

Section A: Outlook on India's Automotive Industry

India is emerging into a global manufacturing powerhouse of technology-led automobiles.

India's automotive market is undergoing a technology-led transformation, which will unlock the next wave of growth in the sector. Innovation in cell technology & the subsequent rise of EVs, increased adoption of software & electronics in vehicles, and government's impetus to domestic manufacturing of technologically advanced vehicles, are the core tenets of this transformation. **These advancements are likely to have a global impact, given India accounts for 15-20% of global production for 2W and is the 3rd largest 4W-Passenger Vehicle market in the world (in terms of sales volumes), with strong growth headroom in both segments.**

India automotive market consists of ~28Mn vehicles and is central to the economy.

India has a large automotive market, comprising annual production of ~28Mn vehicles as of FY 2024 (excluding electric rickshaws - Source: Society of Indian Automobile Manufacturers (SIAM)). **It is central to India's manufacturing sector and the overall economy, contributing ~35% to the manufacturing GDP and ~7% to the overall GDP in FY 2023. Further, the Indian government envisions improving contribution of the automotive industry to reach ~40% of the manufacturing GDP by FY 2026 (Source: Automotive Mission Plan 2016-26).**

While India's (and global) vehicle production experienced a short-term decline in the FY 2020 – FY 2022 period, (due to the global shortage of semiconductors, pandemic-induced lockdowns, increase in fuel prices and volatile geo-politics driven by the Russia-Ukraine conflict), it has recovered well to ~92% of FY 2019 levels (as of FY 2024). Despite having large two-wheeler (2W) and four-wheeler passenger-vehicles (4W-Passenger Vehicle) markets, India sees limited penetration, indicating a solid backdrop for medium to long-term volume growth.

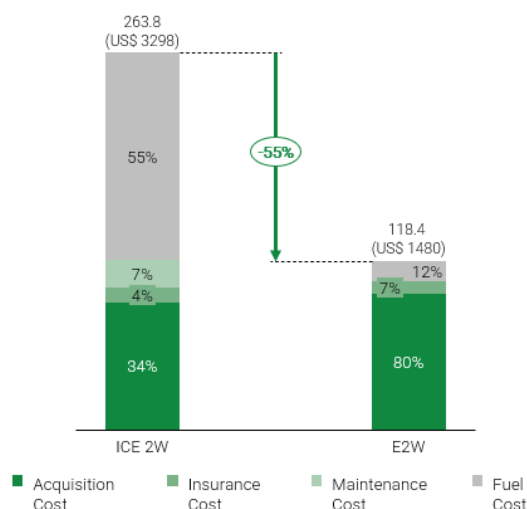
Technology is driving the next wave of growth in the automotive market, led by the following factors:

1. Advancement in Cell Technology is driving penetration of Electric Vehicles (EVs) – Cell technology development is making **EVs comparable to or better than their Internal Combustion Engine (ICE) counterparts, in terms of speed, range, and energy efficiency**. An EV uses cells to store and supply electrical energy (as per their composition chemistry). With the evolution of cell chemistry, the India (and global) market is transitioning towards globally popular lithium-ion based cells such as NMC (Nickel-Manganese-Cobalt Oxide Cathode) and LFP (Lithium Iron Phosphate), which offer unique benefits. Thermal runaway temperature and cycle life is higher in LFP batteries, which are robust but heavier. On the other hand, NMC batteries charge faster and have higher energy density, leading to higher range with a small size.

Further, **EVs have lower total cost of ownership (TCO) vs ICE vehicles**, for e.g., electric two wheelers (that have led EV adoption in India) have ~55% lower TCO vs their ICE counterparts over the life of the vehicle. This is driven by lower fuel costs (roughly 1/10th of ICE) and other savings on vehicle spends (maintenance, registration subsidies).

- Petrol & diesel prices have been on the rise in India in the last five years, due to high import dependence (import dependency of crude oil in FY 2024 was 87.7%, as per Ministry of Petroleum and Natural Gas) and increase in price of global crude oil. This along with the increase in the initial vehicle prices have raised the TCO of ICE vehicles.
- Unlike crude oil, the price of electricity in India follows a stable trend (generally lower than inflation), because India is a power surplus nation with total installed power generation capacity of ~441.9 GW as of 31 March 2024 (while its peak demand has only reached ~243.3 GW in the year 2023). Electricity generation in India is also cheaper than many of its global counterparts and efforts are being taken to maintain its affordability in the long run (e.g., revised framework of Day-ahead National level Merit Order Dispatch Mechanism).

Fig.1. Cost of ownership comparison of E2W scooter and ICE 2W scooter (as of 31 Mar 2024)
(in ₹ Thousands)

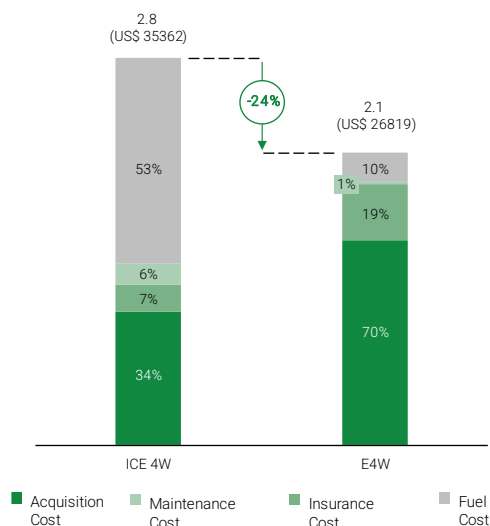


Source(s): Redseer Research and Analysis

Note(s): 1. Products Compared are Ola S1X+ and Leading 2W ICE scooter model in the comparable price range. Total Life of both Vehicles has been assumed to be 10 years (90,000 kms at 30 km per day and 300 days a year) 3. Acquisition Cost includes On-Road Price of the vehicles inclusive of GST 4. Maintenance and Insurance Costs have been calculated over the Life of the vehicle 5. 1 US\$ = ₹ 80

On similar lines, TCO for E4Ws is also ~24% lower than their equivalent ICE counterparts.

Fig.2. Cost of ownership comparison of E4W and ICE 4W (as of 31 Mar 2024)
(in ₹Mn)



Source(s): Redseer Research and Analysis

Note(s): 1. Products Compared are ICE 4W and E4W of same model of a Leading 4W OEM. Total Life of both Vehicles has been assumed to be 15 years; (270,000 kms at 60 km per day, 300 days a year) 3. Acquisition Cost includes On-Road Price of the vehicles inclusive of GST 4. Maintenance and Insurance Costs have been calculated over the Life of the vehicle 5. 1 US\$ = ₹ 80

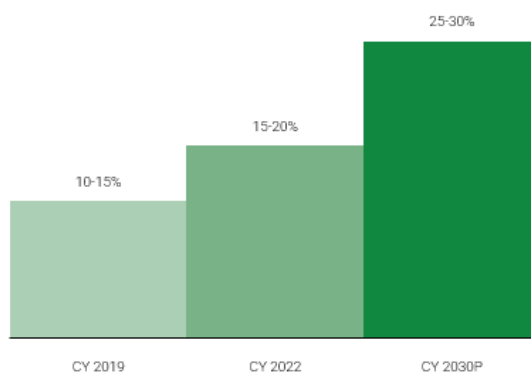
Moreover, **stronger software enablement** (than ICE vehicles) in EVs enables provision of next-generation features (e.g. connected vehicles, enhanced safety systems, vehicle to user communication and enhanced infotainment systems etc.) that enhance the driving experience.

Additionally, the rise of EVs will aid in achieving **India's promise to cut emissions to net zero** by CY 2070 (communicated at UN COP26 summit). Unlike ICE vehicles, EVs have zero tailpipe emissions. Moreover, the GHG emissions associated with an EV over its lifetime, are typically lower than those from an average ICE vehicle (Gasoline car GHG emissions are 2.6x of an EV with 300-mile range, as per illustrative estimates by United States Environmental Protection Agency), even when accounting for manufacturing. EVs also typically have a smaller carbon footprint than ICE vehicles even after considering the electricity used for charging. Further, 40% of India's installed electricity capacity comes from non-fossil fuel sources and measures are being taken to make power generation more sustainable (such as the National Hydrogen Mission, Viability Gap Funding support and Framework for Pumped Storage Projects).

2. Shift from 'commute-only' vehicles to 'computer-on-wheels'- Evolving customer needs around safety, performance, comfort, and utility are leading to an increased role of software and electronics in vehicles. India is incrementally aligning vehicle safety rules with global standards. Features like anti-lock braking, rear parking sensors, speed sensing door locks are already provided by OEM's. Moreover, advanced safety features like electronic stability control, emergency stop signal, emergency calling etc. have been mandated by the European Union and will drive Indian OEMs to further enhance safety features in their products.

As a result, the share of electronics (incl. semi-conductor chip) components as a percentage of the vehicle BOM (Bill of Materials) for cars has increased by 5-10 percentage points (of the total BOM cost) in the last 2-3 years. With the evolving electronic architecture and electrification of the vehicle powertrain, this share is projected to reach 25-30% of the vehicle (4W) BOM cost in CY 2030.

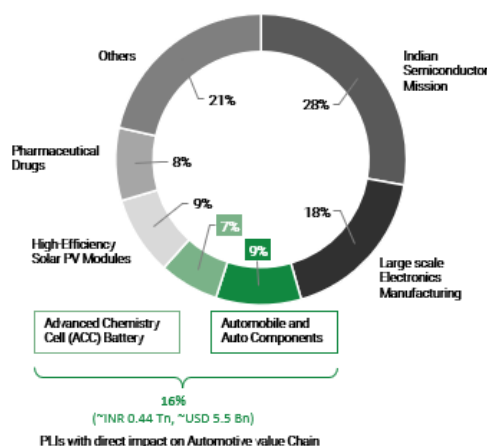
*Fig.3. Electronics as a % of Vehicle (4W car) BOM (CY 2019, CY 2022, CY 2030)
(as % of BOM Cost)*



Source(s): Redseer Estimates

3. Government's Impetus to Technologically Advanced Automotive Manufacturing in India-
 - a. **Production-linked Incentive (PLI) Schemes** – In 2020, the government launched PLI scheme to boost domestic manufacturing, cut down import bills, encourage exports and generate employment. These incentives are linked to incremental sales of new-age technology products manufactured domestically. The scheme invites foreign and local investors to set up new capacities and expand existing manufacturing units. With a budget of ₹ 2.73 Tn (US\$ 34.1 Bn), these schemes were launched across 14 sectors, to create national manufacturing champions and an additional production of ₹ 30 Tn (US\$ 375 Bn) over the next 5 years. The Automotive industry is a key beneficiary in the following PLI schemes:

Fig.4. Budget Allocation in the PLI Scheme – Sector-wise distribution
(as % of total PLI amount allocation)



Source(s): Invest India

Note(s): Others includes PLI for sectors such as Aviation, Food Processing, Medical Devices, Metals and Mining, Telecom, Textiles and Apparel

- i. Automobiles and auto components sector (budget: ₹ 259 Bn i.e., ~US\$ 3.2 Bn) The primary objectives of this PLI include overcoming cost disabilities, creating economies of scale, generating employment, building a robust supply chain for **Advanced Automotive Technology (AAT)** and higher value-added products. The PLI proposes financial incentives of up to 18% (sales-linked) to boost domestic manufacturing of AAT products (min. 50% domestic value addition will be required) and attract investments. The financial incentive under the scheme has been recently declared to be applicable from FY 2024 (though it was initially declared to be started from FY 2023) for a total of five consecutive financial years.
 - ii. 'Advanced Chemistry Cell (ACC) Battery' (budget: ₹ 181 Bn i.e., US\$ 2.3 Bn) Scheme was launched for setting up **ACC Battery Storage manufacturing** facilities in India, with a total manufacturing capacity of 50 Giga Watt-hour (GWh) for 5 years. Under the scheme, the production-linked subsidy is based per KWh and percentage of value addition achieved on actual sale for manufacturers who set up production units with a capacity of at least 5 GWh up to a maximum of 20GWh per company. The scheme will help develop a strong domestic supply chain for electric vehicle manufacturing.
 - iii. India Semiconductor Mission 2021 (budget: ₹ 760 Bn i.e., US\$ 9.5 Bn), included various schemes (such as semiconductor fabrication, display fabrication, compound semiconductor & semiconductor assembly, testing, making & packaging, and design-linked incentive). The scheme will lead to **tech-based innovation** and increased competitiveness of the Indian automotive market globally.
- b. **Faster Adoption and Manufacturing (of Hybrid &) Electric Vehicles in India (FAME)** - The scheme was launched in 2015 to enable a leapfrog to environmentally cleaner, sustainable, advanced, and more efficient electric vehicles-based system. Phase I (budget: ₹ 9.0 Bn (US\$ 0.1 Bn)) of the scheme was launched between FY 2015 and FY 2019, while Phase II (budget: ₹ 100 Bn (US\$ 1.3 Bn)) was launched in FY 2020 for 3 years and later extended up to FY 2024. Demand generation and charging infrastructure development have been the key objectives of the scheme.

