing new battery packs is more energy-intensive than recycling, making recycling a more environmentally friendly option by reducing the impact from both mineral-mining and electricity production.

Select advantages and use cases for second-life batteries

- **Business opportunity**: Second life of batteries offers a business opportunity to OEMs, that are ultimately responsible for the recycling/dismantling of batteries once they reach their end-of-life period for EV usage. These batteries can perform well in a less-demanding use case and help offset their recycling costs.
- **Value for customer**: Figure 26 highlights the cost differential at the end of use for EV battery once it has been used in secondary application[48]. These savings can be used to offset upfront costs for electric vehicles, allowing for a reduced total-cost of ownership for the EV consumer, promoting faster adoption.

Figure 25: Cost differential between new and reused battery



47 Recycling of Lithium-Ion batteries in India, JMK Research, 2019
48 Bloomberg New Finance-Quint



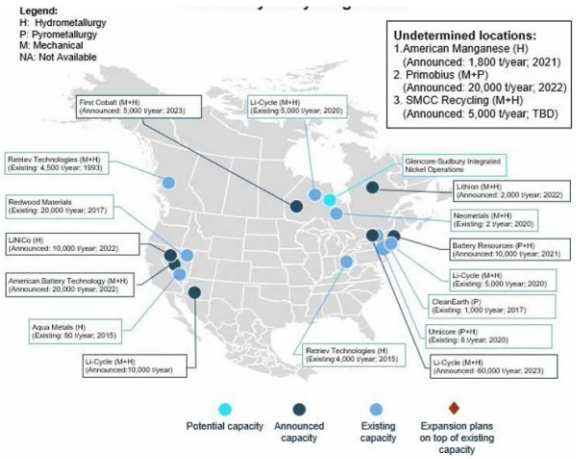
Figure 26: Applications of SLBs

Key applications of second life batteries				
1	**Renewable energy storage** Used EV batteries are ideal for storing electricity from solar panels and wind turbines and allowing its usage when needed.			
2	**Grid stabilization** Batteries can be used for handling the load shifting when there is high peak demand.			
3	**Power backup** Batteries can be used for backup power supply and improving power quality inside residential and commercial buildings.			
4	**EV charging** Stored energy in used batteries can be leverages to offer EV charging services in locations where constructing a high-power connection whould be very costly.			
Major industries	Telecom	Utilities	Real estate	Automate

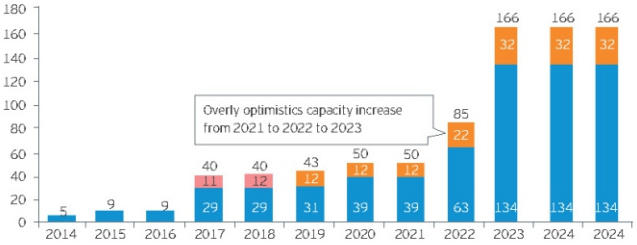
Figure 27: Battery Recycling capacity and network in North America and Canada

Across the next three years, the aggregate capacity of recycling operations in North America and Canada is expected to increase from 60 ktpa today to 184 ktpa by 2023

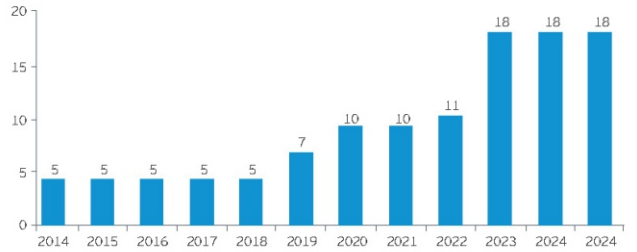
EV Battery recycling plants



North American EV battery reclying capacity (ktpa)



Canada EV battery recycling capacity (ktpa)



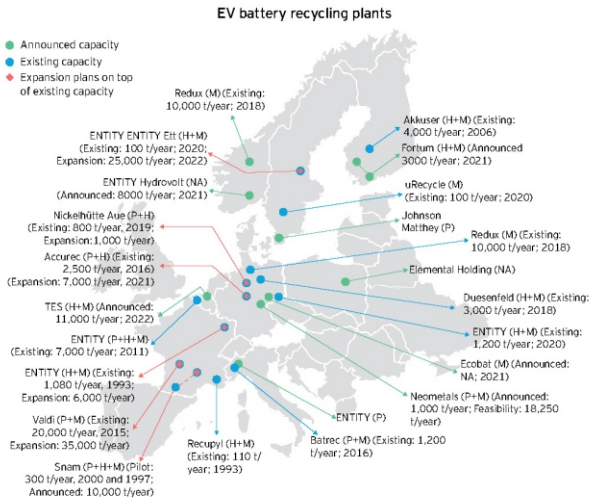
Source: Company announcements; Press release, FY - Parthenon analysis

Note: Several plants adopt both pyromet and hydromet technologies; in these instances, the capacity has been divided equality between technologies

Figure 28: EV battery recycling landscape in Europe

The European EV battery recycling landscape is expected to grow to 80ktpa capacity by 2025, driven by increases in hydrometallurgical capacity

EV battery recycling plants

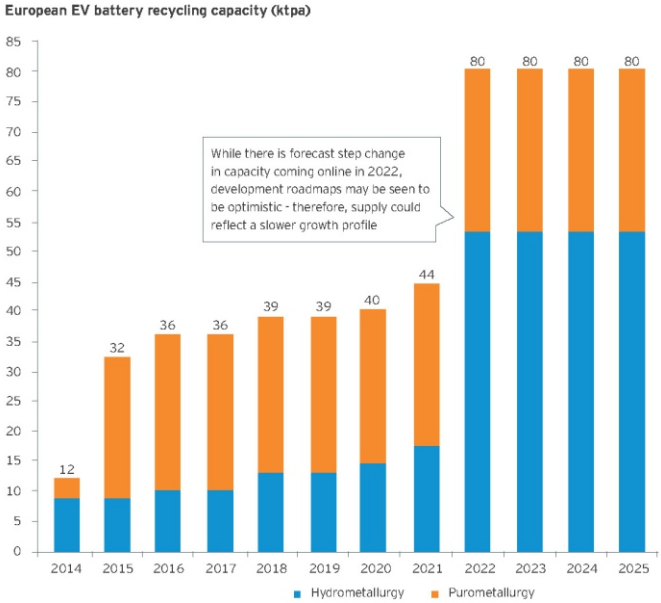


Legend:
H: Hydrometallurgy
P: Pyrometallurgy
M: Mechanical
NA: Not Available

Undetermined locations:
Battery Resources (H) (Announced: NA; TBD)

Source: Company announcements; Press release, FY - Parthenon analysis

European EV battery recycling capacity (ktpa)



Note: Several plants adopt both pyromet and hydromet technologies; teh capacity has been divided equality between technologies



The primary challenge to the application of an SLB is the lack of a standardized product available in the market. Some battery chemistries are not adept at repurposing as others, while the unpredictable lifetime of the batteries poses a threat to guarantees in secondary application. Additionally, re-using batteries in a heavily regulated secondary market, such as the utility sector, poses serious challenges in the approach and deployment of SLBs, which may make the re-purposing commercially unviable.

Our understanding

TThe Indian EV policy should prioritize the development of an end-to-end supply chain, focusing on component availability, localization, and standardization of EV batteries to facilitate easier recycling and the development of second life battery (SLB) solutions.

Enforcement of the battery waste management rules should be a focal point of further EV policies to ensure the intended impact of battery recycling is seen in the ecosystem.



10 Skill development initiatives for EV ecosystem

On the academic forefront, India has been striving meticulously towards the development of efficient energy storage systems, particularly batteries. CSIR-CECRI has developed a prototype Li-ion fabrication facility for 18650 cells. It is India's first pilot plant facility which will manufacture Li-ion cells with a capacity of 1500 mAh/3.7 V, dedicated to improving the capacity of Li-ion batteries. IIT-Madras has been working on electrode materials and novel redox couples for vanadium redox flow batteries. IIT-Bombay is primarily focused on developing energy storage materials for Li-ion batteries and fuel cells towards EV applications.[49]

However, major industry players will be required to collaborate with leading institutions to support research and development for EV technologies, globally organizations are collaborating with academic institutions to fund research and development initiatives. One of the leading cell manufacturing companies in Japan plans to invest 15.1 trillion won by 2030, including 9.7 trillion won in R&D. It will build an institute in South Korea for training in battery technology, expected for completion in January 2023.[50]

Thus, skill development initiatives will need to be undertaken by all stakeholders, including industry, academia and government bodies. Some of the focus areas for skill development include:

1. **Flexi MoUs with industry partners**: ITIs are signing flexible Memoranda of Understanding (MoUs) with industries to conduct specialized EV-related training programs that meet specific industry requirements.
2. **Model ITIs**: Selected ITIs are being upgraded to "Model ITIs," which focus on high-quality training delivery, including EV technologies.
3. **State government participation**: State governments are playing an active role in the establishment of electric mobility centers in state-owned polytechnic colleges. This initiative aims to go a step further by integrating electric vehicle (EV) education into the polytechnic diploma syllabus.
4. Addition of new courses in the syllabus and adapting the content based on final application: For EVs, mechatronics, the technology that combines electronics and mechanical engineering, is gaining currency. As a multidisciplinary engineering branch, it serves both electrical and mechanical systems, with skill sets useful in the advanced automated manufacturing segment.

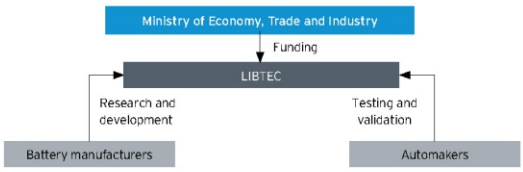
49 Department of Science and Technology, 2020
50 Bloomberg report, 2021

Figure 29 : Skill domains for EV

Domain	Application
Electronics and communication	Firmware and application software for power electronics and controllers
Chemical engineering	Lithium Ion cells manufacturing and assembly
Mechanical engineering	Thermal management and vehicle design
Mechatronics	Component and vehicle design
Automation	Shopfloor automation for assembly of components
Computer engineering	CMS software, analytics platforms
Electrical engineering	Charger development, HV wiring harness

5. Focused R&D with collaboration from stakeholders: Industry players, supported by funding from the ministry and the industry, are developing EV technologies and establishing testing and validation infrastructure for components. A similar approach is being adopted in Japan for battery research and development.

Figure 30: Japan's EV battery development consortium



6. EV manufacturing skill upgradation: Manufacturing EV vehicles requires new assembly and production practices. These will require employees to be reskilled. Industry players can develop in-house training programs for upskilling the workforce or collaborate with institutions for on-the-job training programs. For example, assembling electric car involves dealing with high voltage systems and thus proper training will be required to ensure a safe working environment for the employees working on production lines.



11 Conclusion and way forward

While the overall EV ecosystem is still at its nascent stage in India, it is accelerating with a strong momentum. The spike in fuel prices is providing a compelling business case for the transition towards EVs and alternate powertrain vehicles across personal and commercial segments alike. To support this transition, different aspects of the EV value pool will need to evolve in conjunction going forward:

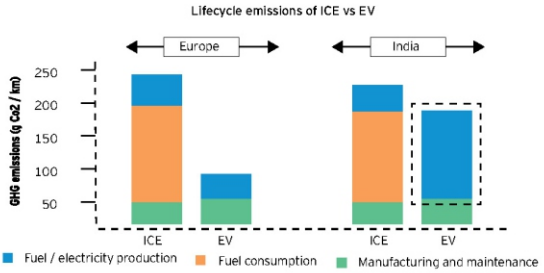
- A mix of vehicle ownership models and business models for charging infrastructure have to be planned, based on the target use case, operational pattern, locations, and available resources. The higher upfront cost of EVs can be offset by Vehicle-as-a-Service (VaaS) or Battery-as-a-Service (BaaS) models specially for commercial applications with battery swapping options for 2Ws, 3Ws and SCVs along with Gross Cost Contract (GCC) or Cost per Kilometer (CPK) models for heavier vehicle segment. Fleet operators can also evaluate EV retrofitment in their transitionary phase. For infrastructure, while public sector initiatives and collaborations with DISCOMs are sufficient at the introductory stage, as the EV landscape matures, other models such the PPP model may be better suited.
- The current market share of manufacturing unique EV parts in India is merely 1%. This number is expected to rise to 5% in the next few years[51]. The large manufacturing volume will reduce the costs of making EV parts in India with economies of scale kicking in. While the government is doing its bit by rolling out the Faster Adoption and Manufacturing of Electric Vehicles (FAME Phase II) Scheme with an outlay of INR10,000 crore, Production Linked Incentive (PLI) Scheme for automobiles and automobile components with an outlay of INR26,000 crores, OEMs are taking advantage of it, with the PLI estimated to catalyse fresh investments of over INR42,500 crore in the automobile sector[52]. To de-risk from import dependency and disruptions such as the ongoing semi-conductor shortage, developing a resilient supply chain will prove to be vital.
- To address the localization of battery and cell manufacturing, the PLI for Advanced Chemistry Cell (ACC) has been approved to build an annual capacity of 50GWh by FY30. A sum of ~US$2.42 billion has been made available for giga factories with at least 5GWh of annual production capacity per site.

As the EV revolution in India picks pace it will become critical for focus to be driven on End of Life (EOL) management. In this respect, recycling is the best way forward for India to address the safe disposal of end-of-life batteries as well the availability of raw materials for lithium ion batteries. Apart from creating awareness, India will need to take cues from global best practices such as:

- Development of systematic processes, standards and guidelines to promote seamless battery reuse, refurbishing, and recycling.
- Incorporate traceability across the value chain to strengthen the battery retrieval process
- Definition of responsibilities of battery manufacturers, OEMs, recyclers and the govt stakeholders for appropriate EOL management.

Apart from recycling, the sustainable generation of electricity would be required for reducing the GHGs and Well-to-Wheel (WTW) emissions going forward. India's dependence on thermal coal for its power generation indicates its EVs have the highest GHG emissions compared to other developed markets (refer figure 31). Renewable energy for charging should be planned as the way forward as this has significant upsides for the EVs of the future as compared to traditional powertrains.

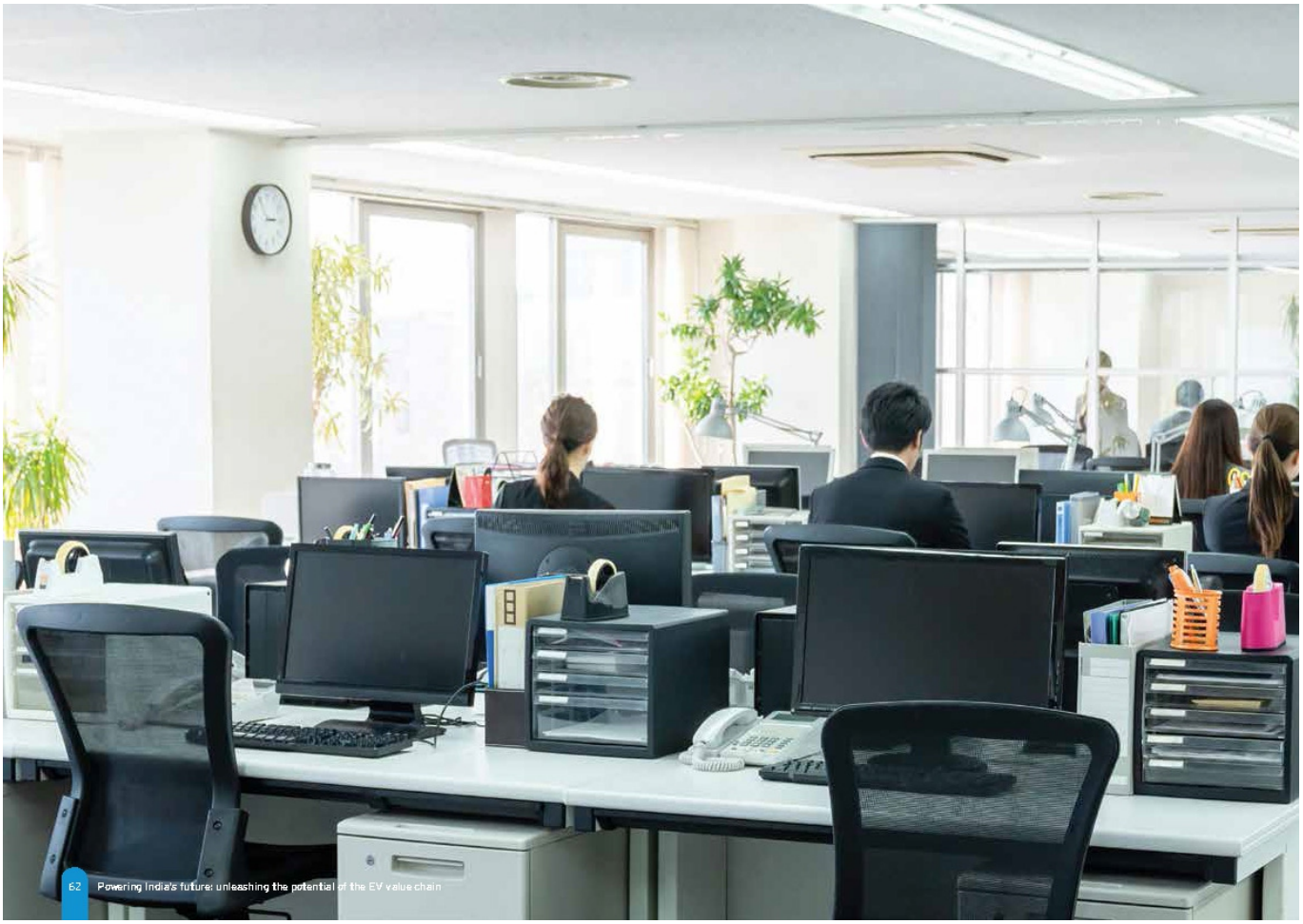
Figure 31: Lifecycle emissions of ICE and electric cars in India and Europe[53]



In the ambitious journey to achieve the govt. target of 30% EV adoption in new vehicles sales by 2030, PM and NOx emissions could reduce by 17%, CO2 emissions can reduce by 18% and GHG emissions by 4%. With the crude oil demand growing by 3-4% YoY, resulting in a consumption of ~7M barrels a day by 2030, the targeted EV adoption could lead to a 1.1 lakh crore (15% reduction) in the import bill[54].

To realize all this potential, synergies and collaboration are the key principles to the success of electric vehicles entailing stakeholders to come together to generate a sustainable ecosystem of mobility for the future.

51 Motoroids, Kabra Extrusiontechnik, January 2022
52 DHI, MoRTH, Automotive PLI Scheme
53 EA, Sustainable development scenario, 2021
54 Council on Energy, Environment and Water (CEEW), March 2022





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M-Agile, Pan Card Club Road
Baner, Taluka Haveli
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Overview of Indian Electric Vehicle Market and Infrastructure in India

by

FROST & SULLIVAN





- ELECTRIC VEHICLES MARKET OVERVIEW
  - KEY TRENDS INFLUENCING THE MARKET IN 2024
  - EV MARKET OVERVIEW 2023 – GLOBAL
  - EV GROWTH AND PENETRATION – LEADING MARKETS
  - EV GROWTH AND PENETRATION - LEADING OEMS
  - EV SALES FORECAST – 2030
- OVERVIEW OF EV MARKET IN INDIA
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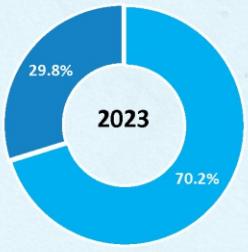
  - EV GROWTH AND PENETRATION – LEADING MARKETS
  - EV SALES FORECAST – 2030
  - FUTURE EV POLICIES
  - LOCALIZATION OF EV PARTS/COMPONENTS IN INDIA
  - FUTURE EV LAUNCHES
  - EV CHARGING INFRASTRUCTURE OUTLOOK
- FUTURE OUTLOOK OF INDIAN EV MARKET

ELECTRIC VEHICLES MARKET OVERVIEW

GLOBAL EV MARKET, 2023 AND 2024e

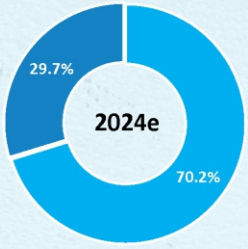
Electric Vehicle Market: EV Market Overview, Global, 2023 and 2024e



EV Sales
14,165,623
Up 41.9%
From 9,980,856

BEV PHEV

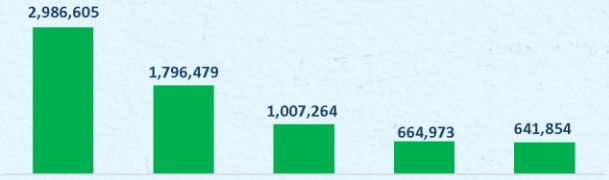
- The EV market is expected to slow down by around 10-11% driven by various factors including expiry of incentives in Europe.
- Tesla Model Y will continue to be the top selling model in 2024 as well surpassing 1.5-million-unit sales.
- BEV and PHEV split will continue to be the same with 70.2% BEV and 29.7% in PHEV.



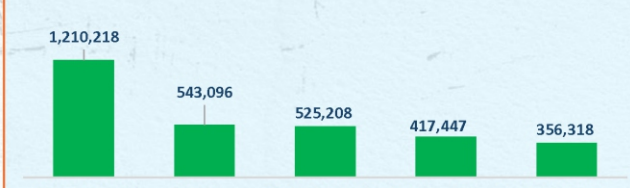
EV Sales
18,493,857
Up 30.6%
From 14,165,623

BEV PHEV

Electric Vehicle Market: Sales By Top 5 OEMs, Global, 2023



Electric Vehicle Market: Sales By Top 5 Models, Global, 2023



Note: The "e" by the year indicates it is an estimate.

Source: Frost & Sullivan

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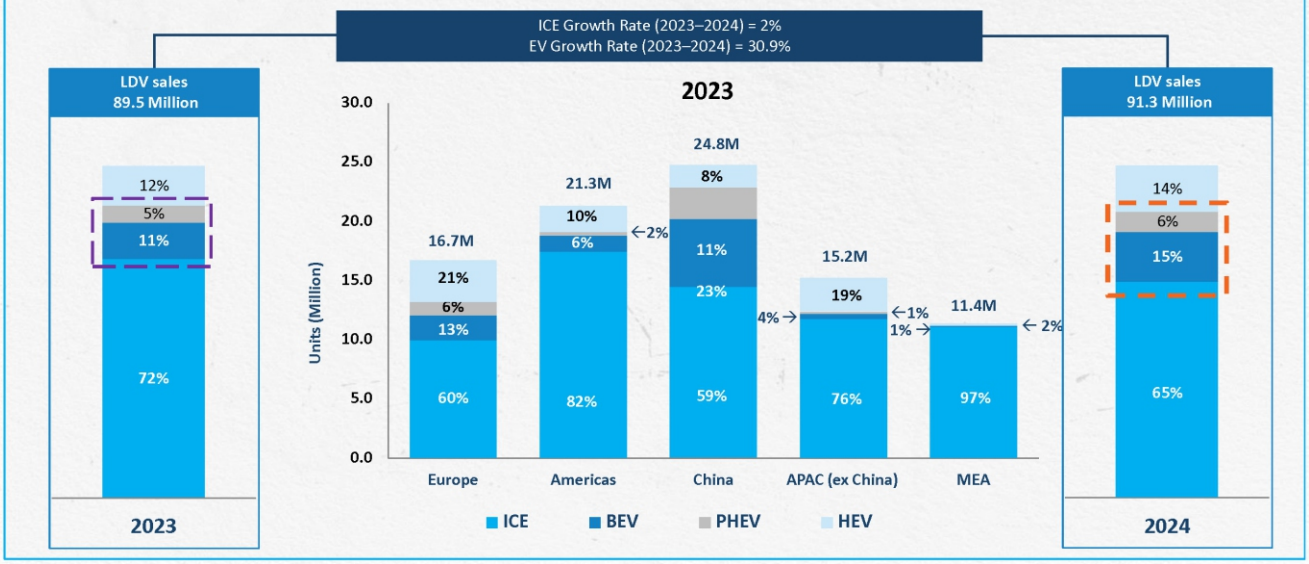
GLOBAL EV MARKET, 2023 AND 2024e

Electric Vehicle Market: EV Market Overview, By Region, 2023 and 2024e



Note: HEVs analysis is limited to this slide only and is not covered in the study

5

EV GROWTH AND PENETRATION—KEY OEMS

BYD EMERGED AS THE MARKET LEADER WITH OVER 2.9 MILLION SALES IN 2022 AND IS ESTIMATED TO SELL APPROXIMATELY 3.9 MILLION IN 2023.

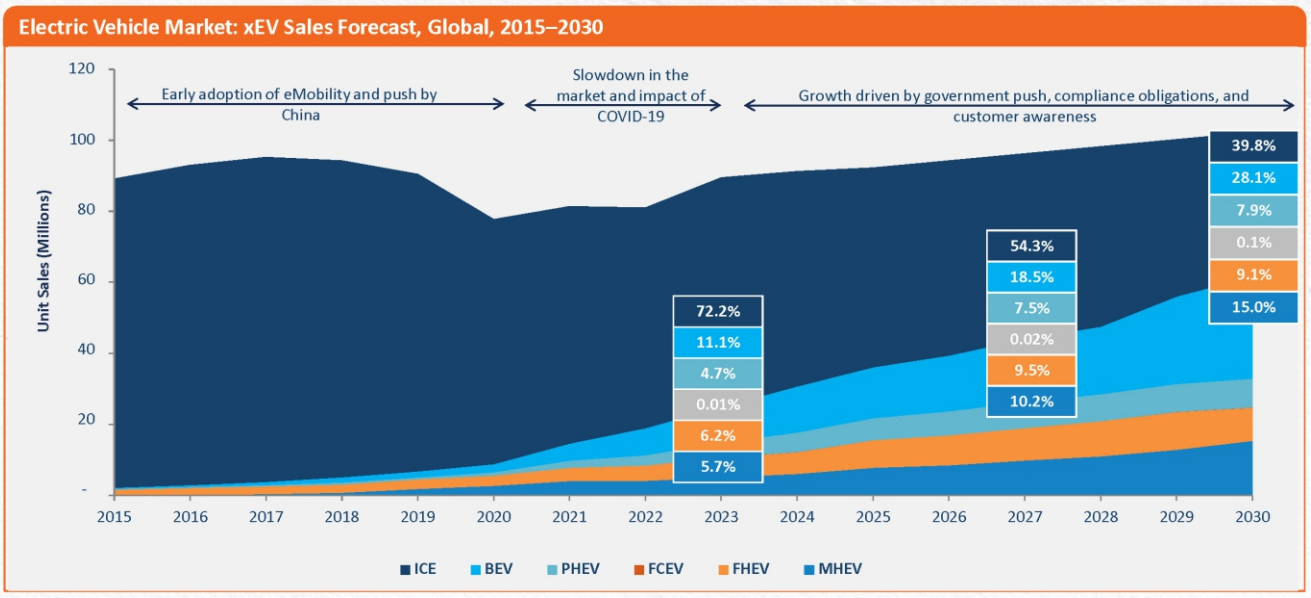
Electric Vehicle Market: EV Growth And Penetration, Key OEMs, Global, 2023 and 2024e

OEM	Sales	Est. Growth (2023-2024e)
BYD	3,940,958	32.0%
Tesla Inc.	2,344,057	30.5%
VW Group	,264 1,282,052	27.3%
GM	,973 873,565	31.4%
Stellantis	,854 817,575	27.4%
Geely Auto Group	,808 786,296	30.9%
BMW Group	9,434 718,072	28.4%
Hyundai Motor	0,811 683,344	24.1%
GAC	9,058 693,197	31.0%
Mercedes-Benz Group	06,526 517,795	27.4%

2023 2024e

6

GLOBAL xEV FORECAST



Note: All figures are rounded. The base year is 2023

Source: Frost & Sullivan

7

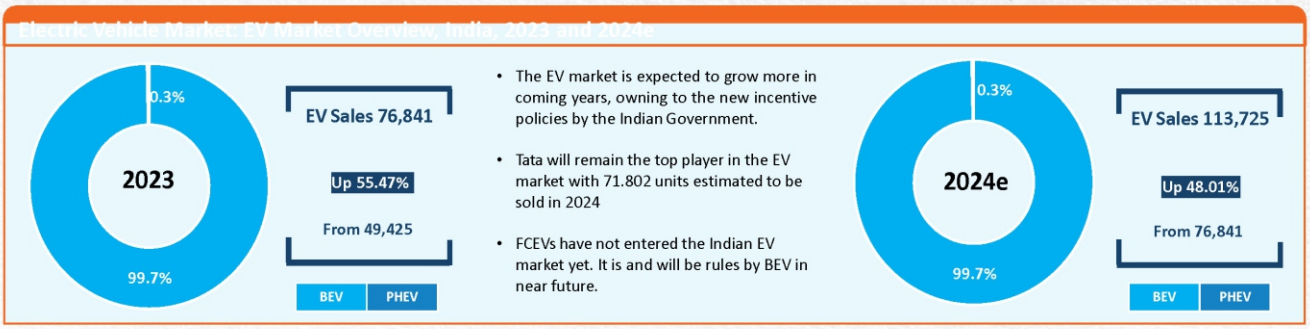


Key Highlights of 2023

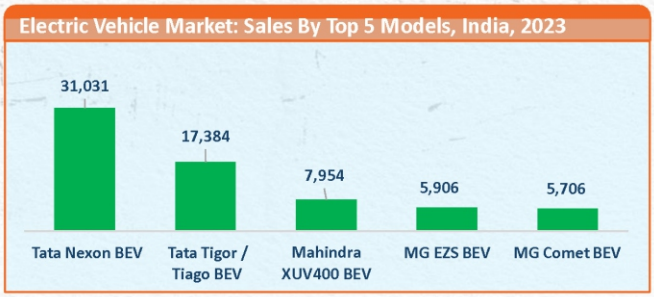
- India is well poised to develop the electric mobility eco system in the next 10 years especially for **E2W and E3W**, with encouragement from government through incentives and policies; Development of capabilities in E4W segment to take longer.
- Two-wheeler segment to lead the Indian electric mobility and estimated to convert 50 to 60% of total demand in 2030 to be electric vehicles; this would be followed by 3W and small trucks (less than 1.5T)
- F&S estimates around 10% of total car demand will be met by electric vehicles. Price sensitivity, inhibition of customers, charging infrastructure growth and still evolving technology are factors for slow adoption of electric cars in India
- Charging infrastructure development is happening with private-public partnerships and government incentives; however, the pace is slow currently and hopefully would accelerate in the future to meet demand
- Many global players like Renault-Nissan, Stellantis have announced intentions to manufacturer EVs in India and export to other destinations given the low-cost advantage.

