ELECTRIC VEHICLES

SPOTTING THE CHALLENGES & CHARTING THE COURSE

A Knowledge Report by Alvarez & Marsal
In Collaboration with Blue Circle

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INDEX

FOREWORD

Foreword

India aims to be at the forefront of EV adoption in the forthcoming years. The government aims to electrify 70% of commercial cars, 30% of private cars, 40% of buses, and 80% of two-wheelers and three-wheelers sales by 2030.

Today we witness a significant push in the country to not just drive adoption and also become a world leader in production as we scale up our manufacturing facilities and localise supply chains. This presents a huge opportunity for the industry to support the nation's drive to become an automobile hub.

However, the industry witnesses its own set of unique challenges that need to be addressed on priority. We are in the middle of critical supply chain-induced shortages, especially with the limited availability of key components such as lithium-ion battery cells and semiconductor chips in recent times. The industry is grappling with poor charging infrastructure, limited financing options and low product availability for consumers which aggravates the challenges further. Affordability needs to be understood in terms of the total cost of ownership (TCO) and not just upfront cost, which is another key bottleneck to adoption.

India has traditionally been very strong in automotive, mobility and technology, and EVs lie at the intersection of all three. Supply shortages on account of battery cells have been 20-25% and semiconductor chips have been a whopping 40%-50%, causing production halts for market leaders in the space. Moving forward, as India embraces EVs, firms will need to make sure that supply matches the demand. Globally, additional investments and assembly lines planned to become operational over the next 2-3 years should shorten the gap. Meanwhile, companies can focus on proprietary solutions instead of relying on licensed technology to build scale. Increasing interest from local and global investors will surely give much needed support to this industry.

We have done over 50 discussions and extensive consultations with a wide variety of industry participants for this white paper. Consequently, we discuss the challenges and solutions that each stakeholder needs to adopt to put India in the league of nations leading the transition to electric vehicles.

We hope you find this report useful.

Manish Saigal
Managing Director
Alvarez & Marsal India

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Introduction

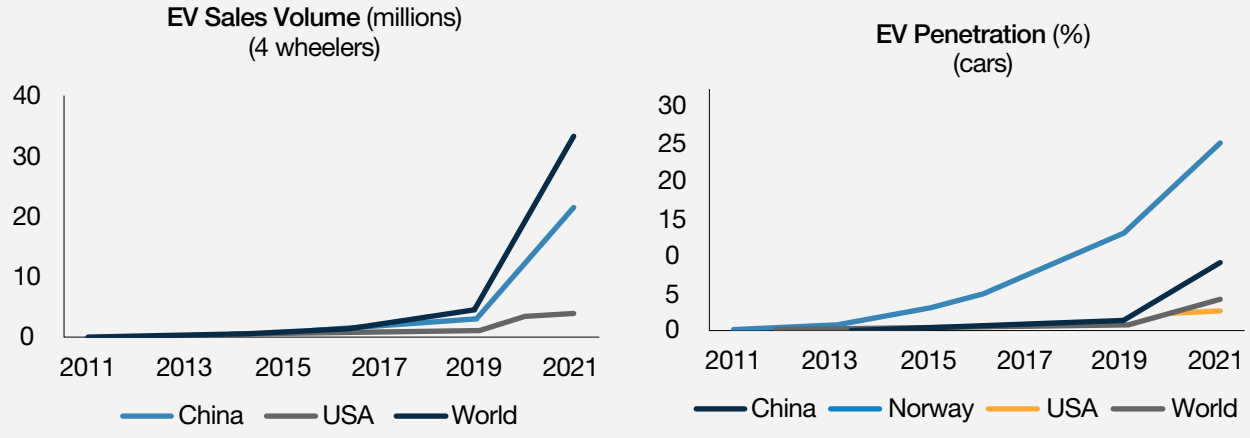
As countries have moved towards a more sustainable ecosystem to tackle climate change, EV industry has picked up pace globally. **33 countries** signed a COP26 declaration to collaborate and work towards selling vans and cars that are only zero-emission vehicles (ZEV) by 2035 for developed and by 2040 for emerging economies.[1]

Countries like USA and China have been at the forefront of the growth in the EV industry with impetus from key stakeholders like the government and automotive players. The number of EV OEMs has been increasing over the years with companies like Tesla, BYD and SAIC as the market leaders. A lot of incumbent automotive manufacturers like Volkswagen, BMW, Daimler and Toyota have set electrification plans and have introduced EV models in the market.

Increasing fuel prices globally have contributed to EV adoption. While EVs have a higher upfront cost, they present several benefits in comparison to ICE vehicles that range from low operating and maintenance costs to higher efficiency of the motor as compared to an ICE engine. Technological advancements over the years in the EV space have reduced manufacturing costs thereby attracting more players to enter the market and Improve EV adoption globally.

Figures 1 & 2: Global EV sales and penetration

Source: IEA



India has also been picking up on the transition into electric vehicles to move towards a more sustainable ecosystem. The government has set targets to tackle climate change i.e., to achieve net zero emissions by 2070 and reduce 1 billion tonnes of projected emissions by 2030[2]. The transport sector accounts for around 13% of total CO2 emissions in India and road transport accounts for 90% of total energy consumption followed by rail and domestic aviation[3].

[1] IHS Markit | [2] BBC | [3] Climate Action Tracker

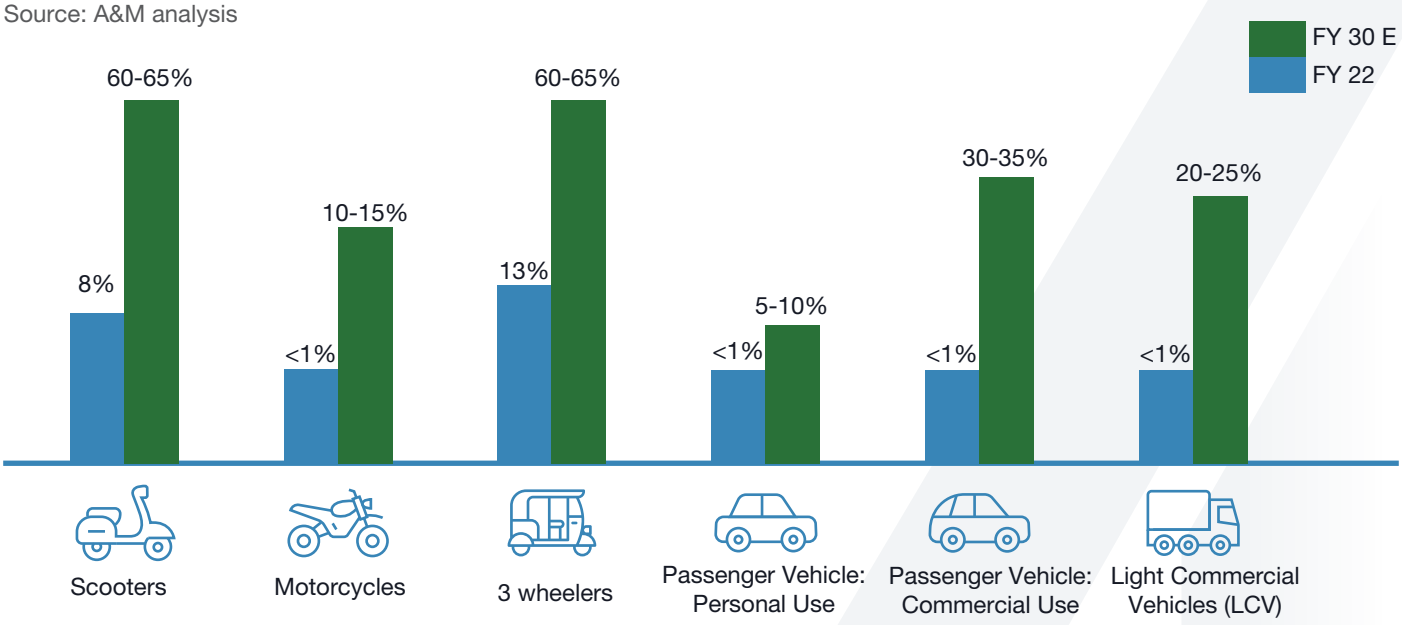
Electrifying the transport sector will play an important role in reducing carbon emissions and import dependence on hydrocarbon fuels. Currently, India depends on imports for about 85% of its domestic oil consumption and achieving a 30% EV penetration by 2030 can reduce import bills by 15% amounting to savings of INR 1.1 Trillion[4].

While the EV market in India is in its early stages, it has been growing on the back of interventions by the government, start-ups, and automotive OEMs. However, it is majorly dominated by 3W and 2W with 4W occupying a very small share of the market. The 3W segment has seen decent EV penetration whereas the 2W, 3W and 4W segment has seen very low penetration.

India has set out a strong vision for the e-mobility sector - to electrify 70% of commercial cars, 30% of private cars, 40% of buses and 80% of 2W and 3W by 2030[5]. A projection of expected penetration by 2030 is given below for the different vehicle segments.

Figure 3: Expected Penetration for EV segments

Source: A&M analysis



The 2W EV scooter and 3W EV market has already seen a decent penetration and is expected to grow much faster over the next 5 years. Such high growth is expected as scooters and 3-wheelers have been benefited by an early TCO advantage with the help of subsidiaries that are still expected to remain for the next 2-3 years. Additionally, the challenges concerning charging are less for 2W and 3W due to options like battery swapping and removable batteries that can reduce the downtime and their dependence on charging infrastructure. As EV penetration in LCVs is very low, subsidies are expected to increase over the next 2 years driving adoption.

B2C companies such as e-commerce and food delivery services have set out plans to electrify their fleets. Companies such as Flipkart and Zomato have announced targets to electrify 100% of their fleets by 2030 by 2030[6]. This is expected to drive a sharp increase in EV penetration across 2W, 3W and LCV segments over the next few years. Commercial vehicles are expected to have higher adoption in comparison to personal use vehicles due to favorable TCO experienced because of high daily usage and presence of dedicated captive charging stations that will reduce range anxiety.

Economies of scale and increased localisation, in the long run, are expected to reduce manufacturing costs and improve the affordability of EVs over the next few years. A further rise in fuel prices is expected in the future which could disincentivise the purchase of ICEs. A ban on registration of new ICE vehicles in India may be expected in the next few years as other countries like UK, US and Norway[7] have announced plans to phase out sales of new ICE vehicles within the next 5-10 years.