Additionally, growth in investments, export potential, improving credit access and push towards domestic manufacturing, are also contributing to the automotive market growth.

1. Growth in Investments –The risk of supply chain shocks has never been more palpable than today, following compounding crises from the US-China trade issues, the COVID-19 pandemic, and the conflict in Ukraine. Manufacturers across the world are seeking supply-chain resilience, which would mean investment into diversification of the supply chain. (Source: Economic Survey FY 2023)

India's economic resilience, geopolitical stability, large & young working population resulting in cheap & abundant labour and simplified labour-laws make India an attractive alternative for global manufacturers (including automotive manufacturers). Moreover, youth upskilling initiatives like the National Skills Development Mission build a skilled workforce with depth of technical knowledge. Relative ease of doing business and high return potential in the Indian market also aid investment flow in the country.

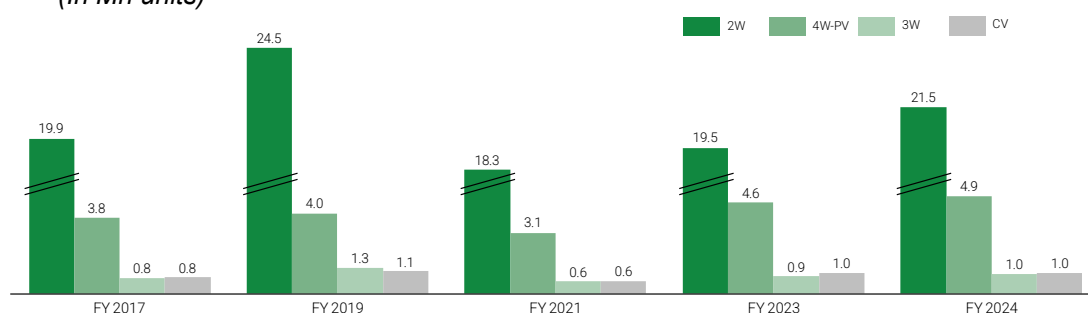
Further, automotive OEMs are focusing on increasing production capacities, as indicated by the growing private capex (~₹ 240 Bn i.e. US\$ ~3 Bn) in FY 2023 i.e., 4-5% of total Private sector capex). As per the Ministry of Heavy Industries, PLI scheme for AAT has also been successful in attracting proposed investment of ₹ 748.5 Bn (US\$ 9.4 bn) against the targeted investment of ₹425 Bn (US\$ 5.3 bn) over a period of five years. The scheme has also attracted foreign investments. Government's thrust on capex is improving supporting infrastructure through the development of national highways and electric charging infrastructure.

2. Export Potential – Of the total domestic vehicle production in FY 2024, ~16% (approximately 4.5 Mn vehicles) were exported. Driven by the recent geo-political concerns, global manufacturers are looking for alternatives to China as a production base. Also, India is seen as a market which produces high-quality, value-for-money vehicles suited for tropical climates and road conditions. Consequentially, **India stands to grab a bigger share of global exports**. Under the Export Promotion Capital Goods Scheme, import of capital goods at zero Customs duty for export production is being further rationalized.
3. Improving access to formalized credit – Steady progress in financial inclusion and growth in penetration of vehicle loans (major banks saw outstanding vehicle loans surge 20.5% Y-o-Y as on 29 December 2023, as per RBI data) suggest strong consumer demand.
4. Measures to strengthen domestic manufacturing – The government has imposed increased custom duties (5-10% increase across different vehicle types) on import of vehicles (Budget 2023-24) to promote localized manufacturing. This is expected to improve cost efficiency and affordability in the long run. Subsidies and tax & fee waivers are being used to fuel demand for domestically produced, especially clean energy, vehicles in the market by state and central governments.

2W, 3W, 4W-Passenger Vehicle and Commercial Vehicles are the key segments in India's automotive market.

India's automotive market is majorly distributed into the following four segments –

Fig.5. Automotive Vehicle Production Volume in India (FY 2017 – FY 2024)
(In Mn units)

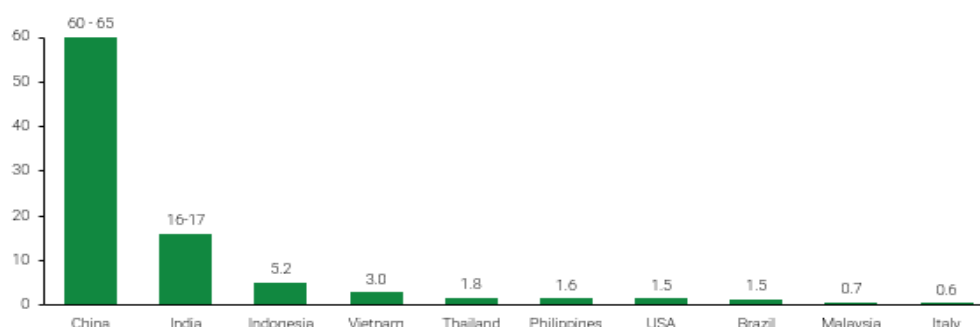


Note(s): 3Ws excluding electric rickshaws.

Source(s): Society of Indian Automobile Manufacturers (SIAM)

1. **Two-wheelers (2W)**– India is a global production hub for two-wheelers – a total of ~19.5 Mn 2W were produced in India in FY 2023 contributing 15-20% of the world's total 2W production, making it the second largest 2W producer in the world after China. Of the total production, ~4 Mn units were exported. 16-17 Mn units were sold domestically. Globally, **India is the second largest 2W market in terms of domestic sales volumes**. Value of 2W domestic market size in India was ₹1.4-1.6 Tn (US\$17-20 Bn) in FY 2023.

Fig 6. Two-Wheeler Domestic Sales – India vs Global Benchmarks (Key Countries by 2W Domestic sales) – CY 2022
(in Mn)



Source(s): Redseer Research

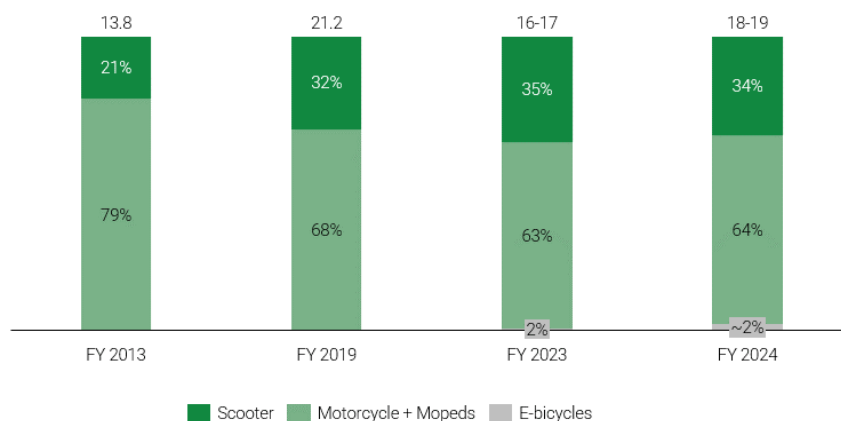
Note(s): 1. India: Figure for FY 2023

Multiple factors are pushing the personal mobility demand towards 2Ws:

- a. Need for affordable personal mobility – 2Ws offer greater reach and convenience than public transport facilities and modes of shared mobility, while also being more affordable than other personal mobility options (like 4W-Passenger Vehicles).
- b. Current state of road transport infrastructure – 2Ws are suitable to travel across unpaved (especially in smaller towns & rural areas) and traffic congested roads that require ease of maneuvering and, narrow lanes which do not allow bigger & bulkier 4Ws.
- c. Strong supply – Availability of wide 2W option range across price-points, fuel types and with multiple features etc., marketed specifically towards targeted age-groups, gender and income levels.
- d. Last-mile mobility – Travel requirements to reach public transport stations and increasing demand for last-mile deliveries (for industries such as food, ecommerce etc.). The latter will also fuel greater demand for electric 2Ws as players in these markets move towards meeting their sustainability commitments.

The 2W market is further segmented into scooters, motorcycles & mopeds and Low speed scooters & E-bicycles.

*Fig. 7. Segment-wise domestic two-wheeler share (FY 2013, FY 2019, FY 2023, FY 2024)
(in Mn, as % of domestic 2W sales)*



Source(s): Society of Indian Automobile Manufacturers, Redseer Estimates

Scooter sub-segment has grown quickly in past few years owing to:

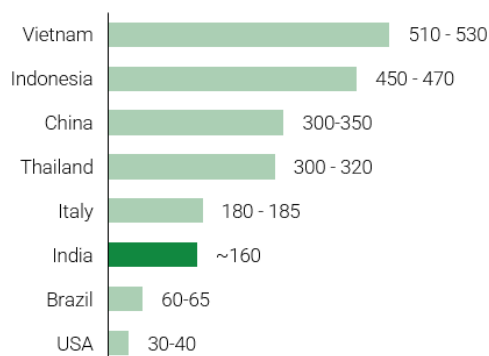
- Ease of learning & riding** – smaller structure, gearless, light-weight framework (which makes it the preferred choice for most women, old and inexperienced riders). This also pushes the demand in domestic and international tourism markets where people need rentals for temporary use.
- Utility and features** – Storage space, safer (low top speed), ease of maneuvering through congested roads.

Affordable price segments dominate both scooters and motorcycles (including mopeds), with 86% and 82% of sales volumes respectively in less than ₹100 thousand (<US\$ 1250) price bracket (at ex-showroom prices) in FY2024. This reflects the demand for 2Ws being driven by the growing middle-class population that has sizeable discretionary spend but is price conscious.

Despite large domestic volumes, there is headroom for 2Ws to grow in India.

High fuel prices and the resulting total cost of ownership (TCO) have limited 2W penetration to ~160 2Ws per '000 people in India in CY 2022, which is much lower than some of the SEA countries, suggesting a large headroom for 2W growth ahead.