Source: Frost & Sullivan

INDIA EV MARKET, 2023 AND 2024e





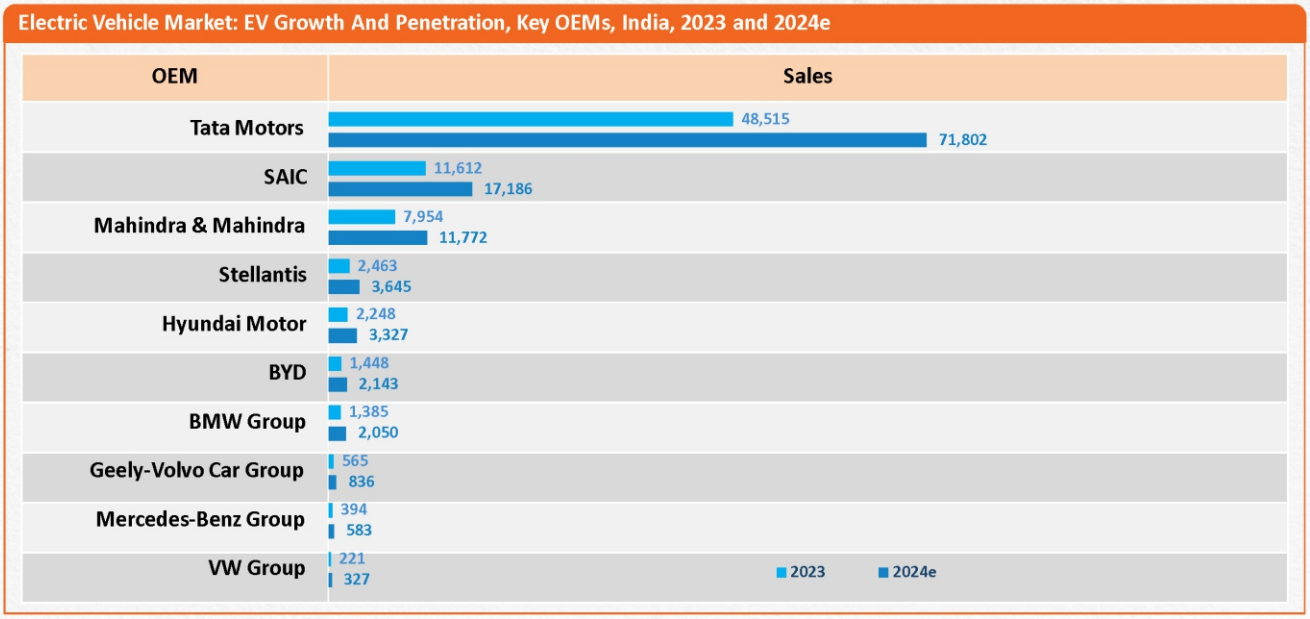


Note: The "e" by the year indicates it is an estimate.

Source: Frost & Sullivan

EV GROWTH AND PENETRATION—KEY OEMS

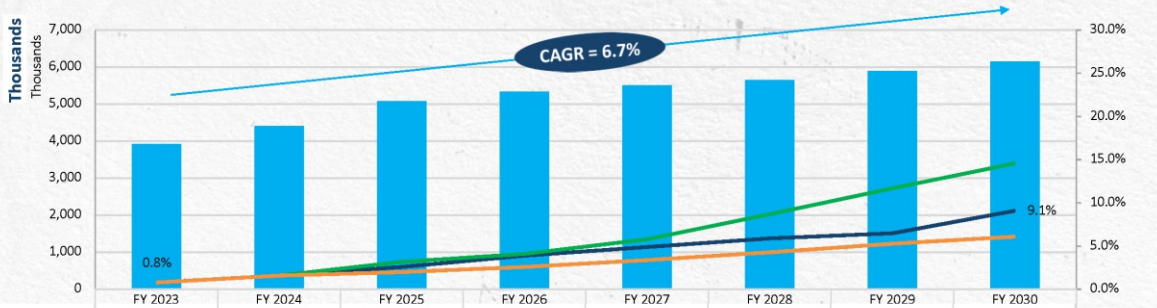
The data indicates a consistent and substantial growth rate of around 48% across various OEMs in EV sales from 2023 to 2024, highlighting a robust and uniform expansion in the electric vehicle market.



Electric Car Outlook in India

Lack of long range EVs and high cost of acquisition has been the major restraint for EV uptake in India

Electric Car Market – India, FY18-FY20



	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
Total (ICE+EV)	3,923,114	4,401,400	5,069,454	5,338,570	5,511,915	5,655,490	5,894,143	6,156,667
F&S Scenario (EV)	33,000 0.80%	72,500 1.60%	1,33,110 2.60%	2,06,321 3.90%	2,68,217 4.90%	3,35,271 5.90%	3,85,561 6.50%	5,59,064 9.10%
Optimistic Scenario (EV)	33,000 0.80%	72,500 1.60%	1,62,690 3.20%	2,19,632 4.10%	3,18,466 5.80%	4,93,622 8.70%	6,91,071 11.70%	8,98,392 14.60%
Conservative Scenario (EV)	33,000 0.80%	72,500 1.60%	1,01,500 2.00%	1,37,025 2.60%	1,84,984 3.40%	2,40,479 4.30%	3,12,623 5.30%	3,75,147 6.10%

*Line chart indicates penetration scenarios of favoring EVs in Total Market (includes ICE+EV)

Source: Primary interviews, Industry Journals, Articles, Frost & Sullivan

Electric Vehicle Policy Roadmap

To assist the adoption of EVs in the country, the central government has announced several promotional measures in past ten years, including tax incentives for electric vehicle owners, public EV charging infrastructure development



2015 — FAME India launched for 2 years with an outlay of **INR 6,500 million (US$ 81million)**

2019 — FAME II approved by the Indian government on April 1, 2019, for 3 years with an outlay of **INR 93,500 million (US$ 1,169 million)**

2020 — Renewal of the government's EV policy for the sale of E2Ws and E3Ws without batteries

2021 — Modifications to the FAME II scheme; 50% increase in purchase incentives for E2Ws

2022 — Niti Aayog released a draft policy in April 2022 on battery swaps for two- and three-wheelers. This battery swap policy helps reduce battery costs and promotes affordability

2023 — The Union Budget 2023-24 is provided grants for EV battery R&D, better financing for EVs, battery swapping, and charging infrastructure

2024 — Fame III for electric vehicles: Govt plans up to **INR 500,000 million (US$6,250 million)** outlay. Likely to include incentives for battery recycling, Commercial Vehicles

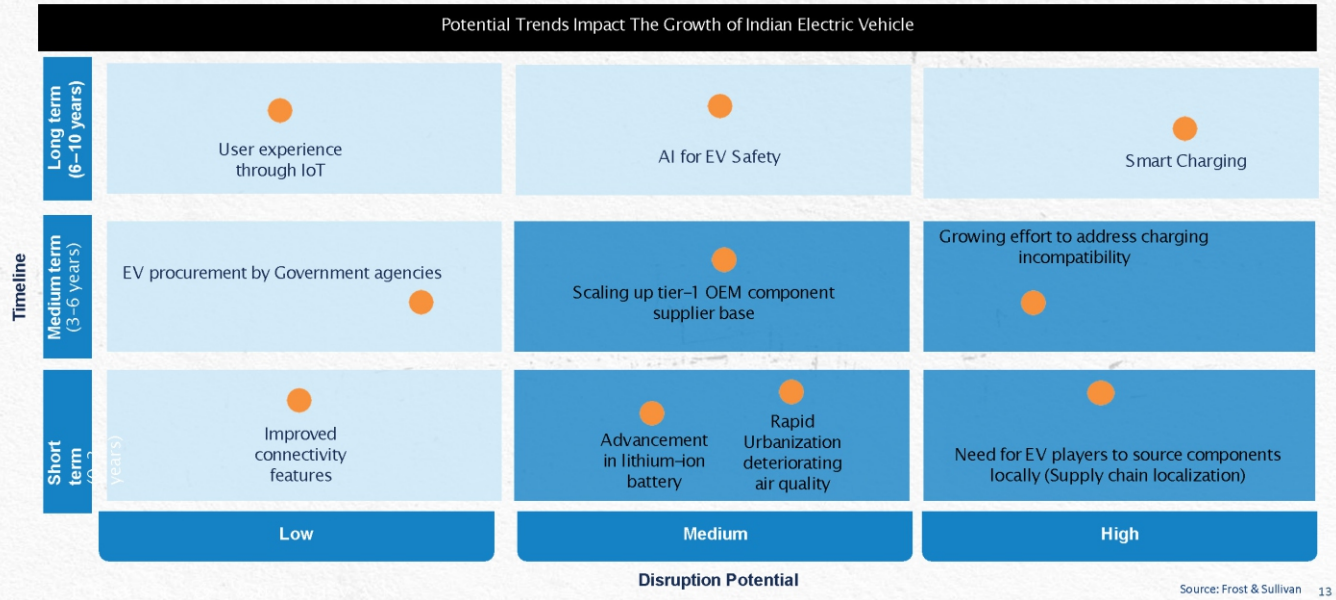
2025 — The Central Government is also working on a PLI scheme for components of EV batteries and may also bring in a PLI for niche battery technologies, reuse and recycling of batteries

2030 — The government aims to achieve significant market shares for electric vehicles by 2030. These targets include capturing 30% of private car sales, 70% of commercial vehicle sales, and 80% of two- and three-wheeler sales as electric vehicles

Source: NITI Aayog, Industry Journals, Articles, Frost & Sullivan

Potential Trends Impact The Growth of Indian Electric Vehicle Market (1/2)

Growth Opportunities In Indian Electric Vehicle Market: Potential Trends Impact The Growth of Indian Electric Vehicle Market, 2023



Source: Frost & Sullivan

Potential Trends Impact The Growth of Indian Electric Vehicle Market (2/2)

	Details	Implications
Growing efforts to address charging Incompatibility.	Bharat DC-001, Bharat AC-001, CCS, and CHAdeMO are the four charging standards that India has approved which makes the charging market incompatible and fragmented.	Focus on universal charging solutions e.g., Bolt. Earth Pro provides charging solutions for all types of vehicles.
Need for EV players to source components locally	The government of India's FAME scheme insists localization of component sources to at least 50% of the total components used in the vehicle.	EV players have to refund the subsidies to the government for non-adherence which will result in improved local production capacity in the future.
Rapid urbanizaion deteriorating air quality	Urbanization increases the need for vehicles to commute while at the same time increasing pollution.	Local state governments impose EV policies to cut down vehicular emissions and focus on public-private partnerships to develop charging infrastructure.
Scaling up tier-1 OEM component Supplier base	EV players to focus on scaling up their original equipment manufacturers (OEMs) to increase EV production.	Help EV players to mass produce at comparatively lower pricing than before which will help to achieve cost parity against ICE vehicles.
Advancement in lithium-ion battery	Apart from high-power lithium-ion batteries, developed technical expertise in advanced technologies such as sodium-ion and solid-state batteries e.g., GODI India.	Progress in battery technology and vehicle compatibility to advanced technologies to fast track the growth of EVs.

Source: Frost & Sullivan

Global Player Investment Plans

Global Players have announced EV plans for India to address domestic and export demand (exploring exports from India)

Tesla

- Tesla looking to make about half million EVs annually in India
- Tesla is also exploring the possibility of utilizing India as a manufacturing hub to export cars to nations in the Indo-Pacific region
- Tesla is currently in discussions with the Indian government regarding an investment proposal to establish a factory capable of producing approximately 500,000 electric vehicles on an annual basis

Stellantis

- Stellantis has plans to launch its first EV in India - an electric model of its Citroen C3 compact car by the end of 2023
- Stellantis is perceiving india as a low-cost manufacturing hub to produce electric vehicles export to Europe
- Stellantis plans are in feasibility study stage and decisions regarding investments would be taken post the study looking at viability

Renault-Nissan

- Renault has announced the investment of INR 53,000 million (~US$ 663 million) through its joint venture partner Nissan Motor to launch six new products, including two small electric cars in India by 2025



1 US$ = INR 80

Source: Company Websites, Industry Journals, Articles, Frost & Sullivan

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EV Parts Localization in India

100% Localization in India is not possible as India does not have certain rare earth materials required, Li-ion mining and electronics manufacturing in India is low

Electric Vehicle Parts Localization

Critical EV Component	Localization (FY'23)	Localization (FY'30)
Battery	~ 20% - 25%	~ 40% - 50%
Power and control wiring harness along with connectors	~ 15% - 35%	~ 60% - 70%
AC Charging Inlet – Type 2	~ 35% - 40%	~ 70% - 80%
DC – DC Convertor	~ 0% - 10%	~ 60% - 70%
Vehicle Control Unit	~ 0% - 5%	~ 20% - 30%
On-board Charger	~ 0% - 5%	~30% - 40%
MCB, Circuit Breakers, Electric Safety Device (Power Electronics)	~ 30% - 35%	~60% - 70%
Electric Compressor	~ 0% - 5%	~60% - 70%
DC Charging Inlet	~ 15% - 20%	~60% - 70%
Traction Motor & Controller	~ 0% - 10%	~50% - 60%

Source: Primary Interviews, Industry Journals, Articles, ACMA, Frost & Sullivan

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supply drivers: e4W OEMs made in India manufacturing and launch Roadmap (1/2)

Electric Vehicle Launch Roadmap, India, 2018-2025+

	2018	2019	2020	2021	2022	2023	2024	2025+
MARUTI SUZUKI/ TOYOTA								Wagon-R EV, EVX
TATA MOTORS		Tigor	Nexon	Tigor, Tiago (Extended Range)		Altroz EV	Punch EV	Sierra EV, Harrier EV, CURVV
HYUNDAI		Kona			Kona (Facelift)	Ioniq 5	e-SUV, e-Compact (Compact India Focus)	Creta EV, Ioniq 6&7, Compact EV
MAHINDRA	e2O, e-Verito				KUV 1OO, XUV 3OO		XUV.e8	XUV.e9, BE.05, BE.07, BE.09
MG MOTORS				ZS EV		ZS EV (Ext. Range FL)		EV - Hatchback

To jumpstart EV growth, e4W in India is key. OEMs are testing their models with EV drivetrain to cement their position by 2025.
Note: e4W- Electric 4-wheeler, OEM – Original equipment manufacturer, FL – Face Lift Legend:

Source: Company Websites, Industry Journals, Articles, Frost & Sullivan

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Supply drivers: e4W OEMs made in India manufacturing and launch Roadmap (2/2)

Electric Vehicle Launch Roadmap, India, 2018-2025+

	2018	2019	2020	2021	2022	2023	2024	2025+
Kia								MVP, Kia AY Compact SUV
Tesla								Model 3, Model S
BYD							Seal	
Renault Nissan								Small Electric Vehicles

To jumpstart EV growth, e4W in India is key. OEMs are testing their models with EV drivetrain to cement their position by 2025.
Note: e4W- Electric 4-wheeler, OEM – Original equipment manufacturer, FL – Face Lift Legend:

Source: Company Websites, Industry Journals, Articles, Frost & Sullivan

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OVERVIEW: EV Charging infrastructure

- For scaling up EV adoption, a clear understanding of the necessary EV charging infrastructure is required as One-size-fits-all approach will not be the way forward
- In case of 2W and 3W, battery configuration of fixed vs. detachable decides if the charging option will be through plug-in charging or battery swapping, respectively
- Although, battery swapping options are popular for e-2W and e-3W, setting up a charging facility for its own brand of vehicles is beneficial for a four-wheeled EV manufacturer

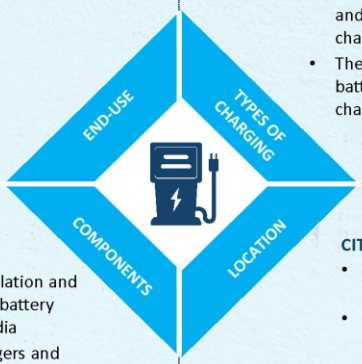
Based on requirement of various vehicle segments, EV charging infrastructure can be divided into 4 main categories/ segments

COMMERCIAL, PUBLIC, HOME

- The EV charging infrastructure in India, based on end-use, is split into Home Charging, Commercial Charging, and Public Charging

BATTERY SWAPPING, SLOW AC CHARGING, FAST DC CHARGING

- Basis the type of charging, is segmented into battery swapping and direct charging which is further segmented into AC/slow charging and DC/ fast charging
- The battery swapping option allows a vehicle's discharged battery or battery pack to be immediately swapped for a fully charged one, thereby eliminating the delay of battery charging



HARDWARE, SOFTWARE AND SERVICES

- Basis the type of component, is segmented into software & services, and hardware
- Software & services include platform as a service, installation and maintenance of charging units, and towing service and battery delivery service, which are in a very nascent stage in India
- Hardware includes charge points, connectors, and chargers and associated equipment. The charging technologies involved in setting up a charging infrastructure are rapidly evolving

CITIES, HIGHWAYS

- The EV charging infrastructure market in India, basis the location type, is segmented into cities and highways
- Majority of charging stations are however currently being deployed in cities with plans underway to install more charging points in major expressways and highways

Source: NITI Aayog, Industry Journals, Articles, Frost & Sullivan

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EV CHARGING INFRASTRUCTURE : Key DRIVERS

There has been continued and expanded policy interventions at state and central level to ensure deployment of charging Infrastructure in the last few years

STRONG GOVERNMENT PUSH

- Most significant step has been to treat EV charging as a "service". This allows anyone to set up and operate an EV charging station without requiring a license
- The states have introduced fiscal and non-fiscal incentives such as reduced tariff charges for the manufacture and operation of chargers
- In addition, treating 'EV Charging Station' as a separate category under Tariff Order by electricity regulators has been a step in the direction of promoting e-Mobility in the country
- GST rate on EV charger/charging stations was reduced from 18% to 5%

INDUSTRY INITIATIVES

- **Tie-up** with Fleet Operators, with Petrol pumps, with shop owners
- **Community charging stations** – increasing trend of setting up of EV charging stations known as community charging stations by hotels, businesses, or resorts which are at a distance of 40-70 km around cities to setup normal 15 Amp charge points for electric cars and electric bikes
- **Charging Plazas** - In order to boost the e-mobility ecosystem in India and availability of charging facilities at public places there has been an advent of charging plazas with India's first public charging plaza already inaugurated on July 20, 2020 at Chelmsford Club, New Delhi, by EESL
- The charging plaza is capable of charging 14 electric cars at the same time
- Technically, a plaza has more than one charger with different types of power output for servicing different kinds of automobile models

Source: NITI Aayog, Industry Journals, Articles, Frost & Sullivan

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EV CHARGING INFRASTRUCTURE: Key CHALLENGES (2/2)

India's infrastructural challenges are unique, and, hence, the best e-mobility practices identified in advanced international markets might not be effective or feasible to address India's problems; approach to tackle the challenges; solutions needs to be home-grown or tailor-made for Indian cities

CPO's (CHARING POINT OPERATORS)

- **Sub-optimal Utilization Rates**
  - Taking into account the current trend including the FAME II scheme and its benefits, the number of EVs on the roads are not expected to be exciting enough
  - High costs associated with rent/ land cost, equipment and its installation acts as the major challenge when the returns are not substantial owing to utilization rates being quite poor
- **Land Banks**
  - Land banks including parking spaces in right corners of the cities has been one of the bottlenecks that the government till now has failed to address
  - Even the state enterprises have been facing the issue of procurement of land even though they get the land for free of cost as per the government order
  - In addition, there have been no fixation of charges, leading to high rental costs. e.g., in certain cases, land lease alone is said to constitute more than 40% of the operational cost of a charging station
- **FAME II**
  - FAME II requires having at least 2 chargers of ~100kW each on every PCS which works fine in a state like Delhi that considers this much power under the low tension (LT) connection
  - However, in a state like Gujarat/Uttar Pradesh that considers limit of LT connection as ~50kW, the concerned CPO will have to go for high tension (HT) connection and in the process, install cables, transformers etc.
  - The price of latter is 2-3 times more than the subsidy it is getting. So, the whole effort goes in for a toss

Source: Company Websites, Industry Journals, Articles, Frost & Sullivan

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EV CHARGING INFRASTRUCTURE: Key CHALLENGES (1/2)

India's infrastructural challenges are unique, and, hence, the best e-mobility practices identified in advanced international markets might not be effective or feasible to address India's problems; approach to tackle the challenges; solutions needs to be home-grown or tailor-made for Indian cities

END-USER CHALLANGES

- **Range Anxiety** - For an EV user, range anxiety deals with the concern for the number of kms. an EV will run. Many EV users like to travel long distances on a single charge, which is not feasible with the current battery technology installed in electric vehicles
- **Time Anxiety** - Customers are keen to charge as quickly as they can refuel a petrol tank, which is not feasible with the current charging technologies especially with the slow charging technologies
- **Charge Anxiety** - Charge anxiety is about whether or not the EV will find a charging station in the first place. This is followed by the issue of trust. people in India often check the meter twice even before filling the tank; similarly, they have trust issues with electric charging stations such as whether the vehicle is getting charged or not and whether the charging station is working properly

PRIVATE FLEET OPERATORS

- Obtaining a reliable electricity connection for an EVSE installed at the EV charging station that is owned and operated by fleet operators is a concern
- The cab aggregators/fleet operators operating in multiple states find it difficult when different tariffs for EV charging are charged in different states with many states declaring EV as a separate tariff category

DISCOMS (ELECTRICITY DISTRIBUTION CO.S)

- Distribution network and frequent overloading of system components. The issue of increase in peak load of the service areas will require more investment in network up-gradation and procurement of power which will not be profitable for DISCOMs in the long run
- Unpredictable electricity demand, given the consumers charge their vehicles at various locations and for varying periods. This will impact the grid in terms of power quality
- Further mass adoption of EVs will lead to skewed nature of power demand which in turn will lead to issues including unforeseen peaks in power consumption

Source: Company Websites, Industry Journals, Articles, Frost & Sullivan

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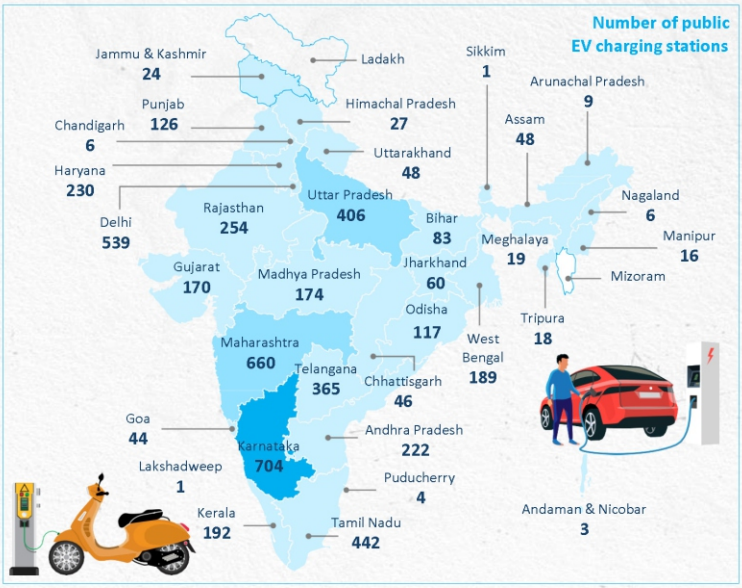
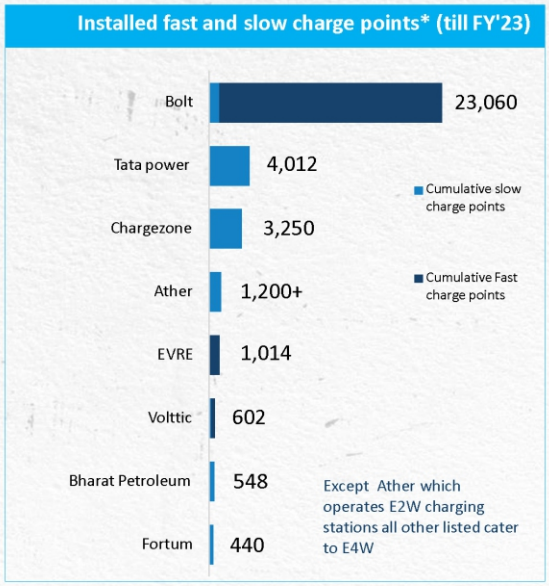
EV Charging Stations CURRENT STATUS

As of January 2023, India had 5,254 public electric vehicle (EV) charging stations





*A slow charger uses an AC power supply to charge the EV battery, whereas a fast charger uses DC power as input. Slow chargers charge slowly but are low-cost and good for the battery's long-term health

Source: NITI Aayog, Industry Journals, Articles, Frost & Sullivan

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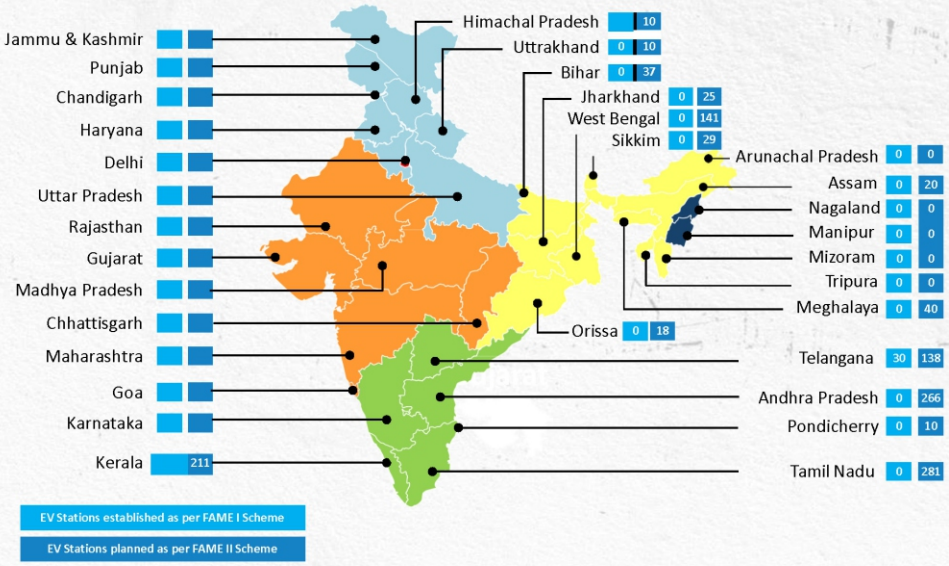
EV Charging (additional to existing) Stations established/ to be established under fame scheme

The country is flying high on the support extended by the government through FAME I and FAME II schemes as well as the interest shown by the private players



- Under FAME II India Scheme INR 10 Bn (INR 3 Bn for FY 2020-21; INR 4 Bn for FY 2021-22; INR 3 Bn for FY 2022-23) has been allocated for the establishment of charging infrastructure.
- Dedicated 241 charging stations for electric buses were sanctioned under the scheme