[4] Auto | [5] CEEW | [6] Press Release: Flipkart, Zomato | [7] ICCT

Key challenges to EV adoption

As EV adoption is on the rise globally, India has also started observing a transition to electric vehicles. The current penetration of EVs is on the lower end and driving adoption will require overcoming the various challenges that are present in India. A list of the key challenges has been given below:

Table 1: Key challenges to EV adoption

Source: A&M analysis

KEY CHALLENGES TO ADOPTION	CHALLENGE - DESCRIPTION
Limited charging infrastructure	Present charging infrastructure is limited in India which may cause range anxiety among consumers
Unfavourable TCO	While EVs may have lower operating expenses compared to ICEs, the high upfront cost of EVs raises the total cost of ownership (TCO) making it unfavorable in certain vehicle segments
High upfront cost	Even with favourable TCO, high upfront costs remain a barrier as it disincentivises consumers due to low awareness of opex advantages and higher down payments
Limited access to financing options	As the EV market is at its early stage, financial institutions are not fully confident about the sector, thereby limiting financing options for the involved stakeholders
Limited consumer awareness	Consumers are not fully aware of EV products and their benefits as the industry is still in its nascent stage. Only adopters are exploring the product which can be reflected by the EV penetration
Issues in supply chain scalability	Current scale of EV manufacturing is low, and the existing supply chain is dependent on imports due to which manufacturing costs are high. There is also a global supply shortage of key EV components like battery cells and chips that are affecting the manufacturing capabilities of EV OEMs in India that is unlikely to restore in the immediate future
Impact caused by high charging time	The total time required to charge an EV is much higher in comparison to the fuel refilling time of an ICE vehicle which may lead to issues such a loss of time and earnings
Inadequate government push	Actions by the government to drive EV adoption such as financial incentives like subsidies for EV consumers and policy mandates implementing strict bans on ICE usage.
Limited product range	EVs offer fewer product choices in comparison to ICE vehicles which denotes that market isn't mature and limited options cannot satisfy consumer requirements
Concerns around technological obsolescence	Consumers are delaying adoption as they expect current EV models to become obsolete and witness technological advancements in the near future
Servicing issues	Servicing in EVs may be a matter of concern due to inadequate skilled technicians and difficulty in sourcing spare components
Safety and quality issues	There have been some concerns around the safety and quality of EVs which may have created a negative perception of EVs among consumers

While there are other very relevant challenges like recycling, in this report we solely focus on challenges that drive adoption. These challenges vary with respect to the various segments of vehicles, thereby, affecting the EV penetration differently for each segment. A segment-wise understanding of the different issues has been given in Table 2.

Table 2: Key challenges to adoption based on segment importance[8]

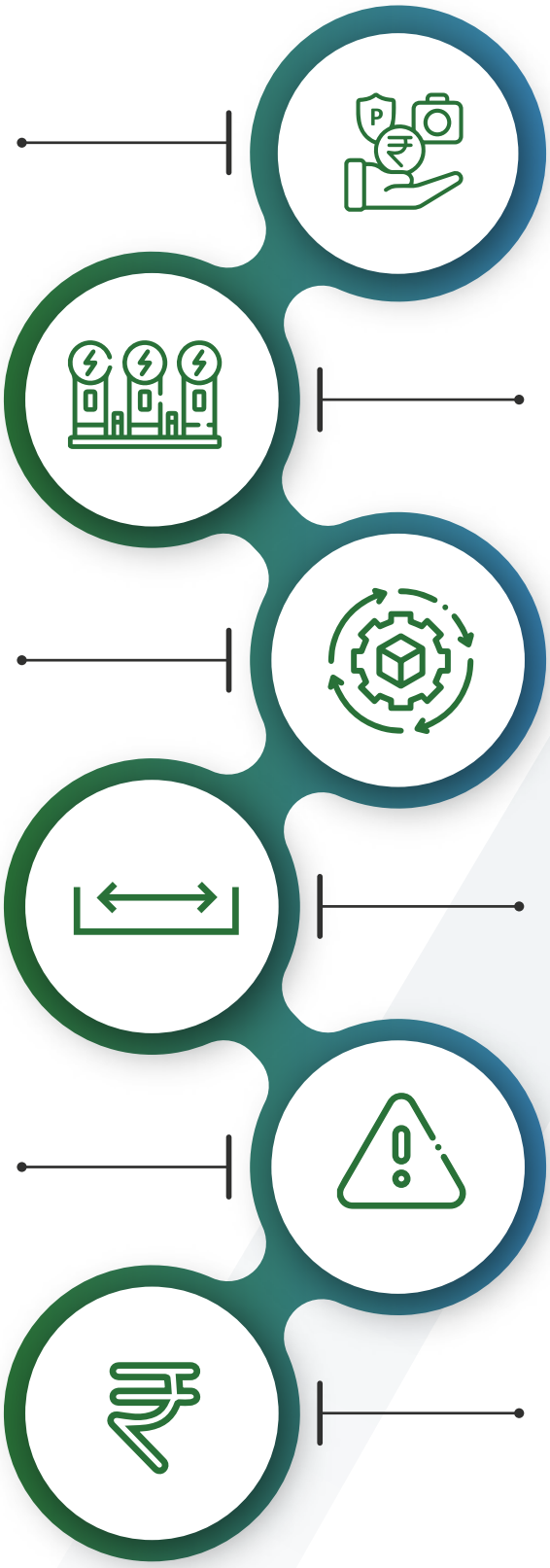
Source: A&M Analysis

Key challenges to adoption	2W		3W		Car		LCV***
	Scooter	Motorcycle	E-Ricks	Auto	Retail	Commercial	
Unfavourable TCO	Low	High	Low	Low	High	Medium	Low
High Upfront Cost	Medium	High	NA*	Low	High	Medium	High
Limited access to financing options	Medium	High	High	High	Medium	Medium	Medium
Limited charging infrastructure	Low	Low	Medium	Medium	High	High	High
Limited consumer awareness	Low	High	Low	Medium	High	Medium	High
Issues in supply chain scalability	High	High	High	High	High	High	High
Impact caused by high charging time	Low	Low	High	High	Medium	High	High
Inadequate government push	Medium	Medium	Medium	Medium	High	Medium	Medium
Limited product range	Medium	High	Medium	Medium	High	High	High
Concerns around technological obsolescence	Low	High	Low	Low	High	High	High
Servicing issues	Low	Medium	Low	Medium	Medium	Medium	Medium
Safety and quality issues	High	NA**	Medium	Low	Low	Low	NA**

*High upfront cost not applicable for e-ricks as counterparts are manually powered
**Safety and quality issues not applicable for motorcycle and LCV due to limited product options
***Assuming that a viable LCV product is launched in ~INR 1.1-1.3 Mn price range

[8] Appendix 1

Based on industry discussions and internal analysis, six issues have been highlighted from the above list to delve deeper into as we believe they have a strong role to play in inhibiting EV adoption currently in India:



01
Unfavourable TCO

02
Limited charging infrastructure

03
Issues in supply chain scalability

04
Limited product range

05
Safety and quality issues

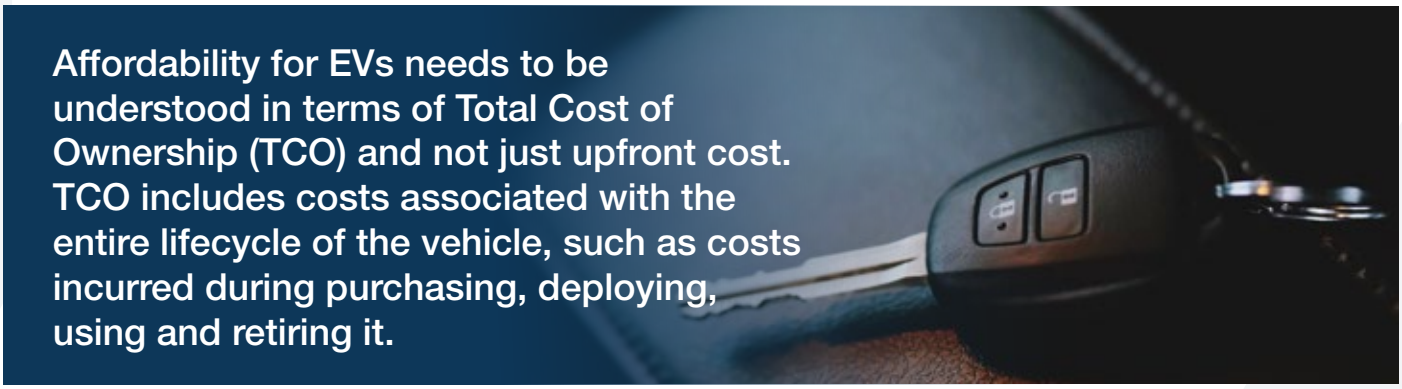
06
Limited access to financing

Table: Key challenges to adoption | Source: A&M analysis

Unfavourable Total Cost of Ownership (TCO)

EVs lack affordability in certain key vehicle segments currently, however, this is expected to change in the near future

EVs lack affordability in certain key vehicle segments currently



While upfront costs may be higher for EVs, the overall cost of running an EV is lower compared to an ICE which reduces operating costs and helps improve overall affordability. However, certain segments exhibit higher TCO for EVs as compared to ICE counterparts as shown in this analysis.

