Crisil
Intelligence

Assessment of Electric Two-wheeler Industry in India – QIP Report

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A. Overview of the Global Economy

Review and Outlook of Global GDP

The global economy registered steady growth of 3.4% in CY2025 and was initially projected to maintain this trajectory, with expansions of 3.3% in CY2026 and 3.2% in CY2027, according to the IMF's World Economic Outlook (January 2026). However, the onset of conflict in West Asia has introduced notable downside risks to this outlook. The crisis has impacted economic stability through damage to critical infrastructure, disruptions in transportation and supply chains, and escalating humanitarian challenges. These factors have contributed to higher commodity prices, increased inflationary pressures, and heightened market volatility, with import-dependent developing economies bearing a disproportionate impact.

As a result, global growth expectations have been revised downwards. According to the IMF's April 2026 estimates, global GDP growth is now projected at 3.1% in CY2026 and 3.2% in CY2027, reflecting a moderation from the 3.4% growth recorded in CY2025. While trade policy challenges persist, the adverse effects are being partly mitigated by increased investments in technology—particularly artificial intelligence—along with supportive government policies and the resilience and adaptability of businesses. Nevertheless, uncertainty surrounding trade dynamics, macroeconomic policies, and geopolitical developments is expected to remain elevated through CY2027.

Growth in advanced economies, including the United States, the United Kingdom, the Euro area, and Japan, is projected at 1.8% in CY2026 and 1.7% in CY2027. The West Asia conflict has exerted additional pressure on these economies, with an estimated drag of approximately 0.1 percentage points on growth in CY2026.

In emerging markets and developing economies—such as China, Russia, Brazil, Mexico, and India—growth is expected to moderate to 3.9% in CY2026 before recovering to 4.2% in CY2027. The impact of the Middle East conflict varies across countries, depending on factors such as geographic proximity, trade and financial linkages, remittance flows, and energy dependencies.

Against this backdrop, India's growth outlook remains relatively resilient despite the uncertain global environment. The country's continued economic expansion is being supported by robust private consumption, increasing investment activity, and sustained government focus on infrastructure development.

GDP growth (% y-o-y) of key economies

** Euro area comprises 19 member countries of the EU*
Source: International Monetary Fund (IMF); World Economic Outlook (WEO) – April 2026 update

Real gross domestic product (GDP) in the US was revised to 1.6% (annualised) in the first quarter of 2026 from the previous estimate of 2%, driven by revisions in consumer spending and investments. But growth remained stronger than 0.5% in the previous quarter led by higher government gross expenditure and investment (4.4% vs -5.6%) and exports (13.1% vs -3.2%). CPI-based inflation rose to 4.2% in May from 3.8% in April and ~1.8 percentage points above the pre-conflict level in February.

In the first quarter of 2026, growth in the eurozone was revised to -0.2% from the previous estimate of 0.1%. This is the first contraction since the fourth quarter of 2022. According to the flash estimate, inflation rose to 3.2% in May from 3% in April and ~1.3 percentage points higher than the pre-conflict level. Higher core inflation (CPI, excluding energy, food, alcohol and tobacco) was the primary driver (2.5% vs 2.2%), led by a rise in services inflation (3.5% vs 3%). Energy inflation inched up to 10.9% from 10.8%. In June, the ECB raised rates by 25 bps, the first hike since 2023. Deposit rate stood at 2.25% and the main refinancing facility at 2.4%.

GDP growth (Q-o-Q SA annualized, %)

	Q1-CY25	Q2-CY25	Q3-CY25	Q4-CY25	Q1-CY26
US	-0.6	3.8	4.4	0.5	1.6
Euro area#	0.7	0.1	0.3	0.2	-0.2
Japan	2.0	1.1	-2.3	0.7	1.8
China*	5.4	5.2	4.8	4.5	5.0
India*	7.0	6.8	8.3	8.0	7.8

*Note: *: y-o-y growth, #: Not Annualized*
Source: Statistical Bureau, respective countries

Consumer price inflation (year-on-year, %)

	Oct-25	Nov-25	Dec-25	Jan-26	Feb-26	Mar-26	Apr-26
US	-	2.7	2.7	2.4	2.4	3.3	3.8
Euro area	2.1	2.1	2.0	1.7	1.9	2.6	3.0
Japan	3.0	2.9	2.1	1.5	1.3	1.5	-
China	0.2	0.7	0.8	0.2	1.3	1.0	1.2
India	0.3	0.7	1.3	2.7	3.2	3.4	-

Source: Statistical Bureau, respective countries

Japan's economy accelerated at an annualised 1.8% in the first quarter of 2026 from 0.7% in the fourth quarter of 2025, led by a rise in private consumption and exports. Private consumption rose to 1.4% (vs 0.3%), while exports grew to 7.4% (vs 0.8%). Public investment also picked up to 6.1% (vs -0.5%) after declining for two straight quarters. More recently, on 16 June, the Bank of Japan hiked its policy rate by 25 bps to 1%, the highest since 1995 by a 7-1 majority.

The S&P Global RatingDog China General Manufacturing PMI eased to 51.8 in May from 52.2 in April. Demand continued to rise, albeit at a softer pace compared with April. Input costs continued to rise at a faster-than-average pace, given higher energy and raw material costs and supply chain disruptions. The RatingDog China General Services PMI

rose to 54.4 from 52.6, driven by higher demand for services. Inflation remained at 1.2% in May as a sharper fall in food prices (-1.7% in May vs -1.6% in April) offset the rise in non-food inflation (1.9% vs 1.8%). The People's Bank of China maintained the seven-day repurchase rate at 1.4% and the one-year loan prime rate at 3% in May.

As per the International Monetary Fund's (IMF) World Economic Outlook:

- **Advanced economies** are projected to grow at 1.8% in CY2026, moderating slightly to 1.7% in CY2027. The ongoing conflict in West Asia is expected to exert a marginal drag on growth in these economies, reflecting its impact on trade flows, energy prices, and overall economic sentiment.
- **The United States** economy is forecast to expand by 2.3% in CY2026, supported by easing monetary policy and a relatively accommodative fiscal stance. Additionally, the adverse effects of heightened trade barriers introduced since April 2025 are expected to gradually diminish, contributing to improved economic stability. While the West Asia conflict may have a limited negative impact on the U.S., this is likely to be offset by a rebound in economic activity observed in early 2026.
- **The Euro area** is expected to experience a moderation in growth, with GDP projected to decline from 1.4% in CY2025 to 1.1% in CY2026, before recovering modestly to 1.2% in CY2027. This slowdown is primarily attributed to heightened geopolitical uncertainties, a pronounced contraction in the manufacturing sector, subdued export performance, and the adverse effects of energy price shocks. Inflation in the region is anticipated to remain slightly elevated, easing to 2.2% by CY2027.
- **Emerging markets and developing economies (EMDEs)** are projected to see growth moderate to 3.9% in CY2026, followed by a recovery to 4.2% in CY2027. The impact of the West Asia conflict on these economies is more pronounced, given their varying degrees of exposure through geographic proximity, financial linkages, remittance inflows, and energy dependencies. Consequently, growth projections for EMDEs have been revised downward for CY2026 compared to earlier IMF estimates.
- **China's** economy recorded growth of 5.0% in CY2025, supported by increased policy bank lending for investment and relatively lower effective tariff rates on exports to the United States. However, growth is expected to moderate to 4.4% in CY2026 and further to 4.0% in CY2027, partly reflecting the adverse external shock stemming from the West Asia conflict.
- **India's** economy demonstrated robust performance, with growth estimated at 7.6% in CY2025, driven by strong momentum in the latter half of the year. Building on this high base, growth is projected to moderate to 6.5% in both CY2026 and CY2027, while remaining among the fastest-growing major economies globally.

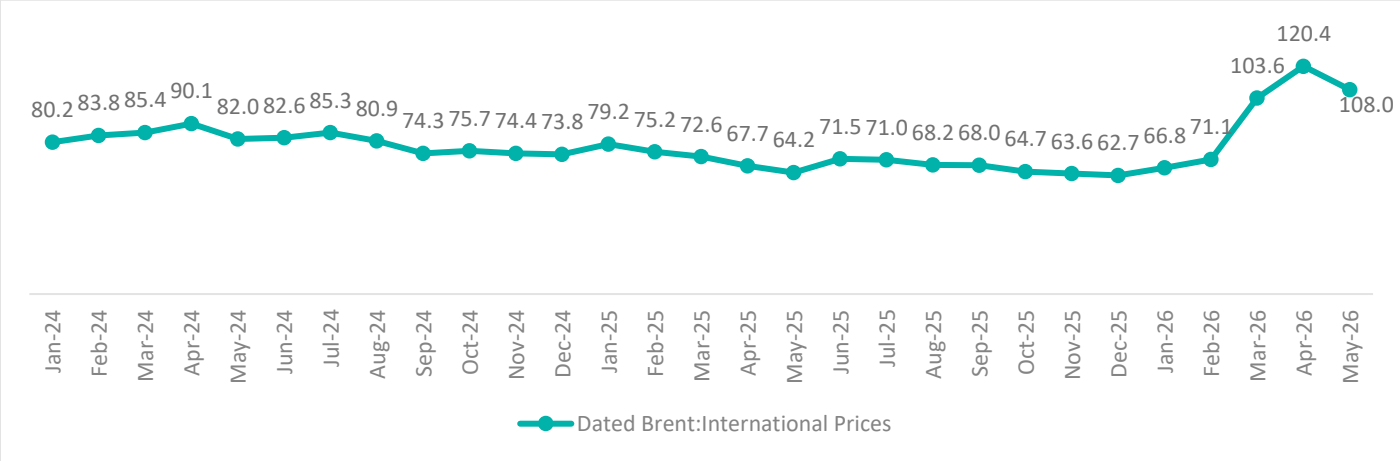
Crude oil prices surge on critical transit disruptions

Crude oil prices experienced a significant surge in March 2026, rising by 45% to an average of USD 103.6 per barrel. This sharp increase was largely driven by escalating geopolitical tensions in the Middle East, which raised concerns over potential supply disruptions. In particular, fears surrounding possible interruptions to oil flows through the strategically vital Strait of Hormuz prompted investors to incorporate a substantial risk premium into crude prices, thereby fuelling the upward momentum.

In April 2026, crude oil prices further spiked by 16.2%, reaching an average of USD 120.4 per barrel. This escalation was primarily attributed to severe supply disruptions stemming from the ongoing West Asia conflict, which effectively led to the closure of the Strait of Hormuz. The resulting crisis triggered one of the largest oil supply shocks in history, removing a significant portion of global supply from the market and intensifying price pressures. However, recently the crude oil prices dropped by 10% in May 2026 reaching USD 108 per barrel. The decline reflected easing of shipping disruptions.

Looking ahead, crude oil prices in the first quarter of fiscal year 2027 are estimated to range between USD 105-115 per barrel, compared to USD 67.8 per barrel during the same period in fiscal 2026. The steep increase is expected to be driven by near-term supply tightness and logistical constraints, including partial rerouting of supply chains. However, as supply conditions stabilize and transit routes normalize over time, prices are projected to moderate, averaging approximately USD 90-95 per barrel for the full fiscal year 2027.

Brent Crude prices (USD/barrel)



Sources: CRISIL Intelligence

In contrast, fiscal year 2026 witnessed a decline in crude oil prices to an average of USD 70 per barrel, down from USD 79 per barrel in fiscal 2025. This decrease was primarily supported by subdued demand growth, influenced by trade uncertainties arising from tariff impositions, as well as a stable supply environment—particularly from non-OPEC producers. Additionally, OPEC nations increased output in a phased manner during the second quarter of 2025, contributing to elevated supply levels and downward pressure on prices. By December 2025, OPEC+ had fully reversed its voluntary production cuts of approximately 2.8–3.0 million barrels per day and subsequently announced a pause on further production increases in the first quarter of 2026. Although prices experienced short-lived spikes due to US sanctions on Russia and geopolitical tensions in the Middle East during mid-2025, they eventually stabilized within the USD 65–70 per barrel range.

From a demand perspective, global crude oil consumption continues to be heavily influenced by aviation fuel requirements. However, the ongoing transition toward alternative energy sources and increasing electric vehicle (EV) penetration are expected to exert downward pressure on traditional transportation fuel demand over the longer term.

The outlook remains highly contingent on the evolution of supply and transit conditions. Continued disruptions could sustain upward pressure on prices, while improvements—particularly in the reopening or normalization of transit routes such as the Strait of Hormuz—may help ease price levels. In the near term, crude oil prices are expected to remain volatile, driven by persistent geopolitical risks and uncertainty regarding the duration and severity of current supply disruptions.

Navigating the West Asia conflict

The global economy, previously expected to maintain a steady expansion, is now projected to moderate to 3.2% growth in 2026, compared with 3.4% in the preceding year. This downward revision reflects a deterioration in the external environment, driven principally by a severe energy market shock and rising geopolitical risk.

A major disruption to global energy supply has emerged following the partial destruction and shutdown of a key liquefied natural gas facility in Qatar, alongside closures of select oil production assets in West Asia. Compounding these supply-

side constraints, maritime traffic through the Strait of Hormuz has become restricted, with passage limited to certain vessels. Given that the Strait accounts for approximately one-fifth of global oil flows, any sustained impairment to transit through this corridor represents a systemic shock to global energy markets.

The impact of the disruption is expected to be most acute in Europe and Asia, where economies remain structurally dependent on imported energy. Reduced availability of oil and liquefied natural gas, combined with elevated risk premiums, is likely to exert upward pressure on energy prices, increase import bills, and weigh on household and corporate purchasing power.

For Asia-Pacific, the shock is particularly significant. The region continues to benefit from resilient domestic activity and robust demand for technology-related exports. However, these supportive factors are increasingly being offset by the economic consequences of the conflict in West Asia, higher energy costs, and uncertainty surrounding changes in United States trade policy, including tariff measures.

Several major Asian economies—including India, Indonesia, Japan, Malaysia, and Thailand—are exposed to higher energy prices due to their reliance on energy imports from West Asia. A prolonged increase in oil and gas prices would likely weaken real incomes, compress corporate margins, and dampen domestic consumption and investment. It would also place additional pressure on fiscal balances, particularly in countries where governments provide fuel subsidies or other energy-related support measures.

The inflationary impact is likely to vary across economies, depending on energy intensity, exchange-rate movements, subsidy frameworks, and the degree of pass-through to consumers. While inflation remains relatively constrained in much of the region, central banks may need to remain vigilant against indirect impact on the economy, particularly if higher energy prices become embedded in broader price expectations.

At this stage, monetary authorities retain scope to adopt a measured approach, given the still-benign inflation environment in many Asian markets. However, policy flexibility could narrow if energy prices remain elevated or if currency depreciation intensifies imported inflation pressures. Exchange rates across the region may come under renewed downward pressure as higher energy import costs widen current account deficits and increase demand for foreign currency.

West Asia is a crucial supplier of energy (including crude oil and petroleum products, and natural gas), fertilisers and industrial raw materials. The Indian economy has deep linkages to West Asia through trade, remittances and investments. The region accounts for 40-50% of India’s oil imports, 13% of goods exports, 38% of remittance inflows and 8% of foreign direct investment (FDI) inflows.

Domestic requirement of energy and supply through strait of Hormuz in fiscal 2026

Energy source	Domestic requirements imported in FY26*	Imports through the Strait of Hormuz in FY26
Crude oil	88.7%	46%
LPG	66.4%	85-95%
LNG	50.2%	56%

Note: Data on imports is for April-February 2026
Source: Petroleum Planning and Analysis Cell, Ministry of Petroleum and Natural Gas, Crisil Intelligence

Under an adverse scenario in which the conflict in West Asia persists, causing deeper supply disruptions and a slower recovery in regional energy exports, India would face a more prolonged and broad-based energy shock. Following an initial price spike, Brent crude is expected to average around USD

90–95 per barrel during the fiscal year, assuming the Strait of Hormuz remains partially operational for select countries, including India.

Over time, the shock is likely to evolve from an initial oil price shock and gas supply shock into a more entrenched and broad-based energy price shock. Elevated input costs are expected to persist through much of the year, compressing producer margins across energy-intensive sectors. At the same time, firms' ability to pass on higher costs to consumers may be constrained as inflationary pressures build and household purchasing power weakens.

As a result, downside risks to growth are likely to intensify. India's GDP growth is expected to moderate to around 6.6% in fiscal 2027 under this scenario, reflecting weaker domestic demand, tighter cost conditions for businesses, and softer external demand.

Higher prices for crude oil, natural gas, and downstream energy-linked inputs would raise production costs across major sectors of the economy. The impact would extend beyond direct fuel use, with second-round effects visible in transportation, logistics, packaging, petrochemical-based inputs, and other raw materials.

Exports may face headwinds from slower global growth, higher shipping costs, and continued logistics constraints. Energy-related disruptions could also weaken external competitiveness by raising production and transport costs for Indian exporters.

On the domestic front, private consumption—currently the strongest driver of growth—could soften. The main transmission channels would be slower agricultural income growth, higher retail fuel and food prices, and reduced discretionary spending by households. This would be particularly relevant for lower- and middle-income consumers, who are more sensitive to energy and food inflation.

Impact on the Automotive Industry

The ongoing geopolitical tensions between Iran and the United States are having a notable impact on India's automotive industry, primarily through elevated crude oil prices and rising input costs. Given India's significant dependence on crude oil imports, any sustained increase in global oil prices—particularly in the range of USD 90–100 per barrel—translates into higher domestic fuel prices. Fuel prices have already risen by approximately ₹10 per litre since the onset of the West Asia conflict, which has begun to weigh on consumer sentiment.

Rising fuel costs increase the overall cost of vehicle ownership, thereby affecting demand, especially in price-sensitive segments such as two-wheelers and entry-level passenger vehicles. Consumers in these categories are more likely to postpone or reassess purchase decisions in response to higher recurring expenses, potentially leading to moderation in volume growth.

On the supply side, the sector is facing mounting pressures from higher raw material costs. Key inputs such as steel, aluminium, and petrochemical derivatives are expected to witness price increases in the range of 5–15% by fiscal year 2027. This escalation is likely to compress automaker margins and could necessitate further vehicle price hikes to partially offset rising costs.

Additionally, any disruption in critical maritime routes—particularly the Strait of Hormuz—has the potential to increase freight and logistics costs significantly, adding another layer of pressure across the value chain.

Although demand has remained relatively stable thus far, persistently high oil prices and broader inflationary pressures pose a downside risk to future growth. If these conditions persist, they could lead to a slowdown in demand and continued margin pressure across the industry.

Moreover, US and Iran signed an MoU on 17th June 2026 to end the conflict and to reopen the strait of Hormuz

B. Overview of the Indian Economy

Review of GDP growth over fiscals 2023-2026 and Outlook for fiscals 2027-2031

As per IMF World economic outlook April 2026, India has become the sixth largest economy from the previous fourth place ranking, falling behind UK and Japan. The decline is driven by the depreciation of Indian rupee against the US dollar and a downgrade revision of GDP. Despite this, India continues to be among the world's fastest growing major economy with real GDP growth projection between 6-7%, outpacing its global peers.

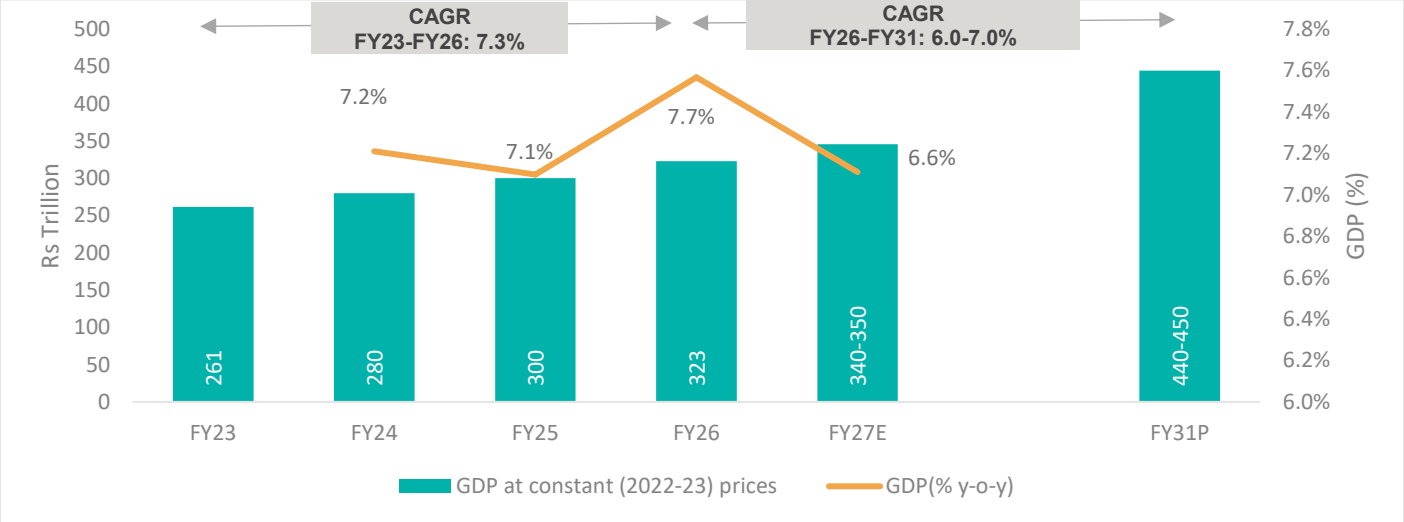
The Indian economy logged 7.3% CAGR between fiscals 2023 and 2026 (as per the new series). Economic growth was supported by benign crude oil prices, soft interest rates and low current account deficit. The Indian government also undertook key reforms and initiatives, such as Saptarishi priorities focused on infrastructure, green growth (economic growth ensuring sustainable use of natural resources), youth empowerment financial inclusion initiatives, and gradual opening of sectors such as retail, e-commerce, defense, railways, and insurance for foreign direct investments (FDIs). Growth exceeded expectations in fiscal 2024 supported by higher public capex and strong industrial activity.

According to the National Statistics Offices (NSO), India's real gross domestic product (GDP) grew at 7.7% for the fiscal 2026, slightly higher than second advance estimates of 7.4%. The GDP growth accelerated by private consumption followed by fiscal support such as tax cuts, GST cuts and lower interest rates. The sentiments improved in private investments with recovery in private capex underway, driven by emerging sectors like green hydrogen, semiconductor, battery manufacturing and data centers are the key growth areas.

In fiscal 2027, however, growth is likely to weaken amid multiple headwinds, including higher prices of crude oil and other commodities, softer global growth and the forecast of a below-normal monsoon. Global supply chain disruptions are already intensifying cost pressures and reduced input availability is expected to add to the pressure.

CRISIL expects GDP growth forecast for fiscal 2027 at 6.6% with risks tilted to the downside. Despite the slowdown in real GDP, the nominal GDP growth is set to be higher due to higher inflation based on both Wholesale Price Index and the Consumer Price Index

India's GDP growth trend and outlook



Note 1: E- estimated, P – projected
Note 2: A new national accounts series has been released with 2022-23 as the base year, superseding the 2011-12 series, with figures available FY23 onwards

Source: National Statistical Office (NSO), IMF, Crisil Intelligence estimates

Near-term Review and Outlook on GDP

Steady growth in industrial and Services GVA

The industrial sector continues to play a pivotal role in the Indian economy, contributing approximately 30% to the overall Gross Value Added (GVA). Over the fiscal period 2023–2026, the sector demonstrated strong performance, registering a compound annual growth rate (CAGR) of 9.2%. In fiscal 2026, industrial GVA growth remained healthy at 8.8%. However, the manufacturing segment began to face emerging challenges, primarily due to rising input costs driven by supply chain disruptions and escalating global commodity prices following the onset of the West Asia conflict.

The services sector, which accounts for nearly 53% of total GVA, also exhibited robust growth. During the fiscal 2023–2026 period, it expanded at a CAGR of approximately 8%. In fiscal 2026, services GVA grew by an impressive 9%, an improvement over the 7.9% growth recorded in fiscal 2025, underscoring the sector's resilience and its critical contribution to overall economic expansion.

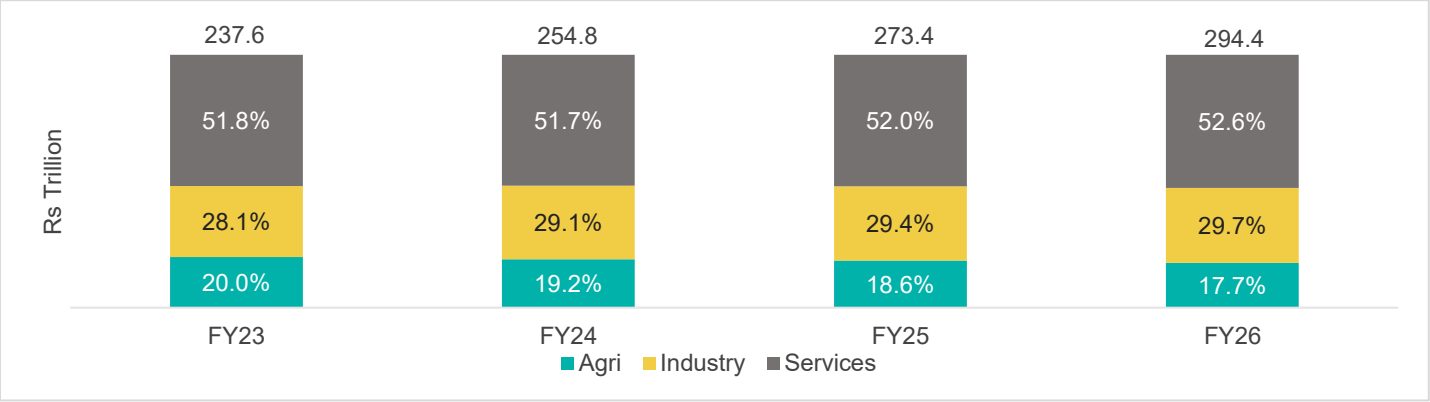
The agriculture and allied sectors have shown consistent and stable performance over recent years, supported by largely favourable monsoon conditions. Rainfall patterns have generally remained within acceptable deviation limits, contributing to steady agricultural output. Over the fiscal 2023–2026 period, the sector recorded a CAGR of 3.1%, despite a relatively moderate growth of 2.5% in fiscal 2024.

Fiscal 2024 was marked by an uneven spatial distribution of rainfall, with overall monsoon precipitation recorded at 6% below the long-period average (LPA). In contrast, fiscal 2025 witnessed a strong recovery, with India receiving 108% of the LPA—an 8% surplus—during the June to September monsoon season.

In fiscal 2026, the country again experienced above-normal rainfall, with total precipitation reaching 108% of the LPA. These favourable climatic conditions supported agricultural activity, resulting in Agri GVA growth of 2.4%, following a robust 4.6% growth in fiscal 2025.

Looking ahead to fiscal 2027, the anticipated El Niño conditions are expected to adversely impact monsoon patterns, which may, in turn, exert pressure on agricultural output and growth in the sector.

Share of sector in GVA at constant prices



Note: A new national accounts series has been released with 2022-23 as the base year, superseding the 2011-12 series, with figures available FY23 onwards
Source: NSO

Outlook on GDP

As per CRISIL estimates, India's GDP growth is projected to moderate to 6.6% in fiscal 2027, with risks predominantly tilted to the downside. While real GDP growth is expected to decelerate, nominal GDP growth is likely to remain relatively elevated, supported by higher inflation as reflected in both the Wholesale Price Index (WPI) and the Consumer Price Index (CPI).

The anticipated slowdown in growth can be attributed to a combination of factors, including elevated crude oil and commodity prices, weakening global economic conditions, and expectations of a below-normal monsoon. Ongoing global supply chain disruptions are further intensifying input cost pressures, while constraints on input availability are expected to weigh on industrial output.

Growth in fiscal 2026 exceeded expectations, supported by favourable macroeconomic conditions such as fiscal measures boosting private consumption, monetary easing through policy rate cuts by the Reserve Bank of India, robust global demand, low inflation, a favourable monsoon, and subdued crude oil prices. However, many of these supportive factors are expected to reverse in fiscal 2027, thereby exerting pressure on overall economic activity.

The Indian economy benefitted from relatively low crude oil prices in fiscal 2026, averaging around $70 per barrel. In contrast, following the escalation of tensions in West Asia, oil prices have surged to multi-year highs and are expected to remain elevated in fiscal 2027, averaging $90–95 per barrel, as per CRISIL Intelligence. This is likely to contribute to heightened inflationary pressures and impact economic stability.

On the agricultural front, the India Meteorological Department (IMD) has projected rainfall at around 90% of the long-period average (LPA) during the 2026 southwest monsoon season, indicating below-normal precipitation. The potential onset of El Niño conditions further exacerbates risks to agricultural output. A weaker monsoon, coupled with El Niño effects and a low base, is expected to push up food inflation, thereby limiting the scope for accommodative monetary policy.

Overall, the growth outlook remains subject to downside risks. Global demand is expected to soften in calendar year 2026, partly due to geopolitical tensions stemming from the West Asia conflict, which may adversely affect India's exports. Nevertheless, fiscal policy is expected to play a key supportive role. Continued focus on capital expenditure by the central government, progress in Goods and Services Tax (GST) rationalisation, and direct income support measures by state governments are likely to help cushion growth and sustain domestic demand.

India to remain a global outperformer

India's growth is expected to outperform other emerging and advance economies in the medium run. Its steady growth momentum will be accelerated by resilient domestic demand, with rural consumption gaining momentum, rise in urban spending and private investment increasing at a faster rate. We expect GDP growth to average 6-7% between fiscals 2026 and 2031, compared with 3.3% globally as estimated by the IMF.

Near-term Review and Outlook on Inflation

Consumer Price Index (CPI)-based inflation edged up marginally to 3.48% in April 2026 from 3.40% in March 2026. Despite the West Asia conflict entering its second month during April, the transmission of upside risks to retail inflation has been gradual. Notably, the anticipated pass-through of elevated energy and input costs to end-consumer prices across goods and services has yet to fully materialise, as reflected in stable core inflation, which remained unchanged at 3.7% for the fourth consecutive month.

In contrast, Wholesale Price Index (WPI)-based inflation witnessed a sharp spike, rising to a 42-month high of 8.3% in April 2026 from 3.9% in March 2026. This increase reflects the early impact of the West Asia conflict on input costs across multiple sectors.

The revised inflation outlook is primarily driven by an upward revision in crude oil price assumptions and the associated spillover effects for fiscal 2027, compounded by persistent geopolitical uncertainties. Global fuel prices have continued to rise, exerting significant pressure on transportation costs, particularly petrol, diesel, compressed natural gas (CNG), and airfares.

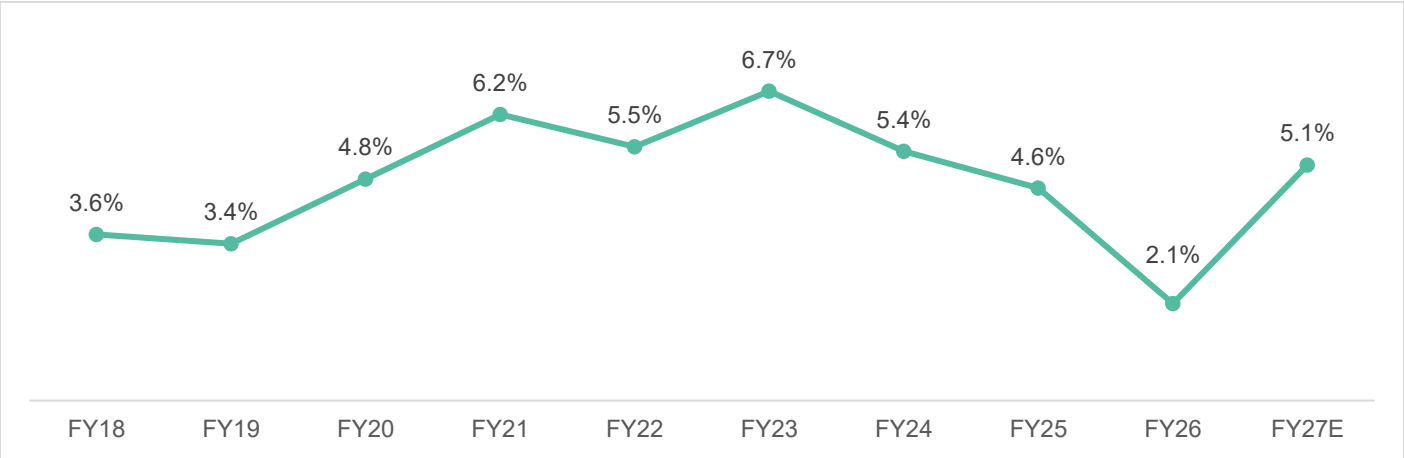
CRISIL estimates CPI inflation to average 5.1% in fiscal 2027, a sharp increase compared to 2.1% in fiscal 2026. This projected rise is largely attributed to a favourable base effect in the previous year, coupled with expectations of intensifying price pressures across key consumption segments, as higher fuel costs are passed on to consumers and manufacturers transfer elevated input costs through pricing.

Elevated input cost pressures, as indicated by the sharp rise in WPI inflation, are expected to gradually transmit into core inflation, as producers seek to protect margins. The rise in crude oil prices is already being reflected in retail fuel prices, particularly petrol and diesel, which together carry a weight of approximately 4.8% in the CPI basket.

Additionally, weather-related risks pose further upside pressures to inflation. The expectation of below-normal monsoon rainfall, coupled with the likelihood of El Niño conditions and ongoing heatwave trends, could adversely impact agricultural output and elevate food inflation.

In light of these evolving macroeconomic dynamics and rising inflationary pressures, it is anticipated that the Reserve Bank of India (RBI) will maintain a cautious stance and keep policy rates unchanged in the near term.

CPI trendline



E- Estimated
Source: Ministry of Statistics and Programme Implementation (MOSPI), RBI, CRISIL Intelligence

IIP growth accelerated in April

Industrial growth, as measured by the revised Index of Industrial Production (IIP) series, accelerated to 4.9% in April 2026 from 3.2% in March 2026, driven by stronger growth in manufacturing and electricity production. Domestic demand remained resilient, as evident in auto sales, retail credit, electricity demand and other indicators, despite headwinds from the West Asia conflict.

Industrial production anticipated to remain subdued in the coming months ahead owing to weaker global demand and supply chain disruptions. The larger risk, however, is rising costs. The energy supply shock caused by the conflict has shifted into a price shock, with the costs of fuel, transport and other imported inputs increasing. Cost pressures are already visible, with wholesale inflation jumping to a 42-month high of 8.3% in April 2026, alongside consecutive increases in the retail prices of diesel and petrol.

However, government capital expenditure and other fiscal support measures, such as rationalisation of goods and services tax (GST) rates and unconditional cash transfers by states, should support the economy, some moderation in economic activity is expected.

Also, the performance of several key export-oriented sectors, such as computer and electronic products, textiles, chemical products and pharmaceuticals, improved in April versus March. This aligns with the acceleration in core export growth to 10.4% on year in April (vs -7.5% in March)

Accelerators of India's Economic Growth

- Robust domestic demand is expected to remain a primary engine of India's economic expansion, positioning the country to outperform its peer economies over the medium term.
- The growth outlook is further strengthened by sustained government-led capital expenditure on infrastructure and asset creation. Such investments are likely to yield strong economic multipliers and catalyse private sector participation.
- The government's capacity to maintain elevated capital spending is supported by structural improvements, including enhanced tax buoyancy, rationalised tax frameworks with lower effective rates, ongoing tariff reforms, and increasing digitisation of the tax administration and filing ecosystem.
- The investment climate remains conducive, driven by continued public capex initiatives, steady progress under the Production Linked Incentive (PLI) scheme, improved corporate balance sheets, and a well-capitalised banking sector characterised by low levels of non-performing assets (NPAs).

Decelerators for India's Economic Growth

- **External headwinds:** Global growth is expected to moderate amid heightened geopolitical uncertainties and persistent macroeconomic risks. The ongoing conflict in West Asia has constrained global monetary policy flexibility and disrupted energy supply dynamics, resulting in elevated crude oil prices. This is likely to weigh on global growth in 2026 and dampen external demand for Indian exports. Additionally, higher input and logistics costs arising from elevated energy prices could push up domestic inflation, thereby moderating consumption demand. Collectively, these external factors are expected to exert downward pressure on India's growth outlook for fiscal 2027.
- **Rising inflationary pressures:** Inflation is projected to rise meaningfully, with CRISIL estimating an increase to 5.1% in fiscal 2027 from 2.1% in the previous fiscal. Elevated inflation poses a key risk to growth by compressing household disposable incomes and, consequently, private consumption—one of the principal drivers of India's

GDP. Rising input costs, particularly energy inputs (including crude oil, natural gas, and mineral oils), are also increasing production costs across industries such as chemicals, plastics, textiles, and construction materials, thereby exerting upward pressure on prices and negatively impacting output levels. Notably, the sharper increase in the Wholesale Price Index (WPI), relative to the Consumer Price Index (CPI), reflects stress on the production side, driven largely by supply chain disruptions linked to geopolitical tensions. Further, higher crude prices are translating into increased fuel costs, with petrol and diesel carrying a significant weight in the CPI basket, thereby reinforcing inflationary trends.

- **Weather-related risks:** The India Meteorological Department's projection of below-normal rainfall (around 90% of the long-period average) for the 2026 southwest monsoon season indicates potential stress on agricultural output. The likelihood of weather disruptions, including emerging El Niño conditions, heightens the risk of lower crop yields and supply-side pressures. This, in turn, could lead to elevated food inflation, particularly impacting rural consumption and demand, thereby adding to broader inflationary concerns and constraining overall economic growth.

- **Tight financial conditions and elevated interest rates:** Lending rates are expected to remain elevated through fiscal 2027, supported by a relatively steady policy repo rate (around 5.25%), evolving liquidity dynamics, and persistent global uncertainties. Elevated borrowing costs may dampen credit offtake, thereby impacting both consumption and investment demand. In an environment of rising inflation, the Reserve Bank of India (RBI) is likely to maintain a cautious stance, prioritizing price stability over aggressive monetary easing. While policy rates may eventually ease, lending rates are expected to remain relatively high in the near term to anchor inflation expectations, which could weigh on aggregate demand and public consumption in the short run.

- **Monetary policy constraints:** The global tightening of monetary space, exacerbated by geopolitical tensions such as the West Asia conflict, has limited the flexibility of central banks, including the RBI. With inflationary pressures expected to rise due to supply-side disruptions and elevated energy prices, the RBI is likely to adopt a calibrated and cautious approach to monetary policy. The Monetary Policy Committee (MPC) is expected to maintain its policy stance in the near term, with limited scope for rate cuts, thereby keeping financial conditions relatively tight.

Key Structural Reforms in the Indian Economy

Over the past decade, the Government of India has undertaken a series of structural reforms aimed at strengthening the country's economic framework and improving overall competitiveness. Key initiatives such as the Goods and Services Tax (GST), the Insolvency and Bankruptcy Code (IBC), and the Production Linked Incentive (PLI) schemes are expected to have a transformative, long-term impact on industrial growth and efficiency.

A central pillar of these reforms has been a sustained focus on infrastructure development, particularly physical infrastructure, with the objective of enhancing connectivity and reducing logistics costs. Significant investments have been directed towards modernizing highways, ports, airports, and railways, thereby addressing critical bottlenecks in transportation and supply chains. In parallel, efforts have been made to improve subsidy delivery mechanisms and streamline payment systems, ensuring greater efficiency and transparency in governance.

Additionally, the government has emphasized digital infrastructure development, creating synergies with physical infrastructure to enhance connectivity, accessibility, and ease of service delivery. Reforms such as faster regulatory clearances, reductions in corporate tax rates, and liberalization of Foreign Direct Investment (FDI) norms have further contributed to improving the ease of doing business in India. While substantial progress has been achieved, continued scope for improvement underscores the government's ongoing commitment to reform.

Enhancing Logistics Efficiency through Infrastructure Development

The government's push has been focused largely on transport-related sectors, such as roads, railways, and urban infrastructure. This is being complemented with policies geared towards improving and integrating different segments of the logistics ecosystem. All these are expected to reduce bottlenecks and improve competitiveness of domestic production and trade via reduced logistics costs and improved connectivity.

- **National Infrastructure Pipeline:** The National Infrastructure Pipeline (NIP) is a flagship Government of India initiative launched in 2019 to provide a long-term roadmap for infrastructure development, originally envisaging about Rs 111 lakh crore investment for fiscal 2020–25 across sectors such as transport, energy, urban, and water infrastructure. In its latest evolution, the NIP has significantly expanded both in scale and scope, covering over 14,500 projects with a total investment of around Rs 213 lakh crore by March 2026, reflecting continued additions and a shift toward larger, more complex projects. Investments are heavily concentrated in key sectors like logistics/transport, energy, construction, and water management, which together account for the bulk of spending, while the pipeline has broadened to cover 30+ sectors and nearly 80 sub-sectors to improve investor visibility and coordination.
- **PM Gati Shakti:** The PM Gati Shakti National Master Plan (NMP), launched in October 2021, aims to enhance multimodal connectivity and reduce logistics costs through integrated infrastructure planning across multiple ministries. The initiative leverages a GIS-based digital platform to enable coordinated development of infrastructure projects, improving planning efficiency and reducing execution delays.

  The plan integrates key infrastructure programs such as Bharatmala, Sagarmala, railways, inland waterways, and aviation, ensuring seamless connectivity across transport modes. By enabling data-driven decision-making and eliminating bottlenecks, PM Gati Shakti is expected to improve supply chain efficiency, promote modal shift, and enhance overall logistics performance in India.
- **National Logistics Policy (NLP):** National Logistics Policy (NLP) was launched in September 2022 to complement PM GatiShakti National Master Plan (NMP). NLP addresses the soft infrastructure and logistics sector development aspect, including process reforms, improvement in logistics services, digitization, human resource development and skilling. The targets of the NLP are to: (i) Reduce cost of logistics in India; (ii) improve the Logistics Performance Index ranking – aim to be among top 25 countries by 2030 (India was ranked 38 out of 139 countries in 2023), and

(iii) create data driven decision support mechanism for an efficient logistics ecosystem. A Unified Logistics Integrated Platform has been set up under this, which, as of September 2023, had integrated 34 logistics portals/digital systems across 33 ministries/ departments, and had over 600 industry players registered. Twenty-one states have also notified their own logistics policies, in line with the NLP.

The infrastructure policies would enhance the logistical efficiency there by strengthening the supply chain for automobiles and auto components. These initiatives will further lower the logistical cost and the lead time in components/automobile transit. In the case of raw materials, this allows various stakeholders in the ecosystem to have a clear understanding of raw material availability and necessary logistics for the same. Thus, these policies augment the efficiency in production and supply.

Overview of Government policies impacting automotive industry

Atmanirbhar Bharat Campaign

Atmanirbhar Bharat Abhiyan or the self-reliant India campaign was launched in May 2020 amid the Covid-19 pandemic, with a special and comprehensive economic package of Rs 20 trillion, equivalent to 10% of the country's GDP. The scheme was launched with the primary intent of fighting the pandemic and making the country self-reliant based on five pillars: economy, infrastructure, technology-driven system, demography, and demand.

Lowering supply chain dependency on China

India including other nations are actively pursuing strategies to reduce supply chain dependency on China in the wake of pandemic and growing geo-political tensions. This includes diversifying the supply chain by sourcing inputs from various countries with a goal of reducing the risk of relying on a single country. Furthermore, India is also trying to strengthen the domestic manufacturing environment through various policy initiatives. Key strategies adopted by India to diversify the supply chain includes attracting foreign investment via tax benefits and incentive schemes, pushing domestic manufacturing and diversification of trade partners.

PLI scheme provides boosts to industrial investments in the short-to-medium term

The PLI scheme's primary objective is to make manufacturing in India globally competitive by removing sectoral obstacles, creating economies of scale and ensuring efficiency. It is designed to create a complete component ecosystem in India and make the country an integral part of the global supply chain. The PLI scheme is a time-bound incentive scheme by the government which rewards companies in the 5-15% range of their annual revenue based on the companies meeting pre-decided targets for incremental production and/or exports and capex over a base year.

The government has more than doubled the PLI scheme allocation for fiscal 2026 to Rs 19.5 thousand crores, significant increase of 76% from the fiscal 2025 outlay, aimed at driving growth across industries and enhancing competitiveness. Capex is expected to peak in the next two fiscals, followed by incentive payouts, which will support the growth of Indian businesses and reduce import dependence.

The Automobile sector saw a sharp increase in the allocation in the last few years- from Rs 2.63 crore in fiscal 2024 to Rs 346.87 crore in fiscal 2025 to Rs 2,818.85 crore for fiscal 2026 and to Rs 5,940 crore for fiscal 2027. The allocation for Automobile and Auto component industry for fiscal 2026 was the second largest amongst all sectors. Similarly for Advance Chemistry cell, the allocation rose from Rs 7.73 crore in fiscal 2024 to Rs 15.42 crore in fiscal 2025 to Rs 155.76 crore for fiscal 2026 and now, seen a drop to Rs 86 crore for fiscal 2027.

Budgeted incentives for each sector under the PLI scheme in budget 2026-27

Sector	Segment	FY27Budget Estimates (Rs Crore) *	
Automobile	Advance chemistry cell (ACC) battery	86	6,026
	Automobiles and auto components	5,940	

Source: Budget Document 2026-27, Crisil Intelligence

An outlay in the Union Budget 2026-27 of Rs 6,026 crore has been made for automobiles, auto components and ACC which is the second highest allocation amongst all sectors:

- Rs 5,940 Crore allotted for enhancing India's manufacturing capabilities or automobile and auto component industry - Advanced Automotive Products (AAT). The scheme has two components, viz. Champion OEM Incentive Scheme and Component Champion Incentive Scheme. A total of 95 applicants have been approved under this PLI scheme.

- Rs 86 Crore under the 'National Programme on Advanced Chemistry Cell (ACC) Battery Storage' for achieving manufacturing capacity of 50 Giga Watt Hour (GWh) of ACC. Four companies have been selected till date for incentive under the PLI Scheme for ACC battery storage.

GST reforms to accelerate consumption and support domestic sales

- In fiscal 2026, the Government of India revamped the Goods and Services Tax (GST) structure with three slabs of 5%, 18% and 40%.
- In the automobile industry, electric vehicles will continue to be taxed at 5%, while other segments have undergone a rate revision to either 18% or 40% (see tables below).
- For the small cars and compact utility vehicles, which contribute around 55% of the passenger vehicle industry volume. The rate cut is expected to result in 8-9% price reduction, leading to a 200-bps improvement in volume to 4-6% compared with our earlier estimates of 2-4%.
- Prices for LCVs, MHCVs and buses will reduce by about ~7.8%. However, it does not consider any pass-through that may happen from automotive component manufacturers to original equipment manufacturers (OEMs) in the form of GST reduction. From a domestic sales perspective, in fiscal 2026, CVs may see flattish-to-marginal-positive growth.

GST Rate on Automobiles

Category	Old GST Rate	New GST Rate	Impact on prices for end-user
2W (<350cc)	28%	18%	<350cc 2Ws have become more affordable as the tax savings have been passed on to the customers Improved demand in entry and mid segments
2W (>350cc)	31%	40%	These vehicles became more expensive
3W	28%	18%	Auto drivers and fleet owners benefit due to lower EMIs Improved profitability per km
PV (smaller PVs)	29%	18%	Reduction in prices led to affordable segments car cheaper encouraging first time buyers
PV (large PVs)	28%+ variable compensation cess	40% with no cess	Removal of additional cess simplify taxation Larger cars are more affordable for aspirational buyers
CVs	28%	18%	Reduction in prices, making CVs more affordable for buyers

Note:

1. CVs include LCVs, MHCVs and Buses

2. *Small cars: include petrol engine cars of <1200 cc and not exceeding 4 meters in length and diesel cars of <1500 cc and not exceeding 4 meters in length)*

Source: Press release document by MoF dated 8th Sep 2025

Increased focus on foreign trade agreement

India is actively negotiating and reviewing bilateral trade agreements with major global economies to boost its trade prospects. India signed a trade and economic partnership agreement with the European Free Trade Association (EFTA) on March 10, 2024, which entered into force on 1st October 2025 and the India-UAE bilateral investment treaty came into effect on August 31, 2024. It is also in the process of reviewing its 2009 trade agreement with the Association of Southeast Asian Nations (ASEAN) to make it more equitable and aligned with current economic realities.

The India–UK CETA was signed in July 2025 and India–Oman CEPA in December 2025. The India–New Zealand FTA was announced on 22nd December 2025, followed by the India–EU FTA on 27th January 2026. With United States, the framework for an interim agreement delivered on 7th February 2026.

India-Oman Comprehensive Economic Partnership Agreement (CEPA)

The India-Oman CEPA was signed on 18th December, 2025 in Muscat. The Agreement has entered into force on 1st June, 2026. Oman is India's second-largest trading partner in the Gulf region and serves as a strategic gateway to the wider GCC market through its advanced port infrastructure.

Bilateral trade between India and Oman reached USD 11.18 billion in fiscal 2026, registering a positive trend from USD 10.61 billion in Fiscal 2025. This Agreement will be a force multiplier in the Gulf region. With 99.38% of India's exports receiving duty-free access, the Agreement unlocks new opportunities for our exporters and professionals gain opportunities. By delivering significant benefits to labor-intensive sectors, it will support job creation, drive investment and enable Indian enterprises to compete on an equal footing with suppliers from countries enjoying preferential market access.

The agreement is tariff liberalization and provide gateway to Gulf by enhancing Trade, Services and Prosperity for Viksit Bharat 2047. All zero-duty concessions come into effect immediately, providing certainty and competitiveness to Indian exporters. Earlier, under the MFN regime, only 15.33% of India's exports entered Oman duty-free. With CEPA, Indian exporters gain substantial price competitiveness in Oman's nearly USD 28 billion import market.

The Agreement is expected to significantly boost MSMEs, manufacturing and employment by enhancing competitiveness in labor-intensive sectors such as gems & jewellery, textiles, leather, footwear, marine products, engineering goods, processed foods and pharmaceuticals. Oman's strategic logistics hubs at Sohar, Duqm and Salalah provide Indian exporters' enhanced access not only to Oman but also to wider GCC and East African markets.

India has offered tariff liberalization on 77.79% of tariff lines covering 94.81% of imports from Oman by value, while maintaining strong safeguards for sensitive sectors.

India -New Zealand Free Trade Agreement (FTA)

India and New Zealand announced negotiations for FTA in March 2025. Following several rounds of negotiations, the India-New Zealand FTA was concluded in December 2025, becoming India's fastest-concluded FTAs.

The agreement opens opportunities for India to emerge as a key supplier of skilled workforce, alongside prospects for future cooperation in areas such as AYUSH and services such as Yoga Instructors, Indian Chefs, and Music Teachers,

and services under sector of interests like IT, Engineering, Healthcare, Education, and Construction. Currently, New Zealand is India's second-largest trading partner in Oceania.

Key highlights of FTA

- India- New Zealand FTA eliminates duty on 100% of Indian Exports
- USD 20 billion investment commitment over 15 years, strengthening long-term economic and strategic cooperation.
- India protects its key interests in dairy and agriculture ; Huge win for labour intensive sectors like textile and leather.
- New Zealand signs Annex on Health and Traditional Medicine Services for the first time.
- Student Mobility and Post Study Work Visa for STEM Graduates, Skilled Professionals ; opens new visa pathway for 5,000 skilled occupations.

India UK Agreement

India and the UK signed a landmark FTA in July 2025 to improve bilateral trade and investment flows. The agreement is expected to double trade between the two nations—currently valued ~USD 60 billion—by 2030. Under the deal, India will gain near-complete duty-free access for its exports to the UK, especially in key sectors, such as textiles, gems and jewellery, engineering goods and processed foods. In return, the UK will benefit from phased tariff reductions on high-value goods such as automobiles, Scotch whisky, medical devices and premium food products.

The FTA also introduces streamlined customs procedures and a special mobility pathway for Indian professionals. Beyond goods trade, the agreement includes provisions on digital trade, services, intellectual property and government procurement. A key highlight is the social security pact that exempts Indian professionals from double contributions for up to three years, benefiting around 75,000 workers. The deal is also aligned with sustainability and ESG goals, featuring cooperation on clean energy and green technology. The India-UK FTA is a strategic milestone that strengthens India's trade diversification strategy, complements the supply chain diversification trend and reinforces its position in global supply chains.

The UK-India FTA is more of a medium to long-term opportunity: it lowers entry barriers, especially for premium vehicles, but there are qualifications and gradual implementation that temper its immediate effects. The FTA opens doors for Indian component makers and EV related firms to export to UK markets under more favorable duty structures. For consumers, the FTA may bring down the cost of imported luxury/premium/UK-manufactured cars gradually. At present India imposes a high import duty on fully assembled cars from the range of 60-110% depending on the engine size and other factors. Under the favorable FTA, India will allow the import of a limited numbers of UK made car at 10% duty in a phased manner over the period of 5 years. However, quota has also been defined for the number of ICE models at a reduced rate. The total quota for the number of ICE imports at a reduced tariff rate will increase from 20,000-37000 in the first five years but then it gradually decreases over the next 10 years to just 15,000.

Further over the period of 10 years, the import duty will reduce from 110% to 50% for large capacity Petrol /diesel cars, from 66% to 50% for medium capacity ICE cars and from 66% to 45% for small capacity cars.

India -EU (European Union) Free Trade Agreement (FTA)

The India-EU FTA, also known as the Broad-based Trade and Investment Agreement (BTIA), aims to liberalise trade in goods, services and investment between India and the 27-member European Union. The negotiations were launched in CY2007, but progress was slow due to various challenges and disagreements.

On 17th June 2022, the European union relaunched negotiation with India for FTA. The negotiations for India-EU FTA have made significant progress and concluded on 27th January 2026.The FTA covers 25% of global GDP and targets to double bilateral trade to USD 250 billion within a decade. The trade deal will potentially support manufacturing and service sector between India and EU. Reduction over 90% of tariff expected to double EU goods exports to India.

The India-EU FTA is expected to have a notable impact on trade and investment between the two regions. According to Industry estimates, the agreement could increase bilateral trade by up to 20% and attract significant investment into India. Overall, the India-EU FTA has the potential to be a gamechanger for trade and investment between the two regions.

United States (US)-India Bilateral Trade Agreement

US and India announced framework for an interim trade agreement in February 2026, affirming countries' commitment to the broader U.S.-India Bilateral Trade Agreement (BTA) negotiations launched in February 2025, which will include additional market access commitments and support more resilient supply chains.

The Interim agreement between the US and India showcase a common commitment to reciprocal and balanced trade based on mutual interest and concrete outcomes. Under this interim agreement, India will eliminate or reduce tariffs on all U.S. industrial goods and a wide range of U.S. food and agricultural products.

India intends to purchase $500 billion of U.S. energy products, aircraft and aircraft parts, precious metals, technology products, and coking coal over the next 5 years. India and the United States will significantly increase trade in technology products, including Graphics Processing Units (GPUs) and other goods used in data centres, and expand joint technology cooperation.

The US will apply a reciprocal tariff rate of 18 percent on originating goods of India, including textile and apparel, leather and footwear, plastic and rubber, organic chemicals, home décor, artisanal products, and certain machinery, and, subject to the successful conclusion of the Interim Agreement, will remove the reciprocal tariff on a wide range of goods including generic pharmaceuticals, gems and diamonds, and aircraft parts. India will also receive a preferential tariff rate quota for automotive parts.

The United States and India agree to strengthen economic security alignment to enhance supply chain resilience and innovation through complementary actions to address non-market policies of third parties, as well as cooperation on inbound and outbound investment reviews and export controls.

Foreign Direct Investment (FDI)

FDI plays a pivotal role in economic growth, aiding development and shaping the economic landscape. Through the FDI route, international corporations can invest in India, capitalising on the investment incentives offered by the Indian government, including tax incentives and relatively competitive labour costs. This fosters job creation, offers various additional advantages and facilitates the acquisition of technological expertise from global peers.

- There are two FDI routes in India—the government route and the automatic route. The automatic route allows foreign investors to invest in sectors without requiring a prior approval from the Indian government. Under this route, investors are only required to notify the Reserve Bank of India (RBI) within a specified time frame. While the government route mandates prior approval from the Indian government or relevant authorities for investments in India.
- The automobile (including auto components) industry is one of the largest, fastest-growing sectors in India, with a significant contribution to the country's GDP. The sector has attracted significant FDI over the years, driven by government policies, a large domestic market and skilled workforce.

Summary of FDI in key Indian sectors

Sector	FDI cap	Route
Automobile and auto components	100%	Automatic
Airports - greenfield projects	100%	Automatic
Satellites - manufacturing and operation, satellite data products and ground segment and user segment	74%	Government
Hospitals sector	100%	Automatic
Defense	74%	Automatic Government route up to 100% if resulting in access to modern technology

Source: Department for Promotion of Industry and Internal Trade DPIIT, PIB

FDI to India almost doubled to USD 83.6 billion in fiscal 2022 from USD 45.15 billion in fiscal 2015. Over the past decade (April 2014 to September 2024), total FDI inflows amounted to USD 709.84 billion, accounting for 68.69% of the overall FDI inflow in the past 24 years.

This robust inflow of investments underscores India's pivotal role in shaping the global economic landscape. FDI inflows have received an impetus, with India gaining the eighth position in the list of the worlds' largest FDI recipients in 2022 from 12th in 2018, according to the World Investment Report 2024. From 2000 to 2024, a total FDI inflow of USD 991 billion was recorded.