- Apart from the state EV charging stations, government plans to build EV charging stations on highways
- Initial plan for the following express ways
  - Delhi-Chandigarh : 16 EV charging points
  - Mumbai-Pune : 15 EV charging points
  - Jaipur-Delhi-Agra : 29 EV charging points

Source: NITI Aayog, Industry Journals, Articles, Frost & Sullivan

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Indian Electric Cars & the Type of Connectors in India:

Electric car	AC Connector (Slow Charging)	DC Connector (Fast Charging)
Audi e-tron SUV and Sportback	Type 2	CCS
BMW iX	Type 2	CCS
BYD E6	Type 2	CCS
Hyundai Kona Electric	Type 2	CCS
Jaguar I-Pace	Type 2	CCS
Lexus NZ	Type 2	CHAdeMO
Mahindra e2o	IEC60309	GB/T
Mahindra eVerito	Type 2	GB/T
Mercedes-Benz EQC	Type 2	CCS
MG ZS EV	Type 2	CCS
MINI Cooper SE	Type 2	CCS
Nissan LEAF	Type 2	CHAdeMO
Porsche Taycan	Type 2	CCS
Tata Nexon EV	Type 2	CCS
Tata Tigor EV (Old)	IEC60309	GB/T
Tata Tigor EV (New)	Type 2	GB/T
Tata Tigor EV Ziptron	Type 2	CCS

Notable partnerships in India – EV Charging

Tata Power has signed an agreement with Hindustan Petroleum Corporation Ltd (HPCL) to provide EV charging stations at HPCL's petrol pumps in various cities in India
Tata Power currently has a network of over 500 EV chargers in over 100 cities in India
Hindustan Petroleum currently has more than 18,000 retail outlets

Hitachi ABB Power Grids partnered with Ashok Leyland to install its Grid - eMotion Fleet EV charging system in India

Magenta Power has roped in state-owned Hindustan Petroleum Corporation Ltd (HPCL) to setup 500 electric vehicle (EV) chargers across India

Mahindra collaborated with Magenta, to deploy 100 units of its electric three-wheeler, Treo Zor, in Bengaluru for last-mile delivery of essential and non-essential items

Since 2019, MG Motor and Fortum have built a network of 11 DC chargers across Delhi-NCR, Mumbai, Pune, Hyderabad, Bengaluru, and Ahmedabad

Bharat Heavy Electricals Limited (BHEL) partners with Exicom to set up electric vehicle (EV) charger manufacturing facility and EV charging infrastructure for EVs

Rajasthan Electronics and Instruments Limited (REIL) has partnered wit Okaya Power recently for setting up 4,244 multi-standard EV charging stations across the country

Source: Company Websites, Industry Journals, Articles, Frost & Sullivan

Future Outlook

Parameter	Key Finding/Current	Future Outlook
Regional Leader	• South India leads the sales with close to half of the sales in the country at 45.16% as this region predominantly has the presence of OEMs and component suppliers these manufacturing hubs act as a central force for the growth of EV sales.	• Investment in EV infrastructure, growth of tech-savvy population in south Indian cities like Bengaluru, Telangana, and Chennai to continue to lead the EV sales in the next 7 years with more than 47% of sales contribution.
Market Competition	• Tata's first mover advantage in the EV space with its diverse portfolio from compact city cars to SUVs and strategic partnerships with domestic as well as international companies helped the OEM gain significantly leading market share in the country. These factors helped the OEM sell more than 55K vehicles in the year 2023.	• OEMs who are capable of leveraging the already existing benefits of platform technologies, offering a higher warranty on batteries, and taking maximum advantage of FAME subsidy at attractive price points to lead the Indian market in the coming years.
Subsidies and Incentives	• Despite offering free registration and road tax exemption by states like Telangana and Tamil Nadu, some states like Karnataka have decided to collect a lifetime tax of 10% on high-end cars and jeeps which will ultimately increase the overall price of the vehicle.	• The nature and extent of subsidies for electric vehicles may evolve over a period based on various factors such as budgetary considerations and policy priorities by the states. It is expected that incentivization may go down as the market and preference for EVs grow in the long term.
Technology Advancement	• Innovation in battery technology plays an important role in the Indian EV market. Advancements in lithium batteries have reduced the overall battery costs by 90% in the past 15 years, which in turn made EVs affordable for cost-conscious Indian consumers.	• Advancement in EV chargers and smart grids further boost consumer interest in the future and favorable government policies, comparatively better EV benefits when compared to ICE, and rising consumer demand will spur the Indian EV market.
Foreign Investments	• Global key player Tesla is presently in discussion for tax concessions amid the government's strict "Make in India" stance. The new EV policy gives import duty concessions to OEMs investing a minimum of $500 million in manufacturing units and allows import of up to 8,000 vehicles, costing $35,000 or more each, a year at a lower tax rate of 15%, compared to the 70-100% imposed on imported EVs before.	• Alterations in import duty concession will act in favor of OEMs like Tesla and the entry of the OEM is also expected to provide significant impetus to the overall electric vehicle market and help level the playing field but may challenge the market share of domestic players like Tata and Mahindra in the coming years



Digital Natives: Transforming Automotive-Tech and Mobility

by

Grant Thornton

Grant Thornton

#GTBharat SHAPING VIBRANT INDIA

Digital Natives: Transforming automotive-tech and mobility

Grant Thornton Bharat LLP

August 2024



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Introduction

The automotive industry is undergoing a profound transformation, driven by the rapid adoption of digital technologies. In this evolving landscape, traditional perceptions of vehicles are being redefined. Once viewed primarily as a means of transportation, today's vehicles have evolved into sophisticated gadgets equipped with sensors, communication systems, and artificial intelligence (AI) - enhancing safety, efficiency, and overall user experience. This shift fundamentally alters the automotive value chain, extending far beyond the traditional boundaries of vehicle manufacturers and dealerships.

The catalysts for this transformation are multifaceted, ranging from the need for increased safety features, better vehicle performance to the growing demand for electric vehicles (EVs) and more integrated, data-driven services. For mass-market original equipment manufacturer (OEMs), the emerging strategy is to aggressively pursue scale. This approach is likely to result in further consolidation within the sector, with newly formed entities potentially integrating backwards to secure key strategic suppliers. Additionally, OEMs are enhancing their margins by adopting digital manufacturing techniques, including 3-D printing and automation, increasing purchasing power, and diluting overhead costs. These strategic moves mirror the changes undertaken by hardware manufacturers in the mobile phone industry, where scale in low-margin areas has been essential to generating substantial profits. **The entry of digital natives into the automotive sector, combined with the strategic shifts of mass-market OEMs, has increased efficiency and fostered collaboration between traditional automakers and agile startups. This has given rise to a more interconnected and responsive automotive ecosystem, aligned with the evolving demands of modern consumers**.

Until the last few years, the primary source of value within the automotive ecosystem was rooted in vehicle hardware. However, as the industry undergoes significant transformation, there is a noticeable shift in how value is perceived and created. The below trends **are poised to drive and sustain value in the automotive sector:**

- **Electrification:** Drivetrains are expected to transition towards strong, hybrid-electric, electric, and hydrogen fuel-cell technologies, driven by a global focus on sustainability.
- **Autonomous Driving:** The operation of automated vehicles will advance from current driver-assistance systems to fully autonomous driving as technology matures.
- **Shared Mobility:** As the sharing economy grows and consumer preferences change, the traditional model of vehicle ownership will likely continue to evolve towards rentals and car sharing. Customers are expected to prioritise mobility over vehicle ownership.
- **Connectivity:** The potential for innovations in "infotainment," traffic services, and new business models is set to increase as cars become more connected to each other and the broader digital infrastructure. As people seek to integrate their digital lifestyles into the driving experience, features such as streaming services, voice assistants, and advanced navigation systems are becoming critical in influencing vehicle purchase decisions.

Driven by changing consumer preferences, emerging trends and significant value of the global automotive market, digital transformation has emerged a pivotal theme in today's automotive landscape. **The future of the automotive ecosystem is expected to be dominated by specialised players- both within hardware and software, with a focus on enhancing existing capabilities.**

Hardware	Drivetrain	Industrial design	Entertainment platform
Corner modules, advanced sensors Future scenario: Sub-assemblies get standardised, and players merge to benefit from scaling up.	Electric motors, power electronics, advanced batteries Future scenario: Players with competitive advantage scale up production, such as batteries for EVs, fuel cells, drive units for modular cars.	Modular bodies, advanced user interfaces Future scenario: Vehicle interiors and exteriors to remain a key differentiator, and importance of brand value rises in increasing commoditised sector.	Features & connectivity mirroring the home-entertainment experience. Future scenario: Multimedia ecosystems present attractive opportunity for third-party development

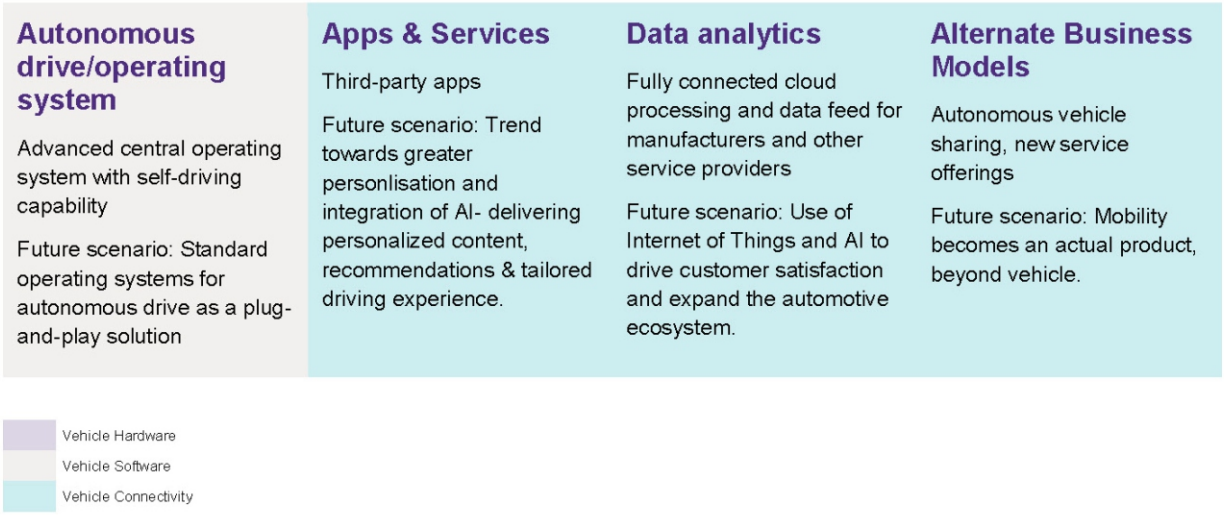


Figure 1: Car as a computer- Evolving automotive landscape

The integration of technology in vehicles has not only improved the driving experience but also redefined the way consumers interact with vehicles, from booking services on demand to accessing ride-hailing platforms. **At the forefront of this revolution are digital natives—startups that are disrupting the traditional automotive value chain by introducing innovative models** in areas, such as the secondary resale market, insurance, and car services. **These companies leverage cutting-edge technologies like AI, data analytics, and the Industrial Internet of Things (IIoT) to create new value propositions. Online platforms have transformed the used car market by offering transparency and convenience, while digital insurance providers are using real-time data to customise policies. Service aggregators are now able to predict and schedule maintenance, reducing downtime and enhancing vehicle longevity.**

Evolution of auto-tech

The Indian car industry has evolved significantly over the decades, reflecting broader technological advancements and changing consumer demands. From basic mechanical systems in the 1980s to the rapid advancements in hybrid and EV technology in the 2010s, the focus has shifted from fundamental features to sophisticated technologies. **Key trends include integrating advanced safety features, enhanced connectivity, and incorporating AI and machine learning (ML), driving the industry's growth and transformation today.**

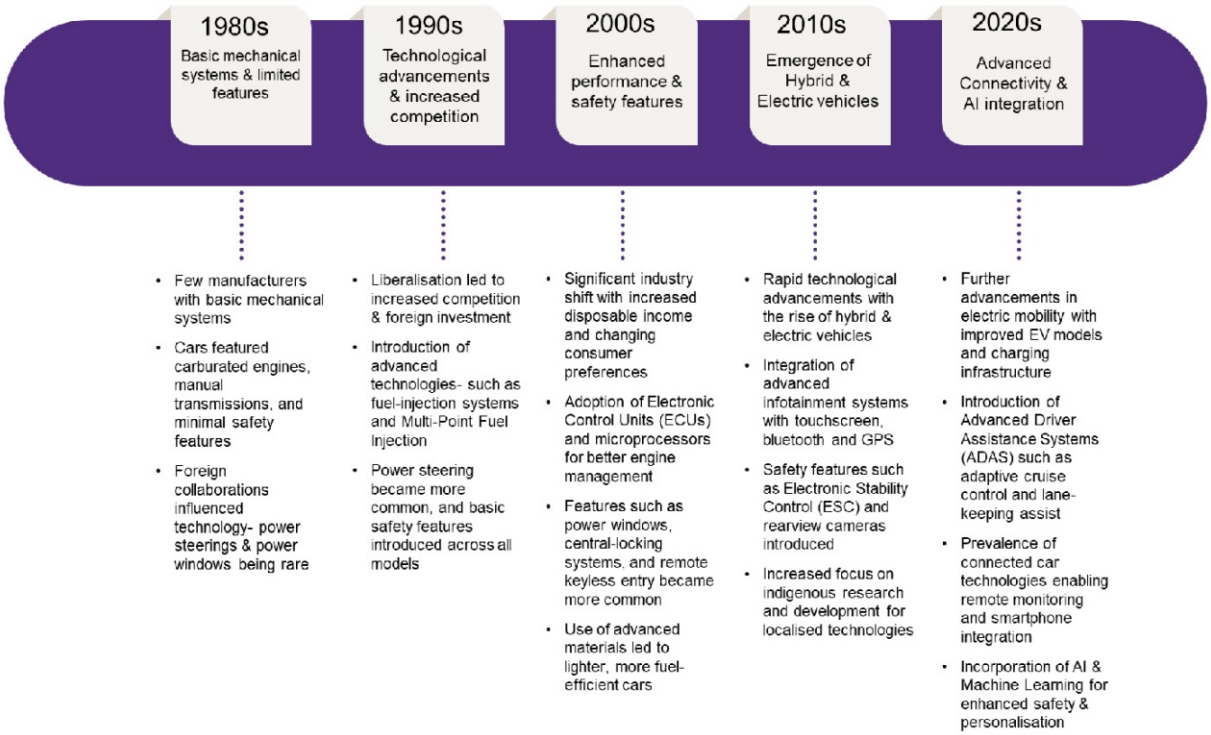


Figure 2: India's auto-tech story

This evolution of Indian automotive industry underscores the sector's deepening reliance on innovation. This journey parallels the trends observed in the Indian's startup ecosystem, including auto-tech. As India's automotive and startup ecosystems continue to converge through technology, this synergy is set to accelerate the development of next-gen mobility solutions, fuelling sustained growth and innovation in both sectors.

The momentum in India's tech industry, which continues to demonstrate remarkable resilience and growth, is set to further accelerate the auto-tech sector. The tech sector's focus on emerging technologies, like AI, cloud computing, and the industrial metaverse, offers significant opportunities for auto-tech to drive innovation and reshape the automotive landscape.

Trends driving the technology sector

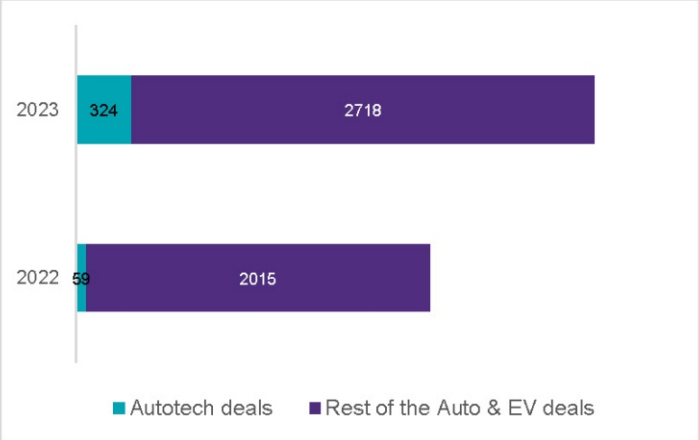
- India's tech sector is on robust growth trajectory, backed by USD 227 billion in revenues in FY22 and poised to grow to USD 350 billion by 2025.[1]
- India is now the third largest start-up ecosystem globally. It is also witnessing the steady rise of software-as-a-service (SaaS) companies based out of India, the massive increase in global capability centres (GCCs), a focus on deep-tech and several emerging technologies, including AI, robotics, space-tech and fin-tech.

[1] GT Bharat Tech Trends report

- The industry continues to be a pivotal talent and employment generator, with over 5 million direct employees, over 1.8 million women employees, and is ranked first globally for AI talent concentration. [2]
- **With millions of citizens having internet access, a strong foundation of digital infrastructure, and enhanced digital access provided by the Digital India Programme, India is one of the countries with the quickest pace of digital adoption. This is driven by- government initiatives, commercial innovation and investment and new digital applications creating significant economic value and empowering citizens.**
- Centres of excellence are being established to promote expertise in emerging fields such as quantum computing, AI, and IoT, revolutionising industries (such as auto-tech) enabling advanced data analytics, automation predictive modeling, and optimisation.
- With the increased bandwidth and reduced latency provided by 5G networks, IoT devices will be able to transmit data in real time, enabling instant decision-making and automation. This will lead to improved efficiency, cost savings, and enhanced user experiences. To harness this potential, India has proposed the establishment of 100 5G labs, highlighting the nation's commitment to driving digital innovation through cutting-edge technology.[3]

Auto-tech is leveraging these technological advancements, driving innovation in connected vehicles, autonomous driving, and electric mobility.

The tech sector's focus on emerging technologies, such as AI, cloud computing, and the industrial metaverse, offers significant opportunities for driving innovation and reshaping the automotive landscape.



Total automotive deal values in India:

- 2022: USD 2,074 million
- 2023: USD 3,042 million

Share of Auto-tech deals within the overall Automotive Deal Values in India:

- 2022: 3%
- 2023: 11%

Figure 3: Breakup of Automotive & Auto-tech Deals (USD Mn)

Source: GT Analysis

Overall, auto-tech deal values in India increased by 4X in 2023, vis-à-vis 2022, marking enhanced investments in the space. Additionally, the deal values for auto-tech (within the total automotive deal values) grew from 3% to 11% from 2022 to 2023, signalling increasing investor interest in the evolving auto-tech business models. Till July 2024, auto-tech deals make up for ~USD 14 million. Overall, the automotive deal space is gradually aligning with the evolving trends and advancements within the industry.

Global Capability Centres (GCCs) contributing to the automotive ecosystem in India

India has established its dominance in the GCC ecosystem, with over 1500 GCCs employing over 1.6 million individuals. Over 125 of the Fortune 500 companies have chosen India as their preferred GCC destination, with around 70% originating from the US and Canada. With Asia-Pacific corporations increasingly looking at India for setting up GCCs, significant diversification in the geographical makeup of GCCs in India are expected.[4]

GCCs have evolved from a cost arbitrage to a value arbitrage centres in India. Initially established as cost arbitrage entities for their headquarters, these centres are now pivotal in driving innovation, expanding their roles from a full spectrum of

[2] GT Bharat Tech Trends report
[3] GT Bharat tech trends report
[4] Press release

capabilities and offering end-to-end solutions. Automotive businesses are increasingly looking at India for engineering R&D, IT and Business Process Management (BPM). India's scale and capabilities allow automotive GCCs to be multifunctional and advance in areas such as Alternative fuel technology (electric and hydrogen powered vehicles) and connected technologies, Advanced Driver Assistance Systems (ADAS) systems. Other allied areas include AI, machine learning, advanced analytics, cybersecurity, among others which are currently the focus areas for GCCs in India.

As of 2023, there are ~60 automotive GCCs in India, employing over 1 lakh individuals.[5]

Auto-tech GCCs currently make up for 19% of the overall automotive GCCs in India and largely focus on in-vehicle automation, vehicle telematics and V2X.

Lately, automotive GCCs are fuelling growth for mid-cap engineering, research and development (E&RD) services companies, while the large IT companies servicing the OEMs are adopting a cautionary outlook towards the industry as the industries priorities are revamping, which could lead to re-allocation of spending and spending priorities. Overall, the deals landscape looks ripe for the mid-market E&RD companies largely servicing auto-tech clients.

[5] Press Release

Trends shaping the advanced mobility ecosystem

The dynamics of vehicle purchase behaviour and customer perceptions are changing. There are new trends, different expectations shift to digital purchases, increasing demand for used vehicles, premiumisation and preference for easy financing options. **Automakers, supported by auto-tech players are adapting their marketing strategies and product positioning to cater to the evolving market trends and needs of the Indian consumer.**

Growing popularity of ride-hailing services

The introduction of ride-hailing applications has brought a paradigm shift, offering convenience, affordability and personalised experience. As technology evolved, ride hailing is becoming more efficient and user friendly. **The industry leveraged AI and ML for predictive analytics, dynamic pricing, and route optimisation, enhancing efficiency and user satisfaction.**

The IoT further enhances the experience by connecting vehicles for real-time data exchange, improving fleet management and passenger comfort. Big data analytics offer insights into customer behaviour and operational performance, allowing for personalised services and improved decision-making. ADAS are improving safety, while mobile technology ensures seamless booking and payment processes. The ongoing evolution in these technologies underscores the growing popularity and transformative impact of ride-hailing services in modern transportation. Blockchain technology is also emerging, providing secure, transparent transaction records and enabling decentralised ride-hailing platforms.

Autonomous vehicles represent the next frontier, promising increased safety and operational efficiency, though challenges remain in regulation and public acceptance.

Network mapping and value creation for Uber using AI: Uber connects primarily with riders and drivers, but it also links to other networks through services like Uber Eats for food delivery and Uber Health for patient transportation. Launched in March 2018, Uber Health allows healthcare facilities to book rides for patients, expanding Uber's value beyond its core ride-sharing service. Uber's intrinsic value offers a myriad of bridging opportunities, shown below:

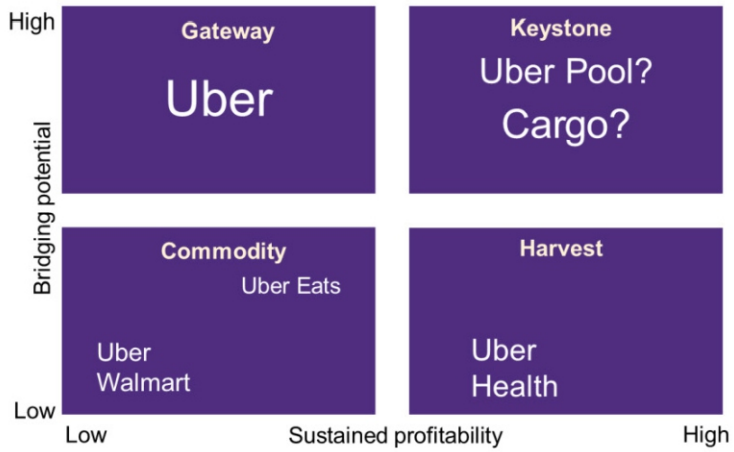


Figure 4: Mapping Uber's value creation opportunities

Source: Competing in the Age of AI, Marco Iansiti & Karim R. Lakhani

The figure highlights that Uber's core service presents an opportunity to enable additional value creation and value capture as the generated data clusters act as a gateway to additional networks and allied business models. One of the bridging opportunities is connecting the driver network with other business networks. Grocery delivery, Uber Eats and Uber Health are all examples of this class of network bridging opportunities. The idea is to foster more enduring, global connections to differentiate Uber from other providers who are fiercely competitive on a local level due to network clustering. Grocery deals are quite competitive because alternatives exist, leading to suspension of Uber's trial with Walmart. Again, Uber Eats suffers massive competition due to local clustering challenges.

Other interesting opportunities include UberPool and Cargo Systems. With UberPool at scale, a local competitor is much less likely to provide a similar service. Cargo connects the rider network with a variety of retail opportunities by offering a convenient way to sell products to riders while they are a captive audience in a ride-sharing vehicle.

Rise of autonomous taxis and Apollo Go's impact: In China, autonomous taxis are rapidly advancing, with Apollo Go exemplifying this shift. Operating in Wuhan, Apollo Go offers a fleet of 500 self-driving vehicles, providing rides at significantly lower costs compared to traditional taxis. This affordable service started in 2022 and is part of a broader trend towards integrating autonomous vehicles into urban transport. The company's plans to expand its fleet to 1,000 by 2024 highlight its growing impact. The base fares for this service start at just 4 *yuan* (USD 0.56), significantly lower than 18 *yuan* (USD 2.51) for a traditional taxi. Wuhan, which currently has 17,000 conventional taxis is witnessing a rapid shift in its transport landscape.[6]

Despite the promise of lower fares and improved convenience, the rise of autonomous taxis has sparked debates about job losses and economic implications. The low pricing of Apollo Go, supported by government subsidies, is intended to encourage widespread adoption, though it has led to concerns over potential negative effects on traditional taxi services.

Globally, while autonomous taxi trials are ongoing in the US and UAE, China stands out with its proactive regulatory approach, granting commercial licenses and encouraging pilot programmes.

Subscription model gaining traction

A subscription is a method of owning a vehicle by paying a fixed monthly amount without having to pay down payments or monthly equal monthly instalments (EMIs), car maintenance, or insurance. Car subscription services have seen rapid growth, fueled by changing consumer attitudes and a desire for more adaptable vehicle usage. Unlike traditional ownership or leasing, car subscriptions offer a versatile alternative, allowing users to access a range of vehicles without long-term commitments or substantial down payments.

The global car subscription market experiences a surge, indicative of growing preference, particularly among younger consumers, for on-demand mobility over fixed ownership. Benefits of car subscriptions include cost savings through bundled insurance and maintenance, the ability to easily switch vehicles, and the flexibility to "test drive" various models before making a purchase decision. In a time marked by economic uncertainty and rising costs, car subscriptions provide a practical solution that aligns with contemporary lifestyle needs, underscoring a shift from ownership to access in the automotive sector.

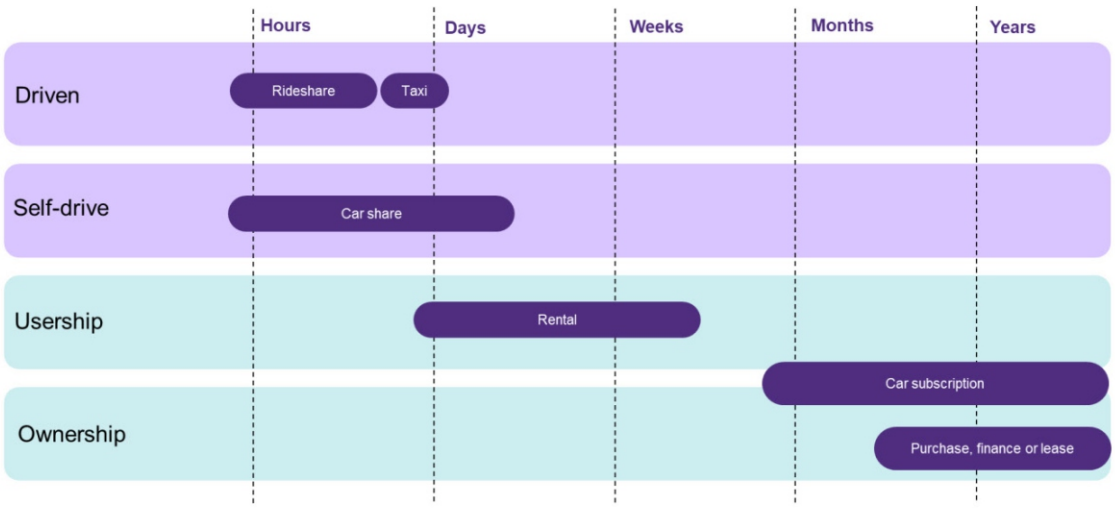


Figure 5: Car subscription bridging the gap between car rental and ownership

The car subscription model is rapidly expanding across various geographies, driven by increasing consumer demand for flexibility and convenience. North America is currently the largest market and is fuelled by the growing need for intelligent mobility solutions and environmental concerns, leading to significant investments in innovative urban mobility and fleet management. Europe is one of the fastest growing markets globally, largely attributed to its advanced car subscription services and the rise of shared mobility platforms, with many companies focusing on sophisticated digital solutions to capture long-term market potential. In the Asia-Pacific region, particularly in India and China, the market is expected to experience the

[6] Press release

highest growth rate due to the rising adoption of intelligent mobility solutions and the expanding subscription economy. The growing preference for shared mobility and urbanisation in countries like India underscores a shift towards more flexible transportation options, reflecting a broader global trend towards car subscription services.