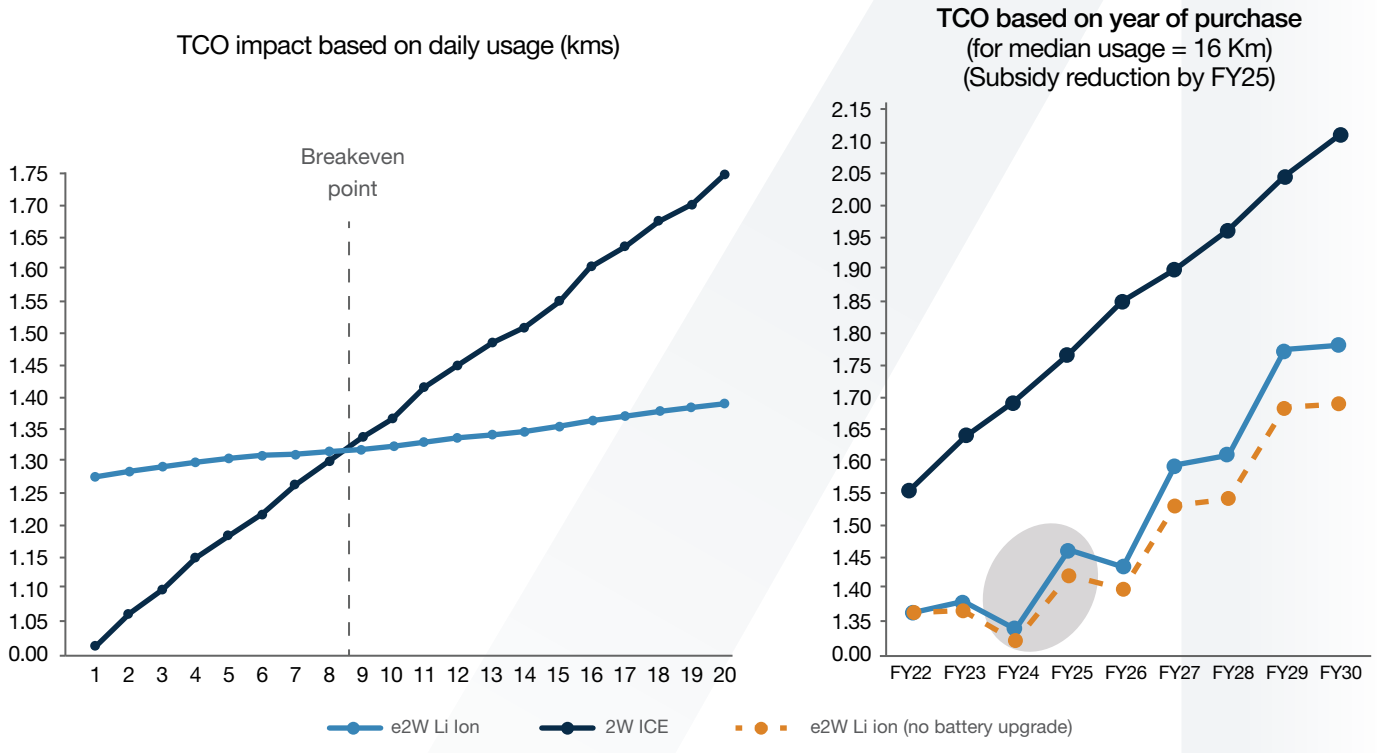
TCO parity is not yet seen in motorcycles and passenger vehicles

Advantages of lower operating costs can be helpful if the usage is on the higher side, which makes a strong case for commercial use cases. Moreover, as vehicle size and complexity increase, battery sizes also increase which increases the upfront cost differential of the vehicle.

An example TCO analysis across EV and ICE is shown below for high speed two wheelers

Figures 4: TCO analysis for EV and ICE in higher speed 2-wheeler segment (INR hundred thousands)

Source: Primary discussions, Secondary research, A&M Analysis



This highlights that the breakeven point for high-speed electric two wheelers is achieved when daily usage is ~8-10 km. TCO for ICE vehicles is increasing each year due to rising fuel prices. TCO for EVs on the other hand falls due to expectations of lower battery costs in the future.

View on Subsidy - It is believed that subsidy availability for EVs will not last forever. Government will likely start rolling back these subsidies as EV penetration improves in the specific product categories. Hence, for TCO analysis, we have assumed scenarios of gradual subsidy rollback over coming years.

A comprehensive TCO parity analysis for key vehicle segments is as follows:

Table 3: TCO parity status as of FY22

Source: A&M analysis

Segment	TCO Parity (for average user)**	Present Scenario	Current Use cases
2W: Scooter	👍	TCO for the EVs is lower than ICE vehicles due to low cost of electricity compared to high fuel costs plus upfront cost is not a barrier as battery packs are smaller	Personal use and commercial fleets
2W: Motorcycle	👎	Motorcycles use larger battery packs as they need higher power, thus, their TCO increases	Not applicable
3W: Auto	👍	Autos run large distances, so they can take advantage of low operational costs and achieve lower TCO compared to ICE	Passenger and cargo autos
4W: Personal use passenger vehicles	👎	As no products are available in the affordable segment, TCO is not favourable for average users Larger battery packs are used in SUVs so upfront cost increases No subsidies are provided under FAME 2 TCO may only be favourable for cases where daily usage is high	Personal use

Segment	TCO Parity (for average user)**	Present Scenario	Current Use cases
4W: Commercial fleet	👍	It is easier to reach breakeven distances for commercial 4W due to their high usage Subsidies under FAME 2 are only available for commercial 4W cars which lead to lower TCO	Fleet operators
LCV*	👍	LCV TCO has only been tested conceptually and should become more concrete as products are launched in FY23 Some sections of industry expect subsidy to be increased further improving the segment TCO	Last mile delivery is expected to emerge as a strong use case going forward

*LCV TCO analysis is done according to preliminary figures in the market
**Including subsidies

TCO is expected to improve further and become favourable in the near future due to multiple factors

The industry expects TCOs to improve based on the following factors

Declining costs for key components

Battery

Battery contributes nearly 40% to the cost of an electric vehicle, the highest among all the other components used in the vehicle.

Battery prices have been falling sharply due to learning curve advantages and economies of scale. Though currently battery prices are more expensive in India compared to global averages, they are expected to fall below $100/kWh soon (in tandem with global trends), which is being regarded as an inflection point for the e-mobility sector.

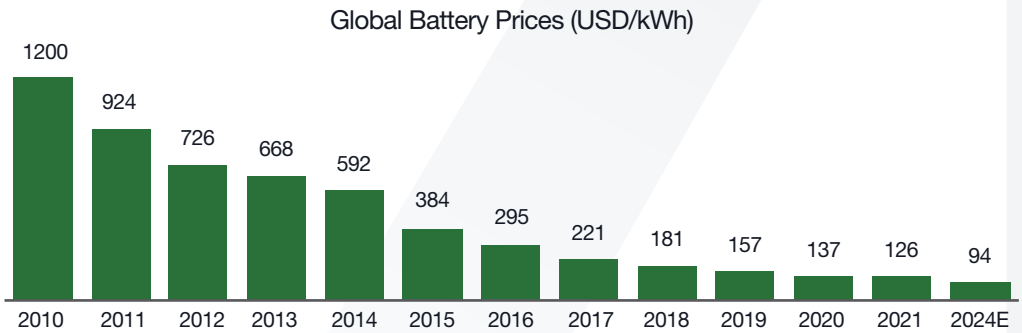


Figure 5: Global average battery prices
Source: BloombergNEF

As batteries account for a significant contribution to the price of electric vehicles, fall in battery prices is expected to lead to a fall in electric vehicle prices as well. This reduction in upfront cost should lead to lower TCOs across electric vehicle segments.

Other components

Inflation is expected to impact the prices for other components used in EVs, however, as demand grows, scale is expected to offer price advantages. Value engineering may also contribute positively to the reduction in prices of various components as the industry matures. Additionally, as localisation of EV supply chain increases, OEMs are expected to gain from lower prices of localised components.

Other factors

Rising fuel prices

Fuel prices have increased sharply in recent times, with petrol prices hitting crossing the INR 100 mark in 2022 in many parts of the country[9]. Such expected increase in gasoline prices will only make the TCO equation more favourable towards electric vehicles.

Government initiatives

The government has been undertaking several initiatives to provide financial incentives and subsequently reduce TCO for EVs. Both state and central governments have established subsidies to boost EV sales. FAME-II subsidies highlighted below reduce the upfront cost of the vehicle by giving incentives based on the battery pack albeit with certain eligibility criteria and caps.

Table 4: List of government subsidies in India for different vehicle segments

Source: MHI – FAME II Subsidies

Segment	FY 22
2W (Personal and Commercial)	Lower of Rs. 15,000 per kWh and 40% of the cost of the vehicle
3W (Commercial)	Lower of Rs. 10,000 per kWh and 20% of the cost of the vehicle
4W Cars (Commercial)	Lower of Rs. 10,000 per kWh and 20% of the cost of the vehicle
e-Buses	Lower of Rs 20,000 per kWh and 40% of the cost of the vehicle

Further, the GST on electric vehicles has been reduced from 12% to 5%. Some state governments also offer purchase incentives and interest rate concessions to further increase adoption.

Penetration of EVs in buses is largely driven by government push as it commits to improving the state of air quality, reducing pollution and curbing dependence on oil imports. Adoption by STUs has been the primary driver so far.

[9] TOI

Certainty in resale value

Electric vehicles are new to the market and most products have not reached their end of life yet. Adding to this, battery prices have also been falling which is expected to reduce the price of the vehicle. Uncertainty looms around the residual value of the vehicle. However, as the market matures, resale values should become clearer. OEMs are also introducing the concept of buybacks which will provide further clarity to residual values.

Disincentives on ICEs

As environmental concerns become even more serious in India, the government may start imposing higher taxes and duties on ICEs, which will disincentivise consumers to purchase ICEs and push TCO in favour of EVs. For example, the government has proposed a green tax on old vehicles running on petrol/diesel.

Lower maintenance cost

Since EVs have fewer components than ICEs, their maintenance requirement will also be lower. However, it is important to note that due to lack of skilled technicians and fairly complex technology involved, servicing may be costly initially. As upskilling initiatives are undertaken and the market matures further, servicing should become cheaper and thus, support the TCO argument further.

Other ancillary incentives

Various ancillary incentives to EV owners can also complement TCO for electric vehicles such as free parking, exemptions from road taxes, exemptions from registration charges, income tax benefits etc.

While TCO benefits are expected to increase in the future, the current scenario poses certain challenges apart from high upfront cost which raises the TCO like higher insurance premiums which is about 50% more when compared to that of ICE counterparts.

The government has provided a discount of 15% on EV insurance premiums. While this will help reduce TCO in the short run, in the long term, insurance premiums are expected to become lower as the EV ecosystem grows and becomes more established in India.

Conclusion

- TCO parity is one of the most important tailwinds to EV adoption in the nation. Segments where TCO parity has already been achieved - 2Ws, 3Ws and commercial 4W cars - are already witnessing growing penetration of electric vehicles, highlighting the significance of TCO
- High upfront cost differential is a key barrier to lower TCOs. Along with this, high insurance costs and financing costs still plague the industry which has a negative impact on TCOs
- In the short term, government incentives will play a crucial role in ensuring TCO parity. However, such incentives may be phased out over a period of time. Thus, in the long term, TCO advantages should flow from lower battery costs, certainty in resale value, higher hydrocarbon fuel costs and disincentives on ICEs among others
- TCO parity will inevitably translate to higher adoption, as cost savings from driving EVs will incentivise the market. However, TCO parity alone cannot guarantee higher EV adoption. Other factors, as highlighted in the report, need to be addressed in order to facilitate EV sales.