Fig.8. 2W per '000 Population – India vs Global Benchmarks (CY 2022)
(Number of 2W units)

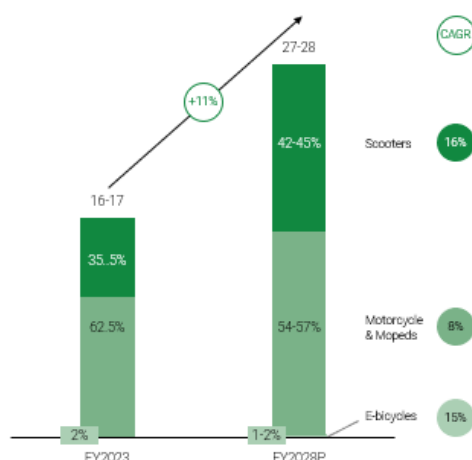


Source(s): World Population Prospects, Redseer Research

Note(s): 1. Global Markets for benchmarks have been selected with the consideration to cover key markets across North America (USA), LATAM (Brazil), Europe (Italy), Asia (China, India), South-East Asia (Indonesia, Vietnam, Thailand)

The domestic 2W sales are still recovering from the pandemic induced decline and have reached 16-17 Mn as of FY 2023 as opposed to the pre-pandemic levels of ~21 Mn. **The high growth potential of the segment along with the partially recovered small base is projected to drive strong growth in volumes at ~11% CAGR over the next 5 years.** This will enable the domestic 2W market to reach ₹2.8-3.6 Tn (US\$ 35-45 Bn) size by FY 2028. Growing middle class population, increasing urbanization-led demand and favorable policy frameworks are the major growth factors.

Fig.9. Two-Wheeler Domestic Sales Forecast – India (FY 2023, FY2028P)
(in Mn units)

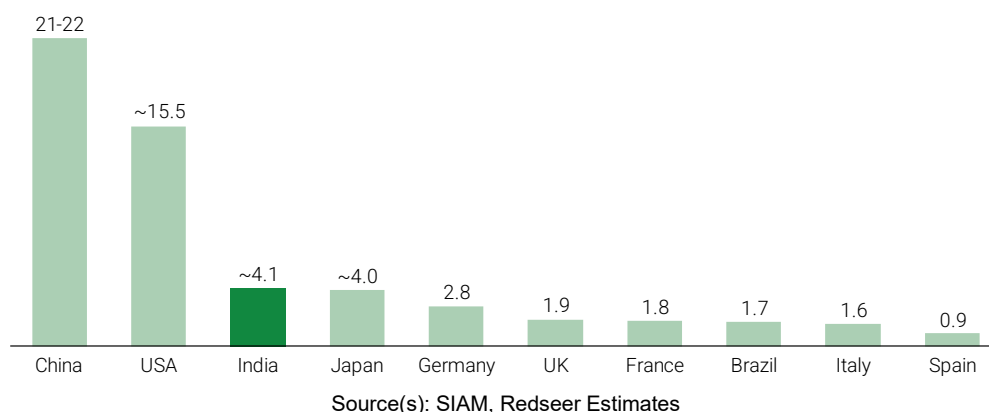


Source(s): Redseer Estimates

2. Four-Wheeler Passenger vehicles (4W-Passenger Vehicle) –This segment comprises cars of various sub-segments such as hatchbacks, sedans and utility vehicles.

As per SIAM, India produced ~4.6 Mn 4W-Passenger Vehicles in FY 2023, of which ~0.7 Mn were exported and 3.9 Mn were sold domestically (domestic opportunity size of ₹3.2-3.5 Tn (US\$ 40-45 Bn) at consumer prices). In terms of domestic sales, India was the world's **third largest 4W-Passenger Vehicle market** in CY 2023.

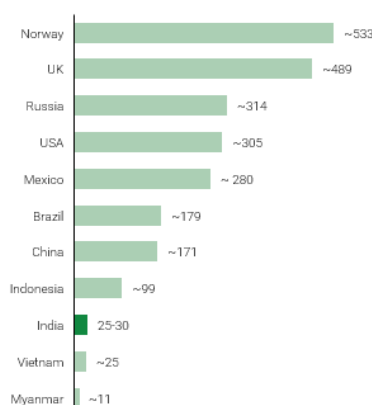
Fig.10. 4W Passenger Vehicles Domestic Sales – India vs Global Benchmarks (Key Countries by Domestic Car sales, CY 2023)
(in Mn units)



Large headroom is available for 4W growth in India.

As of CY 2022, India only had 25-30 4W-Passenger Vehicle per '000 population, which is roughly 1/12th of the USA and 1/7th of China, suggesting a large headroom for growth.

Fig.11. 4W Passenger Vehicles per '000 Population – India vs Global Benchmarks (CY 2022)
(Number of 4W Passenger Vehicle units per 1000 population)



Source(s): World Population Prospects, Redseer Research

Note(s): 1. Norway, UK, Mexico, Brazil, Vietnam, USA: Figures as of CY 2021; China: Figure as of CY 2020

- Global Markets for benchmarks have been selected with the consideration to cover leading and comparable markets across North America (USA, Mexico), LATAM (Brazil), Europe (Norway, UK, Russia), Asia (China, India), South-East Asia (Indonesia, Vietnam, Myanmar)

Cars are being adopted by a higher number of Indian households due to increased affordability led by growing income levels. Furthermore, premiumization trends can be seen with segments like compact SUVs growing faster than the other segments as consumers lean towards better drivability (across different road conditions), greater comfort and improved digital connectivity. Thus, entry-level hatchbacks will relent some market share to more premium segments, however affordability will continue to drive the overall demand. This along with other underlying drivers of automotive growth (e.g., reliance on localized components & fuel, development in road infrastructure and improving credit penetration) will fuel the growth for 4W-Passenger Vehicle ahead.

As a result, domestic sales in the 4W-Passenger Vehicle segment are projected to reach 5-6 Mn units in FY 2028, at a CAGR of ~6%. In terms of value, the market is projected to grow at a CAGR of 8-11% to reach ₹5.2-5.6 Tn (US\$65-70 Bn) size by FY 2028.

Fig. 12. (a) 4W Passenger Vehicles Domestic Sales Volume Forecast – India (FY 2023, FY 2028P)
(in Mn units)

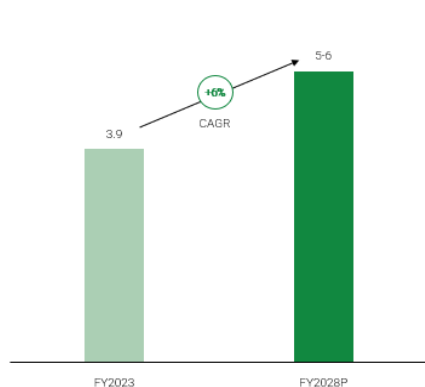
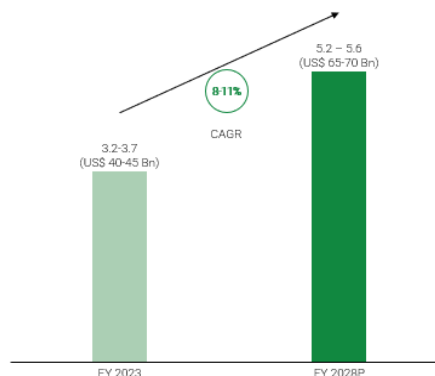


Fig. 12. (b) Value of 4W Passenger Vehicle Domestic Sales Forecast – India (FY 2023, FY 2028P),
(in ₹Tn)



Source(s): Redseer Estimates

4. **Commercial vehicles** – In FY 2023, 1 Mn commercial vehicles were produced in India, of which ~0.08 Mn were exported, and 0.96 Mn were sold domestically. Growth in the segment is driven by increasing govt. capex logistics, last mile mobility demand and development of national highways.
5. **Three-wheelers (3W)** – India is the largest producer of 3W in the world. The three-wheeler market segment includes vehicles used to transfer both passengers (e.g., auto rickshaws) and cargo (e.g., loading autos). 0.85 Mn 3Ws were produced in India, of which 0.36 Mn were exported and 0.48 Mn were sold domestically, as of FY 2023.

Section B: Electrification of India's Automotive Market

2Ws are leading the electrification of India's automotive market with growth prospects in the future.

2Ws are at the forefront of automotive electrification in India as Indian consumer is sensitive to initial vehicle price. **E2W adoption has grown to constitute ~5.4% of 2W registrations in FY 2024, primarily led by scooters. Moreover, EVs are likely to account for almost half of the domestic 2W sales volumes by FY 2028. E2W OEMs are also well placed to serve the exports opportunity of 100-110 Mn 2W units. Select E2W OEMs with greater control over manufacturing technology can also leverage the EV know-how to capture domestic E4W opportunity, taking their overall TAM to ₹ 8.0-9.1 Tn (US\$100 to 115 Bn) in FY 2028.**

Automotive Electrification in India is being led by 2Ws.

All automotive vehicle segments are witnessing the electrification wave. Shared mobility segments (3Ws, commercial vehicles and taxis) are undergoing electrification to achieve better operating economics (than ICE). eCommerce and logistics players have adopted EV fleets as part of their decarbonization commitments. Central and state governments are boosting the electrification of public buses. 3Ws are getting electrified on the back of exemptions from registration and road taxes.

Within personal mobility segments (2Ws and private 4W-Passenger Vehicles), 2Ws are well positioned to lead the electrification wave in India, unlike many developed markets. This is because of high

sensitivity of Indian consumers to the initial vehicle prices of EVs versus ICE vehicles (given the lower GNI per capita vs the developed markets).

- Adjusting for purchasing power parity, the average ₹200-500 thousand (i.e. US\$ 2500-6250) difference between the price of an E4W – Passenger Vehicles and ICE 4W -Passenger Vehicles in India, is quite high for an Indian consumer, unlike the consumers in the developed markets. On the contrary, the difference in prices of E2W over ICE 2Ws in India (₹20-70 thousand i.e. USD 250-875) is more palatable for Indian consumers, resulting in E2Ws leading the electrification in personal mobility automobiles.
- Reduced registration costs for EVs across states make the on-road price differential between E2Ws and ICE 2Ws smaller.

Furthermore, the TCO of an E2W breaks even with a comparable ICE vehicle in <2 years while that for an E4W breaks even with that of a comparable ICE 4W in 6-7 years (assuming total lifetime of 2Ws and 4Ws to be 10 years and 15 years respectively).

Moreover, leaner charging and infrastructural requirements of E2Ws over E4Ws also contribute to their faster adoption in India.

E2Ws have witnessed growth in India.

Fig. 13. (a) Electric 2W Registrations (FY 2018 to FY 2024) and Penetration of Overall 2W market in India

(Registrations in Mn units, Penetration as % of Overall 2W registrations)

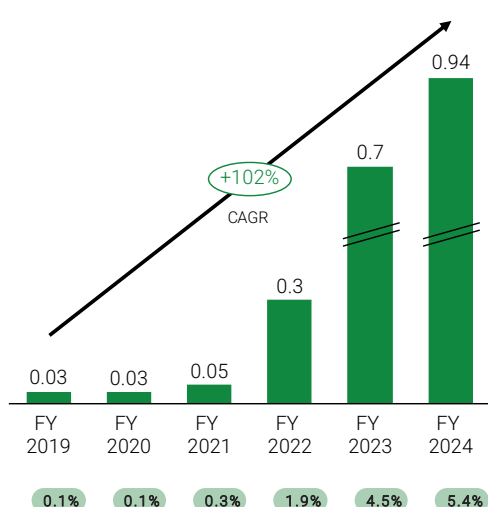
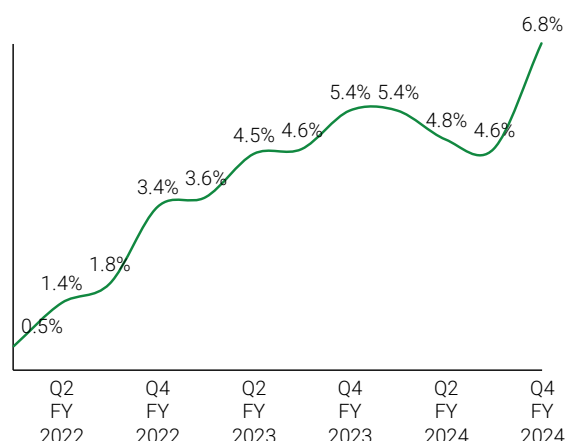


Fig. 13. (b) Electric 2W Penetration in India (Q1 FY 2022 to Q4 FY 2024)

(as % of Overall 2W Registrations)