- Indian automakers such as Maruti Suzuki India, Tata Motors Ltd. and Mahindra & Mahindra have introduced subscription models for their vehicle offerings.[7] This segment caters to a niche audience, especially young consumers seeking asset-light ownership.
- Maruti Suzuki subscribe has crossed a milestone of 10,000 new care subscription sales till March 2024 since its inception in July 2020.[8]
- **Finn drives expansion as car subscription market gains traction:** Finn, a Munich-based startup specialising in new car subscriptions, secured 100 million euros (~ USD111 million) in Series C funding (in Jan 2024), raising its valuation to 600 million euros (~ USD664 million)[9]. Led by Planet First Partners, with a strong focus on sustainability, this investment will support Finn's expansion in EVs and the development of cloud-based tools for service management.
- Finn's strategy of offering new cars on 12-month subscriptions, combined with bulk purchasing directly from OEMs and pre-arranged resale agreements with retailers, has led to annualised recurring revenues of 160 million euros (~ USD176 million). While Finn is not yet profitable overall, the core product has achieved profitability, indicating a sustainable business model. This approach contrasts with other car subscription ventures' struggles, where companies like Fair.com and Onto have highlighted the market's challenges. **Finn's deliberate and data-driven approach is positioning it to navigate and capitalise on the evolving car subscription landscape, which continues to grow as consumer preferences shift towards flexibility and sustainability.**

In the short to medium term, consumers looking for shared mobility alternatives are likely to be drawn to the vehicle subscription model. The consumers would better adopt the model with regulatory clarity around registration policies, accident accountability and insurance claims.



Figure 6: Reasons for preference towards subscription model

Buying experience shifting from physical to *phygital*

Traditionally, vehicles were sold primarily through physical dealerships. However, with the COVID-19 outbreak, a growing preference for contactless digital transactions has emerged as a prominent trend that is projected to spill over into vehicle purchases.

There are two opposite ends within the automotive GTM spectrum: traditional, dealer-led and largely offline model, and a new-age direct-to-consumer (D2C), largely online model. While both have their pros and cons, they are now seemingly converging mid-way into a 'hybrid D2C' model. OEMs looking to redefine customer engagement digitally, are expected to garner a higher share of Customer Lifetime Value, owing to sustained interaction with the customers through multiple channels.

Customers are now showing interest towards digital channels due to seamless service offerings, including hassle free registration certificate transfer, car checks, security checks and payments. Both, new and used passenger car buyers prefer to do their research and discovery on online platforms since they are easily accessible from the convenience of their home or office. The online-buying trend has been witnessed more in used vehicles segment with the emergence of online used vehicles players.

Digital revolution is disrupting auto retailing, making players gradually shift towards online channel to capitalise on the digital wave to drive sales and growth. Over the past few years, multiple passenger car brands have introduced online sales platforms, which offer customers the chance to purchase their preferred vehicles from the comfort of their homes. OEMs, such

[7] Press release
[8] Press release
[9] Press release

as Maruti Suzuki, Hyundai, Honda, Kia, Toyota, Tata Motors, Mahindra & Mahindra and Mercedes-Benz have taken to digitalisation.

By leveraging the latest technology and data solutions with digital interventions, the automobile manufacturers aim to improve the customer experience with the shift from physical to digital. Some of the recent examples include:

- **Honda Cars** launched their virtual showroom which allows customers to interact with the digital version of a car by clicking on various parts.[10]
- **MG Motors** launched the MG eXpert, a platform for customers to experiences the brand's models using AR and AI, delivering the showroom experience to customers from their homes[11]
- **Audi India** introduced AR and VR at their showroom in Gurgaon, that lets the customer experience the look and feel of the car being configured. They are able to view their customizable car before it is configured.[12]
- **Mercedez-Benz India** launched the 'Retail of the Future' (ROTF) channel in 2021, inspired by digital revolution in the segment. By offering a D2C model, the company enables consumers to purchase luxury vehicles directly from the brand, bypassing the traditional dealership model. Within the first 18 months, the company sold over 25,000 cars through the ROTF channel. Beyond India, this model has been replicated in Germany and the UK, signalling its global relevance.

Further, OEMs are realising that the audience visiting online auto portals are maybe more serious buyers and sellers of vehicles and are increasingly shifting digital advertising spend on auto-focused platforms from traditional social media.

Digital channels of sales have changed how dealer, manufacturers and even aftermarket ancillaries market their products online. Some automobile companies have made considerable progress in adopting omni-channel customer engagement solutions.

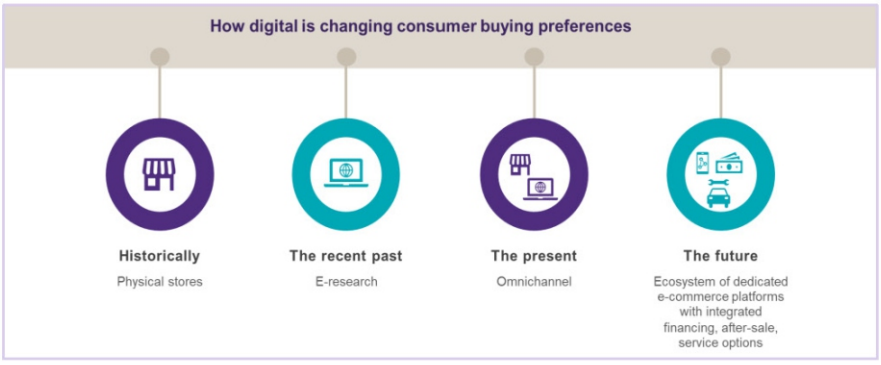


Figure 7: Evolving consumer preferences amidst digital transformation

Transforming sales with immersive Extended Reality (XR) solutions- The Metadome.ai approach: Metadome.ai, founded in 2016, specialises in enhancing sales through virtual reality (VR) and augmented reality (AR) technologies. The company's XR platform offers immersive experiences that significantly boost customer engagement, leading to higher conversions and increased revenue for its clients. Serving major corporations like Hewlett Packard, Tata Motors, Hero MotoCorp, and Asian Paints, Metadome.ai's solutions enable enterprises to quickly implement advanced customer interaction tools. The company's business model revolves around leveraging cutting-edge VR and AR technologies to transform traditional sales processes, making them more interactive and effective in driving business outcomes.

The auto players are deploying AI, AR and VR to improve user experience by offering the entire vehicle demo, and help customers feel more confident when buying a high-involvement item online. Interactive technologies - chat box, virtual test drives, 360-degree views of the interior, exterior walkarounds and video calls help in solving customer doubts and assists them in decision-making.

Increasing affinity towards used vehicles

The Indian used car market is on a robust growth trajectory, fuelled by several factors, including an increasing preference for individual mobility, the availability of more financing options, and the lingering effects of the COVID-19

10 "Use of virtual and augmented reality for new vehicle sales is here to stay: Avataar", Financial Express, September 2020

11 "MG launches AR-powered MG eXpert digital platform", AutoCar India, February 2022

12 Audi website, August 2019

pandemic, which has heightened demand for cost-effective alternatives to new cars. The increasing penetration of online platforms in the used passenger car market has allowed dealers to reach a wider audience. Pure classifieds and discovery-based platforms dominated the used automobile market for the longest time. The market is now, however, moving towards transaction-based models, which provide significant added value for both dealers and end-users, as well as a stronger monetisation path for the platform. The trend is evident in the way even the classifieds and discovery-based platforms have launched transaction-based product offerings.

With the emergence of an organised sector in the used passenger car market, the demand for used passenger cars has witnessed a rise, owing to the improved quality standards for buying and selling used passenger cars. There is increasing demand for pre-owned cars in Tier 2 and Tier 3 cities, largely on the back of growth of organised players offering reliable products and services.

Reduced first ownership period of vehicles by customers is also responsible for the rise of the used vehicle industry. Another key growth driver of the used vehicle market is the increasing financial penetration. While the finance penetration is more than 75% in new passenger vehicle market, it is around 20-21% in used vehicles, highlighting scope for growth, which is already estimated to go up to 35% by 2025.[13]

However, the market faces challenges, including high financing costs and a lack of standardisation, with only 17% of the market being organised. Nevertheless, the increasing demand for luxury used cars, driven by consumer preference for high-end vehicles and better financing options, is expected to play a pivotal role in market growth.

With the entry of start-ups, such as Droom, Cars24, Car Dekho, Spinny, Car Trade, etc. in India, the pre-owned vehicle market received a fillip. The companies have brought a clear disruption in India's used vehicle market; however, they face a policy vacuum. The new-age start-ups having online presence as well as offline outlets across India are able to increase their customer base, not only in metro cities but also in Tier 2, Tier 3 and Tier 4 cities.

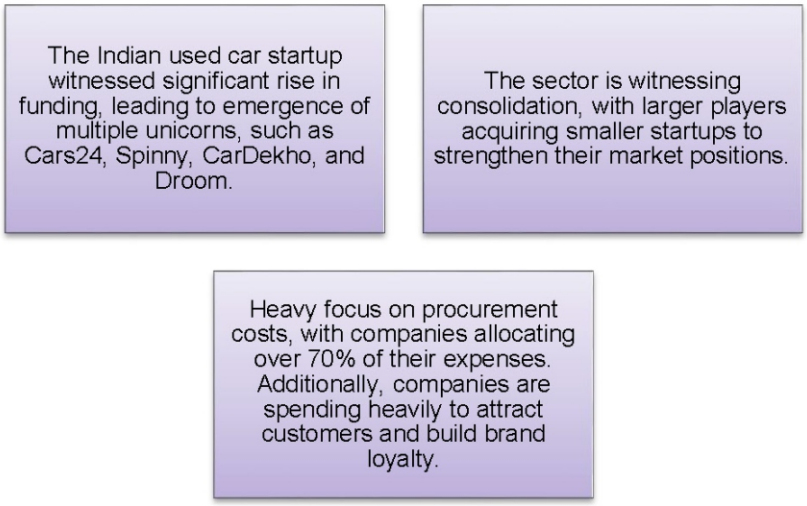


Figure 8: Indian used-car startup landscape

Growing awareness for connected and safer cars

A connected car can communicate with other vehicles or systems through a single device. Consumers can access internet and share data with other devices, both inside and outside the connected vehicle. In India, connected car technology has grown exponentially fuelled by rising disposable income and influx of new models. These cars, with embedded chips, allow internet access and enable drivers to transmit, store and receive information via sensors and currently make up for 30% of new vehicles sold, up from 6% in FY21.

Connectivity is primarily limited to smart phones and in-car infotainment systems. However, customer preference for connected software solutions in passenger vehicles is expected to grow significantly in the coming years and vehicle manufacturers are aligning their strategies to capitalise on this evolution in the automotive ecosystem. India is set to experience the fastest growth in connected car sales between 2023 and 2030 as domestic automakers are gradually catching up with their international counterparts and enhancing their digital offerings to improve the driving experience.

[13] Pres9s release

In the medium to long run, the connected cars would further be redefined as 'Car-As-A-Platform' or CAAP. CAAP introduces software as an enabler with a slew of service partners in the vehicle. SIM connectivity and IoT solutions allow car owners to gain real-time access to connectivity, infotainment, and telematics. It creates digital ecosystems in which suppliers can connect directly with end users, potentially opening up a plethora of new revenue streams in the future.

In terms of technologies, AI, blockchain, 5G, IoT and vehicle data will be key drivers, enabling more customised services that customers value, as well as cybersecurity, which will determine customer acceptance.

Future outlook of CAAP

In-car payments and e-wallets The e-wallet, a digital payment assistant within the vehicle that can automatically make transactions without driver intervention, is an important use case in the connected vehicle context. These could be parking fees, battery charges or tolls, for example.	**Entertainment** Next-generation digital services, such as high-quality music and video streaming, in-car gamification and in-car karaoke will significantly expand the opportunities for in-car experiences.	**Convenient refuelling at fuel stations** Fuel stations (petrol pumps or charging stations) can collaborate with OEMs to provide a more convenient and faster auto payment experience at the pump.
Integrated long route travel planning Service providers can collaborate with navigation and map partners to provide access to verified hotels enroute, nearby medical aids, restaurants/food options of choice and so on, with advanced booking options available in the car itself.	**V-commerce** Customers are already making use of voice-activated care assistants. Customers can use these assistants to make purchases through the dashboard or through phone apps. Integration of such apps may pave the way for voice commerce.	**Automated car repair notifications and suggestions** Smart notifications alert drivers when a service is due, or a repair is imminent. Taking it a step further, smart cars can analyse a specific problem and allow drivers to compare repair costs before deciding on a service location. They can also suggest nearby service stations and compare service charges and costs using geofencing. Add in automated payments, and the driver's experience becomes even more streamlined.

Figure 9: Future outlook of car-as-a-platform (CAAP)

In terms of consumer preferences, technology and innovation are at the forefront of the connected car space in India's automobile industry. The future trend is toward digital transformation, with vehicles becoming an ecosystem of on-demand, in-car services rather than just mobility solutions.

This, in turn, has encouraged automakers to improve their safety features. The government's continuous push for safer mobility and increased awareness about road safety among consumers has made way for cars in India to come equipped with key features such as multiple airbags, ABS, EBD and ESC as a standard in a majority of mass-market cars. Furthermore, with ADAS enhancing car features with functionalities, such as Adaptive Cruise Control (ACC), lane-keep assistance (LKA) are aimed to improving vehicle safety and reducing driver fatigue.

Tesla's disruptive business model- Pioneering connected cars and innovation: Tesla's business model is centred around its mission to accelerate the global transition to sustainable energy. The company achieves this through the integration of EVs, energy generation, and storage solutions. **Tesla's approach is characterised by vertical integration, where it controls its supply chain, manufacturing, and sales channels. This strategy allows the company to maintain quality, reduce costs, and innovate rapidly.**

A significant part of Tesla's revenue comes from the sale of EVs. Additionally, Tesla has also diversified its revenue streams by offering energy products such as solar panels and Powerwall battery packs, which allow consumers to generate and store renewable energy. Additionally, Tesla generates income through software updates, autopilot subscriptions, and services like maintenance and repairs.

Innovation is at the core of Tesla's business model, driving advancements in battery technology, autonomous driving, and energy solutions. This focus on innovation has helped Tesla establish itself as a leader in the EV market.

Looking forward, Tesla aims to expand into new areas, such as autonomous ride-hailing services, and continues to influence the broader automotive industry by pushing the shift towards electric and sustainable transportation.

Evolving Trends in India's Two-Wheeler Market

- **Electric two-wheeler sales and ownership models:** Annual EV sales crossed 1.7 million vehicles in FY24, with two-wheelers accounting for more than 55% of the share[14]. While outright purchases dominate, consumer preferences are shifting towards financing, leasing, and pay-per-use models. Banks, NBFCs, and fintech startups are offering low-interest financing options, and EV leasing is emerging as an affordable alternative to ownership.
- **Consumer preferences in two-wheeler EVs:** Indian consumers are increasingly opting for premium features in electric two-wheelers, such as higher speeds and longer ranges. Most consumers purchase two-wheelers with a top speed of 80 kmph, but many are willing to pay for upgrades to higher speeds and extended battery ranges. This preference for enhanced functionality is driving the evolution of two-wheeler EVs, making them a significant part of India's mobility ecosystem.
- **Virtual reality in luxury motorcycles:** VR is revolutionising the luxury motorcycle market by offering immersive showroom experiences. Customers can explore every detail of a motorcycle, customise it, and even take virtual test rides on diverse terrains. This technology enhances rider engagement, aids in informed purchase decisions, and extends the global reach of luxury brands. The future of VR in motorcycles includes advancements in haptic technology and multi-sensory integration, promising even more realistic and engaging experiences.

Rise of telematics in India

Telematics adoption in India, initiated in 2004, has primarily been driven by OEMs, with a strong focus on commercial vehicles (CVs), which account for 66% of the market. The benefits of telematics for fleet operators and logistics players are significant, particularly in enhancing productivity. Indian telematics manufacturers have tackled unique challenges, such as sporadic network availability, by implementing features, such as automatic switching on eSIMs. Looking ahead, telematics use cases are expected to shift towards improving road safety, especially considering the high incidence of fatalities involving over-speeding trucks. The adoption of driver behaviour and vehicle health monitoring solutions could play a crucial role in enhancing safety on Indian roads.

In 2012, the focus on passenger safety in public transport led to the AIS-140 mandate in 2016, which was later extended to various types of goods vehicles. Over 2 million AIS-140 compliant devices have since been installed, with major CV OEMs like Ashok Leyland and Tata Motors achieving 100% factory fitment. The successful implementation of an Intelligent Transport System (ITS) through AIS-140 could lead to greater visibility of public transportation and potentially expand the standard to include features like CCTV and automatic emergency connections. The introduction of e-Call systems, which have reduced emergency response times in the EU and Russia, could further enhance post-crash outcomes in India.

While telematics in the passenger vehicle segment remains small, with a market value of INR 106 crore, it is expected to grow, driven by the rising adoption of EVs and consumer demand for connectivity. The integration of ADAS and personalised telematics features could significantly improve driving behaviour. OEMs are beginning to see the value in telematics data for reducing vehicle ownership costs through remote diagnostics and maintenance. This could lead to broader ecosystem benefits, similar to those seen in advanced markets. For example, Usage-Based Insurance (UBI) in the UK has shown how telematics data can incentivise safer driving, while route optimisation can identify and mitigate dangerous road conditions, ultimately supporting the development of smart infrastructure like Vehicle-to-Infrastructure (V2I) communications.

However, the telematics ecosystem in India faces challenges that require regulatory intervention. The current AIS-140 regulation, while comprehensive, needs better implementation across states to achieve the Ministry of Ministry of Road Transport & Highways' safety goals. Additionally, the increasing integration of electronics in vehicles calls for stronger cybersecurity measures to protect against data breaches and vehicle thefts. Strengthening regulations around components and telecommunication modules is essential to address existing gaps and prepare for future advancements in the telematics ecosystem. The technological evolution of telematics in India has been in line with telematics journey of other countries with five distinct phases, all of which are characterised by ongoing improvement.

[14] VAHAN Dashboard

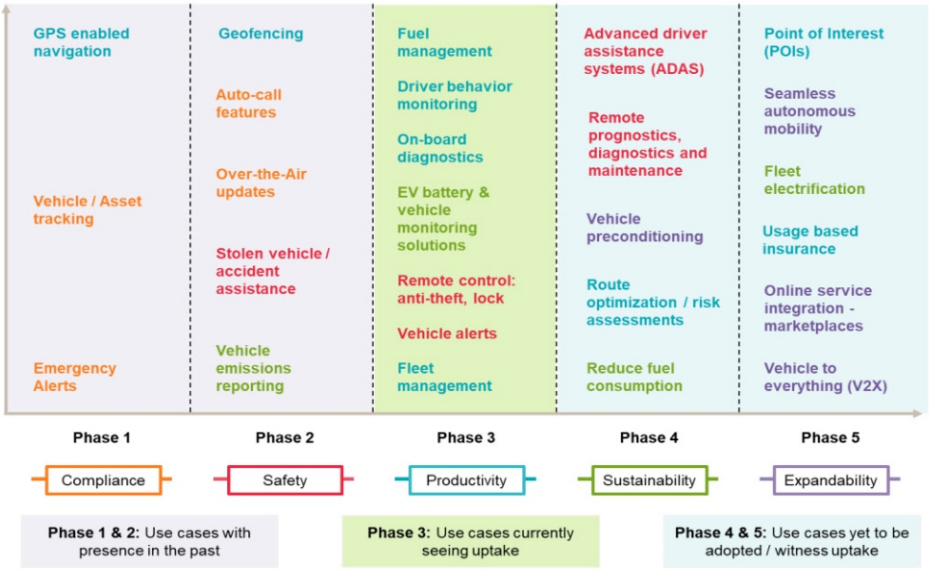


Figure 10: Technological evolution of solutions and their use-cases in India

Note: The above list is not exhaustive, there are other telematics applications across the five phases and use-case buckets.

Opportunities in auto-tech

With these business models within auto-tech, there are multiple opportunities to scale further, some of which are highlighted below:

Trends in auto-tech	Current advancements include:	Opportunity to scale:
Growing popularity of ride-hailing services	AI, ML, Data & Analytics, IoT	Autonomous Vehicles
Subscription model gaining traction	AI, Telematics, IoT	Advancements in EVs, Connected Cars
Buying experience shifting from physical to phygital	AI, AR, VR	Immersive Technology, highly personalised experience
Increasing affinity towards used vehicles	IoT and Blockchain- to enable NBFCs to enhance effectiveness of underwriting process	AI driven customer experience, focus on consolidation of organised players
Growing awareness for connected and safer cars	AI, Blockchain, 5G Connectivity, Internet of Things (IoT), In-Vehicle connectivity, Battery Management System (BMS)	Autonomous Vehicles, V2X communication, enhanced AI & ML algorithm, energy solutions integration
Immersive online purchase environment for two-wheelers- connectedness in two wheeler segment	5G Vehicle connectivity, GPS, Battery Management Systems	Enhanced battery technology, Deep IoT integration – communication with other vehicles and infrastructure
Rise of telematics in India	Fuel management, fleet management, EV Battery & vehicle monitoring, vehicle alerts, remote control: anti-theft, lock	ADAS, reduced fuel consumption, usage-based insurance, online service integration, V2X

Figure 11: Opportunities to scale

Auto-tech presents multiple opportunities for growth and innovation. Few key areas where significant potential lies are highlighted below:

1. **Autonomous vehicles:** Autonomous vehicles represent a significant leap forward in the evolution of transportation. Currently, most vehicles on the road are equipped with basic ADAS, such as Level 1 (driver assistance) and Level 2 (partial driving automation). However, the industry is poised for major advancements in autonomous driving capabilities with the introduction of Level 3 (conditional driving automation) and Level 4 (high driving automation). This growth will be driven by the development of sophisticated sensor technologies, MLalgorithms, and the integration of AI to create safer and more efficient driving experiences.
2. **Vehicle to Everything:** V2X technology plays a critical role in the future of connected and autonomous vehicles. This enables vehicles to communicate with each other (V2V), with infrastructure (V2I), and with other road users, creating a networked environment that enhances safety, efficiency, and overall driving experience. The platooning feature,

which allows vehicles to travel in close proximity by communicating with one another, is expected to be a major driver for the commercial vehicle segment within the V2X market. As the industry continues to prioritise road safety, we can anticipate a growing number of commercial vehicles equipped with V2X technology, further integrating these systems into the transportation network.

3. **Immersive experience:** The integration of immersive technologies, such as AR and VR is revolutionising various aspects of the automotive industry, from research and development to sales and after-sales services. AR Head-Up Displays (HUDs), real-time overlays, 3D models, and virtual test drives are expected to significantly enhance the user experience, making trips safer, more interactive, and engaging. These technologies also offer potential for automakers to personalise the driving experience, provide detailed information to drivers in real time, and streamline the vehicle design and testing process, ultimately reducing costs and time to market.

4. **Leveraging AI:** AI is a driving force behind many of the advancements in the auto tech industry. AI is revolutionising manufacturing processes, optimising supply chains, enhancing vehicle safety, and personalising customer experiences. For instance, AI-driven design and testing processes are enabling manufacturers to develop more efficient and safer vehicles. As AI continues to evolve, it is set to pave the way for fully autonomous vehicles and advanced digital capabilities, creating vast growth opportunities for industry players.

These areas represent just a fraction of the potential within the auto tech industry. As technology continues to advance, the opportunities for innovation, efficiency, and improved customer experiences will only grow, offering significant prospects for those willing to invest in the future of automotive technology.

Navigating challenges: Key issues and solutions

As the automotive ecosystem evolved and the industry pivots itself to redefine mobility, its faces a few challenges- from ensuring data privacy to addressing the skill-gap as we make this transition towards a tech-enabled automotive value chain. Additionally, clarity in regulations and government support towards research and development will enable the industry to leapfrog.

1. **Data privacy and cybersecurity:** With the frequency of cyber-attacks increasing exponentially, hackers are able to access vehicle data in more ways than one, such as manipulating the car's internal code, distributed denial of service (DDoS) attacks, spoofing and phishing attacks, embedding viruses in communication media, etc. Cybersecurity vulnerabilities may be grouped under three areas: Electronic Control Unit (ECU), Communications media and Applications layer. An ideal cybersecurity system should identify areas of risk for various stakeholders and provide risk mitigation solution for such silos, as well as the overall data ecosystem. Best practices include- allocation of a dedicated cybersecurity team to ensure compliance (such as upcoming DPDPA rules), perform gap assessment to ensure that the best practices are followed at each step, and engage within the ecosystem for a holistic perspective on building safer ecosystems.

2. **Addressing the skill gap in India's automotive and auto-tech industry:** India's automotive industry is on the brink of a significant transformation, with the government targeting 30% EV adoption by 2030. This ambitious vision will require around 200,000 skilled professionals, particularly in specialised areas like battery technology, power electronics, and motor design[15]. The shift from traditional internal combustion engine (ICE) vehicles to EVs and autonomous vehicles is creating a pressing need for workforce upskilling. While ICE models consist of nearly 2,000 parts, an electric engine has only about 20 moving parts, making them easier to maintain but requiring different skill sets for servicing.

   This technological transition will not only necessitate the re-skilling of the existing workforce to prevent redundancy but also create new high-quality jobs in allied infrastructure development and human resource maintenance. Industry 4.0 and advancements in auto-tech will profoundly impact the job mix, particularly at automotive component manufacturers and Original Equipment Manufacturers (OEMs), transforming the demand for skills.

   The 2024 Union Budget highlights the importance of industry-engaged employment generation, workforce development, and increasing women's participation in the workforce. It emphasises the need for private sector-led research and innovation, industry-aligned courses and curricula, internships with leading companies, and the transformation of Industrial Training Institutes (ITIs) to ensure the development of a quality workforce.
   The Economic Survey and the Union Budget underline India's commitment to addressing the skill gap, which is expected to positive impact the automotive industry, ensuring the development of an industry-relevant workforce, and reducing unemployment. As the industry evolves, bridging this skill gap will be crucial for maintaining competitiveness and supporting the country's transition to a more advanced automotive ecosystem.

3. **R&D spending:** India has made notable strides, particularly in adapting and localising global e-mobility technologies to fit its unique context. However, there has been limited progress in R&D, especially in areas like e-mobility, connected vehicles, and digitisation. Despite ongoing investments, the sector has yet to achieve major breakthroughs internationally. To stay competitive and harness the potential of these innovations, India needs to significantly ramp up its R&D capabilities. By increasing investment in these areas, manufacturers can drive the next wave of technological advancements and better capitalise on the evolving automotive landscape.
   As announced in the Union Budget 2024, the operationalisation of the Anusandhan National Research Fund will support basic research, prototype development, and private sector-driven innovation with a INR 1 lakh crore financing pool- providing fillip to commercial-scale innovations in industry.

[15] SIAM

Conclusion

The automotive industry is undergoing a dramatic transformation driven by the rapid adoption of digital technologies. Vehicles, once viewed solely as transportation means, have evolved into sophisticated platforms incorporating sensors, communication systems, and AI, fundamentally reshaping the automotive value chain. This evolution extends beyond traditional vehicle manufacturers and dealerships, influencing all facets of the industry.

Key drivers of this transformation include the growing emphasis on safety, performance, and sustainability, which has led to significant advancements in e-mobility, connected vehicles, and digitalisation. The shift towards electric, autonomous, and connected vehicles is not only redefining consumer expectations but also prompting mass-market OEMs to pursue greater scale and efficiency. As a result, the sector is witnessing increased consolidation, digital manufacturing innovations, and enhanced collaboration between traditional automakers and agile digital-native startups.

Emerging trends such as electrification, autonomous driving, shared mobility, and enhanced connectivity are reshaping the automotive landscape. The rise of these trends reflects a shift in value creation, moving from traditional hardware-centric models to more integrated, technology-driven approaches. Opportunities abound in areas such as autonomous vehicles, V2X technology, immersive experiences and AI, each poised to drive significant growth and innovation.

As the industry continues to evolve, embracing digital transformation is crucial for staying competitive and capitalising on new opportunities. The future of automotive technology and mobility will be defined by specialised players adept at harnessing these advancements to meet changing consumer demands and drive the next wave of industry innovation.

Acknowledgements

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INDIAN AUTO COMPONENT INDUSTRY

Industry to incur capex of around Rs. 20,000-25,000 crore in FY2026

August 2024



Highlights

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R&D expenses for ICRA's sample set has remained low at an average of 1-2% of OI. It is significantly lesser than the global counterparts, where the average has been 8-10.5% over the last few years.