Limited charging infrastructure

India needs better charging infrastructure to support the EV growth

ISSUE 2

"India's vision to adopt EV mobility can only be achieved if we can solve for technologies made in and for India which address range anxiety, safety and fast charging, enable giga scale production, establish Pan India charging and after sales network and lastly, a talent pool that can address the needs across the EV sector."

Dr. Akshay Singhal
(Founder & CEO, Log9 Materials)

Range anxiety is a key concern among Indian consumers heightened due to inadequate charging infrastructure

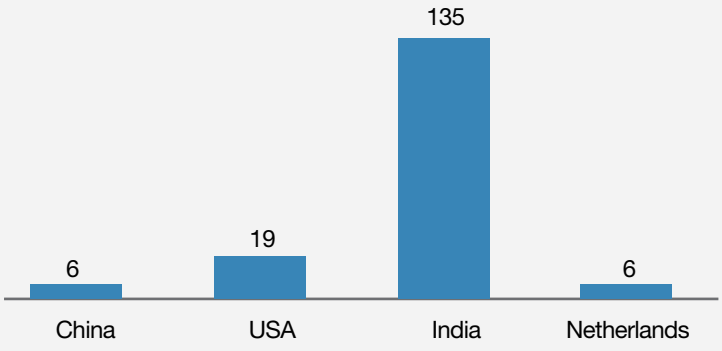
One of the biggest barriers to EV adoption in Indian consumers is range anxiety.

"Sixty-four percent of Indian drivers agree range anxiety is a significant barrier to mainstream adoption of EVs." said a recent consumer study[10].

Due to India's inadequate charging infrastructure, consumers remain worried whether the vehicle will run out of charge before they reach their destination, or if there will be no charging stations around to charge the vehicle.

Figure 6: Ratio of EV : Number of. public chargers

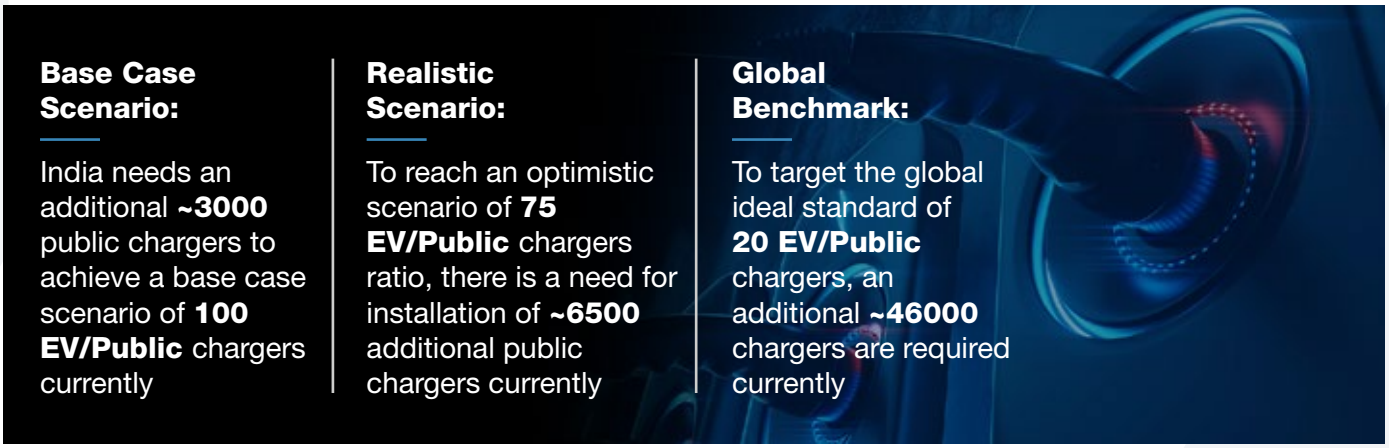
Source: A&M analysis, IEA, Industry discussions



India's EV : Public chargers remain poor compared to countries such as China, Netherlands, and USA. The global ideal EV/Public Chargers ratio is also around 6-20 EVs per public charger, whereas, in India it currently stands at an estimated 135.

[10] Castrol Study

Based on current vehicle density, the following number of additional chargers are required today in varied scenarios -



Base Case Scenario:

India needs an additional **~3000** public chargers to achieve a base case scenario of **100 EV/Public** chargers currently

Realistic Scenario:

To reach an optimistic scenario of **75 EV/Public** chargers ratio, there is a need for installation of **~6500** additional public chargers currently

Global Benchmark:

To target the global ideal standard of **20 EV/Public** chargers, an additional **~46000** chargers are required currently

Table 5: Additional public chargers required in India under various scenarios

Source: A&M analysis

	Base case scenario	Realistic Scenario	Global benchmark
EV/Public Charger Ratio	100	75	20
Required additional public chargers	3000	6500	46000

Realistic Scenario

We need to be mindful that there is no universally accepted EV/Public Charger benchmark or standard that needs to be targeted as it will depend on factors such as the country's population and population density. Additionally, the vehicle segment mix split across 2W, 3W, 4W, LCV and MHCVs, and vehicle density will also create differing requirements as two-wheelers and three-wheelers can be charged easily at home too. However, the analysis brings to notice the inadequacy of charging infrastructure in India right now and calls for building a wider charging infrastructure to support the nation's growing EV ecosystem. As per A&M analysis, India should target an EV/Public Charger ratio of ~75 to be able to provide a Similar compare to what? charging support to its EVs

Unit economics for charging infrastructure is currently not very favorable which creates barriers to building robust charging infrastructure

Charging stations in India require huge investments and present weak unit economics, which deters players from entering the market and setting up charging stations.

Presently, charging stations in India typically witness low average utilisation levels of ~6-7% which also leads to reduced revenue generation. For Finland and Sweden, countries with the highest average AC charging station utilisation, this number is 10-11% presently[11].

As per A&M estimates estimates, charging stations need to target utilisation of more than 20%-25% in order to achieve profitability for a charging station.

[11] Virta Global

Achieving higher utilisation is a long-term process and the key driver to profitability. Thus, it is difficult to expect profitability in the short term. As EV sales grow, charging stations could witness higher utilisation which should improve net profits net profits. But EV sales would also grow on the back of better charging infrastructure in the country. To address this problem, it is crucial to make the charging business model attractive through subsidies and incentives by the government, which would bring down costs and make unit economics favourable for early entrants in this category.

Average utilisation of the top 30 most used AC charging stations in countries such as Sweden, Switzerland, and Finland reach almost 70%. This suggests that higher utilisation can also be achieved through strategic location choices by setting up stations in busy areas. India could further benefit from its dense population which can help drive up utilisations.

Data driven decisions made using technologies such as IoT, may help charging service providers in identifying ideal charging periods to reduce operating expenses on tariffs and in levying surge prices on consumers during peak hours. Additional revenue streams in terms of value-added services such as eateries, convenience stores, car washing services, ATMs, tire shops etc. can positively contribute towards unit economics. BP, a major oil corporation that has avidly ventured into the EV charging business, stated that they see an enormous opportunity on the convenience side of an EV charging station as compared to that of a gas station, owing to the longer time spent there by a consumer.

Though unit economics is presently unfavourable, higher utilisations and data driven decision making is expected to improve it in the long run.

Commercial use cases:
Various players are focussing on charging stations for commercial fleet. This provides better certainty of utilisation and hence improved commercial viability of charging station operations.

High charging time and lack of standardisation of charger types further aggravates the issues experienced with the current charging infrastructure

One of the key disadvantages of EVs in comparison with ICEs is the high charging time. While charging time has reduced for new models like Tata Nexon by about 40-50% compared to older models like Tata Xpres-T, there remains a perceived gap among consumers when they compare charging time for an EV with refueling time for an ICE. Technological advancements is expected to further narrow this gap in the long run.

Table 6: Comparison of charging time of EV with refilling time of ICEs

Source: Industry discussions, Secondary research

	2W	3W	Car	Bus
Battery Size	1-2.5 kWh	4-8 kWh	1-2.5kWh	200kWh
Average Range	60-100km	60-130km	60-100km	150-300km
Charging Time (EVs)	AC: 3-4 hours	AC: 4-5 hours	AC: 7-8 hours DC: 1-2 hours	DC: 3-4 hours
Refilling Time (ICE)	~5 minutes	~5 minutes ~5-20 minutes (CNG)	~5 minutes ~5-20 minutes (CNG)	~5 minutes

Another issue that EV users in India face is the lack of standardisation of chargers. There are five types of connectors prevalent in India, causing charging service providers to invest in multiple chargers to cater to all the EVs and preventing optimal utilisation of charging infrastructure. However, the industry is expected to consolidate towards a common charging standard in the future.

Table 7: List of charging standards used in India

Source: Ministry of Housing and Urban Affairs

Charger Type	Charger Connectors	Rated Voltage (V)
Fast	CCS (min 50 kW)	200-1000
	CHAdeMO (min 50 kW)	200-1000
	Type-2 AC (min 22 kW)	380-480
Moderate	Bharat DC-00 I (15 kW)	72-200
	Bharat AC-00 I (10 kW)	230

Charging Infrastructure requires impetus from key stakeholders to achieve scale

Charging infrastructure involves various stakeholders like government, EV OEMs, charging provider firms, utilities, fleet operators, oil companies and residential and commercial building owners.