FDI equity inflow in the manufacturing sector rose from USD 98 billion in 2004-2014 to USD 165 billion in 2014-2024, demonstrating a 69% increase. The FDI inflow grew to USD 81.04 billion in fiscal 2025 from USD 71.28 billion in fiscal 2024 marking 14% growth. Based on quarterly numbers, FDI inflows rose to USD 21.52 billion in the third quarter of fiscal 2026.

Indian Demographics and its impact on 2Ws

India's Demographic Advantage

India's population surpassed China's by a slight margin, making it the most populous country with 1.46 billion people as per UNFPA's State of World Population Report 2025. According to the report, 24% of India's total population is between 0-14 years, 68% is between the ages of 15 and 64 years, which is considered the working population of a country, and 7% above 65 years. Apart from this, about 17% of the population is between 10-19 years of age, and 26% are between 10-24 years (Generation Z).

While 15% of China's total population is between 0-14 years, 70% is between the ages of 15 and 64 years, which is considered the working population of a country, and 15% above 65 years. Apart from this, about 12% of the population is between 10-19 years of age, and 18% are between 10-24 years. The median age for China is nearly 41 years.

Similarly, 11% of Japan's total population is between 0-14 years, 59% is between the ages of 15 and 64 years, which is considered the working population of a country, and 30% above 65 years. Apart from this, about 9% of the population is between 10-19 years of age, and 14% are between 10-24 years. The median age for Japan is nearly 50 years.

The median age for United Kingdom is 40 years and the median age for United State is nearly 39 years.

India’s median age is about 29 years, and it has largest working population among major global economies. India is expected to have the world’s largest working-age population of 1.03 billion (~68%) by 2030 compared with 0.97 billion in China and 0.22 billion in the US. By 2030, India will have a median age of 31 years versus 43 years for China and 40 years for the US. This will be an important growth booster. This benefit allows greater engagement in productive labor, thus bolstering national income. India's youthful demographic not only strengthens the country's competitive edge in the services and manufacturing sectors but also unlocks the spending potential of a young population towards discretionary expenses.

The working/young population has significantly impacted India’s growth in past few years majorly in the IT, manufacturing, and service sectors. This is in line with past progress of economies like Japan and China where the young population has fueled economic development. India’s young population is embracing new technologies and ideas which is expected to further boost the industries like technology, manufacturing, healthcare, and infrastructure.

The demographic dividend fosters workforce expansion, driving accelerated urbanization and industrialization. This, in turn, will spur investment in both physical and human infrastructure, ultimately enhancing the country's economic productivity.

Rise of the Middle Class

As per Crisil estimates, India’s GDP is expected to grow 6.0-7.0% between fiscal 2026 – fiscal 2031 to make it the third largest economy with a GDP inching closer to USD 7 trillion and lift per capita income to the upper middle-income category. By fiscal 2031, India’s per capita income will rise to ~USD 4500, thereby making it an upper middle-income nation. (As defined by World Bank, lower middle-income countries are those with per capita income of USD 1,000 to USD 4,000 and upper middle-income countries are those with per capita income of above USD 4,000 to ~USD 12,000)

As per the PRICE ICE 360° survey report, India is poised for significant economic growth by 2047, supported by continued political and economic reforms and a projected annual growth rate of 6–7%. By the centenary year of independence, India’s population is expected to exceed 1.66 billion, accompanied by a substantial rise in average annual household disposable income. This transformation is expected to position the Indian Middle Class defined as households with annual incomes between Rs 5 lakh and Rs 30 lakh as the country’s largest income group numerically and a key driver of economic, political, and social development. Estimates from PRICE’s ICE 360° Pan-India primary surveys indicate that the population of the Destitute category (annual household income below Rs 1.25 lakh) and Aspirer category (annual household income between Rs 1.25 lakh and Rs 5 lakh) will decline sharply from around 928 million in 2020-21 to approximately 209 million by 2046-47. In contrast, the Rich segment (annual household income above Rs 30 lakh) is expected to grow significantly from 56 million to 437 million during the same period, while the Middle Class is projected to expand from 432 million in 2020-21 to nearly 1.02 billion by 2046-47.

Within the Indian Middle Class, households with annual incomes between Rs 15 lakh and Rs 30 lakh recorded a growth rate of 6.4% between 2015-16 and 2020-21, while the segment with annual incomes between Rs 5 lakh and Rs 15 lakh grew at 4.8% annually. By the end of this decade, India’s demographic structure is expected to evolve from an inverted pyramid into a rudimentary diamond shape, reflecting the expansion of the Middle Class and a reduction in lower-income populations. The income distribution is anticipated to comprise a relatively small Destitute and Aspirer segment, a large and growing Middle Class, and a sizable affluent Rich population at the top. Notably, population growth rates are projected to remain higher in upper income groups, while growth in the lowest income segments could turn negative.

According to PRICE, two-wheelers are a preferred mode of transportation among Aspirer and Middle-Class households, with ownership increasing steadily across income groups from 34% among Destitute households to 47% among Aspirers and 70% among the Middle Class. Even among Rich households, 75% own a two-wheeler, primarily in the premium segment.

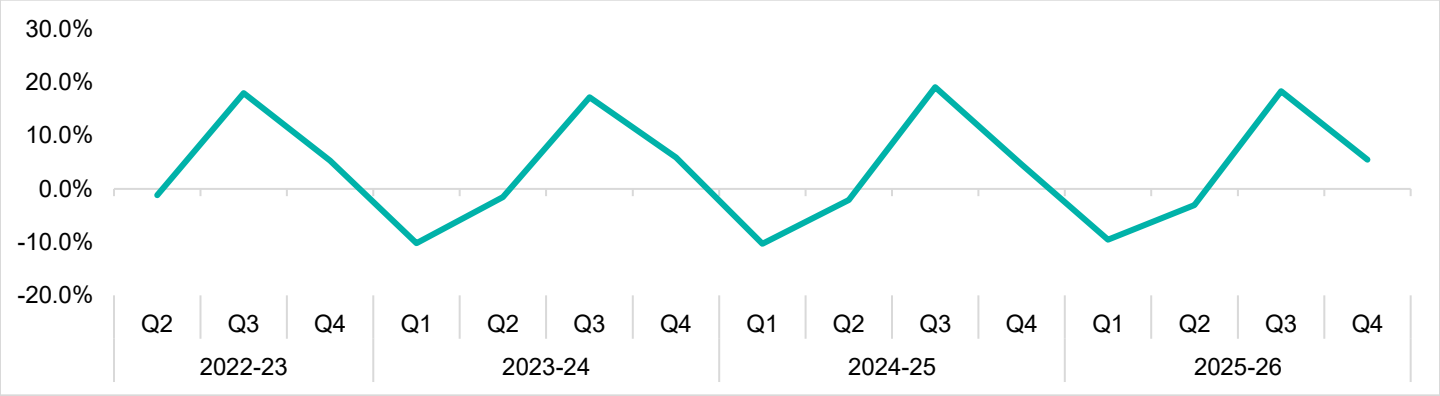
At the macroeconomic level, rising per capita incomes are expected to drive a shift in consumption patterns toward discretionary spending, including consumer durables, automobiles, premium products, and enhanced lifestyle experiences. As disposable incomes increase, demand for higher-value goods and aspirational consumption is likely to strengthen significantly. Continued improvement in per capita income is also expected to support further expansion in two-wheeler penetration across the country, reinforcing the broader consumption-driven growth trajectory of the Indian economy.

Private Consumption

PFCE reflects the overall consumption patterns and spending capacity of households within an economy. When PFCE increases it often translates to increased demand for various goods and services.

Private consumption accounts for the largest share of GDP, at about 56%, and the rise in discretionary spending will keep private consumption healthy in the coming years.

PFCE Quarterly Trend for India (q-o-q growth trend)



Source: Industry, Crisil Intelligence

Rise of Urbanization

According to United Nations Population Division (World Urbanization Prospects: 2025) urban population constituted 40% of the total population in India as of CY2025. The urban population accounted for approx. 589 million people in CY2025, marking the second largest urban community in the world. India's urban population is projected to be 675 million in 2035, which will be approximately 43% of the overall Indian population. In the interim, the urban population is expected to be approximately 607 million in 2030, making urban areas key drivers of consumption. Today urbanization is not only confined to mega-cities but is also altering the landscape of Tier 2 and Tier 3 cities.

With the rapid rise in urbanization, the demand for personal mobility is growing and demands cleaner public transport solutions as well. India's transportation sector is also undergoing a significant change, spurred by the government's strong push towards clean energy and zero emission vehicles.

Growth of Smartphones, Internet Penetration and Consumer Durables

According to TRAI's Indian Telecom Services Performance Indicators, the internet penetration in India has exceeded 1028.61 million as of December 2025. While about 594.33 million subscribers hailed from urban areas, about 434.27 million were from rural areas. The internet growth is outpacing in rural regions compared to urban areas - around 56% of total new internet users will be from rural India by 2025, according to a report by TransUnion CIBIL, which also mentioned that currently 36% of digital payment users hail from rural parts of the country. As per the same report, in 2022 over 1/3rd of Indians owned a smartphone.

In recent years, India has witnessed a significant shift in media consumption towards digital platforms, driven by the Government of India's Digital India initiative, affordable data plans, and increasing smartphone penetration. This has led to rapid growth in internet usage, social media engagement, e-commerce, and mobile-based entertainment consumption across the country.

The widespread adoption of smartphones and digital infrastructure has also accelerated the growth of digital finance in India. The rise of UPI has transformed the payments ecosystem by enabling seamless, real-time transactions, significantly boosting digital payments adoption and positioning India as a global leader in digital financial innovation.

Electricity accessibility in India has seen significant advancements over the years, with an average household now receiving approximately 20.6 hours of power supply daily, according to the IRES 2020 survey. Urban areas typically enjoy longer daily supply, averaging around 22 hours, compared to rural areas with approximately 20 hours. Moreover, there has been a substantial increase in the percentage of households using electricity as their primary lighting source, rising from 26% in 1980 to 97% in 2020. This enhanced availability of electricity has led to widespread adoption of electrical appliances (like smartphones and consumer durables) across the country, fueled by continuous technological innovation, thereby improving the overall quality of life.

Rising 2W penetration in India

Two-wheelers stand as vital and easily accessible mode of transportation across both urban and rural areas of India. Among them, motorcycles hold the highest popularity, trailed by scooters and mopeds. While the presence of mopeds in the two-wheeler inventory is declining, the prevalence of scooters is experiencing a notable surge. Across India, the primary use of two-wheelers among owners is for commuting to their workplaces. Additionally, business-related activities constitute the second-largest segment in the two-wheeler market, with delivery services for food, goods, as well as mail and courier services, extensively relying on two-wheelers. Some of the key drivers supporting the growth of two-wheeler industry are the rise in per capita income, improving infrastructure, urbanization, and worsening traffic congestion etc. Indian two-wheeler penetration per 1000 people had been around 135-140 in fiscal 2021 which rose up to 150-155 in fiscal 2026.

Robust 2W Replacement Demand - Shift from 2W to 4W Takes Time

The Indian passenger vehicle industry recorded a healthy 12% CAGR growth over the last five fiscal years, supported by improving macroeconomic conditions, expanded product portfolios, easing supply constraints, increasing preference for utility vehicles, and benefits from GST 2.0. However, this growth has not significantly impacted two-wheeler sales.

The sharp increase in passenger vehicle prices, along with higher fuel, interest, and operating costs, has limited the upgrade from two-wheelers to entry-level cars, particularly among entry-segment customers whose incomes were also affected during the pandemic. As a result, customers are more likely to upgrade within the two-wheeler category, especially towards >=125cc motorcycles and scooters, rather than shift to passenger vehicles.

For affluent customers, two-wheelers and cars serve different usage purposes and are often owned simultaneously rather than as replacements for one another. Consequently, despite the continued growth of the passenger vehicle segment, replacement demand for two-wheelers is expected to remain strong going forward.

Need for Electrification in India

India is actively accelerating the adoption of electric vehicles (EVs) as part of its broader commitments to environmental sustainability under the Paris Agreement and its participation in the EV30@30 campaign, which targets a 30% share of EVs by 2030.

To achieve this, the government has implemented a series of policy measures over time, beginning with the National Electric Mobility Mission Plan (NEMMP 2020) launched in 2012, which aimed to bring 6–7 million EVs on the road. This was followed by the introduction of the Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) scheme in 2015, with an initial outlay of ₹895 crore to incentivize EV purchases and support early charging infrastructure development.

The scheme was expanded under FAME II in 2019 with a significantly larger outlay of ₹10,000 crore, offering subsidies such as ₹10,000 per kWh for electric two-wheelers and promoting both private and commercial EV adoption alongside infrastructure creation.

Complementing these demand-side incentives, the government has also introduced supply-side measures such as the Production Linked Incentive (PLI) schemes in 2021 including ₹18,100 crore for Advanced Chemistry Cell (ACC) batteries and ₹57,042 crore for the automotive sector as well as the Phased Manufacturing Program (PMP) in 2022, the scrappage policy, and the Make in India initiative, all aimed at strengthening domestic manufacturing capabilities and reducing dependence on imports within the EV ecosystem.

In 2024, the Electric Mobility Promotion Scheme (EMPS) was introduced as a short-term replacement for FAME II to continue support for electric two- and three-wheelers, but with comparatively lower incentives and a limited duration until September 30, 2024. This was subsequently replaced by the PM Electric Drive Revolution in Innovative Vehicle Enhancement (PM E-DRIVE) scheme, launched on October 1, 2024, with a budgetary outlay of ₹10,900 crore and extended until March 31, 2028, with a focus on boosting EV adoption, expanding charging infrastructure, and strengthening the overall EV manufacturing ecosystem.

Under recent updates as of March 27, 2026, the eligibility period for electric two-wheelers under PM E-DRIVE has been revised to July 31, 2026, while electric three-wheelers will continue to receive support until March 31, 2028. However, demand incentives for electric two-wheelers have been reduced for the period between April 1, 2025, and July 31, 2026, to ₹2,500 per kWh (capped at ₹5,000), compared to ₹5,000 per kWh (capped at ₹10,000) in fiscal 2025, indicating a gradual tapering of direct subsidies as the market matures.

Overall, India's EV policy framework reflects a comprehensive and evolving strategy that combines fiscal incentives, industrial policy, and infrastructure development to transition from a fossil fuel-based transport system to a cleaner, sustainable electric mobility ecosystem.

Rising Air Pollution in India and Air Quality Impact of 2Ws

Air pollution continues to be a significant and growing concern in India, particularly across urban centers, prompting sustained policy attention and mitigation efforts by the government.

According to the *World Air Quality Report 2025*, six of the world's ten most polluted countries were located in Asia during CY2025, with Pakistan recording the highest average Air Quality Index (AQI), followed by Bangladesh and Tajikistan. India ranked as the sixth most polluted country globally, with an average AQI of 134, categorised as "Poor," reflecting a deterioration from CY2024 when the AQI stood at 111.

At the city level, Loni in Uttar Pradesh emerged as the most polluted city globally as well as within India in CY2025, recording an average AQI of 191. The city's annual average PM2.5 concentration rose sharply by nearly 23% year-on-year to 112.5 µg/m³, driven by severe pollution episodes observed in March, April, and December.

Encouragingly, India's overall air quality indicators showed a modest improvement at the national level, with the average PM2.5 concentration declining by approximately 3% to 48.9 µg/m³ in 2025 from 50.6 µg/m³ in 2024. Delhi also recorded an 8% improvement in its annual average PM2.5 levels. However, this improvement was overshadowed by persistent

and acute monthly spikes, largely attributable to seasonal factors such as dust storms and winter smog. Notably, a severe dust storm in April led to a 15% increase in PM2.5 levels in the city during that month.

Air pollution across the Indo-Gangetic Plain remained a critical challenge, particularly during the winter months. The region experienced a combination of adverse factors, including crop burning, temperature inversions, industrial emissions, and construction activity, all of which significantly exacerbated pollution levels. December proved especially severe, with PM2.5 concentrations rising by 44% in Delhi and by an average of 62% across neighbouring cities in Uttar Pradesh. Within this context, Loni's elevated pollution levels underscore the intensity and persistence of air quality challenges in the region.

Overall, while incremental improvements are visible at the national level, episodic pollution spikes and regional disparities highlight the need for sustained, multi-pronged interventions to achieve meaningful and lasting air quality improvements.

Pollution level in India at major cities in (µg/m³):

City	2025	2024	Change (%)
Delhi	99.6	108.3	(8.3)
Kolkata	51	45.6	10.5
Mumbai	34.2	33.7	1.4
Hyderabad	33.3	30.6	8.1
Bengaluru	27.5	30	(9)
Chennai	31.3	26	16.9

Source: World Air Quality Report 2025, Crisil Intelligence

India's transport sector accounted for 20% of the total energy consumed in 2025 and the absolute energy use is expected to rise to two to three times by 2047. The sector is also a significant contributor to urban air pollution road transport is responsible for 20–30% of urban air pollution in India, with emissions occurring at ground level in close proximity to densely populated areas, directly affecting public health. Road transport contributes to elevated concentrations of nitrogen oxides (NO_x), particulate matter (PM), and hydrocarbons in urban environments. As per Niti Aayog, transport is a substantial contributor to ambient PM2.5 concentrations; in Bengaluru, road transport accounted for approximately 40% of PM2.5 pollution.

Two-wheelers continue to dominate India's vehicle fleet and represent a significant component of urban road transport emissions. Reducing transport-related emissions would have direct public health benefits, given that a large share of emissions occurs in urban areas at ground level.

To address this issue, the government has implemented stringent emission regulations for vehicles, including two-wheelers, aimed at reducing harmful pollutants and promoting sustainable mobility through vehicle electrification. In India, two-wheelers are a prevalent mode of transportation and contribute significantly to road transport-related air pollution. In addition, the Ministry of Environment, Forest and Climate Change (MoEFCC) launched the National Clean Air Programme (NCAP) in January 2019, with the objective of improving air quality in 131 designated non-attainment and million-plus cities across 24 states and Union Territories. The programme initially targeted a 20–30% reduction in

particulate matter concentrations by 2024, with 2017 as the base year. This target was revised in 2022 to a 40% reduction in PM10 levels, or attainment of National Ambient Air Quality Standards for PM10 (60 µg/m³), by 2025–26.

In 2016, the Delhi government introduced odd-even rule which mandated that only cars with odd numbered license plates could ply on odd dates and even numbered in even dates. For example, vehicles with numbers ending in odd digits (1,3,5,7,9) are allowed to drive on odd dates, while those ending in even digits (0,2,4,6,8) can drive on even dates. This rule primarily applies during peak air pollution periods when Delhi experiences an increase in smog and deteriorating air quality. The rule aims to reduce vehicular emissions by limiting the number of vehicles on the road. The program also resulted in lowering traffic congestion and improved the traffic flow.

India regulates vehicle tailpipe emissions by means of the Bharat Stage (BS) emission standards. In April 2020, India implemented BS-VI standards, which largely parallel Euro-6/VI norms, leapfrogging from BS-IV to BS-VI in only three years. The BS standards are based on European emission norms and are implemented to control and reduce the emission of pollutants from vehicles. The BS emission standards set the permissible limits for various pollutants, including hydrocarbons (HC), carbon monoxide (CO), nitrogen oxides (NOx), and particulate matter (PM), emitted by ICE vehicles. The permissible limits of HC, CO, NOX and PM emissions as per the BS-VI policy is mentioned in the below table. The BS VI norms for two-wheelers comprises the requirement to have onboard diagnostics (OBD), that monitors a vehicle's operation and receives data from various sensors to ensure proper functioning.

In April 2023, phase 2 of the BS6 emission standards, was introduced with several fundamental changes. The second phase of BS6 introduced the Real Driving Emission (RDE) test, which evaluates the actual emissions during real-world on-road driving, in addition to laboratory testing brought in Phase 1. Also, the OBD 2 system is mandated to monitor oxygen sensors, catalytic converters, and engine misfires closely. The Phase A of OBD 2 was mandated from 1st April, 2023 and Phase B was mandated from 1st of April, 2025.

BS IV and BS VI Emission Standards for Two- Wheelers, g/km:

Stage	Engine category	CO	HC	NO_X	PM
BS IV	Class 1 & Subclass 2-1	1.403	-	0.39	-
	Subclass 2-1	1.970	-	0.34	-
	Subclass 3-1 & 3-2	1.970	-	0.20	-
BS VI	SI Engine	1.0	0.1	0.06	0.0045
	CI Engine	0.5	0.1	0.09	0.0045

Note: SI: Spark Engine; CI: Compression Engine

Source: Crisil Intelligence

In addition to emission standards, several policies, including vehicle electrification, have strong benefits for air quality and public health.

Electric vehicles have gained significant traction in the 2W industry and emerged as a promising solution for reducing emissions. With their ability to eliminate tailpipe emissions completely, the benefits of electric vehicles on the environment hold a huge potential for a healthier environment. Traditional internal combustion engines (ICE) 2Ws running on petrol produce exhaust emissions, including various pollutants, notably nitrogen oxides (NOx), and hydrocarbons. In contrast, electric vehicles do not rely on combustion engines and thus do not produce any tailpipe emissions. They operate on

electric power stored in their batteries, leading to the elimination of direct exhaust emissions. Thus, due to the growing electrification in the 2W industry the share of emissions by two-wheelers in passenger transport is expected to decline gradually over the coming years.

India's Climate Commitments

With the world's largest population and an economy projected to reach USD 7.3 trillion by 2030, positioning India as the world's third-largest economy, India has significant growth potential. This growth will inevitably drive an increase in the country's resource demand and environmental impact. According to the IEA's World Energy Outlook 2024, India's total energy demand is set to increase by approximately 35% by 2035 under stated policies, with India projected to account for the largest absolute increase in global energy demand over the next decade. In response, India has announced and is actively pursuing ambitious climate targets, positioning itself as a key emerging market advocating for environmental protection.

The Paris Agreement or Conference of Parties 21 (COP 21) was adopted by India in 2015. It replaced the Kyoto Protocol which was an earlier agreement to deal with climate change. It is a global treaty wherein more than 200 countries agreed to cooperate to reduce greenhouse gas emissions and lead climate conservation. The Agreement aims to limit greenhouse gas emissions so that the rise in global warming by the end of this century does not exceed 1.5ºC above pre-industrial levels.

Under its updated Nationally Determined Contribution (NDC) submitted to the UNFCCC in August 2022, India stands committed to the following targets by 2030:

- To reduce the emissions intensity of its GDP by 45% by 2030, from 2005 levels
- To achieve approximately 50% cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030
- To create an additional carbon sink of 2.5 to 3 billion tonnes of CO_2 equivalent through additional forest and tree cover by 2030

In March 2026, India's Union Cabinet approved the country's updated NDC for the period 2031–2035, further enhancing its climate ambition under the Paris Agreement. The new NDC commits to the following targets by 2035:

- To reduce the emissions intensity of its GDP by 47% by 2035, from 2005 levels
- To achieve 60% cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2035
- To expand carbon sinks to 3.5–4 billion tonnes of CO_2 equivalent through forest and tree cover by 2035

At the COP 26 summit in Glasgow in November 2021, India made commitments to cut total projected carbon emission by 1 billion tonnes by 2030 and achieve net-zero carbon emissions by 2070. The 2022 NDC update is also a step towards achieving India's long-term goal of reaching net-zero emission by 2070; for which India has prepared and submitted a separate framework document titled 'India's Long-term Low Carbon Development Strategy' to the UNFCCC in November 2022. Further at COP 26, India pledged acceleration towards zero emission vehicles (ZEVs) and highlighted the need of electrification in 2W and 3W industry.

The EV30@30 campaign was launched at the 8th CEM (Clean Energy Ministerial) in June 2017 with the goal of accelerating the deployment of EVs with a target of at least 30% EV sales by 2030. Under CEM, the Electric Vehicles Initiative (EVI) was introduced, which is a multi-government policy forum dedicated to accelerating the adoption of EVs across the world including India.

The 28th Conference of Parties (COP 28) was held in Dubai in December 2023, where the representatives from 197 countries showcased their efforts to limit global warming and held discussions to prepare for future climate change. According to Ministry of Environment, Forest and Climate Change, India launched the Green Credit Initiative at COP28 on 1st December, to create a participatory global platform for exchange of innovative environmental programs and instruments. The Conference of Parties (COP 29) was held in Baku, Azerbaijan in November 2024 was concluded with a landmark agreement to boost climate finance for developing nations USD 300 billion annually by 2035 also known as 'finance COP' It finalize rules for global carbon markets.

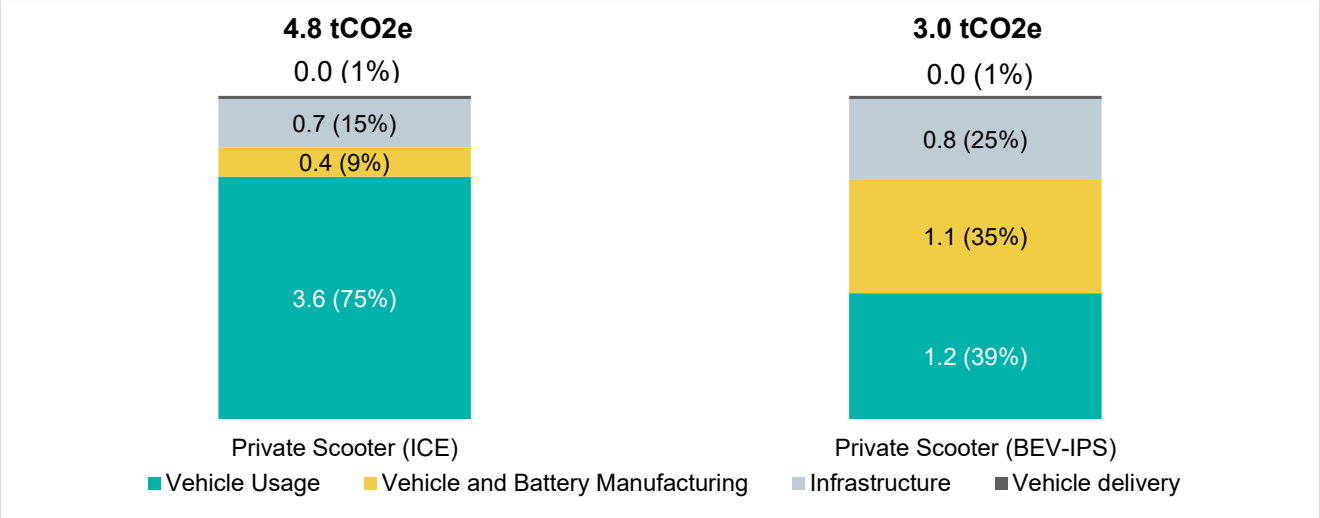
All these global commitments are navigating India towards a sustainable and emission free future. To aid this transition, adoption of free emissions and green technologies needs to be promoted in the transport sector.

Lifecycle Emissions Comparison of Electric vs ICE 2W

Life cycle emissions, referred as well-to-wheel emission, are the total amount of greenhouse gases emitted throughout a product's life, starting from its production, operation, and disposal. It considers present and projected future greenhouse gas (GHG) emissions attributable to every stage in the life cycles of both vehicles and fuels, from extracting and processing raw materials through refining and manufacturing to operation and eventual recycling/disposal.

In terms of life-cycle greenhouse gas (GHG) emissions across different modes and vehicle technologies, vehicle operations contribute the largest share. This encompasses emissions from vehicle usage (tank-to-wheel emissions), and fuel production (well-to-tank emissions) for 2Ws. Private ICE 2W emits the most during the usage phase, whereas vehicle and battery manufacturing causes the most significant chunk of emissions for BEVs. 75% of ICE vehicle emissions are due to usage, 9% are due to manufacturing, and 15% are due to road/rail infrastructure creation. For BEVs, the vehicle and battery manufacturing shares are significantly higher at 35% for private 2W.

Share of GHG emissions by life-cycle phase



Source: International Transport Forum, Crisil Intelligence

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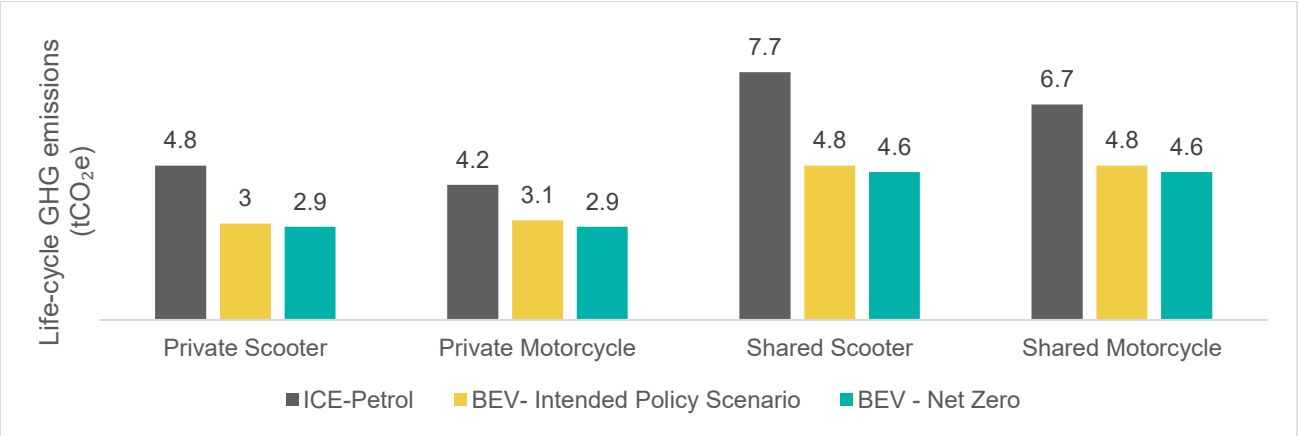
- To expand carbon sinks to 3.5–4 billion tonnes of CO_2 equivalent through forest and tree cover by 2035

The life cycle assessment by International Transport Forum (ITF) in the below section incorporates various decarbonization scenarios for India's energy supply/power grid. The grid energy mix for 2022 is considered as the base case. The Intended Policy Scenario (IPS) of grid decarbonization reflects India's commitment to the 2015 Paris Agreement adopted at COP21. The Net Zero scenario is an accelerated energy transition to meet Net Zero targets, as proposed by the government of India (COP26, 2021).

According to The World Bank and ITF, the transition of private scooters to battery electric vehicles (BEVs) can yield a decrease in their life-cycle greenhouse gas (GHG) emissions by roughly 1.8 to 1.9 tCO2e (tonnes of carbon dioxide equivalent) across all scenarios. An electric scooter for private use has about 38% lower GHG emissions than a petrol scooter (~1.8 tCO2e). Similarly, transitioning private motorcycles to BEVs can lead to reductions of approximately 1.1 to 1.3 tCO2e, representing about 26% less GHG emissions compared to petrol motorcycles. This decline in emissions is attributed to the enhanced efficiency of BEV scooters, supported by their smaller batteries and fewer manufacturing-related emissions.

Shared scooters and motorcycles have the potential to reduce life-cycle greenhouse gas (GHG) emissions by approximately 1.9 to 3.1 tCO2e, depending on various use-case and energy scenarios. However, in the Net Zero scenario, the long-term as well as the additional benefits in charging and other related efficiencies due to grid improvement/enhancement for two-wheelers (2Ws) are limited due to their range bound operations and minimal holding period.

Lifecycle GHG emissions for two-wheelers



Note: Energy supply was analyzed for two scenarios:

1. *Intended Policy Scenario (IPS): Transition of the electricity grid to clean energy based on previously announced policies (COP21, 2015)*
2. *Net Zero Scenario: An accelerated energy transition to meet Net Zero targets, as proposed by the government of India (COP26, 2021)*

Source: International Transport Forum, Crisil Intelligence

The transition to electric two-wheelers holds significant scope for reducing greenhouse gas (GHG) emissions and enhancing air quality, particularly in densely populated urban areas.

India's Dependence on Fuel Imports

India's crude oil import basket has witnessed a significant shift in sourcing patterns since fiscal 2022, driven primarily by the growing role of Russia. Russia's share in India's crude imports increased from 2% in fiscal 2022 to 36% in fiscal 2024

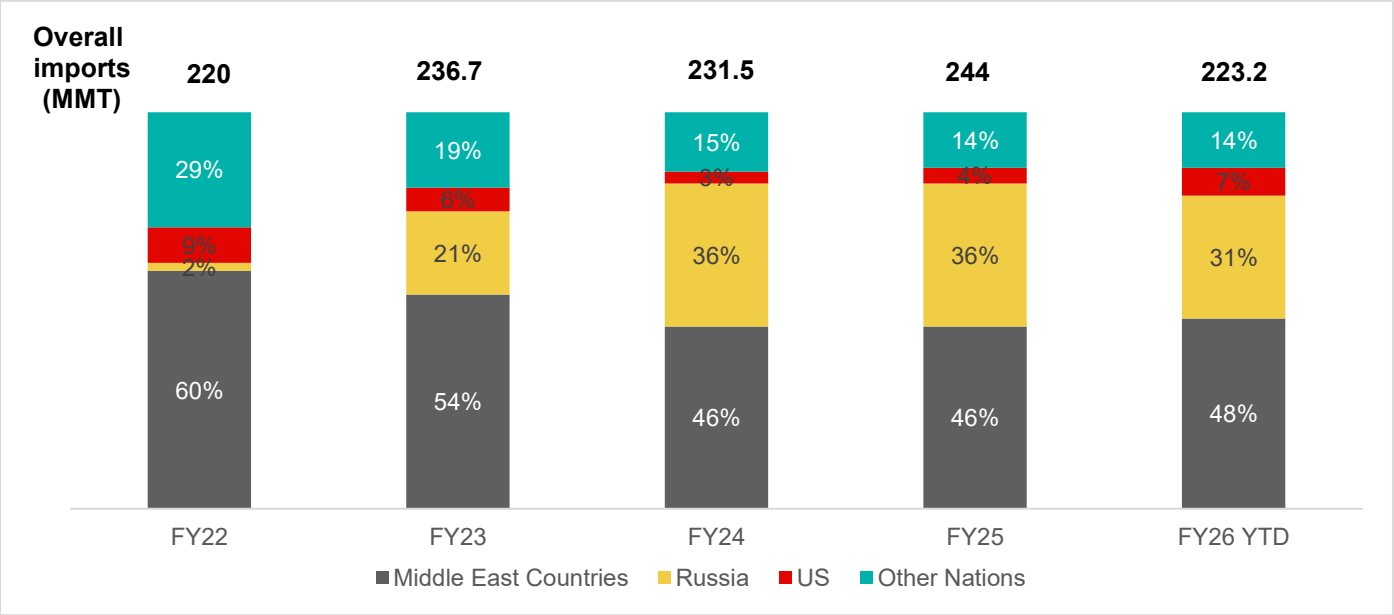
and fiscal 2025, before moderating slightly to 31% in fiscal 2026 (April- Jan). This increase has materially altered the composition of India's import basket and reduced the concentration of imports from traditional supplying regions.

Correspondingly, the Middle East's share of India's crude imports declined from 60% in fiscal 2022 to 45% in fiscal 2024, before recovering marginally to 48% in fiscal 2026 YTD. While the region continues to account for nearly half of India's crude requirements, its relative contribution has reduced compared with historical levels as Russian volumes gained prominence in the import mix.

Imports from the United States have remained relatively stable at low single-digit levels through most of the period, while the contribution of other supplying nations has nearly halved, declining from 29% in fiscal 2022 to 14% in fiscal 2026 YTD.

Overall, the data indicates a rebalancing of India's crude sourcing portfolio since fiscal 2022. The increasing share of Russian crude has emerged as the most notable development, coinciding with a decline in the relative share of both the Middle East and other supplier regions, resulting in a materially different import mix compared with the pre-2022 period.

Historical Crude Oil Imports



Note: YTD refers to April to January period
Source: DGFT, Crisil Intelligence

Crude oil imports to India

According to Energy Statistics India 2026 India's Total Primary Energy Supply (TPES) reached 9,32,816 kilo tonnes of oil equivalent in fiscal 2025, registering a growth of 2.95% over the previous year. The major source of energy comes from Coal (including lignite) (59.21%) which is followed by Crude Oil (29.79%) and Natural Gas (7.12%).

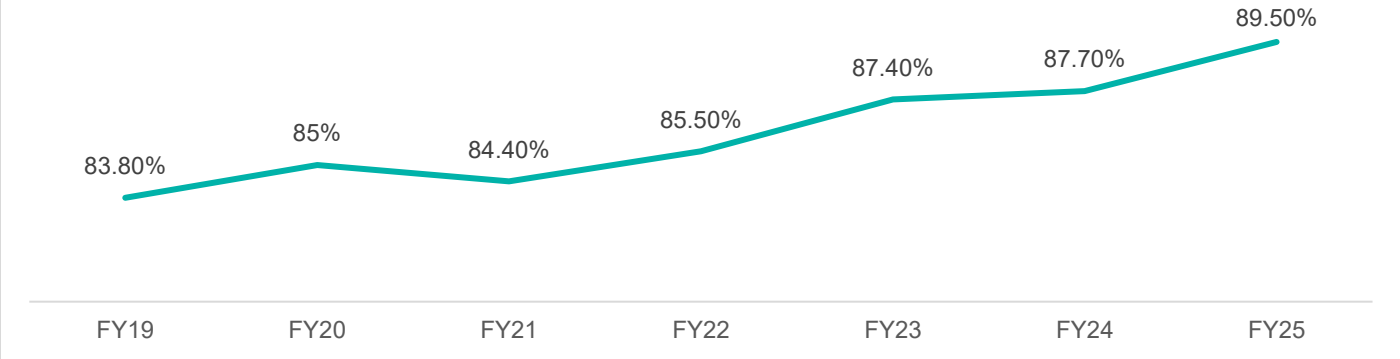
According to the Petroleum Planning and Analysis Cell (PPAC), India's total consumption of petroleum products for fiscal 2025 stood at 239.2 million metric tonnes (MMT), marking a 2.1% increase over the 234.3 MMT consumed in fiscal 2024.

Domestic production of crude oil declined to 28.7 MMT in fiscal 2025, from 29.4 MMT in fiscal 2024 continuing a broader trend of falling indigenous output. Import dependence on crude oil increased further to approximately 89.4 % in fiscal 2025, up from 87.7% in fiscal 2024.

Crude oil has been the main source of energy in the transport sector over the past few decades. Due to high import dependence, India's energy security is severely impacted by price and supply shocks of crude oil in the international market. Crude oil imports also make a significant impact on India's foreign exchange reserves. Since crude oil prices for India depend on the exchange rate, a higher exchange rate puts greater pressure on the economy. The Rs/USD exchange rate has risen from 64.4 in fiscal 2018 to 82.8 in fiscal 2024 and approximately 84.0 in fiscal 2025, with the rupee depreciating further to approximately 95–96 per US dollar as of June 2026 approaching all-time high. This continued depreciation not only widens the trade deficit but also raises input costs for auto production and fuel prices. While the increase in fuel prices directly impacts consumer sentiment, rises in exchange rates and input costs may not always have a direct effect, as OEMs do not always pass these costs to consumers.

Further, volatile crude oil prices are a threat to economy as it impacts the price stability of fuels in India driving inflationary pressure. Therefore, crude oil becomes an important parameter to determine reserve position and trade balance.

Import dependency of crude oil (FY19-FY25)



Source: PPAC, Crisil Intelligence

India could potentially lower its dependence on imports based on its ability to substitute/replace crude oil with other energy sources that can result in a positive effect in the Indian economy. The government has been trying to reduce its oil import dependence through a series of policy interventions. According to the Ministry of Petroleum & Natural Gas, the government has adopted a five-pronged strategy comprising increasing domestic production of oil and gas, promoting energy efficiency and conservation measures, giving thrust on demand substitution, promoting biofuels and other alternate fuels/ renewables, EV charging facilities and refinery process improvements for reducing the county's oil dependence on imported crude oil. This idea of reducing import dependence is paving way policies for ethanol blending and rise of alternate energies such as CNG, battery electric, hybrid and hydrogen in India's transport sector, as a potential replacement for fossil fuel vehicles.

Specific dependence on Middle East

The Middle East continues to be the cornerstone of India's crude oil import basket, accounting for 48% of total imports in fiscal 2026 YTD despite a decline from 60% in fiscal 2022. While the region's aggregate share has moderated over the period, it remains India's single largest source of crude imports, underscoring its continued importance to the country's energy supply chain.

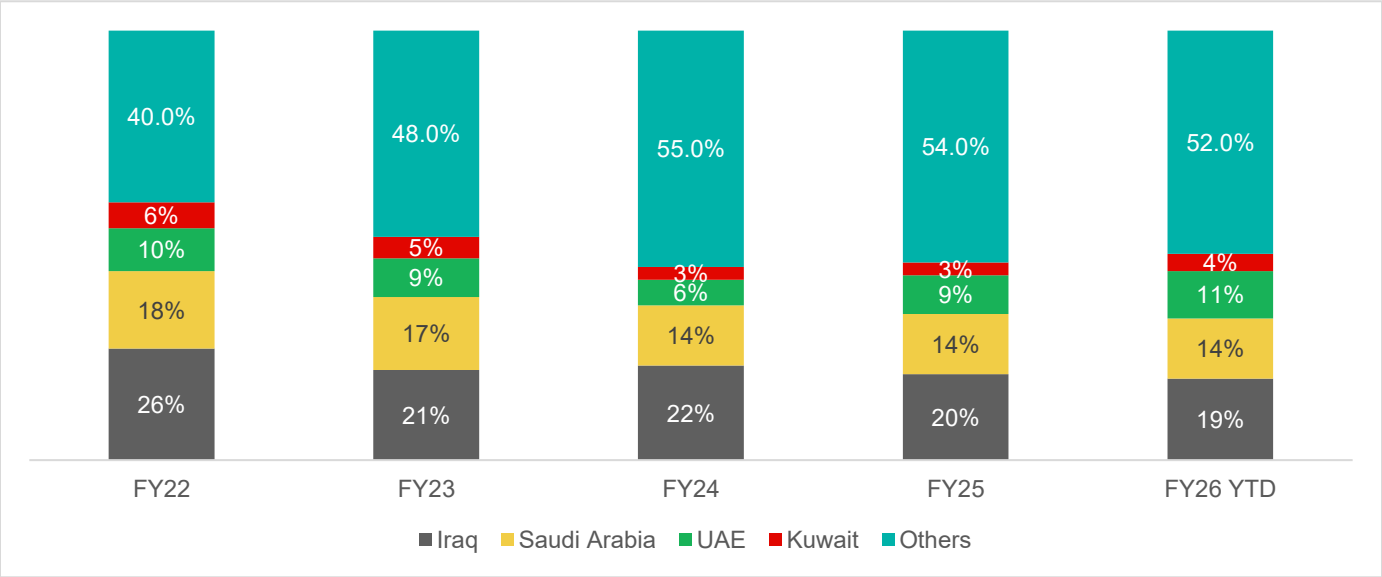
Within the region, Iraq has consistently remained India's largest Middle Eastern crude supplier, contributing close to one-fifth of total crude imports in fiscal 2026 YTD. Saudi Arabia and the UAE continue to represent the other major pillars of

India's regional sourcing strategy, collectively accounting for a significant share of the import basket. Kuwait has maintained a smaller but stable presence, while Qatar's contribution has remained marginal.

The reduction in the Middle East's overall share since fiscal 2022 has not been driven by a complete shift away from the region, but rather by a relative decline in the contribution of key suppliers such as Iraq and Saudi Arabia. At the same time, the UAE has increased its share of India's crude basket compared with fiscal 2022, partially offsetting declines from other regional suppliers.

Despite changes in supplier-level contributions, the data indicates that India's dependence on Middle Eastern crude remains substantial. Iraq, Saudi Arabia, the UAE, Kuwait and Qatar collectively continue to account for nearly half of India's crude imports, highlighting the region's enduring role in India's import portfolio even as sourcing patterns have evolved in recent years.

Historical Crude Oil Imports from Middle East Countries



Note: YTD refers to April to January period
Source: DGFT, Crisil Intelligence

Rise in Fuel Prices in India

The pricing of petroleum products was brought under Administered Price Mechanism (APM) with effect from July 1975. As a result, the pricing of petroleum products was shifted from import parity principles to cost plus principles. Under the APM (1975 to 2002) various oil pool accounts were maintained by the Oil Coordination Committee with the aim to

- Ensure stability in selling price
- Insulate consumers against international price fluctuations
- Subsidization of consumer price of certain petroleum products like kerosene for public distribution

Oil pool accounts are the accounts into which all revenues earned by the public sector oil companies are deposited and expenditures like subsidies are charged. Effective April 2002, the APM was dismantled, and as part of the dismantling of the APM, the oil pool account has been terminated.

However, the Government has again de-regulated the prices of petrol with effect from (w.e.f). 26 June 2010 and that of diesel w.e.f. 19 October 2014. Since then, the Oil Marketing Companies (OMCs) have been taking decisions on prices of diesel and petrol in line with changes in international market and domestic conditions. The OMCs have not only increased but also decreased the prices of petrol and diesel in line with changes in international prices and rupee dollar exchange rates. Effective from 16 June 2017, daily pricing of petrol and diesel has been implemented in the entire country resulting in closer alignment with the international prices.

Both the central and state governments of India levy taxes on petrol and diesel. The central authorities apply excise duty on petrol and diesel. This rate remains the same throughout the country. On top of this, the state governments levy VAT, sales tax, and other additional charges. The rates of these taxes tend to vary by state, leading to a difference in petrol and diesel prices across India.

The three major factors that decide crude oil prices are as follows:

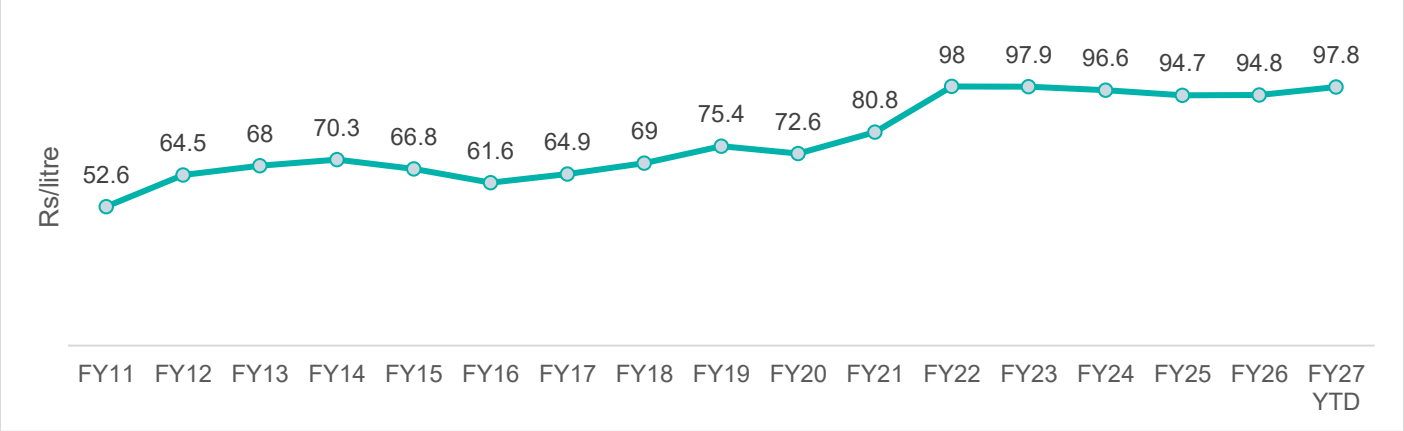
- International crude oil prices are linked to geopolitics
- Fluctuation in the exchange rate
- Tax structure of the respective states and the Centre.

With an aim to reduce the prices of petrol and diesel and give relief to the consumers, the Central Government reduced the Central Excise duty for diesel by Rs 10 per litre and by Rs 5 per litre for petrol with effect from November 2021. The Central Government also requested the State Governments to make a reduction of Rs. 2.50 per litre in Value Added Tax (VAT) imposed by them on diesel and some states have reduced VAT on diesel. Since then, the fuel prices remained constant after the Centre's exercise duty reduction. However, a surge in global crude oil prices owing to the war between Russia and Ukraine led to corresponding hikes in the price of diesel and petrol in India too. Fuel prices have risen significantly after fiscal 2022. Further in March 2024, the Petroleum Ministry reduced petrol and diesel prices by Rs 2 per litre across the country ahead of the general elections.

The two-wheeler industry is sensitive to fuel price fluctuations and consumers are cautious about total cost of ownership (TCO). The increase in fuel prices could result in higher fuel related expenses thereby elevating the TCO. Also, an increase or decrease in fuel prices is likely to affect consumer sentiments and may lead to slow down or pickup in purchase decisions.

Petrol prices in Delhi have shown an upward movement in the recent months of fiscal 2027. In April 2026, prices were around Rs 94.8 per litre. Prices rose through May 2026, closing the month at approximately Rs 102 per litre. This upward trend has continued into June 2026, with prices holding around the Rs 102 per litre mark. The fiscal 2027 YTD average stands at approximately Rs 97.8 per litre, reflecting this recent uptick.

Petrol Price at Delhi from FY2011 to FY2026



Note: YTD: Apr- Jun 19, 2026

Source: Crisil Intelligence

Overview of Policies Supporting the Indian Electrification Journey

Demand Side Incentives

FAME I (2015-2019)

The Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME I) scheme was implemented to promote manufacturing of electric and hybrid vehicle technology and ensure sustainable growth of the same. The first phase of the scheme had four focus areas demand creation, technology platforms, pilot projects and charging infrastructure. About 2.78 lakh EVs were supported through demand incentives, and 465 buses were sanctioned to cities/states under the scheme.

FAME schemes

S. NO.	FISCAL	FUND ALLOCATED	FUND UTILISATION
1	**2015-16**	Rs 75 crore	Rs 75 crore
2	**2016-17**	Rs 144 crore	Rs 144 crore
3	**2017-18**	Rs 165 crore	Rs 165 crore
4	**2018-19**	Rs 145 crore	Rs 145 crore
Total		Rs 529 crore	Rs 529 crore

Source: PIB

Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME II) India Scheme (2019-2024)

According to PIB, Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India (FAME India) Scheme Phase-II was implemented for five years with a Rs 11,500 crore budget. Of the total budget, about 86% was earmarked for demand incentives to boost EV adoption in the country. The scheme incentivised the sale of EVs (i.e., e2Ws, e3Ws and e-4Ws) and offered grants for deployment of e-buses and EV public charging stations (EVPCS). This phase aimed to generate demand by supporting 7,000 e-buses, 5 lakh e-3Ws, 55,000 e-4W passenger cars (including strong hybrid) and 10 lakh e2Ws.

Incentives offered under the scheme

SEGMENT	MAXIMUM VEHICLES SUPPORTED	APPROX SIZE OF BATTERY (KWH)	INCENTIVE OFFERED (RS/KWH)	MAXIMUM EX-FACTORY PRICE TO AVAIL INCENTIVE (RS)
2W	1,000,000	2	10,000	1.5 lakh
3W	500,000	5	10,000	5.0 lakh
4W	35,000	15	10,000	15.0 lakh
4W strong hybrid	20,000	1.3	10,000	15 lakh
Bus	7,090	250	20,000	2.0 crore

Source: Ministry of Heavy Industries

In June 2021, demand incentive for 2Ws was increased to Rs 15,000/ kWh capped at 40% of the vehicle cost. In June 2023, this was again revised and reduced to Rs 10,000 per kWh of battery from Rs 15,000 per kWh earlier and the maximum subsidy cap was reduced from 40% to 15%.

With the expiry of FAME II in fiscal 2024, the government introduced Electric Mobility Promotion Scheme 2024 (EMPS) to support the adoption of EV 2Ws and 3Ws.

Electric Mobility Promotion Scheme 2024

MHI introduced Electric Mobility Promotion Scheme 2024 (EMPS 2024) in March 2024 with a budget outlay of RS 500 crores for a period of 4 months, starting from April 1, 2024 to July 31, 2024, for faster adoption of electric two-wheeler (e2W) and three-wheeler (e-3W). The scheme had further been extended for two months, till September 2024.

The scheme was aimed at providing incentives for the purchase of e2Ws and e-3Ws in the country. The scheme was planned to support the adoption of 372,215 EVs in total, including 333,387 e2Ws and 38,828 e-3Ws. The targeted e-3Ws include 13,590 e-rickshaws and e-carts, and 25,238 e-3Ws in the L5 category. Under the FAME-II scheme, PMP was implemented, and manufacturers were obligated to follow the PMP guidelines outlining the localization of EV components over time. These PMP guidelines for EVs were needed to be followed by OEMs to be eligible for support under Electric Mobility Promotion Scheme 2024.

e2Ws got a subsidy of Rs. 5,000 per kWh with a maximum limit of RS 10,000 per vehicle under the scheme. E-rickshaws and carts got a subsidy of Rs 5,000 per kWh with a limit of Rs 25,000 per vehicle. E-3Ws in the L5 category also got a subsidy of Rs 5,000 per kWh with maximum incentive capped at Rs 50,000 per vehicle. Subsidies plays vital role in driving sales for EVs in the country. With FAME II having expired in March 2024, the introduction of EMPS provided an impetus to the EV market in the short term.

The EMPS subsidy ended on September 30, 2024 and has been replaced by PM E-DRIVE scheme.

PM Electric Drive Revolution in Innovative Vehicle Enhancement (PM E-DRIVE) Scheme

The PM E-DRIVE scheme with an outlay of ₹10,900 crore, will be implemented from October 1, 2024 to March 31, 2026, for faster adoption of electric vehicles (EVs), setting up of charging infrastructure and development of EV manufacturing eco-system in the country. Subsequently, MHI notified extension of the PM E-DRIVE scheme until March 31, 2028. However, terminal date for e2W and e3W was retained at March 31, 2026.

As per the latest notification, dated March 27, 2026, the terminal date for registered electric two-wheelers has now been revised to July 31, 2026, while the deadline for registered electric three-wheelers in the electric rickshaw and electric cart categories has been extended to March 31, 2028.

For electric two-wheelers, demand incentives for vehicles registered between April 1, 2025, and July 31, 2026, have been reduced to Rs 2,500 per kWh, capped at Rs 5,000 per vehicle, compared to Rs 5,000 per kWh (capped at Rs 10,000) in FY25.

Incentives under PM E-DRIVE Scheme for e2W and e3W segments:

Vehicle Segment	No. of vehicles to be supported		Incentives for vehicles		Maximum ex-factory price
	FY25	FY26	FY25	FY26	
e2W	1,064,000	1,415,120	Rs. 5,000/- kWh capped at Rs. 10,000 max	Rs. 2,500/- kWh capped at Rs. 5,000 max	Rs. 1.5 Lakhs

e3W (L3)	43,371	67,225	Rs. 5,000/- kWh capped at Rs. 25,000 max	Rs. 2,500/- kWh capped at Rs. 12,500 max	Rs. 2.5 Lakhs
e3W (L5)	80,546	124,846	Rs. 5,000/- kWh capped at Rs. 50,000 max	Rs. 2,500/- kWh capped at Rs. 25,000 max	Rs. 5 Lakhs

Source: Ministry of Heavy Industries (MHI)

The scheme also aims to establish a robust network of public charging stations, including 22,100 fast chargers for e-4Ws, 1,800 for e-buses, and 48,400 for e2Ws and e3Ws, boosting user confidence. These charging points to be installed in key cities with high electric vehicle penetration and along select highways. The total outlay for charging infrastructure under the scheme is Rs. 2,000 crore.

The discontinuation of the PM E-Drive scheme may result in a short-term moderation in electric two-wheeler demand, with some pre-buying by customers anticipated ahead of the withdrawal of incentives. However, as the industry has gradually reduced its dependence on subsidies through improved product offerings, increasing localization, expanding charging infrastructure, greater financing availability, and rising consumer acceptance of electric mobility, the long-term demand outlook is expected to remain supported by structural growth drivers. The impact is likely to vary across OEMs depending on their pricing strategies, cost structures, product portfolios, and target customer segments.

Delhi EV Policy

The Government of the National Capital Territory (NCT) of Delhi introduced the Delhi Electric Vehicle Policy, 2020 in August 2020 with the objective of accelerating electric vehicle adoption, improving air quality and developing a comprehensive electric mobility ecosystem in the National Capital Territory. The policy aimed to position Delhi as one of India's leading EV markets and established a target for electric vehicles to account for 25% of all new vehicle registrations by 2024. To support this transition, the policy adopted a multi-pronged approach encompassing demand incentives, fiscal benefits, charging infrastructure development and ecosystem creation.

For electric two-wheelers, the policy provided purchase incentives linked to battery capacity, along with scrappage incentives for replacing older internal combustion engine vehicles. Eligible electric vehicles were also exempted from payment of road tax and registration fees, thereby reducing the upfront acquisition cost for consumers. In addition, the policy promoted deployment of public charging stations and battery swapping facilities, recognizing the importance of accessible charging infrastructure in driving EV adoption. The policy further established dedicated institutional mechanisms and awareness initiatives to facilitate implementation and encourage consumer adoption.

Following the expiry of the original policy period, the Government of NCT Delhi continued to extend the Delhi EV Policy, 2020 while deliberating on a revised policy framework.

On June 29, 2026, The Delhi Cabinet approved the Delhi EV Policy 2026, with a Rs.15,000-crore budget. The policy will come into effect on July 1, 2026 and remain operational until March 31, 2030, providing a comprehensive framework to encourage the adoption of electric vehicles (EVs).