Domestic OEM demand constituted 56% of revenues for the industry in FY2024, while exports made up 29% for the same period. Most domestic auto sub-segments reached or exceeded pre-Covid volumes in FY2024 and are expected to grow at a moderate pace in FY2025. Ancillaries are investing in capacity enhancements, new products and product development for committed platforms for the domestic market.

Exports from India, though less than 10% of the global auto component market, have grown in the last few years at a CAGR of 14% between FY2020 and FY2024, and there is potential in auto component export, as India gains spotlight in the global arena. Factors like rising supplies to new platforms because of vendor diversification by global OEMs, higher value addition partly stemming from higher outsourcing by global Tier-Is and OEMs, aftermarket demand potential, increasing cost competitiveness and opportunities for casting/forging players from plants in EU shutting due to viability issues augur well for auto ancillaries.

Gradual increase in usage of advanced components that are unavailable in India led to increased imports. Absence of technology has been a key impediment in localising advanced components, and there is significant scope for localisation and development of vendor ecosystem for the same going forward. With premiumisation and periodic changes in regulatory norms, the demand for these components has gone up. Further, the proportion of alternate powertrains is expected to increase going forward, and only about 30-40% of the EV supply chain is currently localised. Ancillaries are working on these areas, and schemes like the production linked incentive scheme (PLI) are a step in the right direction for this.

These factors are likely to drive capex for auto ancillaries over the medium term. ICRA's interaction with large auto component suppliers indicates sizeable capex in FY2025. The industry is likely to incur around Rs. 15,000-20,000 crore in FY2025 and Rs. 20,000-25,000 crore in FY2026. Capex is expected to hover around 7-8% of operating income (OI) over the medium term, funded largely through internal accruals, except for larger projects (like battery cell localisation) which would be funded primarily through debt initially. As a result, the debt metrics for ancillaries are likely to remain comfortable over the medium term.

Most auto sub-segments have reached or exceeded pre-Covid volumes in FY2024

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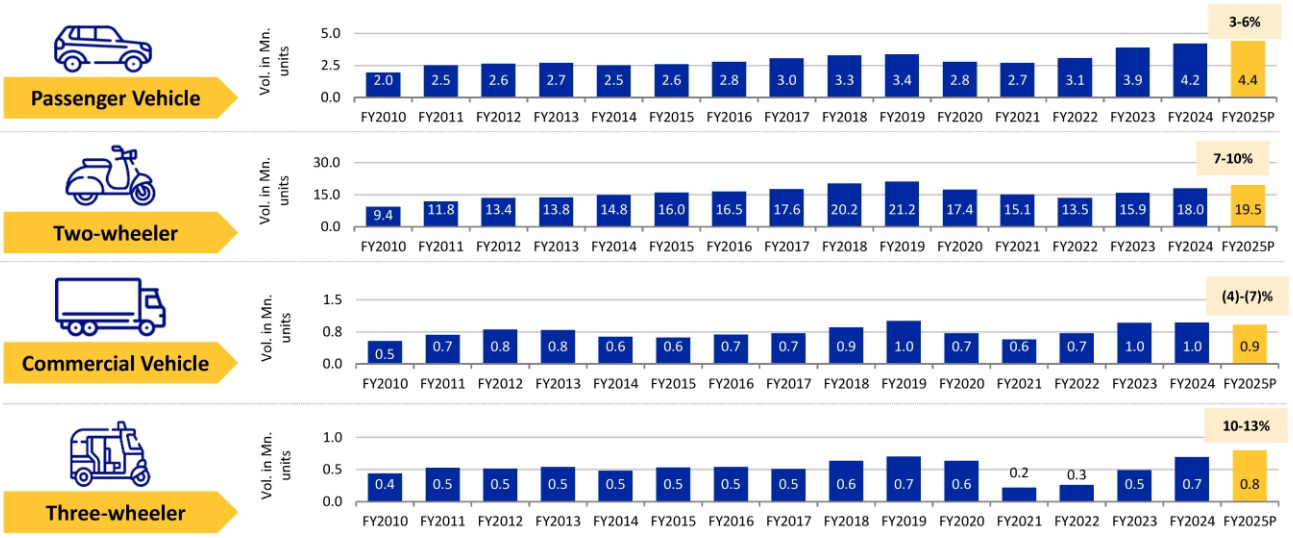
Exhibit: Long-term Trend in Automobile Sales Volumes (Domestic)



Source: SIAM Data, ICRA Research

Diverse powertrains to shape the future of the automotive industry

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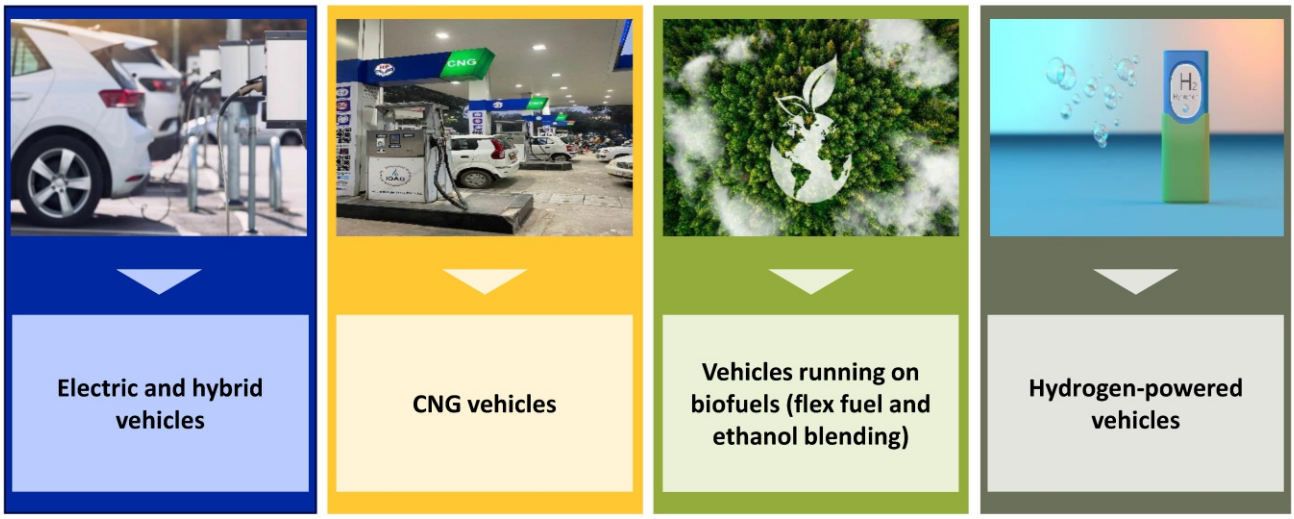
Exhibit: Alternate Powertrain Options



Source: ICRA Research

Penetration of CNG and electric powertrain on the rise in PVs; diesel share gradually declining

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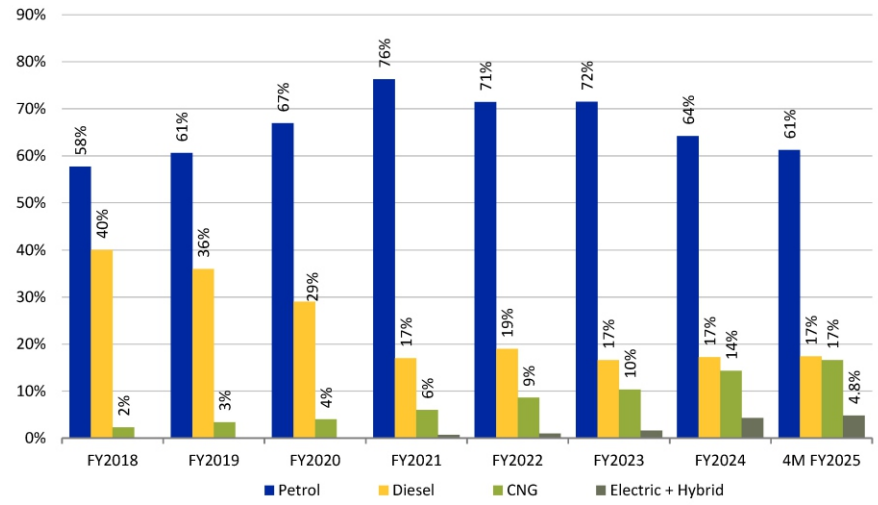
Exhibit: Trend in Powertrain Mix in PVs



CNG passenger car sales reported robust growth in FY2024; volumes improved in the current fiscal

CNG powertrain penetration increased to levels of ~17% in FY2024 (vis-à-vis ~4% in FY2020). Electric and Hybrid has also increased to 4.8% in 4M FY2025 from negligible levels in FY2020.

Diesel mix reduced from 29% in FY2020 to 17% currently. Increase in diesel powertrain mix in FY2022 was led by a significant jump in SUV demand, where diesel preference continues

Source: SIAM, ICRA Research

Notable increase in penetration of cleaner fuels in LCVs and buses in the last few years

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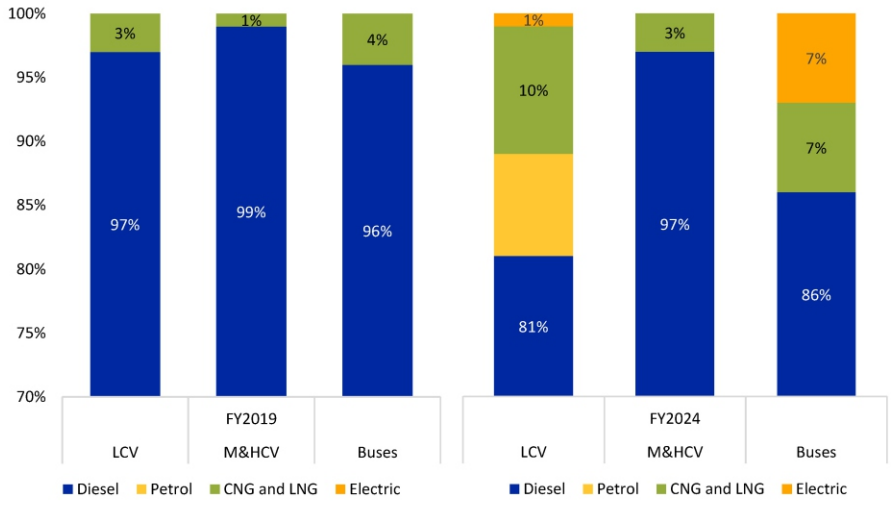
Exhibit: Trend in Powertrain Mix in CVs



Hydrogen-powered vehicles are being worked upon in CVs

Alternate fuel penetration in the buses and LCV segments witnessed a significant increase compared to M&HCVs

While CNG penetration continues to be low in the M&HCV segment, it has increased from FY2019 levels

Source: VAHAN, ICRA Research; Buses include only M&HCV passenger vehicles

Electric two-wheelers leading the alternate fuel trend in 2Ws

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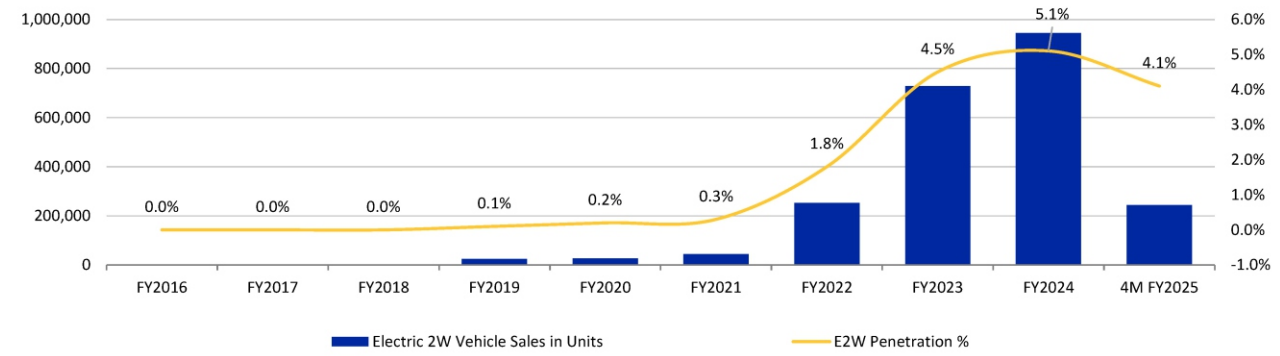
Exhibit: Trend in Domestic E-2W sales



- The share of EVs in two-wheelers was ~5% in FY2024 and has increased significantly in the last few years; for scooters alone, the share being significantly higher at ~14% for the same period.
- To some extent the pace of adoption has slowed down in the current fiscal after the reduction in the subsidy benefit under the EMPS scheme compared to FAME-II. The E2W volume moderated to 243,570 units in 4M FY2025, YoY decline of ~11%. However, 4M FY2024 benefitted from pre-buying in May 2023 before the reduction in FAME-II subsidy.

Source: VAHAN Dashboard, ICRA Research

EV penetration across segments to increase exponentially

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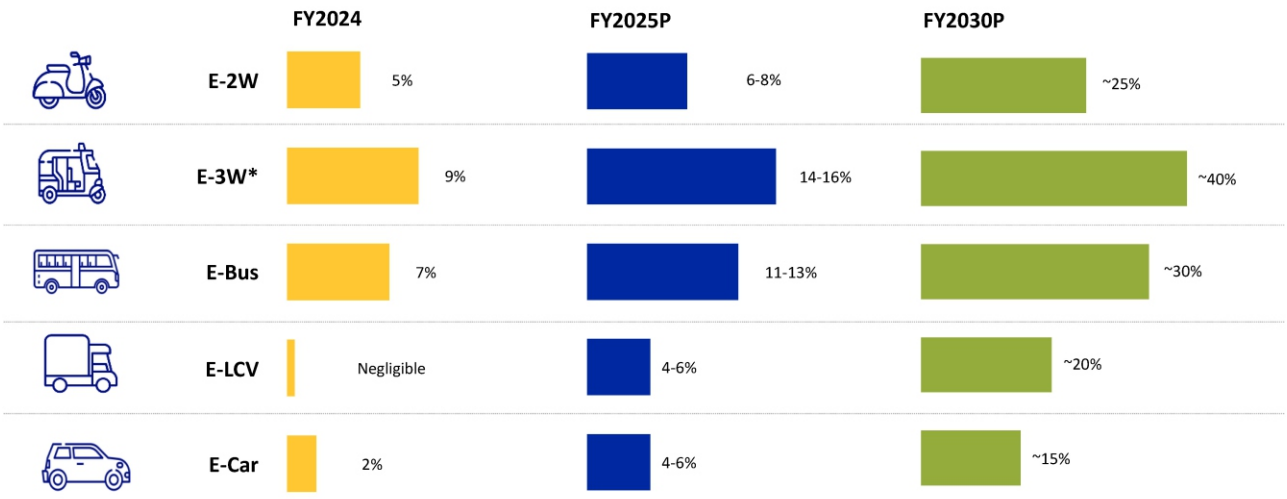
Exhibit: Trend in Electrification across All Segments



Source: ICRA Research; Note – Penetration measured in terms of new vehicle registrations
**Excludes rickshaw segment, which is already electrified to a large extent*

Significant opportunity in localisation of advanced technology components

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Exhibit: Trend in Auto Component Imports

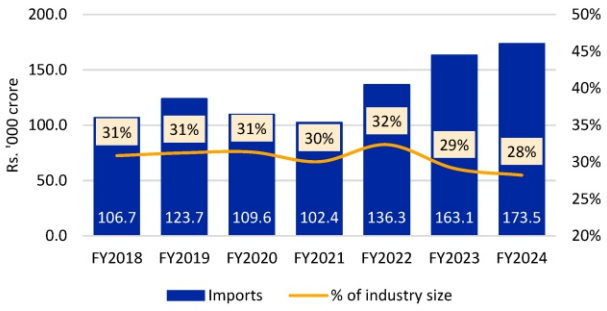
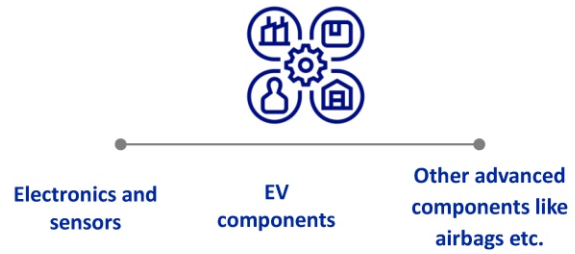


Exhibit: Sample of Products with High Localisation Potential



- Gradual increase in usage of advanced components that are unavailable in India has led to an import increase over the years. With premiumisation and periodic changes in regulatory norms, the demand for advanced components is only expected to go up further going forward.
- Absence of technology has been a key impediment in localising advanced components, and there is significant scope for localisation and development of vendor ecosystem for the same going forward. This will, in turn, lead to higher domestic value addition and improvement in margins for auto ancillaries.
- Ancillaries are working on the same, and schemes like the PLI are a step in the right direction for this.

Source: ACMA, ICRA Research

Only 30-40% of the EV supply chain is currently localised

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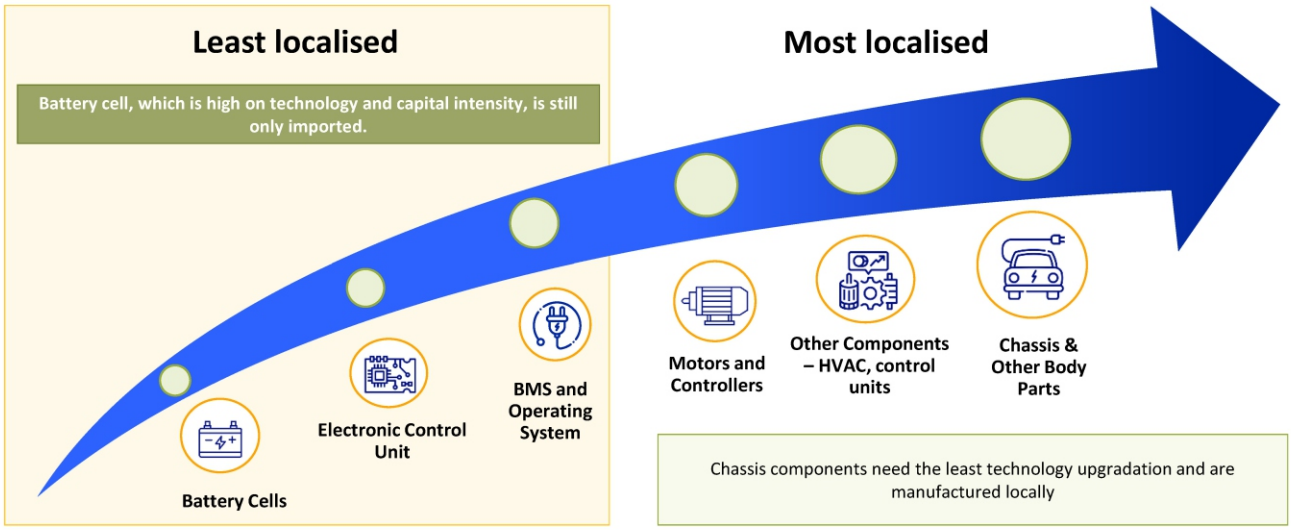
Exhibit: Extent of Localisation of EV Components



Source: ICRA Research

Multiple factors expected to drive growth for Indian auto component exports

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Exhibit: Factors That Could Drive Growth for Indian Auto Component Exports

Supplies to new platforms because of vendor diversification initiatives by global OEMs; ancillaries getting involved in early stages.	Increase in value addition and higher content per vehicle driven by premiumisation of components.	Increase in outsourcing by global Tier-Is and OEMs; tariffs on auto comp imports from China in the US have made Indian players more competitive.	Higher aftermarket potential in global markets with ageing of vehicles and increased sale of used vehicles.	Opportunities for Indian players in metal casting and forgings because of many plants closing down in EU due to viability issues.

Source: ICRA Research

Exports to increase significantly over the medium term

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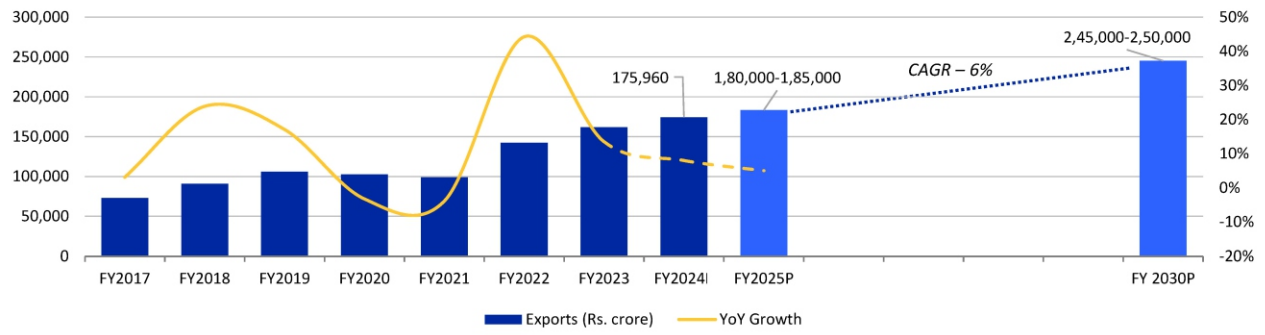
Exhibit: Potential for Auto Component Exports Over the Medium Term



- Several global tier-Is and OEMs have announced intentions to enhance sourcing from India through technology transfer, setting up JVs, etc. There is visible increase in exports for those auto ancillaries from India that have a significant presence in the overseas market.
- The higher volumes along with premiumisation of components and higher content per vehicle would result in sizeable growth in Indian auto component exports over the medium term.

Source: ACMA, ICRA Research

Several factors likely to drive capex for auto ancillaries over medium term

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Exhibit: Medium Term Revenue Drivers



All of these, along with capacity enhancements as domestic volumes pick up, would necessitate investments by auto ancillaries over the medium term.

Source: ICRA Research

Industry expected to incur sizeable capex in FY2025 and FY2026

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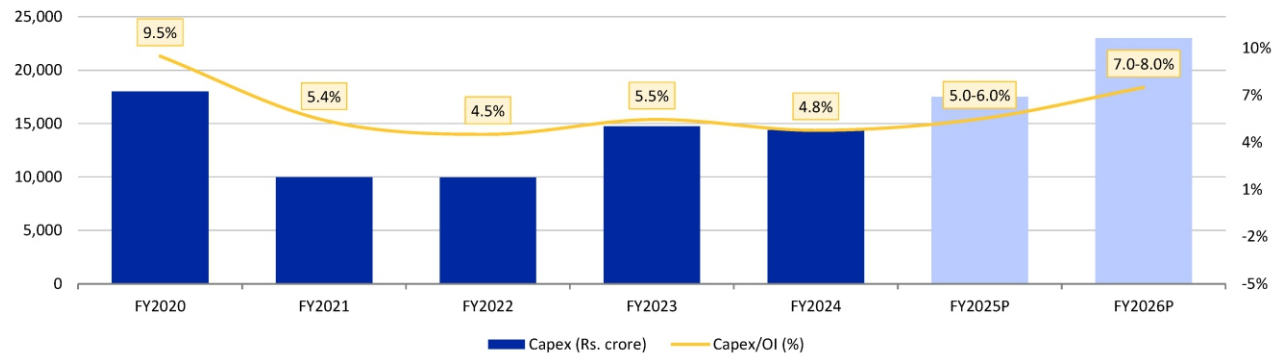
Exhibit: Capex (as % of sales) for ICRA's Sample of Large Auto Ancillaries



ICRA expects auto ancillary industry to incur significant capex of Rs. 15,000-20,000 crore in FY2025, stemming from factors explained earlier. We expect capex to hover around 7-8% of OI over the medium term. In absolute terms, this would be relatively high at Rs. 20,000-25,000 crore for FY2026. The PLI scheme has also been one of the accelerators for capex in advanced technology components.

Source: ICRA Research; estimates based on sample of large auto ancillaries across various product segments

At least Rs. 25,000 crore cumulative capex expected for EV components in the next 3-4 years

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Exhibit: EV Capex Estimate for the Industry over the medium term

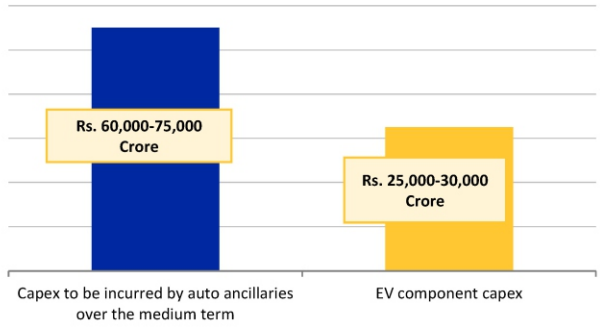
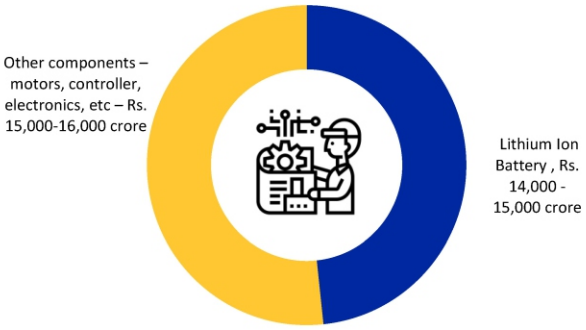


Exhibit: Break-up of EV capex to be incurred over the next 3-4 years



- A sizeable part of the capex to be incurred by auto ancillaries over the medium term, will be towards EV components – for capacity building, technology and product enhancements, including light weighting and upgrading NVH parameters. Of this, about 45-50% would be for EV battery cells and packs. Auto ancillaries have entered into collaborations/JVs in case where technology is an impediment.
- The larger projects (especially for battery cell localisation) are expected to be funded by debt initially. Capex for components other than batteries is expected to be funded largely through internal accruals. There is also substantial private equity interest in this space and a part of the funding is also expected from private equity capital going forward.

Source: ICRA Research

Research and development related expenses for Indian ancillaries have been low vis-à-vis global peers

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Exhibit: R&D Expense Proportion for Indian Auto Ancillaries

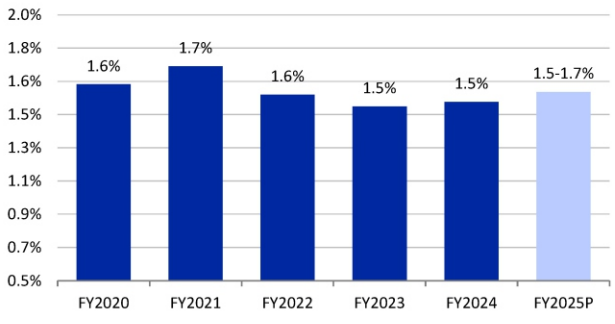
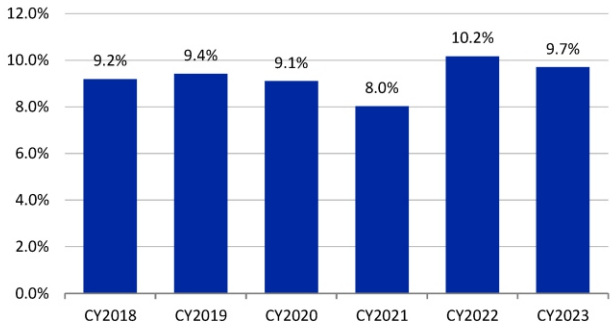


Exhibit: R&D Expense Proportion for Global Auto Ancillaries



- R&D expenses for ICRA's sample set of large Indian auto ancillaries has remained low, at an average of 1-2% of OI. Some companies within the sample set have had higher R&D expenses, at ~2-3% of OI.
- It is significantly lesser than the global counterparts, where the average has been 8-10.5% over the last few years.
- While there is no notable increase expected in R&D expenses of ancillaries in the near term, it is expected to gradually improve over the medium term, as value addition and domestic manufacturing of advanced components increase, and global majors set up R&D/engineering centres in India.