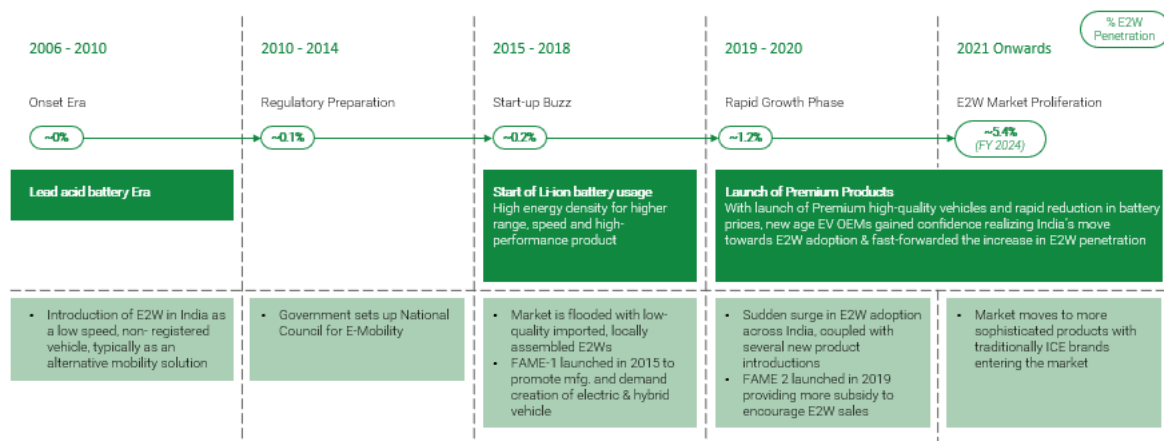


Source(s): Vahan Dashboard Data, Ministry of Road Transportation and Highways

Note: 1. Registration data from Vahan Dashboard does not include Low-speed scooters and E-bicycles sold, 2. Data for Telangana state is not available on Vahan Portal

E2Ws have seen an **accelerated adoption journey** in India, with the penetration increasing over 6x between FY 2021 and FY 2022 and over 2x between FY 2022 and FY 2023, to reach penetration levels of ~5.4% of the 2W registrations reported on the Vahan Dashboard (MoRTH) in FY 2024. It had increased to ~6.8% in Q4 FY 2024. E2W registrations (and subsequently penetration as % of overall 2W registrations) were marginally lower in Q2 FY2024 than the previous quarter due to reduction in FAME subsidy, effective from June 2023.

The journey started in 2007, when India saw the introduction of its first E2W. Since 2010, the government focused on EV adoption and initiated regulatory discussions and planning (including setting up the National Council for E-Mobility) to encourage reliable, affordable, and efficient EVs that meet consumer performance and price expectations.



Note: Penetration figures basis e2W registrations as percentage of overall 2W registrations in India for respective period

Key enablers of E2W adoption in India:

- National Electric Mobility Mission Plan 2020 was launched in 2013, covering multiple initiatives:
 - FAME (Phase I & II) – 86% of the FAME II policy's budget outlay has been allocated for the creation of demand. The new rules provide a demand incentive of ₹ 10,000 per KWh. The cap on incentives for E2Ws has been reduced to 15 per cent of the ex-factory price of vehicles from 40 per cent previously (effective from 1st June 2023).
 - The rate of Goods and Services Tax on electric vehicles has been kept in the lower bracket of 5% (with no cess) as against the 28% GST rate with cess up to 22% for ICE vehicles.
 - MoRTH also issued a notification in October 2018 which exempted electric vehicles from the requirement of obtaining permit for their usage as goods or passenger transport vehicles.
- Production-linked Incentive Scheme (PLI) for Automotive Sector (2021) (detailed in section A): The Scheme was open to existing automotive companies as well as new investors (who are currently not in automobile or auto component manufacturing business). Under the Champion OEM 2W & 3W scheme, 4 incumbent Automotive Investor OEMs (i.e. OEMs already present in the automotive space with ICE 2Ws or 3Ws) and 6 New Non-Automotive Investor OEMs have been approved.
- Production-linked Incentive Scheme (PLI) for Advanced Cell Chemistry (2021): The Program will boost domestic manufacturing and facilitate demand creation for both EVs and stationary battery storage. Three selected bidders (out of 10 received bids) signed the Program Agreement. Under this PLI, the manufacturing facility would have to be set up within a period of two years. The incentive will be disbursed thereafter over a period of five years on sale of batteries manufactured in India. In addition to the capacities allocated by the Ministry of Heavy Industries under the PLI Program, private players are expected to create battery manufacturing capacity to the tune of ~95 GWh.
- State based subsidies on EV are offered by several states in the range of ₹ 2,500-10,000 (US\$ 31–125) per KWh on EV purchase. The tax benefits, registration, and road tax waivers (different policies in different states) etc. further increased penetration in these markets.
- Charging Infra co-development by the government, automotive OEMs and focused startups, has also fueled E2W adoption. As of 31 March 2024, there were over 16000 operational public EV charging stations in India, (Source: Bureau of Energy Efficiency).

Scooters are leading the E2W penetration.

Stronger supply availability, compact and suitable designs, limited range anxiety, smaller (and lighter) batteries, lower initial price difference and growing popularity in the Indian market, have resulted in scooters leading India's E2W market. Within the scooter segment, premium scooters subsegment (priced (ex-showroom) >₹100 thousand i.e. US\$ 1250) have high electric penetration of ~77% (in FY 2024). With the projected decline in electric scooter prices, consumers are likely to see a higher number of options across price ranges, driving greater adoption in the lower price bracket as well.

Fig. 14. (a) Electric Scooter penetration in India (FY 2024)
(Mn, as % of total domestic scooter registrations)

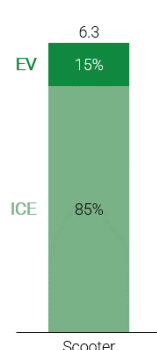
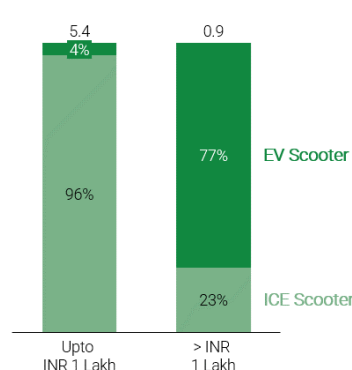


Fig. 14. (b) Price-segment-wise Electric Scooter Penetration in India (FY 2024)
(Mn, as % of domestic scooter registrations)



Source(s): SIAM, Vahan Dashboard Data (MoRTH), Redseer Estimates

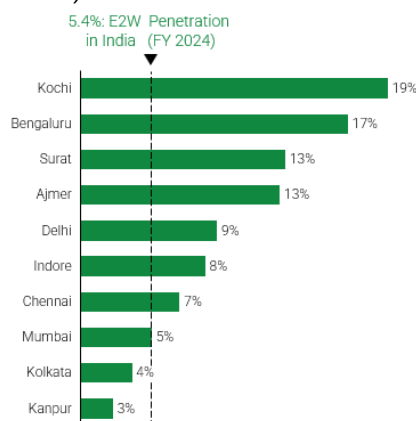
Note(s): 1. Ex-showroom price considered, 2. Data for Telangana state is not available on Vahan Portal

Limited options have restricted EV penetration in the motorcycle segment to <1%, with major EV play in the > ₹100 thousand price segment. With the strengthening of supply in popular price segments through R&D & technological advancements, penetration in the electric motorcycle segment is also expected to see an uptick.

E2Ws have also reached the smaller cities in India.

E2Ws are not only limited to the top cities but have also reached non-metro cities such as Kochi and Surat (with ~19% and ~13% E2W penetration respectively). Short & localized personal mobility needs in the smaller markets, wider distribution networks by E2W OEMs, government initiatives to promote universal household electrification & power infrastructure improvement, and focused financing support for low-mid income consumers, have driven universal adoption of E2Ws in the country.

Fig. 15. Electric Two-Wheeler penetration of selected cities of India (FY 2024)
(as % of Total 2W Registrations)

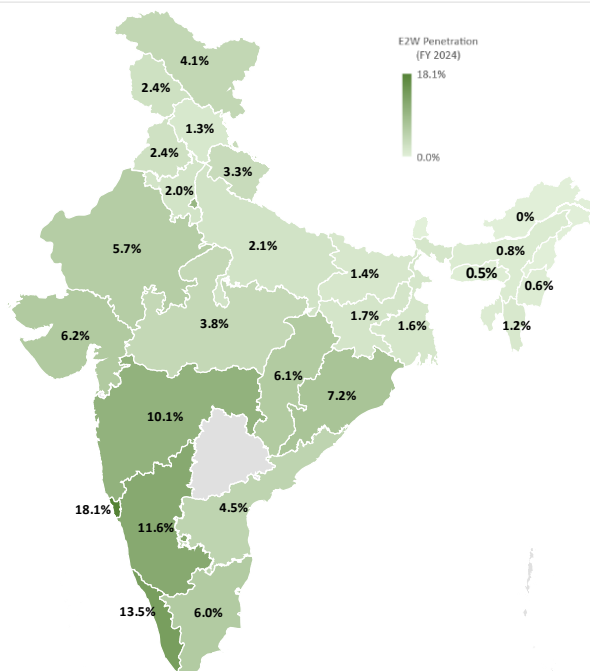


Source(s): Vahan Dashboard Data (MoRTH)

Note(s): 1. As per reported data from Regional Transport Offices (RTOs) in each city, 2. Data for Telangana state is not available on Vahan Portal

Certain states have also seen stronger E2W adoption than others, such as Goa (>15%), Kerala (>13%), Karnataka (>11%) and Maharashtra (>10%).

*Fig. 16. E2W Penetration – State Level – FY 2024
(% of 2W registrations)*

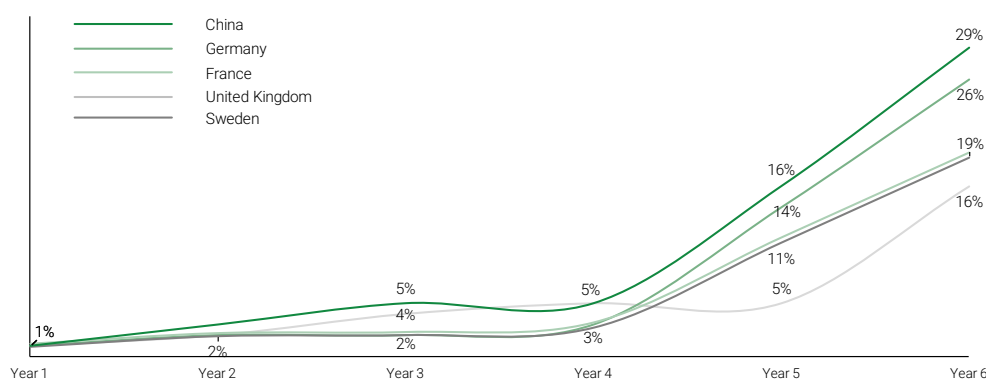


Source(s): Vahan Data (Ministry of Road Transportation and Highways)
Note(s): Data for Telangana state is not available on Vahan Portal

India's E2W penetration is potentially at an inflection point for growth ahead.

Mature EV markets denote that EV penetration levels of 3-5% in the leading vehicle segment, (E4Ws in these markets) have been followed by growth in EV adoption, driven by increased product awareness, greater user comfort and strong market supply. India is projected to follow suit to see rapid increase in E2W adoption in the next ~5 years.