Under the policy, electric cars priced up to Rs. 30 lakh will be eligible for a 100% exemption from road tax and registration fees, significantly improving the affordability of EV ownership. To further drive adoption, the Government will provide purchase incentives of up to Rs. 30,000 for electric two-wheelers, Rs. 50,000 for electric three-wheelers, and Rs. 1 lakh

for electric N1 goods vehicles. The policy also includes vehicle scrapping incentives ranging from Rs. 5,000 to Rs. 1 lakh to encourage the replacement of older, polluting vehicles with cleaner electric alternatives.

As part of its phased transition towards cleaner mobility, Delhi will permit registration of only new electric auto-rickshaws and N1 goods carriers from January 2027. Additionally, from April 2028, only new electric two-wheelers will be registered in the city. These measures are expected to accelerate the shift away from fossil fuel-based transportation and contribute significantly to reducing vehicular emissions.

To support the growing EV ecosystem, the Government plans to develop more than 30,000 EV charging points across Delhi, strengthening charging infrastructure and enhancing convenience for EV users. Through a combination of financial incentives, regulatory measures, and infrastructure development, the Delhi EV Policy 2026 is expected to play a pivotal role in improving air quality, reducing carbon emissions, and positioning Delhi as a leading hub for electric mobility in India.

EV demand incentives offered at state level

Many state governments have come forward and are providing incentives on purchase of an electric vehicles, wherein the benefit provided is in addition to central policy benefits.

State	Amount / Rate	Vehicle Type	Cap per Vehicle	Policy Duration / Others
Maharashtra	Rs 5,000/kWh	All EVs	Rs 1.5 lakh for first 10,000 cars	100% road tax exemption till 2025; No 6% sales tax for EVs > $35,000 (~30 lakh)
Gujarat	Rs 10,000/kWh	All EVs (min 2 kWh battery)	Rs 1.5 lakh for cars	Valid till 2025
Bihar	Rs 5,000/kWh (Rs 7,500–10,000 total) for first 10,000 e2Ws	Electric 2-wheelers	Not specified	While policy remains in force 5% rebate on tax (first 10,000 e2Ws, 50% henceforth.
Odisha	Rs 5,000/kWh	Electric 2-wheelers	Rs 20,000	Policy revised in April 2023
Meghalaya	Rs 10,000/kWh (first 3500 e2Ws)	Electric 2-wheelers	Rs 1.5 lakh	The policy also provides 100% exemption on road tax during policy period
Karnataka	-	All EVs	-	100% exemption on road tax and registration fee
Madhya Pradesh	Rs 5000/kWh	Electric 2-wheelers, Electric 3-wheelers	e2W: Rs 10,000 for max 1 lakh EVs e-3W: Rs 20,000 for max 15k EVs	Till 2030, 1 year parking fee exemption, 100% vehicle tax and registration fee exemption

Telangana	–	Electric 2-wheelers	–	100% exemption of road tax and registration fee (first 2 lakh e2Ws)
Tamil Nadu	Rs 10,000/kWh	Commercial electric 2-wheelers	Rs 30,000	Max 6,000 vehicles incentivized per year
Uttar Pradesh	Rs 5,000/vehicle (e2W); 15% of ex-factory cost	e2W, Electric PVs	Rs 1 lakh (PVs)-(up to 25k units); e2Ws up to 2,00,000 vehicles	Policy extended to 2027

Note: These states contribute ~70% to India's EV retails
Source: BEE, State EV policy documents

Supply Side Incentives

PLI for Automobile and Auto components (ATT)

The government approved the PLI Auto policy in 2021 with a budget outlay of Rs 25,938 crore for a period of 5 years from fiscal 2023 to fiscal 2027. Total Incentive per entire group company is capped at Rs 6,485 crore. The policy offers incentives for manufacturing of Advanced Automotive Technology (AAT) Products. This policy would promote localization for new technology products like EVs and enable creation of indigenous value chain. The policy consists of two components, incentivizing incremental sales of automobile and auto components named Champion OEM Incentive Scheme and Component Champion Incentive Scheme, respectively.

- Champion OEM Incentive Scheme: The Champion OEM Incentive scheme is a sales value linked scheme, applicable to Battery Electric Vehicles (BEV) and Hydrogen Fuel Cell Vehicles (FCEV) of all segments – two-wheelers, 3-wheelers, passenger vehicles, commercial vehicles, tractors, automobiles meant for military use, and any other AAT vehicle as prescribed by MHI. The incentive scheme targeted to address the cost disabilities related to Advanced Automotive Technology vehicles faced by OEMs. depending upon technical developments

- Component Champion Incentive Scheme: The Component Champion Incentive scheme is also a sales value linked scheme, applicable on pre-approved AAT components of all vehicles, CKD/SKD kits, vehicle aggregates of 2-Wheelers, 3-Wheelers, passenger vehicles, commercial vehicles, tractors and any other AAT components prescribed by MHI.

According to the scheme guidelines, applicants for the scheme must achieve a domestic value addition (DVA) of 50% to claim incentives under the same. The OEMs and component makers are required to calculate and present the DVA across their supply chain and present these details to the testing agencies. This is to promote the Make in India campaign and boost domestic manufacturing of advanced automotive products. Further in April 2023, the MHI released the

standard operating procedure (SOP) under the PLI Auto scheme to testing agencies. With this, the applicants under the scheme can now submit their applications for the testing and certification of AAT products (both OEMs and components), which will help them qualify for incentives under the PLI scheme.

The scheme has witnessed significant industry participation. Initially, 115 companies filed applications under the PLI Scheme for Automobile and Auto Components. As per the update issued by the Ministry of Heavy Industries, as of 2025 end, 82 applicants had been approved under the scheme. The approved applicants collectively operate 278 manufacturing units across 17 states and union territories in India.

Approved applicants under the Champion OEM Incentive Scheme include leading automobile manufacturers such as Ashok Leyland Limited, Bajaj Auto Limited, Hero MotoCorp Ltd., Hyundai Motor India Limited, Kia India Private Limited, Mahindra & Mahindra Ltd., Ola Electric Technologies Private Limited, Suzuki Motor Gujarat Private Limited, Tata Motors Limited, Eicher Motors Limited, Piaggio Vehicles Private Limited, and others.

Similarly, approved beneficiaries under the Component Champion Incentive Scheme include several major automotive and auto component manufacturers such as Bharat Forge Limited, Bosch Limited, Tata AutoComp Systems Limited, Cummins Technologies India Private Limited, Hero Motocorp Ltd., Toyota Kirloskar Auto Parts Private Limited, Lucas-TVS Limited, UNO Minda Limited, Sundram Fasteners Limited, Schaeffler India Limited, Sona BLW Precision Forgings Limited, Motherson Sumi Systems Limited, Valeo India Private Limited, Varroc Engineering Limited, and Wabco India Limited.

The approved applicants have established a wide manufacturing footprint across India. Maharashtra has the highest number of approved manufacturing units (85), followed by Tamil Nadu (49), Haryana (43), Karnataka (29), Gujarat (14), Uttar Pradesh (14), and Uttarakhand (12). Overall, 278 manufacturing units are covered under the scheme.

The PLI Scheme for Automobile and Auto Component was able to attract proposed investment of Rs 74,850 crores against the target estimate of investment Rs 42,500 crores over a period of five years. In December 2023, the PLI scheme was revised and is now applicable for a continuous period of five financial years, commencing from the fiscal year 2023-24. The disbursement of the incentive is scheduled for the subsequent financial year, April 1, 2024, to March 31, 2025.The scheme has also contributed towards increased investments in EV manufacturing capacity, localization of advanced automotive components, product development, and employment generation.

As per disclosures made by the Government, the cumulative eligible sales target under the scheme up to March 2028 is Rs 2,31,500 crore over the base year FY 2019-20. Till 30 September 2025, eligible sales of approximately Rs 32,879 crore had already been achieved. Further, as of 30 November 2025, incentives amounting to Rs 1,350.83 crore had been disbursed to five applicants under the scheme.

Subsequently, as per a Press Information Bureau release dated 27 March 2026 issued by the Ministry of Commerce & Industry, cumulative incentives disbursed under the Automobile and Auto Components PLI sector increased to approximately Rs 2,377.56 crore. Further, 72 companies under the automobile and auto components sector reported incremental production of approximately Rs 13,126 crore during the financial year up to December 2025.

The Government has highlighted that the PLI Auto Scheme has accelerated EV adoption, strengthened domestic manufacturing, and enhanced supply chain resilience through localization and DVA requirements.

The scheme is part of a broader industrial strategy supported by initiatives such as PM Gati Shakti, National Logistics Policy, and Semicon India Programme, aimed at boosting domestic manufacturing and reducing import dependence.

Overall, the PLI Auto Scheme is expected to drive technological innovation, investment, and employment, while positioning India as a global hub for next-generation automotive manufacturing.

PLI for Automotive and Advanced Chemistry cells (ACC)

The Government of India on May 2021 approved the PLI policy on Advanced Chemistry Cell (ACC) Battery storage with a budget outlay of Rs 18,100 crores for setting up battery manufacturing facilities with a total capacity of 50 Giga Watt Hour (GWh). This policy will strengthen the ecosystem for electric vehicles and battery storage in the country. The policy aims to enhance India's manufacturing capabilities of ACC by setting up of Giga scale ACC battery manufacturing facilities in India with emphasis on maximum domestic value addition. Under the scheme, the beneficiary OEM must achieve a domestic value addition of atleast 25% and raise it to 60% within 5 years while also making the mandatory investment of Rs 225 crore /GWh for committed capacity within 2 years. The incentives under the PLI scheme will be disbursed over a fixed period of five years, from the time of commissioning of the manufacturing facility.

In the first round of PLI awards (March 2022), four companies secured incentives: Ola Electric for 20 GWh lithium-ion cell manufacturing, Hyundai Global Motors Company Limited for 20 GWh, Reliance New Energy for 5 GWh and Rajesh Exports for 5 GWh lithium-ion cells. However, the 20 GWh capacity initially awarded to a Hyundai company was later deemed invalid, leading to a new round of bidding for 20GWh. Thus, in first round of awards, three companies secured incentives: Ola Electric, Reliance New Energy, and Rajesh Exports. These companies committed a combined investment of Rs 27,000 crore for the scheme. In the next round of bidding, the government is unlikely to relax the criteria for localisation of cell manufacturing, and the minimum bidding capacity is expected to remain at 5 GWh.

In August 2022, the government re-examined its offer for Hyundai Global Motors under the scheme after Hyundai Motor Company issued a public statement saying it had no link with Hyundai Global Motors and has not authorised the company to use the Hyundai trademark and logo. Following this Hyundai Global Motors backed out of the scheme. Thus, MHI cancelled the capacity awarded to Hyundai Global Motors and called for rebids of the vacated 20GWh capacity in 2024.

In April 2024, MHI received bids from seven bidders under global tender for the re-bidding of PLI for 10 GWh (from the 20 GWh vacated capacity) ACC manufacturing announced on 24th January 2024. The list of bidders is ACME Cleantech Solutions Private Limited, Amara Raja Advanced Cell Technologies Private Limited, Anvi Power Industries Private Limited, JSW Neo Energy Limited, Reliance Industries Limited, Lucas TVS Limited, and Waaree Energies Limited for a cumulative capacity of 70 GWh.

In September 2024, the Ministry of Heavy Industries (MHI), Government of India has announced the selection of successful bidder under the Production Linked Incentive (PLI) Scheme for Advanced Chemistry Cell (ACC) Battery Storage. Reliance Industries Limited has been awarded 10 GWh ACC capacity under Production Linked Incentive (PLI) scheme based on QCBS mechanism. All seven bids were evaluated, and six companies were shortlisted for financial evaluation. The remaining five shortlisted bidders are put in the waiting list as per their rank, starting from Rank II onwards. Bidders who were waitlisted under the Program are: ACME Cleantech Solutions Private Limited (Waitlist 1), Amara Raja Advanced Cell Technologies Private Limited (Waitlist 2), Waaree Energies Limited (Waitlist 3), JSW Neo Energy Limited(Waitlist 4), and Lucas TVS Limited(Waitlist 5).

As per recent government updates, out of the total targeted 50 GWh capacity, 40 GWh has been awarded to four beneficiary firms. Till 31 December 2025, a cumulative investment of approximately Rs 3,237 crore has been reported, along with employment generation of 1,118 persons under the scheme.

The scheme has also catalysed broader industry participation beyond PLI beneficiaries. In addition to selected firms, at least 10 manufacturers have announced plans to set up ACC manufacturing capacity of around 178 GWh over the next five years. Further, the scheme has stimulated demand for key battery components such as cathode materials, anode materials, and foils, leading to investments in component manufacturing and battery recycling units within India.

However, till date, no beneficiary firm has claimed incentives under the PLI ACC scheme, as large-scale manufacturing facilities are still in the implementation stage. The beneficiary-wise status of capacity awarded versus installed (as of latest update) is as follows:

- ACC Energy Storage Pvt. Ltd. – 5 GWh awarded, 0 GWh installed
- Ola Cell Technologies Pvt. Ltd. – 20 GWh awarded, 1 GWh installed
- Reliance New Energy Battery Storage Ltd. – 5 GWh awarded, 0 GWh installed
- Reliance New Energy Battery Ltd. – 10 GWh awarded, 0 GWh installed
- Total: 40 GWh awarded, 1 GWh installed

The ACC PLI Scheme is expected to play a crucial role in reducing import dependence on battery cells, building a domestic battery manufacturing ecosystem, and supporting India's energy transition and electric mobility goals. It complements broader government initiatives aimed at strengthening clean energy supply chains and positioning India as a globally competitive hub for advanced battery manufacturing.

Phased Manufacturing Program

Under FAME II policy, PMP has been introduced with the aim of boosting domestic manufacturing of EVs, its assemblies/ sub-assemblies and parts/sub-parts thereby increasing the domestic value addition. The PMP is a government initiative to promote the local manufacturing of EVs in India. The PMP offers a scaled duty structure for imported EV parts. To provide further impetus to electric mobility and promote indigenous development of electric vehicles, the central government has reduced and rationalized basic customs duty on electric vehicles.

The following Phased Manufacturing Programme (PMP) is notified:

S No	Item		Current BCD	PMP	
				Proposed BCD	Proposed date
1	CBU	Bus (HS 8702) & Trucks (HS 8704)	25%	50%	April 2020 onwards
2	SKD	PV (HS 8703) & 3W (HS 8703/8704)	15%	30%	
		2W (HS 8711)		25%	
		Bus (HS 8702)		25%	
		Truck (HS 8702)		25%	
3	CKD	Bus (HS 8704)	10%	15%	
		PV (HS 8703) 2W (HS 8711) 3W (HS 8703/8704) & Truck (HS 8704)			
4	Lithium-ion cells (HS 85076000) for use in the manufacture of Lithium-ion accumulator for electric vehicles		5%	15%	April 2021 onwards
5	Battery packs (HS 8507) for use in the manufacture of electric vehicles		5%	15%	
6	Parts for use in the manufacture of electric vehicles like AC or DC Charger AC or DC Motor AC or DC Motor Controller Power Control Unit (Inverter, AC/DC Converter, Condenser) Energy Monitor Contactor Brake System for recovering		0%	15%	

	Electric Compressor			

Note: BCD: Basic Customs Duty, CBU: Completely Built Up, SKD: Semi Knocked Down, CKD: Completely Knocked Down
Source: MHI, Crisil Intelligence

Charging and EV Infrastructure policy

The government is actively promoting charging infrastructure and battery swapping to support the EV ecosystem in India. The plan is to establish five lakh public charging stations (PCS) by 2025, by offering financial assistance to states and private companies. This initiative addresses the lack of charging infrastructure which is a key barrier to EV adoption. Further through the revised guidelines and standards for charging infrastructure issued by Ministry of Power, the government aims to augment the station density/distance between two charging stations as below:

- At least one charging station to be made available in a grid of three-by-three km. Further one charging station to be set up at every 25 km on both side of highway/roads.
- For long range and heavy duty EVs, there should be one fast charging station at every 100 km, one on each side of the road/highway

Further, the policy was amended to cap the maximum tariff applicable to EV public charging. In addition to Battery Charging Stations (BCS), the government is also promoting Battery Swapping and released its draft Battery Swapping Policy in 2022. The policy is aimed at standardizing battery specifications and creating a battery swapping network by rollout of BSS in phased manner. This policy is targeted at supporting the adoption of battery-swapping for light electric power train vehicles (LEV) of category L, and E-Rickshaw/E-Cart. Also, the policy highlights the importance of re-use of end-of-first-life swappable batteries and recycling of end-of-life batteries.

The charging standards in India is as per the Automotive Industry Standard (AIS) and Bureau of Indian Standards (BIS). There are multiple standards offered by AIS and BIS for AC and DC charging systems respectively. In 2023, BIS launched new EV charging standard that has ability to combine AC and DC charging for light electric vehicles. This also known as Light Electric Combined Charging System (LECCS) is aimed at bringing interoperability between various EV models and charging infrastructure.

Policies towards battery recycling and EPR for e2Ws

Battery Waste Management Rules 2022 were implemented by the Government to promote the re-use and recycling of Advanced Chemistry Cell (ACC) batteries. The Rules establish a comprehensive regulatory framework covering the entire lifecycle of batteries, incorporating environmental safeguards, formal collection mechanisms, and compliance monitoring systems. This policy has set out the government's vision for battery recycling in India, including the provision of financial incentives, the development of standards, and raising of awareness about the importance of battery recycling.

The traditional EV battery value chain includes raw material extraction, battery manufacturing followed by first life application and finally disposal. However, battery re-use and recycle will introduce alternate value chain where batteries are re-purposed for a second life application in the energy-storage segment. This second-life application includes use in stationary energy storage systems such as grid balancing, renewable energy storage, and backup power solutions. Finally, in the end-of-life stage where the battery no longer meets its performance requirements, it is recycled for extraction of metals like Co, Ni, Al, Cu, etc. and other critical minerals such as lithium, thereby reducing import dependence. The introduction of re-use and recycle policy of ACC batteries would help to reduce the battery prices further and improve availability of raw materials in the future.

A policy on Extended Producer Responsibility (EPR) concept has been introduced, where the producers (including importers) of batteries are responsible for collection and recycling/refurbishment of end-of-life batteries and use of recovered materials into new batteries. EPR mandates that all end-of-life batteries must be collected and sent for recycling/refurbishment and prohibits disposal in landfills. To meet the EPR obligations, battery producers may engage themselves or authorise any other entity for collection, recycling, or refurbishment of batteries. The Rules also provide for registration of producers, recyclers, and refurbishers through a centralized online portal to ensure traceability and transparency of battery waste flows.

Further, there are targets for recovery of the battery materials - 70% by fiscal 2025, then 80% by fiscal 2026, and 90% from fiscal 2027 onwards. Producers will also have to include 5% of recycled material in the total dry weight of a cell by fiscal 2028, 10% by fiscal 2029, 15% by fiscal 2030, and expanding to 20% by fiscal 2031. Additionally, the Rules introduce a system of EPR certificates, which may be generated by registered recyclers and used by producers to meet their compliance obligations, thereby enabling a market-based mechanism for recycling.

The battery swapping policy also emphasizes the reuse and recycling of swappable batteries. To promote the re-use of swapped batteries after their end-of-life in automotive applications, energy operators or battery swapping operators will be encouraged to develop a power bank using these batteries to store and use energy for EV charging or other stationary applications. This is expected to improve asset utilization, extend battery life cycles, and support development of a circular economy in the battery ecosystem.

Vehicle Scrappage

The scrappage policy envisages the phasing out of old passenger and commercial vehicles. The policy aims to curb air pollution, improve road, passenger & vehicle safety, enhance fuel efficiency, improve auto sector sales and boost availability of low-cost materials for automotive, steel and electronics industry.

The process kicked off in May 2016, with the Ministry of Road Transport and Highways (MoRTH) issuing a concept paper outlining the Voluntary Vehicle Fleet Modernisation Programme to encourage scrapping of vehicles manufactured before March 31, 2005. The policy was declared during the 2021-22 union budget.

Currently, new vehicle scrapping facilities are being established in various states in accordance with the Motor Vehicles (Registration and Functions of Vehicle Scrapping Facility) Rules, 2021. However, a significant portion of the automobile scrap yards are operated by the semi-formal sector. These recyclers often use basic methods for material recovery and lack proper organization and integration with other stakeholders in the ELV value chain. Vehicle re-use and scrapping present a substantial opportunity for resource transformation. In India, up to 70% of a vehicle can be dismantled and directly re-used or sold to other manufacturers.

On January 30, 2024, India's Ministry of Environment, Forest, and Climate Change (MoEFCC) issued the draft End-of-Life Vehicles (Management) Rules, 2024, demonstrating a commitment to sustainable automotive practices. These draft rules propose the introduction of an Extended Producer Responsibility (EPR) system for car manufacturers and other entities starting in April 2025, to ensure the responsible and environmentally friendly disposal of ELVs.

As of 2026, 129 Registered Vehicle Scrapping Facilities (RVSFs) are operational across 21 States and UTs in the country under Vehicle Scrapping Policy. Also, a total of 4,30,306 vehicles have been scrapped by these RVSFs.

Self-reliance in Rare Earth elements

The rare earth magnet particularly Neodymium-Iron-Boron (NdFeB) plays vital role in the creation of compact, lightweight and high-performance electric vehicle (EVs) motor. Rare earth magnets help reduce energy losses in electric motors, resulting in improved efficiency and longer driving ranges for EVs. This is especially important for EVs, as it directly impacts their overall performance, range, and energy consumption.

The significance of rare earth magnets will continue to increase as the demand for EVs continues to grow.

China dominates every stage of the permanent magnet manufacturing value chain from mining to separation, refining and manufacturing-and holds about 45-50% of global rare earth element reserves. Hence, it is imperative that India prioritise self-sufficiency in this critical industry to avoid reliance on a single supplier.

India's reliance on imported REPMs has been a pressing concern. With the country's domestic industry yet to mature, nearly all REPMs used in India are currently imported.

In fiscal 2025, India imported about Rs 1,744 crore of permanent magnets and articles intended to make permanent magnets, with China accounting for 82% of this import value.

Hence to cut import dependence and strengthen domestic capabilities, the union cabinet, on 26th November 2025, approved the 'Scheme to Promote Manufacturing of Sintered Rare Earth Permanent Magnets', with an outlay of Rs 7,280 crore, comprising sales-linked incentives of Rs 6,450 crore and a capital subsidy of Rs 750 crore. The initiative is aimed at establishing fully integrated rare earth permanent magnet (REPM) plants that can convert rare earth oxides to metals, metals to alloys, and alloys to finished magnets, with a total production capacity of 6,000 tonne per annum (TPA). This capacity will be distributed across five beneficiaries through a global competitive bidding process, with each receiving up to 1,200 TPA. The scheme will run for seven years from the date of award, including a two-year gestation period for setting up the integrated REPM manufacturing facility and five years for incentive disbursement (linked to REPM sales).

India produced around 40 tonnes of neodymium magnets in fiscal 2025 and plans to increase production of neodymium and praseodymium to 200 tonnes by the end of the fiscal 2026. It has also established an REPM plant for manufacturing samarium-cobalt magnets, with a capacity of 3 TPA.

India's rare earth resource base stands at ~7.23 million tonnes in- situ rare earth elements Oxide and 1.18 MT Thorium Oxide contained in 13.15 million tonnes monazite. A mineral of thorium and rare earths,761.97 million tonnes titanium - bearing minerals(ilmenite, rutile and leucoxene) and 38 million tonnes of Zircon occurring in the coastal beach ,teri/red stands and inland alluvium in parts of Andhra Pradesh, Odisha, Tamil Nadu, Kerala, West Bengal, Jharkhand, Gujarat and Maharashtra .The proposal to establish dedicate corridors in the mineral rich states Odisha, Kerala, Andhra Pradesh and Tamil Nadu to promote mining processing ,research and manufacturing aims to streamline logistics cut transportation cost and create localised ecosystem to support the value chain from ore extraction to magnet fabrication.

The removal of Basic Customs Duty (BCD) on monazite from 2.5% marginally lowers the landed cost of this key rare earth element (REE) bearing feedstock, which is primarily used to extract rare earths for permanent magnets in EVs, wind energy and electronics, and the rare earth intermediates within regulated downstream chains. India current supply of monazite is constrained more by licensing requirements, given the radioactive nature of the ore and policy controls rather than by duty rate. Therefore, the intermediate increase in volume is likely to be limited. But the removal processing economics and working capital efficiency and modesty strengthens incentives for domestic separation or refining rather than importing higher value REE intermediates.

India’s dependence on global EV supply chain

According to the IEA Global EV Outlook 2026, China continues to dominate in the battery supply chain. China accounted for over 80% of global battery cell production, approximately 85% of cathode active material (CAM) production, and more than 90% of anode active material (AAM) production. Nearly all battery cells used worldwide are supplied by companies headquartered in China, Korea, or Japan.

According to the IEA Global Critical Minerals Outlook 2025, China processes 60% of lithium, cobalt, and controls over 90% of refining capacity for global graphite and rare earths. The average market share of the top three refining nations for copper, lithium, nickel, cobalt, graphite, and rare earths rose to 86% in 2024, from approximately 82% in 2020, with almost all supply growth coming from the single top supplier, Indonesia for nickel, and China for all others.

Critical Minerals Gap:

The key battery materials are lithium, nickel, cobalt, manganese, and graphite. Lithium is extracted from two very different sources: brine and hard rock. Lithium brines are typically located in the high elevation areas of Bolivia, Argentina, and Chile in South America with Chile being the largest producer. Brine deposits often contain enormous quantities of other useful elements such as sodium, potassium, magnesium, and boron which offsets cost of pumping and processing brine to an extent. Lithium hard rock is primarily mined in Australia.

Nickel plays a vital role in current battery chemistry. Nickel is found primarily in two types of deposit – sulphide and laterite. Sulphide deposits are located in Russia, Canada and Australia and tend to contain higher grade nickel which can be easily processed into battery-grade nickel. Laterite, however, tends to contain lower grade nickel and is found in Indonesia, Philippines and New Caledonia.

The Democratic Republic of Congo (DRC) supplies approximately 70% of global cobalt mined output and cobalt is typically produced as a by-product of copper or nickel mining. However, China dominates cobalt refining: according to the IEA Global Critical Minerals Outlook 2025, China processes approximately 60–70% of global refined cobalt. The DRC-China processing nexus represents a significant concentration risk for cobalt supply chains.

Thus, the extraction and supply of raw materials for battery metals is geographically concentrated and is relatively more vulnerable to supply shocks and constraints. The geographical distribution of mineral extraction is unlikely to shift significantly in the short to medium-term. Also, while comparing current mining production to actual mineral reserves, there appears to be significant untapped potential for diversification of extraction in the longer term. For example, Australia holds significant reserves of both nickel and cobalt. However, Indonesia's nickel production has expanded dramatically, and by 2024, Indonesia accounted for approximately 40% of global nickel supply, compared to Australia's more modest share. The IEA Global Critical Minerals Outlook 2025 projects that the top three nickel-producing countries will supply approximately 85% of global nickel by 2035, up from 75% in 2024, with Indonesia accounting for the bulk of this growth. The gap between reserve ownership and actual production underscores both the opportunity and challenge for non-chinese producers to grow their share of processing and refining.

Many countries are aiming to develop integrated EV supply chains and have announced various strategies. Major automotive manufacturing nations are now seeking to secure stable upstream supply and refining capacity of critical minerals. For example, in March 2022, the European Battery Alliance and the US Li-Bridge Alliance announced a collaboration to accelerate the development of Li-ion and next-generation batteries, including critical raw materials. Global nameplate manufacturing capacity for lithium-ion batteries reached more than 4 TWh by end-2025, up approximately 30% compared with 2024, with growth in the European Union and the United States running at approximately 50% faster than China's approximately 25% though China's absolute capacity lead remains decisive. Chinese battery manufacturer CATL commenced production of its second generation of sodium-ion batteries in 2025,

while BYD has also invested in sodium-ion battery production for EVs and battery storage applications. If brought to commercial scale, sodium-ion batteries could enhance energy security by reducing dependence on lithium and cobalt.

India's Rare Earth Import Dependence

India is more than 90% import dependent for its rare earth supplies due to its mining being restricted to public sector undertakings (PSUs), to manage governance, particularly, the Indian Rare Earth Limited (IREL). Although India has the world’s fifth-largest reserves of rare earth elements (REE), it imports most of its rare earth needs in finished form from China.

India contains mainly light REE while heavy REE is not available in extractable quantities. Only Neodymium and Praseodymium are available in India and are being extracted up to the 99.9 % purity level. There are more than 13.0 million tonnes of REEs, mainly found in the monazite sand, which contains 55-60% total Rare Earth Elements oxide.

India's REE processing capacity has historically been constrained by restrictions on private sector participation in atomic mineral exploration. However, the National Critical Mineral Mission (NCMM), approved by the Union Cabinet on 29 January 2025, includes measures to expand private sector involvement in exploration.

On 4 April 2025, China's Ministry of Commerce introduced export controls on seven medium and heavy rare earth elements including terbium, dysprosium, samarium, gadolinium, lutetium, scandium, and yttrium as well as all related compounds, metals, and permanent magnets. According to the IEA, as export volumes fell sharply in April and May 2025, carmakers in the United States, Europe, and elsewhere struggled to obtain permanent magnets, with some forced to cut utilisation rates or temporarily shut down production. European prices for dysprosium and terbium reached up to six times those prevailing in China, materially hurting the cost competitiveness of rare earth-based products manufactured outside China.

On 9 October 2025, China expanded these controls further, requiring foreign companies to obtain a Chinese license to export components and assemblies containing Chinese-sourced rare earth materials or manufactured using Chinese rare earth technologies. China accounts for approximately 60% of global rare earth mining and nearly 90% of global processing, making these controls among the most consequential supply chain restrictions ever introduced in the EV sector. India, given its near-total dependence on Chinese processed rare earths for EV motors, faces acute exposure to this risk.

India’s ability to grow processing of REE has been limited since the Indian government banned mineral exploration by private companies in 2019. India and Australia have begun working together on critical minerals since their memorandum of understanding (MoU) in 2020. Cooperations, such as the Supply Chain Resilience Initiative (SCRI) and the Quad, have taken shape at all bilateral, trilateral, and multilateral levels. The bilateral announcement to partner on five target critical mineral projects (three cobalt and two lithium) in March 2023 also represents their strengthening supply chain collaboration.

India is primarily dependent on imports for critical raw materials necessary for EV and is actively trying to build a sustainable EV supply chain in India for this energy transition. This effort involves India venturing into overseas lithium exploration and mining for the critical mineral, to loosen China’s stranglehold on India’s transition journey. To address its immediate mineral requirements, a joint venture was established, under the Ministry of Mines by National Aluminum Company (NALCO), Hindustan Copper Ltd (HCL), and Mineral Exploration and Consultancy Limited (MECL) named Khanji Bidesh India Limited (KABIL), tasked with identifying, acquiring, developing, and commercializing strategic minerals from international sources for domestic use.

In January 2024, KABIL secured a lithium exploration deal worth USD 24 million covering five blocks in Argentina. This agreement grants KABIL exclusive rights to assess, prospect, and explore lithium resources in Argentina, with potential exploitation rights for commercial production in five lithium brine blocks in Argentina's Catamarca province. Furthermore,

India is collaborating with Australia on a Critical Mineral Investment Partnership aimed at creating new supply chains for critical minerals. This partnership aims to bolster India's manufacturing capabilities by utilizing critical minerals processed in Australia, focusing on three cobalt projects and two lithium projects.

Additionally, India has joined the US-led Minerals Security Partnership in June 2023 and is actively exploring opportunities to acquire overseas lithium assets, particularly in Chile and Bolivia. All these initiatives coupled with bilateral and free trade agreements are expected help India create a robust supply chain for EVs.

The Quad partners (India, Australia, Japan and the United States) have established the Quad Investors Network (QIN) with a working group focused on clean energy and critical minerals, a formal multilateral mechanism to coordinate private and public investment in critical mineral supply chains. Additionally, India's February 2026 critical mineral partnership agreement with Brazil added a second South American anchor to KABIL's overseas acquisition strategy, complementing the Argentina agreement. A Comprehensive Economic Partnership Agreement (CEPA) with Chile which holds the world's largest lithium reserves remains under negotiation as of mid-2026.

In union budget July 2024, India has announced reforms in customs duties to support domestic manufacturing and promote export competitiveness. Among these measures, the government has fully exempted customs duties on 25 critical minerals and reduced the Basic Customs Duty (BCD) on two others. This reform will strengthen India’s EV supply chain by reducing reliance on expensive imports. Critical minerals like lithium and cobalt, essential for EV batteries, will now be more accessible at lower costs.

Additionally, the government has proposed the establishment of a Critical Mineral Mission. This mission will focus on domestic production, recycling of critical minerals, and overseas acquisition of critical mineral assets.

The Budget 2025-26 fully exempts cobalt powder and waste, scrap of lithium-ion battery, Lead, Zinc and 12 more critical minerals in addition to the 25 critical minerals exempted in the budget last year. India is largely reliant on imports for meeting its critical mineral needs. The complete exemption of waste and scrap of these minerals from BCD is set to give a boost to the domestic processing industry. Both traditional and new-age battery manufacturing will benefit from the move. The exemption of lithium-ion battery scrap from BCD will support the budding black mass recycling industry, supporting lithium extraction domestically. Complete exemption of copper scrap will boost copper value addition in the country.

In the budget 2025-26, to boost manufacturing of Lithion-ion battery in the country, 35 additional capital goods for EV battery manufacturing, and 28 additional capital goods for mobile phone battery manufacturing added to the list of exempted capital goods. The reduction in tax rate to zero from 7.5-15% earlier will result in capex savings for the new-age battery manufacturing industry.

In Union Budget 2026-27, the BCD exemption for capital goods used in lithium-ion battery production was extended to battery energy storage systems (BESS), and BCD exemptions were further provided on capital goods for critical mineral processing. These measures build upon the framework established in the two prior budgets and broaden the incentive scope beyond pure EV battery manufacturing to the wider stationary storage sector.

The Union Cabinet approved the National Critical Mineral Mission (NCMM) on 29 January 2025 with a total financial outlay of Rs 34,300 crore over seven years (fiscal 2025 to fiscal 2031). The NCMM is implemented under the Ministry of Mines and covers all stages of the value chain, including mineral exploration, mining, beneficiation, processing, and recovery from end-of-life products. Key elements include: (i) intensified GSI exploration- 1,200 projects planned over seven years, with 368 projects completed and 195 ongoing in fiscal 2025; (ii) domestic critical mineral block auctions - 24 blocks of critical and strategic minerals successfully auctioned in four tranches through fiscal 2025; (iii) overseas acquisition through KABIL; (iv) development of a black mass recycling ecosystem; and (v) establishment of a Centre of Excellence on Critical Minerals (CECM).

Import Dependence for Chips, Vehicle Control Units, Battery Management Systems, etc.

Semiconductors also play a critical role in driving the EV industry and associated cutting edge technologies. The growing software content in the EVs requires high performance processors or computers for their day-to-day operations. Currently India is import dependent for semiconductors and China, Japan, Korea, Singapore are the major suppliers for India. During the pandemic, the Indian automotive industry witnessed major disruptions in semiconductor supply. This impacted the automotive production and major OEMs like Tata Motors, Volkswagen, Hyundai were impacted.

In the wake of pandemic, India realized the need for developing a local supply chain for semiconductors in India and formulated supporting schemes to incentivize the semiconductor manufacturing, which is a high capex led business. In case of advanced technologies like semiconductors, India has adopted an open FDI policy where in the electronics industry, 100% FDI is allowed through Automatic route.

In March 2024, Prime Minister Narendra Modi gave approval for India's semiconductor fab facility, a joint venture between Tata and Powerchip Taiwan, to be established in Dholera, Gujarat. With an investment of Rs 270 billion, the facility aims to produce 48 million chips daily, marking a significant advancement in India's semiconductor industry. This collaboration underscores the government's emphasis on domestic semiconductor production to reduce dependency on imports and foster technological self-sufficiency and economic development. Stellantis and Zeta Energy have partnered to supply EV lithium-sulfur batteries to address supply chain resilience, cut costs and boost performance. The collaboration aims to transform battery technology by addressing critical supply chain challenges such as cost, performance, sustainability and resilience.

In a significant milestone, the India Semiconductor Mission (ISM), Tata Electronics Private Limited (TEPL), and Tata Semiconductor Manufacturing Private Limited (TSMPL) signed a Fiscal Support Agreement (FSA) on 5 March 2025 for India's first commercial semiconductor fabrication facility in Dholera, Gujarat. The project entails an investment of Rs 91,526 crore with a planned capacity of 50,000 wafer starts per month (WSPM) at 28 nanometre process node, targeting automotive, consumer electronics, and industrial applications. The Government of India, through ISM, has committed 50% fiscal support on a pari-passu basis for eligible project costs. Additionally, on 9 April 2026, the central government notified a Special Economic Zone (SEZ) for Tata Semiconductor in Dholera, establishing the regulatory framework for the facility. Tata Electronics also entered into an agreement with Netherlands-based ASML to supply critical lithography equipment for the fab.

At the Digital India Future LABS Summit 2024, the Ministry of Electronics, and Information Technology (MeitY) announced that Saankhya Labs, a subsidiary of Tejas Network, and Sensesemi Technologies, both semiconductor companies based in Karnataka, have been approved as the latest beneficiaries under the Design-Linked Incentive (DLI) scheme. The DLI scheme is part of the Ministry of Electronics and Information’s (MeitY) comprehensive program for the Development of Semiconductors and Display Manufacturing Ecosystems in the country launched in December 2021. The DLI scheme offers financial incentives and design infrastructure support to domestic companies, startups and MSMEs in this space. The incentives will be provided across various stages of development and deployment of semiconductor design for Integrated Circuits (ICs), Chipsets, System on Chips (SoCs), Systems & IP Cores and semiconductor linked design for over a period of 5 years. Samsung Semiconductor India Research (SSIR) has recently opened a semiconductor research and development (R&D) center in Bengaluru, India.

These initiatives are crucial for reducing India's reliance on imported semiconductor chips and fostering self-sufficiency in critical technology sectors. With semiconductor chips playing a vital role in emerging automotive C.A.S.E (Connected, Autonomous, Shared, Electric) technologies, developing an indigenous supply chain is inevitable. Also, with the growth of EVs and connected vehicles, the demand for semiconductor chips is expected to grow exponentially.

Price Volatility Impacting EV Affordability in India:

Critical mineral prices witnessed a sharp deflationary trend between 2022 and 2024. According to the IEA Global Critical Minerals Outlook 2025, lithium prices fell by over 80% since 2023 from an eightfold surge peak in 2021-22 back to pre-pandemic levels despite lithium demand in 2024 being approximately six times larger than in 2015. Graphite, cobalt, and nickel prices declined by 10–20% in 2024. This deflation reflected supply surpluses from major producers in China, Indonesia, and the DRC. Reflecting lower input costs and competition, global average lithium-ion battery pack prices fell 20% in 2024 the largest drop since 2017 and a further 8% to a record low of USD 108/kWh in 2025. In China, pack prices fell to USD 84/kWh, widening the gap with pack prices in Europe (approximately 48% higher) and the United States.

For India, the sustained decline in global battery pack prices has been a partial offset to import dependence, reducing the landed cost of cells and packs for domestic EV assemblers. However, battery costs still represent approximately 30–40% of the ex-factory price of an electric vehicle. The IEA cautions that the supply surplus driving low prices may discourage future investment, with risks of supply shortfalls for lithium and nickel potentially emerging by 2030, which could trigger a renewed price spike. Evidence of this volatility is already visible: in Q1 2026, battery-grade lithium carbonate prices nearly doubled from trough levels. India's structural dependence on imports means it has limited ability to insulate domestic EV pricing from global commodity cycles.

To mitigate these risks, India is promoting domestic battery manufacturing, critical mineral acquisition, recycling of battery materials, and diversification of import sources. The government's customs duty exemptions on critical minerals and battery manufacturing equipment are also expected to improve cost competitiveness across the EV value chain.

Geopolitical Risks:

Geopolitical developments have emerged as a significant risk for India's EV supply chain.

China's dominant position in battery materials, rare earth processing, battery manufacturing, and component production creates strategic vulnerabilities for countries dependent on imported EV inputs. This risk became evident in April 2025 when China imposed export controls on seven medium and heavy rare earth elements, including dysprosium and terbium, which are critical for permanent magnet EV motors. The restrictions disrupted global supply chains and led to sharp increases in rare earth prices outside China.

In October 2025, China further expanded export controls by introducing licensing requirements for components and assemblies containing Chinese-origin rare earth materials. Given that China accounts for approximately 60% of global rare earth mining and nearly 90% of rare earth processing, these measures significantly increased supply chain uncertainty for global automakers.

India remains particularly vulnerable because of its heavy dependence on imported processed rare earths, battery materials, cells, and electronic components. Trade disputes, export restrictions, geopolitical tensions, and resource nationalism across critical mineral-producing nations could potentially impact component availability, increase costs, and delay EV adoption.

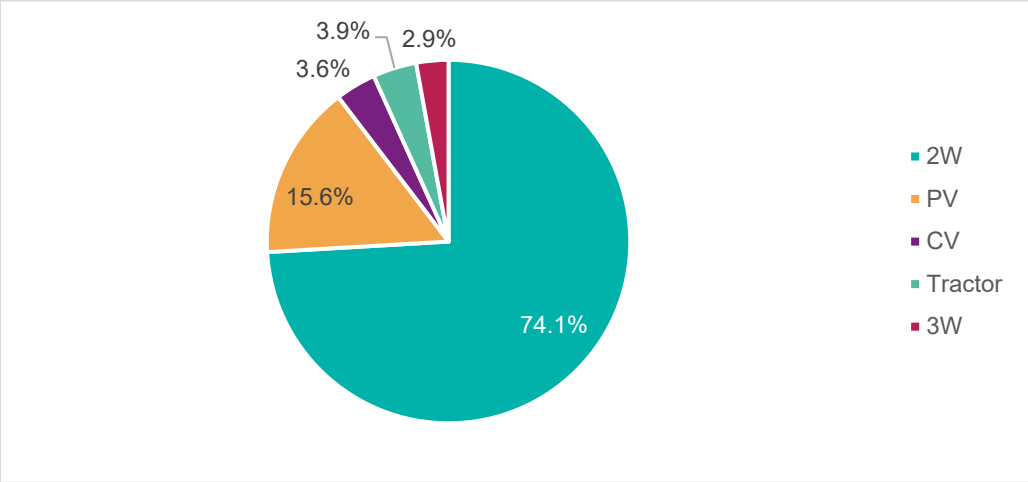
Consequently, India is pursuing a dual strategy of domestic capability development and international supply chain diversification through bilateral agreements, strategic mineral partnerships, overseas resource acquisitions, and participation in multilateral initiatives such as the Quad, MSP, and SCRI to strengthen long-term EV supply chain resilience.

C. Review and outlook on the Indian Two-wheeler industry

Review of the Indian Domestic Two-wheeler industry (fiscals 2021 to 2026)

The country's automobile industry is primarily comprised of five key segments: two-wheelers (2W), passenger vehicles (PV), commercial vehicles (CV), three-wheelers (3W), and tractors. During fiscal 2026, with a significant lead, two-wheelers emerged as the largest segment, accounting for 74.1% of the total auto industry by volume. Passenger vehicles followed, contributing 15.6% to the market share, while three-wheelers make up a smaller but notable 2.9% of vehicle sales in fiscal 2026.

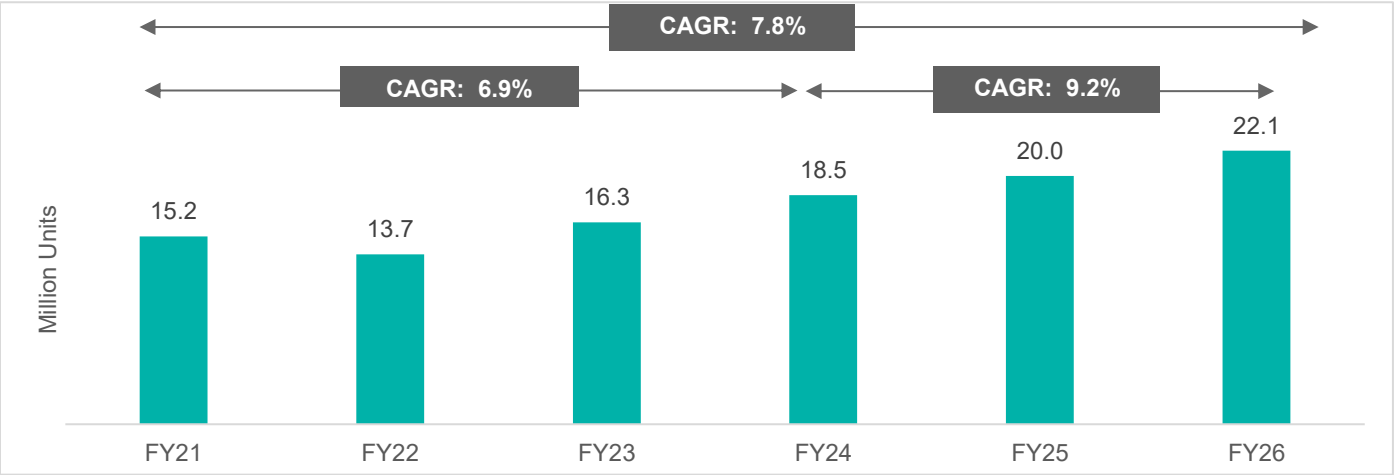
Segment wise split of the Indian Automobile market by volumes (fiscal 2026)



Source: SIAM, VAHAN, Crisil Intelligence

Two-wheelers industry sees a healthy demand in India and are preferred over four wheelers by a notable share 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.

Domestic two-wheeler sales volume trend – fiscals 2021 to fiscal 2026

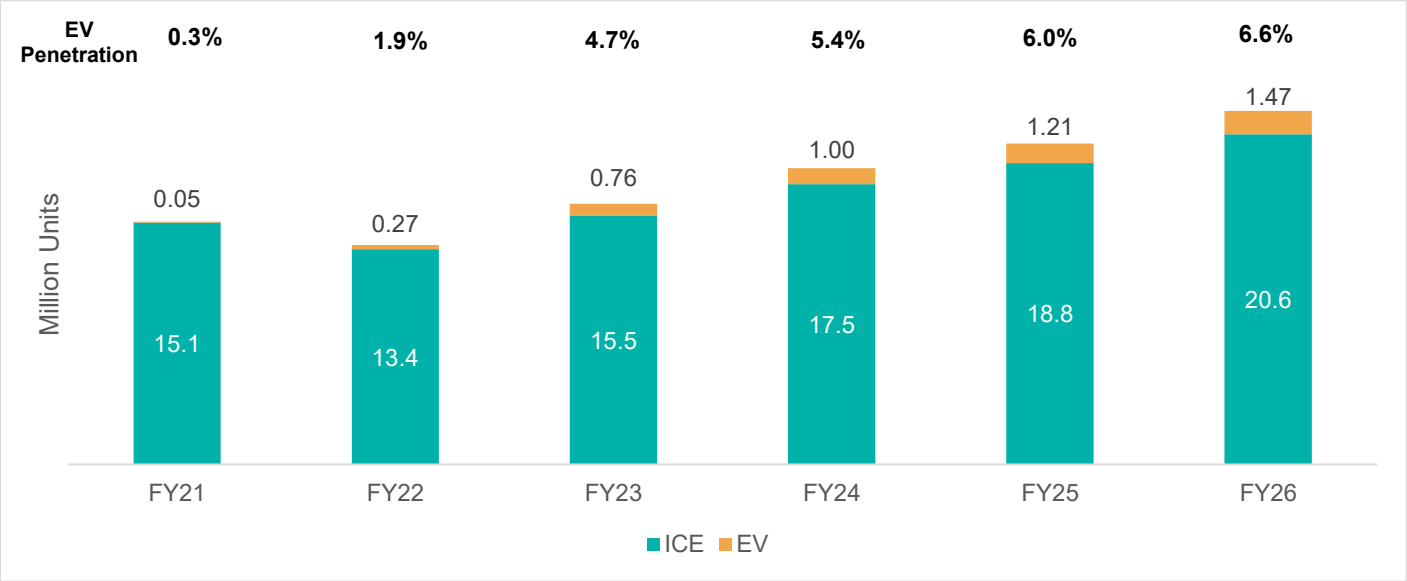


Source: SIAM, VAHAN, Crisil Intelligence

Following the pandemic-induced slowdown in fiscal 2022, India's two-wheeler industry rebounded strongly in fiscal 2023, recording an 18.8% growth driven by improving consumer sentiment, normalization of economic activities, increased mobility, and pent-up demand. The reopening of colleges and offices boosted scooter demand, while the need for last-mile mobility remained strong despite the restoration of public transport services. Rapid growth in electric vehicle sales further supported overall industry performance. Building on this momentum, the two-wheeler market expanded at a CAGR of 7.8% between fiscal 2021 and fiscal 2026, aided by an improving macroeconomic environment, stronger rural demand, and sustained preference for motorcycles with engine capacities of 125cc and above, along with scooters. In fiscal 2025, industry sales reached 20 million units, reflecting an 8.3% year-on-year increase, while retail sales grew by 7.6%.

Fiscal 2026 recorded sales of 22.1 million units, supported by GST cuts in September 2025 along with continued rural market momentum with improved rural productivity, diversification towards horticultural crops, government income support schemes and structural measures taken by the government such as PM-KISAN, eNAM, Pradhan Mantri Fasal Bima Yojna (PMFBY) to name a few, aided rural income.

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



Source: SIAM, VAHAN, Crisil Intelligence

Y-o-y growth trend (ICE vs EV)

y-o-y growth	FY21	FY22	FY23	FY24	FY25	FY26	FY21-26 CAGR
ICE	-13.2%	-11.1%	15.5%	12.7%	7.5%	9.5%	6.4%
EV	74.8%	466.0%	186.9%	31.3%	21.0%	21.2%	99.1%

Source: SIAM, VAHAN, Crisil Intelligence

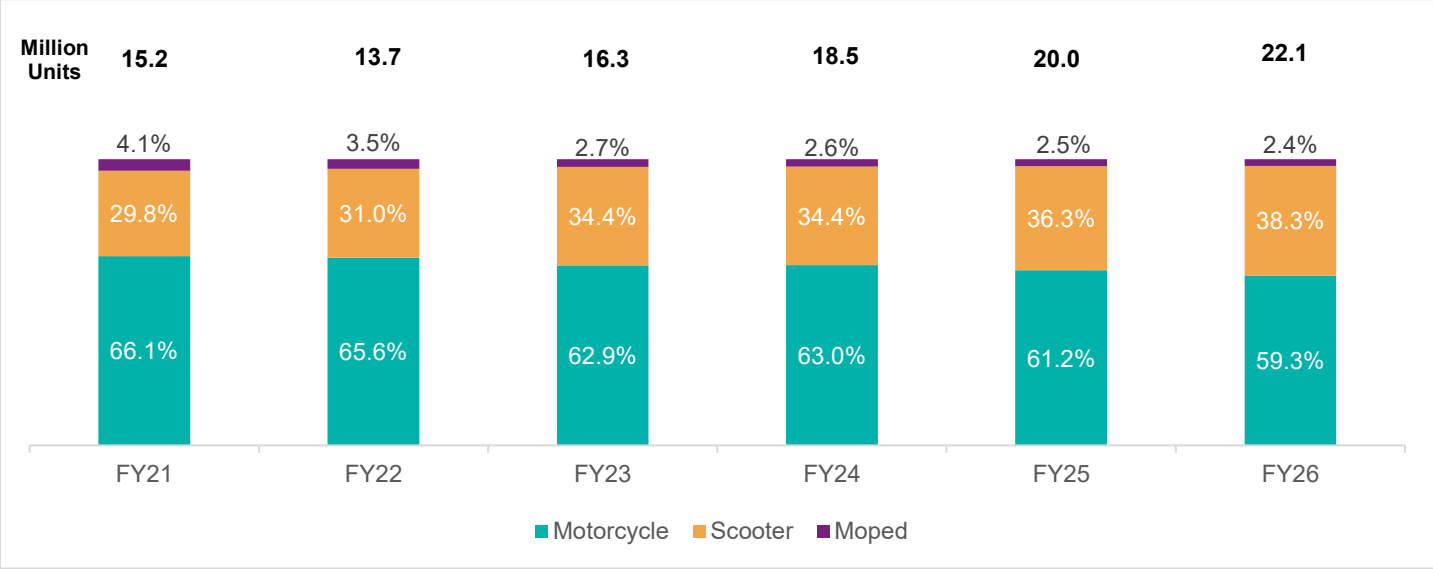
Over the last 5 years, the electrification within the industry has contributed significantly to growth in overall industry sales. In fiscal 2022, electric 2-wheelers achieved highest growth. The sharp rise in EV was driven by government push for EV adoption and increasing consumer interest in electric vehicles. Even during the years, when ICE vehicle sales slightly declined, the sharp rise in EV retails restricted the drop in the overall 2W sales volume.

During fiscal 2021 to 2026, ICE segment grew at a moderate 6.4% CAGR. However, EV retails grew with 99.1% CAGR for the same period. For fiscal 2026, EV penetration reached around 6.6% and EV volumes recorded 1.47 million units.

Segment wise domestic sales trend

Motorcycles dominate the domestic two-wheeler industry sales with approximately 60% contribution to the annual domestic sales volumes. However, their contribution gradually contracted over the years, from 66.1% in fiscal 2021 to 59.3% by fiscal 2026. On the other hand, the scooters segment expanded its presence over the long-term horizon; from 29.8% in fiscal 2021 to 38.3% in fiscal 2026. The mopeds segment also lost some ground to scooters over the years, from 4.1% share in fiscal 2021 to 2.4% in fiscal 2026.

Domestic two-wheeler sales segmental trend – fiscals 2021 to fiscal 2026



Note: Data includes ICE and EVs; EV retail data from VAHAN has been considered.
Source: SIAM, VAHAN, Crisil Intelligence

Scooters

In the last 5 years, scooters witnessed gradual expansion, and their share increased from 29.8% in fiscal 2021 to 38.3% in fiscal 2026. The strong demand for new model launches (like the Hero Destini 110, Jupiter 113, upgraded Jupiter/Activa, Access, Dio 125, and Ntorq), increasing usage of scooters by working professionals, especially women in urban areas (due to high convenience) and a growing preference as a second vehicle in households coupled with sharp rise in EV sales supported the expansion in scooter share.

Earlier, the scooter was positioned primarily as an urban vehicle. However, they are being increasingly accepted in rural areas with increasing road penetration and utility purposes.

Thus, the overall scooters segment during fiscals 2021-2026 registered 13.3% CAGR vis a vis 5.5% CAGR for motorcycles and 2.8% CAGR contraction for mopeds.

During the pandemic, reduced need for mobility due to lockdowns, closure of schools/ colleges and offices impacted the scooter demand significantly. Sales of scooters (ICE+ EV) witnessed a sharp drop of 19% in fiscal 2021 and a further drop of 6% in fiscal 2022. However, scooter sales rebounded in fiscal 2023 led by reopening of offices, schools & colleges. Pent up demand from the last two years provided a boost to scooters sales. Moreover, the increased retails of e-scooters provided an additional boost to the scooter sales during the year. Scooters segment grew at a faster pace of 32% y-o-y compared to 14% growth witnessed in motorcycles, thus backing the share expansion of scooters during the fiscal 2023.

During fiscal 2024, both motorcycles and scooters increased at a healthy pace of around 14% keeping the share near steady. Growth pace of scooters normalised in fiscal 2024, from the increased pace seen in fiscal 2023.

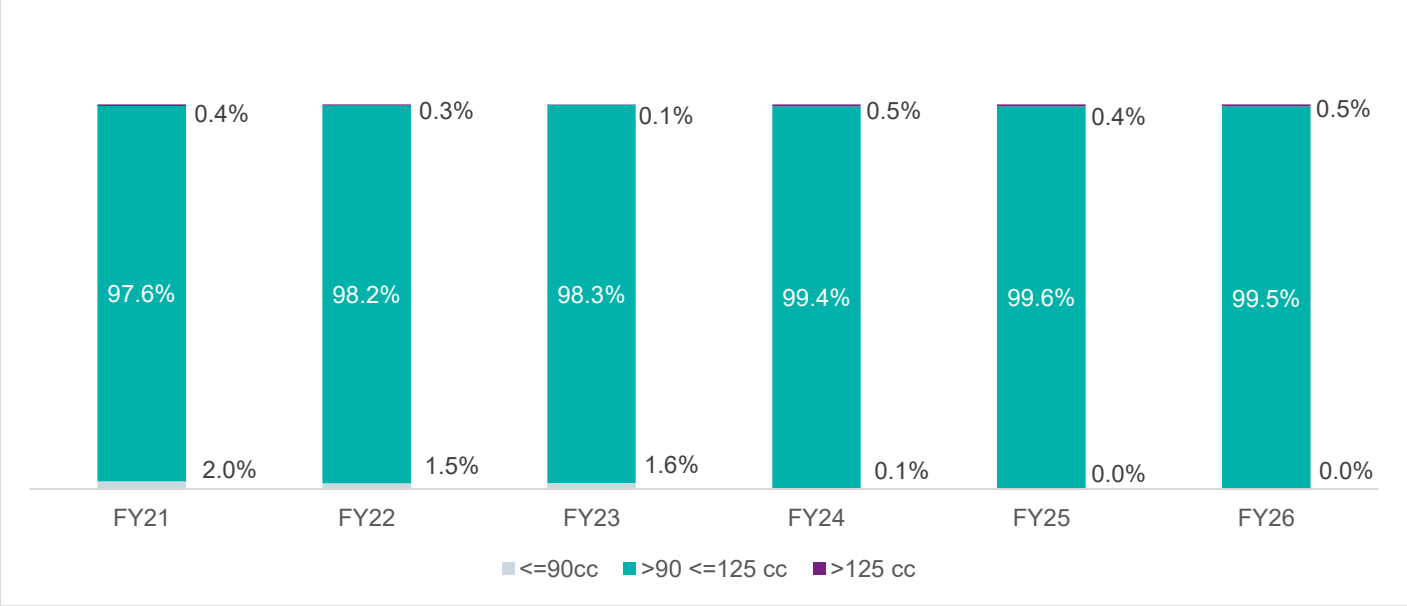
In fiscal 2025 the share of scooters increased to 36% from 34% during the same period last year, driven by the added push for scooters across OEMs, new variants like Jupiter 113 getting traction from customers. With continued increase in women participation in the workforce, the demand for scooters has been on the rise.