Table 8: List of relevant stakeholders for setting up charging infrastructure, their roles, and way forward

Source: A&M analysis, press releases, secondary research

Stakeholder	Role	Way Forward
 Government	Provide financial stimulus in the form of subsidies and tax breaks and set mandates to push other stakeholders **Example:** GST reduction from 18% to 5% on EV chargers, tariff reduction of electricity, capital subsidy of 25% on charging equipment	Stricter mandates from the government can help nudge other stakeholders to setup charging infrastructure; GST reduction on selling separate lithium-ion batteries will help improve economics of battery swapping
 EV OEMs	Set up own charging infrastructure to improve EV adoption and enter strategic tie-ups **Example:** Ather and Bounce tied up with retail shops for charging and battery swapping services respectively for 2Ws and are setting up their own charging infrastructure; OLA electric has tied up with Indian Oil Corporation (IOC) for setting up battery swapping stations for scooters at their pumps	EV OEMs can take initiative to set up their own charging infrastructure and offer incentives such as low cost or free charging services. This could increase EV adoption, leading to higher sales and can offset the losses incurred in charging infrastructure Example: Tesla followed a similar strategy to set up its fast-charging network in the USA
 Charging Service Providers	Build charging infrastructure via strategic tie-ups and explore innovative business models to improve economic viability of charger **Example:** Sun Mobility and VoltUp have tied up with Indian Oil Corporation and HPCL respectively to set up battery swapping stations; EESL set up India's first charging plaza in 2020 to facilitate charging of multiple cars at the same time	Charging service providers can look into more strategic tie-ups with other stakeholders (petrol pumps, residential and commercial complexes) and explore different business models that can ensure profitability for the company such as a subscription-based model which will ensure a fixed revenue stream and reduce uncertainty Example: : ChargeMOD, a start-up in India has started this modelExample: : ChargeMOD, a start-up in India has started this model

Stakeholder	Role	Way Forward
 Utilities	Set up own charging infrastructure and upgrade grid to facilitate fast chargers **Example:** Tata Power has set up 2200 public charging stations and 13000+ home chargers in 250 cities. State utility firms such as BESCOM, and MSEDCL have also been actively involved in setting up charging stations	Government has set up a mandate for every state to appoint a state nodal agency for building charging infrastructure, which shall generally be the state DISCOM. Utility companies can consider investing to upgrade the existing grid to accommodate fast charging and invest in setting up additional charging infrastructure on their own or in partnership with EV charging companies. Utilities can look into smart metering as an innovative solution to reduce the operating costs involved in charging.
 Fleet Operators	Leverage large scale of their fleets to setup own charging infrastructure ensuring better economic viability **Example:** Jio-bp has entered into an agreement to set battery swapping stations for Swiggy	Commercial fleets, being early adopters of EV, will have relatively favourable unit economics hence can consider setting up their own charging infrastructure
 Oil Marketing Companies	Leverage existing network of petrol pumps to set up charging infrastructure **Example:** Indian Oil deployed 1000 EV charging points in 2022 and plans to set up chargers in 10,000 stations in the next three years	Oil companies can significantly help multiply the existing charging infrastructure network due to wider reach across cities and highways; Higher contribution is anticipated by oil companies as they look to meet aggressive sustainability targets
 Residential and Commercial Owners	Design buildings that are equipped with charging infrastructure in parking spots **Example:** Nexus malls has tied up with jio-bp to deploy EV charging infrastructure at Nexus malls across 13 cities, and PlugIndia has supported initiatives to set up community charging stations for hotels and resorts	Majority of EV charging occurs at home or office therefore strict mandates are required for building owners to set up necessary charging infrastructure. Adding EV charging setup can lead to an increase in spending by customers at commercial complexes due to longer time spent there while their vehicle is being charged
 Utilities	Banks and NBFCs can aid in financing capital expenditure for setting up charging infrastructure. Private equity and venture capital investments will also enable access to capital for initial investments **Example:** LendingKart, an NBFC provides loans for financing SME EV charging companies	Due to unfavourable unit economics, banks are not confident to finance charging infrastructure projects. Government push and initiatives such as inclusion of EVs in PSL and risk sharing models can potentially help improve the financing scenario for setting up EV charging infrastructure

Innovative business models can make charging ecosystem more favourable and consequently reduce range anxiety

New and innovative business models have been coming up that focus on improving the charging ecosystem without depending on charging stations. This can help reduce range anxiety significantly.

Removable Batteries:

Removable batteries have become extremely popular for electric 2W and 3W. Such batteries enable the user to remove the battery from the vehicle and charge it separately without the presence of vehicles. Such charging can be undertaken conveniently at homes, offices, restaurants, etc. This offers much more convenience than finding a charging station and plugging in the vehicle for hours and helps in cases where there is no charging infrastructure at parking spots.

Example: Multiple OEMs such as Bounce, Hero Electric, Revolt, among many others offer EV 2W with removable batteries

Battery swapping model:

In this model, EVs are sold without a battery and EV users subscribe to a BAAS (Battery-as-a-service) where they can access battery swapping stations and replace uncharged batteries with fully charged batteries. This also reduces the upfront EV cost significantly and reduces downtime to fewer than five minutes. It is suitable for EV 2W and 3W as the battery can be manually replaced unlike for EV 4W and e-buses that have larger batteries and require machines to swap them

Example: Sun Mobility (for EV, 2W, 3W, Buses), Yulu in India

Battery innovations:

Continuous innovations in battery technology can lead to alternate battery chemistries that offer better range thereby reducing charging frequency and also reducing charging time as well.

Example: Log9, an Indian battery technology startup, uses a patented high-power cell technology that provides 9x faster charging, 9x better performance, and 9x battery life[12] New battery chemistries such as silicon anode lithium-ion batteries can charge extremely fast. Multiple startups are working towards developing and commercialising newer technologies and variations.

[12] Business Standard

Conclusion

The current charging infrastructure in the country is still in its nascent stages. This has a significant role to play in increasing range anxiety among consumers that impedes EV adoption despite other widely recognised advantages of EVs.

The issues present in the current charging infrastructure challenge can be resolved when support from multiple stakeholders is received.

- Government mandates, and not just guidelines, are crucial to provide initial stimulus and nudge other stakeholders as well to contribute to building necessary infrastructure.
- OEMs can also explore building their own charging infrastructure to drive EV adoption.
- Charging stations at residential and commercial complexes can increase convenience for EV owners
- Support from oil marketing companies, utilities, and strategic tie-ups by charging infrastructure providers can collectively pave the way for better charging infrastructure in the future.

Efforts in improving charging infrastructure unit economics would also help in attracting more players and investors. While in the short term this will be achieved through government subsidies, in the long-run, we may see higher utilisation rates which will drive better unit economics. It is expected that as EV sales pick up, higher utilisations would follow.

Innovative measures such as battery removing and swapping models, and technological advancements in batteries will become more relevant moving forward in order to reduce range anxiety

Issues in supply chain scalability

Current supply chain in India restraints EV scalability in the near term

ISSUE 3

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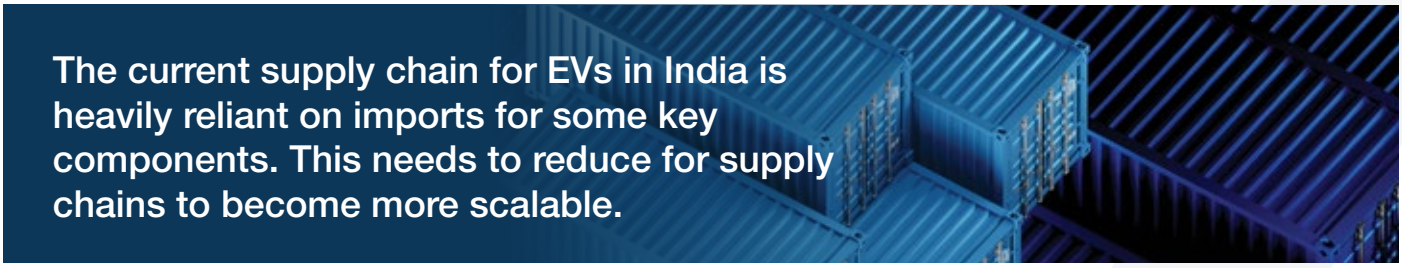
Supply chain is expected to play a key role in EV scalability

The EV supply chain is quite different as compared to the ICE supply chain due to fewer components and different technologies involved. As the EV industry scales up, the supply chain and related infrastructure will need to scale up in tandem with it to support the growth. Production of a few key components is concentrated in only certain regions around the world making scalability a challenge to meet the upcoming demand for EVs. Therefore, strategies to enhance the supply chain are a must for EV manufacturers. Globally, companies have adopted strategies such as vertical integration, strategic alliances, local supply base, and innovation in battery chemistry. For example, Tesla has one of the most vertically integrated supply chains among EV manufacturers. Setting up the Tesla Gigafactory for batteries has ensured scalability and reduced battery production costs by 30%[13].



The growing EV market represents an opportunity for both OEMs and disruptors to completely reimagine their supply chain operating models. Here, technology has played a central role in achieving this. However, the current supply chain for EVs in India is heavily reliant on imports which can be a cause of concern due to geopolitical constraints and higher import costs.

Jeetender Sharma, Founder & MD, Okinawa Scooters

[13] Tech Crunch

However, the current supply chain for EVs in India is heavily reliant on imports which can be a cause of concern in the long run

The import dependence of supply chain may lead to challenges for OEMs due to following factors:

Uncertainties caused by geopolitical constraints

Recent shortage in global chip supplies created a shortfall of EVs in major markets and pandemic-induced supply chain constraints made importing a challenge. Other geopolitical issues in the world also trickle down to supply chain challenges. For example, supplies of lithium and metals have been impacted by the Russia-Ukraine war as Russia is one of its key suppliers. Such constraints can create concerns while importing.

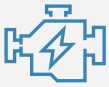
High costs

High custom duties and freight costs dictate imports. Apart from this, the cost of raw materials can rise due to limited availability in certain countries, pushing prices in the future. Concentrated manufacturing of certain components can induce companies to charge higher premiums as well.

The current state of localisation for various components in EV supply chain can be studied as:

Table 9: List of key EV components

Source: A&M Analysis, Industry discussions, Secondary research

Component	Description	Current Status
 Battery Cell	A cell is the most basic unit of a battery pack. The battery is a critical component of EVs and accounts for about 25% of the total EV cost.	EV OEMs rely on its imports due to a lack of local access to key raw materials like Lithium, Nickel and Cobalt. Presently, there are no players manufacturing battery cells indigenously. However, few Indian OEMs have started setting up manufacturing units for assembling and customising battery packs presently.
 BMS	Battery Management System (BMS) along with the Thermal Management System (TMS) measure and control critical parameters of batteries to keep them safe and operationally efficient. They account for almost 8-10% of total EV cost	BMS has started witnessing localisation, but more than 50% is still imported. Electronic components of the BMS like control units are imported primarily from China and Taiwan.
 Motor	An electric motor performs the same function as an engine does in an ICE vehicle – it propels the vehicle. The sub-components additionally involve gearbox, housing, and connectors. They account for about 10% of total EV cost.	Local manufacturers primarily focus on building motors for light EVs like 2W and 3W. However, they rely on imports from China for the supply of magnets which is a key and costly component of the motors presently used in Indian EVs. Electric cars typically require larger sophisticated motors and hence rely on imports due to a lack of technical know-how.
 Power Electronics	Power Electronics includes major electronic components of the EV like the motor controller and vehicle control unit. They account for 7-10% of total EV cost	Power electronics supply relies heavily on imports (about 65-70%) primarily from China and the incumbent OEMs currently lack technical knowledge. Local manufacturers focus mainly on light EVs (2W, 3W). Power electronics copiously require semi-conductor elements as well which are entirely import-dependent
 Power Converters	Power Converters include AC-DC Converters, DC-DC Converters, Power Distribution Units, and Onboard chargers	OEMs are still dependent on imports for the supply of power converters as only a few local manufacturers exist at present
 Chassis & Body	Structural components like the base frame of the vehicle, which are common with ICE vehicles as well. They account for about 20% of total EV cost	This segment is highly localised with major automotive OEMs having existing supply chains catering to ICE vehicles
 Others	Others would include includes remaining components like the rest of the drivetrain and other accessories like tyres, HVAC, etc.	Most of the remaining components are common with ICEs and have existing supply chains that can be easily localised