*Fig. 17. E4W Penetration in Global Markets (Year 1 to Year 6)
(as % of total 4W domestic sales)*



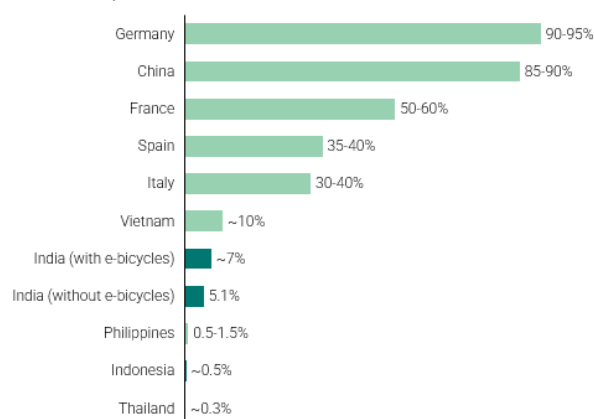
Source(s): 1. IEA, Electric car registrations and sales share in selected countries, 2018-2022, IEA, Paris
<https://www.iea.org/data-and-statistics/charts/electric-car-registrations-and-sales-share-in-selected-countries-2018-2022>, IEA.
Licence: CC BY 4.0
2. IEA (2023), Global EV Outlook 2023, IEA, Paris <https://www.iea.org/reports/global-ev-outlook-2023>, License: CC BY 4.0

3. IEA, Electric car registrations and sales share in selected European countries, 2018-2022, IEA, Paris
<https://www.iea.org/data-and-statistics/charts/electric-car-registrations-and-sales-share-in-selected-european-countries-2018-2022>, IEA. Licence: CC BY 4.0

- Note(s): 1. Year 1 represents the year when electric 4W penetration in the respective country was 1%
 2. This is a work derived by Redseer from IEA material and Redseer is solely liable and responsible for this derived work. The derived work is not endorsed by the IEA in any manner.

Moreover, there is a significant growth headroom in terms of E2W penetration when compared to the global markets. While Vietnam's electric vehicle market sees significant share from lead acid electric vehicles which are banned in India by the Transport Authority in certain vehicle types, the penetration in China and European markets shows how E2W adoption can grow on the back of regulatory support and strong supply. India has been following a similar journey, which is expected to yield sizeable growth in E2W penetration.

**Fig.18. Electric 2W Sales Penetration – global benchmarks (CY 2022 unless specified)
 (as % of Domestic 2W Sales)**

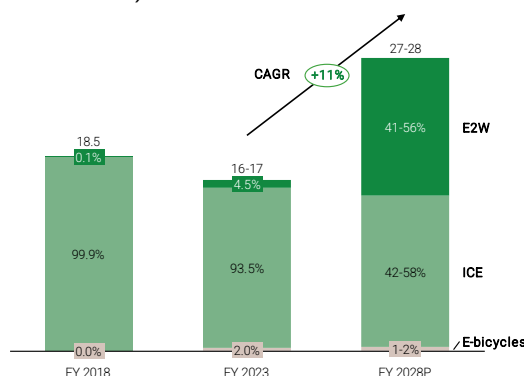


Source(s): Redseer Research and Analysis

Note(s): 1. India: Figure as of H1 FY 2024; Vietnam: Figure as of 2021; 2. Figures include E-bicycles 3. France, Germany, Italy, Spain, and UK: Motorcycle figures Includes L3e, L4e and L5e categories.

As a result, **E2W penetration is projected to grow to 41-56% of the domestic volumes in FY 2028.**

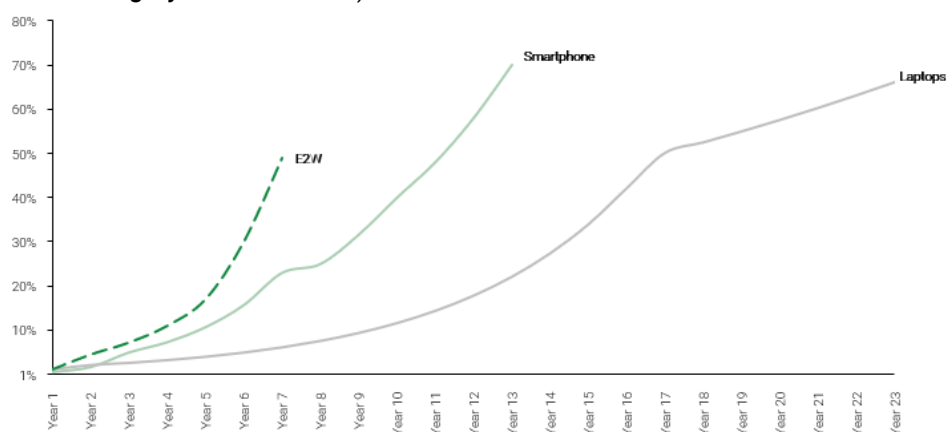
**Fig. 19. Electric Two-Wheeler Penetration Projection (FY 2018, FY 2023 and FY 2028P)
 (in Mn, % of Two-Wheeler Sales)**



Source(s): Redseer Research and Estimates

As per these estimates, E2Ws (1% in 2022 to ~50% penetration in 2028-2029) are expected to see faster adoption than other disruptive technologies like smartphones (1% to 50% penetration in 11-12 years) and laptops (1% to 50% penetration in 17-18 years).

Fig. 20. Category sales penetration curves for Smartphones, Laptops and E2Ws (as % of category sales volumes)



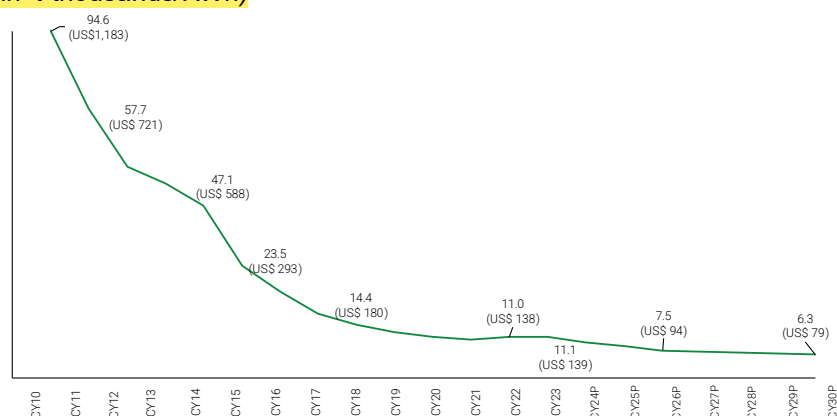
Source(s): Redseer Research & Estimates

Note(s): 1. Year 1 represents the year when technology achieved 1% category sales penetration

Multiple factors are expected to drive the steep adoption of E2Ws in India.

1. Reduction in initial vehicle price (led by the drop in Battery Price) – Battery pack (primarily constituted by cell and BMS) contributes to 35-40% of an E2W's Bill of Materials (BOM) cost. Global E2W battery pack prices have reduced by ~88% between CY2010 and CY2023, reducing from ₹ 94.6 thousand/kWh (US\$ 1183/kWh) to ₹ 11.1 thousand/kWh (US\$ 139/kWh). This has been due to the fall in the prices of cell raw materials, innovation in cell chemistry (e.g. increased usage of cheaper and abundant materials in the cell composition such as iron phosphate in LFP i.e. Lithium, iron phosphate batteries), greater supply of cell manufacturers and, increase in energy density (which has made batteries smaller, lighter and cheaper). Further, a ~43% reduction in global battery pack prices is projected in the next 7-8 years.

Fig.21. Global Li-ion Battery Pack price trend (CY2020 to CY2030P)
(in ₹ thousands/KWh)



Source(s): IEA, Evolution of Li-ion battery price, 1995-2019, IEA, Paris <https://www.iea.org/data-and-statistics/charts/evolution-of-li-ion-battery-price-1995-2019>, IEA. Licence: CC BY 4.0, Redseer Research

Note: This is a work derived by Redseer from IEA material and Redseer is solely liable and responsible for this derived work.
The derived work is not endorsed by the IEA in any manner

2. Easing access to 'Electric fuel' and improving driving range – While ICE 2Ws need to be refueled at stations, 'fuel' for E2Ws comes home for its users – leading to lesser energy loss, smaller refueling costs and greater convenience. A single battery charge provides a range of 70-115 km on

an average (for lithium-ion batteries) for E2Ws. Ongoing improvements in the EV driving range (e.g. increasing battery density) are solving range anxiety, one of the primary challenges to EV adoption.

The Ministry of Power has allowed sale of electricity as 'service' for charging of electric vehicles incentivizing investments in charging infrastructure. Under Phase II of the FAME India scheme, Ministry of Heavy Industries has also sanctioned Rs. 800 Cr. as capital subsidy to the three Oil Marketing Companies (OMCs) of the Ministry of Petroleum and Natural Gas (MoPNG) for establishment of 7,432 electric vehicle public charging stations. Further, 148 EV Charging Stations were sanctioned to other entities under this scheme. As of 31 March 2024, there were over 16,000 operational public EV charging stations in India (Source: Bureau of Energy Efficiency).

Multiple categories of charging options being provided by various parties in India:

- a) Charging at residences/offices using existing electricity connections and Electric Vehicle Supply Equipment.
 - b) Public Charging Stations installed by EV-OEMs or Non-OEMs in the EV charging space, including fast-charging stations that allow quicker charging of the company specific EVs.
 - c) Battery Swapping Stations where any discharged or partially charged EV battery can be replaced.
3. Scale Expansion by E2W OEMs – As opposed to the domestic ICE 2W market, which is heavily dominated by traditional OEMs, E2W is more democratized in terms of supply. Easier product assembly due to fewer moving parts and availability of certain components for off-the-shelf purchase along with regulatory support have encouraged new entrants in the market. E2W OEMs will also be able to scale faster through quicker product diversification – they will be able to develop new offerings (customized variants, new models) more easily than traditional ICE OEMs. They can utilize different configuration and combinations of constituent components such as battery, motor etc. (with different ratings and capacities) to introduce newer products much faster than their ICE counterparts. Typically, ICE variants require higher level of analysis and modifications at component level (viz. engine, body shape and internal configuration) and manufacturing level. Growing demand has also pushed traditional OEMs to increase their E2W production capacity.
 4. Serving a variety of use-cases— E2Ws have piqued the interest of all industries providing last mile and hyperlocal deliveries (e.g. online food & grocery delivery, last-mile couriers, at-home beauticians / handymen etc.) as well as ride-hailing services (2W taxi), owing to better economics and lower carbon footprint. E2W OEMs are designing specific products to serve the B2B use cases which include features like greater carrying space (rather than the conventional pillion seat), longer range over single charge etc. Innovations like swappable batteries also have the potential to accelerate B2B adoption.
 5. Service network – While servicing and maintenance needs in E2Ws are low, owing to lesser number of moving parts (as compared to ICE 2Ws), dedicated servicing & repair fleets are being developed by OEMs to cater to occasional customer demand. Given E2Ws' high technological depth and complexity, the after-sale service market for E2Ws is expected to stay largely organized and OEM controlled. However, repair and service centers for EVs are not yet developed compared to ICE vehicles.
 6. Consistent government push – Persistent regulatory support across supply, demand, infrastructure, and financing etc. for EVs is expected to continue.

Electrification is a “flywheel” and will accelerate the overall 2W adoption in India

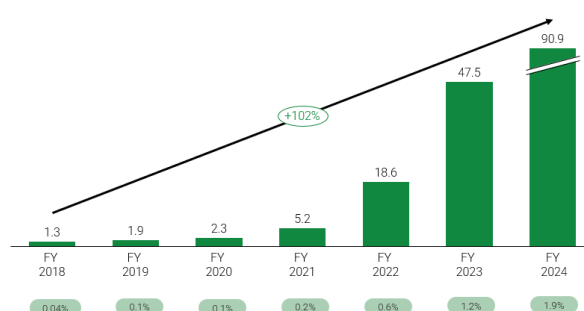
E2Ws are likely to capture not just the 'replacement' demand but also generate new 2W demand by tapping interest from households that do not currently own 2Ws, but look for lower cost of ownership, better performance, and sustainability. Moreover, by providing use-case specific design and efficiency,

E2Ws are projected to better capture the emerging demand in the last mile and hyperlocal delivery segments. Thus, continuous flow of the electrification flywheel will accelerate the overall 2W adoption in India.