In fiscal 2026 the share of scooters increased to 38% from 36% during the same period last year. This upward trend can be attributed to several other factors, including the rising participation of women in the workforce and a growing preference for automatic transmission vehicles. Notably, even in semi-urban and rural areas, where traditional gender roles are more pronounced, women are increasingly taking to scooters as a mode of transportation. The launch of scooter models that cater to the needs and preferences of this demographic, with a focus on aesthetics and utility, has also contributed to the segment's growth. Additionally, improvements in rural road infrastructure and the introduction of a wide range of models have helped bridge the price gap, making scooters more accessible to a broader audience.

Within the scooters segment, e-scooters witnessed growth at an accelerated pace and contributed a sizeable share of 16-17% to overall scooter sales in fiscal 2026. Launch of new models, government incentives, rising awareness, increased acquisition & operating costs for the ICE equivalents provided a boost to the EV sales during the fiscal 2021-2026 period. E-scooters clocked growth at 99.4% CAGR in the last 5 years and their penetration within the scooters segment rose from 1% in fiscal 2021 to 16-17% in fiscal 2026.

On the other hand, the ICE scooter segment witnessed relatively slower growth amidst the increased vehicle prices (due to BS VI emission norms compliance), higher operating costs (fuel price hike), increased interest outgo as well as increased competition from EVs. During fiscal 2021 to fiscal 2026 period, ICE scooter sales grew at 9.4% CAGR.

ICE scooters domestic sales split– fiscals 2021 fiscal 2026



Source: SIAM, Crisil Intelligence

Within ICE scooters, majority of the market by volumes fell under the >90cc and <=125cc subsegment, consistently since fiscal 2021, with over 99.5% of the volumes in fiscal 2026. The <=90cc subsegment which had a 2% volume share in fiscal 2021, reduced at a CAGR of 48% and has dropped to 0.0% volume share in fiscal 2026. This subsegment has seen only one model, the TVS Pep+, in this period, whose sales have declined over the years as customers are now preferring higher cc scooters, increasing adoption of electric two-wheelers and rising fuel and maintenance costs.

Based on Crisil Intelligence's estimates and market understanding, there has also been a lot of shifting within the >90cc and <=125cc subsegment in terms of customers purchasing higher cc scooters. The 110 cc scooters held almost ~64% share in fiscal 2021. However, their volumes have seen a sharp decline in recent times. The customer base for these scooters is relatively price conscious. Increased ownership and operating costs as well as reduced usage requirements during the pandemic years led to significant postponement of purchase from this customer base. Additionally, the shift

towards higher cc ICE scooters (=>125cc) as well as EVs exacerbated the situation for this subsegment. As per Crisil Intelligence's estimates, the share of 110 cc scooters within the ICE scooter segment slid from ~64% in fiscal 2021 to 51-54% in fiscal 2026.

Conversely, the 125cc scooter volumes have grown significantly during the period, albeit from a smaller base. A relatively price agnostic customer base, feature-rich vehicles and young buyers that prefer high performance and advanced features have led to a premiumization trend in scooters causing OEM to increase focus with multiple vehicle launches in this subsegment, which has in turn has aided the growth. The share of 125cc scooters within the ICE scooter segment rose from ~36% in fiscal 2021 to 46-49% by fiscal 2026.

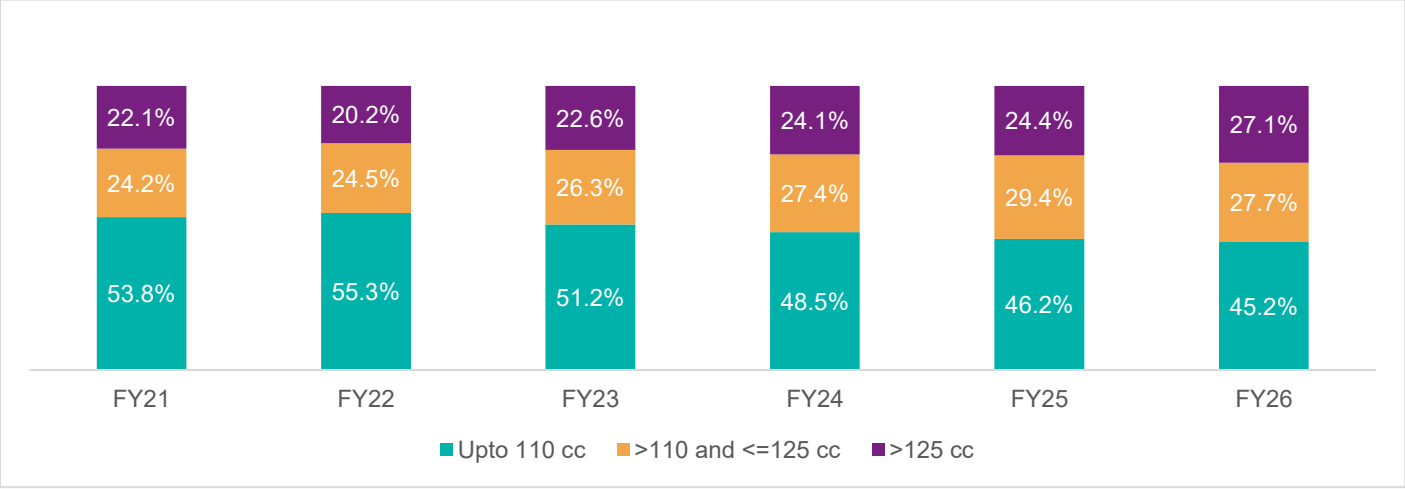
Motorcycles

In the overall domestic sales, motorcycles have maintained their leading position in the last 5 years, however, they lost some ground to scooters during the period. During the pandemic period of fiscal 2021 and fiscal 2022, amidst the lack of availability of public transportation, requirement of motorcycles continued especially for daily commute, thereby restricting their drop.

During the pandemic, availability of public transportation was limited and shared mobility options including office buses and taxis were also restricted, making personal vehicles including motorcycles the primary option for daily commute especially for the blue-collar workers, essential services employees and rural customer base. Whereas most white-collar workers were utilizing the work from home option or their four wheelers during the period, limiting the requirement of two wheelers during that period. This led to a moderate market share expansion of motorcycles during fiscal 2021. Post pandemic, improving mobility and gradual rise in scooters demand caused the share of motorcycles to contract in the next 5 fiscals and reach ~59.2% by fiscal 2026 from 66.1% in fiscal 2021.

Notably, the electric vehicle (EV) contribution within the motorcycle segment has been negligible, primarily due to the limited availability of EV options. Although manufacturers like Revolt, Tork, and Ultraviolette introduced EV motorcycles, and more recently, Ola, Royal Enfield launched its electric motorcycle, the adoption of EVs has been gradual. The motorcycle category has seen limited EV options, and concerns regarding range anxiety and higher acquisition costs have hindered widespread adoption. As a result, EVs are estimated to account for less than 1% of overall motorcycle sales by fiscal 2026, with ICE variants continuing to dominate the market.

ICE motorcycles domestic sales split– fiscals 2021 to fiscal 2026



Source: SIAM, Crisil Intelligence

Within the ICE motorcycles segment, the 125 cc subsegment has witnessed 8.3% CAGR growth during fiscal 2021-2026 period while the <=110 cc subsegment has grown at a marginal pace of 1.9% CAGR. The >125cc subsegment has grown by 9.8% CAGR during this period.

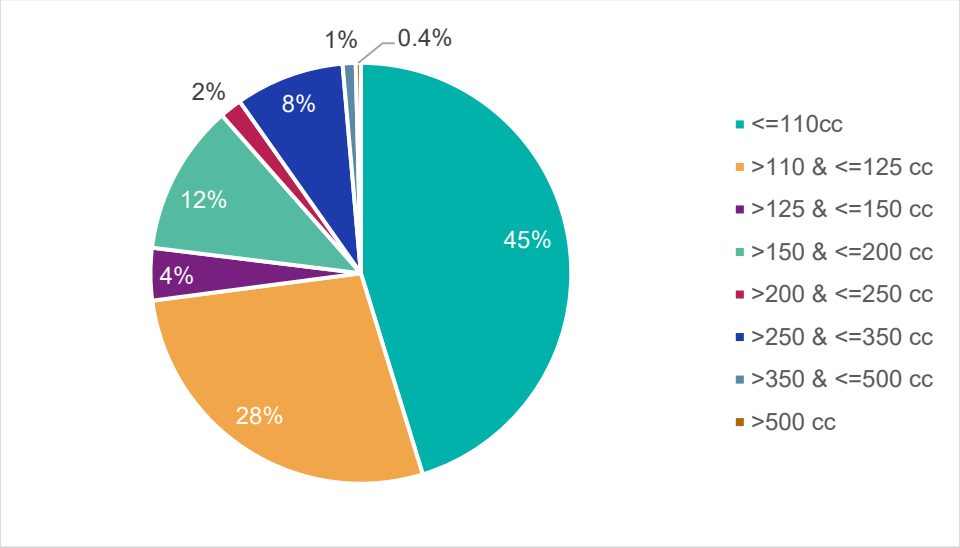
Within the ICE motorcycles segment, the 125cc and above (>110 and <=125cc and > 125 cc) subsegments together hold 54.8% of the market share by volume in fiscal 2026 as against 46.3% in fiscal 2021, thereby indicating a shift towards higher cc motorcycles.

The price sensitive <=110cc subsegment (53.8% share in fiscal 2021) has been under pressure amidst the sharp rise in vehicle prices due to emission and safety norms, increased insurance costs, hike in fuel prices, escalated interest costs coupled with pressure on incomes of this customer group especially during the pandemic. This subsegment has witnessed 3 years of consecutive contraction between fiscal 2020 to fiscal 2022 (16% CAGR drop till fiscal 2022).

On this lowered base, <=110cc motorcycles subsegment saw some growth during fiscals 2023 and 2024 aided by the pent-up demand and added support from OEMs in the form of discounts and other incentives. However, for the complete 5-year period (fiscals 2021-2026), the <=110cc subsegment witnessed marginal growth at 1.9% CAGR.

On the other hand, the 125cc and >125cc motorcycles subsegments together witnessed growth at 9.1% CAGR backed by the financially resilient customer base that was less impacted by the pandemic, higher OEM focus with increased vehicle launches, feature rich vehicle introductions and entry of global players like Harley Davidson, KTM, Triumph and Husqvarna with India focused models. High performance tech enabled vehicles are seeing higher acceptance amongst the rising younger buyer base. Thus, the share of 125cc and >125cc motorcycles, within the ICE motorcycles segment, increased from 46.3% in fiscal 2021 to 54.8% in fiscal 2026.

ICE motorcycles detailed domestic sales split– fiscal 2026



Source: SIAM, Crisil Intelligence

Mopeds

The smallest segment of mopeds witnessed a contraction during fiscal 2021-2026, amidst the increasing adoption of scooters in the semi-urban and rural markets which are historically major markets for mopeds. Limited product portfolio and no new launches also impacted the sales of mopeds. Moreover, the pressure on the income of the bottom of the pyramid customer base of mopeds as well as increased operating expenses due to increased fuel costs and higher interest outgo, impacted the demand for mopeds. In turn, the share of mopeds dropped from 4.1% in fiscal 2021 to 2.4% in fiscal 2026.

Segmental growth within the industry in the last 5 years

Segment	FY21-FY26 CAGR	FY21 share	FY26 share
Motorcycles	**5.5%**	**66.1%**	**59.3%**
ICE	5.4%	66.1%	59.2%
EV	78.8%	0.0%	0.1%
Scooters	**13.3%**	**29.8%**	**38.3%**
ICE	9.4%	29.5%	31.8%
EV	99.4%	0.3%	6.4%
Mopeds	**(2.8) %**	**4.1%**	**2.4%**
Total	**7.8%**	**100%**	**100%**

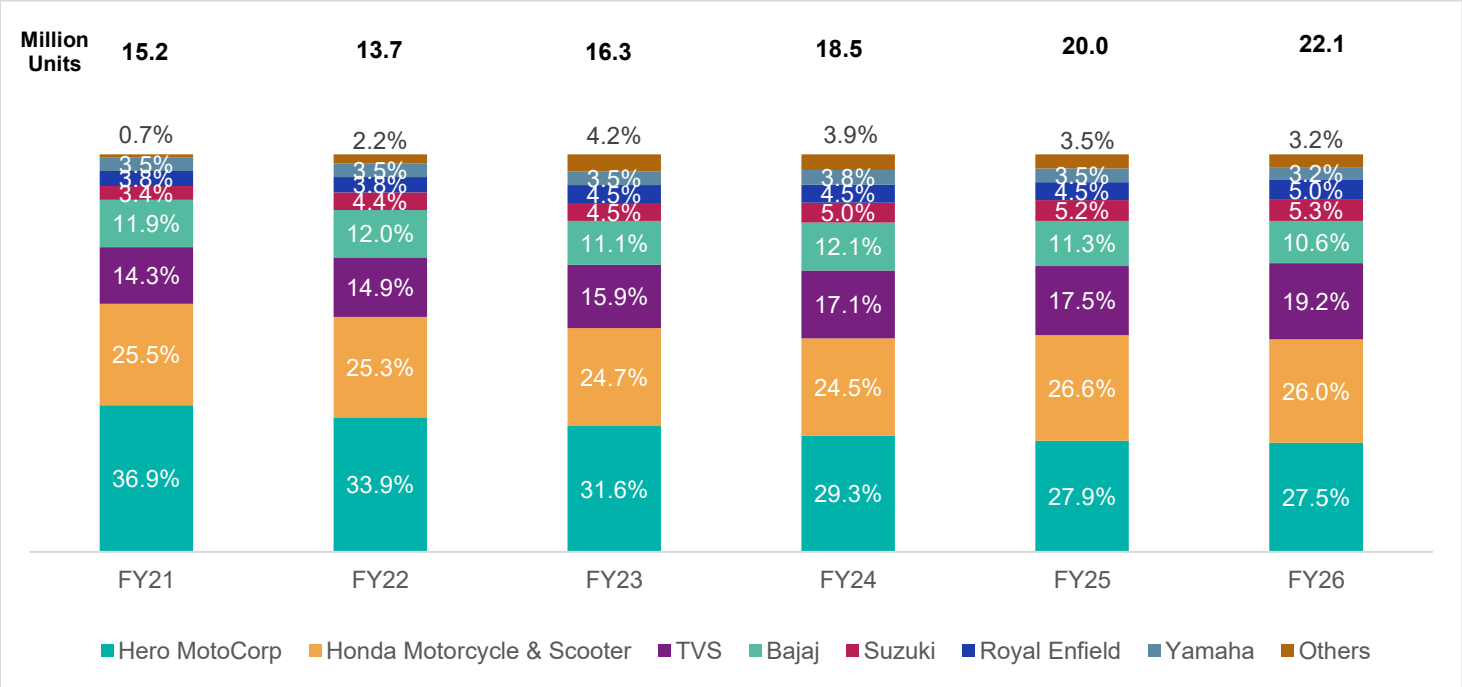
Note: Figures in bracket to be read as negative (Eg. (10) to be read as minus 10), EV retail data from VAHAN has been considered.
Source: SIAM, Crisil Intelligence

Competitive landscape of the domestic two-wheeler industry

India's Two-wheeler industry has traditionally been a market with only few major players, wherein the top 4 players have contributed to more than 80% of the annual sales. However, over the years, competition has intensified within the industry, especially, with the entry of new age players in the electric scooter segment like Ola, Ather energy and Ampere (Greaves Electric Mobility) catering to the fast-expanding segment of EVs.

Hero MotoCorp (HMCL) leads the market, with a market share of 27.5% in fiscal 2026. The second largest contributor, Honda Motorcycle & Scooter (HMSI), gained some ground during fiscal 2025, but lost minor share in fiscal 2026.

OEM wise contribution to overall two-wheeler domestic sales – fiscals 2021 to fiscal 2026

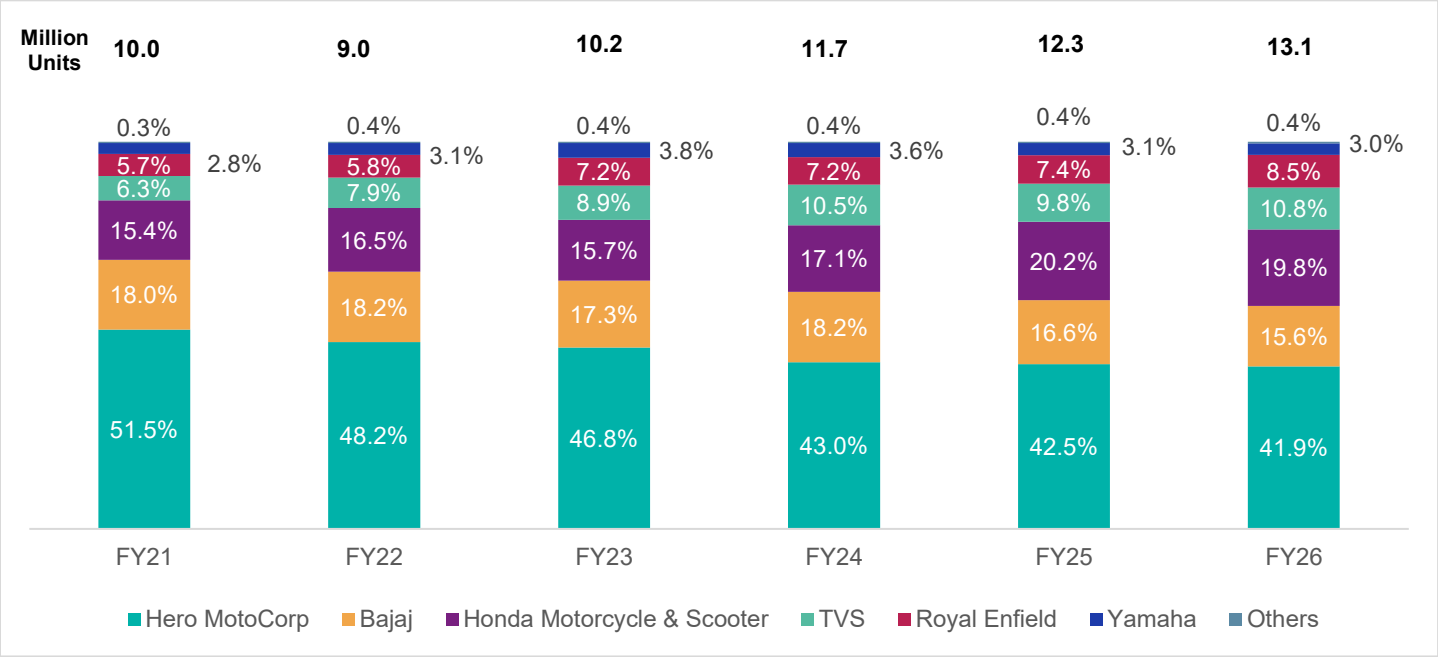


Note: Data includes ICE and EVs; EV retail data from VAHAN has *been considered.*
Source: SIAM, VAHAN, Crisil Intelligence

With the continued traction for its >=125cc motorcycles and scooters- especially Jupiter, coupled with rising adoption of its e-scooter model iQube, TVS has gained ground in the market during the period. Bajaj's share has dropped in last 5 years from 11.9% in fiscal 2021 to 10.6% in fiscal 2026. Rising sales of 125cc scooters backed Suzuki's share expansion while multitude of launches in the growing >=125cc motorcycles segment led to share expansion for Royal Enfield.

Relatively recent entrants like Ola and Ather have also grabbed notable share led by the rising electrification within the domestic two-wheeler market. As of fiscal 2026, Ola & Ather contributed 0.7% and 1.1% respectively to two-wheeler annual domestic sales.

OEM wise contribution to Domestic Motorcycles sales - fiscals 2021 to fiscal 2026



Note: Data includes ICE and EVs; EV retail data from VAHAN has been considered.
Source: SIAM, VAHAN, Crisil Intelligence

The Indian Internal Combustion Engine (ICE) motorcycle market witnessed a shift in dynamics, with Hero MotoCorp maintaining its leadership position, albeit with a decline in market share from 51.5% in fiscal 2021 to 41.9% in fiscal 2026. The company's strategic product refreshes, including the introduction of new models such as Karizma XMR, Xtreme 125, and Xpulse 200, Xpulse 210 enabled it to re-enter the premium market and appeal to a wider customer base. Additionally, its popular commuter bikes, including Splendor+ and HF Deluxe, continued to dominate rural and semi-urban markets, solidifying its position in the entry-level segment.

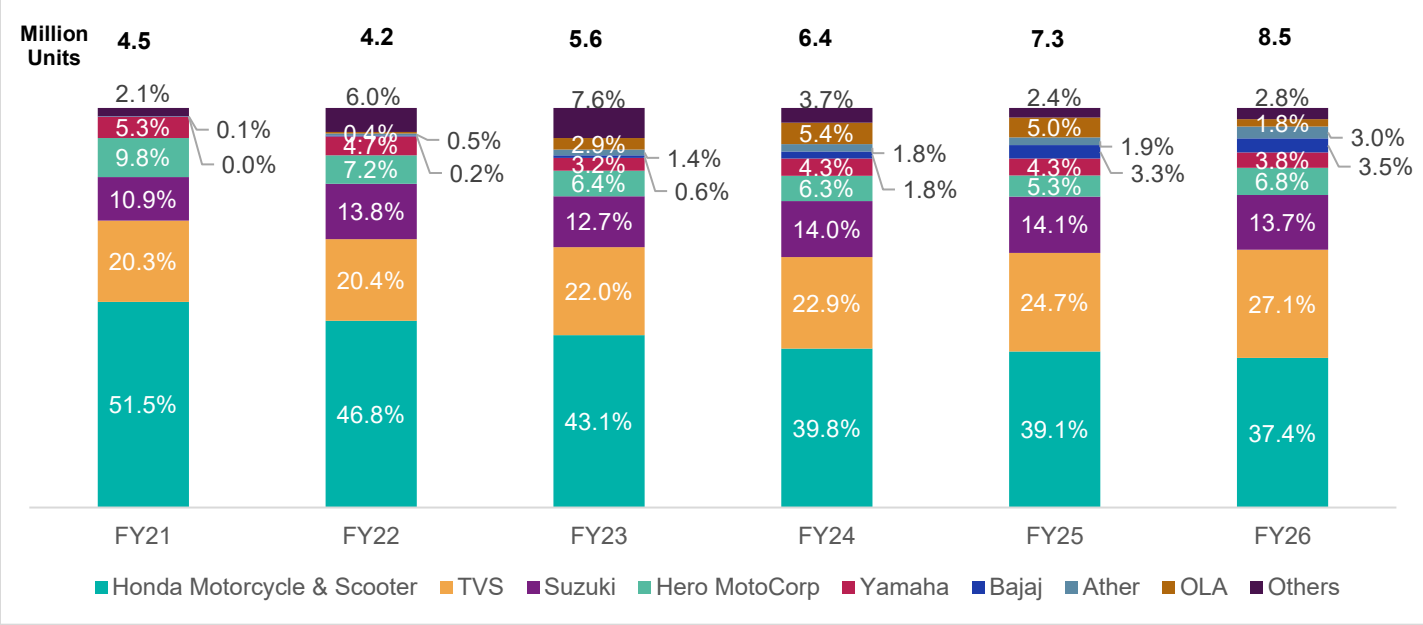
Bajaj Auto, however, faced intense competition, leading to a decline in its market share. Despite this, the company's refreshed Pulsar line-up, featuring new variants such as Freedom 125, Pulsar variants received a positive response from urban and semi-urban customers, helping to mitigate the decline.

Honda Motorcycle and Scooter India (HMSI) made significant gains, increasing its market share from 15.4% in fiscal 2021 to 19.8% in fiscal 2026. The company's successful models, including Shine, SP, SP160, Hornet 2.0, helped it gain traction in the commuter and mid-premium segments, appealing to young riders and urban commuters with its focus on premium styling, performance, and wider availability.

TVS Motors also experienced a notable surge in market share, rising from 6.3% in fiscal 2021 to 10.8% in fiscal 2026. The company's new premium motorcycles, including Apache RTR 160, Apache RTR 310, TVS Raider, and TVS Ronin, helped it gain traction in the youth and enthusiast segment with performance-oriented and lifestyle bikes.

Royal Enfield's market share rose to 8.5% in fiscal 2026, driven by the enduring popularity of its classic models, including Classic 350 and Bullet 350, as well as recent launches like Hunter 350, Shotgun 650, which appealed to urban youth and touring enthusiasts, strengthening the brand's lifestyle positioning and global presence.

OEM wise contribution to Domestic Scooters sales - fiscals 2021 to fiscal 2025



Note: Data includes ICE and EVs; EV retail data from VAHAN has been considered.
Source: SIAM, VAHAN, Crisil Intelligence

The ICE scooter segment is led by Honda Motorcycle and Scooter India (HMSI), with its iconic Activa model. Despite intensifying competition, the company has maintained its position, albeit with a slight erosion of market share. However, the increased demand for its higher-cc variants, such as the Activa 125 and Dio 125, has helped HMSI limit its share contraction.

TVS Motor Company has gained traction in the scooter segment, driven by the continued demand for its 110cc, 113cc and 125cc variants of its popular model, Jupiter. Increased traction for Ntorq also supported the scooter sales. This has enabled TVS to expand its share within the scooter segment.

Suzuki, on the other hand, has focused primarily on the 125cc scooter segment. The company's share expansion in this segment can be attributed to the premiumization trend within the industry.

Yamaha has maintained a stable market share in the 3-5% range over the past five years, driven by continued demand for its RayZR series. The launch of the Aerox scooter range in fiscal 2024 helped Yamaha expand its presence and regain some lost ground, although its market share dropped slightly in fiscal 2026.

In the moped segment, TVS Motor Company is the sole player in the domestic market, with its popular model, the XL100.

Demand drivers and trends in the domestic two-wheeler market

The performance of the Indian two-wheeler industry is dependent on numerous social and economic factors, including demographic trends and preferences, income levels, affordability of two-wheelers for customers, changes in government

policies, overall economic conditions and the availability of finance and interest rates. Certain factors, such as general macroeconomic and consumer trends, have a direct impact on the demand of two-wheelers.

- **Two-wheeler penetration:** CRISIL Intelligence estimates 2W penetration in India is 150-155 two-wheelers for every 1000 people as of fiscal 2026 compared to ~145 two-wheelers for every 1000 people as of fiscal 2024. This two-wheeler penetration of India is much lower than many of the countries like Indonesia (473 per thousand people), Thailand (315), Sri Lanka (275), and Brazil (157) as of CY2023. This provides a sizeable headroom for the two-wheeler industry to grow going forward. Some of the key drivers aiding India's domestic two-wheeler industry demand are rising rural income, premiumization and electrification.

- **Macroeconomic support:** Macroeconomic growth has been a key enabler of two-wheeler demand by improving affordability, disposable incomes, and consumer spending. During fiscals 2023-2026, India's GDP grew at a 7.3% CAGR, supporting a corresponding rise in private consumption expenditure and driving the domestic two-wheeler industry to grow at an 6.3% CAGR. Looking ahead, India's GDP is expected to expand at 6.0-7.0% CAGR through fiscal 2026-2031, providing sustained support for long-term growth in two-wheeler sales.

- **Private consumption:** Private Final Consumption Expenditure (PFCE), a key indicator of household spending capacity, plays a crucial role in driving two-wheeler demand. Rising per capita incomes and discretionary spending have increased consumer expenditure on automobiles and premium products, supporting higher two-wheeler penetration and premiumization trends. Continued growth in household consumption sustained demand, with PFCE growing by 7.7% in fiscal 2026, following 5.8% growth in fiscal 2025, thereby providing a strong foundation for future industry expansion.

- **Rising per capita income:** It is expected to be a major driver of two-wheeler demand by enhancing disposable income, purchasing power, and consumer spending on personal mobility. While per capita income is expected to grow by 8.3% in calendar year 2026 following 4.6% growth in calendar year 2025, the IMF projects it to expand at a 6.7% CAGR during 2025-2031. Supported by India's expected GDP growth of 6-7% and the economy crossing the USD 5 trillion-mark, per capita income is projected to reach around USD 4,500 by fiscal 2031, elevating India into the upper middle-income category. This income growth is likely to accelerate vehicle ownership, increase two-wheeler penetration, and support premiumization as consumers upgrade to higher-value models with advanced features.

- **Finance availability:** Financing has emerged as a key demand driver for the Indian two-wheeler industry, supported by the expanding reach of banks, NBFCs, and fintech players across urban and rural markets. Increased finance penetration has improved affordability, broadened access to vehicle ownership, and reduced lending risks through digital tracking and credit assessment capabilities. As financing becomes more accessible across customer segments, it is expected to continue supporting growth and profitability in the two-wheeler market.

- **Growing gig economy:** The growing gig economy and rapid expansion of e-commerce have emerged as significant demand drivers for the two-wheeler industry, particularly for last-mile delivery applications. As per NITI Aayog, India had nearly 7.7 million gig workers in fiscal 2021, a figure expected to rise to 23.5 million by fiscal 2030, driven by growth in food delivery, grocery, electronics, and e-commerce services.

  The Indian e-commerce market, estimated at ~Rs 5.5-6.0 trillion in fiscal 2026, has expanded by more than 2.5 times between fiscal 2021 and 2026 and is projected to reach `Rs 11.5-12.5 trillion by fiscal 2030, growing at a 20-25% CAGR. Supported by increasing internet penetration, rising online shopping adoption, improving consumer sentiment, and moderating inflation, this growth is creating substantial opportunities for the two-wheeler industry, particularly electric vehicles (EVs), in the rapidly expanding last-mile mobility segment.

- **Inflation:** High inflation adversely affects consumers' disposable income and affordability, thereby constraining overall demand. In India, however, inflation has moderated significantly in recent years after peaking during the post-pandemic recovery phase, when supply chain disruptions, elevated commodity prices, and geopolitical uncertainties exerted upward pressure on costs.

  Over the past two years, inflation has followed a favorable trajectory, declining to approximately 2.1% in fiscal 2026. This relatively stable inflationary environment has supported consumer spending, strengthened purchasing power, and created a more conducive backdrop for economic growth and demand across sectors.

  While ongoing geopolitical tensions in West Asia may exert some upward pressure on inflation expectations for fiscal 2027, a gradual normalization of inflation over the medium to long term is anticipated. Such stability is expected to provide sustained support to growth in the two-wheeler industry by improving affordability and encouraging demand expansion over the longer horizon.

- **Shrinking replacement cycles:** Shortening replacement cycles have emerged as a significant growth driver for the two-wheeler industry, supported by broader product portfolios, frequent model refreshes, technological advancements, improved access to financing, and evolving consumer preferences. The increasing popularity of scooters, along with rising premiumization and the transition toward electrification, has further incentivized customers to upgrade more frequently.

  Consequently, the average replacement cycle has declined from approximately 10–12 years to 7–8 years over the past decade. This shift has contributed to higher sales volumes and sustained industry growth by accelerating the adoption of newer, feature-rich, and technologically advanced vehicles.

- **Rising rural incomes:** Rural India remains a critical growth engine for the two-wheeler industry, contributing 55-60% of total sales, with demand supported by improving rural infrastructure, road connectivity, agricultural income growth, and government-led rural development initiatives. Enhanced affordability and connectivity have increased two-wheeler penetration in Tier 3 and Tier 4 markets, while electrification has further expanded demand in rural regions. As agriculture remains heavily dependent on monsoons, favorable rainfall continues to play a key role in supporting farm incomes and vehicle purchases. Following a weak monsoon in fiscal 2024, rainfall improved significantly in fiscal 2025 and 2026 with an 8% positive deviation from the long-term average, boosting crop output, farm profitability, and rural purchasing power, thereby strengthening two-wheeler demand.

- **Rural infrastructure:** Rural infrastructure development continues to be a key enabler of two-wheeler demand by improving connectivity, mobility, and economic activity in rural regions. Government initiatives such as the Pradhan Mantri Gram Sadak Yojana (PMGSY) have significantly expanded the rural road network, with 26,000 km of roads constructed in fiscal 2024 (89% of the annual target) and an additional 18,000 km and 16,000 km completed in fiscal 2025 and fiscal 2026, respectively. Improved infrastructure supports two-wheeler sales by generating rural employment and income during road construction, while also enhancing accessibility and transportation needs, thereby creating a strong foundation for long-term demand growth in rural markets.

- **Women participation in the workforce:** The increasing participation of women in India's workforce has emerged as a significant demand driver for the two-wheeler industry, particularly the scooter segment. Scooters have gained popularity among working women due to their ease of use, lightweight design, maneuverability, and practicality. Rising female employment, supported by corporate initiatives and greater workforce inclusion, has not only boosted direct demand for personal mobility solutions but has also increased household incomes, further supporting overall two-wheeler sales growth in the country.

- **Advancement in vehicle technology:** Advancements in vehicle technology are increasingly shaping demand in the two-wheeler industry, particularly among younger, tech-savvy consumers who seek connected features,

modern designs, enhanced performance, and personalized mobility solutions. In response, OEMs have significantly increased investments in R&D, spending nearly 2% of their annual operating income over the past six years to develop advanced technologies, improve safety, and introduce innovative features. Both ICE and EV models now offer digital instrument clusters, navigation, Bluetooth connectivity, USB charging ports, cruise control, and other smart features, making vehicles safer, more efficient, and more appealing. Continuous technological innovation, coupled with shorter replacement cycles and frequent new product launches, is expected to remain a key driver of long-term growth in the two-wheeler industry.

- **Electrification in 2W industry:** Electrification is emerging as a key growth driver for the Indian two-wheeler industry, supported by government initiatives such as PM eDrive incentives, tax benefits, increasing environmental awareness, and the need to reduce pollution. EV adoption has accelerated significantly in the post-pandemic period, driven by expanding product portfolios, rising consumer acceptance, and strong participation from new-age manufacturers such as Ola, Ather and Ampere. With continued policy support, technological advancements, and growing consumer preference for sustainable mobility, electrification is expected to contribute substantially to the long-term growth and transformation of the two-wheeler market.

- **R&D support:** R&D investment has become increasingly critical in the two-wheeler industry, driven by the evolving expectations of younger, technology-oriented consumers who demand advanced features, connected capabilities, enhanced safety, and regular product innovation. To remain competitive and effectively respond to shortening replacement cycles, OEMs typically allocate around 1–2% of their revenues toward research and development.

  These investments are directed at improving vehicle design, integrating innovative technologies, enhancing rider safety, and supporting a steady pipeline of new product launches. Sustained focus on R&D is therefore essential for driving innovation, aligning with evolving consumer preferences, and ensuring long-term growth and competitiveness within the industry.

- **Incremental growth through accessories:** Over the years, traditional ICE two-wheeler OEMs have expanded their offerings to include company-branded accessories and merchandise such as mirrors, vehicle covers, seat covers, helmets, and apparel, which have become an integral part of the industry. Premium brands, in particular, have leveraged merchandising to strengthen brand image and foster long-term customer loyalty—exemplified by players like Royal Enfield—while generating additional revenue streams.

  Typically, accessories, merchandise, and spare parts together contribute around 10–15% of overall revenues for ICE OEMs. Following this trend, new-age EV two-wheeler players have also entered the segment, offering both conventional accessories and technologically advanced products such as smart helmets, portable chargers, fast chargers, and tyre pressure monitoring solutions. These tech-enabled accessories command premium pricing and cater specifically to EV users, with demand expected to grow alongside the expansion of the e2W market. Notably, accessories and merchandise remain high-margin products (25–30%), supporting both topline growth and profitability while reinforcing brand engagement.

Domestic two-wheeler industry outlook (fiscals 2026 to 2033)

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 added support to the growth of the industry over the long-term horizon.

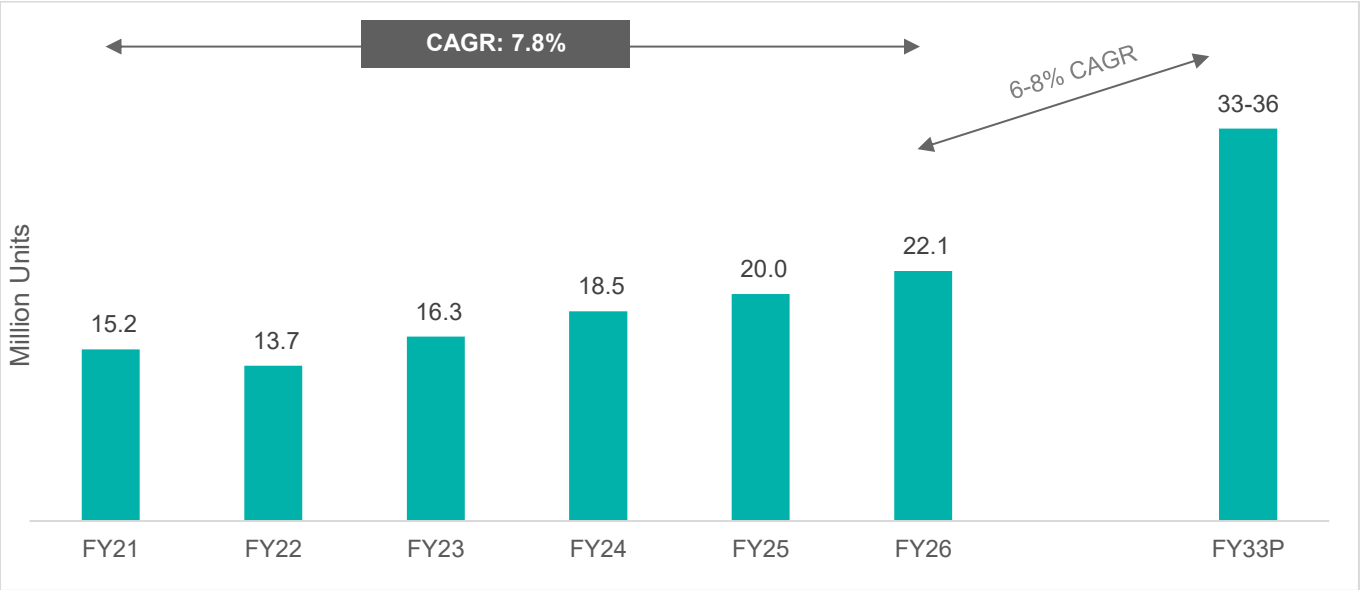
Additionally, the fast-rising EV segment, with EV portfolio expansion by legacy players, capacity expansion by new age players will accelerate industry growth. Entry of Legacy players like HMSI, Suzuki, Yamaha and Royal Enfield in the EV space will provide further thrust to the segment growth.

Introduction of CNG powertrain motorcycle by Bajaj and TVS also announced CNG scooter, which will offer lower operating costs compared to petrol variants, will push the two-wheeler industry further growth.

Led by these positive industry drivers, the two-wheeler industry sales are projected to grow at 6-8% CAGR and reach volumes of 33-36 million by fiscal 2033. Of this, the e2W segment is projected to clock a healthy CAGR of 35-37% during the period and the ICE 2W vehicle segment is expected to grow at a moderate pace of 0-2% CAGR on an elevated base.

With the growth in e2Ws, the EV penetration is expected to reach 35-40% of overall 2W industry sales by fiscal 2033. (EV subsegment outlook is covered in detail in the later section)

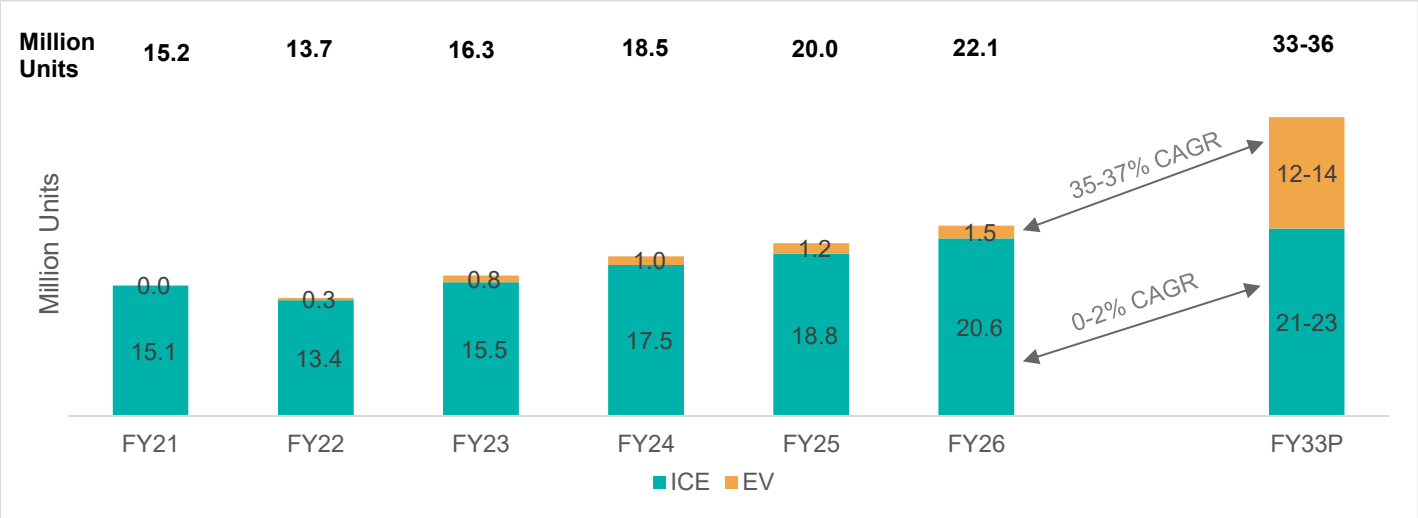
Domestic two-wheeler industry outlook – till fiscal 2033



Source: SIAM, Crisil Intelligence

Growth in the industry will be supported by increased EV launches, favorable government support, faster momentum in infrastructure development, reduced battery prices, easing supply chain constraints, localized value chain and faster consumer shift towards electrification.

Domestic two-wheeler industry powertrain wise outlook



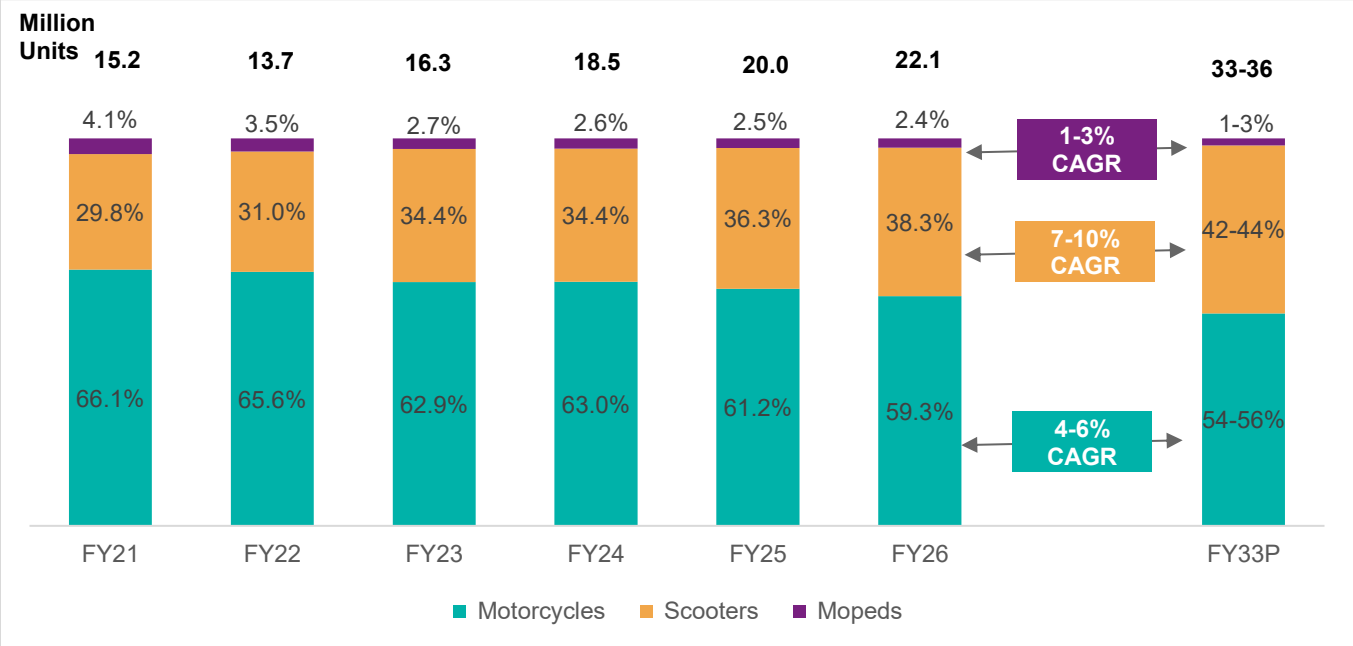
Note: Figures above the graph showcase the total sales

Source: SIAM, Crisil Intelligence

Going ahead, over the long-term horizon, Crisil Intelligence expects the scooter segment to grow at a 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 Intelligence projects the scooters segment to grow at a faster pace of 7-10% 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.

Segmental Split Outlook



Source: SIAM, Crisil Intelligence

Motorcycles, on the other hand, are projected to grow at a moderate pace of 4-6% CAGR over the long-term horizon- till fiscal 2033. The primary contributor to motorcycle sales, the ICE motorcycles are expected to grow at 3-5% CAGR. The >=125cc subsegments are expected to continue to provide the thrust to the motorcycles segment going ahead while the <=110cc subsegment is projected to grow at a moderate pace. Premiumization and upgradation will limit the growth of <=110cc motorcycles subsegment

Mopeds are expected to witness relatively slower growth registering a CAGR of 1-3%. Electrification within the mopeds segment is expected to support demand in this price sensitive category. Crisil Intelligence expects the relatively financially weak, bottom of the pyramid customer base of mopeds segment to opt for EV mopeds which have relatively lower acquisition costs.

There is only one model, the recently launched E luna, currently present in the mopeds segment, however, launch of more models, if done in the short term, will revive the growth of this contracting segment.

Segmental growth within the industry in the last 5 years and outlook till fiscal 2033

Segment	FY21-FY26 CAGR	FY26-FY33P CAGR
Motorcycles	**5.5%**	**4-6%**
ICE	5.4%	3-5%
EV	78.8%	68-73%
Scooters	**13.3%**	**7-10%**
ICE	9.4%	(9)-(7)%
EV	99.4%	33-35%
Mopeds	**(2.8) %**	**1-3%**

Segment	FY21-FY26 CAGR	FY26-FY33P CAGR
ICE	(3.3) %	(20)-(18)%
EV	NM	68-73%
Total	**7.8%**	**6-8%**

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 Intelligence

Upcoming launches in ICE 2W segment

OEM	Vehicle	Segment / Subsegment	Tentative Launch
Bajaj	Pulsar Classic Refresh (125/150)	>=125cc Motorcycle	2026
TVS	Maxi Sccoter 160	>=125cc Scooter	2027
HMCL	Karizma XMR 250	>=125cc Motorcycle	2026
HMSI	ADV 160	>=125cc Motorcycle	2026
Yamaha	NMax 155	>=125cc Scooter	2026-2027
	YZF-R2	>=125cc Motorcycle	2026
Royal Enfield	Himalayan 750	>=125cc Motorcycle	2026
	Continental GT 750	>=125cc Motorcycle	2026
	Interceptor 650 Facelift	>=125cc Motorcycle	2026
Norton	Manx R	>=125cc Motorcycle	2026
Triumph	Trident 800	>=125cc Motorcycle	2026-2027

Note: Based on information in secondary sources
Source: Industry News Reports

Upcoming launches in e2W segment

OEM	Vehicle	Segment	Tentative Launch
Yamaha	Aerox	Scooter	2026
Bajaj	Chetak next gen	Scooter	2026
Royal Enfield	Flying Flea S6	Motorcycle	2026
	Himalayan Electric	Motorcycle	2027
Ather	EL01	Scooter	2026
Ultraviolette	Shockwave	Motorcycle	2026
	Tesseract	Scooter	2027
Simple Energy	Family Scooter	Scooter	2026

Note: Based on information in secondary sources Source: Industry News Reports

D. Review and outlook on the Indian Electric Two-wheeler industry

Review of the Indian Electric Two-wheeler industry (fiscals 2021 to 2026)

The global momentum toward Electric Vehicles (EVs) is accelerating as countries increasingly prioritize sustainability and pollution reduction. In India, EV adoption is gaining significant traction, supported by a range of government initiatives, including the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME II) scheme, EMPS subsidies, and the PM E-Drive program, along with various state-level incentives and tax benefits. Rising environmental awareness and stricter emission norms are also expected to further drive EV penetration in the country.

The COVID-19 pandemic has acted as a catalyst for EV adoption in India, with increased consumer awareness, supportive policy measures, and a growing portfolio of EV offerings contributing to higher sales. Additionally, the entry of new-age, non-traditional players such as Ola Electric, Ather Energy, and Ampere has invigorated the ecosystem, fostering innovation, enhancing competition, and accelerating the development and adoption of electric mobility solutions.

Evolution of e2W offerings

The electrification of India's two-wheeler industry initially began with low-speed electric vehicles characterized by limited speed and range. However, the introduction of high-speed electric two-wheelers (e2Ws) around 2018 marked a pivotal inflection point for the sector. These vehicles offered performance levels comparable to internal combustion engine (ICE) counterparts, while organized manufacturing practices enhanced reliability and consumer confidence in the segment.

The entry of prominent players such as Ather Energy and Greaves Electric Mobility during 2018–2019 further accelerated the development and adoption of high-speed e2Ws, catalyzing market growth. Ather Energy introduced the country's first smart electric scooter built on an aluminium chassis, featuring a touchscreen dashboard, 3G-enabled connectivity, and integrated onboard navigation. Since then, the segment has witnessed significant advancements in technology, performance, and design. Battery costs currently account for approximately 35-40% of total manufacturing costs, followed by components such as the chassis/platform and the motor-controller system.

Progress in lithium-ion battery technologies, particularly Lithium Iron Phosphate (LFP) and Lithium Nickel Manganese Cobalt (NMC), has played a critical role in mitigating range anxiety. These chemistries offer improved energy density, enhanced thermal stability, and longer life cycles. Among these, LFP batteries have gained strong traction in India due to their superior safety profile, longer cycle life, and relatively lower material costs.

Regulatory interventions, including AIS 156 standards and recent BIS safety norms, have further strengthened the safety framework for EV batteries in India. As a result of technological and regulatory advancements, the driving range of e2Ws has nearly doubled over the past six years from approximately 60–75 km per charge to 100–150 km per charge. Simultaneously, the expansion of product offerings across diverse price points, battery capacities, and performance categories has supported the rapid growth of the segment.

OEMs have also introduced high-performance electric scooters with top speeds exceeding 80 km/h, catering to performance-oriented consumers. Beyond improvements in core attributes such as speed and range, manufacturers have significantly enhanced feature offerings to appeal to increasingly tech-savvy buyers. Early-generation models were equipped with basic functionalities such as digital instrument clusters and battery indicators, whereas newer models incorporate advanced features including touchscreen interfaces, cruise control, geofencing, cloud connectivity, and over-the-air (OTA) updates. These continuous technological enhancements have fundamentally reshaped the two-wheeler

landscape and accelerated EV adoption. In fact, e2Ws designed and manufactured in India offer a higher number of features and similar performance compared to a majority of global peers.

In parallel, OEMs have broadened their product portfolios to cater to diverse consumer segments. The market now spans a wide price spectrum from entry-level models priced below ₹1 lakh targeting cost-sensitive buyers to premium offerings exceeding ₹1.5 lakh focused on performance and advanced features. Legacy OEMs such as Hero MotoCorp, Bajaj Auto, and TVS Motor Company have concentrated on the mass and mass-premium segments, while newer entrants like Ather Energy have positioned themselves more strongly in the premium category.

The rapid advancement of technology, increasing product diversification, and sharper market segmentation have collectively propelled strong growth in India's electric two-wheeler sector. Success in this space is increasingly determined by a company's ability to deliver high product quality, develop robust software capabilities, maintain design control over critical components, achieve sustainable unit economics, and build resilient, well-integrated supply chains.

Category-wise price positioning of electric scooter portfolios in India (as of March 2026)

Category	Price*	No. of Variants
Premium	>1.5 lakh	10
Mass Premium	1.25-1.5 lakh	10
Mass	1.00-1.25 lakh	10
Entry	<1.00 lakh	5

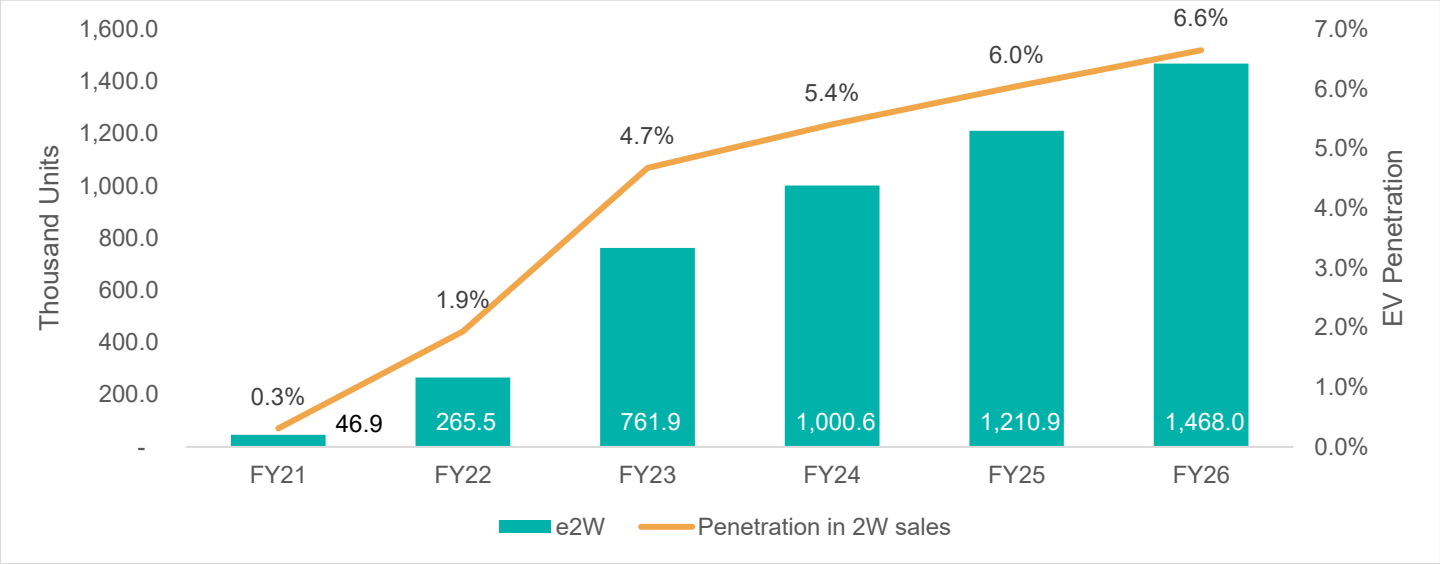
OEM	Entry	Mass	Mass Premium	Premium	Total
Ather			2	7	**9**
Bajaj	1	2	2	-	**5**
OLA	2	2	3	1	**8**
TVS	1	3	2	2	**8**
HMCL	1	3	1	-	**5**
Total	**5**	**10**	**10**	**10**	**35**

*Note: Scooter Offerings from Ather, Bajaj, Ola, TVS and Vida (Hero MotoCorp). * Ex-showroom Bengaluru price with TecPac, inclusive of subsidy.*

Source: Industry News Reports

Over the last 6 years, high speed e2W have propelled momentum in e2W sales, having increased at a rapid pace from 47k retails in fiscal 2021 to 1468k retails in fiscal 2026. The healthy growth in electrification was propelled by rising awareness, continued government support, lower total cost of ownership of EVs compared to their ICE counterparts, narrowing gap between acquisition cost of EV and ICE parallels, lower maintenance, new age advanced features and expanding EV portfolio of the industry. The entry of the new age non-traditional OEMs like Ola, Ather and Ampere has enabled the growth of the e2W segment in India.

e2W Retails (high speed) and Penetration trend – fiscals 2021 to fiscal 2026



Note: Only high-speed electric two-wheelers have been considered for the analysis
Source: SIAM, SMEV, VAHAN, Crisil Intelligence

However, e2W retails were growing only at a moderate pace till fiscal 2021 due to limited vehicle portfolio, lower awareness, customer concerns regarding the range, charging infrastructure etc; despite the Rs 10,000 per kWh government incentive under the FAME scheme. In June 2021, demand incentive for 2Ws increased to Rs 15,000/ kWh from Rs 10,000/kWh incentive given earlier. This heightened FAME incentive coupled with expansion in vehicle portfolio by players as well as entry of Ola provided an additional thrust to the e2W retails in fiscal 2022.