Source: ICRA Research; sample of 46 large auto ancillaries across various product segments; global sample includes 6 large auto ancillaries

Coverage indicators to remain comfortable for the industry

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Exhibit: Trend in Return on Capital Employed (RoCE) for ICRA's Sample Set

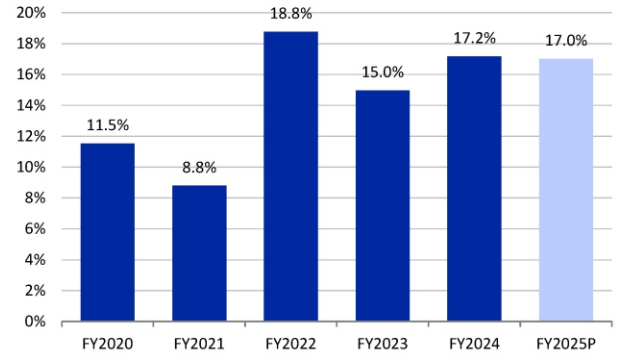
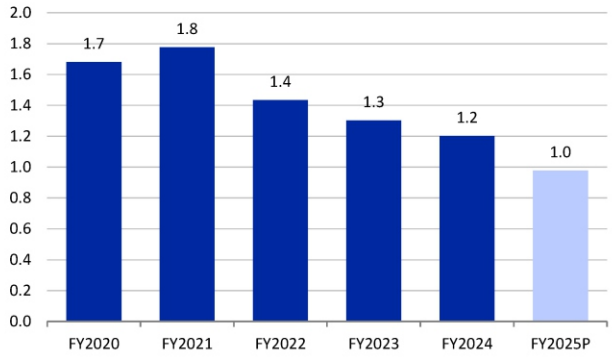


Exhibit: Trend in Total Debt/OPBITDA for ICRA's Sample Set



- Auto components is one sector, where the reliance on debt has been fairly limited. Capex in the past was largely funded by internal accruals. Liquidity position remains comfortable, especially across tier-I and II players.
- ICRA expects coverage metrics for the sector to remain comfortable going forward as well, aided by healthy accruals and relatively low incremental debt funding.

Source: ICRA Research, Ace Equity; Based on 46 large auto ancillaries with aggregate annual revenues of over Rs 3,00,000 crore in FY2024

Most rated auto ancillaries are investment grade, reflecting healthy credit profiles

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Exhibit: ICRA's Ratings in the Auto Component Industry

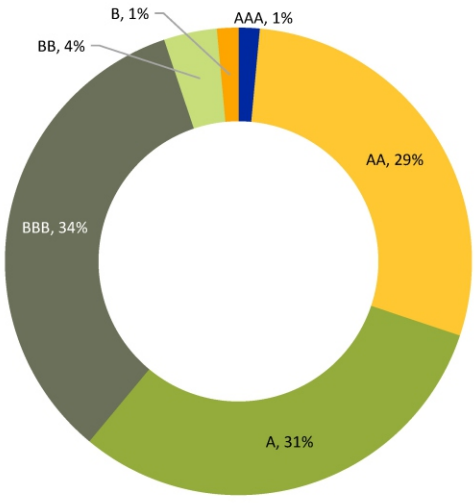
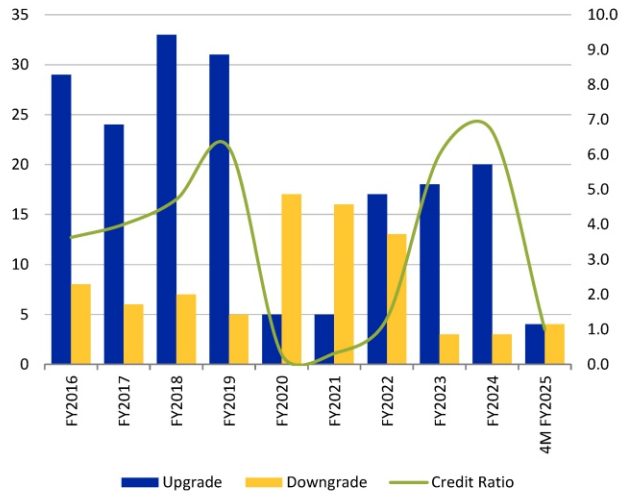


Exhibit: Rating Movement in ICRA's Portfolio of Auto Component Companies



Source: ICRA Research; As of July 31, 2024, and does not include INC cases

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WORKFORCE 2024

by

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BE MORE THAN

WORK FORCE 2024



ABOUT KORN FERRY WORKFORCE 24 STUDY

Korn Ferry spoke to 10,000 professionals at all stages of their career, from entry-level to CEO, in six markets: USA, UK, Brazil, Middle East, Australia, and India.

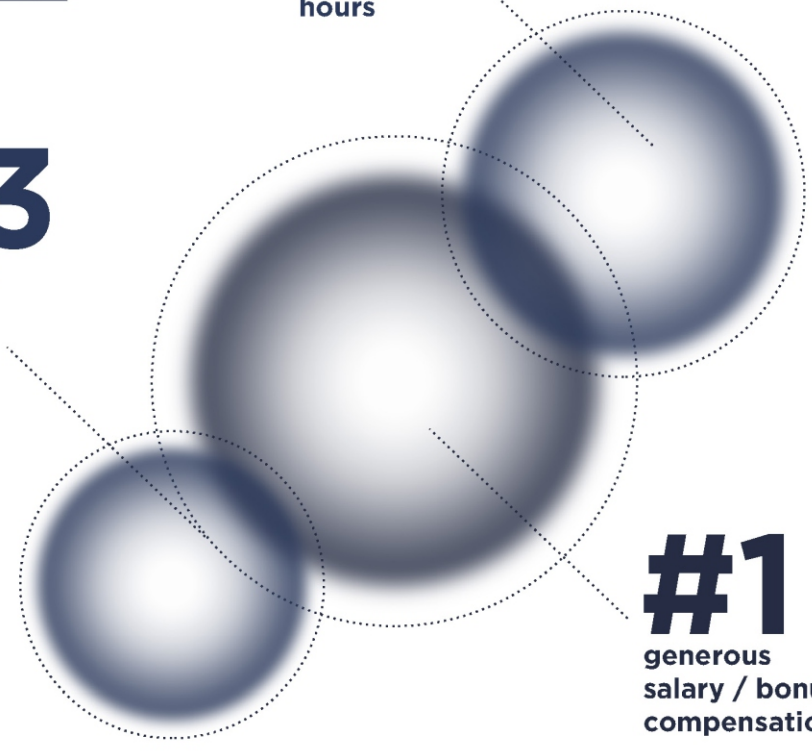
Their insights reveal a global snapshot of how people are feeling in the Americas, EMEA, and APAC about

- Their top priorities when choosing a new job
- What keeps them in their current job
- What makes them want to leave a job
- How organizations can motivate their workforce

WE DISCOVERED THAT THE TOP THREE DRIVERS FOR THE PEOPLE IN 2024 ARE:

#2
flexible working hours

#3
high job security



#1
generous salary / bonus compensation

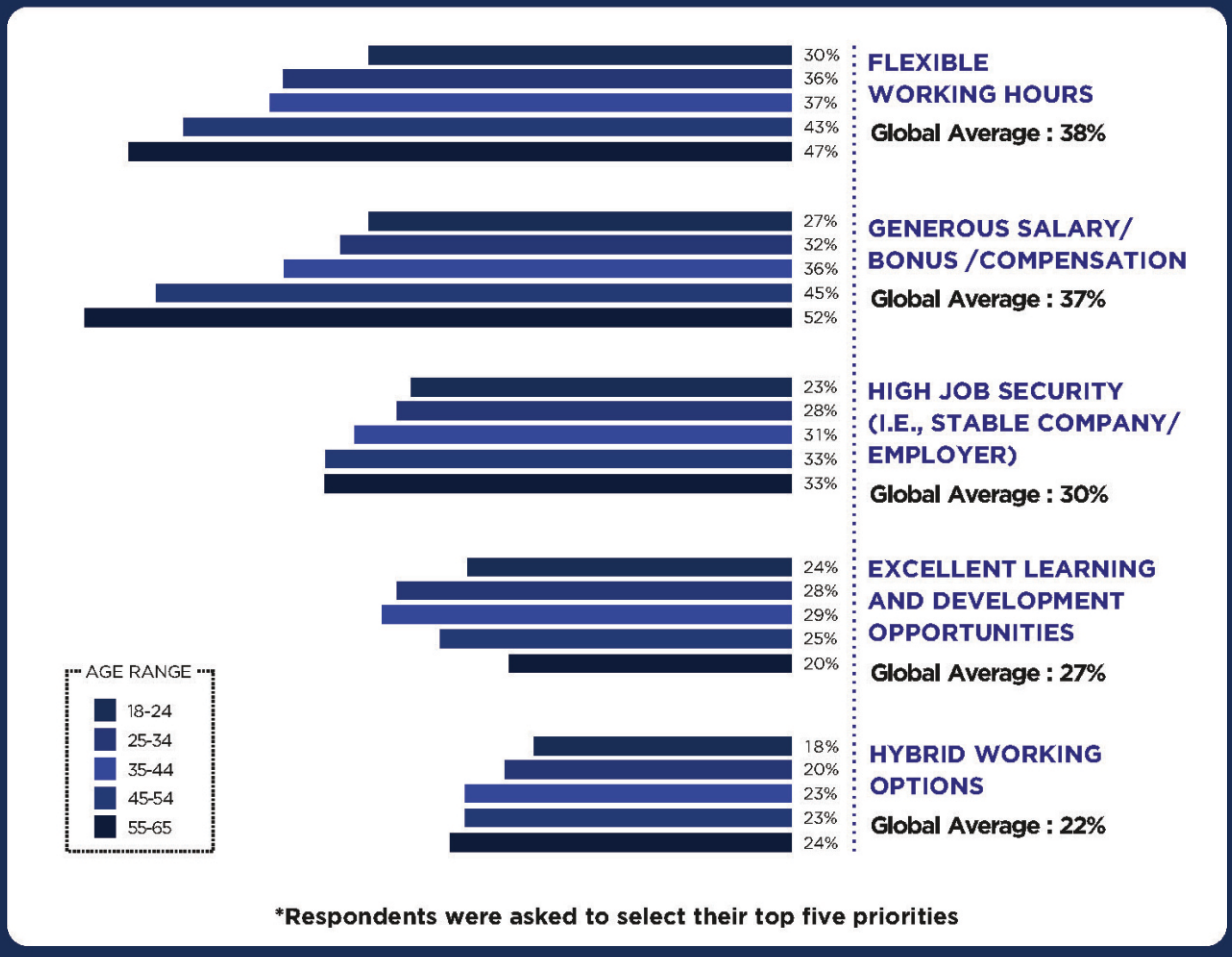
GLOBALLY, what are the reasons for choosing a new job?

Surprisingly, salary is only the second reason most employees choose to accept a new job in 2024.

The top reason is flexible working hours

This shifts slightly for the over 45s, when salary nudges into the top spot, but even then, the two are neck-and-neck.

Top 5 Reasons Different Generations Choose A New Job*



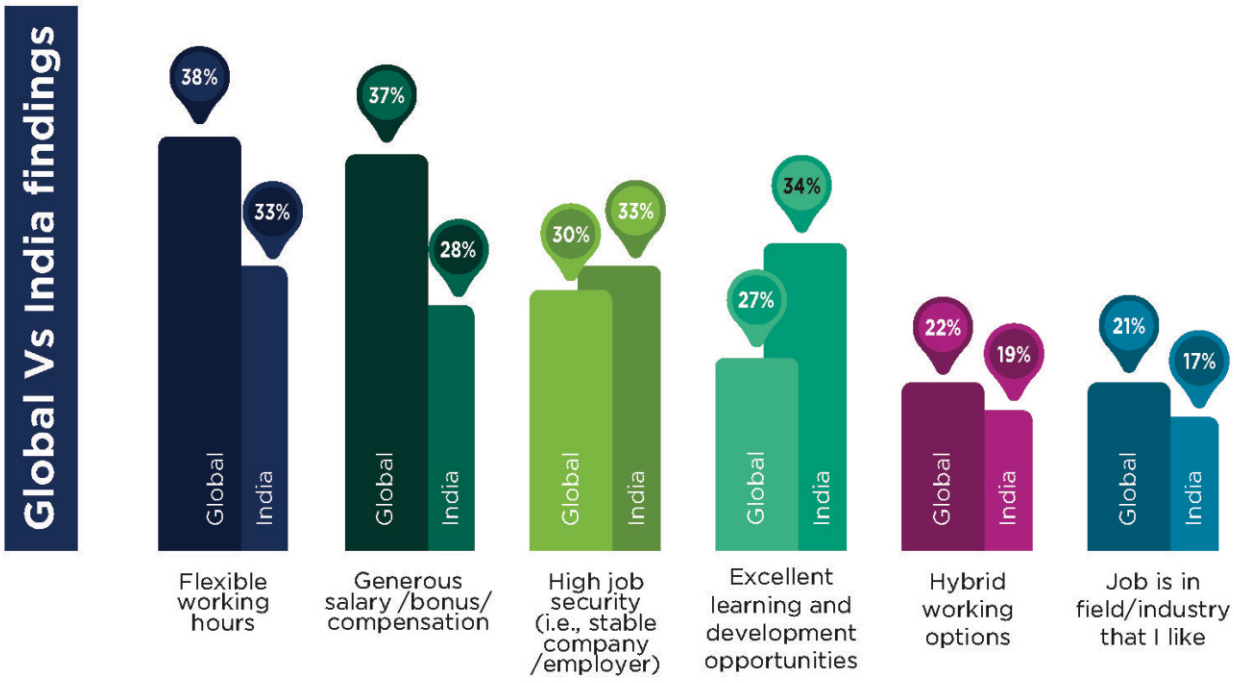
*Respondents were asked to select their top five priorities

While In India, LEARNING & DEVELOPMENT Tops the Job Wishlist

"As our workforce evolves, particularly among experienced professionals, the emphasis on growth opportunities is clear. It's not just about securing a job; it's about securing a future. This insight challenges us to prioritize L&D in our talent strategies, ensuring we meet the aspirations of a diverse and ambitious workforce."

Navnit Singh, Chairman & Regional Managing Director, Korn Ferry India

If you were to look for a new job, what are the most important things a new employer / role could offer you?



India's job market presents a unique narrative compared to other economies. While flexible working hours and generous compensation top the global list of job priorities, in India, learning and development (L&D) opportunities take the lead, with 34% of respondents rating it as their most important factor for choosing a new job. This is closely followed by flexible working hours and job security, with generous compensation trailing behind.

Employees aged 35-65 show the highest preference for L&D as a key growth driver, especially when considering a new job. Older employees prioritize this more than any other factor, while younger job seekers (18-34 years) value flexible working hours the most. Among female employees, excellent L&D opportunities ranks highest (37%), followed by flexible working hours (35%) and high job security (35%).

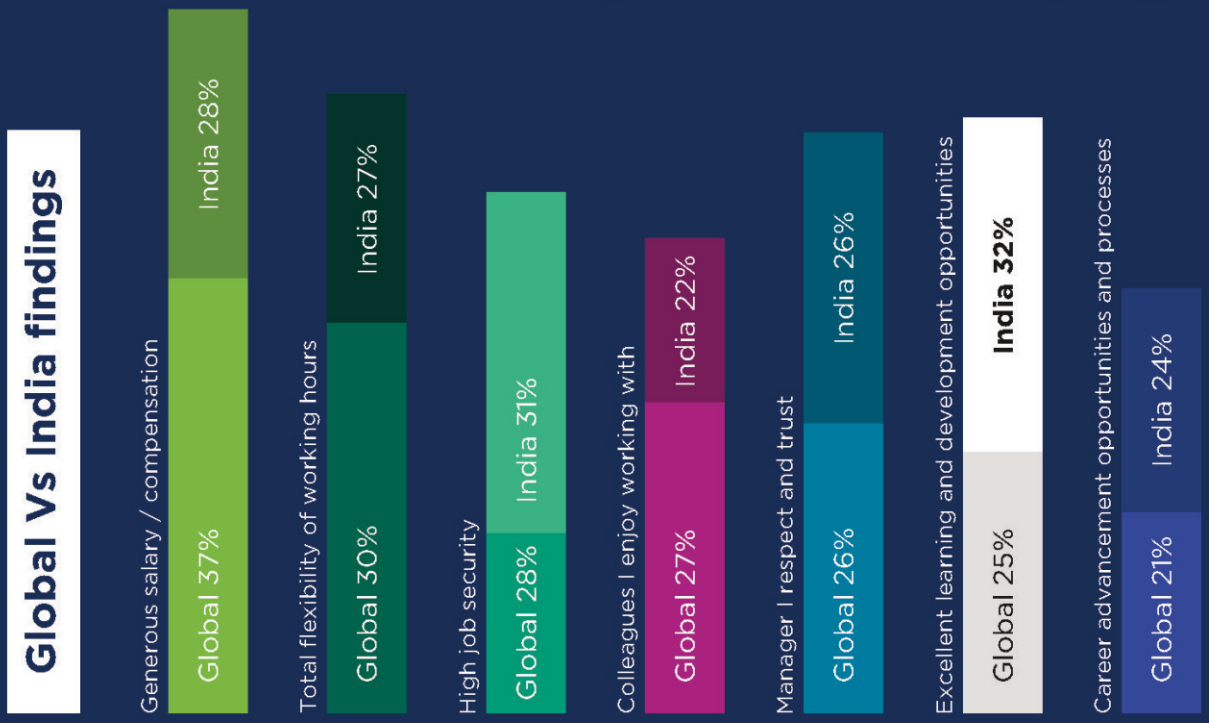
Why Indians Stay: LEARNING and DEVELOPMENT Outshines Compensation in Job Retention

"In India, the narrative of job retention is evolving. While compensation and job security have traditionally anchored employee loyalty, our latest insights reveal that learning and development opportunities are now the true differentiators.

The fact that 80% of Indian employees would remain in a role they dislike if it offered rapid growth and upskilling speaks volumes

Ashwin Saboo, Senior Client Partner, Korn Ferry India

What is most likely to make you stay at your current company?



While generous compensation remains the top reason for employees globally to stay with their company, the story is different in India. Excellent learning and development opportunities emerge as the leading factor for job retention, closely followed by high job security. Though traditional factors like job security and compensation remain significant, the emphasis on L&D opportunities marks a shift in what drives Indian employees to stay in their roles.

When asked if they would stay at a job if it granted them opportunities to progress and upskill quickly, even if they hated the current role, 80% of Indians agreed.

5

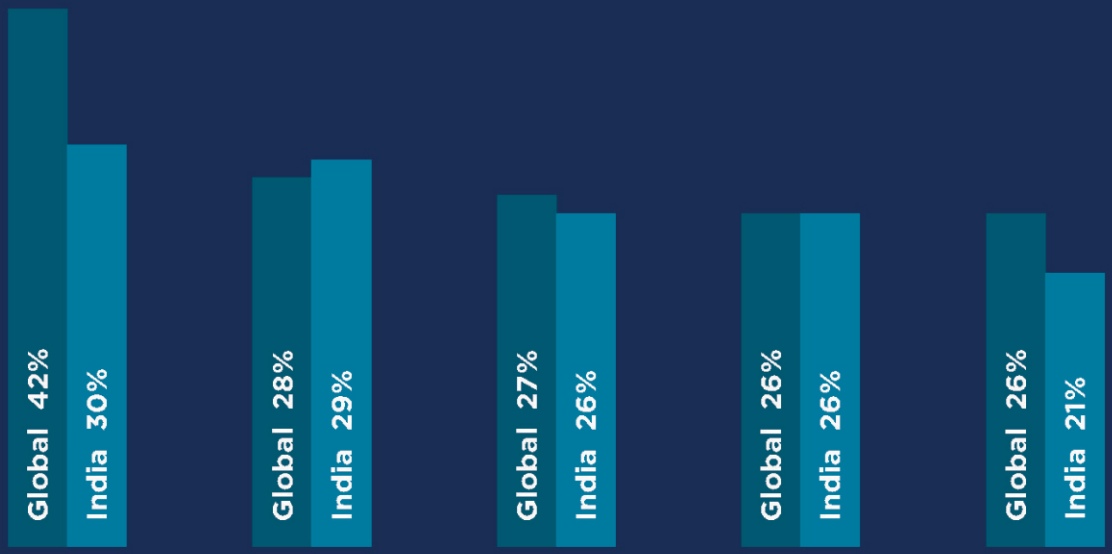
In INDIA'S Job Market, L&D Pulls, While Low Salary Pushes

"The shift from viewing compensation as a key motivator to recognizing it as a hygiene factor represents a fundamental change in how employees evaluate their careers."

Vicky Bahl, Principal,
Korn Ferry India

What is most likely to make you leave your current company?

Global Vs India findings



Globally, low salary emerges as the primary reason for considering job change, including in India, followed closely by lack of career advancement opportunities.

In India's rapidly expanding economy, the desire to upskill and progress in one's career takes precedence and is being considered as a satisfier. Salary is increasingly viewed as a hygiene factor and acts as a dissatisfier prompting job changes.

6

An Insight Into MANUFACTURING/ INDUSTRIAL Findings

In India, L&D emerges as a key driver in selection of job and retention in Manufacturing & Industrial industries. While financial incentives/job security are critical, non-monetary factors such as work environment, professional development, and leadership quality are highly influential in shaping employment choices and experiences in these sectors.

Unlike global trends that favor flexible working hours, Indian job seekers in these industries shared a preference for full-time office work. This may reflect a cultural preference for structure and in-person collaboration or could indicate a difference in how remote work is perceived in India.

Conversely, being mandated to work full-time in the office is also a significant reason for leaving a job, showing a divide in preferences within the Indian workforce. This suggests that while some employees prefer the traditional office setup, others are resistant to losing the flexibility they may have experienced during the pandemic.

	Global Findings	India Findings
TOP REASONS TO CHOOSE A NEW JOB		
1	Generous salary (40%)	**Excellent learning and development opportunities (33%)**
2	Flexible working hours (39%)	Full-time in the office (32%)
TOP REASONS TO STAY IN A JOB		
1	Generous salary (38%)	**High job security (36%)**
2	Manager I respect and trust (33%)	**Excellent learning and development opportunities (36%)**
TOP REASONS TO LEAVE A JOB		
1	Low salary (42%)	**Lack of career advancement opportunities (34%)**
2	Poor company culture or values (30%)	Full-time in-office attendance is being mandated (32%) / Inflexible working hours policy (31%)

47% of the respondents agreed that their company gives them salary and benefits that match their contribution to the company, 14% agreed that their salary and benefits exceed their contribution to the company.

91% agreed that their job provides opportunities to do challenging and interesting work.

86% felt that the job they do reflects their value to society.

An Insight Into AUTOMOTIVE INDUSTRY Findings

Global Findings VS India Findings

TOP REASONS TO CHOOSE A NEW JOB		
1	Generous salary (28%)	**High Job Security (37%)**
2	High job security (28%)	Job is in field/industry of choice (34%)

TOP REASONS TO STAY IN A JOB		
1	Generous salary (27%)	**Clear Career Advancement Opportunities And Processes (34%)**
2	Colleagues I enjoy working with (24%)	High job security (32%)

TOP REASONS TO LEAVE A JOB		
1	Low salary (39%)	**Poor Sustainability Policies And Practices Within The Company (29%)**
2	Poor company culture or values (22%)	Lack of career advancement opportunities (27%)

The findings reveal distinct differences in job preferences and motivations between the global automotive workforce and the Indian workforce and emphasize the importance of job security, career growth, and ethical practices in attracting and retaining talent. In the Indian Auto Industry, high job security emerges as a prominent driver in both job selection and retention.

Indian Workforce Insights

61% agreed that their company is responding effectively to changes in the business environment.

61% think using AI in their role will bolster their value in the next three years.

80% said that connection with their colleagues is one of the most important things about their job.

Auto Vs Manufacturing/industrial

India Findings	
TOP REASON TO CHOOSE A NEW JOB	
Auto	**Mfd/Ind**
High Job Security (37%)	**Excellent L&D Opportunities (33%)**

TOP REASON TO STAY IN A JOB	
Auto	**Mfd/Ind**
Career Advancement opportunities and Processes (34%)	**High Job Security, Excellent L&D Opportunities (36%)**

TOP REASONS TO LEAVE A JOB	
Auto	**Mfd/Ind**
Poor sustainability policies and practices within the company (29%)	**Lack of career advancement opportunities (34%)**

The findings reveal distinct priorities between the automotive and manufacturing/industrial sectors in India when it comes to job selection, retention, and turnover.

In the automotive sector, high job security (37%) and working in a preferred field or industry (34%) are the top reasons for choosing a new job. This suggests that automotive professionals are prioritizing stability and aligning their careers with their knowledge areas/passions. On the other hand, employees in the manufacturing/industrial sector are more driven by excellent L&D opportunities (33%) and full-time office work (32%), indicating a strong focus on skill enhancement and a preference for structured, in-person work environments.

When it comes to staying in a job, career advancement opportunities and processes (34%) and high job security (32%) are the main retention factors in the automotive sector, reflecting the importance of career growth within a stable environment. In contrast, employees in the manufacturing/industrial sector place equal importance on L&D opportunities and job security (both 36%) for job retention, emphasizing the need for continuous professional development and stability.

Interestingly, both sectors identify the lack of career advancement opportunities as a key reason for leaving a job, with the automotive sector also highlighting poor sustainability policies (29%) and the manufacturing/industrial sector noting the mandate for full-time in-office attendance (32%) as a significant turnover trigger.

These insights underscore the different motivations and challenges faced by employees in these sectors, with the automotive workforce leaning towards stability and industry alignment, while the manufacturing/industrial workforce emphasizes growth and development.

The Evolving Auto Industry

The auto industry is experiencing a profound shift, particularly in the realms of automation, digitization, and the integration of the Internet of Things (IoT). Electronics have surpassed mechanical engineering as the primary driver of features and specifications, shifting the industry's focus to a technology-centric model. As the scope broadens to encompass autonomous driving, connected vehicle technologies, ride-sharing services, new mobility solutions, active safety systems, and the advancement of hybrid and electric vehicles, the demand for talent adept at navigating this complex landscape is growing. To address these demands, companies must develop new skill sets within the workforce, which may involve sourcing talent with digital expertise from outside the traditional auto sector.

> "Vik Bahl emphasizes the importance of this shift, noting that "as the world of connectivity accelerates, we need talent that can navigate both the 'digital engine' powering the future of the car industry and the 'mechanical chassis' that has long been its foundation."

Companies that have matured in the domestic market are now looking towards portfolio diversification or international expansion, with both models requiring greater control over the high-tech segments of the value chain— areas that have traditionally been underdeveloped in India. From an HR perspective, this transformation presents both opportunities and challenges. Without proactive planning, this transition could lead to significant recruitment challenges as new value chains are built domestically.

> "Navraj Makkar, Senior Client Partner, Consulting, underscores this view, "Companies are facing a challenge of adapting to environmental regulations and significant shifts in product categories driven by changing consumer behavior. To manage this transition successfully, we need leaders who can envision futuristic, breakthrough strategies while adeptly managing the complexities of execution in today's environment."

Moreover, roles within the industry are not just expanding—they are evolving. Traditional positions are being redefined, and new roles, such as Chief Learning Officer and Chief Customer Officer, are emerging to address the industry's changing demands. This evolution highlights the critical importance of L&D programs for upskilling employees in technical, functional, and leadership areas. It is clear that organizations that will prioritize and effectively execute L&D strategies will gain a competitive edge in staying agile amid industry changes.

Recommendations: Preparing for the Future

Companies must adopt a strategic mindset, aligning their talent strategy with the organizational roadmap from the outset rather than as an afterthought. Conducting human capital risk assessments early on is crucial to ensuring that the workforce is prepared and capable of meeting future challenges.

Leadership Readiness.

Today's leaders need more than just a strong background in the auto sector; they must possess a broad perspective, often gained through multi-industry experience. Korn Ferry's Workforce 2024 Global Insights Report examines attitudes affecting employee sentiment and emphasizes the growing need for leaders to be agile learners, inclusive visionaries, and tech-savvy innovators.

> "Sandeep Bhalla, Senior Client Partner & Head of Consulting, India says, "The sector requires a diverse set of leadership competencies compared to a generation ago, when corporate structures were simpler, product programs were often regional rather than global, and inter-company joint ventures and partnerships were less common.
> Today, we need leaders who can bridge the gap between performance and transformation, uniting teams with a shared purpose through empathy and compassion. Leaders who act as catalysts, driving reinvention across their teams, organizations, and the broader ecosystem. For this, foundational leadership skills—such as listening, empathy, and storytelling—are becoming vital, as they empower leaders to adapt and excel in new situations."

Compensation Strategy.

Addressing internal equity in compensation is crucial for organizational health. Although external pay parity often receives more attention, our research indicates that perceived internal inequities in pay can drive employees to either exit or worse, remain disengaged and less productive. Therefore, companies must ensure internal parity to sustain a motivated and committed workforce.

Attracting top talent.

A robust talent strategy includes identifying and developing leaders from within the company, but not exclusively. The disruptive forces at play necessitate a broader candidate pool. Bringing in fresh talent from diverse industries can positively influence the entire workforce, hence, striking the right balance between internal and external resourcing is essential.

Gender Diversity.

Diversity continues to be a significant challenge, particularly in industries where the workforce has historically been male dominated. To attract and retain gender-diverse talent, a mindset shift is required supported by enabling policies. Leadership development programs for women should start early and emphasize mentorship and the cultivation of role models to ensure long-term success.

Recommendations: Preparing for the Future

Redefining Career Growth.

As career spans lengthen and the half-life of skills drops to 3-4 years, continuous learning becomes essential. Employees who are able to apply past experiences to new situations and develop quickly will thrive in this environment.