Certain E2Ws OEMs can also capture domestic E4W market and E2W export opportunities.

1. Domestic 4W Electrification- Government subsidies, EV specific car loans, significant tax rebates, lower running costs and negligible maintenance costs pushed the initial demand for electric vehicles in the 4W-Passenger Vehicle market. Traditional ICE OEMs entering the EV market and tech-led reduction in input prices, have built a supply of affordable electric cars in India. On the back of these growth factors, **EVs penetrated ~1.9% of the overall 4W registrations in FY 2024**, as per the vehicle registrations reported by MoRTH (Ministry of Road Transport and Highways) on the Vahan portal.

*Fig.22. Electric Four-Wheeler sales and Penetration in India (FY 2018 to FY 2024)
(In 000 units, penetration as % of total 4W domestic sales volume)*

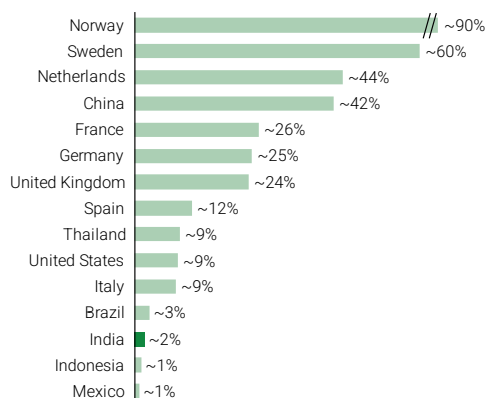


Source(s): Vahan Dashboard Data (MoRTH)

Note(s): Data for Telangana state is not available on Vahan Portal

Yet, E4W penetration is much lower than 2Ws, because of higher initial prices vs ICE, lack of charging space in Indian households, limited supply with few players in the market, underdeveloped charging and servicing infrastructure. Most OEMs in the nascent India E4W market are ICE-OEMs cross-utilizing their existing ICE-4W platforms to produce E4Ws. There is a large headroom available for E4W penetration in India (as compared to the global markets), creating space for more OEMs to enter the market and for OEMs to advance their EV production approaches.

*Fig.23. E4W Penetration – Global Benchmark (CY 2023)
(As % of total 4W domestic sales volume)*



Source(s): Redseer Research and Analysis

Note(s): 1. Global Markets for benchmarks have been selected with the consideration to cover leading and comparable markets across North America (US, Mexico), LATAM (Brazil), Europe (Germany, Norway, Sweden, Netherlands, UK, France, Italy,

Spain), Asia (China, India), South-East Asia (Thailand, Indonesia) 2. Figures include Battery Electric Vehicles (BEV) and Plug-in Hybrid Electric Vehicles (PHEV)

Growth in E4W penetration in Norway and Sweden has been driven by strong policy interventions, aimed at reducing the purchase price of electric vehicles and deployment of charging infrastructure. With a similar government-led emphasis in India, along with supply strengthening, increased consumer education & awareness around advanced feature set, improved product experience and lower total costs of ownership, **E4W penetration is projected to reach 11-13% of total 4W-Passenger Vehicle sales volume by FY 2028.**

Fig.24. (a) E4W sales and Penetration in India (FY 2018, FY 2023 and FY 2028P)
(In Mn, penetration as % of Total 4W-Passenger Vehicle Domestic Sales)

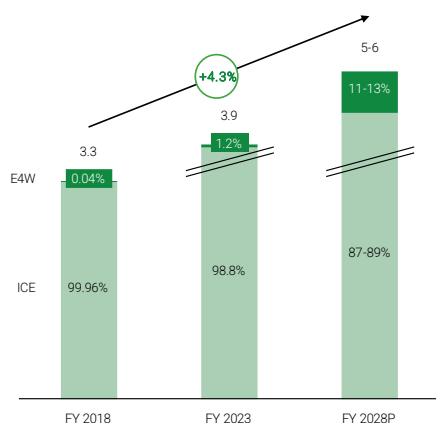
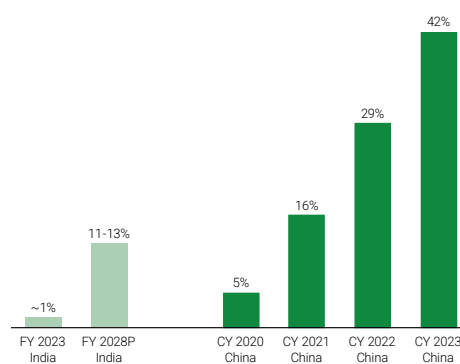


Fig. 24. (b) E4W Penetration in China (CY 2020 - CY 2023) and comparison with India
(penetration as % of Total 4W-Passenger Vehicle Domestic Sales)



Source(s): 1. India: Vahan Dashboard Data (MoRTH), Redseer Estimates, 2. China: As per IEA (2023), Global EV Outlook 2023, IEA, Paris <https://www.iea.org/reports/global-ev-outlook-2023>, License: CC BY 4.0, China Association of Automobile Manufacturers

Note(s): Data for Telangana state is not available on Vahan Portal

E2W OEMs, who own the EV's manufacturing technology, are well equipped to extend their play in the E4W segment and unlock a part of the growth potential. Specifically, ownership of the cell technology and vehicle software will be crucial to drive extendibility in the E4W segment. Further, E2W OEMs can cross-leverage portions of their supply-chain and EV brand to command a strong position in the E4W market.

2. **2W Exports** – India is globally the second largest market in terms of domestic sales of 2Ws. Other global key markets of 2Ws (in terms of sales) include China (~60-65 Mn), Indonesia (~5 Mn), Vietnam (~3 Mn) and Thailand (~2 Mn) as of CY 2022. **~18% of the 2W volumes produced in India have been exported in the last 5 years (FY 2019 to FY 2023).** Indian climate, traffic, road, and riding conditions that require robust, sturdy high-quality products, have has created a strong image for Indian 2Ws globally.

This provides a strong export opportunity for domestically produced E2Ws, which are more efficient & sustainable and available at a slightly higher initial price (vs ICE 2Ws). **Furthermore, the government is facilitating increase in exports under the Export Promotion of Capital Goods Scheme where battery electric vehicles of all types will be eligible for reduced export obligation requirement.** Custom duty exemptions have also been provided on imported capital goods required to manufacture lithium-ion cells for EV batteries, to maintain global competitiveness and enhance their exports.

Emerging markets such as Africa, LATAM and SEA countries which see thriving 2W demand can serve as significant export opportunities. These markets currently constitute ~75% of India's 2W

exports and therefore share stable and established trade relations. Promising demand in these markets is under-tapped due to limited domestic E2W supply in these markets.

In addition, mature western markets like Europe, which contribute a major share to China's E2W exports, hold great demand potential owing to mature customer sensibilities and rapidly growing awareness about sustainability. Growing tension in trade relations between the western markets and China (20-80% tariffs have been levied by the United States and European Union on Chinese imports), can create greater demand for better value Indian alternatives. The total addressable market for 2W exports from India is ₹ 7.2-8.0 Tn (US\$ 90-100 Bn).

Huge addressable market is available for E2W OEMs.

As a result of the above, E2W players are addressing a large and promising domestic vehicle market of ~20 Mn unit sales volume in FY 2023 (~5.2 Mn scooters, ~10.8 Mn motorcycles, ~3.9 Mn 4W-Passenger Vehicles), which is projected to grow to ~32 Mn units annual sales volume by FY 2028 (~12 Mn scooters, ~15 Mn motorcycles, ~5 Mn 4W-Passenger Vehicles). This translates into a TAM of ₹ 4.5-5.4 Tn (US\$55-65 Bn) in FY 2023, which is projected to reach ₹8.0-9.1 Tn (US\$100-115 Bn) by FY 2028.

Fig.25. (a) Total Addressable Market (Domestic Sales of Motorcycle & Mopeds, Scooters and 4W) in India (FY 2023 and FY 2028P)
(In ₹Tn)

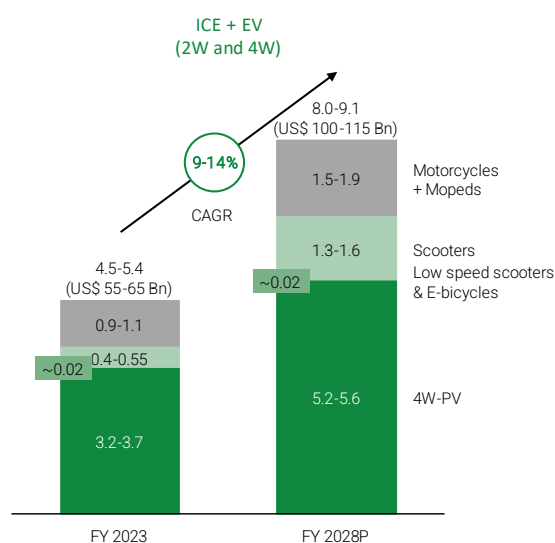
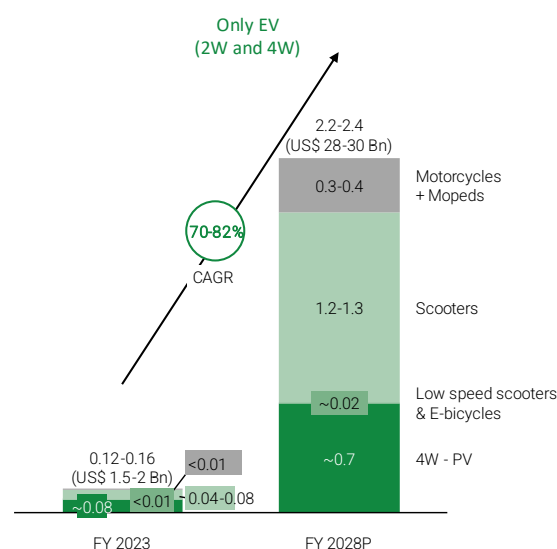


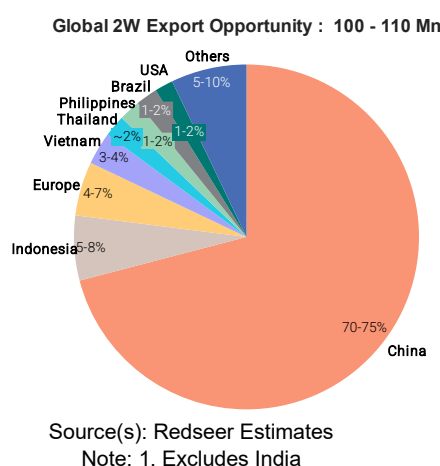
Fig. 25. (b) Electric Vehicle sales - Motorcycle & Mopeds, Scooters and 4W in India (FY 2023 and FY 2028P)
(In ₹ Tn)



Source(s): Redseer Estimates

In addition, 2W exports provide a global market opportunity of 100-110 Mn units.

Fig.26. 2W Export Opportunity for India (CY2022)
(% share of country / region in total global 2W sales)



Section C: Global Business Models and Success Factors

Global EV players can be categorised into "Disruptors", which are pure-bred EV OEMs and "Others", which are OEMs having existing ICE 2W products and have also introduced Electric 2W products in India. These also include subsidiary companies of such OEMs. Global market-leading Disruptor OEMs follow a vertically integrated approach which involves ownership and development of EV technology elements such as cells, battery pack, software, motor & drive-train and electronics & electricals etc., along with their interplay with each other and rest of the EV components. Disruptor OEMs have scaled well to cover ~67% of the E2W domestic sales by volume in FY 2024 in India. Additionally, in the Indian context, it is crucial for OEMs to rely on domestic sourcing and manufacturing as it enables them to improve product quality and compliance with regulation while saving costs & import duties.