Additionally, ICE vehicles witnessed a steep rise in prices in fiscal 2021 due to the BSVI implementation and a further hike during fiscal 2022 amidst the hike in raw material prices. This price hike was much higher than the normal 3-4% annual hike undertaken by the industry. Over and above, this increase in vehicle acquisition costs, the sharp rise in petrol prices (petrol prices crossing Rs 100 mark) during the year provided an additional incentive to customers to shift from ICE vehicles to e2Ws. During fiscal 2022, amidst the much severe Covid second wave, pressure on incomes and increased medical expenses; limiting other expenses was a priority for most of the customer base.

Thus, the increased subsidy on e2W, vehicle portfolio expansion coupled with increased acquisition and operating costs of ICE 2Ws led to the sharp growth in e2W retails during fiscal 2022. e2W retails rose 5.7x from 47k in fiscal 2021 to ~266 k in fiscal 2022.

Growth momentum continued for the e2W segment in fiscal 2023. During the year, sharp push from new age EV players supported the growth in e2W. The legacy OEMs also scaled up their EV production, providing an added push to the EV retails during the year.

Fiscal 2024 began on a very strong growth trajectory. However, On June 1, 2023, the government reduced the FAME subsidy incentive cap from 40% of a vehicle's value to 15% and capped the subsidy at Rs 10,000 per kWh of battery from Rs 15,000 per kWh earlier. Due to this, manufacturers have had to increase the prices of electric scooters, which

led to a 57% sequential slowdown in sales in June. This sharp sequential contraction was on an elevated base of May 2023, where sizeable pre-buying was done by the customers due to the price rise from June.

However, after the initial hiatus in June and July, EV retails witnessed gradual momentum in the later months, especially during the festive period. Many OEMs also incentivized customers with additional discounts during the festive period. Additionally, OEMs also introduced competitively priced vehicles like Ola S1 Air, Ather 450S, Chetak Urbane, TVS X etc. in the second half of the year aiding overall demand.

However, the government discontinued the FAME II subsidy from fiscal 2025 (April 2024). The announcement of the subsidy discontinuation pushed e2W retails during March. For the complete year fiscal 2024, e2W retails rose 31% further to 1001k units.

At the start of fiscal 2025 in April, retail sales were initially lower due to pre-buying in March 2024, prompted by the discontinuation of the FAME II subsidy. However, retail sales reached 115.9k units in July as pre-buying happened in anticipation of the EMPS subsidy ending on July 31, which was then extended to September 30, 2024. The EMPS was subsequently replaced by the PM e-drive subsidy starting on October 1, 2024.

For fiscal 2025 initially, the government introduced Electric Mobility Promotion Scheme 2024 (EMPS 2024). The scheme ended on September 30, 2024 offered support of up to Rs 10,000 per two-wheeler for about 3.33 lakh two-wheelers, which continue to aid e2W demand, at least in the short term.

New PM Electric Drive Revolution in Innovative Vehicle Enhancement (PM E-DRIVE) Scheme for promotion of electric mobility in the country has been implemented from October 1, 2024, to July 31, 2026. The scheme has an outlay of Rs 10,900 crore over a period of two years. The scheme aims to incentivize approximately 24.79 lakh electric two-wheelers (e2Ws). Only e2Ws equipped with advanced batteries are eligible for this incentive. Both commercially registered and privately owned e2Ws can benefit from the scheme. The demand incentive is proposed at Rs. 5,000 per kWh for e2Ws registered in fiscal 2025 and Rs. 2,500 per kWh for fiscal 2026. Incentives will be capped per vehicle or at 15% of the ex-factory price, whichever is lower.

However, there has been a rise in acceptance of higher EV prices amongst customers, and these increased prices have become the new normal for the industry. The dependence on EV subsidy to drive the EV demand is expected to be limited going forward.

The fiscal year 2026 witnessed a modest beginning for electric vehicle (EV) penetration, commencing from a relatively low base in April, amidst a reduced subsidy. However, EV penetration gradually increased until September, driven by rising EV sales, although growth was somewhat constrained by the limited availability of rare earth magnets. The introduction of GST 2.0 led to a reduction in GST on internal combustion engines (ICE) vehicles, providing an additional boost to ICE vehicle sales during the festive months of October and November.

Conversely, the GST on EVs remained at 5%, widening the price gap between ICE and EVs, which negatively impacted EV penetration during this period. Nevertheless, December saw a gradual uptick in EV penetration.

In fiscal 2026, EV penetration reached 6.6% to 1468k retails, indicating steady, albeit gradual, progress towards increased adoption of electric vehicles.

Segment wise EV sales trend

Electrification within the Indian two-wheeler market has been significantly more pronounced in the scooter segment, with adoption in motorcycles remaining relatively limited. Within the broader two-wheeler landscape, scooters were the first to witness the introduction of electric models. This early adoption was driven by an already well-established consumer preference spanning diverse demographics including women, men, students, and working professionals along with increasing usage as a secondary vehicle for intracity commuting.

Scooters also offer a more compelling value proposition compared to motorcycles, owing to advantages such as higher storage capacity, greater load-carrying capability, and relatively lower upfront acquisition costs. In contrast, motorcycles are typically used for longer-distance travel, where range anxiety associated with electric variants remains a key deterrent to widespread adoption.

As a result, most original equipment manufacturers (OEMs) have prioritised the scooter segment for their electric offerings, with only a limited number of players such as Revolt, Ultraviolette, and Tork Motors focusing on electric motorcycles. Consequently, consumer acceptance of electric motorcycles has remained subdued.

This trend is reflected in overall electric vehicle retail sales, where motorcycles continue to account for a marginal share. As of fiscal 2026, electric motorcycles and bikes contributed approximately 2–3% of total EV sales, while scooters overwhelmingly dominated the segment, accounting for over 97% of total volumes.

State wise electric two-wheeler sales and EV penetration for fiscal 2026

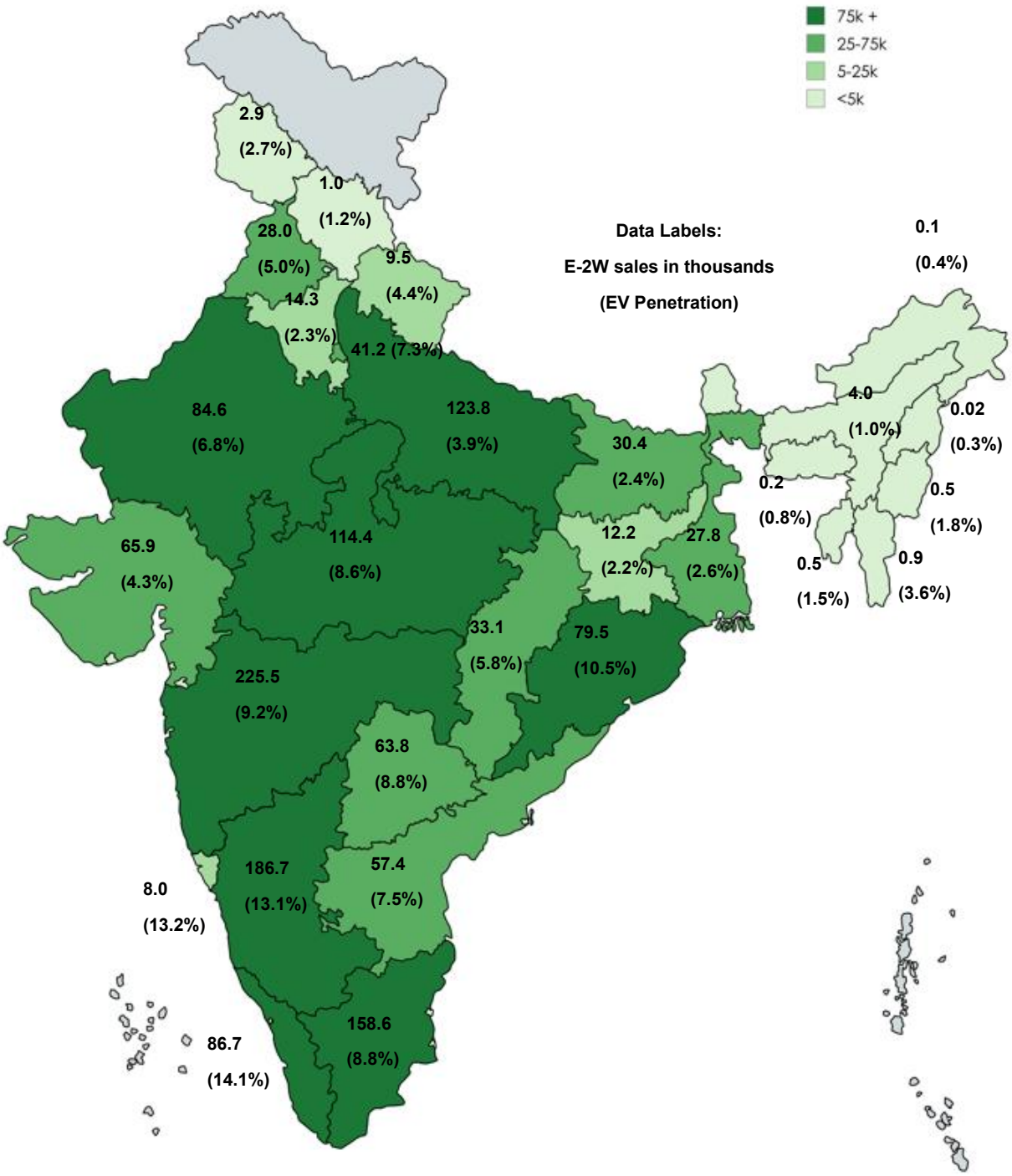
The graph shows the penetration of electric two-wheelers (e2Ws) alongside state-wise sales distribution for fiscal 2026. Southern states continued to lead in EV adoption, with Kerala, Karnataka, Tamil Nadu, and Telangana recording notably high penetration levels.

In terms of absolute e2W sales, Maharashtra emerged as the largest market, followed by Karnataka, Tamil Nadu, Madhya Pradesh, Uttar Pradesh, and Kerala. Among these high-volume states, Maharashtra, Karnataka, Tamil Nadu, and Madhya Pradesh also demonstrated relatively strong penetration rates, reflecting broad-based EV adoption despite the large size of their overall two-wheeler markets.

Western and central states, including Gujarat, Rajasthan, and Chhattisgarh, exhibited moderate to strong adoption trends. In contrast, northern states such as Punjab, Haryana, Himachal Pradesh, Uttarakhand, and Jammu & Kashmir continued to show comparatively lower penetration levels.

The eastern and northeastern regions remained relatively underpenetrated. States such as West Bengal, Bihar, Jharkhand, and most northeastern states recorded EV penetration below 4%, with several states remaining below 2%. Although certain eastern states reported moderate sales volumes, EV adoption remained at an early stage, indicating significant headroom for future growth as charging infrastructure expands and consumer awareness improves.

State wise e2W penetration (fiscal 2026)



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Note: EV retail data from VAHAN has been considered
Source: VAHAN

Competitive landscape of the electric 2W industry

The e2W segment has been highly concentrated with a few players primarily catering to the entire segment. During fiscal 2021, a few OEMs like Hero Electric and Okinawa completely dominated the market with more than 50% of the market share. Over the years, with the entry of new players, EV launches from legacy ICE OEMs as well as expansion in EV portfolio of players, competition intensified within the EV space.

High speed vehicles offered initially by Hero Electric and Okinawa offered relatively lower speed and acceleration compared to the ICE counterparts. Ather Energy entered the market in fiscal 2019 with its 450 model which offered comparable power and acceleration as an ICE vehicle along with internet connectivity and “smart” features. This helped Ather achieve ~10% market share in fiscal 2021, although it has lost some share and achieved ~8% market share in fiscal 2022 post which they have managed to maintain that share through multiple updates to the Ather 450 line, despite the intensifying competition in the next 4 years. Ather Energy had a 17.1% market share in fiscal 2026 emerging as the third largest player by volumes during the year. Intermittent launches, technology rich products, expansion in retail network and development of the overall e2W ecosystem have helped the company maintain its momentum in the market.

Ola entered the EV market in fiscal 2022 and expanded its presence at a very fast pace and became the leading contributor to EV retails in India. Expansion in product portfolio and distribution network thrusted the contribution of Ola in e2W market. As of fiscal 2026, Ola is at 4th position in market leadership in e2W sales with a share of 11.5% as compared to 29.7% in fiscal 2025. Drop in market share was primarily driven by massive service center bottlenecks, a wave of consumer complaints, and aggressive competition from legacy manufacturers.

The legacy OEMs have also entered the EV space. TVS introduced the iQube model in fiscal 2020 and has gradually increased its supply over the years. Its model iQube received healthy traction helping them clock highest retails during fiscal 2026, with TVS gaining the market share of 24.4% in fiscal 2026 and became the top player.

Bajaj’s Chetak EV was introduced in Q4 of fiscal 2019. The company gradually expanded its presence across the country in the next few years. With increased company focus, coverage expansion and higher production, the company’s share increased to ~20% in fiscal 2025 and 2026 from ~11 in fiscal 2024.

HMCL entered the EV segment with VIDA in fiscal 2023. In the two years, the company’s contribution has increased to ~2% by fiscal 2024. Its share increased to ~10% in fiscal 2026 amidst increased traction for its VIDA models.

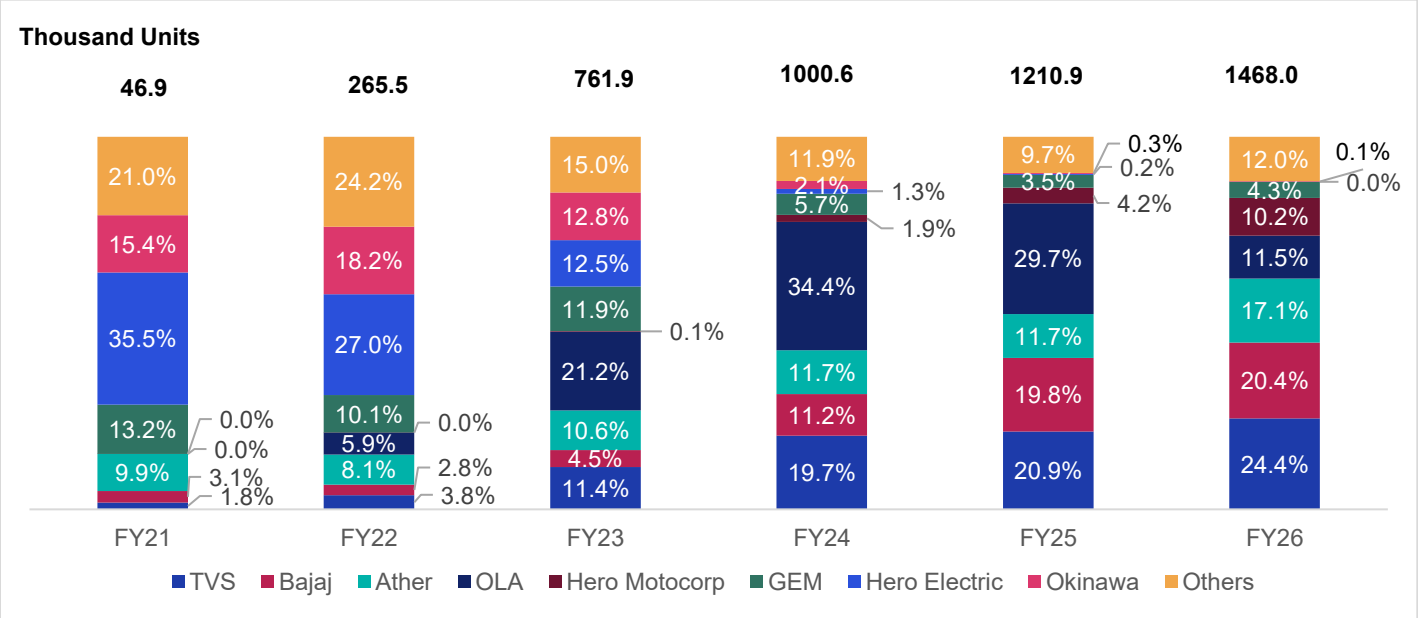
In late November 2024, HMSI entered the electric scooter market with the launch of the Activa e model featuring swappable batteries, and the QC1 model equipped with a fixed battery system.

Erstwhile leading contributors in the e2W industry, Hero Electric and Okinawa faced stiff competition from newer entrants and increased focus from other legacy two-wheeler manufacturers. From a high base, their share contracted in the next 3 years.

The industry has also experienced a phase of consolidation in recent years, with the top three players TVS Motor, Bajaj Auto, and Ather Energy accounting for over 60% of total industry sales in fiscal 2026.

The ability of leading companies to expand their market presence has been driven by their focus on delivering high-quality, reliable products, complemented by strong after-sales service networks and customer support.

OEM wise contribution to e2W retails



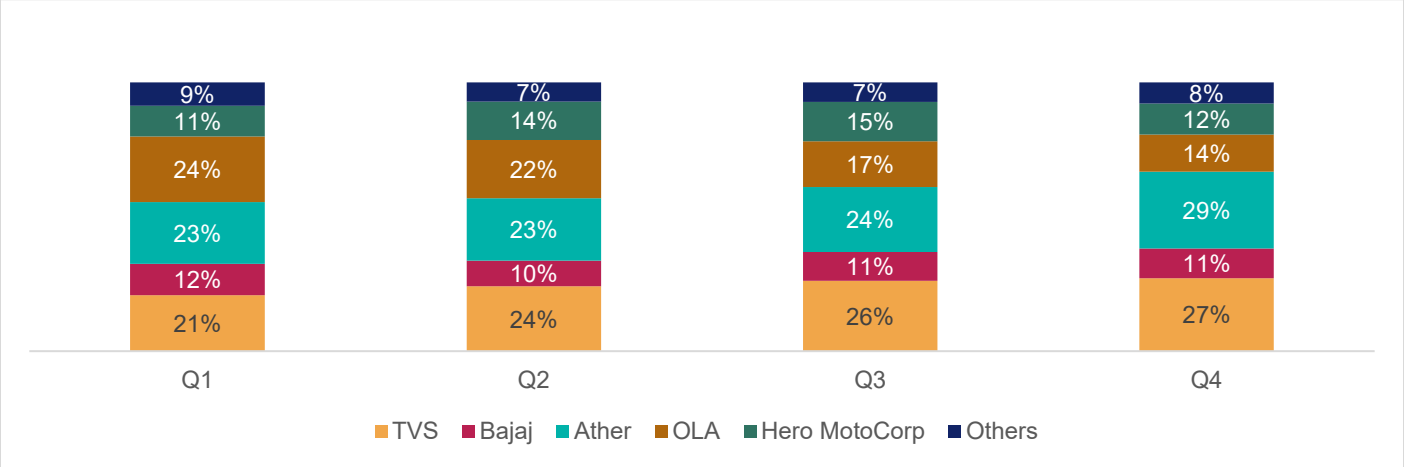
Note: EV retail data from VAHAN has been considered

Source: VAHAN, Crisil Intelligence

Given more than 97% contribution of scooters in e2W retails, OEM wise contribution for scooters is in line with the OEM wise contribution for overall e2W segment.

The Indian E-motorcycle/E-bike segment remains a niche sub-category, contributing only around 2–3% of the overall electric two-wheeler market, with key players such as Revolt Motors, Tork Motors, Ultraviolette, Ola Electric, and Oben Electric accounting for the majority of sales and dominating this small subsegment.

EV brand-wise keyword search trends (fiscal 2026)



Source: Google Keyword Planner

Over the years, the e2W segment has undergone notable consolidation, with the top three players accounting for over 60% of total retail volumes in fiscal 2026. This concentration is further reflected in digital engagement trends, as keyword search data indicates that these leading players contributed approximately 60% of overall e2W-related searches during the year.

Growth Drivers

Over and above the conducive environment for electrification, including government focus on environment & limiting air pollution, support for manufacturing EVs, demand incentives and tax breaks, below key drivers are expected to aid the electrification in the two-wheeler industry over the long-term horizon. (Above mentioned factors have been covered in detail in previous chapters)

Cost of Ownership Comparison - EV vs ICE

For the Total cost of ownership (TCO) calculation, an annual running of 8000 km is considered, i.e., 25 km per day for 325 days of operation per year. A 7-year holding period is considered, assuming no battery replacement happens during the ownership period.

In fiscal 2026, the total cost of ownership (TCO) of an e2W, with subsidy till fiscal 2027, was 43% lower than that of an ICE 2W for an annual running of 8,000 km.

Going ahead, by fiscal 2033, e2W ownership is expected to become financially more lucrative. For an annual running of 8,000 km, the e2W TCO is projected to be 50% lower than its petrol counterpart with subsidy considering only till fiscal 2027. Total cost of ownership for e2W is decreasing over the years amidst the lowering global battery prices, economies of scale and improving technology resulting in higher manufacturing efficiency of the electric vehicles.

TCO for seven-year ownership with subsidy till fiscal 2027

Year/Annual Running	3,000 km	6,000 km	8,000 km	10,000 km	12,000 km
Fiscal 2026	14% lower cost than petrol	34% lower cost than petrol	43% lower cost than petrol	49% lower cost than petrol	53% lower cost than petrol
Fiscal 2033	29% lower cost than petrol	44% lower cost than petrol	50% lower cost than petrol	55% lower cost than petrol	59% lower cost than petrol

Note:

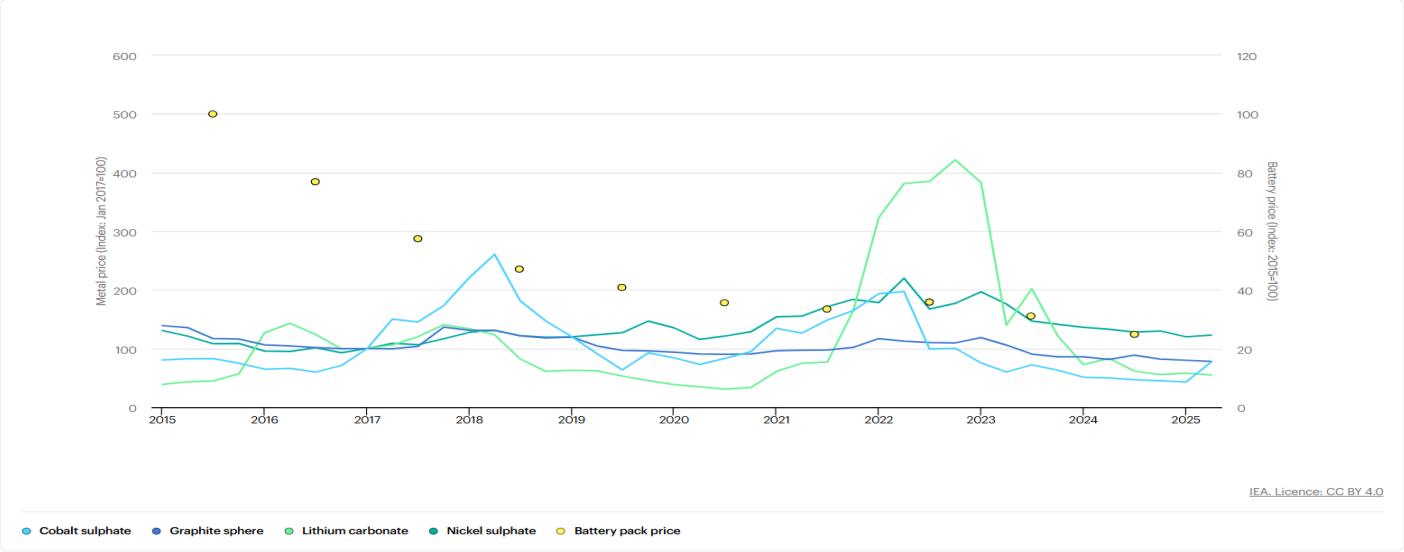
- *Convenience ICE scooter and Convenience E-scooter have been considered for the comparison*
- *In both the above scenarios, the GST and road tax structure have been assumed to be constant as per current structure.*
- *Above analysis is done without considering battery replacement*
- *According to Ather Energy, battery packs will not need a replacement in 7 years, however, the battery can degrade in case of extreme use cases such as excessive use of fast charging, accidental damages, lack of periodic maintenance, use of unauthorized chargers, extended exposure to temperatures higher than 50 degrees Celsius and prologued idle periods.*

Source: Crisil Intelligence

Battery pack price glide path and drivers

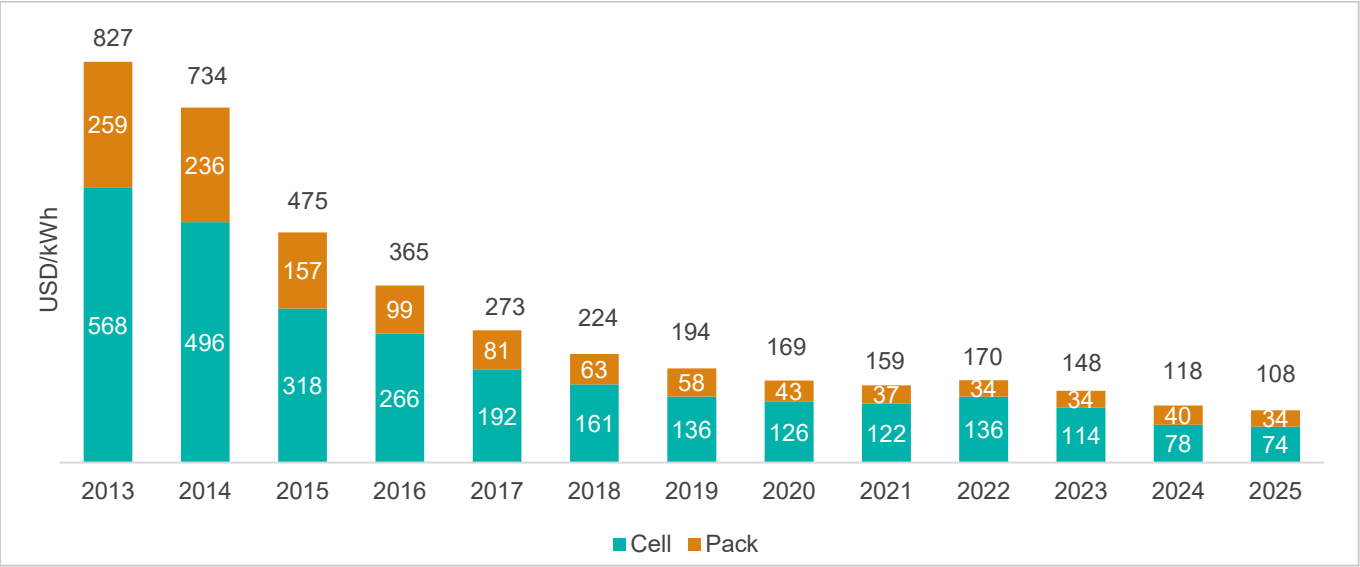
The prices of lithium-ion cells and battery packs have been declining steadily in recent years. This is due to several factors, including increased demand, technological advancements, and economies of scale. The battery pack prices fell by almost 14% between CY2022 and CY2023. As the price of all key battery metals dropped during 2023 with cobalt, graphite and manganese prices falling to lower than their CY2015-2020 average by the end of 2023. The Battery Metal prices increased in 2025 in part due to supply risks from certain Chinese lithium assets and new cobalt export from Congo. However, metal price increase did not translate into annual prices for cell and battery packs.

Price of selected battery raw materials and lithium-ion batteries, 2015-2025



Notes: "Battery pack price" refers to the volume-weighted average pack price of lithium-ion batteries over all sectors.
Source: IEA analysis based on data from Bloomberg and Bloomberg New Energy Finance Lithium-Ion Price Survey (2025). IEA. CC BY 4.0

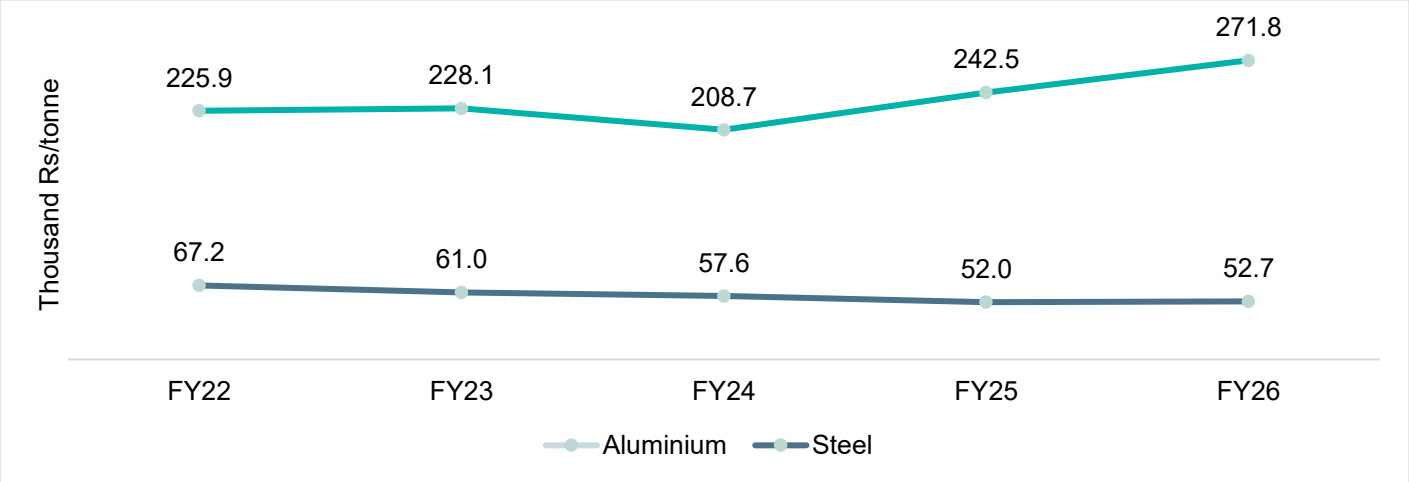
Volume weighted average lithium-ion battery pack and cell price (2013-2025)



Notes: Historical prices have been updated to reflect real 2025 dollars. Weighted average value includes 320 data points from passenger cars, buses, commercial vehicles, and stationary storage.
Source: Bloomberg NEF

According to Bloomberg New Energy Finance (BNEF), the price of lithium-ion battery packs dropped 8% y-o-y to a record low of USD108/kWh in 2025 after an unprecedented price increase in 2022. Despite an increase in battery metal costs, the battery pack prices were declining due to the shift towards lower cost lithium chemistry like LFP, intense competition and continued cell manufacturing overcapacity. Manufacturing process improvements, continued R&D investment, and capacity expansion across the battery value chain would help improve battery technology and reduce costs over the next decade. With lowering costs of battery, vehicle prices are expected to decrease thereby reducing the acquisition cost and operational costs of an EV. This would create positive sentiment among EV buyers and drive EV adoption further.

Trend for Aluminium and Steel domestic prices



Note: Average HR coil prices used for Steel prices
Source: Crisil Intelligence

On the other hand, domestic aluminum prices remained range-bound at ₹225- 228 k /tonne through fiscal 2022-fiscal 2023, before easing to ₹208 k/tonne in fiscal 2024. Prices then rose sharply, rising to ₹242 k/tonne in fiscal 2025 and further to ₹271 k /tonne in fiscal 2026, a five-year high. This uptrend has broadly tracked global prices, which rose through calendar 2025 on improved demand sentiment, supply-side tightness, and trade-related volatility, and are expected to stay elevated in 2026 as supply growth remains sluggish.

Domestic steel prices declined steadily from ₹67k /tonne in fiscal 2022 to ₹52 k/tonne in fiscal 2025, before edging up marginally to ₹53 k/tonne in fiscal 2026. Going forward, prices are expected to grow further. The West Asia conflict is expected to push the metal prices.

Government Policies

Government policies like FAME (I & II), EMPS, PM E-DRIVE etc. have helped drive EV growth in India, especially in the e2W segment. Supply side policies like PLI and PMP along with overall government agenda of Atmanirbhar Bharat are also promoting localisation and manufacturing in India, which could bring down electric vehicle manufacturing costs in the future and subsequently their prices, thereby enabling more people to purchase them. Such Government policies will also enable OEMs and other players to make further investments to develop newer technologies and capabilities in the e-mobility space.

Increasing charging infrastructure

To support the rising electric vehicle population, EV ecosystem in India is evolving and there is a growing focus on expanding the supporting charging infrastructure network across the country. Public charging stations are being installed in cities, highways, and commercial areas, making it more convenient for EV owners to charge their vehicles. There is an increasing adoption of fast charging technologies, such as DC fast charging, to reduce charging times and provide greater convenience to EV users.

Setting up charging stations demands a considerable quantum of investment, which includes capital expenditure, grid connection fees, and operations and maintenance expenditures. Another issue for charging infrastructure development is assuring charger compatibility. As a result, in the charging infra segment, capital availability as well as technical skill is required.

To address this issue, the leading EV charger manufacturers in India are currently engaged in manufacturing a diverse product portfolio of AC and DC chargers.

Additionally, to aid the charging infrastructure, the government has allotted ₹ 20 billion as the total outlay in the PM E-DRIVE scheme, to establish a robust network of public charging stations, including 22,100 fast chargers for e-4Ws, 1,800 for e-buses, and 48,400 for e2Ws and e3Ws.

The concerted efforts to enhance charging infrastructure have yielded significant results, with the number of public charging units growing from 14 thousand in fiscal 2022 to ~28 thousand in fiscal 2026. This momentum has continued, with the total number of charging units reaching 29 thousand by May 2026.

Looking ahead, the growth momentum in charging infrastructure is expected to sustain. By fiscal 2030, the number of public charging units is projected to reach 125 -130 thousand, representing a substantial increase from ~28 thousand in fiscal 2026. This expansion is expected to support further adoption of electric vehicles.

Key players present in standard as well as fast charging infrastructure

Ather Energy's charging infrastructure initiative, Ather Grid, is a crucial aspect of their electric vehicle ecosystem. For corporates, the company is also offering incentives to host a charging station on their premises. Ather Grid EV chargers

incorporate their in-house designed charging connector, which has been established as a national charging standard for electric two-wheelers (LECCS) recognized by the BIS (Bureau of Indian Standards).

Ather was the first two-wheeler OEM to establish a two-wheeler fast charging network in India in 2018, the Ather Grid, which has the widest footprint amongst two-wheeler fast charging networks.

Hero MotoCorp has partnered with Ather Energy to establish an interoperable fast-charging network. This collaboration will allow Hero's EV users to seamlessly access Ather Grid stations.

Ola Electric has also introduced its hyper charger network, a charging infrastructure tailored for their two-wheeler products. According to the company, these hyper chargers can provide 50km charging range in 15 mins of charging. As of October 16, 2024, there are 288 hyper charging guns (as quoted on the company website as on June 2026) across various locations in India. Ola intends to build an estimated 900 hyper charger guns over fiscals 2025 and 2026.

The government is playing a crucial role in promoting electric mobility and charging infrastructure development. Various initiatives and policies, such as subsidies, incentives, and regulations, support the growth of both standard and fast charging infrastructure for two-wheelers.

The Solar push

For an EV, the charging per unit electricity costs determines the primary operating costs for the vehicle. Operating costs for EVs are already low compared to ICE vehicles. Moreover, amidst the push for renewable energy sources, specifically solar, the operating costs are expected to reduce further.

The union budget of 2026-27 highlighted the pivotal role of solar energy in India's goal to achieve 500 GW of renewable energy by 2030. It is crucial for reducing reliance on fossil fuels and addressing climate change.

Among the various renewable energy options, rooftop solar energy has gained significant traction, especially with the introduction of the Pradhan Mantri Suryodaya Yojana. This initiative aims to provide solar rooftop installations to one crore households, enabling them to generate their electricity and even earn extra income by supplying excess power back to the grid. The scheme, announced in January, underscores the government's commitment to promoting solar energy adoption at the household level. These households can also become EV owners going forward, as the charging cost for them would be practically zero.

CRISIL foresees a surge in solar power capacity, reaching 210-250 GW from fiscal years 2027 to 2031, in addition to this 40-45 GW is expected in fiscal 2026. This growth is primarily spurred by robust government backing, demonstrated through an aggressive tendering strategy. Key catalysts include technological advancements (eg. floating solar and module efficiency), affordable financing, and supportive policies.

The government's push for solar energy will not only make electricity cheaper but can also lead to long term cost saving, reducing dependence on fossil fuels. Reduction in per unit electricity cost and solar power adoption will lend support the EV adoption over a long-term horizon.

Expanding portfolio offerings

The electrification of India's two-wheeler industry initially began with the introduction of low-speed electric two-wheelers, characterized by limited speed and range and primarily suited for short-distance commuting. However, the sector underwent a significant transformation with the launch of high-speed electric two-wheelers (e2Ws) around fiscal 2019. These vehicles offered performance comparable to internal combustion engine (ICE) counterparts, while the emergence of an organized manufacturing ecosystem enhanced credibility, quality assurance, and consumer trust in the segment.

Since then, the e2W market has experienced substantial technological progress, particularly in battery innovation. Advancements in lithium-ion chemistries—including Lithium Iron Phosphate (LFP), Lithium Nickel Manganese Cobalt (NMC), and Lithium Nickel Cobalt Aluminum Oxide (NCA)—have improved energy density, extended vehicle range, and enhanced overall performance. Concurrently, developments in software and powertrain technologies have enabled features such as fast charging, improved energy efficiency, and better battery management systems, effectively addressing range anxiety—a key barrier to EV adoption.

Over the past six years, the range of high-speed electric two-wheelers has nearly doubled to approximately 100–150 km per charge. OEMs have also introduced high-performance electric scooters—such as the Ather 450, TVS X, Ola S1 Pro, and Ampere Nexus—with top speeds exceeding 80 km/h, catering to consumers seeking both performance and sustainability. In addition, manufacturers have significantly enhanced feature offerings, incorporating advanced functionalities such as connected technologies, smart dashboards, and over-the-air updates, thereby increasing the appeal of e2Ws, particularly among tech-savvy consumers.

The breadth of product offerings has expanded considerably, supported by new launches such as e-Activa, e-Access, QC1, Ampere Magnus G Max, and Yamaha EC-06, further accelerating market growth. OEMs have diversified their portfolios across a wide range of price points and battery capacities to address varying consumer needs, from cost-sensitive buyers to premium segments. Furthermore, the entry of established automotive players such as Royal Enfield, Suzuki, and Yamaha into the EV space is expected to strengthen the competitive landscape and contribute to sustained segment growth.

Overall, these advancements in technology, performance, features, and product diversity have significantly improved the value proposition of electric two-wheelers, driving their transition from niche alternatives to mainstream mobility solutions. This has supported the gradual shift from ICE-powered vehicles to EVs and underpinned the robust growth trajectory of the electric two-wheeler industry in India.

Expanding sales network

The proliferation of electric vehicles (EVs) across various segments, including two-wheelers, three-wheelers, passenger vehicles, and commercial vehicles, is significantly influenced by the expansion of sales and service networks. A crucial strategy employed by original equipment manufacturers (OEMs) is the aggressive expansion of dealerships and experience centers into non-metro areas, thereby enhancing awareness and accessibility of electric two-wheelers.

Furthermore, OEMs are establishing captive pure EV dealerships across India, catering specifically to the growing demand for electric vehicles. This strategic expansion of sales networks has improved accessibility across Tier 1, Tier 2, and Tier 3 cities, bridging the gap between urban and rural markets.

In addition to the expanding sales network, the growth of after-sales support through authorized service centers has played a vital role in bolstering customer confidence. By providing comprehensive support and services, OEMs are addressing concerns related to maintenance and repair, thereby fostering a more favorable environment for EV adoption. As a result, the combined efforts of OEMs to enhance accessibility, awareness, and after-sales support are driving the demand for electric vehicles and propelling the growth of the EV industry in India.

Competitive pricing through technological advancements

Over the past few years, improvement in battery technology has significantly impacted and reduced the manufacturing costs. In particular, the development of high-density lithium-ion batteries, and innovations in motor efficiency usage of lightweight materials have enabled the manufacturers to offer e2Ws at comparable prices with that of ICE vehicles.

Many companies are shifting towards Lithium Iron Phosphate (LFP) batteries. LFP batteries are cheaper to produce than traditional NMC batteries. They also have a longer lifecycle helping manufacturers to cut costs without compromising on

performance. OEMs have also invested in designing and producing their own electric motors. This in-turn reduces reliance on expensive imports and lowers the production costs. Advancements in the Battery Management Systems (BMS) have made batteries more reliable and efficient. Also, instead of importing costly parts, companies have started localizing significant portion of supply chains in India. This has reduced import duties and logistics costs, in turn making e2Ws cheaper for the end consumers.

Financing Support

There was an initial inhibition from financers regarding financing of electric vehicles amidst the uncertainty about the vehicle resale and its end-of-life valuation. However, for leveraging the sharp growth in the e2W segment, banks as well as NBFCs have been expanding their product offerings in the e2W space.

Over and above the traditional financers, digital commerce platforms and fintech companies like OTO Capital, Revfin, CASHe Green, Mufin Green Finance, LoanTap, Ecofy Finance, Vidyuttech have entered the e2W segment, offering competitive financing terms for EV buyers. These new age financing companies offer novel customized financing options for EV buyers offering improved transparency, accessibility, and simplify the entire financing processes for e2Ws. Besides the fully digital financing solutions, instant approval-disbursal and flexible EMIs, these financers also offer flexibility in financing components like battery replacements, system upgrades, exchange option, allowing consumers who wish to exchange their existing ICE two-wheeler for a new e2W.

Additionally, financers also offer leasing and subscription schemes for e-commerce players opting for e2Ws for their logistics operations. Thus, the expanding financer scope and intensifying competition within the e2W financing space will help scale up vehicle electrification in the two-wheeler industry.

Barriers to adoption of electric vehicles and challenges in the Indian EV ecosystem

The government of India is actively promoting electric mobility through initiatives such as the development of public charging infrastructure, incentives for investments in EV component manufacturing and R&D, and support for advanced battery technologies, including Advanced Chemistry Cells (ACC). Despite these efforts, the EV industry continues to face several structural challenges. A significant portion of the EV value chain, particularly critical components such as batteries and electric motors, remains dependent on imports. While domestic manufacturing capabilities are expanding, achieving a fully indigenous supply chain will require substantial time and investment. Key challenges hindering large-scale EV adoption include:

- **Limited charging infrastructure:** The inadequate availability and slow expansion of public charging networks remain major barriers to EV adoption in India. Although most electric two-wheelers are equipped with personal charging solutions, the limited public charging ecosystem contributes to range anxiety and concerns regarding charger accessibility during emergencies, thereby restricting mass-market adoption.

- **Uncertainty in vehicle resale value:** The resale market for EVs remains underdeveloped, primarily due to uncertainties surrounding battery health, battery valuation, and long-term performance. Since the battery constitutes a significant proportion of an EV's overall cost, concerns regarding residual value continue to influence consumer purchasing decisions.

- **Limited product portfolio:** While the EV market has witnessed substantial growth in product offerings through the entry of new manufacturers and portfolio expansion by established players, the range of available EV models remains relatively limited compared to the extensive offerings in the internal combustion engine (ICE) segment.

- **Low consumer awareness:** Despite the environmental and operating cost advantages offered by EVs, limited consumer awareness regarding these benefits continues to constrain adoption. Greater education and outreach efforts are required to improve understanding of EV economics and performance advantages.

- **Dependence on imported battery raw materials:** EV battery production relies heavily on critical minerals such as lithium, cobalt, nickel, and manganese. India currently lacks sufficient domestic reserves and processing capabilities for several of these materials, resulting in significant import dependence. This exposes the industry to global price volatility, supply chain disruptions, and geopolitical risks, thereby increasing battery costs.

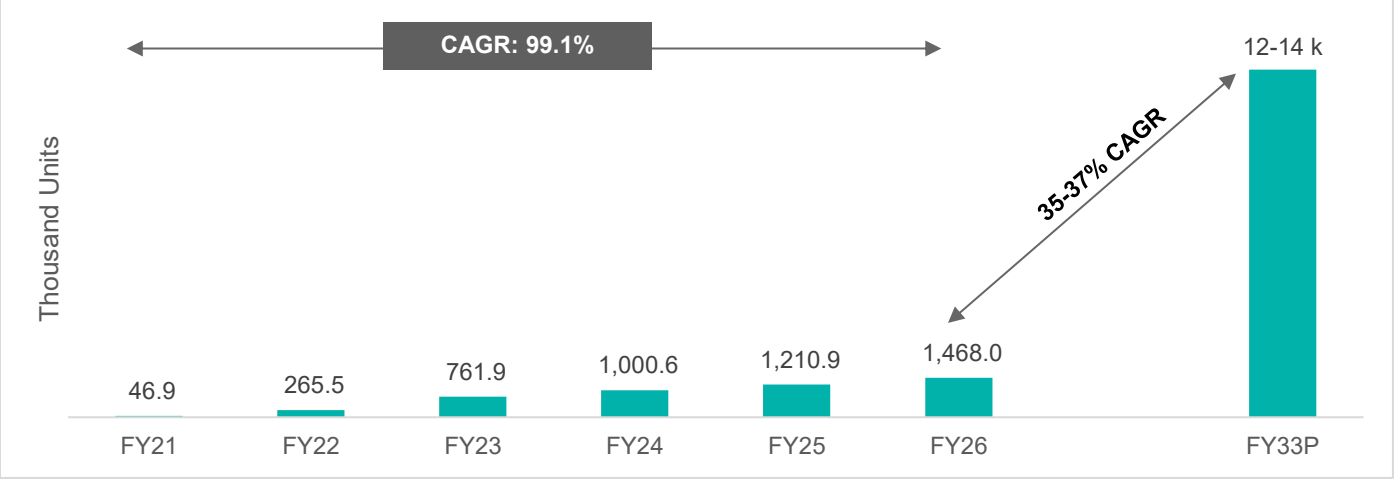
- **Reliance on imported EV components**: Although localization levels have improved in recent years, several high-value EV components including semiconductor chips, permanent magnets, power electronics, and printed circuit boards (PCBs) continue to be imported. Developing domestic capabilities for manufacturing these technologically complex components require significant capital investment, technical expertise, and a robust supplier ecosystem.

Electrification Outlook for Indian Two-wheeler Industry (fiscals 2026-2033)

The electric two-wheeler retails rose at a sharp growth pace of 99.1% CAGR between fiscal 2021 to fiscal 2026, albeit off the small base of fiscal 2021. Going ahead, the growth momentum in the industry is expected to continue over the long-term horizon led by increasing acceptance of EVs, rising awareness, improving TCO for electric vehicles, bridging acquisition cost gap between EV and ICE counterparts, larger vehicle portfolio, expanding charging infrastructure, furthering financing support, increasing EV manufacturing capacity, and continued government support.

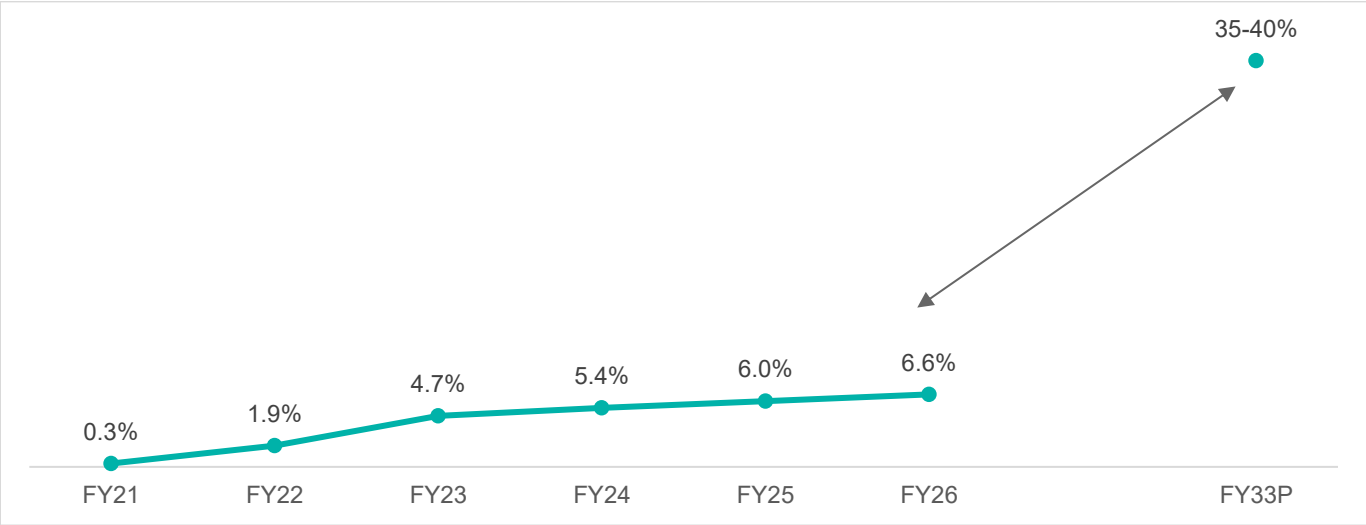
Crisil Intelligence expects the EV retails to rise at a healthy pace of 35-37% CAGR and reach volumes of 12-14 million in fiscal 2033. And the EV penetration to reach 35-40% by fiscal 2033. Such expansion will make e2Ws one of the fastest growing segments in the automotive industry in India.

e2W Retails and CAGR Outlook



Note: Only high-speed electric two-wheelers have been considered for analysis.
Source: SIAM, VAHAN, Crisil Intelligence

Outlook for EV Penetration in 2W segment



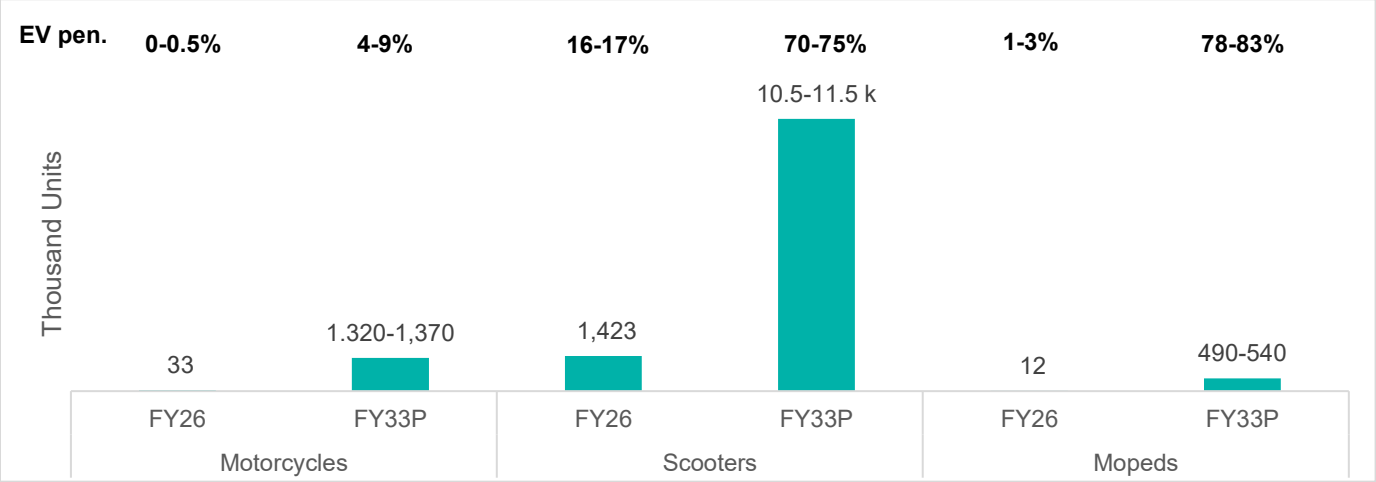
Note: Only high-speed electric two-wheelers have been considered for analysis.
Source: SIAM, SMEV, VAHAN, Crisil Intelligence

Scooters are expected to lead the change going ahead as well. EV penetration within scooters is currently the highest at 16-17% as of fiscal 2026. Due to the fast-expanding e scooter portfolio, OEM focus, highly tech-enabled e-scooter offerings, lowering TCO and reduction in acquisition cost difference vs ICE counterparts, the customer preference is expected to shift from ICE scooters to e scooters leading to a sharp rise in e-scooter penetration going forward. Crisil Intelligence expects EV penetration to reach 70-75% for scooters by fiscal 2033.

Mopeds is another segment which is projected to see sharp electrification going ahead. The price sensitive nature of the moped customer base, lower operating costs of EV, lowering the acquisition price gap between EVs and ICE equivalents will propel the EV sales within the moped segment. The launch of mopeds by Kinetic Green and expected offering from TVS will aid the E-moped demand over the long-term horizon. Crisil Intelligence projects EV penetration to reach 78-83% for the mopeds segment by fiscal 2033.

Electrification within motorcycles segment has remained limited amidst limited offerings as well as longer distance usage of motorcycles compared to scooters. However, amidst the projected launch of e bikes/ motorcycles from OEMs including Oben Electric, Ultraviolette, TVS, Revolt, Ola, Tork and Ather will back electrification within motorcycles as well. Hence, EV penetration is expected to reach 4-9% within motorcycles by fiscal 2033.

Segment wise EV Outlook



Note: Only high-speed electric two-wheelers have been considered for analysis. Above figures are approximate figures.
Source: SIAM, SMEV, VAHAN, Crisil Intelligence

Key Electric Two-Wheeler (e2W) Player Profiles

Bajaj Auto Limited

Bajaj Auto established Chetak Technology Limited (CTL), a 100% subsidiary, in October 2021. CTL operates a manufacturing plant in Akurdi, Pune, and as of Q4 fiscal 2026, CTL's production capacity reached 50,000 units per month.

During fiscal 2026, company expanded its product portfolio with the C35 series, featuring enhanced range, faster charging, and increased storage capacity. CTL also introduced Chetak C2501 and C3001, aimed at accessible electric mobility while maintaining focus on durability and everyday usability.

Chetak models are currently offered through a network of over 500 exclusive Chetak stores and nearly 3,000 Bajaj motorcycle stores, with brand presence spanning more than 850 cities across India.

In 2024, Bajaj Auto invested an additional Rs. 45.75 crores in Yulu Bikes Private Limited, taking its total investment in the company to Rs 165 crore. Following the investment, Bajaj Auto's stake in Yulu Bikes increased to 18.8% of the paid-up equity share capital. In 2025, Bajaj Auto International Holdings B.V., a wholly owned subsidiary of Bajaj Auto Limited, successfully acquired control of Pierer Bajaj AG, the parent entity of KTM AG.

In fiscal 2026, CTL reported healthy performance, with sales reaching approximately 3 lakh units, a 25% year-on-year increase.

Product Portfolio (fiscal 2026)

Model	Effective Ex-Showroom Price (in Rs)	Software Pack Price	Battery capacity (in kWh)	Range (ARAI Certified)	Maximum Speed	Acceleration	Charging Time (100%)	Fast Charging (Yes/ No)	OTA updates	Telematics	Software Enabled Safety features
Chetak C2501 Standard	87 thousand	NA	2.5kWh	113km	60kmph	NA	3 hrs 45min	Yes	No	No	No
Chetak C2501 TecPac	90 thousand	Included at Rs 3,000	2.5kWh	113km	60kmph	NA	3 hrs 45min	Yes	No	No	Yes
Chetak 3001 Standard	1 lakh	NA	3.0 kWh	127km**	70kmph	NA	2 hrs 55 min*	No	No	No	Yes
Chetak 3001 TecPac	1.03 lakhs	Included at Rs 3,000	3.0 kWh	127km**	70kmph	NA	2 hrs 55 min*	No	No	Yes	Yes
Chetak 3501 Standard	1.35 lakhs	NA	3.5 kWh	153km	80kmph	NA	3 hrs*	No	Yes	No	Yes
Chetak 3501 TecPac	1.40 lakhs	Included at Rs 5000	3.5 kWh	153km	80kmph	NA	3 hrs*	No	Yes	Yes	Yes
Chetak 3502 Standard	1.22 lakhs	NA	3.5 kWh	153km	80kmph	NA	3 hr 25 min*	No	Yes	No	Yes
Chetak 3502 TecPac	1.27 lakhs	Included at Rs 5000	3.5 kWh	153km	80kmph	NA	3 hr 25 min*	No	Yes	Yes	Yes
Chetak 3503 Standard	1.10 lakhs	NA	3.5 kWh	151km	70kmph	NA	3hr 25 min	No	No	No	Yes
Chetak 3503 TecPac	1.13 lakhs	Included at Rs 3000	3.5 kWh	151km	70kmph	NA	3hr 25 min	No	No	Yes	Yes

Source: OEM website, Crisil Intelligence
*Note: Details as of March 2026; *: Charge time for 0-80% NA : Not Applicable*
*Note: **: Website claims range to be 131km and brochure mentions 127km*
Note: Prices are as of March 2026, ex-showroom Bengaluru, inclusive of PM E-drive subsidy benefit.. Standard versions refer to without the TECPAC, whereas TECPAC versions are inclusive of TECPAC prices

Ola Electric Mobility Limited

Ola Electric Mobility Limited is one of the leading players in the electric two-wheeler segment in India and went public via an IPO in August 2024. The company has received approvals under both the PLI Scheme for Advanced Chemistry Cell (ACC) manufacturing and the PLI Scheme for Automobile and Auto Components.

Ola operates the Future Factory in Tamil Nadu with an installed capacity of one million units as of fiscal 2026 and runs the Battery Innovation Centre (BIC) in Bengaluru focused on developing cell technology and manufacturing processes for its Gigafactory operations. Ola operates 2.5 GWh of battery cell manufacturing capacity, with installation of the planned 6 GWh Gigafactory capacity largely complete as per the fiscal 2026 Q4 shareholder letter.