In the near future, India is expected to have a largely self-reliant supply chain for several key EV components

Localization will be instrumental in securing the EV supply chain in India. The government has made efforts to reduce imports and incentivize local production of EV components through various schemes:

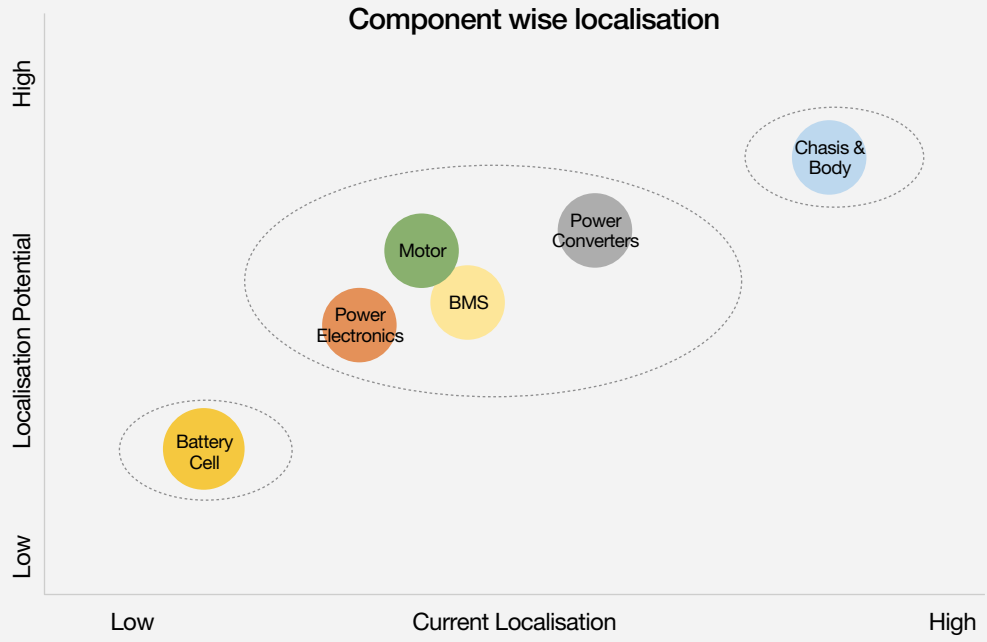
1. Phased Manufacturing Program: A graded duty structure proposed for EV components to promote indigenization was released in 2019. Additionally, OEMs are required to ensure the localization of certain EV components to avail of demand incentives under FAME-II.[14]

2. Production Linked Incentives (PLI) for batteries: Government approved a PLI scheme for achieving a manufacturing capacity of 50 Giga Watt Hour (GWh) of Advanced Chemistry Cell (ACC), with a budgetary outlay of ₹ 18,100 crores. Selected ACC battery storage manufacturers are required to set up an ACC manufacturing facility with a minimum capacity of 5 GWh and incur the mandatory investment of INR 2.25 billion/GWh within two years, to avail the incentives. Four companies (Reliance New Energy Solar Limited, Ola Electric Mobility Private Limited, Hyundai Global Motors Company Limited, and Rajesh Exports Limited) have been selected for incentives under the PLI scheme with a total allotted capacity of 50 GWh[15]

In addition to the government push, the future outlook of the EV supply chain will depend on the localisation potential of respective EV components. Based on the current state of localisation and localisation potential, EV components can be bucketed into three categories:

Figure 8: Localisation of key EV components

Source: A&M Analysis, Industry discussions



[14] pib.gov.in (PMP) | [15] pib.gov.in (PLI)

Category 1: Current localisation is very low, future localisation outlook is low

Table 10: Future outlook of category 1 components (Battery cell)

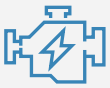
Source: A&M Analysis, Industry discussions

Component	Future Outlook
 Battery Cell	• While battery pack manufacturing can be highly localised in the short run, localisation of battery cells will remain a challenge in the long term for EV OEMs in India. Even with PLI incentives, there is still expected to be a shortage in local supply that will ultimately have to be fulfilled by imports. • Setting up long-term partnerships and increasing scale with global suppliers can help OEMs negotiate lower prices for the cells being imported. Players like Tesla have done the same with Panasonic to ensure a steady supply of battery cells. • Circular economy is a concept that can potentially help reduce import dependence on key raw materials of a battery cell. It involves recycling Li-ion batteries that have reached their end-life and extracting back key raw materials like Li, Ni, and Co that can be reused to manufacture new batteries. While few global players like Redwood Materials and Li-cycle have entered this business, commercial viability is presently low in India due to low market opportunity as the majority of EVs in India have not reached their end-of-life yet and high investment requirements. However, commercial viability is expected to increase within the next 10 years, as EVs reach their end-of-life.

Category 2: Current localisation is low, future localisation outlook is moderate

Table 11: Future outlook of category 2 components (BMS, motor, power electronics and power converters)

Source: A&M Analysis, Industry discussions

Component	Future Outlook
 BMS	• While the software system involved in BMS can be localised in the short-term owing to India's existing capability in software technology, localisation of hardware components will remain a challenge. • A complete shift to smart BMS is expected in the future which currently only premium EV OEMs are using. Local manufacturers will have to upgrade themselves to cater to this shift.
 Motor	• While we can expect more local motor manufacturers to enter the industry in the coming years, deep localisation of motors will remain a challenge due to the high dependence on imports for permanent magnets, mainly from China. • In the long run, we can expect the adoption of magnet-less motors like SRM motors that will help overcome the import dependence on magnets. However, technological improvements to increase efficiency will be required to replace the current motors.
 Power Electronics	• Power electronics are heavily import-dependent, and localisation will require high investment. While software and hardware systems can be localised in the near future, localising the semiconductor components will remain a challenge in the long run
 Power Converters	• Localisation can be expected in the short term as manufacturing complexities are not high, however, a shift to a more economical and integrated unit is expected in the long run

Category 3: Current localisation is high, future localisation outlook is high

Table 12: Future outlook of category 3 components (Chassis & body)

Source: A&M Analysis, Industry discussions

Component	Future Outlook
 Chassis & Body	While the current supply of chassis-related components and body parts can be sourced from the existing automotive supply chain in India, upgradation would be required to make chassis more suitable for EV usage. EVs are heavier than ICEs and therefore require lightweight components. We can expect more players to have light weight manufacturing capabilities in the long run.

Meanwhile industry grapples with acute supply shortages for key components being imported, but is expected to ease out in future

Presently, the supply constraints around the global shortage of chips and battery cells are affecting the local manufacturing capabilities of EVs. Currently, there is an estimated 20-25% shortage of batteries due to COVID-led supply issues but it is expected to ease over the next 1-2 years as global players like LG, CATL and Panasonic are scaling up their capacities and indigenous players are setting up local cell manufacturing units under the PLI scheme. India is expected to have a local battery cell supply of 50 GW by 2030 and hence a supply deficit is not expected over the next 5 years.

Table 13: Analysis of EV battery demand and supply

Source: A&M Analysis, Industry discussions

Charger Type	FY 22	FY 27 (Projected)
Global EV battery requirement (USD Bn)	60-65	213-230
Current global EV battery supply (USD Bn)	40-50	240-250
Global supply deficit/excess (-/+)	-(20-25%)	+(10-15%)
India market demand (GW)	1	29

The supply issue with chips is however more severe with a current shortage of 40-50%.

There is a planned investment of USD 130-150 Bn by chip manufacturers to expand capacity and is expected to ease the supply shortage by FY 25-26. Therefore, the prevalent supply issues are expected to stabilise within the next 3-4 years.

To ensure that the EV OEMs can cater to the expected future demand, it is crucial to ensure limited risk from global suppliers of key components and sufficient availability of raw material. An analysis of the expected supply risk for key components in the future has been shown in the next table:

Table 14: Component-wise localisation and supply risk analysis

Source: A&M Analysis

Charger Type	Localisation		Supply Risk	
	Current	Future (5 Year Term)	Short Term	Mid/Long Term
Battery Cell	○	◔	◑	◔
BMS	◔	◑	◕	◑
Motor	◔	◕	◔	◑
Power Electronics	◔	◑	●	◕
Power Converters	◑	◕	◔	◔
Chassis & body	◕	●	◔	○

○ Very Low ◔ Low ◑ Moderate ◕ High ● Very Moderate

Conclusion

While there is an immediate concern around the global supply shortage of key EV components such as chips, it is expected to normalise in the next 3-4 years as global suppliers scale up their manufacturing capacities.

The current supply chain for EVs in India is highly import-dependent owing to the limited access to key raw materials and the required technology being at its nascent stage in the country. Localisation is expected to increase as OEMs look to have tighter control of their supply chains. Government has also taken initiatives such as the Phased Manufacturing Program (PMP) and Production Linked Incentives (PLI) to incentivise localised production of EV components.

However, a certain amount of import dependence is still expected to remain in the future for certain components like battery cells and chips due to the nature of raw material and technological complexities involved. A shift to newer and more advanced technologies that require less import-dependent components can help overcome this issue.

There is a strong opportunity for EV OEMs in India to make large-scale investments and reinvent the current supply chain, given the scope of technological advancements expected in the future.