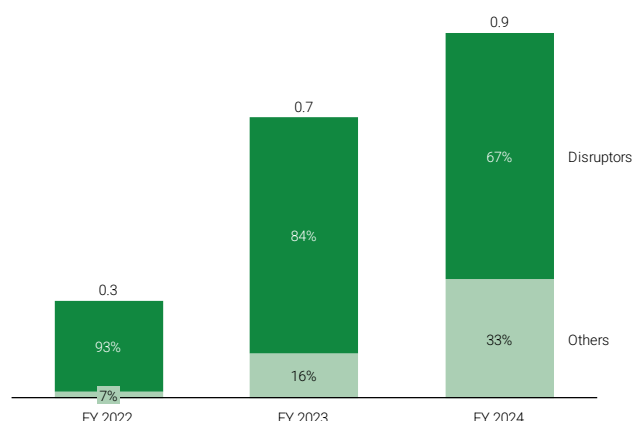
Disruptors have led the global EV markets and are also ahead in India's E2W market.

In the global EV market, **Disruptors**, who are **born electric players**, focus on innovation (a key part of their organizational culture) and **have emerged as market leaders**. Disruptors have not only innovated at the product level, but also have inculcated significant process innovations. Global disruptors have built EV-specific manufacturing-to-market paths. Their EVs are built as next-gen automobiles enabling a transition from commute-only vehicles to digitally-connected smart devices with advanced functionality. Being category creators helps disruptors in establishing recognizable brands becoming synonymous to the market / product for the consumers.

Others (OEMs who initially manufactured ICE-vehicles and have later entered EV market) on the other hand, face challenges that may inhibit their ability to capitalize on the EV opportunity. These challenges include their dependence on ICE, split focus on R&D between ICE and EV, limited electric powertrain expertise, assembly-led industry model and typically long product development timelines. Several such OEMs have started building capability in terms of research of EV components like battery and manufacturing technology and have entered the market with EV products. They are using their existing presence (sales and service/ Dealer networks), financial capabilities and longer experience in the auto-sector to enter and sustain in the EV market.

Disruptor OEMs have also emerged in the India E2W market and have gained a larger market share.

Fig.27. Total E2W Registrations in India, market share of Disruptors vs Others in India (FY 2022 – FY 2024)
(in Mn units, share as % of E2W registrations)



Source(s): Vahan Data (Ministry of Road Transportation and Highways), Redseer Analysis

Note(s): - 1. Disruptors: E2W OEMs who have entered the market with only electric 2-wheeler products in their automotive product portfolio such as Ola Electric, Okinawa Autotech, Ather Energy etc. 2. Others: E2W OEMs who have existing ICE 2W products and have also introduced Electric 2W products in India. These also include subsidiary companies of such OEMs 3. Registration data from Vahan Dashboard does not include Low-speed scooters and E-bicycles, 4. Data for Telangana state is not available on Vahan Portal

Globally, a vertically-integrated approach, which comprises of ownership of majority of the EV value chain activities including research and manufacturing technology has been more effective.

Globally, leading disruptor OEMs have taken a vertically-integrated approach which involves ownership of key research and manufacturing activities within the EV value chain.

*Fig.28. Approaches taken by EV OEMs globally
(Descriptive)*

Activity / Infrastructure facilities	Global Leading Disruptor EV OEMs	Others
R & D	<p><i>Complete R&D capabilities and focus on all key EV components -</i></p> <ul style="list-style-type: none"> • Cell • Battery Pack • Software • Motor & Drive Train • Electronics • Manufacturing Technology 	<p><i>Limited EV R&D capability for EVs.</i> Undertake R&D on fewer aspects of EV such as Battery Pack, Software, Motor & Drive Train, Electronics</p> <p>Traditionally more focused on other R&D areas such as vehicle design and dynamics, crash-testing, NVH (Noise, Vibration and Harshness), braking etc.</p>
Manufacturing	In-house capability and ownership	In-house capability and ownership
Charging Network	Self-owned or through partnerships	NA
Sales & Distribution Network	Self-owned or through dealer network	Dealer network
After-sales	Self-owned or through service partner network	Service partner network

Note(s): 1. "Disruptor EV OEMs" are those EV OEMs which manufacture only Electric Vehicles (i.e. "pure-bred"); examples of Leading Global Disruptor OEMs are Tesla, BYD, Vinfast 2. "Others" includes those EV OEMs which manufacture both Electric and ICE vehicles or are subsidiaries of such OEMs

Vertically integrated approach has generated better outcomes for Global Leading Disruptor EV OEMs as it offers strong control over the product, profitability and scalability. This was demonstrated in the strong resilience of such OEMs during the global chip shortage, which affected all automotive manufacturers. Global EV disruptor OEMs with vertically integrated approach were able to capture market demand by coming up with agile and adaptable solutions (e.g. rewriting software which was compatible to available chip supply).

Key aspects in Auto Sector and the emerging EV sector in India

Ownership of R&D & Technology – R&D has been a key focus area for Indian OEMs in the Auto sector. India has a thriving R&D ecosystem with quality testing centres like ARAI, ICAT and VRDE which are equipped with state-of-the-art facilities for comprehensive testing and validation. Both Indian and foreign ICE vehicle OEMs have established R&D facilities in India. Indian OEM's have overcome intense competition from foreign OEMs by developing quality and affordable products. The average spend on R&D over FY21, FY22 and FY23 for the top 4 publicly listed 2W OEMs (in terms of 2W unit sales) in India has been ~INR 462.1 Cr per annum.

Within the Automotive market, EV is an emerging sector in India. Design and development of EV-specific technology components (including software, motor & drive train, cell & battery pack and electricals & electronics) in-house will be an important aspect for success. Key technological components of an Electric vehicle are explained below -

- a. **Cell:** Battery pack comprises 35-40% of a typical E2W vehicle cost, of which 80-85% is constituted by the cells, making it the most critical component of the E2W. The speed, per charge range, charge time, safety, weight and price of the vehicle depend heavily on the cell.

Innovations in cell chemistry have been (and will continue to be) core to EV adoption globally (making EVs comparable to ICE vehicles in terms of both performance and costs). Cell technology is expected to undergo greater innovation to reduce dependence on critical materials and ensure supply-chain sustainability. Innovations such as the use of silicon (as anode) and cheaper alternatives like sodium-ion batteries, are already underway, though their commercialization may take several years.

Consequently, leading **global EV OEMs** have developed in-house cell manufacturing capabilities. Large scale cell production has helped these players unlock greater efficiency, making their products superior in terms of quality and accessibility to consumers across the world.

Additionally, it can help OEMs to control industry manufacturing value-chains in the long run. India is projected to require 40-60 GWh in terms of E2W battery requirements by FY 2028 (considering 11-15 Mn E2W vehicle sales in FY 2028). Furthermore, India's annual demand for ACC batteries is projected to rise to 104-260 GWh (from 2.7 GWh) by 2030 across multiple sectors (Source: Niti Aayog). Under the PLI scheme for ACC energy storage, manufacturing facilities are being set up with the objective of achieving 50 GWh of domestic capacity by 2030.

- b. **Battery Management System (BMS)** – Multiple cells are assembled into a module and connected with battery management system, to create the battery pack. The BMS safeguards both the rider and the battery by ensuring that the cell operates within safe (and optimum) operating parameters. Global battery packs made in South Korea, China and USA are not made specifically for Indian riding conditions (tropical temperatures, rain, dust, road vibrations and high humidity). BMS for electric vehicles in India need to be contextualized to manage safety, range, and performance of the vehicle, making its ownership critical for long-term success.
- c. **Software** – OEMs who build their own vehicle software can better adapt it to the hardware and provide superior experience (vs OEMs who outsource software development) during and beyond the ride. Owning the software may also provide greater scalability by allowing cross-leveraging of features across various EV products and models (e.g. scooters, motorcycles,

mopeds and four-wheelers). In addition, it will allow for wider feature-sets and contextualization to local conditions (e.g. maps, call control, voice-activated assistance, reverse mode in E2W etc.) Also, it might enable the EV OEM to drive customer engagement efforts such as community building, new feature updates etc.

- d. Integration capabilities – In addition to owning the individual technological components discussed above, it is important for EV players to also own their integration with each other. An integrated assembly provides greater product control (performance, experience, design and costs), while also better preparing OEMs against external disruptions. For example, design integration capability can enable OEMs to create products that serve multitude of use-cases. On the other hand, while software-led integration of electronics is crucial to improve power train efficiency and digital feature enablement, in-house motor manufacturing can provide flexibility and smoother interplay of hardware components. Additionally, vertical integration will allow for better usage and utilization of manufacturing as the OEMs will be able to churn out more market-ready and customer-centric products. It will also result in lower dependency on other agencies, leading to higher efficiency in operations and leaner cost structures.

Localized supply chain will be an important lever for EV OEMs to succeed in India

Localization has been an important strategic move that has been adopted by ICE vehicle OEMs in India. Both global and India-born ICE vehicle OEMs have increased localization content in their vehicle models (even up to 95% in some vehicle models). This has helped them to not only reduce costs with reduction in imports and human-resource costs but also to introduce customized products with reduced supply-chain related lead times. Similarly, localization of EV production can optimize quality and margin benefits by eliminating supplier margins & import duties, part of which can be passed on to the consumers.

Following components have significant indigenization potential:

1. Cell - ~60% of the cell's cost comes from the raw materials in use. OEMs can localize 50-60% of the overall cell BOM costs as rest of the raw materials are unavailable in the country (e.g., Lithium, Nickel and Cobalt create dependence on imports). However, graphite, manganese (used in NMC batteries) and aluminum (used in Nickel Cobalt Aluminum batteries) are abundantly present in India and can be used in domestic cell production. A cell usually consists of CAM (Cathode Active Material) and AAM (Anode Active Material). While several formulations may be possible for a Lithium-ion cell, a typical formulation for CAM comprises of lithium hydroxide which has been calcinated with nickel, manganese and cobalt sulphates while AAM comprises of synthetic processed graphite produced by mixing graphite with additives such as petroleum coke.
2. Motor – Electric motors require rare earth magnets that are not available in India, however, all the other components of the motor can be locally sourced.
3. Power electronics - While silicon-based semiconductors are not yet produced in India, electronic components like printed circuit boards that use these chips, can be locally designed and assembled through contract manufacturing to contextualize the products as per Indian environments.
4. Other electrical and mechanical components – These are produced domestically at scale by Indian manufacturers and can be localized to enhance control and improve the production economics.

In addition to a better supply chain and product quality control, localization is also required for achieving the **benefits of the regulatory schemes**. Indian government has been consistently promoting localized production of vehicles and auto components through incentives - Incentive for Auto sector (which applies to existing ICE OEMs also) under PLI scheme for **Advanced Automotive Technology (AAT)** requires beneficiaries to achieve a Domestic Value Addition of minimum 50% to claim incentives. The PLI proposes financial incentives of up to 18% (sales-linked) to boost domestic manufacturing of AAT products. Specifically for Electric Vehicles, FAME subsidy requires the production or assembling of the vehicle to be done domestically.

Section D: Threats and challenges to Ola Electric Mobility Limited and its products and services

The automotive market in India, in which Ola Electric Mobility Limited operates, may encounter several threats that could impede their growth trajectory and stability as outlined below:

1. Economic downturns, recessions and the heightened inflationary pressures can diminish consumer purchasing power, leading to lower sales volumes and profitability, with consumers de-prioritizing non-essential purchases.
2. Geopolitical tensions pose substantial risks to supply chain continuity and cost structures, potentially leading to inventory shortages and increased costs.
3. Potential shifts in government policies, including changes in taxation, subsidies, foreign direct investment regulations, EV battery disposal and labour laws, could introduce regulatory challenges.
4. Intensified competition, fuelled by substantial investments and technological advancements, presents another risk factor. With the presence of multiple business models within the automotive market, competitors may gain competitive advantages, potentially undermining the market position of Ola Electric Mobility Limited and/or others.