In 2025, Ola launched the Roadster series, entering the electric motorcycle market. In October 2025, Ola Electric launched India's first residential Battery Energy Storage System (BESS), named Ola Shakti, using the company's Bharat 4680 cell to provide energy independence for homes, farms, and businesses in India. As of fiscal 2025, Ola's network has expanded to over 4,000 touchpoints across India.

In fiscal 2026, company's domestic sales declined to ~1.7 lakh units from ~3.6 lakh units in fiscal 2025 amid intensifying competition.

Product Portfolio (fiscal 2026)

Model	Effective Ex-Showroom Price (in Rs)	Software Pack Price	Battery capacity (in kWh)	Range (ARAI Certified)	Maximum Speed	Acceleration	Charging Time (100%)	Fast Charging (Yes/No)	OTA updates	Telematics	Software Enabled Safety features
S1 Pro+ 3rd Gen	1.75 lakhs	Included in the Price	5.3 kWh	320 km	141 kmph	(0-40km/h) 2.1 sec	7hrs*	Yes	Yes	Yes	Yes
S1 Pro+ 3rd Gen	1.45 lakhs	Included in the Price	4 kWh	242 km	128 kmph	(0-40km/h) 2.3 sec	4hr 50min*	Yes	Yes	Yes	Yes
S1 Pro 3rd Gen	1.40 lakhs	Included in the Price	4 kWh	242 km	125 kmph	(0-40km/h) 2.7 sec	4hr 50min*	Yes	Yes	Yes	Yes
S1 Pro 3rd Gen	1.25 lakhs	Included in the Price	3 kWh	176 km	117 kmph	(0-40km/h) 2.7 sec	7hr 15min*	Yes	Yes	Yes	Yes
S1X+ 3rd Gen	1.20 lakhs	Included in the Price	4 kWh	242 km	125 kmph	(0-40km/h) 2.7 sec	4hr 50min*	Yes	Yes	Yes	Yes
S1X 3rd Gen	1.15 lakhs	Included in the Price	4 kWh	242 km	123 kmph	(0-40km/h) 3 sec	4hr 50min*	Yes	Yes	Yes	Yes
S1X 3rd Gen	99 thousand	Included in the Price	3 kWh	176 km	115 kmph	(0-40km/h) 3.1 sec	7hr 15min*	Yes	Yes	Yes	Yes
S1X 3rd Gen	78 thousand	Included in the Price	2 kWh	108 km	101 kmph	(0-40km/h) 3.4 sec	4hr 50min*	Yes	Yes	Yes	Yes
Roadster X	1 lakh	Included in the Price	4.5 kWh	252 km	118 kmph	(0-40km/h) 3.1 sec	4.9 hrs*	Yes	Yes	Yes	Yes
Roadster X	93 thousand	Included in the Price	3.5 kWh	196 km	118 kmph	(0-40km/h) 3.1 sec	4.6 hrs*	Yes	Yes	Yes	Yes
Roadster X	80 thousand	Included in the Price	2.5 kWh	140 km	105 kmph	(0-40km/h) 3.4 sec	6.2 hrs*	Yes	Yes	Yes	Yes
Roadster X+	1.90 lakhs	Included in the Price	9.1 kWh	Upto 500km	125 kmph	(0-40km/h) 2.7 sec	8 hrs*	Yes	Yes	Yes	Yes

Roadster X+	1.10 lakhs	Included in the Price	4.5 kWh	252 km	125 kmph	(0-40km/h) 2.7 sec	4.9hrs*	Yes	Yes	Yes	Yes

Source: OEM website, Crisil Intelligence
*Note: Details as of March 2026; *: Charge time for 0-80%, ex-showroom Bengaluru, inclusive of PM E-drive subsidy benefit*

Ather Energy

Ather Energy, founded in 2013 and headquartered in Bengaluru, Karnataka, is one of India's leading electric two-wheeler (e2W) manufacturers, supported by a strong focus on technology innovation and vertically integrated operations.

The company currently operates two manufacturing facilities in Hosur, Tamil Nadu. Looking ahead, Ather is undertaking a significant capacity expansion through its upcoming "Factory 3.0" in Chhatrapati Sambhajinagar, Maharashtra, which is designed for an eventual production capacity of around 1 million units per year. Phase 1 of this facility, with an initial capacity of 500,000 units annually, is expected to be operational by Q3 fiscal 2027, positioning the company for sustained volume growth and improved operating leverage.

On the product front, Ather continues to strengthen its premium positioning through consistent innovation. Ather Energy has brought about several firsts in the e2W industry by introducing features like touchscreen dashboard with navigation, internet connectivity via 3G SIM, aluminum chassis, fast charging and guide-me-home lights. They have also introduced several industry first features such as traction control, fall safe, cloud integration, OTA updates (Over-The-Air), ride statistics on app, through their software package, AtherStack. Ather was also the first OEM to introduce an electric scooter with a high speed of 80 kmph, first OEM to establish its own fast charging network (Ather Grid) and also the first OEM to develop a smart helmet (Halo).

In 2024 Ather Energy launched a new range of 'Rizta' scooters targeting the family convenience segment. It features a large seat, WhatsApp notifications on the vehicle dashboard, voice commands through Alexa Skills and upto 56L of storage space. It has also introduced traction control which is a segment first feature in the e2W market.

In January 2025, it launched the updated Ather 450X, featuring advanced functionalities such as multi-mode traction control and enhanced connectivity. During fiscal 2026, the company further expanded its portfolio with higher-range variants across the Rizta and 450 series, while also introducing a Battery-as-a-Service (BaaS) model for select offerings.

Ather has established itself as a technology leader in the Indian EV ecosystem, underpinned by its proprietary AtherStack platform, which has enabled the introduction of several industry-first features. The company was also an early mover in building supporting infrastructure, including the Ather Grid fast-charging network and the Halo smart helmet ecosystem. In fiscal 2026, the launch of AtherStack 7 further enhanced its product proposition, introducing differentiated features such as Infinite Cruise, vernacular dashboards, and pothole detection, thereby reinforcing its focus on rider experience and software-led differentiation.

Despite not receiving PLI support, the company has remained at the forefront of technological innovation within the industry. It has continued to drive strong sales momentum while steadily expanding its footprint in the Indian electric two-wheeler (e2W) market, emerging as the third-largest contributor to the segment in fiscal 2026.

Operationally, Ather demonstrated robust growth during fiscal 2026, with domestic sales rising to approximately 2.5 lakh units from around 1.4 lakh units in fiscal 2025, reflecting a strong year-on-year growth of ~78%. This performance was primarily driven by the rapid expansion of its physical sales and service network. The company nearly doubled its

Experience Centre presence to 700 locations (from 375 as of March 2025) and operated a total of 548 service centres, significantly strengthening its customer reach and after-sales support infrastructure.

In parallel, Ather continues to strengthen its charging ecosystem as a key competitive moat. In 2023, the company also entered into a collaboration agreement with Hero MotoCorp Limited to enable interoperability across charging networks.

Ather has widest charging network with customers having access to 6,000+ charging points as of March 2026, comprising of Ather Grid, Neighborhood chargers and other OEM chargers on the Light Electric Combined Charging System (LECCS) standard. Notably, EVs compatible with the LECCS standard can seamlessly access Ather Grid fast-charging stations.

Product Portfolio (fiscal 2026)

Model	Effective Ex-Showroom Price (in Rs)	Software Pack Price	Battery capacity (in kWh)	Range (ARAI Certified)	Maximum Speed	Acceleration	Charging Time (0-80%)	Fast Charging (Yes/No)	OTA updates	Tele-matics	Software Enabled Safety features
RiztaS	1.15lakhs	Rs 13,999	2.7/2.9 kWh	123 km	80 kmph	(0-40km/h) 4.7 sec	6hr 30min	Yes	Yes	Yes	Yes
RiztaS	1.38 lakhs	Rs 15,000	3.7 kWh	159km	80 kmph	(0-40km/h) 4.7 sec	4hr 30min	Yes	Yes	Yes	Yes
RiztaZ	1.32 lakhs	Rs 21,000	2.7/2.9 kWh	123km	80 kmph	(0-40km/h) 4.7 sec	6hr 30min	Yes	Yes	Yes	Yes
RiztaZ	1.52 lakhs	Rs 22,000	3.7 kWh	159km	80 kmph	(0-40km/h) 4.7 sec	4hr 30min	Yes	Yes	Yes	Yes
450S	1.31 lakhs	Rs 14,000	2.9 kWh	122km	90 kmph	(0-40km/h) 3.9 sec	5hr 30min	Yes	Yes	Yes	Yes
450S	1.46 lakhs	Rs 15,000	3.7 kWh	161km	90 kmph	(0-40km/h) 3.9 sec	4hr 30min	Yes	Yes	Yes	Yes
450 Apex	1.90 lakhs	Included	3.7 kWh	157km	100kmph	(0-40km/h) 2.9 sec	4hr 30min	Yes	Yes	Yes	Yes
450X	1.48 lakhs	Rs 21,000	2.9 kWh	126km	90 kmph	(0-40km/h) 3.3 sec	3 hr	Yes	Yes	Yes	Yes
450X	1.58 lakhs	Rs 22,000	3.7 kWh	161km	90 kmph	(0-40km/h) 3.3 sec	4hr 30min	Yes	Yes	Yes	Yes

Source: OEM website, Crisil Intelligence
Note: Details as of March 2026; ex-showroom Bengaluru, inclusive of PM E-drive subsidy benefit.

TVS Motor Company Limited

TVS Motor Company entered the electric mobility segment with the launch of the TVS iQube in 2020 and subsequently institutionalized its EV strategy through the incorporation of TVS Electric Mobility Limited (TVSEM), a wholly owned subsidiary, in December 2021. The company benefits from a diversified and globally integrated manufacturing footprint, comprising four facilities—three in India (Hosur, Mysore, and Nalagarh) and one in Indonesia (Karawang).

TVS has steadily expanded its electric two-wheeler portfolio across price segments and use cases. Following the introduction of its premium offering, the TVS X, in 2023, the company broadened its addressable market with the launch of higher-spec variants such as the TVS iQube ST (5.1 kWh battery) and a more affordable 2.2 kWh iQube variant in 2024. In fiscal 2026, TVS further strengthened its urban mobility proposition with the introduction of the TVS Orbiter, an electric scooter tailored for city commuting. This calibrated product strategy reflects a balanced focus on premiumization as well as mass-market penetration.

TVS Motor's extensive distribution network remains a key competitive advantage. As of fiscal 2025, the company operated over 8,000 dealers across more than 3,800 cities in India and 4,000 cities globally. Within the EV segment, the iQube-specific dealership network expanded to 1,074 outlets as of fiscal 2025, complemented by a growing public charging infrastructure of approximately 5,000 charging points. This expanding ecosystem enhances customer accessibility and supports broader EV adoption.

Strategically, TVS has pursued global partnerships and acquisitions to strengthen its technology and brand portfolio. The company has invested in the Swiss E-Mobility Group (SEMG), which includes premium brands such as Norton Motorcycles and EGO Movement. In addition, through its Singapore subsidiary, TVS Motor (Singapore) Pte Limited, it acquired ION Mobility and Killwatt GmbH in 2024, underscoring its intent to build capabilities in advanced EV technologies and expand its international footprint.

Operationally, TVS Motor delivered solid growth in its domestic EV business during fiscal 2026, with electric two-wheeler sales increasing to approximately 3.6 lakh units from 2.5 lakh units in fiscal 2025, representing a year-on-year growth of approximately 42%. This performance highlights sustained demand momentum, supported by portfolio expansion, distribution scale, and ongoing investments in ecosystem development.

Product Portfolio (fiscal 2026)

Model	Effective Ex-Showroom Price (in Rs)	Software Pack Price	Battery capacity (in kWh)	Range (ARAI Certified)	Maximum Speed	Acceleration	Charging Time (0-80%)	Fast Charging (Yes/No)	OTA updates	Tele-matics	Software Enabled Safety features
iQube	1.03 lakhs	NA	2.2 kWh	94km	75 kmph	(0-40km/h) 4.2 sec	2hrs 45min	No	Yes	Yes	Yes
iQube	1.11 lakhs	NA	3.1 kWh	123km	82 kmph	(0-40km/h) 4.2 sec	4hr 03min	No	Yes	Yes	Yes
iQube	1.24 lakhs	NA	3.5 kWh	145km	82 kmph	(0-40km/h) 4.2 sec	4hrs 40min	No	Yes	Yes	Yes
iQube S	1.30 lakhs	NA	3.5 kWh	145km	78 kmph	(0-40km/h) 4.2 sec	3 hrs	No	Yes	Yes	Yes
iQube ST	1.45 lakhs	NA	3.5 kWh	145km	78 kmph	(0-40km/h) 4.2 sec	3 hrs	No	Yes	Yes	Yes
iQube ST	1.62 lakhs	Included	5.3 kWh	212km	82 kmph	(0-40km/h) 4.5 sec	6 hrs 50 min	Yes	Yes	Yes	Yes

TVS X	2.66 lakhs	NA	4.4 kWh	159km	110 kmph	(0-40km/h) 2.5 sec	3hrs 30 min	Yes	Yes	Yes	Yes
TVS Orbiter	1.00 lakhs	NA	3.1 kWh	158km	68 kmph	(0-40km/h) 6.8 sec	4hr 10min	No	Yes	Yes	Yes

Source: OEM website, Crisil Intelligence;
Note: Details as of March 2026, ex-showroom Bengaluru, inclusive of PM E-drive subsidy benefit

Hero MotoCorp Limited

Hero MotoCorp, India's largest two-wheeler manufacturer, entered the electric mobility segment in fiscal 2023 under the VIDA brand, marking a strategic diversification into clean mobility. The company's dedicated EV manufacturing facility is located in Tirupathi, Andhra Pradesh, providing the foundation for scaling its electric two-wheeler operations.

The company has collaborated with Zero Motorcycles, a global leader in electric motorcycles and powertrain technologies, to co-develop a dedicated electric motorcycle platform. Additionally, the company has partnered with Ather Energy to enable an interoperable fast-charging network, enhancing customer convenience and supporting broader ecosystem development.

In fiscal 2026, Hero MotoCorp expanded its EV portfolio with the launch of the VIDA VX2 EVOOTER. The company also unveiled its VIDA Novus portfolio and showcased multiple electric motorcycle concepts at EICMA (Esposizione Internazionale Ciclo Motociclo e Accessori) 2025, highlighting its intent to compete across both scooter and motorcycle EV segments. The Vida Dirt.E K3 off road electric vehicle for young riders was also unveiled. A key differentiator of the VIDA platform is its removable battery architecture, which enhances flexibility and ease of use. This was further complemented in fiscal 2026 by the introduction of a Battery-as-a-Service (BaaS) model, aimed at reducing upfront costs and improving adoption.

Operationally, Hero MotoCorp delivered strong growth in its EV business during fiscal 2026, with domestic VIDA sales reaching ~1.5 lakh units, compared to ~51 thousand units in fiscal 2025, representing a robust year-on-year growth of approximately 194%. This performance reflects increasing customer acceptance and a strengthening product-market fit.

Product Portfolio (fiscal 2026)

Model	Effective Ex-Showroom Price (in Rs)	Software Pack Price	Battery capacity (in kWh)	Range (ARAI Certified)	Maximum Speed	Acceleration	Charging Time (0-80%)	Fast Charging (Yes/ No)	OTA updates	Tele-matics	Software Enabled Safety features
VX2 Plus	1.11 lakhs	NA	3.4 kWh	142km	80 kmph	(0-40kmph) 3.1s	4hrs 13min	Yes	Yes	Yes	Yes
VX2 Go	1.02 lakhs	NA	3.4kWh	142km	70 kmph	(0-40kmph) 4.2s	4hrs 13min	Yes	Yes	Yes	Yes
VX2 Go	85 thousand	NA	2.2kWh	92km	70 kmph	(0-40kmph) 4.2s	2hrs 41min	Yes	Yes	Yes	Yes

Vida V2 Plus	1.21 lakhs	NA	3.44kWh	143km	85kmph	(0-40kmph) 3.4s	5hrs 15 mins	Yes	Yes	Yes	Yes
Vida V2 Pro	1.40 lakhs	NA	3.94kWh	165km	90kmph	(0-40kmh) 2.9s	5hrs 55 mins	Yes	Yes	Yes	Yes

Source: OEM website, Crisil Intelligence
Note: Details as of March 2026; ex-showroom Bengaluru, inclusive of PM E-drive subsidy benefit, state subsidy

Player-wise financial comparison (Fiscal 2026)

Particulars	Ather Energy	Ola Electric Mobility	TVS Motor	Chetak Technologies	Hero MotoCorp
e2W Sales Volume (FY26)	251,711	168,614	358,200	299,389	149,341
e2W Market share (FY26)	17.15%	11.49%	24.40%	20.39%	10.17%
Operating revenue (Rs Crores)	3,671.76	2,253.00	56,069.52	NA	47,411.24
Operating margin (%)	(11.38%)	(59.72%)	12.57%	NA	15.50%
PAT margin (%)	(13.53%)	(74.51%)	5.68%	NA	11.92%
Return on Capital Employed (%)	(13.44%)	(24.03%)	16.21%	NA	33.26%
Return on Net worth (%)	(20.10%)	(54.70%)	29.74%	NA	26.48%
Debt Equity Ratio	0.26	0.82	3.06	NA	0.04
Current Ratio	2.42	1.14	0.98	NA	1.91

Player-wise financial comparison (Fiscal 2025)

Particulars	Ather Energy	Ola Electric Mobility	TVS Motor	Chetak Technologies	Hero MotoCorp
e2W Sales Volume (FY25)	141,701	360,196	253,052	239,229	50,800
e2W Market share (FY25)	11.70%	29.75%	20.90%	19,76%	4.20%
Operating revenue (Rs Crores)	2,255.01	4,514.00	44,089.01	87.32	40,923.42
Operating margin (%)	(30.44)%	(38.73%)	12.68%	(16.20%)	14.31%
PAT margin (%)	(35.24%)	(46.15%)	5.39%	(14.95%)	10.43%
Return on Capital Employed (%)	(63.09%)	(21.96%)	16.99%	(4.73%)	29.87%
Return on Net worth (%)	(164.77%)	(44.25%)	25.20%	(4.36%)	22.55%
Debt Equity Ratio	1.26	0.69	2.49	0.00	0.04
Current Ratio	0.99	1.87	1.12	6.28	1.80

Note: For all the players consolidated financials are used
Sales Volume is taken as per VAHAN electric 2W for FY25 & FY26
Operating margin is calculated as EBIT by Total income
PAT Margin is calculated as Profit after tax by Total income
Return on capital employed is calculated as EBIT by Total Debt plus Net worth
Return on Net Worth (%) is calculated as profit/loss for the year divided by the Net Worth at the end of the respective year.
Debt to Equity ratio is calculated as Total Debt by Total Equity
Current ratio is calculated as current asset by the current liabilities
Key Players constitute 80% Market share
Source: Company Financial Reports, Crisil Intelligence

Key Financial KPIs for last three fiscals (fiscal 2024 to fiscal 2026) for Listed Players

Key Performance Indicators		Ola Electric Mobility			Bajaj Auto			Hero MotoCorp		
	Units	March 31, 2026	March 31, 2025	March 31, 2024	March 31, 2026	March 31, 2025	March 31, 2024	March 31, 2026	March 31, 2025	March 31, 2024
Pure EV Player	(Yes/No)	Yes			No			No		
Vehicles sold	Numbers in thousands	165	354	330	5,118	4,651	4,351	6,469	5,900	5,621
o/w2W	Numbers in thousands	165	354	330	NA	3,982	3,728	6,469	5,900	5,621
Year-on-year growth of Vehicles Sold [2]	(%)	(53.30%)	7.25%	111.54%	10.03%	6.90%	10.91%	9.66%	4.95%	5.48%
o/w 2W [2]	(%)	(53.30%)	7.25%	111.54%	NA	6.82%	8.43%	9.66%	4.95%	5.48%
Revenue from Operations	Rs in Crore	2,253.00	4,514.00	5,009.83	62,905.00	50,994.55	44,870.43	47,411.24	40,923.42	37,788.62
Year-on-year growth in Revenue from Operations [3]	(%)	(50.09%)	(9.90%)	90.42%	23.36%	13.65%	23.08%	15.85%	8.30%	10.63%
Adjusted Gross Margin [4]	(%)	36.46%	24.82%	16.47%	34.84%	32.80%	31.13%	34.64%	35.88%	33.99%
EBITDA [5]	Rs in Crore	(785.00)	(1,321.00)	(1,034.14)	15,804.03	11,026.66	10,465.17	8,487.84	6,828.80	6,083.92
EBITDA Margin [6]	(%)	(31.91%)	(26.78%)	(19.72%)	24.28%	21.02%	22.60%	17.51%	16.27%	15.74%
Revenue Mix:										
Sale of Vehicles [7]	(%)	NA	86%	92%	NA	NA	NA	NA	83%	83%
Sale of Non-Vehicles [8]	(%)	NA	14%	8%	NA	NA	NA	NA	17%	17%
Revenue per unit from Two wheeler Vehicle Sold [9]	In Rs	NA	109,998.16	139,503.42	NA	NA	NA	NA	57,478.20	55,730.90
Profit/ (loss) after tax	Rs in Crore	(1,833.00)	(2,276.00)	(1,584.40)	10,744.21	7,324.73	7,708.24	5,775.70	4,375.81	3,742.16

Profit/ (loss) after tax Margin [10]	(%)	(74.51%)	(46.15%)	(30.22%)	16.51%	13.96%	16.65%	11.92%	10.43%	9.68%
Working Capital days [11]	Days	(64.13)	(33.66)	(22.99)	(13.04)	(27.43)	(21.43)	(28.17)	(24.42)	(23.32)
e2W Market Share [12]	(%)	11.5%	29.7%	34.4%	20.4%	19.8%	11.2%	10.2%	4.2%	1.9%
P/E Ratio[13]	Times	NA	(10.27)	0.00	NA	30.02	33.13	NA	17.00	25.20
P/B Ratio[14]	Times	NA	NA	0.00	NA	6.26	8.82	NA	4.17	5.57

Key Performance Indicators	Units	TVS Motor			Ather Energy		
		March 31, 2026	March 31, 2025	March 31, 2024	March 31, 2026	March 31, 2025	March 31, 2024
Pure EV Player	(Yes/No)	No			Yes		
Vehicles sold	Numbers in thousands	5,889	4,744	4,191	263	155	110
o/w 2W	Numbers in thousands	5,670	4,609	4,045	263	155	110
Year-on-year growth of Vehicles Sold [2]	(%)	24.14%	13.19%	13.82%	69.21%	41.81%	18.99%
o/w 2W [2]	(%)	23.02%	13.94%	15.14%	69.21%	41.81%	18.99%
Revenue from Operations	Rs in Crore	56,069.52	44,089.01	38,778.82	3,671.76	2,255.01	1,753.78
Year-on-year growth in Revenue from Operations [3]	(%)	27.17%	13.69%	21.28%	62.83%	28.58%	(1.52%)
Adjusted Gross Margin [4]	(%)	37.82%	39.48%	37.58%	24.21%	18.59%	8.79%
EBITDA [5]	Rs in Crore	7,894.07	6,644.16	5,540.37	(257.04)	(530.64)	(649.41)
EBITDA Margin [6]	(%)	14.07	15.05%	14.25%	(6.72%)	(23.02%)	(36.30%)
Revenue Mix:							
Sale of Vehicles [7]	(%)	NA	NA	NA	87%	88%	90%

Sale of Non-Vehicles [8]	(%)	NA	NA	NA	13%	12%	10%
Revenue per unit from Two wheeler Vehicle Sold [9]	In Rs	NA	NA	NA	121,386	128,295	143,333
Profit/ (loss) after tax	Rs in Crore	3,186.43	2,379.81	1,778.54	(517.17)	(812.28)	(1,059.74)
Profit/ (loss) after tax Margin [10]	(%)	5.68%	5.39%	4.57%	(13.53%)	(35.24%)	(59.23%)
Working Capital days [11]	Days	(51.28)	(50.39)	(42.43)	(53.46)	(57.48)	(45.81)
e2W Market Share [12]	(%)	24.4%	20.9%	19.7%	17.1%	11.7%	11.7%
P/E Ratio[13]	Times	NA	48.32	58.24	(53.82)	NA	NA
P/B Ratio[14]	Times	NA	17.35	19.08	NA	NA	NA

Note: All the financial information for the competitor entities mentioned above is on a consolidated basis and is sourced from the annual reports/quarterly
NA stands for Not available as the data is not reported in the Annual report / Quarterly financials / Investor presentations as available"

(1) Eicher vehicles sold excludes commercial vehicles sold via VE Commercial Vehicles (VECV) JV, which is not consolidated.

*(2) Year-on-year growth of Vehicles Sold (%) is calculated as ((Number of vehicles sold during the relevant fiscal year – Number of vehicles sold during the relevant previous fiscal year)/ Number of vehicles sold during the relevant previous fiscal year) *100*

*(3) Year-on-year growth in Revenue from Operations (%) is calculated as ((Revenue from operations during the relevant fiscal year– revenue from operations during the relevant previous fiscal year)/ revenue from operations during the relevant previous fiscal year) *100*

*(4) Adjusted Gross Margin (%) is calculated as adjusted gross profit divided by total income in the relevant fiscal year *100. Where in Adjusted Gross Profit is calculated as total income reduced by Cost of materials consumed, Purchase of stock-in-trade and change in inventories of finished goods, stock-in-trade and work-in-progress.*

(5) EBITDA is calculated as Profit/(Loss) before exceptional items and tax reduced by finance costs and depreciation and amortisation expenses.

*(6) EBITDA Margin (%) is calculated as EBITDA divided by total income in the relevant fiscal year *100.*

*(7) Revenue Mix – Sale of Vehicles (%) is calculated as revenue from sale of Vehicles divided by revenue from operations *100.*

*(8) Revenue Mix – Sale of Non-vehicles (%) is calculated as revenues from operations reduced by revenue from sale of vehicle divided by revenue from operations *100.*

(9) Revenue per unit of two-wheeler vehicle sold is calculated as revenue from sale of two-wheeler vehicles during the fiscal year divided by the number of two wheeler vehicles sold during the relevant fiscal year.

*(10) Profit/(Loss) for the year margin (%) is calculated as Profit/(Loss) for the relevant year divided by Total income in the relevant year*100.*

(11) Working Capital Days is computed as Trade Receivables days plus inventory days minus trade payable days; Wherein, Trade Receivable Days is calculated as average trade receivables divided by revenue from operations multiplied by 365 for Financial, Inventory Days is calculated as average inventory divided by cost of goods sold multiplied by 365 for Financial Years and Trade Payable Days is calculated as average trade payables divided by cost of goods sold multiplied by 365 for Financial Years. Further Cost of Goods Sold is the sum of Cost of materials consumed, Purchase of stock-in-trade and Change in inventories of finished goods, stock-in-trade and work-in-progress.

(12) e2W market share is based on VAHAN Retail volume for electric 2W during that fiscal year

(13) P/E Ratio is calculated as Market price per share is divided by Reported Post Tax Earnings Per Share
(14) P/B ratio is calculated as Market price per share is divided by Reported Book Value Rs Per share

Sources: Company financial reports, VAHAN

E. Review and Outlook of 2W Exports from India

Exports typically account for 15-20% of the overall two- wheeler sales in India. Two-wheelers are primarily exported to developing countries across the globe. Africa, Asia and Latin America form a sizeable part of exports from India.

Between fiscals 2021 and 2026, two-wheeler exports logged 9.5% CAGR reaching 5.2 million in volume in fiscal 2026 from 3.3 million in fiscal 2021.

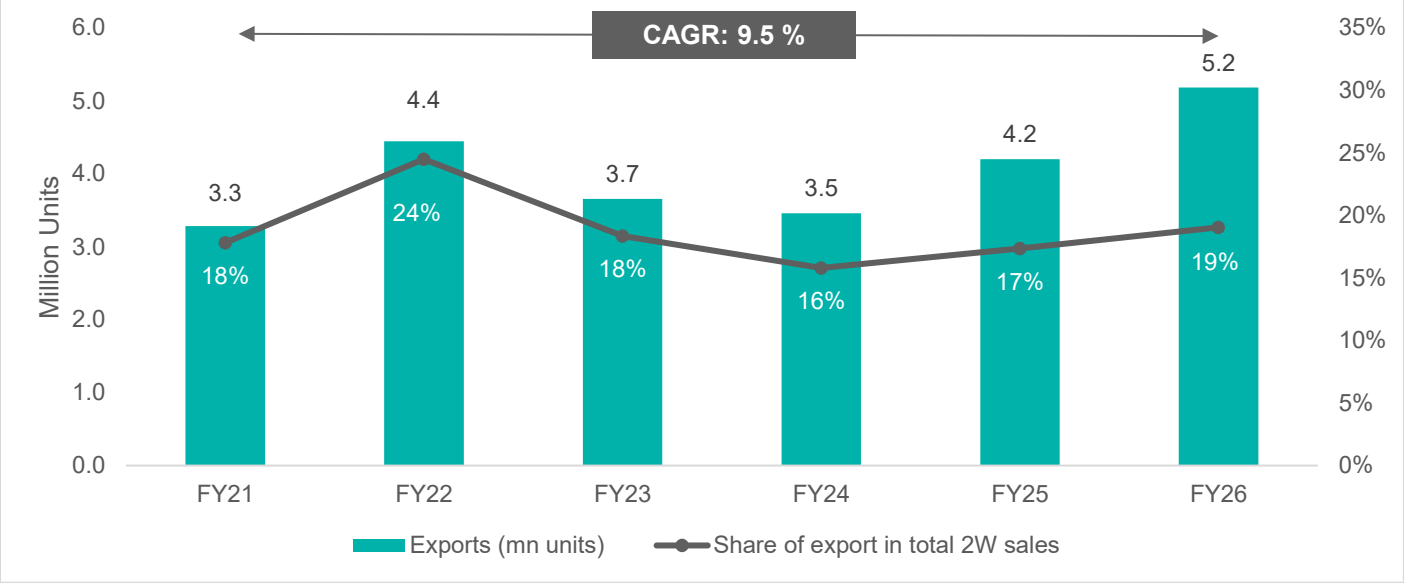
The growth was led by an increase in global demand, expansion of export portfolio and entry into newer markets such as the US, Europe and Middle East by the industry players. Also, joint ventures with global brands — such as KTM, Husqvarna and BMW — and catering to the global demand of these brands from India has given an additional thrust to two-wheeler exports.

However, the tightening global monetary condition after the inflation spiral and forex unavailability limited the exports. Geopolitical conflicts have also been impacting overseas demand.

During the five-year period fiscal 2021 to fiscal 2026, share of exports within the total sales remained range bound between 16-19% with fiscal 2022 being an exception, when the shipments rose to a healthy 24% as OEMs focused on exports amid a slowdown in the domestic market.

Fiscal 2026 saw exports touch their highest level in the period at 5.2 million units, with export share at 19% of total sales, reflecting a ~23% y-o-y growth.

Two-wheeler exports trend



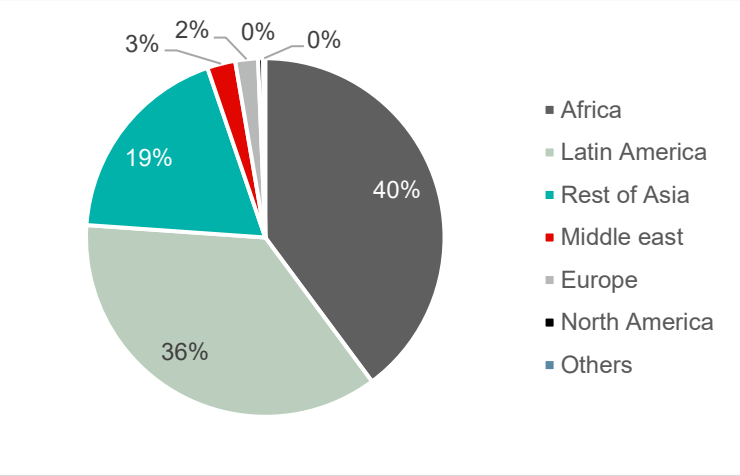
Source: SIAM, Crisil Intelligence

Two wheelers are primarily exported to developing countries from India with Latin America and Africa contributing the major share. In fiscal 2026 Latin America emerged as the second largest destination, accounting for 36% of total two-wheeler exports in fiscal 2026. Colombia was the largest country destination with a 13.1% share, followed by Nigeria at 7.7% and Mexico at 6.3%.

Contribution of Africa has remained at 40%. However, exports to Africa have been under pressure amidst the slowdown in their economy, sharp rise in inflation levels and unavailability of forex in Nigeria, the leading two-wheeler importer from India.

India also exports a sizeable portion to Southeast Asian countries like Philippines, Sri Lanka and Nepal, with Rest of Asia accounting for approximately 19% of exports in fiscal 2026. Philippines accounted for 4.8% of total exports while Nepal accounted for 5.2%. Middle East, Europe and North America together accounted for approximately ~5% of two-wheeler exports in fiscal 2026.

Geographical split for Indian two-wheeler exports volumes (Fiscal 2026)

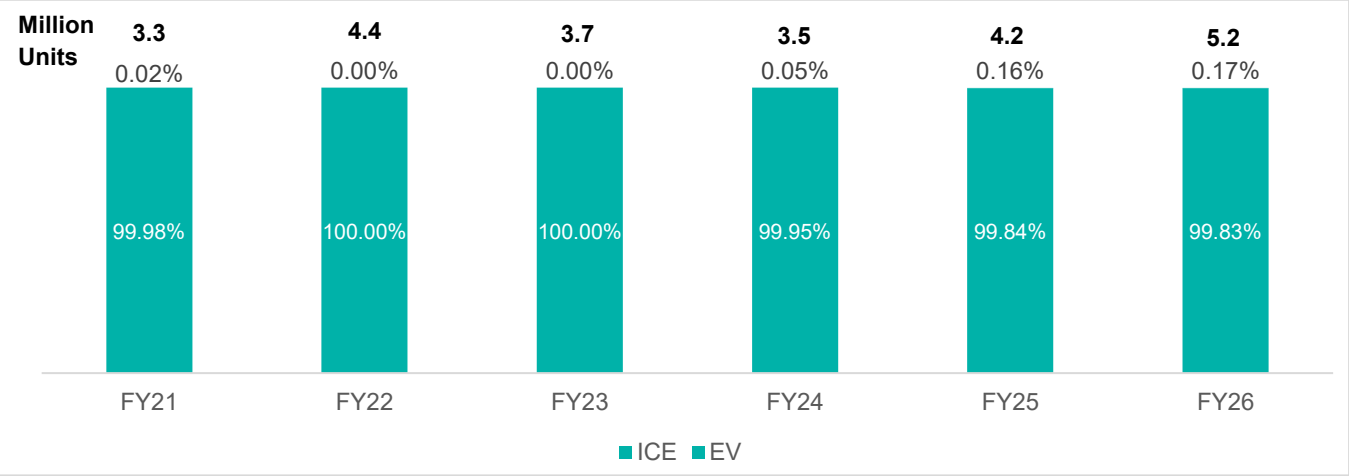


Country	Share in fiscal 2026
COLOMBIA	13.10%
NIGERIA	7.70%
MEXICO	6.30%
GUINEA	6.10%
SRI LANKA DSR	5.50%
NEPAL	5.20%
PHILIPPINES	4.80%
CONGO D. REP.	4.40%
BRAZIL	4.20%
KENYA	3.70%

Note: Rest of Asia: Entire Asia except Middle East
Source: Ministry of Commerce and Industry, Crisil Intelligence

ICE two-wheelers completely dominate the exports, accounting for 99.83% of total two-wheeler exports in fiscal 2026. However, EV exports have seen a gradual rise in share, increasing from 0.02% in fiscal 2021 to 0.17% in fiscal 2026.

Powertrain Split within two-wheeler exports



Note: EV exports data does not include Ola exports as SIAM does not report Ola numbers.
Source: SIAM, Crisil Intelligence

Segment-wise Exports Trend

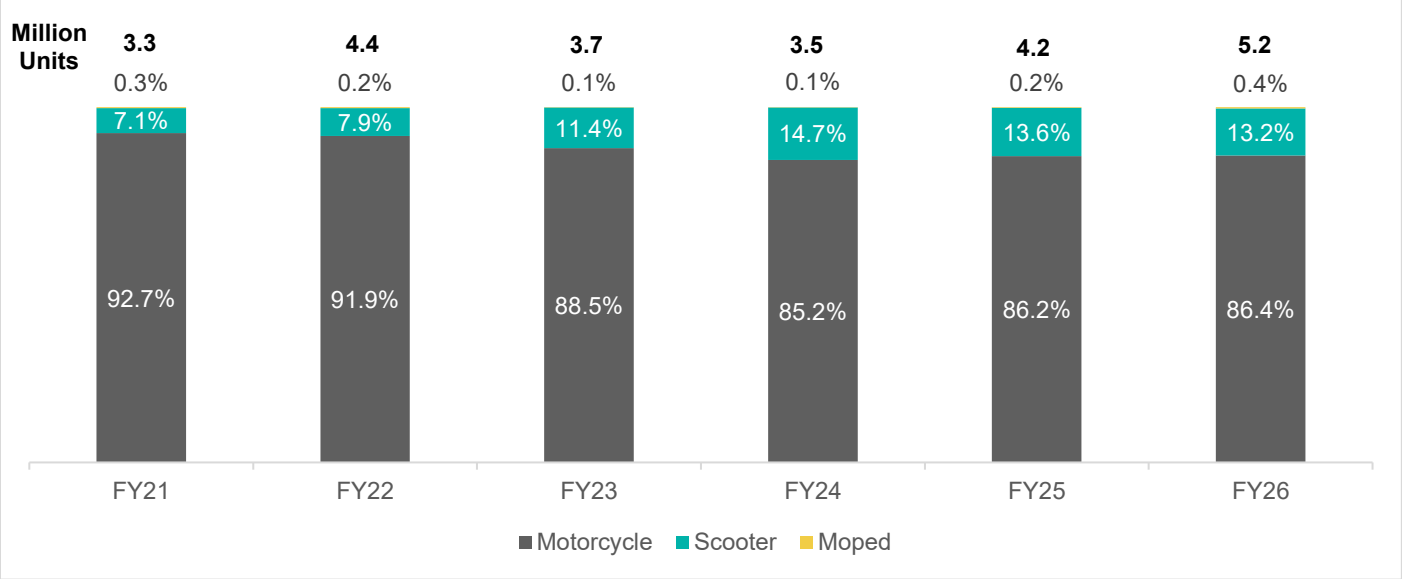
Motorcycles dominate the exports segment with approximately 86% share in overall exports in fiscal 2026. However, motorcycle share has moderated from an elevated base of 92.7% in fiscal 2021 to 86.4% in fiscal 2026. Motorcycle exports grew at a CAGR of approximately 8% during fiscal 2021-2026.

Scooters have gradually gained ground within the export mix over the last six years growing from 7.1% in fiscal 2021 to 13.2% in fiscal 2026, clocking a CAGR of 24% during the same period. Share peaked at 14.7% in fiscal 2024 before moderating slightly to 13.2% in fiscal 2026. Increased push from HMSI as well as TVS with further geographical expansion aided the faster growth of scooter exports.

Mopeds form an insignificant part of two-wheeler exports, with their share remaining largely negligible at 0.1%-0.4% across fiscal 2021-2026.

In fiscal 2026, the share of motorcycles and scooters in total two-wheeler exports stood at 86.4% and 13.2% respectively, with moped accounting for 0.4%.

Segmental split within exports



Source: SIAM, Crisil Intelligence

Exports Competitive Landscape

Bajaj is the leading contributor in two-wheeler exports, with a dominant share in motorcycle exports. However, Bajaj's overall share in exports has declined steadily from 54.7% in fiscal 2021 to 38.0% in fiscal 2026. This moderation in share can be attributed to the growing presence of other original equipment manufacturers (OEMs) in the global market.

TVS Motor Company has made significant progress in strengthening its global footprint over the fiscal 2021–2026 period. The company expanded its share in overall two-wheeler exports from 23.3% in fiscal 2021 to 27.5% in fiscal 2026. Within the motorcycle segment, its export share rose from 23.5% to 28.9% during the same timeframe, reflecting strong traction in this category.

This growth has been driven by robust demand across key international markets, particularly in Africa and Latin America. In fiscal 2026, the company recorded a healthy year-on-year export growth of approximately 30%, supported by higher shipments of its core motorcycle models, including Sport, Star City 125, Radeon, and Apache.

Beyond motorcycles, export volumes were further bolstered by the strong performance of its premium scooter, Ntorq. Additionally, increased international traction for its electric vehicle offering, the iQube, also contributed positively to the overall export momentum.

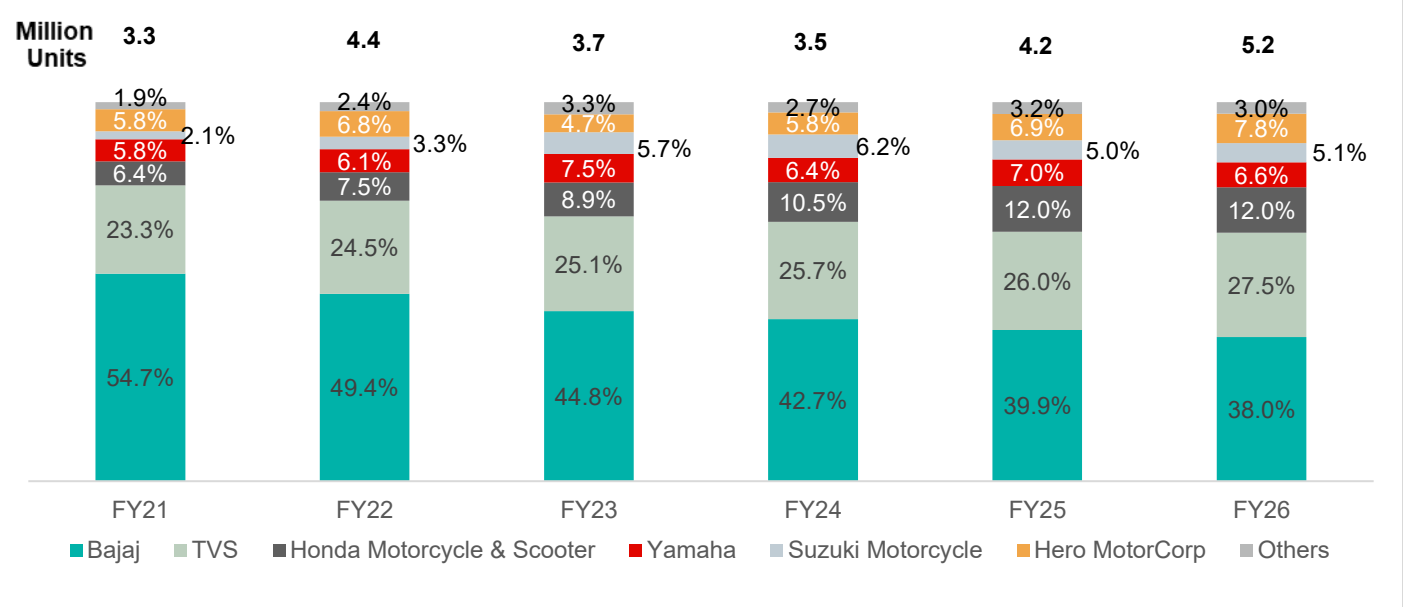
Other OEMs, including Honda, have also increased their export contributions, leveraging product localization and strategic market entries to tap into new geographies. HMSI faced intense competition within the scooters segment, however continued to lead scooter exports with a 51.7% share in fiscal 2026. HMSI's share in scooter exports has risen from 43.6% in fiscal 2021, consolidating its dominance in the segment.

Yamaha has successfully maintained its 5-8% share in overall two-wheeler exports over the last six years, standing at 6.6% in fiscal 2026.

Hero MotoCorp, traditionally focused on the domestic market has maintained modest presence in the exports market and has remained in the 6-7% range in overall two-wheeler exports across fiscal 2021-2026.

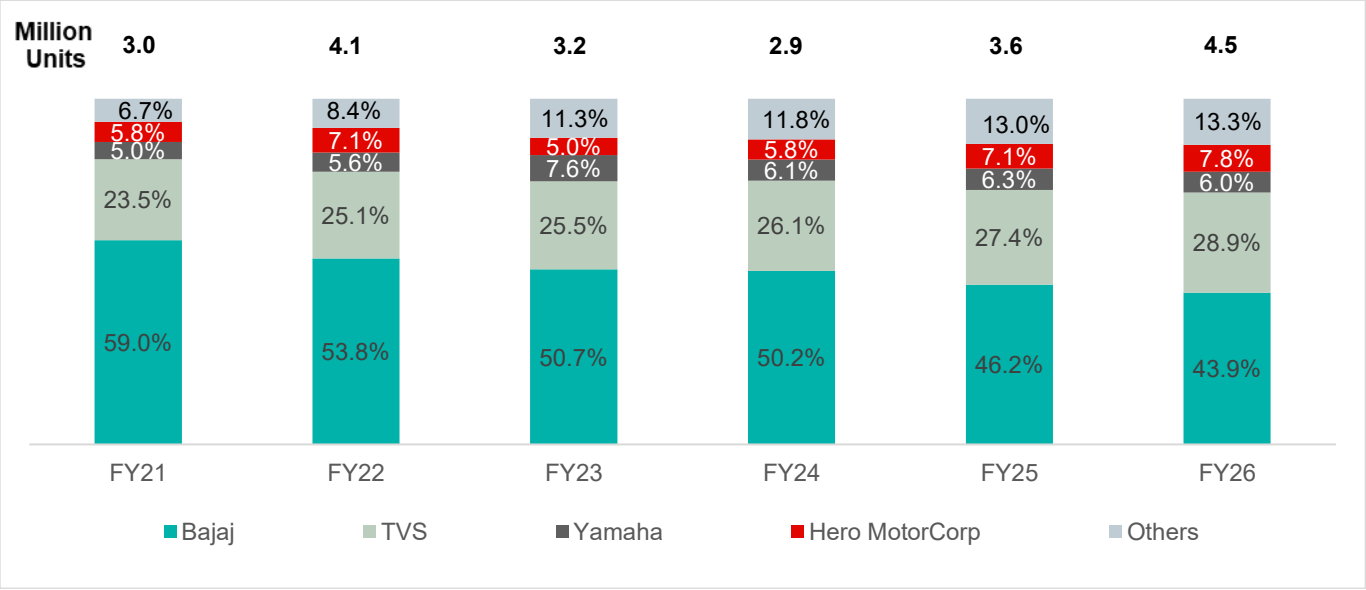
Overall, in fiscal 2026, Bajaj maintained its lead as the largest exporter, with TVS and HMSI as the second and third largest contributors respectively.

OEM wise share in two-wheeler exports



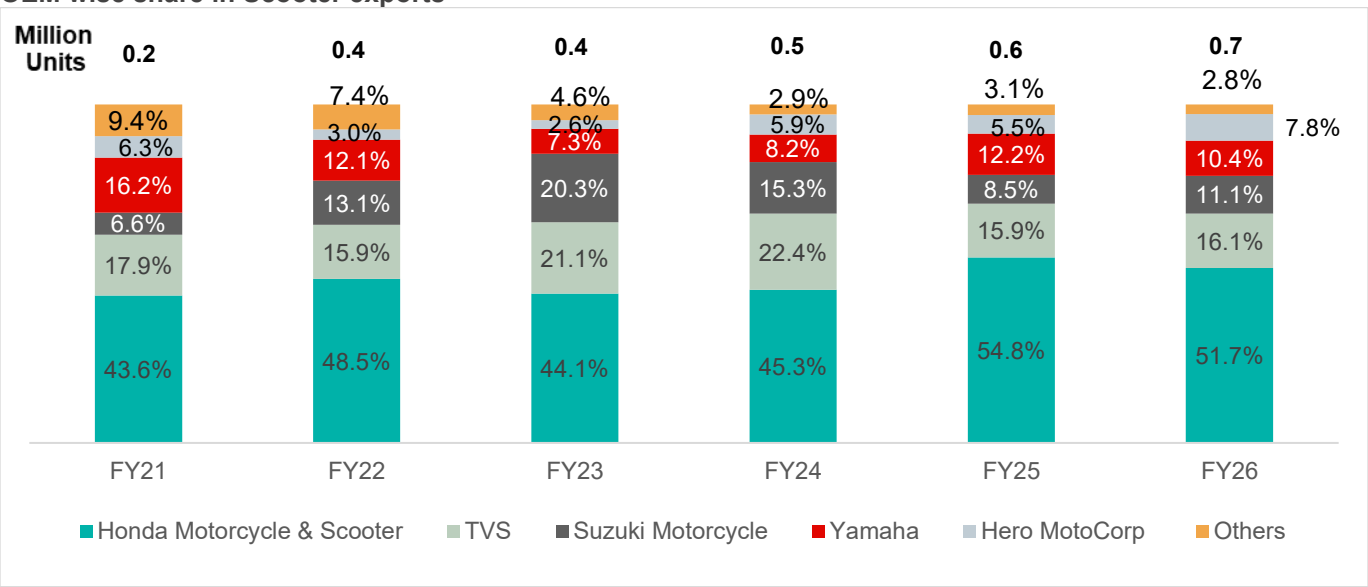
Note: Share of Ather Energy's exports in total two-wheeler exports was 0.1% in fiscal 2026.
Source: SIAM, Crisil Intelligence

OEM wise share in Motorcycle exports



Source: SIAM, Crisil Intelligence

OEM wise share in Scooter exports



Source: SIAM, Crisil Intelligence

Exports Outlook

The two-wheeler export market has demonstrated a steady growth rate of 9.5% CAGR between fiscal 2021 and fiscal 2026. We anticipate this trend to continue, with exports projected to reach 8.5-9.5 million units by fiscal 2033, representing an 8-10% CAGR between fiscals 2026-2033.

This growth is expected to be driven by macroeconomic improvements in export markets, expansion of geographical coverage by original equipment manufacturers (OEMs), and an increase in the number of vehicle models being shipped. Furthermore, the rapidly growing electric vehicle (EV) segment is anticipated to make a notable contribution to exports,

driven by capacity expansion by players, a sharpening focus on exports, and a surge in the number of EV models. Additionally, recent FTAs signed will India are also expected to provide an added fillip to industry exports.

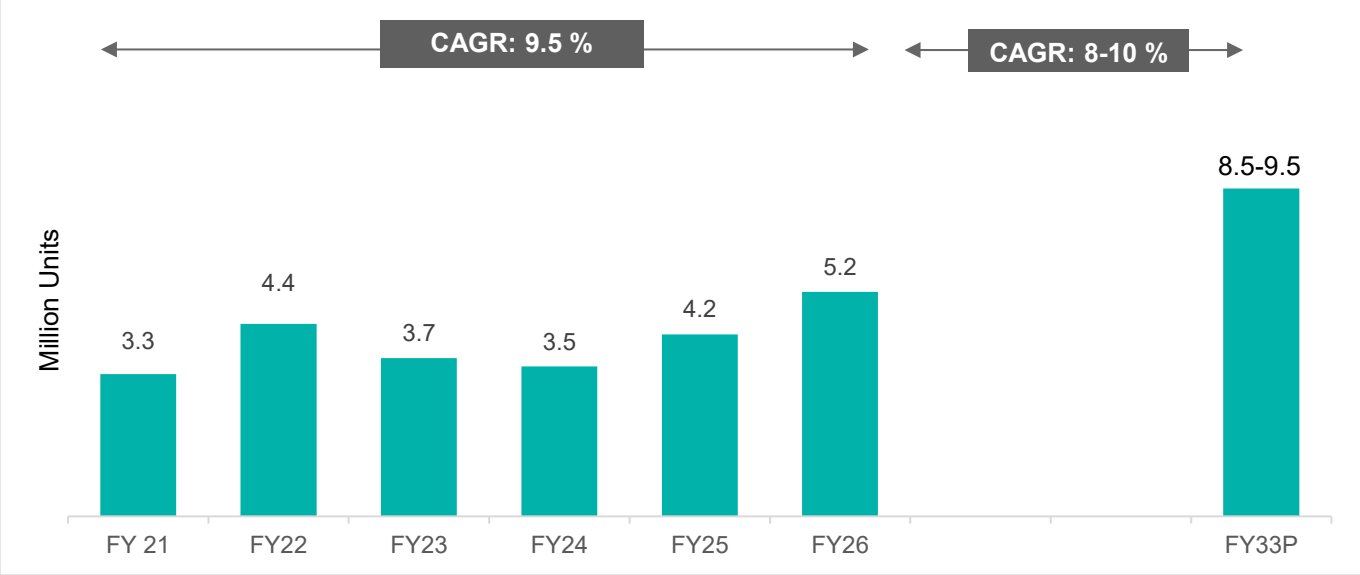
India, as one of the largest two-wheeler markets globally, is well-positioned to capitalize on its scale, cost efficiencies, and manufacturing capabilities to emerge as a key production hub for electric two-wheelers, catering to both domestic demand and export markets. Furthermore, the availability of a diverse portfolio of feature-rich electric vehicles—offering advanced connectivity, enhanced performance, and competitive pricing—creates a strong opportunity for Indian manufacturers to expand their presence across international markets. Moreover, steep electrification targets by countries like Nepal will also support the export demand for e2Ws from those countries.

The government's Production Linked Incentive (PLI) scheme is providing momentum to domestic OEMs to manufacture and export EVs, offering incentives for the entire EV ecosystem, including automobiles, auto components, and advanced chemistry cell (ACC) batteries.

The growing global demand for eco-friendly and sustainable transportation options is expected to provide a significant boost to the demand for electric two-wheelers in the future. Additionally, India's trade agreements with major global economies are expected to facilitate the export of automobiles and related components by domestic OEMs.

However, geopolitical tensions and fluctuations in oil prices can have a negative impact on inflationary pressures in major importing countries, which may, in turn, affect demand for vehicles in the near term. India’s two-wheeler exports have limited exposure to the Middle East, partially cushioning the impact of regional conflicts. Ongoing global conflicts and trade wars also remain key monitorables that could potentially impact the growth trajectory of two-wheeler exports.

Exports Outlook



Source: SIAM, Crisil Intelligence

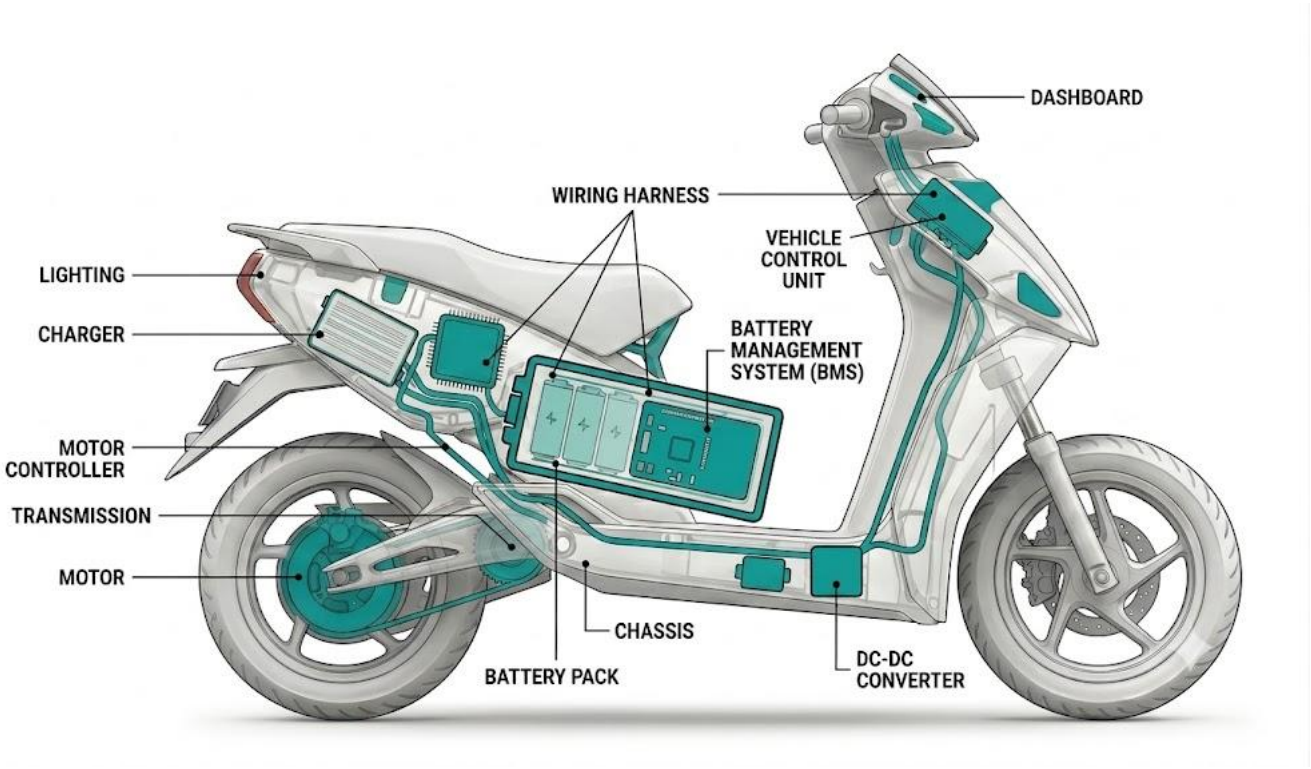
F. Technology overview of e2Ws

Key components of an e2W

India's EV sector is accelerating, with the e2W segment serving as one of the primary growth drivers. e2Ws are emerging as a viable substitute for high-emission internal combustion engine (ICE) two-wheelers, offering superior total cost of ownership (TCO) across their lifecycle. Their ease of operation and environmentally conscious profile have further broadened their appeal. With zero tailpipe emissions, e2Ws hold significant potential to improve air quality, particularly in densely populated urban centres.