Limited product range

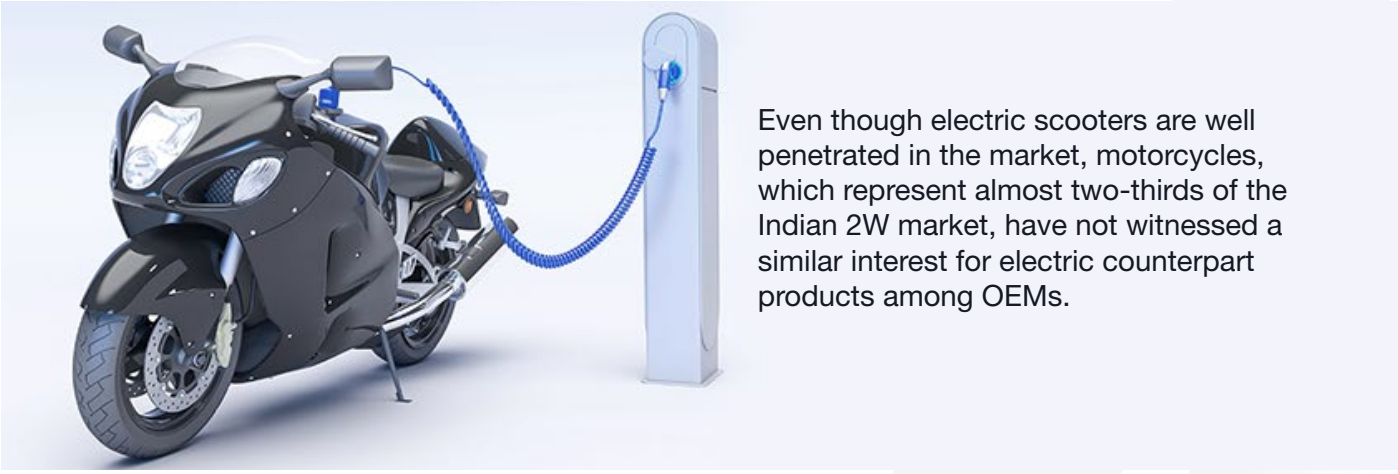
Lack of adequate product range for EVs is a significant barrier to mainstream adoption

Wider product range symbolises product maturity and instills confidence within consumers

The slow adoption of EVs in India can be attributed to the low or non-existent product range in certain segments of the automotive industry. Very few players operate within these segments and offer a limited product range as compared to ICE counterparts.

A wider product range could improve the visibility of EVs in India as well as push OEMs to introduce better performance specifications to fight competing products. Increased product range would also help instill confidence in the minds of Indian consumers about the EV market.

Two-wheeler market sees high penetration in scooters but limited product options for motorcycles



Even though electric scooters are well penetrated in the market, motorcycles, which represent almost two-thirds of the Indian 2W market, have not witnessed a similar interest for electric counterpart products among OEMs.

Almost 95% of the motorcycles market is underserved with not enough products launched, while only 67% of the overall two-wheeler market is currently underserved. More EV variants for motorcycles are needed, particularly in the economy and executive segments, which represent a major share of the 2W market in India.

Table 15: 2W product range analysis[16]

Source: A&M analysis

Vehicle Type	Category	Classification	% Breakdown of sales volume	Unserved	Underserved
2W/scooters	Mopeds	Low	4%	10%	67%
2W/scooters	Entry Level (100 CC)	High	4%		
2W/scooters	Executive (100-150 CC)	High	25%		
2W/scooters	Performance (>150 CC)	Low	<1%		
2W/motorcycles	Economy	Low	37%		
2W/motorcycles	Executive	Low	15%		
2W/motorcycles	Premium	High	4%		
2W/motorcycles	Performance	Low	6%		
2W/motorcycles	Sports Bike	Low	5%		

Unserved: No products available in the market | **Underserved:** Two or lesser products available in the market

Three-wheelers have witnessed multiple OEMs entering the market

The favourable TCO equation has popularised electric three-wheelers, made attractive by the advantage of lower operational costs for higher distances. The presence of a large number of local e-Rickshaw manufacturers has, however, made the market highly fragmented. Players such as Amazon, Flipkart, etc. have committed to fleet electrification targets which is expected to rapidly increase the demand for electric cargo autos. Subsequently, many players have entered the electric cargo auto market to cash in on the anticipated increase in demand from such players. However, the number of passenger electric autos is still picking up as owners are mostly retail customers and awareness is at a nascent stage.

Table 16: 3W product range analysis[16]

Source: A&M analysis

Vehicle Type	Category	Classification	% Breakdown of sales volume*	Unserved	Underserved
3W	E-Rickshaw (P)	High	30%	0%	0%
3W	E-Rickshaw with cart (G)	Medium	4%		
3W	Three-Wheelers (Goods)	High	17%		
3W	Three-Wheeler (Passenger)	Medium	39%		

Unserved: No products available in the market | **Underserved:** Two or lesser products available in the market

*unregistered 3W have not been considered in sale volume

[16] Appendix 2

While there are multiple products catering to the luxury car segment, there is a scarcity in the affordable category

Majority of the ICE four-wheeler market comprises of mini hatchbacks, small hatchbacks and compact sedans, catering mostly to the affordable segment of the market. This segment is an underserved market in the EV space with low product penetration observed in these categories. The newly released models like Tata Nexon and MG ZS which command a large share of EV personal vehicle (PV) market, belong to the compact utility vehicle segment and are priced higher than the affordable segment vehicles. EVs in the sedan segment like e-Verito and Xpres-T are mainly used in commercial fleets. Introducing new models in the hatchback and sedan segments at affordable prices can help increase penetration of EVs in the cars segment, as they represent a large chunk of the existing ICE market.

Table 17: Cars product range analysis[16]

Source: A&M analysis

Vehicle Type	Category	Classification	% Breakdown of sales volume	Unserved	Underserved
Cars	Mini Hatchback	Low	13%	37%	67%
Cars	Small hatchback	Low	25%		
Cars	Compact sedan	Low	23%		
Cars	Super Compact Hatchback Sedan	Low	<1%		
Cars	Mid-Size Sedan	Low	3%		
Cars	Premium/luxury/executive Sedan	High	<1%		
Cars	Compact UV	Medium	30%		
Cars	Mid-Size UV	Low	4%		
Cars	Premium/luxury/executive UV	High	2%		

Unserved: No products available in the market | **Underserved:** Two or lesser products available in the market

LCVs have not seen any mainstream use cases, but buses have been picking up on the back of government push

LCVs have not seen much penetration in EVs even though the TCO seems to be favourable conceptually. There are not enough mainstream LCV models that have been launched and tested over a long period of time on Indian roads and freight movement conditions. Industry continues to observe this space with interest. Buses, on the other hand, have seen better penetration and wider product ranges due to government push.

[16] Appendix 2

Table 18: LCVs and bus product range analysis[16]

Source: A&M analysis

Vehicle Type	Category	Classification	% Breakdown of sales volume	Unserved	Underserved
LCV/Load carrier	Mini trucks (up to 2 tonnes)	Low	33%	63%	99%
LCV/Load carrier	Pick-up Truck (2 tonnes - 3.5	Low	54%		
LCV/Load carrier	3.5 tonnes - 6 tonnes	Low	3%		
LCV/Load carrier	6 tonnes - 7.5 tonnes	Low	3%		
LCV/Passenger carrier	Max. Mass up to 5 tonnes	Low	2%		
LCV/Passenger carrier	5 tonnes - 6.5 tonnes	Low	1%		
LCV/Passenger carrier	6.5 tonnes - 7.5 tonnes	Low	1%		
Buses	Light	Medium	1%		
Buses	Intermediate	High	<1%		
Buses	Heavy	High	1%		

Unserved: No products available in the market | **Underserved:** Two or lesser products available in the market

The industry is expected to witness wider product range on the back of growing consumer interest

[16] Appendix 2

Table 19: Segment-wise product range outlook

Source: Secondary research, Company websites, Press releases

Segment	Way forward
 Two-wheelers	Scooters may see more product launches, especially from traditional OEMs, and both startups and OEMs are eyeing the Indian motorcycle market For example, • Performance-oriented motorcycles like the Ultraviolette F77 have been announced but not yet commercially launched in the market • Honda, one of the leading OEMs in scooters and motorcycles, has announced the release of a performance -oriented bike and range of electric scooters
 Three-wheelers	Wider range of products from traditional three-wheeler autos are are expected to be launched. Meanwhile, newer players may keep entering as the market has already reached maturity stage For example, • Top OEMs such as Bajaj and TVS have announced the intention of entering the three-wheeler space; Bajaj plans to launch its first autorickshaw by 2023 which will be a small passenger • Murugappa group is looking to launch vehicles across passenger, cargo autos, and e-rickshaw categories
 Cars	While Tata enjoys majority of the market share, other ICE and EV OEMs are also planning huge investments to introduce more four-wheeler EV models For example, • Mahindra & Mahindra is making an investment of Rs. 3000 crores to launch 16 new electric vehicles in the next seven years • Hyundai has started a program to manufacture a small and affordable EV, which is a part of Hyundai's broader plan to invest 40 billion rupees to launch six electric vehicles in India by 2028 • Ola Electric is planning to launch its first electric car in 2023
 LCV & Buses	Firms are carrying out testing trials for LCVs before launch. Once these products are launched and TCO is established, more players may enter the market to manufacture LCVs industry participants have concerns that a viable LCV product may need a much bigger battery and hence may not be eligible for Fame 2 subsidy. Additionally, a higher price will imply a very steep upfront price difference between an ICE LCV and an equivalent EV LCV, potentially making it unviable. As some of these questions get answered, we will have better visibility on EV adoption in this segment. For example, • Ashok Leyland's arm, Switch Mobility, will be investing ₹1,000 crore in a dedicated EV plant to set up 30,000 units of E-LCV capacity • Omega has unveiled M1KA, an electric LCV aimed at intracity commute and looks to target the owner-cum-driver and fleet operator segments

Conclusion

- As per our analysis, almost one-sixth of the entire automobile market is completely unserved which means that no EVs exist in the market to cater to this untapped demand. Additionally, about two-third of the market is underserved due to an inadequate range of models within each category and a lack of better-quality models.
- Categories that have seen early TCO benefits such as scooters and three-wheelers have seen many models being introduced in the market. However, even though motorcycles form a majority of the market in two-wheelers, this segment is severely under-served by EV OEMs. Furthermore, there are hardly any mainstream use cases of electric LCVs and penetration in cars remains low.
- The various underserved segments of the market highlight the need for OEMs to launch a wider range of products and invest in R&D to develop models with better performance specifications. Some of the underserved segments like LCVs and motorcycles are expected to see a higher rate of new product introduction, which will lead to better EV penetration in these categories

Safety and quality issues

Concerns around product safety have been rising

Perceived apprehensions around safety have clouded the industry's confidence on EVs

There has been a growing concern around the safety of EVs in India, especially with rising cases of EVs catching fire. There have been more than 10 incidents of EVs catching fire in 2022 alone. Most of the cases have been observed in 2W EVs. This issue is not specific to India and has been observed globally as well by firms such as Tesla, Ford, Hyundai, General Motors among others. Yet, a negative perception has formed around the adoption of EVs in India, which is a matter of concern as India is still in its early stage of adoption.