There is a need to shift the narrative around career growth from a focus on upward movement to horizontal growth and holistic learning. Stretch assignments and experiences that broaden perspectives are key to helping employees grow without relying solely on promotions. By promoting a broader view of career development, companies can better engage an ambitious and dynamic workforce.

> "Navraj continues, "Korn Ferry's surveys frequently highlight a significant gap between confidence in business strategies and talent strategies. To bridge this gap, companies need to focus on leadership and talent that exhibit high adaptability, open-mindedness, and the ability to think and act quickly. Learning Agility is key to staying competitive."

Building and Communicating Purpose.

Most companies clearly articulate their vision (the what) and strategy (the how), but few succeed in effectively instilling a sense of purpose (the why) in their leaders and employees. Purpose is essential because it fuels vision, fosters engagement, strengthens commitment, and enhances retention. When employees understand and connect with the purpose behind their work, they are more motivated and dedicated, which translates into higher productivity and job satisfaction.

For the younger workforce, purpose is even more critical. This generation prioritizes meaningful work and alignment with personal values over financial rewards or status. They seek employers whose mission and values resonate with their own, and who offer opportunities to make a tangible impact.



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Guarding: The Digital Highway - Enhancing Cyber Security in Connected Automotive System

by

Nangia Andersen LLP
A member firm of ANDERSENGLOBAL

Guarding
The Digital Highway

Enhancing Cyber Security in Connected Automotive system



NANGIA & CO LLP

Introduction



From the visions of Mr. Henry Ford's Model T to Mr. Elon Musk's Tesla, the automobile landscape has grown exponentially in all aspects of technology- Materials, Production techniques, Safety, Comfort, Features, and Ease of operability to name a few. Since the turn of watershed to Microprocessors and advent of Internet in the automobile landscape, the constant enhancement and advancement of, ever so intricate, connectivity has provided unimaginable breakthroughs in and on the roads, with the epitome as Self-Driving cars, and although along with it, brought several challenges of its own as well as imported challenges from the related and connected ecosystems.

Furthermore, the rapidly increasing dependence on cyber-physical systems (CPS) in building critical infrastructures as opened the gates to increasingly sophisticated and harmful attacks. While a traditional cyber-attack may leak personal sensitive information, a CPS attack can lead to a loss of control.

A Timeline of attacks on Automotive Sector in India

2024
Ransomware Attack on one of the leading player in commercial vehicle sector

2022
Data Breach on the leading SUVs manufacturers in India

2021
Security Flaw on an emerging player in the 2 wheeler EV space

2021
Ransomware Attack on leading commercial vehicle manufacturer

2021
Ransomware Attack on one of the largest conglomerates and PV / CV manufacturer

2019
Data Breach on one of the leading car manufacturers in India

Breaches the sector has witnessed- Indian Scenario

2019

Data Breach on one of the leading car manufacturers in India

Incident: Company suffered a data breach that compromised sensitive customer and investors' PI- Indian and Global. Misconfigured Azure storage server led to breach

Impact: The breach exposed personal data of customers, raising concerns about data privacy and security

Response: Need for Public cloud security, secure configuration baselines and strong data governance

2021

Ransomware Attack on one of the largest conglomerates and PV / CV manufacturer

Incident: Company experienced a ransomware attack that affected its internal IT systems

Impact: While the company managed to contain the attack, some operations were disrupted, affecting the business processes temporarily

Response: Company enhanced its cyber security measures and conducted a thorough investigation to prevent future incidents

2022

Data Breach on leading SUVs manufacturers in India

Incident: Mahindra & Mahindra reported a data breach where unauthorized access to sensitive information was detected

Impact: Personal and financial information of customers and employees was potentially exposed. Lead to fake and fraudulent calls on account of RSA, Memberships etc.

Response: Company took immediate steps to secure its systems, notified affected individuals.



Vulnerabilities in Connected Automotive System:

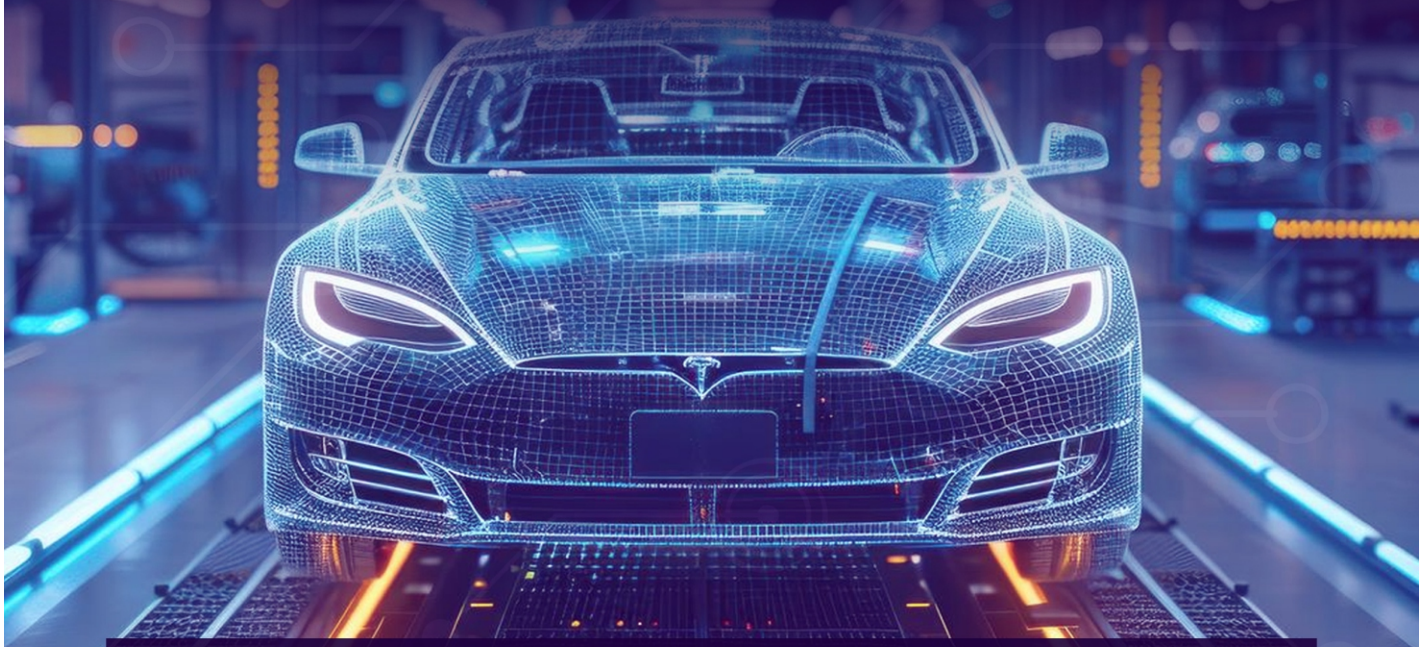
"Guarding the Digital Highway" delves into the critical realm of cybersecurity of automobiles, examining the present and emerging threats, vulnerabilities and their risks, strategies for these risk management and mitigation, technologies that could reduce the exposure to these threats, and policies essential for protecting the landscape.
Let us classify the vulnerabilities in connected automotive system based on different phases.

1. Production Phase
2. Usage Phase
3. After Market Phase



1 Production phase

Production Phase poses organizational security threats in the chain, where 2 most prominent cybersecurity vulnerabilities creep in form of, firstly, use of automated machines in assembly lines and, secondly, insecure coding practices.

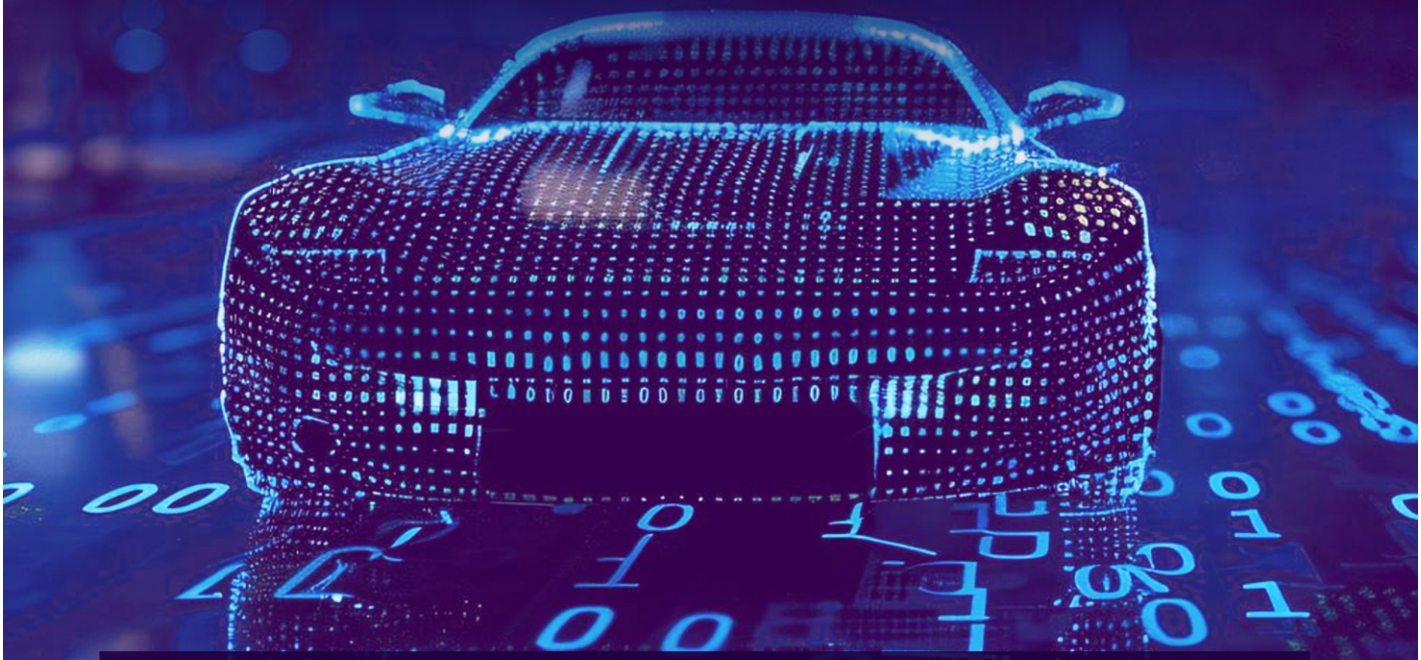


1.1 Connected assembly lines:

For mass production of vehicles in factories and to increase production capacity of their factories, Automobile Manufacturers are leveraging Industrial Revolution 4.0, which uses emerging technologies like Artificial Intelligence and Machine Learning, Big Data and Analytics. Along with these, use of automated arms and robotics are being increasingly adopted in assembly lines.

These technologies in production environments are often controlled by centralized system components, with physical and logical access to multiple stakeholders. There poses an eminent vulnerability from unauthorized access to the production environment, which creates a risk of creation, modification, alteration, or deletion of designs, configurations and safety standards. Most robust mitigation to such threats is segmentation of system components and periodic vulnerability assessment and penetration testing to ensure that the production environment remains secure at the first stage

1 Production phase



1.2 Increasing complexity of codes:

poses cybersecurity threats. If the security aspects are not incorporated through the Software Development Lifecycle (SDLC), these insecure software and applications roll out in production and pose severe and critical security threats. The risk insecure SDLC With the evolving plethora of features in modern automobiles, and the ease with which each feature is executed, there works lines of code behind the electronic and motor-electrical systems. These codes have multiplied manyfold to serve these features. To give an estimate, a modern vehicles' code evolved to 100 Mn lines at present, which is expected to grow to 300 Mn lines by 2030. And by comparison a Commercial Airplane consists of 15 Mn lines while a fighter jet consists of 25 Mn lines of code. This humungous coding creates can be unimaginable, most threatful being where the perpetrator can himself modify, alter, or delete sections of codes that are to be coded and flashed in the ECUs and CAMs.

Advancement in coding practices have led to development of concept of Secure Software Development Lifecyle (SSDLC), which provides for adoption of such secure coding measures throughout the software and coding lifecycle, from the initial prospecting phase to planning to coding and to finally testing phase

2 Usage phase

The most vulnerable phase in automobile industry that has emerged due to increasing connectivity of the vehicles, is when an automobile user purchases and uses his vehicle for his needs.

1. Threats to safe operation of the vehicle
2. Threats to interfaces of Internal, Public and Satellite networks of the vehicle
3. Threats to Architecture
4. Threats to Data



2.1 Threats to operational safety



2.1.1 Sensor spoofing



Automotive Systems commonly integrates dozens of functions to manage the physical components (i.e., sensors and actuators) and interact with the environments. Sensor spoofing type of practical physical attack deceives a victim's sensors into performing risky actions. Initially, the attacker injects false data into the sensors, which is then sent to perception functions. This causes the functions to produce inaccurate state estimates. These erroneous perceptions can then disrupt planning and control stages, ultimately resulting in unintended hazards. For example, non-invasive sensor spoofing attacks targeting the anti-lock brake systems (ABS) in automobiles.
This vulnerability arises from the unsecured communication in the internal network of the vehicles, which as a major threat can be exploited creating risk of life and death for the passengers by executing actions such as failure of critical essential and safety systems of the vehicle. Furthermore, this creates way for horizontal traversing to execute other spoofing attacks like GPS Spoofing, Camera Spoofing Microphone spoofing etc.
A possible solution to the threat is encrypted and secured communication between sensors, ECUs, and CAM

2.1.2 Telematics



Telematics works by installing a device in the vehicle that connects to the vehicle's port and a SIM card and modem that communicates with a wireless network or satellite. The device sends the data to a centralized server that interprets and displays it for end users via websites and applications.
Features that use telematics like remote access to locking-unlocking, remote turning ON/OFF vehicles, and using features remotely, are prone to cyberattacks. Most prominent attacks targeting telematics consist of Remote-Code Execution, Man-in-the-Middle attack, DoS and DDoS. U se of relay attacks to gain unauthorized access poses one of the biggest threats to automotive industry.
The risks emanating from telematic threats can again result in operation failures, thus staking the safety and life of the passengers onboard.
Possible mitigation to such attacks encompasses using strong encryption protocols for transmission of data, regularly update software and firmware, conduct vulnerability assessments and penetration testing, and enforce access controls to protect from telematic attacks

2.1.3 DoS and DDos



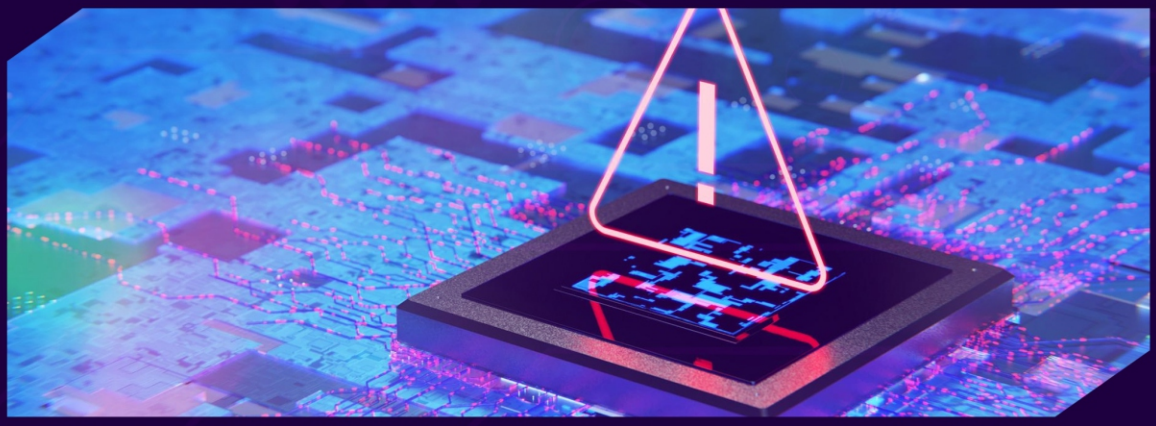
DoS (Denial-of-Service) and DDoS (Distributed Denial-of-Service) attacks in automotive systems involve malicious attempts to overwhelm or disrupt the availability of services, networks, or connected devices.
In DoS attack, malicious actor floods a targeted automotive system, such as a vehicle's telematics unit or a connected service platform, with a high volume of traffic or requests. DDoS attack amplifies the impact of a DoS attack by coordinating multiple compromised computers or devices (a botnet) to simultaneously flood the target with traffic.
These attacks pose operational disruptions and safety risks for the passengers and the vehicle.
Some mitigation strategies common in use are Traffic Filtering and Rate Limiting, Cloud-based Protection Services, Redundancy and Load Balancing, and IDS systems

2.1.4 Unauthorised Access to OBD Port



OBD ports are used for vehicle diagnostics, emissions monitoring and compliance, performance monitoring and vehicle security.
Unauthorized access to OBD ports is the most critical threat in automotive systems. Wired and wireless communications via OBD relays vehicle information, allows modification to configurations and vehicle essential data. This enables unauthorized accessor to even flash the ECUs, and CAM of the vehicle with altered or malicious codes, thus completely compromising the operational and functional security of the vehicle.
One of the most important mitigations that is industry standard practice is use of security certificates to be able to access and use the OBD port. Daimler and Ford have used this mitigation for unsecured and unauthorized access to OBD port. However, there still exists the threat of certificate forgery

2.1.5 Malware attacks



Malicious software designed to compromise the functionality, safety, or privacy of vehicles and their associated systems. These attacks can exploit vulnerabilities in onboard computers, electronic control units (ECUs), infotainment systems, telematics devices, and other interconnected components.
These includes Ransomwares, Remote Access Trojans, Key loggers, Infected USBs, and Bluetooth devices, Software updates over-the Air (SOTA) etc. These threats pose eminent risks to the safety of the passengers by compromising the functioning of essential vehicles components. Malware attacks can potentially interfere with critical vehicle systems such as brakes, steering, engine control units (ECUs), or advanced driver assistance systems (ADAS). This interference could lead to accidents, injuries, or fatalities if control over these systems is compromised. Malware can be used to collect sensitive information about vehicle occupants, such as location data, driver behavior, and personal preferences stored in infotainment systems or connected devices. Unauthorized access to this data can result in privacy violations and expose individuals to identity theft or surveillance.
Possible mitigations to malware attacks in automotive systems include secure software development practices (SDLC), encryption of communication channels, regular software updates, intrusion detection systems, and network segmentation

2021

Security Flaw on an emerging player in the 2 wheeler EV space

Incident: Researchers discovered a security flaw in Ola Electric's mobile application that could allow attackers to take control of certain features of the electric scooters remotely

Impact: The vulnerability could potentially be exploited to track the vehicle's location, unlock it, or disable its security features

Response: Company in a response actively patched the vulnerability and secured the app



3 After Market Phase

3.1 Rapidly emerging threats in Indian EV landscape

EV Charging stations- growing bottlenecks for attacks

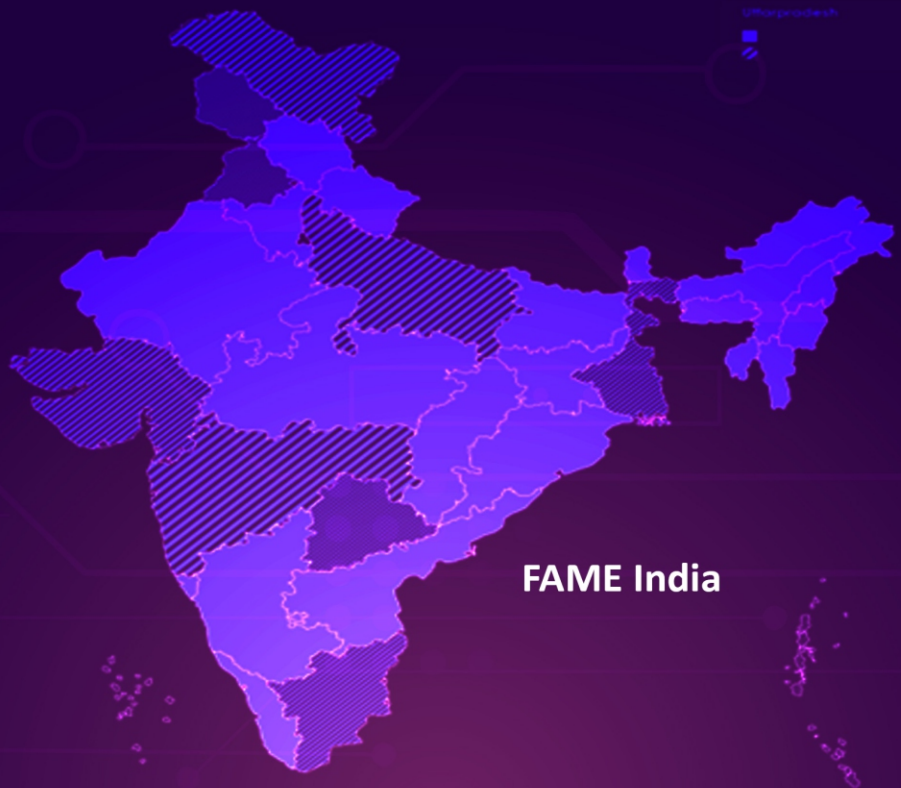
EVs make up for 15% of Global new car sales and are expected to gain substantial rise by 2040. With the EVs, the deployment of charging stations ramps up and more threat actors are exploring at exploiting the charging infrastructure.

Major threats include:

- Charging stations can be attacked remotely and a fake extensive charging demand is created- leading to a widespread denial of services.
- Compromise of the charging points to gain access to the customer information such as personal data and financial data such as credit card details, payment details etc.



The Department of Heavy Industries has also sanctioned 2636 charging stations in 62 cities across States/UTs under FAME India scheme phase II. State-wise allocation of these charging stations is as follows



3.2 Vulnerabilities in Electric Vehicle Charging Stations

Insecure Mobile Apps	Vulnerabilities in companion apps used for controlling or monitoring charging sessions could be exploited for unauthorized access or manipulation.
NFC Vulnerabilities	Weaknesses in NFC protocols may lead to unauthorized access or data manipulation during charging.
Exposed USB Ports	Charging stations with unprotected USB ports may be vulnerable to attacks from malicious devices.
V2G Communication disruption	Interfering with V2G (Vehicle-to-Grid) communication can disrupt energy exchange or grid balancing.
Denial-of-Service (DoS) Attacks	Overloading input channels with excessive requests or malicious data can disrupt the charging station's availability for legitimate users.

3.3 Mitigating IoT Security Risks

Intrusion Detection Systems	Deploy systems to detect and respond to unauthorized access or suspicious activities.
Firmware Updates	Regularly update firmware to address security vulnerabilities and incorporate the latest security features.
Network Segmentation	Isolate critical systems to limit exposure to potential cyber threats
Secure Communication Protocol	Use secure protocols to protect data integrity during charging sessions.
Access Controls	Implement strict access controls to limit physical and digital access to authorized personnel.

Fortifying the Digital Frontier:
Solutions for the Connected Automotive Industry





Pragmatic approach to safeguard the digital highway

Basic cyber hygine

Regular software updates:
Ensure all software, including operating systems and applications, is up-to-date with patches

Strong password policies:
Use complex passwords and change them regularly.
Implement multi-factor authentication (MFA) for an additional layer of security

Security operation center

Enhance expertise and capabilities to oversee the cybersecurity of vehicles on the roads comprehensive management of the **vehicle's digital lifecycle** and its configuration through digital twins.
Ultimately, establish a security operations center for vehicles that monitors data from both the vehicles and the broader digital ecosystem.

Access Controls

MFA:
Enforce usage of MFA for accessing critical information infra

Role based access control:
Limit the level of accesses to information based on staff's role. Conduct stringent review of accesses

Incident Responce

IR plan:
Detailed plan outlining the step-by- step approach in event of cyber incident

Incident Reporting:
Obligation to report CERT-In within 6 Hrs. of breach.

Regular Drills:
Familiarize staff with the responsibilities

Security by design

Establish a culture:
of digital security by design across engineering, quality assurance, and other core functions, ensuring that car software architectures incorporate security from the outset.

Necessitate a comprehensive overhaul of OEMs' software engineering and quality assurance practices.

leveraging security standards

Empower OEMs to meet regulatory and international standards for cybersecurity and to create and sustain secure software.

Implementing a Cybersecurity Management System (CSMS) can ensure the consistent application of cybersecurity practices across vehicles and the digital mobility ecosystem

United Nations Economic Commission for Europe cybersecurity requirements for Automotive Industry

Cybersecurity Management

- Identify and manage cyber risks associated with different vehicle types, including those involving suppliers and service providers
- Ensure that systems undergo security testing throughout both the development and production stages
- Track and address cyberattacks affecting various vehicle types
- Respond to emerging and evolving cyber threats and vulnerabilities
- Ensure security by design, including detailed design and testing of information, and gather comprehensive data.

Safeguarding vehicles and their ecosystems

- Build cybersecurity into system design and contain known vulnerabilities in used hardware/software components
- Assess the security of hardware and software components through methods such as vulnerability scans , penetration testing and code analysis
- Safeguard the integrity of hardware and software components from suppliers by implementing measures such as contractual clauses
- secure access to production environment including software servers and flashing process etc.

Delivering secure software updates

- Ensure complete traceability of software versions and vehicle configurations throughout the entire vehicle lifecycle, including both initial and updated software.
- Identify target vehicles for updates and assess impact on certified systems and compatibility with vehicle configuration
- Deliver software updates while maintaining the highest standards of safety and security.

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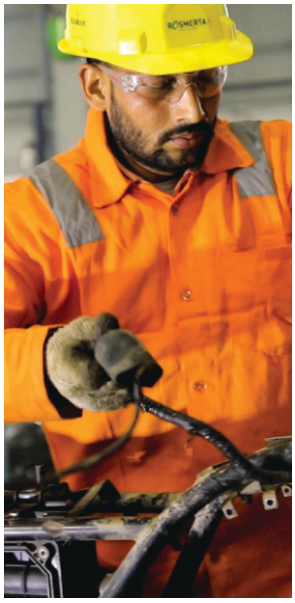

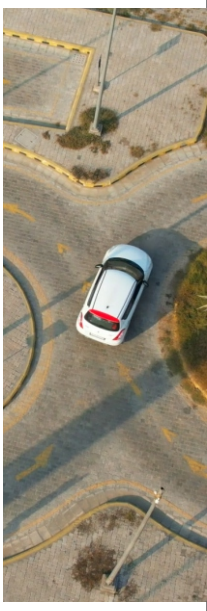

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- Diesel Exhaust Fluid (DEF)-Rosblu
- Pollution Under Control (PUC)



CONNECTED ELECTRONICS
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- Driver Monitoring & Alert System
- Smart Card Manufacturing (Banking & Telecom)





COMPLIANCE SERVICES
- Automated Testing Stations (ATS)
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- Last Mile Service Delivery
- Automotive Components and Accessories



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These remarkable fifty years have been a testament to our commitment: responding to customers with groundbreaking innovation, serving our community with boundless compassion, and building the nation with pride.

As an institution, we've consistently stayed ahead of the curve, dedicated to empowering both Indian and global OEMs. Our outlook centers on delivering excellence and playing a pivotal role in catalyzing paradigm shifts.

Keeping innovation as the core, we have developed a comprehensive product design, development, and testing facility that enables us to deliver cutting-edge solutions. We cater to a wide range of industries, from passenger cars to agriculture, construction and mining, medium & heavy commercial vehicles, and electric vehicles.