The principal components constituting an e2W include the charger, battery pack (incorporating the battery management system BMS), motor controller, motor, transmission, vehicle control unit, dashboard, DC-DC converter, wiring harnesses, and chassis.

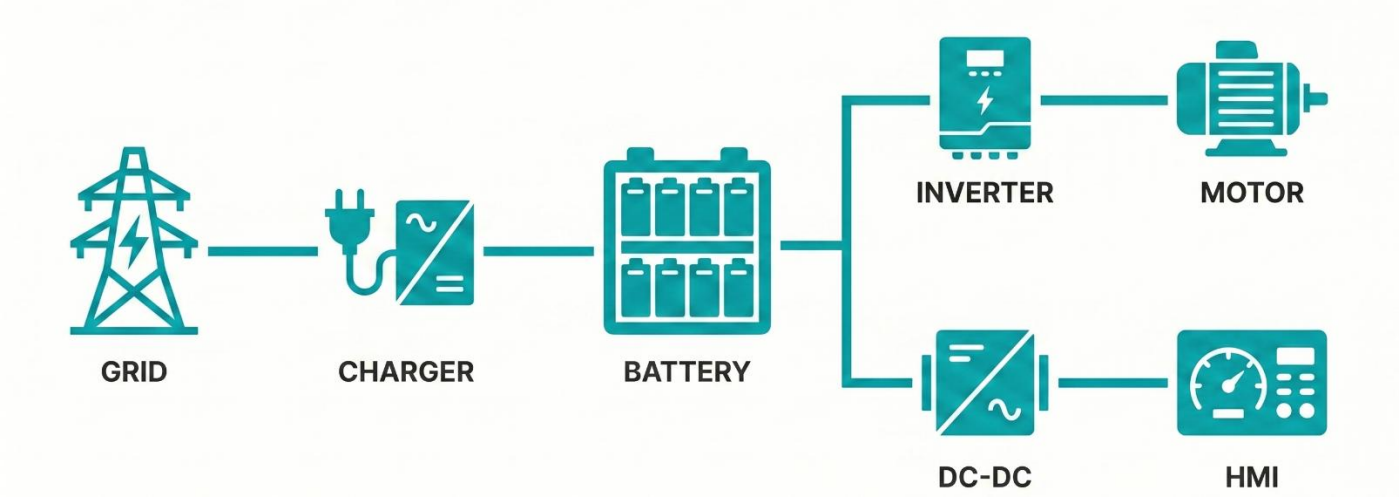
Schematic overview of the components of an e2W



Note: Above image provides a schematic overview, the actual positioning of components may vary in actual models
Source: Crisil Intelligence

The charger draws electricity from a grid or socket and converts it to charge the battery. The battery supplies direct current, which the inverter or motor controller converts into alternating current to drive the motor. Auxiliary electronic systems such as lighting and the human machine interface (HMI) draw power from the battery via a DC-DC converter, which steps down the battery pack voltage to the lower levels required by these components.

Flow of electricity within an e2W

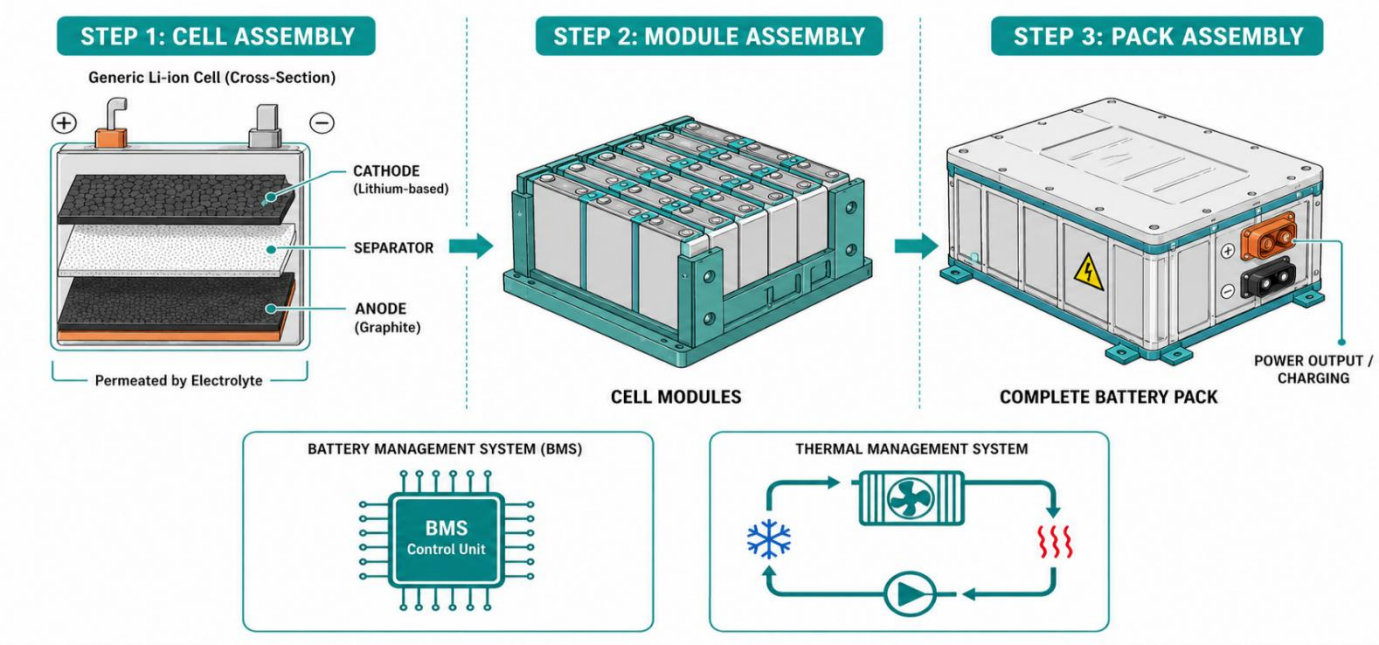


Source: Crisil Intelligence

The charger is a critical subsystem, enabling batteries to be charged efficiently and rapidly. Its performance is defined by parameters such as efficiency, reliability, weight, charging time, and power density all of which are determined by the charger's components, switching strategies, and control algorithms. These control algorithms are executed digitally through a microcontroller.

The battery serves as the vehicle's electrical energy reservoir. Lithium-based chemistry is predominantly used for cathode materials, with graphite forming the basis of the anode. Individual cells comprising cathode, anode, and electrolyte are assembled into cell modules and subsequently into a complete battery pack, which also includes the BMS, thermal management system, and connectors. The BMS continuously monitors voltage, current, and temperature within the pack, using these measurements to inform system control decisions and enable protection functions.

EV Battery Architecture



Source: Crisil Intelligence

The motor transforms electrical energy into mechanical energy to propel the vehicle. It governs start/stop behaviour, forward and reverse rotation, speed selection and regulation, torque control, and protection against overloads and faults. Several motor types find application in e2Ws, including induction motors, Brushless Direct Current (BLDC) motors, Permanent Magnet Synchronous Motors (PMSM), and Switched Reluctance Motors (SRM). Based on the integration of the motor in the vehicle, the motors can be classified into two types: hub motors and frame mounted (mid-drive) motors. In a hub motor setup, the motor is positioned on the front/rear wheel, with the motor placed in the wheel hub. The motor delivers propulsion by spinning the wheel on which it is mounted. Whereas in a mid-drive setup, the motor is mounted on the vehicle frame/chassis in the middle and power transmission to rear wheel is enabled through a belt drive mechanism (like the traditional ICE engine which uses chain mechanism). Mid-drive motors use a transmission/gearing mechanism to control the torque delivered to rear wheel of the vehicle. Based on placement within the vehicle, motors are classified as hub-drive or mid-drive: hub motors are mounted on the rear wheel, while mid-drive motors are integrated into the chassis. Each motor operates with a dedicated controller that governs performance according to pre-programmed logic. This controller also referred to as the inverter regulates the power delivered to the motor in response to throttle input.

A DC-DC converter is an electromechanical device that transforms direct current from one voltage level to another. It temporarily stores energy received from the battery and releases it at a reduced output voltage. Energy storage within the converter occurs either in magnetic-field components such as inductors or transformers, or in electric-field components such as capacitors. DC-DC converters are conventionally designed for unidirectional power transfer from input to output though bidirectional topologies also exist. Many electric two-wheelers support regenerative braking through bidirectional power flow between the traction motor and battery, typically managed by the motor controller/inverter.

Hub vs Frame mounted motor comparison in EVs

Hub motors are easier to install on a bike without the need for extra mounting brackets, gears, or belts. Since these are directly mounted on the wheel, they avoid the use of transmission mechanism thereby resulting in fewer moving parts. Hence, they are easy to maintain and avoid wear and tear on gears/belts. Besides, hub-motor bikes are simpler in design and lower in cost. However, there are several factors that impact vehicle performance, handling and dynamics while using the hub motors. Hub motors are exposed to water, dust and mud owing to their lower position near the wheel. This impacts the durability and longevity of hub motors. Whereas mid-drive motors are placed into the scooter's frame, protected by the body, and isolated from road shocks by the suspension.

Hub motor can lead to an increase in wheel assembly weight when compared to the rear wheel of a mid-mount motor scooter. This increase in un-sprung mass impacts the suspension tuning and vehicle handling. Apart from this, the motor weight is concentrated to one side there by moving further away from the center of gravity of the vehicle, which impacts the ride quality and balance. Lack of transmission results in limited torque and they are not as efficient as mid-drive motors.

Mid mount motors ensure a low and central center of gravity, providing load balancing and better weight distribution, thus resulting in better handling and stability. Further, the transmission mechanism in mid-drive motor enables efficient power transfer and increased toque. The addition of a mid-drive motor and associated components can add more complexity to the vehicle as compared to hub setup. Mid-drive systems involve more mechanical components like belt drives, requiring more maintenance.

Thus, for having better control over the speed and power, mid-drive motors are the most preferred choice. They offer efficient power delivery with ability for torque multiplication and superior handling quality to tackle challenging terrains

and long distances. On the other hand, the hub-motor setup can be used for city commuting and low torque applications.

Technology in e2Ws – Commoditization and emerging tech

The Indian electric two-wheeler segment has matured considerably over the 2020–2026 period, driven by a combination of policy-induced demand acceleration, competitive OEMs entry, launch of several products and progressive safety standardization. As the market has scaled recording approximately 1.44 -million-unit sales in fiscal 26 and achieving a penetration rate of approximately 6.5%,a clear stratification has emerged within the e2W technology landscape.

Certain components and feature sets have crossed the threshold from differentiators into table-stakes. Their presence across virtually all major OEM models reflects the degree to which the segment has standardised around a common technical baseline. Simultaneously, a second phase of technologies remains at early-to-mid adoption stages present in select advanced OEM models, not yet universal, and representing the primary axis of product differentiation for the foreseeable future.

Commoditized Technologies

Lithium-ion battery packs have similarly become standard across the segment, with NMC (Nickel Manganese Cobalt) and LFP (Lithium Iron Phosphate) chemistries now both prevalent. Li-ion has displaced lead-acid across all prominent OEM offerings. While selecting between NMC for higher energy density versus LFP for thermal stability and cycle life in Indian ambient conditions continues to reflect OEM-level engineering choices, the broader adoption of lithium-ion chemistry itself is no longer a differentiator.

At the regulatory layer, the Ministry of Road Transport and Highways mandated updated battery safety standards under AIS-156 and AIS-038 Rev.2, implemented in two phases from December 2022 and March 2023 respectively. These standards introduced minimum requirements for microprocessor-based Battery Management Systems covering cell-level monitoring, thermal event detection via four mandated temperature sensors, and audio-visual warning systems for thermal incidents. Compliance is a legal prerequisite for market participation for all L-category vehicles; a basic, protection-oriented BMS has therefore become a regulatory floor across the segment.

Beyond drivetrain and battery, the feature set visible to the end consumer has also largely standardised. LED lighting and digital or semi-digital instrument clusters are now near universal across mass-market offerings. Regenerative braking in its basic form recovering kinetic energy during deceleration is routinely offered across OEMs. Companion mobile applications providing ride statistics, battery status, and charging information paired over Bluetooth are now an expected baseline feature. Fixed riding mode options typically Eco, Normal, and Sport variants are offered across virtually all competitive e2W models

Taken together, these elements constitute the minimum viable technology configuration for a competitive e2W product in India today and in about four to five years, rapid industry changes have turned these past unique advantages into the standard baseline.

Emerging Technologies

The second phase of the Indian e2W technology landscape comprises capabilities that exist in production vehicles either already introduced by select Indian OEMs or demonstrated by advanced global players but remain unevenly adopted, confined to specific models, and not yet present across the broader market. These technologies represent the current and near-term frontier of competitive differentiation in the segment.

Traction Control Systems: Active traction control which modulates motor torque output in real time to prevent rear-wheel slipping on low-friction surfaces has begun to appear in the Indian e2W segment, though its penetration remains

limited to select advanced models. Ather Energy introduced a Multi-Mode Traction Control system on the 2025 Ather 450X and 450 Apex variants in January 2025, offering three configurable modes - Rain, Road, and Rally each calibrated for distinct riding conditions. The system works by synchronising rear-wheel speed with the front wheel, intervening under slip conditions to restore stability.

Advanced Rider Assistance System (ARAS): Ather's ARAS incorporates software-enabled safety features designed to respond to accident scenarios. The system can detect when a scooter has fallen and automatically cut motor power to prevent unintended acceleration, while emergency stop signaling alerts following vehicles during sudden braking events. ARAS also includes crash alert functionality that can notify designated contacts and share the rider's location after a detected crash.

Multi-language dashboard: Ather has introduced a multi-language dashboard interface supporting Hindi and additional regional languages, alongside a voice-based interaction system that enables riders to control navigation, vehicle settings, and media functions through natural-language commands.

AI-Powered Riding Features and ADAS: The integration of Artificial Intelligence into the vehicle's onboard operating system represents a qualitatively distinct step beyond connected features. Ola Electric unveiled MoveOS 6 in 2025, introducing multiple AI powered features across three capability clusters.

1. Ride Coach, which delivers personalised riding efficiency analysis.
2. Assistant, a conversational AI interface powered by Ola's proprietary Krutrim AI supporting 11 Indian languages.
3. Guardian, a real-time safety system incorporating front collision warning, lane departure warning, blind spot detection, and adaptive cruise control.

Proprietary Fast Charging and Intelligent Charging Standards: Vehicle-side intelligent charging management encompassing proprietary connector standards and integrated charging network access remains concentrated among a small number of advanced OEMs. Ather Energy developed the Light Electric Combined Charging System (LECCS) connector, originally as a proprietary standard in 2021.The Bureau of Indian Standards formally approved LECCS as Indian Standard IS17017 (Part 2/Sec 7):2023 in October 2023, and it has since been adopted by multiple OEMs and charge point operators including Hero Vida, Matter, Bolt, and Kazam. As of 2026, Ather's charging network comprised over 5,900 fast chargers globally across 395 cities. Vehicle-side intelligent charging management of this depth spanning proprietary connector design, BIS-standardised interoperability, and integrated network access remains absent across the majority of Indian e2W OEMs.

Vehicle software, Apps and Cloud, Software defined vehicles

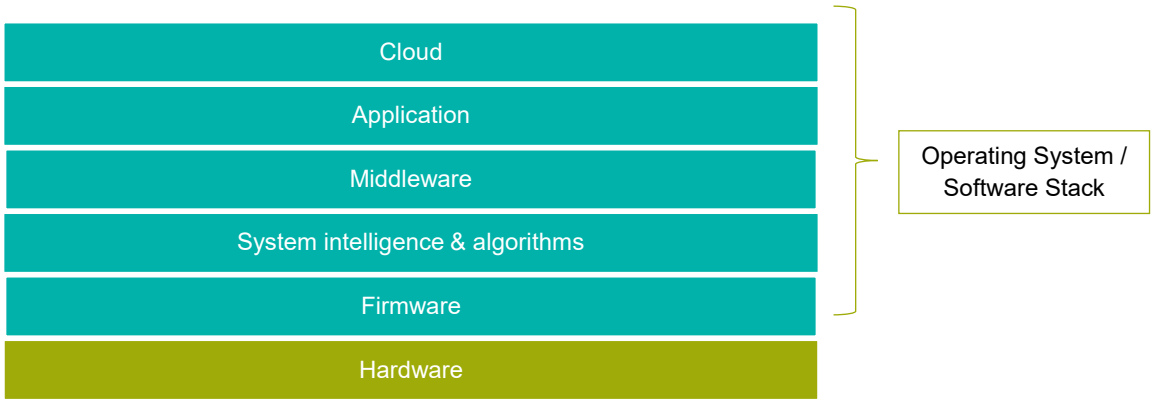
Vehicle software serves as the critical bridge between mechanical systems and digital control, enabling a fundamental transformation in how vehicles operate. A range of automotive software systems drives this shift, each designed to manage specific functions from infotainment and safety to powertrain control. These systems rely on multiple electronic control units (ECUs) to govern the various operations within a vehicle. The growing adoption of advanced software has redefined two wheelers as sophisticated, technology-driven machines, elevating rider experience and strengthening safety capabilities. In many respects, software-enabled vehicles mirror smartphones or computers, with several layers of specialized software modules operating in coordination.

The architectural choices made during vehicle software development have far-reaching implications across cost efficiency, scalability, and integration potential. OEMs may choose to build their software stack internally through vertical integration consolidating multiple software functions across the vehicle into a unified platform or alternatively, license software platforms from third-party technology providers and suppliers. Vertically integrated architecture also facilitates

cross-functional compatibility, promoting greater synchronization between features and delivering a more seamless experience for the user.

A software stack refers to a set of independent components that collectively support the execution of an application. These components spanning firmware, algorithms, middleware, applications, and a cloud layer are arranged in a hierarchical structure, each sitting atop the other. Lower-level layers within this hierarchy interface directly with the vehicle's hardware, while upper-level layers handle specific functions and deliver end-user services through the cloud.

Software stacks in automotive



Source: Crisil Intelligence

Firmware, algorithms, and middleware

Firmware is a software program embedded directly onto a hardware device, providing the foundational instructions that enable its components to function. It serves as the communication layer between the operating system or software stack and the underlying hardware. Since firmware is installed onto hardware during the manufacturing process, it is commonly referred to as embedded software. In the automotive context, firmware development involves creating and deploying the software that governs a vehicle's electronic systems. It plays a central role in managing core functions such as powertrain control, infotainment, telematics, and advanced driver-assistance systems (ADAS). Across these domains, firmware enables critical capabilities powertrain systems depend on it to regulate motor performance, manage battery discharge, and monitor range; infotainment systems use it to deliver entertainment, navigation, and connectivity; and ADAS relies on it to power safety features including collision avoidance, lane departure warnings, and adaptive cruise control. Every technology within a modern vehicle from sensors to navigation systems carries its own dedicated firmware to perform its designated function.

An algorithm is a defined set of instructions executed by processors or high-performance computers to carry out a specific operation. Within a software-enabled vehicle, algorithms function as step-by-step directives that guide system actions. They are also integral to data processing and play a significant role in autonomous system operations. Algorithms typically reside within the system intelligence layer, where they drive features such as auto-indicator cancellation, theft and tow detection, and range prediction, drawing on sensor inputs received from the hardware. Based on the required output, algorithms transmit signals to the relevant control mechanisms or ECUs to initiate or terminate a function.

Middleware is the software layer that sits between firmware and the application within a vehicle's software architecture, acting as a communication bridge between the two. It enables applications to exchange data with the underlying system software, linking front-end user inputs through the application layer with back-end resource management. Middleware creates avenues for deeper integration of third-party hardware and software solutions, while also reducing the number of interfaces required and enabling faster communication across system components. It can be deployed either as an individual module covering discrete functions such as infotainment, powertrain, or climate control or as a comprehensive

platform solution that consolidates all such modules. Middleware can also be developed using open-source frameworks such as the Android Open-Source Platform (AOSP).

Vehicle HMI

An automotive human-machine interface (HMI) defines the point of interaction between the rider and the vehicle, encompassing the technologies, interfaces, and controls through which users operate and communicate with vehicle features. The core objective of HMI is to deliver an intuitive, user-friendly experience while keeping the rider's attention directed at the road. Common HMI elements include touchscreen displays, voice assistance, handlebar controls, and touch-sensitive surfaces.

HMI systems are built around controls designed for ease of use while in motion. Smart touchscreen dashboards and voice commands simplify how riders engage with vehicle functions, reducing physical effort and contributing to a more comfortable overall experience. Modern HMI systems also incorporate connectivity features that enable seamless smartphone integration, providing hands-free access to navigation, calls, and message notifications for a more connected ride. Beyond convenience, touchscreen displays are integral to both EV functionality and advanced rider assistance systems (ARAS). In EVs, HMI units enable intelligent data visualization presenting information such as battery range, tire pressure, and charging status in an accessible format. For ARAS, HMI communicates visual and audible alerts about the vehicle's surroundings, supporting improved safety and situational awareness, such as alerting riders to sudden wheel slip, low tyre pressure, or nearby charging opportunities.

As EVs gain wider adoption, HMI systems have expanded to accommodate EV-specific requirements, including drivetrain management, battery management, and charging infrastructure information. The evolution of HMI from conventional manual controls to dynamic, responsive interfaces reflects the broader trajectory of the automotive industry. As vehicles grow increasingly connected, automated, and electrified, HMI continues to play an expanding role in shaping the rider experience.

Applications

Software applications are unlocking new frontiers in the automotive industry, enabling OEMs to extract real-time vehicle data while allowing users to interact with vehicle functions through the dashboard or their smartphones. This capability is largely driven by telematics. Beyond telematics, software also enables a range of applications including assisted driving, in-vehicle solutions such as on-board navigation, smart driving features that sync driving data with smartphones, and cloud-based services.

Applications aimed at improving the rider experience are seeing growing adoption in the two-wheeler segment, offering capabilities ranging from navigation assistance to real-time traffic updates, making rides more efficient. Alongside this, IoT integration is emerging as a prominent trend. IoT, or telematics, involves the convergence of telecommunications and informatics within vehicles, encompassing GPS tracking, remote diagnostics, and V2X communications. These applications allow vehicle functions to be managed remotely such as controlling charging or locating the vehicle.

The increasing penetration of software has also given rise to applications dedicated to vehicle safety and maintenance, delivering timely service alerts and continuous vehicle health monitoring to keep the vehicle in optimal condition. Further, the concept of connected vehicles is driving the evolution of V2X communications, enabling vehicles to interact with one another and with road infrastructure, fostering a safer and more intelligent driving environment. The objective of overarching software applications is to enhance vehicle safety, make mobility more intuitive and predictive, improve the overall riding experience, and deliver greater rider comfort.

AI and its implications on development, manufacturing, time to market and features

AI in Product Development

The application of artificial intelligence in e2W product development is progressively reshaping how OEMs approach design iteration, component engineering, and platform architecture. Globally, AI-assisted generative design and physics-based simulation tools have enabled automotive engineers to evaluate significantly larger design pieces within compressed timeframes relative to conventional computer-aided engineering workflows. These tools are particularly consequential for e2W-specific engineering challenges including battery thermal management, motor geometry optimisation, and chassis topology where performance-to-weight trade-offs are central to product differentiation.

In India, this shift is particularly pronounced among vertically integrated OEMs that have chosen to develop proprietary software and hardware stacks in-house, rather than relying on conventional outsourced design workflows. The transition toward software-defined vehicles has been a key enabler as vehicles increasingly carry dense sensor arrays, connected platforms, and over-the-air update capability, the data generated through normal operation becomes an active input into product iteration and improvement cycles.

A notable characteristic of AI-led development in the Indian e2W context is the deployment of edge-AI architecture frameworks that distribute computation between the vehicle's onboard hardware and the cloud, enabling real-time feature execution alongside model iteration at the cloud layer. Ather Energy's engineering approach is among the more documented in this regard. The company has disclosed that its vehicles carry approximately 50 onboard sensors generating continuous data streams, which are used not only to operate the vehicle but to train and iterate AI algorithms via a cloud-edge computing framework. The data science team has developed fundamental algorithms modelling physical vehicle behaviour, ride patterns, and charge behaviour enabling low-latency use cases including automatic indicator-off, theft and tow detection, fall detection, load detection, and pothole detection, among others. The cumulative intelligence gathered across the fleet, on ride behaviour, charge patterns, road conditions, and vehicle dynamics, feeds back into a system that grows more precise with scale, quietly informing the decisions that shape what the next version of the product becomes.

Among other Indian OEMs, Ola Electric launched the Ola Digital Twin Platform in October 2024, developed on NVIDIA Omniverse and integrating Krutrim AI alongside advanced simulation tools and IoT platforms. The platform creates comprehensive digital twin environments designed to fast-track the planning of manufacturing facilities, optimise equipment layouts, and support product development lifecycle management. The platform uses generative AI to produce synthetic image data encompassing simulated lighting conditions, environmental scenes, and defect scenarios to train perception AI models. The company has disclosed that this approach is intended to compress AI model training timelines from months to weeks, reducing dependence on real-world data collection for scenarios that are difficult or unsafe to replicate physically.

Taken together, these developments point to a structural shift in how e2W product development is being conceived and executed in India. AI is no longer functioning solely as a tool applied at discrete stages of the engineering process; it is becoming embedded within the product itself, creating a continuous feedback loop between vehicle operation, data generation, and development iteration. The distinction between the deployed product and the development environment is increasingly difficult to draw, as fleet-scale operational data actively informs the next generation of algorithms, features, and physical design decisions. This dynamic is particularly consequential for vertically integrated OEMs with proprietary hardware-software stacks, as the accumulation of fleet intelligence compounds over time into a competitive asset that is difficult to replicate through conventional engineering approaches. At the platform level, the adoption of digital twin environments and synthetic data generation further compresses the boundary between simulation and physical validation, reducing both time and risk in the development cycle. What emerges from this convergence is a development

model where scale, data, and computational architecture are as central to product differentiation as the underlying mechanical and electrical engineering.

AI in Manufacturing

The application of AI in e2W manufacturing encompasses a range of shop floor capabilities including autonomous robotics, AI-driven quality inspection, intelligent manufacturing execution systems, and digitally managed assembly processes.

Ather Energy has deployed Scalex System. It is a manufacturing execution system across its vehicle assembly and battery production facilities. The system enables end-to-end monitoring, tracking, and full process traceability.

Ola Electric's Digital Twin Platform, while also applied to product development workflows has a distinct manufacturing application: the simulation of autonomous robotic welding lines at its Futurefactory. Welding processes and quality inspection systems are modelled and tested in a virtual environment before physical deployment on the shop floor, enabling changes to be evaluated without disrupting live production operations.

Bajaj Auto's Akurdi (Chetak Technology Ltd) EV plant was designed with robotic and automated manufacturing systems across logistics, fabrication, painting, assembly, and quality assurance.

TVS Motor Company has deployed computer vision-based AI systems across its manufacturing facilities for quality inspection applications. The company's internally developed implementation applies machine learning algorithms including YOLO (You Only Look Once) and FRCNN (Faster Region-based Convolutional Neural network) integrated with IoT and manufacturing execution systems for automated defect detection in assembly operations. The deployment enables real-time, vision-based quality inspection on the production line, reducing dependence on manual inspection processes.

Among global e2W manufacturers, Gogoro, a Taiwanese electric scooter and battery-swapping ecosystem company has publicly documented its Smart Factory manufacturing approach. The company deploys robot automation, end-to-end factory digitisation, and deep data management across its production operations, with every part, process, and execution step during production controlled by a proprietary manufacturing execution system. The facility employs intelligent Automated Guided Vehicles powered by Gogoro's own smart batteries for material handling and deploys a near-touchless battery assembly process designed to deliver consistency at scale. The factory's modular and reconfigurable format is designed to allow rapid transitions between vehicle models and production sequences. Every wiring connection and assembly step is recorded and catalogued, enabling full traceability throughout the life of the vehicle.

Another manufacturer AIMA Technology a Chinese e2W brand has incorporated artificial intelligence into its electric two-wheeler manufacturing operations at its production facility in Tianjin, China. Among the technologies integrated into its manufacturing process is AI visual recognition, which has been deployed as part of the company's broader intelligent manufacturing framework. In addition to AI visual recognition, AIMA has established a CNAS-certified research and development laboratory, reflecting a degree of institutional commitment to maintaining standardized and verifiable capabilities in product development. The company characterizes these developments as part of an ongoing intelligent transformation of its manufacturing infrastructure.

Across these examples, a consistent pattern emerges: AI in e2W manufacturing is being applied not as an isolated capability but as an integrating layer that connects process control, quality assurance, traceability, and operational flexibility within a unified digital infrastructure. The deployment of manufacturing execution systems, whether Ather's Scalex or Gogoro's proprietary platform, reflects a shared orientation toward end-to-end visibility and process

accountability at the shop floor level. Simulation-led approaches, as demonstrated by Ola Electric's digital twin application to robotic welding, indicate a broader shift in how manufacturers validate and de-risk process changes, moving evaluation upstream into virtual environments before committing to physical reconfiguration. What these developments collectively suggest is that competitive differentiation in e2W manufacturing is increasingly a function of digital infrastructure depth, with AI serving as the connective tissue between physical production processes and intelligence systems.

AI and Time to Market

The deployment of AI across the e2W value chain is compressing product and software delivery timelines through two structurally distinct mechanisms: the acceleration of hardware design-to-commissioning cycles, and the establishment of AI-enabled software testing and deployment pipelines that allow continuous iteration across live vehicle fleets. Together, these mechanisms are materially altering the competitive dynamics of product development cadence.

On the software side, Over-the-air (OTA) update capability increasingly standard across connected e2W platforms in India has fundamentally restructured the product delivery model. Rather than being constrained by physical product launch cycles, OEMs are now able to deploy new capabilities, performance improvements, and safety-critical updates directly to vehicles already in the field, on a continuous basis. This decouples software iteration speed from hardware production cycles a structural shift with direct implications for how quickly an OEM can respond to competitive developments, regulatory changes, or consumer feedback.

Ather Energy employs AI-enabled automation to support the development and deployment of its AtherStack OTA software updates. The company's software validation framework uses automated testing across multiple parameters, including functionality, performance, stability, accuracy, and resilience to failure scenarios, before updates are released to vehicles. Large volumes of test data are processed through an in-house reporting and analytics platform, enabling continuous software refinement and rapid issue identification. By automating much of the testing and validation process, Ather is able to accelerate software release cycles while maintaining the reliability of connected vehicle features.

On the hardware side, the use of AI-driven simulation and digital twin environments has measurably reduced the time required to move from design decisions to operational commissioning of manufacturing systems. Ola Electric has disclosed that through the deployment of its Digital Twin Platform integrating NVIDIA Omniverse and NVIDIA Isaac Sim it achieved over 20% faster time to market from design to commissioning for manufacturing operations at its Futurefactory.

The cumulative effect of these two mechanisms - hardware cycle compression through AI simulation, and software cycle compression through automated OTA pipelines - is a materially faster innovative cadence for OEMs that have invested in these capabilities. In a segment characterised by accelerating product launches and increasing feature competition, the ability to iterate rapidly on both hardware and software dimensions is expected to constitute a progressively significant differentiator among Indian e2W manufacturers.

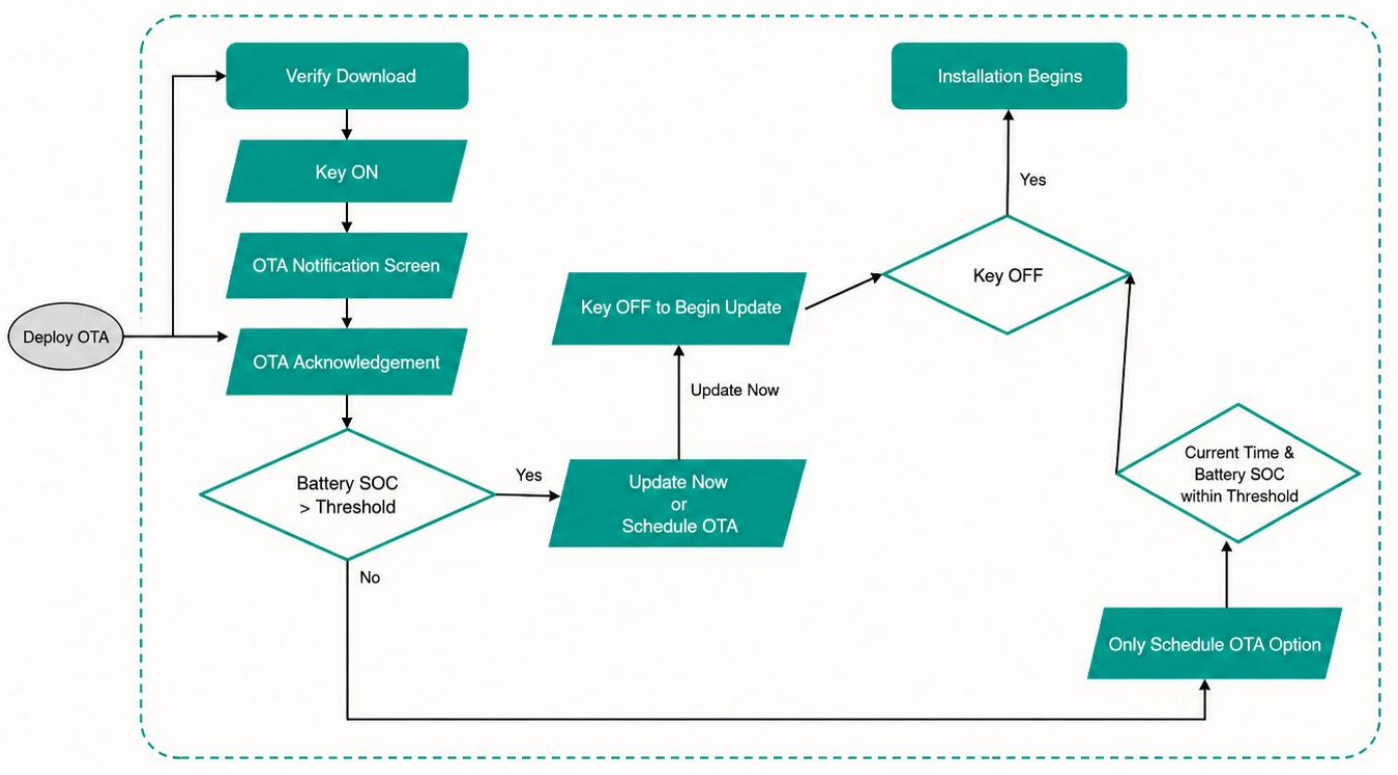
AI in Vehicle Features and the Rider Experience

Consumer-facing AI features represent the most directly visible dimension of artificial intelligence in the Indian e2W segment and the one most immediately relevant to product differentiation and ownership value. Across leading Indian OEMs, AI is progressively embedded into vehicle operating systems as a functional layer that actively interprets rider behaviour, vehicle conditions, and environmental inputs to deliver safety alerts, personalised performance, intelligent navigation, and predictive diagnostics. The cumulative effect is a shift from a static vehicle ownership model toward one in which the vehicle's intelligence deepens with use.

Ather Energy's AtherStack 7 its most recent major software platform which illustrates how AI is being embedded at the operating system level to power rider-facing features. The platform continuously processes data from an onboard sensor array including the inertial measurement unit (IMU), motor controller feedback systems, and battery temperature monitors

to adjust power delivery in real time and deliver predictive safety outputs. A key feature within the safety suite is the platform's ability to analyse vibrations and movement patterns to proactively alert riders to potholes ahead and to detect falls, triggering immediate notification to pre-designated emergency contacts

OTA Flow in an Ather Scooter



Source: Crisil Intelligence

A notable feature introduced in AtherStack 7 is an onboard voice interaction system powered by a large language model fine-tuned for Ather's specific use cases and calibrated for Indian dialects. Unlike conventional command-based voice assistants, the system employs natural language processing to enable more conversational rider interactions, including proactive alerts on tyre pressure, live location sharing prompts, and vehicle status updates.

TVS Motor Company's SmartXonnect platform, deployed across the iQube range, offers a suite of multiple connected features encompassing live vehicle tracking via an in-built SIM, geofencing with up to five configurable zones, real-time vehicle health alerts for critical components including battery and motor, crash and fall alerts to designated contacts, and turn-by-turn navigation. The platform integrates voice assist functionality, including an Alexa skillset available as an add-on for advanced-tier subscribers, enabling hands-free access to vehicles and connectivity features. OTA update capability on the iQube delivers continuous security, performance, and feature upgrades post-sale.

Across the Indian e2W segment, the competitive locus of AI-driven features is progressively shifting toward predictive intelligence where the vehicle anticipates rider needs and potential failure modes rather than reactive connectivity. This trajectory, visible across the disclosed feature roadmaps of leading Indian OEMs, points toward a near-term convergence of AI-assisted safety, personalised performance, and conversational interaction as the defining axes of software-defined product differentiation in the segment.

Charging Infrastructure for Electric 2W

EV charging stations comprise one or more charge points that deliver the electrical power required to charge a vehicle. The fundamental unit of a charging station is the electric vehicle supply equipment (EVSE), which draws power from the electricity grid and employs a control system along with connectors to charge EVs. EVSE manufacturers serve this market by supplying charging equipment to OEMs for retail EV consumers, as well as to charge point operators (CPOs) who install charging stations in public locations. These manufacturers are also collaborating with EV fleet operators to design charging solutions suited to fleet requirements.

Components of EV Charging Infrastructure:

- An EV charging infrastructure consists of multiple EVSE units or charge points, each containing several connectors. These connectors interface with the vehicle's socket to deliver electricity directly to the vehicle.
- The Central Management System (CMS) is a cloud-based backend platform operated by CPOs, responsible for managing user authorization, billing, and charging rate configurations.
- A Mobile Application allows EV users to locate the nearest charging stations, reserve a charging slot, complete payments, and monitor charging status in real time

Charging and EV Infrastructure policy

The government continues to actively promote EV charging infrastructure and battery swapping as foundational pillars of India's electric mobility ecosystem, with particular emphasis on the two-wheeler segment, which dominates India's EV landscape.

As per Minister of State for Heavy Industries, as of Dec 2025 a total of 29,151 public EV charging stations have been installed across the country, a dramatic rise from approximately 6,000 in early 2023. This expanding network directly supports range confidence for two-wheeler users, who constitute the largest share of India's EV base.

The central scheme driving this build-out is the PM Electric Drive Revolution in Innovative Vehicle Enhancement (PM E-DRIVE) Scheme, launched in 2024 with a total outlay of ₹10,900 crore. Of the ₹2,000 crore earmarked for charging infrastructure, a dedicated allocation targets 48,400 chargers specifically for two- and three-wheelers, to be deployed at high-footfall locations including metro stations, airports, railway stations, fuel outlets, and toll plazas along 50 national highway corridors.

In September 2025, the Ministry of Heavy Industries issued operational guidelines for the rollout of these charging stations, establishing a tiered subsidy structure for charge point operators. Battery swapping or charging stations set up at any location will be eligible for 80% subsidy on upstream infrastructure costs under this framework. BHEL (Bharat Heavy Electricals Limited) has been designated as the Project Implementation Agency (PIA) to oversee deployment nationwide.

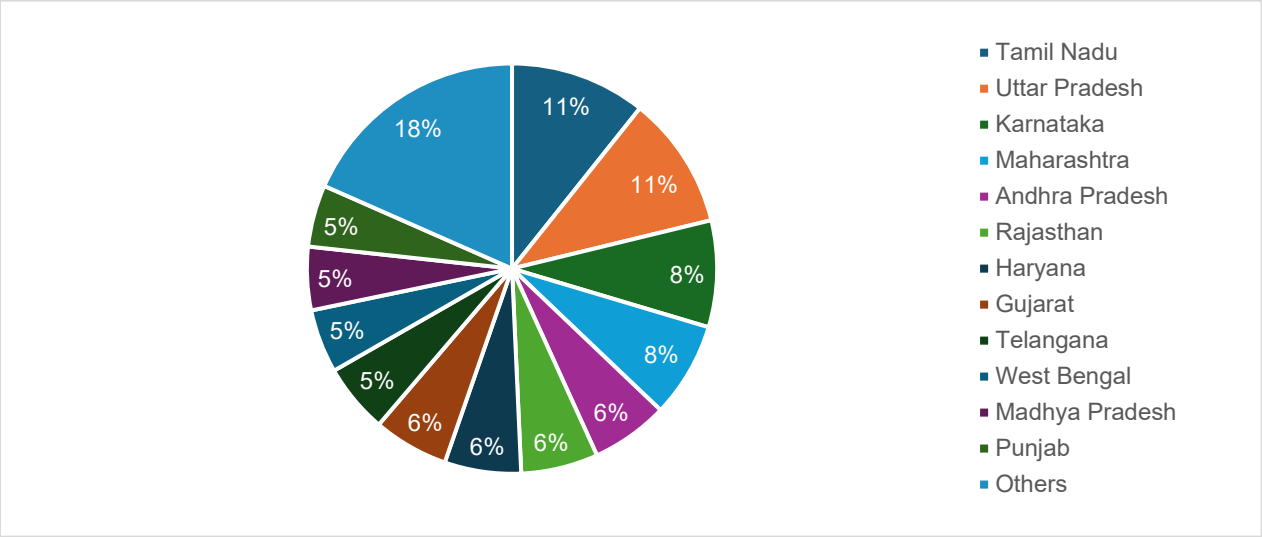
In May 2026, at the National Conference on Enabling Nationwide EV Charging Infrastructure held in Bengaluru, the government announced the development of the Unified Bharat e-Charge (UBC,) a national unified EV charging app being developed by BHEL which will allow users, including two-wheeler riders, to discover chargers, book slots, and make payments across multiple operator networks through a single interface, analogous to UPI for digital payments. This directly addresses the fragmented charging experience currently faced by e-2W users across networks.

On the demand incentive side, the PM E-DRIVE scheme has been the primary driver of two-wheeler adoption. As of January 2026, it had supported the sale of 19.19 lakh electric two-wheelers out of a total target of 24.79 lakh. The subsidy rate was rationalized from ₹5,000/kWh to ₹2,500/kWh (capped at ₹5,000 per vehicle) effective April 2025, reflecting the growing market maturity of the segment. Demand subsidies for e-2Ws, originally set to close on 31 March 2026, have been extended to 31 July 2026, giving buyers and manufacturers additional time to avail incentives.

Current state of the EV charging ecosystem:

Some of the state regulatory commissions have announced tariffs for EV charging as a separate category in their tariff orders. State governments are also taking active steps to increase EV charging networks by providing attractive incentives in the form of capital subsidies and 100% reimbursement of state goods and services tax.

Distribution of public charging infrastructure for EVs across Indian states (as on 1st March 2026)



Source: Minister of State for Heavy Industries

Types of chargers/connectors needed for 2Ws:

The charging levels for EVs in India are similar to global standards. Speed of charging for EV chargers is defined by the amount of energy delivered to the vehicle's battery per unit of time. There are three levels of chargers based on speed of charging: Level 1 charging, Level 2 charging and Level 3 charging. In the case of two-wheelers Level 1 and Level 2 charging are being used.

- Level 1 Charging: L1 charging is a slow type of charging for EVs. L1 chargers plug directly into a standard 230-volt AC outlet or 120V DC outlet under LEV DC. The average power output of an L1 charger is <3.3 kW. L1 charging primarily occurs in residential settings, and there are very few L1 chargers built for public use. Approximate charging time under Level 1 could be 0-12 hours.

- Level 2 Charging: L2 charging is the most prevalent type of charger. L2 chargers operate at 208-240 volts, and the output is anywhere from 7 kW to 22 kW of AC power. L2 charging provides a faster charging speed compared to L1, allowing for quicker replenishment of the EV's battery. L2 chargers can be found in residential townships as an amenity for occupants and visitors, and at public locations such as parking garages, OMC retail outlets, grocery stores, malls, hotels, and workplaces. Approximate charging time under Level 2 could be 0-6 hours.

Level 2 AC chargers are faster than level 1 AC chargers and can fully charge an EV in approximately 4-6 hours. Level 1 AC charging is well-suited for overnight charging at home or work which can take 0-12 hours for a full charge. DC chargers are fast chargers and can fully charge an EV in 4-6 hours.

Specification and types of chargers for two-wheelers in India:

S. No	Charging station	Voltage (V)	Power (kW)	Type of compatible charger
1	Level 1 (AC)	240	<=3.3 kW	Type 1, Bharat AC-001
2	Level 1 (DC)	>=48	<=15 kW	Bharat DC-001
3	Level 2 (DC)	380-400	<=22 kW	Type 1, Type 2, GB/T, Bharat AC-001

Source: NITI Aayog, *E-Amrit, Crisil Intelligence*

Slow charging and fast charging

India's EV charging infrastructure is categorised, by charging type, into two broad segments: AC (slow) charging and DC (fast) charging. Power supplied from the grid is always in the form of alternating current, whereas vehicle batteries invariably require direct current for charging.

AC/Slow charging: In AC/slow charging, the alternating current drawn from the grid is converted to direct current by means of a converter or onboard charger within the vehicle. This method is best suited for parking locations where the vehicle remains stationary for extended periods. Slow charging standards in use include Bharat AC-001 and Type 2 AC, the latter offering a power output of 7.4 kW and operating at a higher speed than Bharat AC-001.

DC/Fast charging: Fast chargers make use of DC power to charge the battery. The AC gets converted to DC before it enters the vehicle. A DC installation requires a lot of power from the grid making it expensive and resulting in higher tariffs for charging. However, it is the preferred charging method to quickly recharge when required. This type of charging is mostly found along highways or public/semi-public charging stations rather than at residential or offices. Electric two-wheelers in India primarily use Type 6 (Dash-6) and LECCS (Light Electric Combined Charging System) for fast charging.

Need for fast public charging infrastructure for 2W:

- Range anxiety and charge anxiety
- Lack of charging infrastructure in apartments

Electric two-wheelers and three-wheelers operate at a rated output voltage of up to 120V DC, as specified under IS 17017 and require a fast-charging power output of between 3 kW and 12 kW. There are 2 BIS standards that exist today for charging of e2Ws

- Indigenously developed Combo AC/DC connector standard: LECCS (Light Electric Combined Charging System)
- Derived from the CHAdeMO ePTW (Electric Powered Two-Wheeler) specification DC-only standard

Types of fast charging connectors used in electric two-wheeler in India:

Connector type	Models
Light Electric Vehicle Combined Charging Standard (LECCS)	• Ather 450 series • Hero VIDA series • Ather Rizta series • Matter Aera
Type 6 connector	• Ola S1 series • Ultraviolette 7
River proprietary connector	• River Indie

Source: Crisil Intelligence

In India, there is currently no regulation that mandates EV manufacturers to adhere to a specific charging connector standard. As a result, e2W OEMs employ different charging standards for their EVs.

LECCS is the combined AC/DC charging standard tailored for Light Electric Vehicles (LEVs). The objective is to enhance charging convenience and interoperability among various EV models and charging infrastructure providers. LECCS is like CCS2 (in EV 4Ws) in the fact that it allows for AC and DC charging through the same connector. This gives OEMs the versatility of having an onboard charger or an off-board charger for their complete portfolio of products. Adopting a connector type that accommodates both AC and DC charging simplifies integration across the entire product range, thus reducing costs through economies of scale.

Use cases in EV charging

Different methods exist for charging EVs: private, public, captive, and battery swapping. Private charging typically occurs at homes, while public charging infrastructure is found in publicly accessible locations. Captive chargers are installed at government offices, housing societies, private fleet owners, corporate buildings, etc., and are used by commercial fleets like electric cars and buses. Battery swapping entails exchanging discharged electric batteries with charged ones.

Private Charging

This mode is the go-to for 2W owners who charge their vehicles at home using a regular plug-in charger. It's a cost-effective option but does take 6-12 hours' time. Every electric vehicle sold comes with this charger provided by the manufacturer.

Public Charging

These charging stations are set up by organisations or governments, allowing EV users to charge on the move. They offer charging points at designated spots like shopping malls, parking lots, and petrol pumps. These companies typically make money through charging fees, which can be paid per kilowatt-hour or via subscription models. The Charge Point Operators (CPOs) currently have ownership of the charging infrastructure they operate, and they follow a Pay per Use model with different variants for revenue-realization. Online mapping of these CPOs through smart phones makes it

convenient for EV owners to check location of a charger, real-time availability of chargers along with their connector type and also make digital payments via the app. CPOs establish, operate, and maintain a network of EV charging points for semi-public or public use.

Further, CPOs are classified as public sector undertakings (PSUs) and semi-public charging. While PSUs are open for all EV users, semi-public charging will be only accessible for a restricted number of EV users. As per the Ministry of Power, India had 29,277 public charging stations as of August 1, 2025.

Ather Grid, developed by Ather Energy, constitutes a network of charging stations tailored for electric vehicles, particularly Ather electric scooters. With introduction of LECCS chargers now, both Hero and Ather users can charge from either of the OEM's chargers driving interoperability between the models. Users can easily monitor their charging statistics via a mobile-friendly application.

Captive Charging

This mode serves fleet operators who establish charging stations at their facilities for their electric two-wheeled vehicles, dedicated to serving EV fleets for captive ride-hailing companies. It's an efficient solution for managing large fleets.

In the logistics e2W sector, Delivery On Time (DOT) operates as a fleet operator and has established centralised captive EV charging facilities for its fleet. Unlike the distributed approach (chargers are spread across various locations) seen in passenger e2W charging, DOT utilises idle time of e2Ws for recharging at warehouses after completing multiple trips. This centralised setup proves effective as it matches the idle time in fleet operations with the charging requirements.

Yulu, a popular micro-mobility service provider, utilises captive charging solutions to charge its fleet of electric vehicles, such as e-bikes and e-scooters. In this setup, Yulu installs charging stations on its own in designated locations where its vehicles are parked when not in use. These charging stations are exclusively dedicated to Yulu's vehicles.

Battery Swapping

Battery swapping, an alternative method for recharging batteries, is gaining worldwide recognition. This approach involves replacing a depleted EV battery with a fully charged one. It is currently being experimented with across different EV categories such as electric two-wheelers, three-wheelers, cars, and even buses.

Some Indian manufacturers of swappable EV batteries are Sun Mobility, Gogoro, Lithion Power, Voltup, Race Energy, Esmito, BatterySmart, ChargeUp and Battery Pool etc.

For propagating green mobility, Indian Oil Board has recently approved the formation of a joint venture company for battery swapping business in India as a Private Limited Company with a 50:50 collaboration between Indian Oil and Sun Mobility Pte. Ltd. Singapore (SMS). They aim to establish over 10,000 battery swapping stations across 40+ cities by 2030.

In November 2024, Honda Power Pack Energy India (HEID), a subsidiary of Honda Motor Co., Ltd., announced its plan to launch battery swapping service for Honda Motorcycle and Scooter India (HMSI). The service began in Bengaluru from February 2025, followed by New Delhi and Mumbai.

Battery-as-a-Service (BaaS)

Under the Battery-as-a-Service model, battery ownership is fully decoupled from vehicle ownership. The operator purchases the vehicle platform and pays for energy consumption or distance travelled, while the battery service provider retains ownership of the battery and assumes responsibility for installation, monitoring, replacement, and end-of-life recovery. BaaS models are increasingly being enabled by modular battery designs and battery swapping infrastructure, which allow rapid replenishment and centralised battery lifecycle management.

In the e2W segment specifically, BaaS adoption has moved from pilot announcements to commercial rollout across major OEMs. Including Hero MotoCorp, Ather and TVS Motors.

Advantages:

- Eliminates upfront battery capital expenditure
- Transfers full battery performance and residual value risk to the service provider
- Enables rapid replenishment where swapping infrastructure is available
- Facilitates standardised recycling and second-life pathways at scale

Disadvantages:

- Requires standardised battery formats and interoperable platforms
- High coordination and infrastructure requirements across ecosystem participants
- Commercial models and contract enforcement mechanisms are still evolving

Economic viability depends on utilisation density and swap network coverage

Charging Standards

The Automotive Industry Standards (AIS) in India have designated the charging standards for both AC and DC conductive charging as AIS 138 part-1 and part-2. These standards encompass all facets of conductive charging, including general charging requirements, ratings, charging modes, connectors, safety measures for EV Supply Equipment (EVSE), and safeguards against electric shocks. Additionally, the Bureau of Indian Standards (BIS) has released the IS 17017 series of standards pertaining to EV Supply Equipment (EVSE), covering connectors, sockets, plugs, outlets, their design, compatibility, and interoperability.

Overview of charging standards:

Standard	Overview	Key points covered
AIS 138: Part 1	Electric Vehicle Conductive AC Charging System	General system requirement for AC charging, safety functions of AC EVSE, charging cable assembly requirement, EVSE requirement
AIS 138: Part 2	Electric Vehicle Conductive DC Charging System	General system requirement and functions of DC charging, connection, and communication between EV and EVSE, protection against electric shock, requirement of vehicle coupler, cable assembly and EVSE requirements
IS 17017: Part 2: Section 1	IS 17017: Part 2: Electric Vehicle Conductive Charging System: Plugs, Socket, Outlets, Vehicle Connectors and Vehicle Inlets Section 1: General requirements	Specifies general requirement of plug, socket, outlet, connectors, inlet. Provides mechanical, electrical, and performance requirements.
IS 17017: Part 2: Section 2, 2020	Section 2: Dimensional compatibility and interchangeability requirements for AC pin and contact-tube accessories	Provides detailed construction and design of vehicle inlets, connectors, latches for AC charging.
IS 17017: Part 2: Section 3	Section 3: Dimensional compatibility and interchangeability requirements for dc and ac/ dc pin and contact-tube vehicle couplers	Provides detailed construction and design of vehicle inlets, connectors, latch for DC charging.

IS-17017 Part 2 Section-2	Part 2 Plugs, socket-outlets, vehicle connectors, and vehicle inlets Section 6- Dimensional compatibility and interchangeability requirements for AC and contact-tube vehicle coupler	It mentions about high-power DC and combined AC/DC interface of vehicle couplers
IS-17017 Part 2 Section-3	Section 6- Dimensional compatibility and interchangeability requirements for DC and AC/ DC pin and contact-tube vehicle coupler	It mentions high power DC and combined AC/DC interface of vehicle couplers
IS-17017 Part 2 Section-6 (2021)	Section 6- Dimensional compatibility requirements for DC pin and contact-tube vehicle couplers intended to be used for DC EV supply equipment where protection relies on the electrical separation	It mentions the accessories used for DC conductive charging, whereas the protection depends on the electrical separation between the primary and secondary sides of DC EVSE
IS17017 Part 2 Section-7 (2023)	AC and DC Combined Charging connector standard for Light Electric Vehicles (LEVs)	Electric Vehicle Conductive Charging System Part 2 Plugs, Socket-Outlets, Vehicle Connectors and Vehicle Inlets Section 7- Dimensional Compatibility and Interchange Ability Requirements for a.c., d.c. and a.c./d.c. Pin and Contact-Tube Vehicle Couplers Intended to be used for a.c./d.c. EV Supply Equipment where Protection Relies on Electrical Separation
IS 17017: Part 31, 2024	AC or DC EV Supply Equipment for where protection relies on electrical separation	Supplementary specification to IS 17017 Part 2 Section 7; defines AC or DC EV supply equipment relying on electrical separation for protection, applicable to systems up to 480V AC or 600V DC with output not exceeding 240V AC (32A) or 120V DC (100A); supports compact, safe charging for light EVs including LECCS-compliant infrastructure.
IS 17017: Part 30, 2025	Dual Gun DC Electric Vehicle Supply Equipment	Covers dual gun DC EVSE allowing simultaneous charging of two vehicles or higher power delivery; supports rated supplies up to 1000V AC or 1500V DC with outputs up to 1500V DC; enhances fast-charging capabilities for large EV fleets.

Source: NITI Aayog

The Bureau of Indian Standards (BIS) is tasked with crafting EV charging standards in India to guarantee interoperability and compatibility among all electric vehicle supply equipment (EVSE) and electric vehicles (EVs). BIS operates as a member of the International Electrotechnical Commission (IEC), which is responsible for establishing global standards to facilitate interoperability and reduce trade barriers for EVs and their components. While Indian EV charging standards adhere to global norms, adjustments are essential to accommodate local climate conditions and the diverse range of vehicle types available in the country.

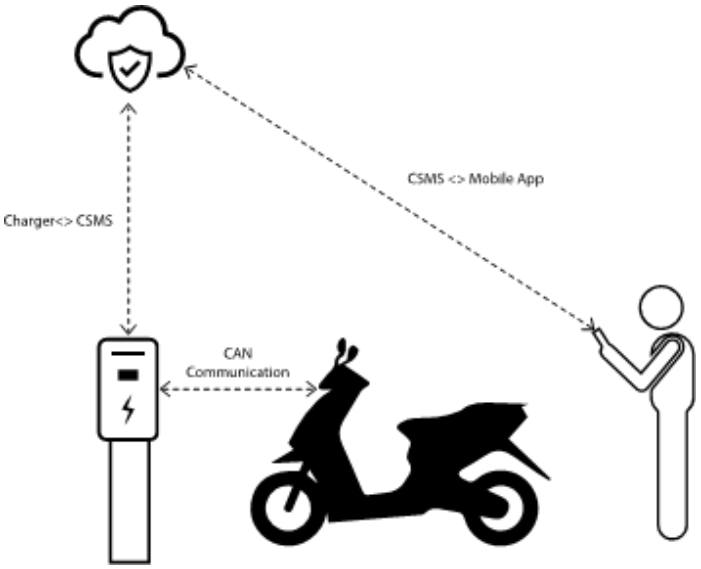
BIS introduced a new charging standard Light Electric Combined Charging System (LECCS) based on IS17017 - Part 2/Sec 7. This standard is the first AC-DC charging system specifically designed for light electric vehicles.