Conclusion

India accounts for 15-20% of global production for 2W and is the 3rd largest 4W-Passenger Vehicle market in the world (in terms of sales volumes), with strong growth headroom in both segments. India's automotive market is undergoing EV-led transformation with EVs emerging as the next-gen smart products. Indian government has also provided impetus to promote domestic manufacturing and adoption of Electric vehicles through production-linked incentives for manufacturers and subsidies.

2Ws have been at the forefront of automotive electrification in India, emerging as the more appealing alternative (as compared to 4W) to the price sensitive Indian consumer, with a lower initial price differential vis-à-vis their ICE counterparts. Technologically advanced electric vehicles are expected to disrupt the India market with greater affordability, advanced software enabled features, better consumer experience and decarbonization capabilities. E2W adoption has grown rapidly to reach ~5.4% of total 2W registrations in India in FY 2024. E2W are projected to account for 41-56% of the domestic 2W sales volumes by FY2028. E2W OEMs are also well placed to serve the exports opportunity of 100-110 Mn units globally.

Globally, Disruptor EV OEMs have emerged as the market-leaders in the EV industry driven by their ability to innovate. These OEMs have taken a vertically-integrated approach which has enabled them to have a stronger control over the vehicle performance and costs. Other OEMs which originally manufactured ICE vehicles only, have also entered the EV market with electric products both in 2W and 4W. These players have also started building capabilities in key aspects such as battery and software etc. and are leveraging their longer experience & knowledge, financial strength and country-wide presence (through sales and service/delivery networks) to compete with the disruptor OEMs. As an emerging sector in India, it will be critical for the players to own key EV technology elements such as, software, motor & drive train, the cell & battery pack and electronics along with their interplay with each other and rest of the EV components. It will also be crucial for OEMs to rely on domestic sourcing as it will enable them to improve product quality and compliance with regulations while saving costs & import duties.

Glossary

Term Used	Description
2W	Two wheeled vehicles including scooters, motorcycles, mopeds, Low speed scooters & E-bicycles
3W	Three wheeled vehicles including those used to transfer both passengers (e.g., auto rickshaws) and cargo (e.g., loading autos).
4W-Passenger Vehicle	Four wheeled Passenger Vehicles: Vehicles used for the transport of passengers and comprising no more than 8 seats in addition to the driver's seat. This segment comprises of cars of various sub-segments such as hatchbacks, sedans, and utility vehicles.
ADAS	Advanced Driver Assistance Systems
ARAI	Automotive Research Association of India
CAGR	Compound Annual Growth Rate
CY	Calendar Year
Commercial Vehicles (CV)	Commercial Vehicles including trucks, trailer trucks, tippers, mini-trucks, pickup vans, transit mixer, coaches, buses and are licensed to be used to transport goods or passengers for the profit of an individual or business.
E2W	Electric Two wheelers including electric scooters, motorcycles, mopeds, low speed scooters & e-bicycles
E4W	4W-Passenger Vehicles which are powered by electrical energy stored in batteries (i.e. battery-operated vehicles)
Low speed scooters & E-bicycles	2-wheeled electric vehicles with maximum speed up to 25 km per hour, which may or may not be pedal-assisted excluding kick-scooters
FY	Financial Year
GDP	Gross Domestic Product
GNI	Gross National Income
GW	Gigawatt
GWh / KWh	Giga Watt-hour / Kilo Watt-hour
ICAT	International Center for Automotive Technology
IMF	International Monetary Fund
₹	Indian Rupee
Km	Kilometers
Metro	Indian cities with 5 Mn+ population (9 cities)
MoRTH	Ministry of Road Transport and Highways
OEM	Original Equipment Manufacturer
R&D	Research & Development
SUV	Sports Utility Vehicle
TAM	Total Addressable Market
UNCOP26	26 th United Nations Conference of Parties
US\$	United States Dollar (1US\$ = 80 ₹)

VRDE	Vehicle Research and Development Establishment
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Appendix – Claim Statements Validated by Redseer

1. India is the second largest 2W market and the third largest 4W market globally in terms of domestic sale volume
2. Ola Electric had the highest revenue of all Indian incorporated electric 2Ws (“E2Ws”) original equipment manufacturers (“OEMs”) from E2W sales in Fiscal 2023.
3. Ola Electric commenced delivery of their first EV scooter, the Ola S1 Pro, in December 2021 and within 9 months of launch, Ola Electric became India’s best-selling E2W brand in terms of monthly registrations on Vahan Portal (excluding the data for Telangana state), with a market share of 35% in terms of vehicle registrations in FY 2024 (Market share in FY22: 6%, FY23: 21%, Q1 FY24: 31%, Q2 FY24: 31%, Q3 FY24: 35%, Q4 FY24: 39%, Dec’23: 40%, Mar’24 – 38%, May’24 – 48%)
4. The Ola Future Factory is the largest integrated and automated E2W manufacturing plant in India (in terms of production capacity) by an E2W-only OEM, as of March 2024.
5. Ola operates their own direct-to-customer (“D2C”) omnichannel distribution network comprising 870 experience centers situated across India, which was India’s largest company-owned network of experience centers as of 31 March 2024.
6. Ola Electric is India’s first E2W OEM of scale to provide an end-to-end online purchase experience to customers.
7. Ola Electric was the largest E2W seller in India by number of units registered for FY 2024 and accounted for approximately 35% of total E2W registrations in India for such period.
8. Cell PLI was awarded for a total of 30 GWh capacity, of which Ola Electric was awarded 20GWh, the most received by any Cell PLI recipient. Ola Electric is the only EV OEM in India that is a beneficiary of two PLI schemes.
9. India’s 2W production market of approximately 21.5 Mn units in Fiscal 2024 is primed for electrification and is expected to aid in achieving India’s promise at the UN COP26 Summit to cut emission to net zero by 2070
10. Penetration rate of 2Ws in India is approximately 15% in FY 2023, evidencing significant growth potential within the Indian 2W market.
11. Monthly E2W registrations of Ola Electric (E2W units) as per Vahan Sewa Dashboard for the period of Oct 22 to May 24 are as follows (data excludes Telangana state):
 - a. OCT’22 – 16,355
 - b. NOV’22 – 16,385
 - c. DEC’22 – 17,369
 - d. JAN’23 – 18,353
 - e. FEB’23 – 17,757
 - f. MAR’23 – 21,413
 - g. APR’23 – 22,024
 - h. MAY’23 – 28,617
 - i. JUN’23 – 17,585
 - j. JUL’23 – 19,384
 - k. AUG’23 – 18,736
 - l. SEP’23 – 18,691
 - m. OCT’23 – 23,829
 - n. NOV’23 – 30,010
 - o. DEC’23 – 30,407
 - p. JAN’24 – 32,355
 - q. FEB’24 – 33,942
 - r. MAR’24 – 53,391
 - s. APR’24 – 34,052
 - t. MAY’24 – 37,233

12. The S1 Pro (Gen 2) has the highest top speed and the longest range per full charge among the E2W offerings by E2W players of scale in the Indian market as of March 2024
13. Ola Electric had a 35% to 40% market share of the premium E2W segment and a market share of 35% of the overall E2W (with >25kmph maximum speed) segment in FY 2024. In Q1 FY 2024 (3 months ending June 2023), Ola had 31% market share of the overall E2W (with >25kmph maximum speed) segment. In the period of FY2024, Ola had market share of 35% of the overall E2W (with >25kmph maximum speed) segment. Ola Electric had India's largest company-owned network of experience centers as of March 31, 2024, among all 2W OEMs
14. Ola's hyper charging facilities offer more than twice the range per minute of charging as compared to other fast-charge functionality in E2W models offered by E2W players of scale in India, as of March 31, 2024
15. Global shortage of electronic child parts was experienced by the Auto industry in Calendar Year 2022.
16. The technology surrounding cells is rapidly evolving, with development of advanced technologies and battery alternatives as of March 2024
17. Charging point locations in India are significantly less widespread than fuel pumps
18. Internet-led distribution model is relatively new and unproven in India's automobile industry as of March 2024
19. As per data on new 2W and 4W registrations between January 2021 and March 2024 in the Indian automotive market available on the Vahan Portal of Ministry of Road Transport and Highways (excluding the data for Telangana state), demand for 2W and 4W vehicles generally peaks between January and March of each year and declines in February. Demand for automobiles increases again during the festival season in November, with a decline in December as customers choose to defer purchases to the following year.
20. Quarterly private final consumption expenditure in India peaked in the third quarter of Fiscal 2023 as it was higher than in the first, second and fourth quarters of Fiscal 2023 as per the Ministry of Statistics and Programme Implementation.
21. Ola Electric is one of only three beneficiaries awarded benefits under the Cell PLI Scheme as of 31 March 2024.
22. Breakup of 2W market volume of 18-19 Mn units in India in FY 2024 is as follows (ex-showroom prices) –
 - a. Low speed e-scooters and E-bicycles – 0.2-0.3 Mn (Mass Market i.e. <= ₹ 100 thousand)
 - b. Scooters
 - i. Mass market (<= ₹ 100 thousand) - ~5.4 Mn
 - ii. Premium (> ₹ 100 thousand) – ~0.91 Mn
 - c. Motorcycles
 - i. Mass market (<= ₹ 200 thousand) – ~11.2 Mn
 - ii. Premium (> ₹ 200 thousand) – ~0.9 Mn
23. The maximum purchase incentive available on a new E2W purchase (without scrapping of old vehicle) with ex-factory cost of under ₹ 150 thousand and battery capacity of 2.5 KW is ₹ 42,500 as on 31 March 2024. This amount includes purchase incentive under FAME II scheme of the Government of India and State Government incentive (which differs from state to state).
24. Certain states in India provide EV purchase related subsidies, tax benefits, vehicle registration and road tax waivers to enhance EV penetration in such local markets.
25. In the Fiscal 2024, after a review phase II of FAME subsidies, the MHI introduced EMPS-2024 (applicable from 1 April 2024) for faster adoption of E2Ws and E3Ws and to provide further impetus to green mobility and development of EV manufacturing ecosystem in India.
26. As per Vahan data, players have the below-mentioned market share in E2W (excluding the data for Telangana state and data extracted as of 11th June 2024)

Players	Founding Year	E2W Market Share			
		FY21	FY22	FY23	FY24
Ola Electric Mobility	2017	0.0%	5.7%	21.0%	34.8%
TVS Motors	1962	1.9%	3.9%	11.3%	19.3%

Eicher Motors	1948	0.0%	0.0%	0.0%	0.0%
Bajaj Auto	1945	3.3%	2.8%	3.9%	11.3%
Hero Motor Corp	1984	0.0%	0.0%	0.1%	1.9%

27. According to publicly available data on company websites, the driving range for E2W models for top-4 E2W OEMs based on market share as per Vahan are as follows:

Company	Model	Certified range
Ola Electric Mobility	Ola S1 Pro	195km
Ather	Ather Apex 450	157km
Bajaj	Chetak Premium	126km
TVS Motors	TVS iQube ST 5.1 kwh	150km

28. According to e-AMRIT, a web portal on EVs launched by the Government of India, CO2 emissions for E2W is 1.5 tonnes compared to ICE 2W which is 2.1 tonnes during the entire EV lifecycle. This indicates that E2W emits 0.6 tonnes less emission during its life compared to ICE 2W. Please note that these estimates do not include any environmental impact caused by battery packs in EVs during its manufacturing process or post disposal of battery after the EV life cycle. (Key assumptions: 2W Life cycle – 10 years, Journey distance per day - 15km, Range - 95km, EV battery capacity - 3kWh, ICE 2W CO2 emission factor – 39.04 g/km)
29. Ola became the first E2W company to cross 50,000 registrations for electric two wheelers in a single month in FY2024 (March 2024)