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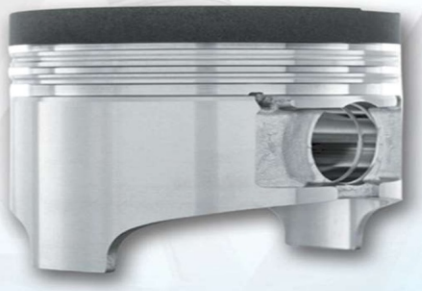





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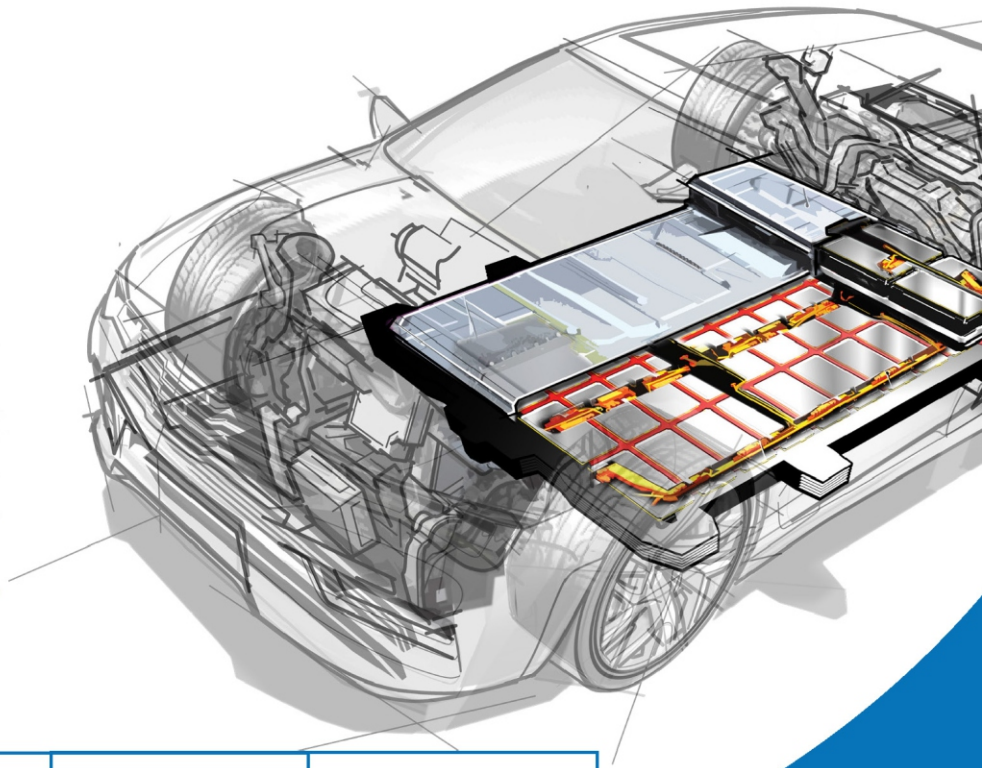



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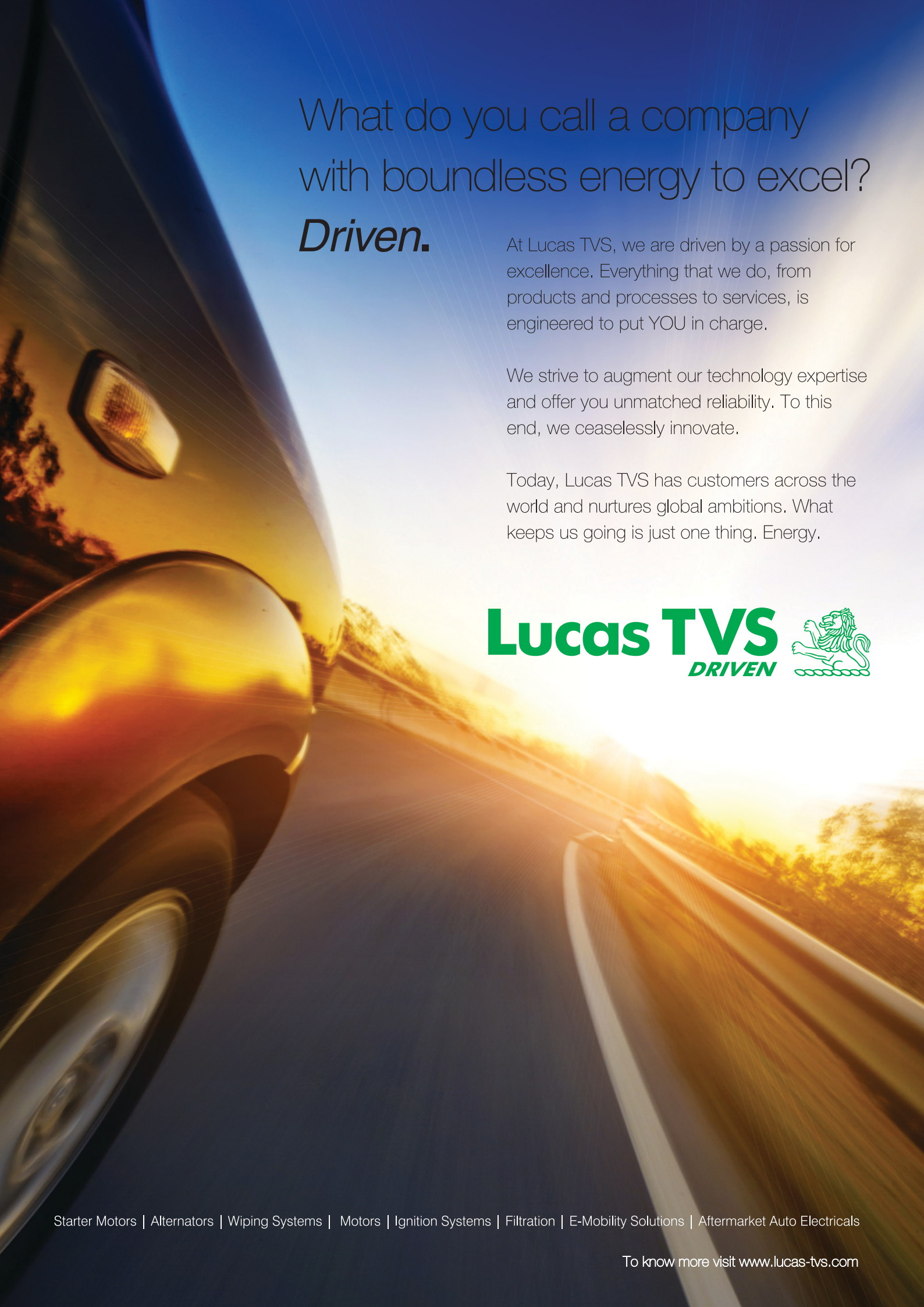
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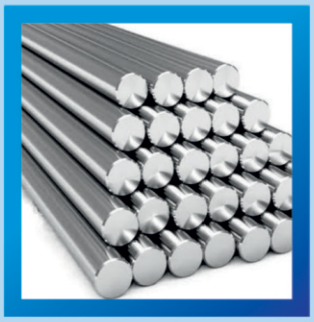

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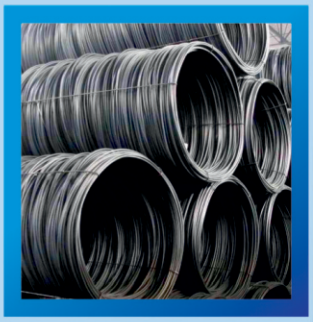

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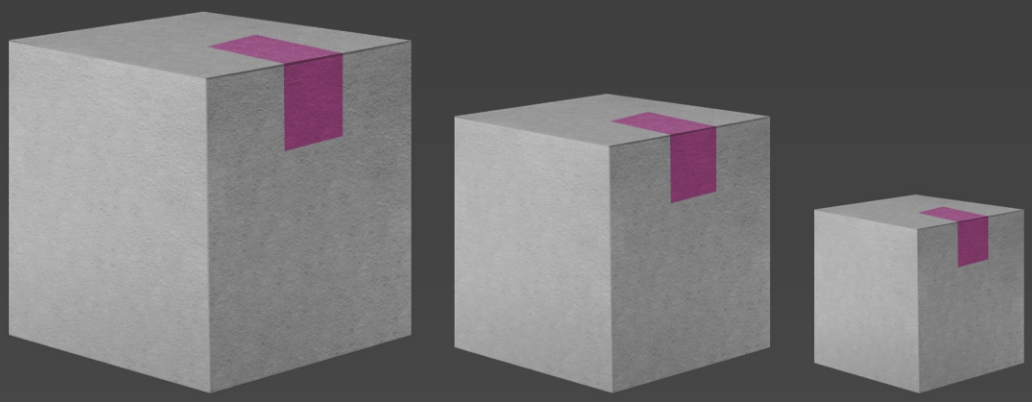

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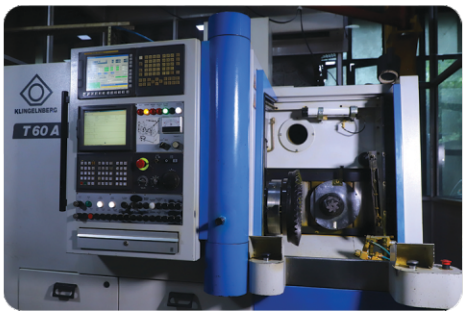

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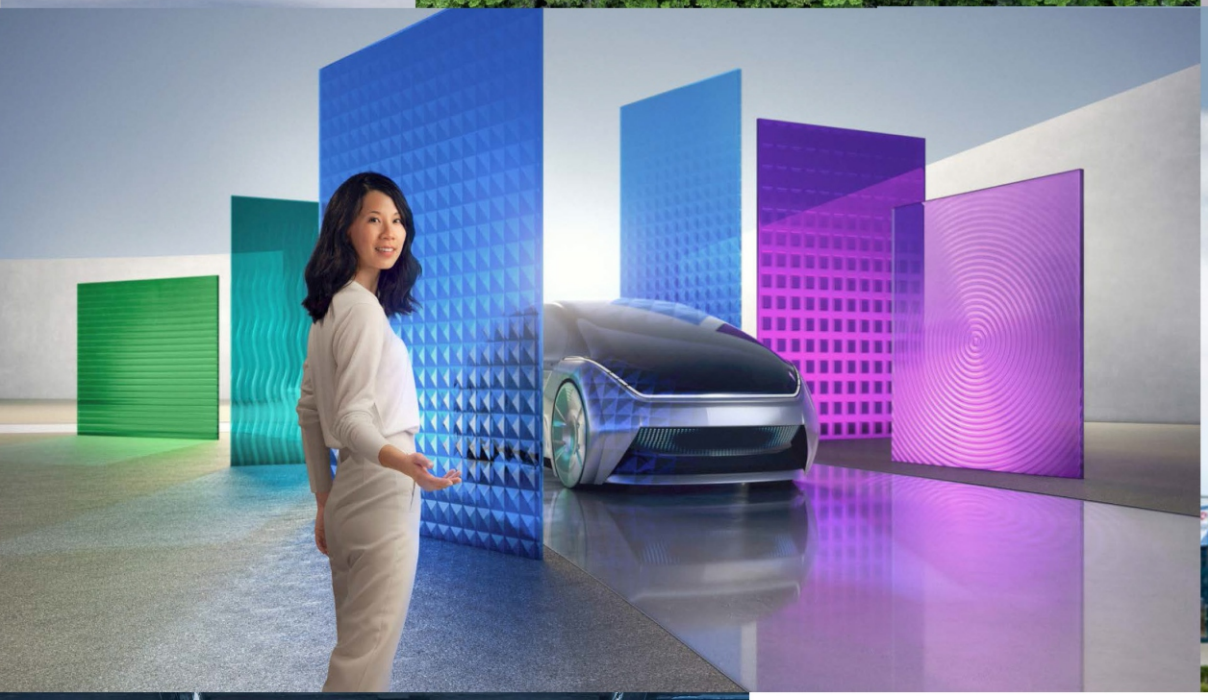





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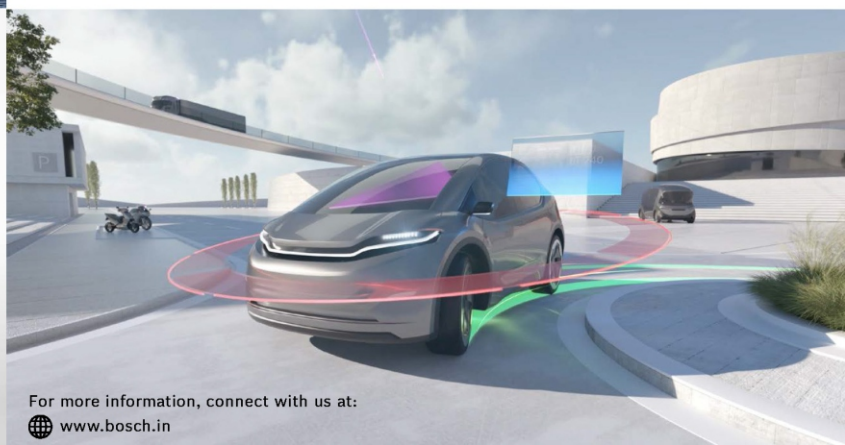

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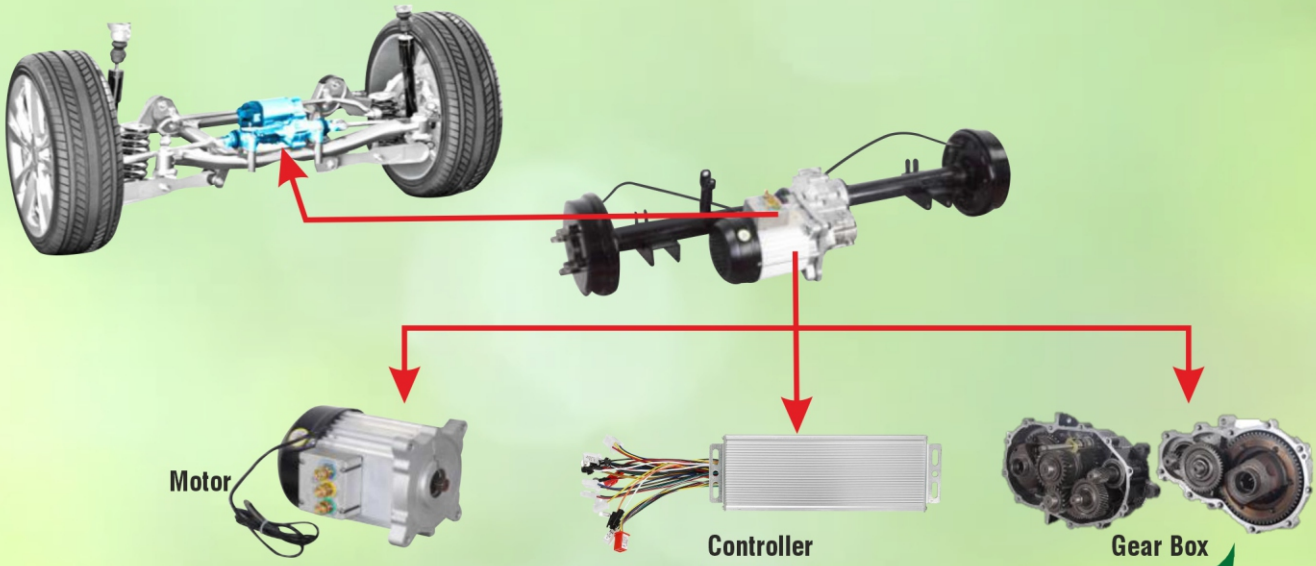

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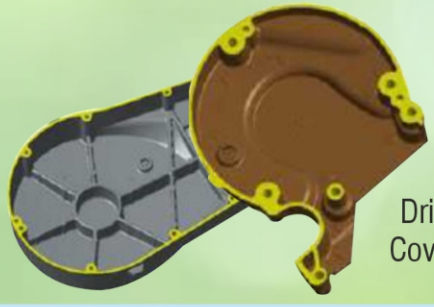

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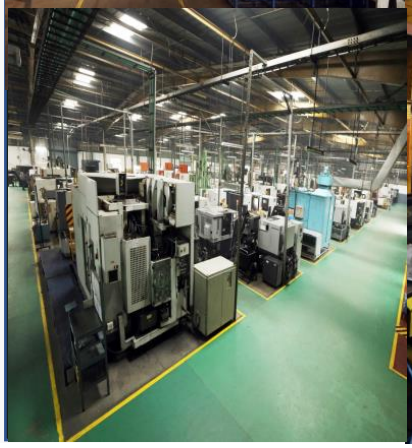







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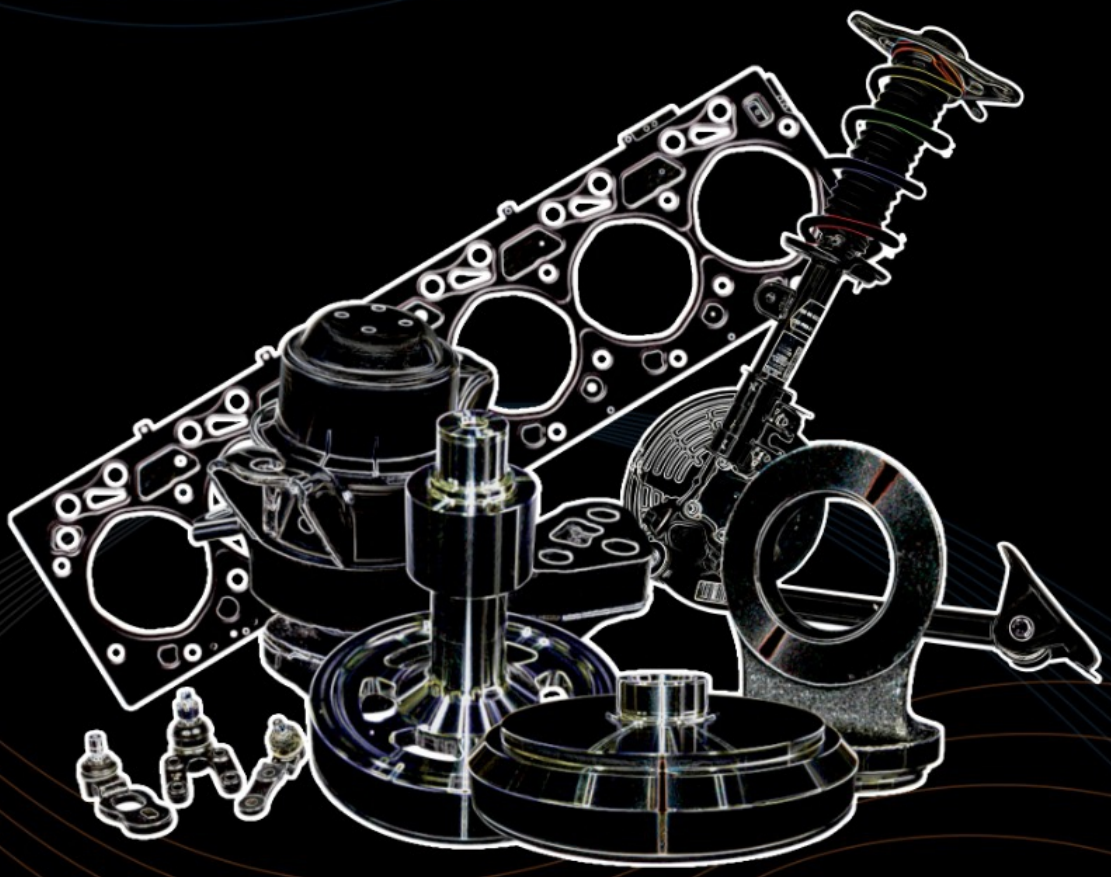

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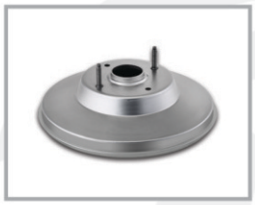
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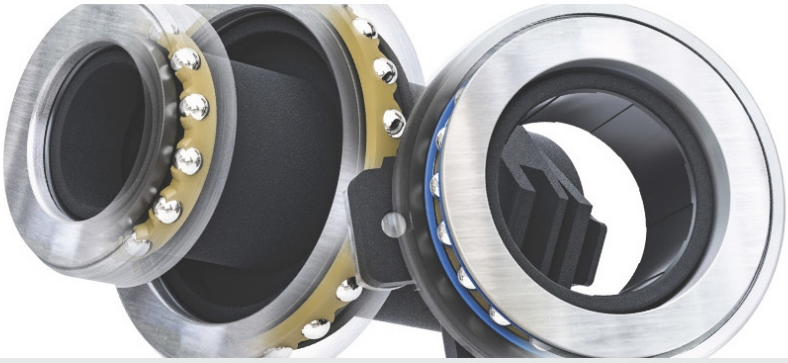

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High Power E-Cooling Compressor

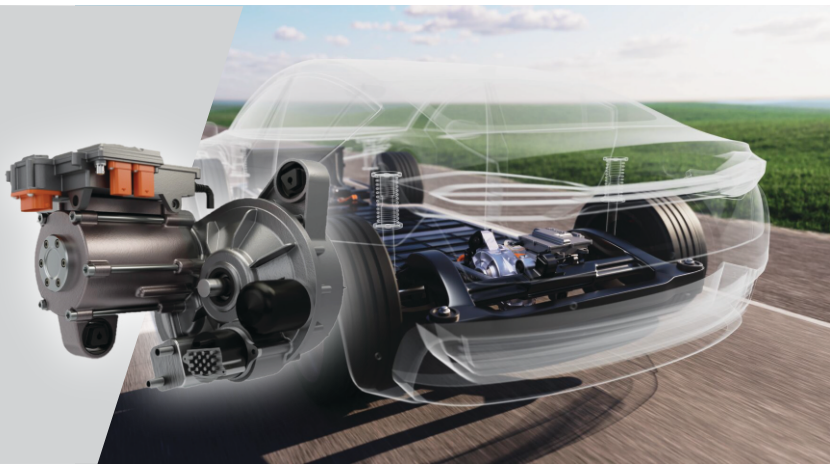
The innovative design offers a 2x smaller packaging for the same cooling / heating power and an oil-less configuration.



High-Speed E-Axle

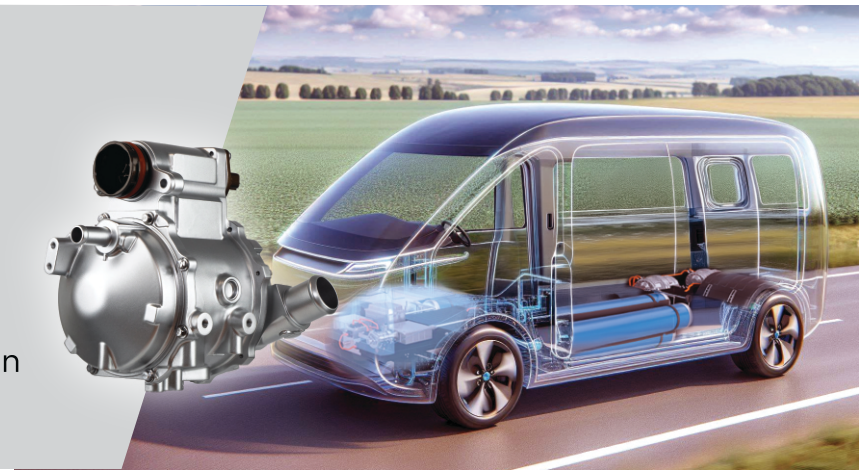
Our E-Axle maximizes efficiency by operating at +30,000 RPM, using ~40% less space*, being +30 kg lighter, and saving ~33% on rare materials.

**When compared to industry benchmarks*



Hydrogen Fuel Cell Compressor

Optional turbine expander uses 20% less power, while ultra-high -speed (>150 krpm) ensures a compact, high-performance design with maximized efficiency.



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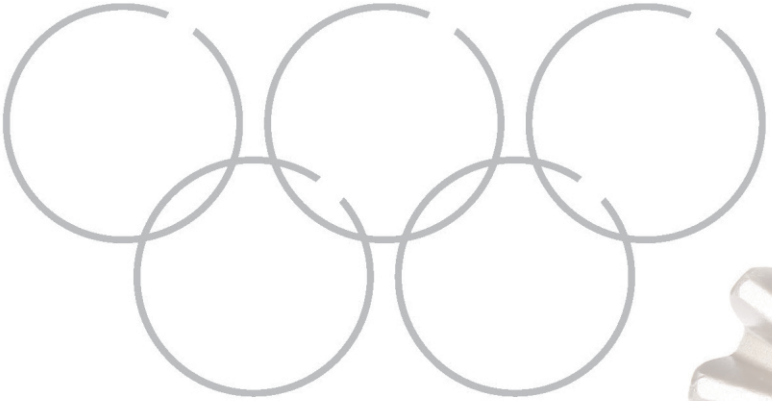



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Roop Polymers Ltd. was founded by Shri M.G. Jain in the year 1973 with the commencement of Roop Rubber Mills which is now known as Roop Polymers Ltd.





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- **Plastic Molding**
- **Rubber Extrusion**
- **Plastic Extrusion**
- **Paint Shop**
- **R&D Tooling Center and compounding**

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KOPP — Joint Venture with a German Company (Willhelm KOEPP Zellkautschuk GmbH & Co. KG) in india for Rubber Foam Products

MFS — Technical assistance agreement for the assembly of hydraulic brake hose, Fuel Hoses and Master Power Tubes in India

Tekno — Joint Venture with a Turkish Company (tekno Kaucuk Sanayi AS) for Rubber & Plastic white goods industry products

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Corporate Office: ROOP POLYMERS LTD.

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Factory Locations:

68, Rozkameo Industrial Area, Sohna, Gurgaon - 122103, Haryana

27/18, IDC, Mehrauli Road, Gurgaon - 122 001, Haryana

Plot No. 19, Sector 9, IIE, Sidcul, Pant Nagar - US Nagar - 263 153, Uttranchal

Gate No. 357/46, Waghjai Nagar, Kharabwadi, Chakan, Tal-Khed, Dist-Pune, Pin-410501, Maharashtra

F/2-Sipkot Industrial Park, Sriperumbudur, Chennai - 602105, Tamil Nadu

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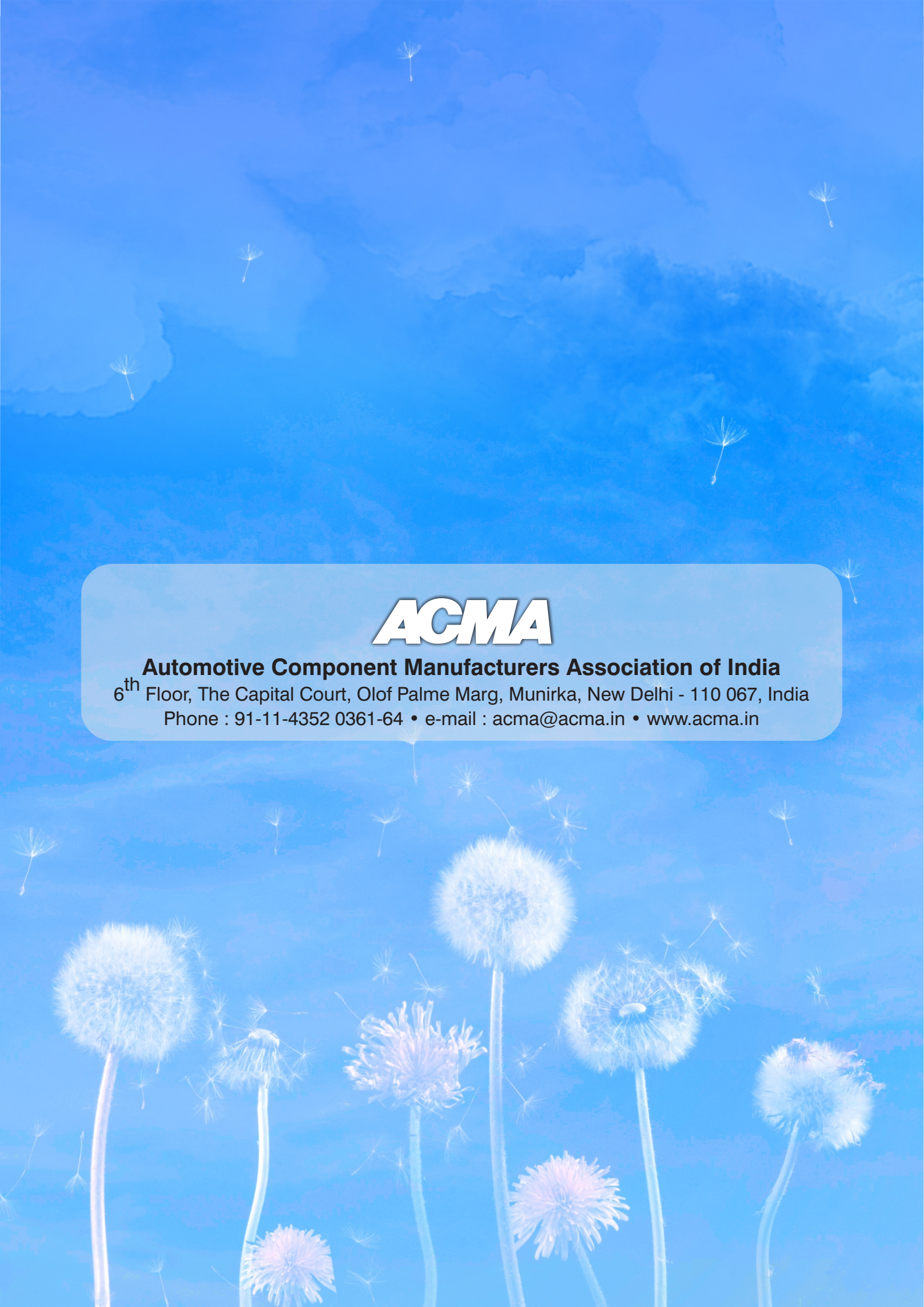

Automotive Component Manufacturers Association of India

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