Charging tech stack (connector to cloud)

During vehicle charging, there are four essential touch points: vehicle, charger, mobile app, and Charging Management System (CMS) or Charging Station Management System (CSMS). CMS is software developed to monitor the activities of EV Chargers. Through CMS, the EV Charger owner could manage and monitor the utilization of the charger, maintain its data, analyze the utilization, keep records of billing, track their revenue, and control the operations of chargers. CMS is usually cloud-connected which helps EV owners to easily locate, book, pay, and monitor their charging sessions through an interconnected app. The EV Charger owner can also monitor the charging session remotely through this system. CMS also facilitates the communication between the EV and the charger through Control Area Network (CAN) based system.

Communication stack in 2W charging:

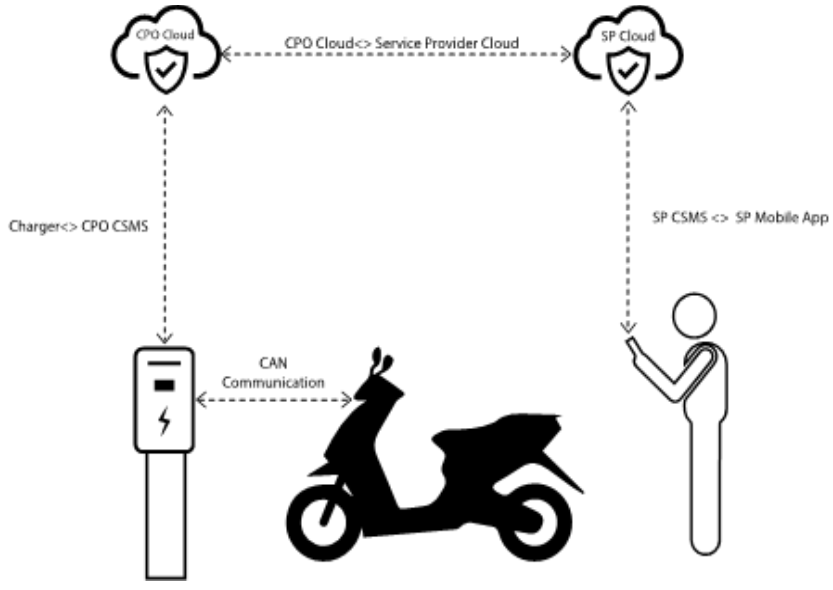
Scenario 1



Source: Crisil Intelligence

In scenario 1, the CMS and mobile application are connected to the same cloud server. In such a case, the customer utilizes a vehicle and charger from the same brand, creating a closed ecosystem. User authentication is carried out through Controller Area Network (CAN) communication. The same scenario is applicable for where customers use a different brand vehicle and utilizes a charger and mobile app provided by a charge point operator. In this case, CAN messaging is limited to safety, with user authentication conducted via the mobile application.

Scenario 2:



Source: Crisil Intelligence

In scenario 2, the customer employs the mobile app from one charge point operator and the charger from another. This represents the usual operation of a public charging station. Data is restricted to storage between the two parties involved in providing the service, namely CPO owning the charger and the service provider managing the customer.

The lack of a standardized charging connector for two-wheelers poses a significant challenge, given their average 3 kWh battery pack size and the need for a 12-kW peak power charging solution. To bridge this gap, the Bureau of Indian Standards introduced IS 17017 (Part 2/Sec 7): 2023, LECCS, aimed at enabling an interoperable charging infrastructure tailored for Light Electric Vehicles (LEVs).

Data and its increasing role in product development

In the automotive industry, data serves as a foundational element of the product development process. The data-driven approach draws upon information generated across multiple sources to inform decisions throughout the development lifecycle. Companies leverage insights derived from this analysis to conceptualize ideas, build prototypes, and execute real-time product adjustments. Such strategies allow organizations to pinpoint critical areas of improvement and deliver products aligned with consumer preferences. The integration of data analytics and intelligence has fundamentally reshaped how products are designed, engineered, and manufactured.

Data finds application in product development across several dimensions:

- Customer behaviour data and patterns related to vehicle driving, operation, and ownership inform the design of products that fulfil customer expectations, enhance user experience, and enable personalised experiences.
- Real-world data gathered from on-road vehicles can be used to test virtual product models, enabling engineers to evaluate the performance of varied designs across different conditions facilitating the development of more efficient, safer, and reliable products.
- Properties of materials such as strength, weight, and durability are assessed through data, with findings applied to optimise material selection, reduce costs, and improve product performance.

Monitoring vehicle data supports product quality analysis, defect identification, and performance optimisation, contributing to higher-quality products, reduced maintenance requirements, and improved customer satisfaction.

A thorough analysis of customer driving and ownership patterns equips OEMs with valuable insights into rider actions, usage modes, and maintenance cycles. These insights enable customer segmentation based on distinct personas, allowing OEMs to develop tailored products that address the specific needs and expectations associated with each persona.

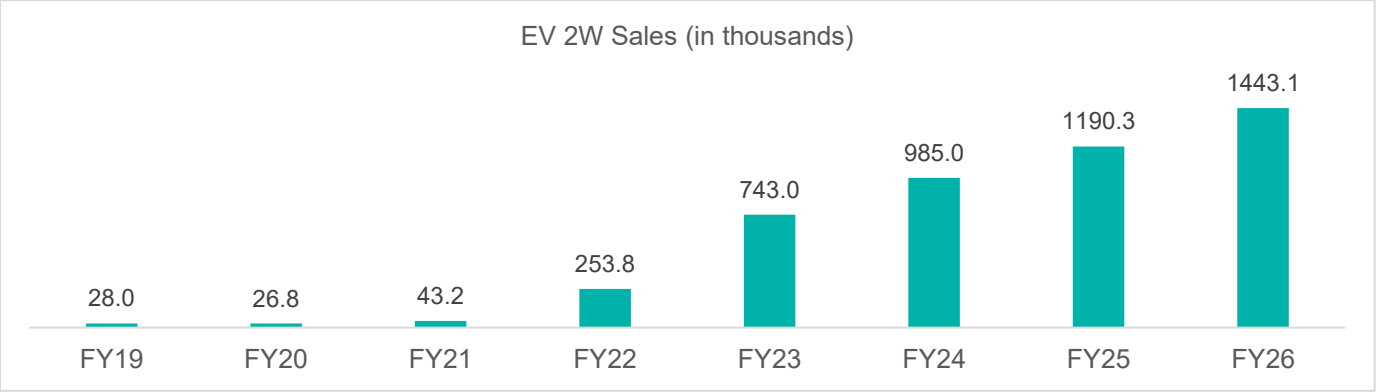
OEMs have access to vehicle usage data spanning customer behaviour and sensor-derived information from various vehicle components. This data includes GPS locations, seat positions, acceleration patterns, and speeds, from which further insights such as customer driving patterns, user profiles, braking frequency, use of driving modes, and traffic conditions can be derived. Such information underpins the analysis of customer needs and shapes product development decisions. Embedding customer usage data into the development process allows actual usage patterns to be integrated into product optimisation and supports the introduction of new features capable of enhancing vehicle performance. Greater volumes of data contribute to more accurate product development grounded in extensive data-driven insights, and also facilitate the creation of new vehicle functionality. Ongoing analysis of usage data further strengthens development precision while enabling faster responses to shifts in market conditions.

Access to large volumes of data enables OEMs to craft differentiated product offerings tailored to distinct consumer personas. Through analysis of segmented customer behaviour, OEMs are positioned to develop both mass-customised and mass-personalised products. The primary objective underlying data collection and analysis is the creation of customer-centric products that effectively address safety and performance concerns in vehicles. In the two-wheeler industry, data plays an integral role in the development process, supporting the creation of products that are safer, more efficient, and more convenient. Its applications span a broad range from customer insights through to supply chain optimisation all directed toward improving product design and development.

Across the manufacturing sector, a growing number of factories are embracing Industry 4.0 practices, wherein data from multiple systems and sensors including those embedded in products and services is integrated and analysed to enable streamlined manufacturing and the efficient operation of factory machinery and systems. Performance data captured from vehicles in the field can be correlated with manufacturing data to generate actionable insights.

India's leadership in electric 2W technology

e2W retails trend



Source: VAHAN

Unlike conventional ICE vehicles, where technology was developed abroad and introduced to India through joint ventures, Indian OEMs have invested significantly in indigenous R&D to develop core EV technologies. This has resulted in domestic ownership of capabilities across the EV value chain including motors, battery systems, power electronics, software, and onboard charging systems.

The government's push through the Phased Manufacturing Programme (PMP) and the Production-Linked Incentive (PLI) Scheme for the Automobile and Auto Components sector has been central to building this ecosystem. The PLI-Auto Scheme, with a total outlay of ₹25,938 crore, as of December 2025, had attracted cumulative industry investments of ₹35,657 crore as of September 2025, with ₹2,321.94 crore in performance-linked incentives disbursed as of December 31, 2025.

The PM Electric Drive Revolution in Innovative Vehicle Enhancement (PM E-DRIVE) Scheme launched in October 2024 with a total outlay of ₹10,900 crore and targeting the support of approximately 24.79 lakh electric two-wheelers complements the PLI framework on the demand side. As of November 2025, the government had disbursed ₹1,634.62 crore in demand subsidies under the scheme, with the incentive window for e-2Ws subsequently extended to July 2026.

These combined policy interventions and sustained OEM investment in R&D have enabled Indian manufacturers to develop electric two-wheelers with product capabilities representing a material step-up over conventional ICE alternatives. Features such as interactive touchscreen displays, hill-hold assist, real-time on-board navigation, and connected vehicle platforms several of which have been among the first-of-their-kind offerings in the global two-wheeler

segment have strengthened the competitive positioning of Indian OEMs relative to global peers in both technology and market share.

Developed markets like Europe are mainly focused on motorcycles instead of scooters. While markets in Southeast Asia and Africa are similar to India in terms of product launches and technology development. This presents a massive opportunity for Indian OEMs to in the global market. Globally India is the 2nd largest market for e2W after China. This has only been possible due to investments in R&D, product development, manufacturing investments that Indian OEMs have invested over the last 3-5 years with greater support from government through fiscal and non-fiscal incentives.

Current and Future battery chemistries of note

The battery pack is the most consequential component of an electric two-wheeler, and the choice of battery chemistry exerts a direct and determining influence on the vehicle's performance, economic viability, and safety profile. Battery chemistry defines the electrochemical properties of the cell specifically the cathode and anode materials which in turn govern the parameters that matter most in the electric two-wheeler context: range, cost, safety, charging behaviour, and operational life.

Range

Energy density expressed in watt-hours per kilogram (Wh/kg) is the primary chemistry-driven determinant of vehicle range. Higher energy density allows more kilometres per charge for a given battery weight. Nickel Manganese Cobalt (NMC) chemistries offer higher energy densities than Lithium Iron Phosphate (LFP), making them better suited to range-intensive applications. LFP, while carrying a lower energy density, has demonstrated sufficient range performance for the typical commuting distances of the Indian urban e2W use case, and continues to benefit from incremental improvements through variants such as Lithium Manganese Iron Phosphate (LMFP).

Cost

Battery chemistry is a principal determinant of the e2W vehicle cost structure. The raw materials required for NMC chemistry particularly cobalt and nickel are subject to significant price volatility and supply concentration. Chemistry selection therefore has a direct bearing on how quickly e2Ws reach price parity with their ICE equivalents in a price-sensitive market.

Safety

Thermal stability is the primary chemistry-driven safety parameter in battery systems and carries particular significance in India's operating environment. Across large parts of the country, ambient temperatures regularly exceed 35–40°C, and batteries in e2Ws are further exposed to direct sunlight, prolonged parking, and charging in uncontrolled conditions. LFP offers significantly superior thermal stability, NMC chemistries are more susceptible to thermal runaway under high-temperature or fast-charging conditions and require more sophisticated and costly thermal management systems to achieve equivalent safety profiles. This distinction has direct design and compliance implications for Indian e2W OEMs.

Charging Speed

Battery chemistry governs the maximum rate at which a cell can accept charge expressed as the C-rate without accelerating degradation or triggering safety risks. Chemistries with high structural and thermal stability, such as LFP, generally tolerate repeated charge cycles with lower degradation penalties compared to NMC under comparable conditions. For the current Indian e2W use case, where the majority of charging occurs through standard domestic power sockets, fast-charging capability is a secondary performance parameter. However, as public charging infrastructure expands and fleet electrification deepens, the chemistry-driven limits on charging speed will emerge as an increasingly relevant variable in OEM product architecture decisions.

Battery Life

Cycle life defined as the number of full charge-discharge cycles a cell sustains before capacity degrades below an acceptable threshold is a direct function of battery chemistry and the primary long-run determinant of total cost of ownership (TCO) for e2W users. LFP chemistry offers substantially higher cycle life than NMC under comparable operating conditions, which translates into a lower per-kilometre cost over the vehicle's life. This dimension carries particular weight in the Indian market across two use cases: the price-sensitive individual consumer who evaluates a vehicle on long-run running cost, and the fleet operator in last-mile delivery or commercial mobility where battery replacement costs materially affect unit economics. In both cases, chemistry selection directly influences product competitiveness.

Current Battery Chemistries

The five large-scale commercialized chemistries are LCO, LMO, LFP, NMC, and NCA. The most common versions of lithium-ion batteries that have proven to be the most suitable and viable for India are LFP, NMC and NCA.

Lithium Cobalt Oxide (LCO): As the name suggests, the cathode material is made of three elements, out of which lithium and cobalt are the key materials, obtained through mining. LCO offers a high energy density which makes it suitable for electronic devices. However, limited cycle life is one disadvantage for LCOs. Another challenge with LCO is that it has a lower temperature tolerance limit. Due to these reasons, this cell cannot be fast charged or discharged, as this would produce excessive heat internally, leading to safety problems. This is not considered a major limitation for most consumer electronic devices since any typical device takes more than 2 hours to charge and 24 hours to discharge. Hence this is commonly used in laptops and smartphones where they can deliver energy for a lengthy period under low-load applications. LCO is best used for applications that require extremely lightweight solutions but do not need high power. However, from a safety and durability point of view, LCO technology is not considered ideal for EV applications.

Lithium Manganese Oxide (LMO): Some of the limitations of LCO were overcome with the introduction of LMO. LMO offers high thermal limit of stability and allows fast charging. These two qualities together make it ideal for high-power applications. These advantages coupled with the low cost of LMO make it an attractive cathode material. However, it has lower cycle life and energy density compared to other battery chemistries. The low cost is primarily due to the inexpensiveness of its main constituent, manganese. The short lifespan of LMO owing to low cycle life impacts the total cost of operation (TCO) and increases replacement costs, thus making it less viable for EVs. These batteries charge quickly, offer high specific power, and can operate at higher temperatures making them suitable for portable power tools and medical instruments.

Lithium Nickel Cobalt Aluminum Oxide (NCA): The cathode is made of four elements namely lithium, nickel, cobalt, and aluminum. The key benefit of NCA is its high energy density which translates into a longer driving range for EVs. However, NCA technology is less suitable for high-power applications, where fast charging and discharging is required due to their low cycle life. When used under high cycling rates, the cycle life of the battery is significantly reduced.

Lithium Nickel Manganese Cobalt Oxide (NMC): The cathode material is made of lithium, nickel, manganese, cobalt, and oxide. The variations of NMC such as NMC 111, NMC 311/622, and NMC 811 indicate varying composition of Ni, Mn, and Co in the cell. The cathode combination in NMC 111 is typically 33.3% Ni, 33.3% Mn and 33.3% of Co (1:1:1 ratio) whereas in NMC 811 the combination is typically 80.0% Ni, 10.0% Mn and 10.0% of Co (8:1:1 ratio). A minor compositional change in the material yields large performance benefits. Of all these chemistries, NMC possesses better cycle life, fast charge-discharge capability (c-rate) and high energy density. The overall optimum performance of NMC on all parameters has warranted that their growing used in e2Ws.

Lithium Iron Phosphate (LFP): LFP cathode includes three materials – lithium, iron and phosphate. The phosphate material has high decomposition temperature (>400°C), giving it a strong safety advantage in case of elevated temperature operations. LFP cells have cycle life and power capability comparable to NMC cells. However, their energy density is relatively lower. LFP cells have found good traction in the mobility sector, particularly for four wheelers and buses. Another key advantage of LFP is its reduced reliance on critical and scarce minerals. Unlike NMC, it does not require cobalt or nickel, making it a less mineral-intensive and more sustainable chemistry. Importantly, iron—one of its principal constituents—is abundantly available in India, which reduces dependence on imports and mitigates exposure to global supply chain volatility and commodity price fluctuations.

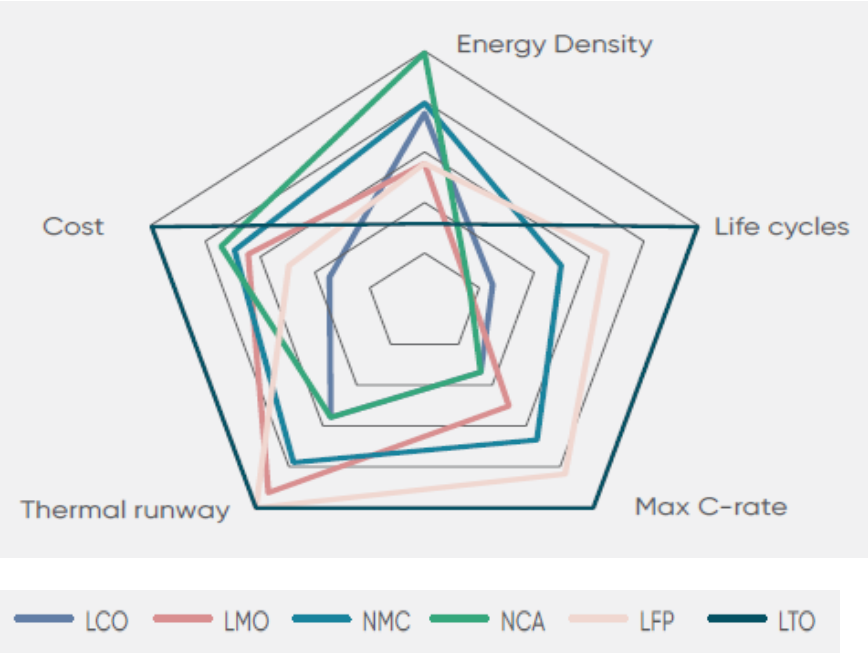
Lithium Titanium Oxide (LTO): In these cells, the anode LTO is made of lithium and titanium. The cathode may be either LMO, NMC, or LFP. The energy density of LTO cells is the lowest compared to other technologies, which means they need more cells to provide the same amount of energy storage which makes them an expensive solution compared to other chemistries. However, the cycle life of these cells is the highest amongst all, and batteries can provide a high charging and discharging rate, making them worthwhile for applications requiring quick charging and a high current. LTO can be cycled at extremely high c-rates without affecting the cycle life and thermal stability. This makes them ideal for electronic appliances, EVs, military systems, and rail systems.

Comparison of key battery chemistry

Parameter	Impact	NCA	NMC622	NMC111	LMO	LFP	LTO-LMO
Energy density (Wh/kg)	Range and number of cells	240-270	240-260	220-240	140-158	130-143	75-84
Energy density (Wh/L)	Range and size of the battery pack	650-680	650-670	600-650	350-358	270-282	175-186
Discharge and charge rates (c rates)	Fast charging and discharge rate	C/4-1C	C/4-2C	C/4-2C	C/4-3C	C/4-2C	C/4-10C
Cycle life	Number of charge and discharge cycles	1,000-1,500	3,800-4,000	3,000-3,500	800-1,000	3,800-4,000	8,000-10,000
Thermal stability (safety)	Safety, performance, and efficiency	150° C	210° C	210° C	250° C	400° C	250° C
Max. operating temperature	Performance degradation and capacity of battery	55° C	55° C	55° C	55° C	65° C	65° C

Source: WRI India

Radar map basis key battery specifications



Source: NITI Aayog
Note: Thermal Runway is indicative of highest temperature at which the thermal runway happens. Higher the value, higher the Thermal Safety and thereby safety of the battery

Future Battery Chemistries

The global electric vehicle battery industry is in a period of active technological evolution, with several next-generation chemistries advancing from research-stage development toward early-stage commercialisation. While lithium iron phosphate (LFP), nickel manganese cobalt (NMC), and nickel cobalt aluminium (NCA) currently dominate e2W production worldwide as assessed in the preceding subsection the medium-to-long-term competitive trajectory of the Indian electric two-wheeler segment will be meaningfully shaped by three emerging chemistries: lithium manganese iron phosphate (LMFP), sodium-ion batteries, solid-state batteries.

These three chemistries span a wide spectrum of commercial readiness. LMFP and silicon-anode technologies are closest to near-term adoption, representing evolutionary improvements upon the lithium-ion platform rather than wholesale departures from it. Sodium-ion batteries have recently entered early commercial deployment but face energy density limitations that constrain their immediate applicability in performance-oriented e2W segments. Solid-state batteries while offering transformative performance potential, remain pre-commercial and face substantial manufacturing and electrochemical barriers before cost-competitive deployment in automotive applications becomes feasible.

Lithium Manganese Iron Phosphate (LMFP): It is an olivine-structured cathode chemistry derived directly from LFP through partial substitution of iron with manganese, yielding a material with the general composition $Li(Fe_{1-x}Mn_x)PO_4$. This substitution elevates the average cell operating voltage from approximately 3.2 volts in standard LFP to approximately 3.6–3.8 volts, enabling a meaningful improvement in energy density without requiring the introduction of cobalt or nickel into the cathode composition. The olivine structural framework responsible for LFP's well-established thermal and chemical stability is preserved in LMFP, maintaining intrinsic resistance to exothermic decomposition under thermal stress.

LMFP's most commercially significant advantage is that it achieves higher energy density than LFP without introducing the cost, thermal, and supply-chain complexities associated with cobalt- and nickel-bearing cathodes. Against LFP, the

energy density improvement translates directly to extended vehicle range per unit of battery weight a meaningful differentiator in the e2W segment where battery pack dimensions are tightly constrained by vehicle platform design. Against NMC and NCA, LMFP retains the thermal safety margin of the olivine structure while eliminating cobalt and nickel entirely, removing the key raw material supply-chain vulnerabilities that weigh on the cost stability of layered oxide chemistries. For OEMs seeking to improve range without adopting costlier or thermally less stable cathode chemistries, LMFP represents a structurally attractive upgrade path.

The principal technical limitation of LMFP is manganese dissolution at elevated operating temperatures a consequence of the Jahn-Teller distortion associated with manganese ions which can accelerate capacity degradation over the battery's cycle life. Electrolyte formulations must also be adapted to accommodate LMFP's higher charge voltage window relative to standard LFP-grade electrolytes, requiring compositional modifications that add design complexity. These challenges are not insurmountable: manufacturers have addressed manganese dissolution through cathode surface coating techniques and electrolyte additive strategies. However, commercially verified long-term cycle life data at e2W-relevant operating conditions particularly in the context of Indian climate and duty-cycle profiles remains limited.

Sodium-Ion Batteries: Sodium-ion batteries (NaIBs) operate on an intercalation mechanism fundamentally similar to lithium-ion chemistry but utilise sodium (Na^+) as the charge-carrying ion in place of lithium. Sodium's substantially greater natural abundance and geographically dispersed occurrence confer potential advantages in raw material cost and supply chain resilience relative to lithium-based systems. Three principal cathode material families have been advanced commercially: layered transition metal oxides, Prussian blue analogues, and polyanionic compounds. Hard carbon, derived from biomass or synthetic precursors, is the most commercially mature anode option. A notable structural advantage of NaIBs is the ability to use aluminium current collectors on both the anode and cathode unlike lithium-ion, which requires copper for the anode reducing cell material costs given aluminium's lower unit price. At the performance level, current-generation commercial NaIBs achieve cell-level energy densities of approximately 100–160 Wh/kg, below both NMC and LFP. The chemistry demonstrates superior charge retention at sub-zero temperatures relative to lithium-ion alternatives and exhibits strong rate capability that is potentially favourable for fast-charging applications.

Sodium-ion batteries offer a sustainable, cheaper, and safer alternative to lithium-ion. Their primary advantages include dramatically lower production costs, exceptional thermal stability, superior cold-weather performance, and greater environmental sustainability

The central challenge for NaIBs in the e2W context is energy density. At current performance levels, delivering the 2–3 kWh of usable pack capacity required for a commuter scooter targeting 100–130 km of range would necessitate either a larger battery pack volume or greater battery mass compared with an equivalent LFP configuration directly constraining vehicle design and effective range economics. The nascent commercial ecosystem for NaIB cells covering electrolyte formulation, hard carbon precursor sourcing, and end-of-life recycling also introduces supply-chain complexity for Indian OEMs accustomed to a more mature lithium-ion procurement infrastructure.

Solid-State Batteries: Solid-state batteries (SSBs) represent a fundamental architectural departure from conventional lithium-ion cells, replacing the liquid or gel-polymer electrolyte with a solid ionic conductor thereby eliminating the flammable organic solvent component that constitutes the primary thermal runaway risk in liquid-electrolyte systems. Three principal solid electrolyte classes are under active development globally: inorganic oxide ceramics, most notably lithium lanthanum zirconium oxide (LLZO); inorganic sulfide-based compounds; and solid polymer electrolytes. The transition to a solid electrolyte also enables, in principle, the use of metallic lithium as the anode material, releasing the capacity constraint imposed by conventional graphite anodes and substantially increasing theoretical energy density. SSBs are projected to achieve cell-level energy densities in the range of 300–500 Wh/kg in advanced configurations employing lithium metal anodes, compared with approximately 200–300 Wh/kg for current-generation NMC-based commercial cells. Beyond energy density, SSBs offer improved thermal stability across a wider operating temperature

range, resistance to electrolyte leakage, and longer theoretical cycle life attributes of direct relevance to two-wheeler applications where compact pack design, safety, and service longevity are commercially material

The potential advantages of SSBs over current lithium-ion chemistries span multiple commercially relevant dimensions. The projected doubling or greater of achievable energy density enables significantly extended vehicle range without increasing battery pack volume or weight. Elimination of the flammable liquid electrolyte represents a qualitative rather than incremental improvement in cell-level safety, an attribute of heightened market and regulatory significance in the Indian e2W context, where battery thermal events have periodically attracted consumer and regulatory attention. The wider usable temperature window and longer theoretical cycle life offer additional commercial value in segments where total lifecycle cost of ownership is a key purchasing criterion.

Despite their considerable promise, SSBs face formidable commercialisation barriers that are not expected to be resolved within the near-to-medium-term horizon for cost-competitive, high-volume automotive applications. Interfacial resistance is the primary electrochemical challenge maintaining adequate ionic contact across solid-solid electrode interfaces under the volumetric changes that accompany cycling elevates internal cell resistance and degrades effective performance, particularly at ambient and sub-ambient temperatures.

Differentiators in battery pack design (Cell choice, Thermal management, BMS, Structural integrity, Battery software)

Within the electric two-wheeler industry, battery chemistry has progressively converged toward a small number of dominant electrochemical formulations principally Nickel Manganese Cobalt oxide (NMC) and Lithium Iron Phosphate (LFP) making raw chemistry an insufficient basis for sustained competitive differentiation. The cell, in isolation, determines only the theoretical energy storage potential and certain intrinsic safety and longevity characteristics; it does not determine how that potential is realised across the operational life of a vehicle deployed in varied and demanding real-world conditions. The manner in which cells are assembled, thermally managed, structurally protected, and electronically governed at the pack level has therefore emerged as the more consequential locus of product differentiation among electric two-wheeler OEMs. Two manufacturers sourcing cells from the same supplier to the same chemical specification can deliver substantially divergent outcomes in range delivery, safety incident frequency, battery longevity, and user experience differences attributable almost entirely to pack-level engineering choices.*)*

In the Indian electric two-wheeler market, these engineering choices carry particular analytical weight. The operating environment is demanding: ambient temperatures across much of the country routinely exceed 40°C during summer months; road surface quality varies considerably across urban, peri-urban, and rural geographies, subjecting battery packs to sustained vibration and mechanical stress; and the charging infrastructure, while expanding under progressive government support, remains concentrated in Tier I cities and select Tier II centres. Customers entering the segment for the first time carry limited prior familiarity with lithium-ion battery technology, making reliability and consistency of performance directly relevant to both initial purchase decisions and long-term brand equity. OEMs that have invested systematically in pack-level engineering have begun to exhibit measurable advantages in warranty claim experience, battery longevity metrics, and safety records factors that are increasingly material to the investment assessment of listed and soon-to-list companies in this segment.

Battery Pack Design

The battery pack in an electric two-wheeler is the complete integrated assembly comprising individual cells, interconnects and busbars, a structural enclosure or housing, a thermal management subsystem, and the mounting interface with the vehicle frame. While the cell governs the fundamental electrochemical characteristics of energy storage, the pack-level design determines how that energy is accessed, sustained, and protected across thousands of charge-discharge cycles under variable ambient and load conditions. Each major design choice within the pack thermal architecture, form factor, ingress protection, cell configuration reflects a set of engineering trade-offs with direct commercial implications.

Thermal management is among the most consequential dimensions of pack design, and is particularly critical in the Indian context. During both charging and discharging, electrochemical reactions within cells generate heat; if this heat is not adequately dissipated, cell temperatures rise, accelerating degradation mechanisms such as electrolyte decomposition and lithium plating, and in extreme cases precipitating thermal runaway an exothermic self-reinforcing cascade that can result in fire or structural failure of the pack. India's ambient temperature profile amplifies this risk materially. In states across the northwestern, central, and peninsular regions, peak summer ambient temperatures routinely exceed 42–45°C, a baseline that compresses the available thermal headroom within the pack before protection thresholds are approached. OEMs whose thermal management architectures were designed with more temperate reference conditions face a structural disadvantage in the Indian market that cannot be corrected solely through software intervention.

Passive thermal management relying on thermally conductive materials, strategic cell spacing, and natural airflow through the pack structure represents the predominant approach in volume-segment e2W products, where the cost premium associated with active systems is inconsistent with target vehicle pricing. Active liquid cooling systems, in which a coolant fluid is circulated through channels positioned adjacent to cell modules or within the pack housing, offer substantially more precise temperature regulation and the ability to maintain cell temperatures within a tighter operating band during sustained high-load scenarios such as extended urban stop-and-go traffic or loaded uphill riding. Premium e2W manufacturers targeting higher price segments have adopted liquid-cooled pack architectures for flagship products, and the performance advantages under Indian summer conditions represent a meaningful differentiator at that price point.

Pack form factors such as the physical geometry, volume, and mounting configuration of the battery within the vehicle chassis has implications for vehicle dynamics, serviceability, and the practical experience of ownership. Fixed, vehicle-integrated packs permit closer engineering integration with the frame structure, enabling more efficient use of available volume and a lower centre of gravity. Removable or swappable pack formats address access constraints for a significant segment of Indian urban consumers particularly those residing in multi-storey apartments where vehicle-level charging at a dedicated point is impractical by allowing the battery unit to be carried to a power outlet for charging or exchanged at a battery-swapping station. The engineering requirements of removable packs are distinct and non-trivial: the connector interface must maintain electrical integrity and ingress protection across many insertion and removal cycles, and the enclosure must be structurally self-sufficient.

Cell Choice

The selection of battery cells encompassing electrochemical chemistry, physical format, and supplier base is among the most consequential decisions in the product development process for an electric two-wheeler. It determines the foundational characteristics of the battery system in terms of energy density, cost per unit of stored energy, thermal stability, cycle life, and supply chain structure, with downstream implications for vehicle pricing, range capability, safety profile, and total cost of ownership over the vehicle's service life.

The two principal chemistries used in Indian e2W battery systems are NMC and LFP. NMC cells offer higher gravimetric and volumetric energy density, which allows OEMs to achieve greater range within the space and weight constraints of a two-wheeler platform, or to package equivalent range in a lighter and more compact pack. The higher energy density of NMC is particularly relevant at the premium end of the market, where range expectations are higher and the weight penalty of a larger LFP pack would affect ride dynamics. However, NMC cells are more thermally sensitive: they are more susceptible to capacity degradation at sustained elevated temperatures, and carry a higher risk of thermal runaway under abuse conditions including overcharging, physical damage, or fast charging at high ambient temperatures. LFP cells offer materially better thermal stability and a longer cycle life, sustaining a larger number of charge-discharge cycles before reaching end-of-life capacity thresholds. Their lower cost per kilowatt-hour, attributable in part to a cathode

formulation that does not include cobalt and uses less nickel, is also relevant in a price-sensitive market. In the Indian context, where vehicles are frequently charged at high ambient temperatures and customers may charge daily, LFP's superior thermal and cycle-life characteristics translate into practical ownership advantages.

The physical format of cells introduces additional trade-offs that affect pack architecture. Cylindrical cells particularly the 18650 and 21700 formats have historically been the dominant format in Indian e2W applications, supported by a mature global manufacturing ecosystem, established quality control standards developed across decades of consumer electronics and automotive application, and a demonstrated record of mechanical robustness. Cylindrical cells are mechanically self-supporting and tolerate vibration well, an attribute of practical value in the Indian operating environment. Pouch cells offer higher volumetric packing efficiency and allow more flexible pack geometries, but are more susceptible to swelling as a result of gas generation during cycling, requiring additional structural provisions. Prismatic cells, which dominate certain passenger EV segments globally, are less prevalent in two-wheeler applications due to form factor and weight constraints.

Battery management systems (BMS): BMS controls and monitors the battery condition that records the key operational parameters such as voltage, current, temperature and state of charge. The system provides inputs to the protection devices so that the circuits can generate alarms and disconnect the battery from the load or charger if any of the parameters exceeds the values set by the safety zone. Main parts of the BMS are battery controller, an electrical voltage detecting circuit, an electrical current detecting circuit, a temperature detecting circuit, and the battery pack safeguard circuit.

Battery controller is the brain of the BMS which monitors and manages the battery alongside connections with other BMS circuits and gives alarms if issues are found. The voltage detecting circuit detects the voltage of every single cell in the pack of batteries to ensure that all the cells in the battery pack are functioning within a safe range. The battery's current is measured by the current detecting circuit to make sure it is not above safe limits. The battery pack's temperature is monitored by the temperature detecting circuit, which ensures the temperature is not above or below safe limits. If any of the security restrictions are exceeded, a battery pack safeguard circuit cuts off the energy from the electric motor controller.

Battery thermal management system (BTMS)

BTMS helps to maintain the battery pack at its optimal temperature range regardless of ambient temperature. BTMS consists of heating and cooling systems that keep the battery temperature in a desired range. For each vehicle design, the required performance and cycle life of the battery pack will be considered to determine the specific set point for the battery pack temperature. BTMS can be active, passive and hybrid based on their operation. Passive systems are the most preferred BTMS in electric vehicles where heat is naturally dissipated into air through conduction/convection technology. Further, these are energy efficient and low cost as they draw no energy from the battery and do not require additional systems for heat dissipation. Active BTMS involves circulation of forced air or coolant into the cells. For forced air systems, fans may be used to circulate cold air through the battery cells. For liquid coolant systems, the liquid can be in direct contact with the cells, or it can be circulated through pipes. Thus, active BTMS draws energy from battery and requires additional systems. Hybrid BTMS means the combination of both active and passive cooling system.

Batteries often have Phase-change materials (PCMs) in them, which is another way of dissipating heat. PCMs are materials that manage heat by changing their phase. They go from solid to liquid or from liquid to vapor when absorbing heat, and back to their original state when expelling that heat. As the battery reaches a critical temperature, these materials undergo a phase transition, expelling heat very efficiently. PCMs are used for passive cooling. They are an integral part of the battery’s design and do not require additional components like fans or pumps that draw power for heat regulation.

Battery Casing

Battery casing is a container designed to protect and house batteries, shielding them from mechanical, thermal, and chemical damage. A well-designed battery case optimizes heat distribution, ensuring the efficient functioning of the battery cells or modules. The materials used in manufacturing battery casings must meet stringent requirements in terms of impact strength, thermal insulation, resistance to fire and electrical breakdowns. Common materials used for battery casings include:

- **Plastic**: Plastics are lightweight and cost-effective but offer lower thermal conductivity and mechanical strength compared to steel or aluminium. Plastic housing is commonly used in consumer electronics.
- **Steel**: Steel is a popular choice for battery casing due to its mechanical strength, chemical stability, and cost-effectiveness. However, its high density adds mass to the battery, reducing energy and power density.
- **Aluminium**: Aluminium is a lightweight and durable material that has low mass while maintaining good mechanical strength and thermal conductivity. It is resistant to corrosion and can be moulded into complex shapes, making it an advantageous alternative to steel. Aluminium casings have better thermal conductivity compared to steel and plastic, and hence dissipate heat better, but are also costlier than steel and plastic.
- **Composites**: Composite materials, such as carbon fiber-reinforced plastic (CFRP) and glass fiber-reinforced plastic (GFRP), are evolving as a suitable material for battery housing due to ongoing innovations. Composites are stronger and lighter than traditional materials, which can improve vehicle performance. However, they are more expensive compared to traditional materials.

Structural Integrity

Structural integrity, in the context of a battery pack, refers to the capacity of the pack assembly to withstand mechanical, thermal, and electrochemical stresses including road-induced vibration, physical impact, temperature cycling, and the internal mechanical changes within cells that occur across charge-discharge cycles without compromise to either safety or performance over the designed service life of the vehicle. In the Indian two-wheeler segment, where vehicles are operated across a wide range of road surface conditions and frequently at high utilisation rates, structural integrity is both a fundamental safety requirement and a primary determinant of long-run reliability and warranty cost performance.

The pack enclosure is the primary structural element providing external protection to the cell assembly, and material selection for the enclosure reflects a core engineering trade-off between weight, cost, thermal conductivity, and structural rigidity. Aluminium alloy enclosures offer high rigidity, effective passive heat dissipation from the pack surface, and resistance to deformation under impact loads, and their use is most prevalent in premium e2W segments where the cost premium is accommodated within the vehicle price point. Reinforced polymer composites are used in more cost-constrained applications where weight reduction is a priority. For OEMs targeting both segments, enclosure design must therefore be re-evaluated at each product tier rather than applied uniformly across the portfolio.

The internal architecture of the pack specifically whether cells are organised into discrete replaceable modules or integrated in a monolithic cell-to-pack configuration has implications for both structural performance and the economics of in-service battery maintenance. A modular architecture allows for targeted repair or replacement of degraded or damaged sections without disposal of the full pack. In the Indian market, where total cost of ownership is a pronounced consideration for a broad segment of the buyer population, the serviceability advantages of modular designs translate directly into customer confidence and reduced lifetime ownership cost. Modular designs also facilitate second-life battery applications. Partially degraded modules may retain sufficient capacity for repurposing in stationary energy storage a market in early development in India but expected to grow in line with the expanding e2W installed base.

Technology (Vertical integration/design control of key components, example of Atherstack)

The electric two-wheeler (e2W) industry in India has progressed through a foundational phase in which product differentiation was driven primarily by hardware-level parameters certified range, battery capacity, motor output, and peak charging speed and manufacturers best positioned to source capable components at competitive cost held meaningful market advantages. As battery cell chemistries, electric drivetrains, and power electronics have progressively standardised across the global supply base, the axis of competitive differentiation in the industry has undergone a structural shift. Technology ownership encompassing in-house software platforms, design control over performance-critical sub-systems, and the capacity to integrate hardware and software into a coherent vehicle architecture has emerged as an increasingly important determinant of product capability, long-cycle reliability, customer experience quality, and sustainable competitive positioning.

Vertical Integration in Electric Two-Wheelers

Vertical integration in the electric two-wheeler industry refers to the extent to which an OEM designs, controls, and internalises the development of key vehicle sub-systems, rather than procuring them as finished assemblies from third-party suppliers. This dimension of manufacturing strategy is particularly consequential in the e2W segment, given the central role that powertrain sub-systems battery packs, battery management systems, electric motors, motor controllers, and associated vehicle electronics play in determining vehicle performance, safety, and long-term reliability outcomes.

The structural profile of the electric powertrain creates a different set of vertical integration considerations compared with internal combustion engine (ICE) two-wheelers. The e2W powertrain is architecturally simpler, comprising a materially smaller number of mechanical sub-assemblies relative to an ICE drivetrain. This relative simplicity makes it technically feasible though capital-intensive for manufacturers with adequate engineering capacity to develop proprietary design control across one or more powertrain sub-system domains. The strategic calculus is, however, not uniform across manufacturers. OEMs must weigh the capital commitment and sustained operational investment required to build in-house design capability against the procurement flexibility offered by the established third-party supplier base, particularly during high-growth phases where supply chain agility may take precedence over proprietary development.

In the Indian e2W industry, the degree of vertical integration varies considerably across the competitive landscape. India's e2W segment has grown from a nascent base to one of the world's largest electric two-wheeler markets, characterised by a range of OEM strategies across design control, supply chain depth, and technology ownership. As the market matures, the structural differences between assembled-component strategies and proprietary technology platforms are increasingly visible in product performance, reliability outcomes, and customer experience quality.

The commercial rationale for deeper vertical integration typically encompasses several dimensions: greater visibility into and control over component-level cost structures; improved quality management over sub-systems whose performance is directly visible to the end customer; the ability to iterate on product features and calibration parameters without dependence on external supplier development timelines; and the gradual accumulation of proprietary design knowledge that is not exposed to competitive transfer through shared supply relationships. These strategic advantages are accompanied by material trade-offs. Vertical integration demands sustained capital allocation toward engineering, testing, and manufacturing infrastructure. It concentrates technical execution risk within the OEM organisation and requires longer gestation periods before investment in proprietary capability generates measurable commercial return.

Design Control of Key Components

Within the broader vertical integration framework, design control over specific sub-systems carries disproportionate strategic significance. The components over which proprietary design authority is most consequential in the e2W context

include the battery management system, thermal management architecture, the motor and controller assembly, and vehicle electronics and connectivity hardware.

The battery management system (BMS) governs the charge-discharge behaviour of individual battery cells, manages cell balancing across the pack, monitors operating temperatures, and enforces protective parameters to preserve pack safety and longevity across the vehicle's operational life. Manufacturers that develop proprietary BMS software and associated hardware are able to optimise these parameters specifically for their selected cell chemistry, vehicle architecture, and target use profile an outcome that is structurally difficult to achieve using generic third-party BMS solutions calibrated for broad compatibility across diverse cell types and vehicle configurations

Thermal management the sub-system responsible for maintaining battery pack and motor operating temperatures within safe and efficient ranges is of particular strategic importance in the Indian operating environment. India's climate diversity across geographies, combined with the prevalence of high-utilisation duty cycles characteristic of urban commuting, fleet, and last-mile logistics applications, creates thermal management requirements that differ materially from temperate-climate markets where many global component suppliers originally design their reference architectures. OEMs with in-house thermal management design capability can configure system architectures specifically for Indian ambient and utilisation conditions, rather than deploying solutions optimised for other geographies.

Motor and controller design is a further domain where proprietary capability can translate into product differentiation. An electric motor's performance characteristics are defined by its torque delivery profile across the speed range, efficiency under sustained load, and thermal headroom under peak-demand conditions. OEMs with in-house motor and controller design capability can specify these characteristics to target precise performance and efficiency outcomes, and can calibrate or iterate on designs without the lead-time constraints associated with external supplier engagement cycles. For manufacturers targeting performance-oriented product tiers, design authority over the motor-controller interface is particularly relevant to achieving differentiated ride characteristics and range outcomes.

Vehicle electronics including embedded computing hardware, instrument cluster architecture, sensor arrays, and communication module specifications represent an increasingly consequential design domain as e2Ws incorporate progressively more sophisticated connectivity features. OEMs that develop vehicle electronic architectures in-house retain flexibility in specifying performance requirements, cybersecurity protocols, and integration standards with proprietary software platforms, rather than accepting architectural constraints imposed by third-party hardware suppliers. In the context of connected e2W platforms, design authority over the electronics layer directly governs the quality and granularity of vehicle data that can be generated and utilised in service operations and product development feedback loops.

AtherStack

Ather Energy Limited is among the Indian e2W manufacturers that has developed and disclosed a strategy of building and maintaining a proprietary integrated technology platform. The company refers to this architecture as AtherStack a platform spanning vehicle operating software, electronics systems, connected vehicle infrastructure, and analytics capabilities, reported to have been substantially developed in-house.

By developing and controlling the software and electronics architecture across the vehicle and its connected-service infrastructure, the company is positioned to iterate on product capabilities at software-cycle timescales and to accumulate proprietary insights from its connected fleet at scale. In this respect, AtherStack is a case study in the deployment of

technology ownership as a competitive differentiator an approach that multiple Indian e2W manufacturers are pursuing to varying degrees and through varying architectural strategies.

Battery technology (LFP vs NMC / NCA)

The primary difference between battery technologies lies in their cathode chemistries. LFP (Lithium Iron Phosphate) prioritizes safety, longevity, and affordability, while NMC (Lithium Nickel Manganese Cobalt) and NCA (Lithium Nickel Cobalt Aluminum) prioritize energy density, cold-weather performance, and high-power output

Core Comparison

Feature	LFP (Lithium Iron Phosphate)	NMC/NCA (Nickel-Based)
Energy Density	Lower (160 Wh/kg). Bulkier and heavier for the same amount of capacity.	Higher (200 - 260 Wh/kg). Lighter and more compact.
Lifespan (Cycles)	Exceptional (2,000 to over 5,000+ cycles before dropping to 80% capacity).	Moderate (800 to 1,500) cycles.
Safety Profile	Superior. Highly resistant to thermal runaway/overheating.	Good, but requires careful monitoring by a Battery Management System (BMS).
Cold Weather	Struggles more in freezing temperatures; energy output can noticeably drop	Maintains better performance in sub-zero climate
Charging	Can be regularly charged to 100% without degrading the battery lifespan.	Should generally only be charged to (80-90%) for daily use to prevent faster degradation.
Cost	More affordable; relies on abundant iron and phosphate.	More expensive; relies on ethically and supply-constrained metals like cobalt and nickel.

Source: Crisil Intelligence

Understanding Chemistries

LFP (Lithium Iron Phosphate):

LFP is the fastest-growing chemistry, heavily utilized by manufacturers like Tesla. It uses abundant, non-conflict materials, making it cheaper and more environmentally friendly to produce. Because it can be charged to (100%) daily without long-term degradation penalties, it is highly favored for daily urban commuting and commercial fleets.

NMC & NCA:

NMC and NCA remain the gold standards for performance and range. By using nickel, manufacturers pack significantly more power into a smaller, lighter package. This makes them ideal for sports cars, long-distance highway travel, and devices where weight and space are strictly limited. However, they are sensitive to high ambient heat and degradation over time, and require stricter charging management

G. Challenges to the Electric Two-Wheeler Industry in India:

There are certain potential challenges that players in the Indian e2W industry like Ather Energy, Ola Electric Mobility, TVS Motors, Bajaj Auto, Hero MotoCorp etc. could face in the near future. These challenges will affect players differently based on their respective strategies:

Demand Side

- **Slowdown in economic activities impacting buying decision**

  India's GDP grew at 7.7% in fiscal 2026 and is expected to grow at a CAGR of 6% to 7% between fiscals 2026 and fiscal 2031. Any further moderation to GDP growth may have an impact on the incomes of people at large and hence the decision to buy two-wheelers

- **Above or below normal monsoons**

  We have considered a normal monsoon scenario while forecasting domestic sales till fiscal 2033 with some impact of El Nino considered in fiscal 2027. If rains are not normal then farm activities and farming output could be impacted which could adversely affect farm related incomes, rural sentiments, food prices and thereby inflation. This could directly impact demand for overall two-wheelers

- **Increase in vehicle cost of acquisition**

  The cost of vehicle acquisition rises when OEMs transfer the impact of increased manufacturing costs to the customers. In the past, the industry has seen price hikes owing to several reasons like increase in raw material prices and general inflationary hikes. These are also likely to push vehicle prices upwards going forward.

  It is also expected that going forward battery prices will further decline, and economies of scale will help EV OEMs to achieve profitability, thereby the price hikes might be nominal. However, there could be a scenario of potential supply chain shocks leading to rise in/ flattish battery prices, or a scenario of lower economies of scale, which might impact overall e2W costs and prices.

  Also, the cost of acquisition for e2Ws would continue to remain higher than their ICE counterparts over the next few years, which could continue to be a barrier to purchasing.

- **Vehicle Financing and Resale**

  Vehicle finance rates are also pivotal in determining affordability and cost of ownership for e2W customers. While financers have started to offer financing products for e2W, the uncertainty about the vehicle resale values is still a barrier as it impacts the confidence of financiers who aim for higher tenors. Due to relatively lower loan tenors being offered, the effective monthly EMI increases for the customers, leading to higher monthly outgo, thereby posing a barrier to purchase.

  Given that the battery contributes the majority of vehicle cost, there is still an uncertainty about the battery valuation, battery health/life and the overall resale value calculation for e2Ws. The overall EV resale ecosystem itself remains one of the biggest unknowns for the segment.

- **Increase in traffic density on account of increasing congestion**

  Increasing traffic congestion on roads, especially in urban centers is leading to longer transit times, which is also causing a rise in air pollution due to excessive burning of fuel. This problem is leading to more and more people

preferring to use public modes of transport, and is also driving the growth of public transport systems like metro, e-buses, ride hailing etc. The traffic congestion is expected to rise further owing to rapid urbanization, which could lead to customers deferring personal vehicle purchases going forward.

- **Charging Infrastructure**

  One of the major hurdles in adoption of EVs in India is the unavailability and slow development of public charging infrastructure. While e2Ws are sold with dedicated personal chargers, currently India has limited public charging infrastructure which poses a threat to mass scale adoption of EVs in the country. This is primarily because of range anxiety and anxiety of being unable to find a functional charger in case of sudden need.

- **Policy Uncertainty**

  Central policies like FAME, EMPS and PM e-Drive, and state wise subsidies, still have a direct impact on the electric vehicle sales in India. Uncertainty around these policies greatly influence e2W retails on a regular basis and absence of subsidies have impacted their retails in the past. Also, it is unknown as to when customer buying will become stable in the absence of any kind of subsidies.

- **Network Spread**

  Currently e2Ws are present at much lesser number of outlets as compared to ICE 2Ws in India. The number of customer touchpoints, both of sales as well as service, that cater to e2Ws, have a much-restricted geographical spread as compared to ICE 2Ws. While the OEMs are actively expanding their dealer networks for selling and servicing e2Ws, it will be a few years before they are able to match up the scale of the existing ICE 2W network. This could act as a barrier to adoption as customers might be wary of purchasing an e2W due to uncertainty of services for repairs or maintenance in vicinity in case of breakdowns.

Supply Side

- **Dependence on imports for key raw materials**

  Many OEMs in India are still dependent on suppliers based out of locations outside India for critical components including transmission systems, electronics, semi-conductors, magnets, rare earth materials etc. to name a few. Metals like lithium, magnesium, cobalt, nickel, etc. are needed for manufacturing EV batteries. Countries deficient in these resources need to depend on imports for manufacturing EVs from limited countries that possess the production capability as well as control the mines for these elements. Imports increase the cost of procurement of raw materials and hence overall cost of EVs.

  Also, any unprecedented global event, such as the West Asia conflict, could further elevate the raw material prices along with disrupting the entire supply chain for the same. Currently, India is highly dependent on imports for Lithium-ion cells and the dependency on imports along with the lack of robust supply chain network threatens the current supply of the batteries. While India recently discovered Lithium reserves in the country, commercialization and setting up the production capabilities of the same will take time, thereby making India dependent on imports for the medium term.

  While many EV suppliers have reached domestic content requirement as mentioned by the government, there are still a lot of component parts that need to be imported. For example, permanent magnets in electric motors, semiconductor chips, electronic child parts, and printed circuit boards (PCBs). Capability of Indian OEMs to manufacture and design these complex systems is currently limited owing to limited technical expertise, less availability of raw materials and intense investment requirement.

The government is trying to reduce dependence on these imports by driving several initiatives like Make In India, Atmanirbhar Campaign, PMP, PLI scheme, Customs Duty elimination and enabling FDI across sectors, but it may take some time for the OEMs to localize. Until then dependence on imports for certain components will continue to carry an inherent risk from supply, pricing and other risks which may emanate out of global macro-economic situations

- **Geo-political and supply chain risks**

  India is currently dependent on global markets, including China, for the import of battery cells. China dominates the global battery supply chain, from mineral processing to cell component manufacturing and cell manufacturing. Although China has less control over mineral extraction, mineral processing is dominated by China. When it comes to extraction of minerals, there is global concentration of Lithium reserves in Bolivia, Chile, Argentina and Australia; of Cobalt reserves in Democratic Republic of Congo; of copper reserves in Peru, Chile and Australia; and of Nickel reserves in Indonesia, Brazil, Australia and Philippines.

  India is highly dependent on China for battery cell, raw materials and semi-conductors. This makes India vulnerable to geo-political and supply chain risks. During the pandemic, the world faced semi-conductor shortage due to lockdowns in China and disruptions of operations in other supplier countries. Any similar global incidents, like pandemics, may greatly impact the electric vehicle industry in India in the future.

- **Commodity and input material prices**

  The Rs/USD exchange rate also directly impacts the input costs and fuel prices. A weak Rs exchange rate puts the burden on OEMs for deciding whether or not to pass on the costs to the consumer. Often these fluctuations are absorbed by the OEMs which may negatively impact their overall margins. For example, pricing and availability of commodities like steel and aluminum can be volatile due to numerous factors beyond our control, including general domestic and international economic conditions, geopolitical tensions, extreme weather shocks, import duties and tariffs and foreign currency exchange rates.

- **Availability of skilled manpower**

  The automotive industry is undergoing continuous and rapid technological change in terms of introduction of new powertrains like electric, hybrid and CNG, battery technologies, lightweighting, enhanced safety, growth of embedded software technology and driver controls, etc. These continuous advancements have lead to a constant demand for skilled manpower in the industry. Currently few OEMs are taking initiatives in developing the new age skills inhouse or participating in skill training initiatives by associating with various educational institutions and the government.

  However, there will still be an ever-growing demand for skilled manpower as the electric vehicle industry will continue to undergo technological advancements in the future and hence availability of manpower could turn out to be a challenge in case of demand supply mismatch.

- **Technology risk**

  With changing technology also comes the risk of obsolescence of older technologies. The automotive industry today faces the challenge of adapting newer technologies by either upgrading the older technologies or introducing new ones, thereby posing a risk in terms of capability development, investments, skill development, technology development and product development as well. For example, the field of battery technology is continuously evolving with current LFP and NMC battery technologies being challenged by newer technologies like solid state battery, LTO etc. Electric and hybrid technologies are also continuously evolving. Therefore, going forward, OEMs have to be cautious in terms of investing in technology and ensure positive yields.

- **Localization norms**

  The government is encouraging localization across sectors, especially in automotive sector via policies like PLI for Automotive Technology, PLI for Advanced Cell Chemistry, Phased Manufacturing Program, Atmanirbhar Bharat and Make in India. While the end goal of localization is to reduce import dependence, and bring down overall manufacturing costs, it also involves significant initial capital investments from several stakeholders within the automotive industry. While the government has designed the schemes to support investments by offering several subsidies and import duty benefits, there are still concerns around the meeting the eligibility criteria and availing the benefits. Going forward, simplification and better tracking of the policies will ensure localization in India.

- **Adhoc changes in policies**

  Another challenge that the industry is facing is frequent changes in policies which makes it difficult for auto industry stakeholders not only to ensure adherence but also commit investments. Overall policy stability and transparency will be required going forward to ensure smooth technology transition and localization in the country.

- **Increasing competition intensity**

  Several new players have entered the e2W space in the last few years, and the competition is expected only to rise further as investments increase, along with newer technologies and new product launches. Most of the current OEMs have announced future launches and with the increased number of vehicle options in the market, it will be a challenge to acquire more and more customers for each OEM going forward.

Conclusion

The electric two-wheeler (e2W) segment in India is poised for robust expansion, with volumes projected to grow at a CAGR of 35–37%, translating into a market penetration of 35–40% within the overall two-wheeler industry by fiscal 2033. While headwinds across supply and demand may pose intermittent challenges, the sector's long-term fundamentals remain compelling.

Crisil Intelligence underscores that sustained policy support, continued broadening of product portfolios, and a structural decline in battery costs—which will reduce both upfront acquisition prices and total cost of ownership—are expected to serve as key growth catalysts, underpinning steady and sustained expansion of the e2W industry.

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Crisil Intelligence is a leading provider of research, consulting, risk solutions and advanced data analytics, serving clients across government, private and public enterprises. We leverage our expertise in data-driven insights and strong benchmarking capabilities to help clients navigate complex external ecosystems, identify opportunities and mitigate risks. By combining cutting-edge analytics, machine learning and AI capabilities with deep industry knowledge, we empower our clients to make informed decisions, drive business growth and build resilient capacities.

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