Investigations of the various fire incidents have pointed to certain issues that would have caused fires like usage of poor-quality batteries, less efficient battery management systems and faulty charging practices amongst others. High temperatures and humidity in India are also a matter of concern for the battery packs imported from other countries, as they are largely not designed to withstand the climatic conditions in India. Rapid scaling up of the EV supply in India over the past few years has caused challenges with quality control.

Apart from the concerns caused due to EV fires, there have also been quality concerns in EVs arising from the usage of sub-standard components for motors and controllers, which leads to performance issues. This has been observed in three-wheelers and other segments where there is pressure to reduce costs to drive consumer adoption.

Government and OEMs need to collectively work towards creating a safer ecosystem for EVs

While EV OEMs have been working towards ironing out the defects in their products, the government has started taking action to ensure quality control. The current measures have been:

1. A panel of experts was formed with representatives from Visakhapatnam-based Naval Science & Technological Laboratory, IIT Madras and IISc Bengaluru, to come up with a Standard Operating Procedure (SOP) for testing and validation of key components and for formulating a certification standard for the battery used in EVs.[17]
2. The Indian certification agencies ARAI and ICAT are developing the capability to test batteries and electric vehicles.
3. Bureau of Indian Standards (BIS) for the first time has formulated standards for lithiumion traction battery packs and systems of electrically propelled road vehicles and is in the process of specifying two separate standards for batteries used in various passenger and commercial vehicle categories.[18]

[17] Indian Express | [18] Inc 42

Enhancing the safety of EV products will be a key driver to changing consumer perception and boosting future adoption. Further measures can be taken by the stakeholders involved to mitigate the safety concerns that are prevalent can include the following:

- Using advanced materials to design the Battery Thermal Management System (BTMS) that is suitable for hot weather
- Revisiting AIS 156 battery standards and forming them in accordance with international benchmarks, tailored to Indian requirements
- Battery swapping enables cooling and charging in a temperature-controlled environment and reduces the risk of overheating that may occur in the conventional charging model
- Adoption of smart chargers that can provide data about the battery health and temperature and accordingly communicate whether it is safe to charge the vehicle
- Research and development into alternate battery chemistries that have higher thermal stability making them more suitable for India's climate

Conclusion

While safety is a concern at present that might impede EV adoption in India, it is expected to be resolved in the future as the EV market matures.

Strict product compliance measures and quality control from suitable bodies will be important to mitigate the prevalent quality concerns.

As the quality and safety issues get resolved moving ahead, conducting positive campaigns will be important to strengthen the confidence of consumers in the EV sector.

Limited access to financing

Uptake from financing is still facing hurdles for EVs

ISSUE 6

Financing has always played a key role in vehicle purchase, with almost 75% penetration in traditional ICEs

Financing has historically played a crucial role in driving vehicle sales. The penetration of vehicle financing is one of the highest in India at almost 75%. About 95% of all commercial vehicle purchases and 80% of four-wheeler purchases are financed in India[19]. Vehicle financing has been increasing at a rapid pace in the country, with the absolute number of outstanding vehicle finance advances from banks and NBFCs growing at a CAGR of 15%. In such a scenario, the lack of easily available loans for electric vehicle purchases could create a huge hindrance to EV sales. It is crucial for banks and NBFCs to scale up financing for EVs and offer relevant and affordable options to support EV growth.

Figure 8: Financing penetration in vehicle purchases

Source: ICRA

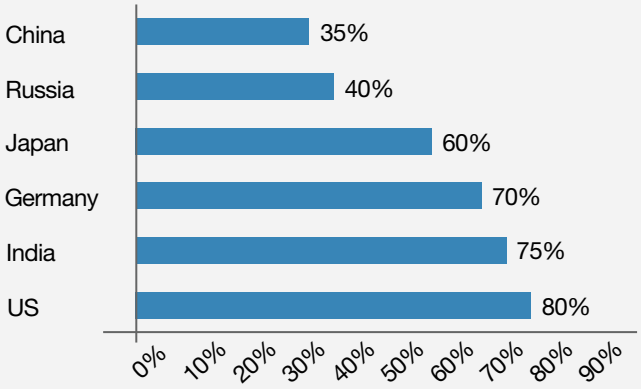
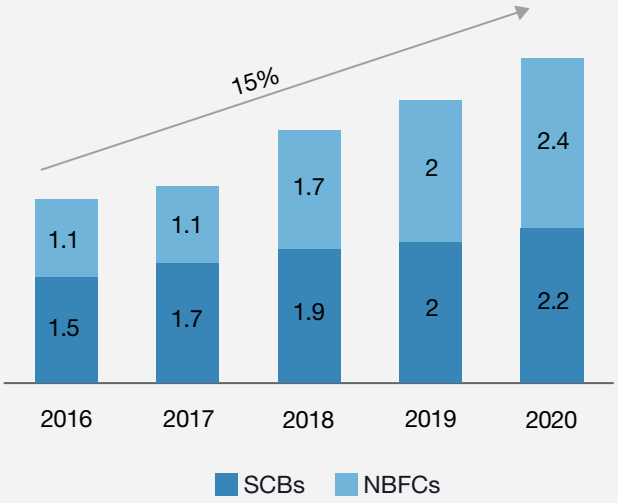


Figure 9: Outstanding vehicle finance advances (in INR trillion*)

Source: RBI database



However, financing is facing challenges when it comes to the EV industry

The industry is facing multiple challenges because of which financiers have not gained confidence in the sector and have been apprehensive about meeting financing requirements. This is triggered by multiple risks that the sector is dealing with.

[19] NITI Aayog

Table 20: List of risks involving in EV financing

Stakeholder	Role	Stakeholder
Product risk	There is less performance track record for EVs	Financers are relatively less confident about the performance of the product which inhibits financing
Technology risk	Technology for EVs is still developing and incremental changes are being witnessed constantly, so there is a risk of the current underlying technology of the vehicle becoming obsolete quickly	This creates concerns around the relevance of current EV products in the future
Resale value risk	Currently, EVs do not have a robust resale market. Residual value is uncertain because of expectations of technological obsolescence and falling EV prices in the future	This creates uncertainty around the industry. For banks, it also creates challenges as residual value is uncertain in case of default

These risks are impacting all stakeholders in the following manner.

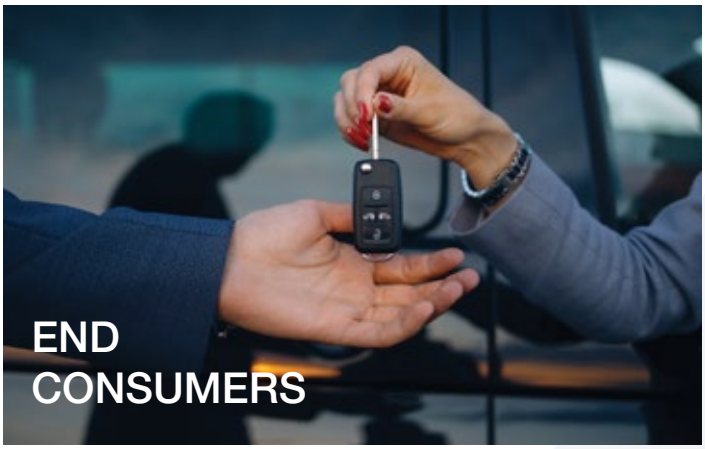
Large OEMs may be able to access capital relatively easily due to their healthy balance sheets, however, small OEMs have smaller balance sheets, and uncertain cash flows which makes loan availability relatively challenging, especially given the huge requirements of funds for capital expenditure and R&D in the sector.

Lately, the industry has also seen OEMs depend on foreign intellectual property to develop EVs instead of developing indigenous technology. They license technology from global firms to develop EVs in India. However, this model makes equity financing challenging because of the risks associated with scaling up the business through licensed technology. At the same time, investing in EV technology and R&D requires huge of capital investments which can also be difficult to procure.

Attracting international investments is also a challenge in India. India needs to set in place attractive policies that can make EVs a good investment avenue for international financiers. While Indonesia, Thailand, and Vietnam have all structured policies to attract international investment in electric vehicle manufacturing, India still lags behind.

To build the EV ecosystem, OEMs must have adequate access to equity capital, loans, and foreign funds to invest in R&D, technology, infrastructure, and more.

End consumers rely on banks to get loans for purchasing EVs. Consumers especially in the financially excluded segment, face huge issues to get loans from banks due the risks involved and rely on NBFCS. Historically, the interest rates for financing EVs have been higher when compared to ICEs. The loan-to-value ratio for EVs has been relatively lower by almost 20-30% and repayment tenures have also been shorter. Collectively these factors impact availability of loans and affordability of EVs. However, this has started improving over the past couple of years.



Setting up charging infrastructure is a capital-intensive business which requires high initial investment. However, financing has remained a challenge here due to the unfavourable unit economics and low EV penetration observed in India.

Efforts are being made by various stakeholders to ramp up financing

Financing has been recognised as a roadblock to higher adoption of EVs and efforts are being undertaken by various stakeholders to make lending and funding easier.

01 Government

Government have been offering incentives such as tax exemptions and interest rate subventions to make loans affordable.

For example,

- The Delhi government offers interest rate subvention of up to 5% for autos, e-rickshaws, and LCVs
- Up to Rs 1,50,000 total tax exemption is allowed through Section 80EEB when paying off an EV loan

02 Banks

Banks have rolled out specialised EV loans called "Green Loans" that offer interest rate concessions compared to ICE rates

Table 21: Interest rate concessions provided by banks as of July 2022

Source: Source: Bank websites

Bank	Interest Rate Concession
SBI Green Loan	0.20%
PNB Green Car Loan	0.10%
Union Green Miles Loan	0.10% - 0.20%
Bank of Baroda Loan	0.25%

03 OEMs

OEMs such as Ather Energy, Ola Electric, Hero Electric, and Ampere have tied up with various banks to provide easy loans to their consumers. OEMs have started offering leasing solutions as well. For example, Tata Motors has tied up with Orix India and MG has partnered with Myles to provide subscription plans for their electric vehicles. Under such leasing schemes, the customer is not required to pay any down payment and there is no hassle of paying for insurance, tax, registration, and maintenance.

Furthermore, buyback programs by OEMs instill faith in the residual value of the product.
For example, Ather has started a buyback program where customers are given an option to sell their vehicle after a certain designated period.

04 Startups

Lately, multiple startups have been coming up with innovative products that enable easy financing for electric vehicles.

Digital underwriting enables startups to provide loans to the financially excluded segment as well as it enables higher sales of electric rickshaws and electric autos.
RevFin, for example, uses non-traditional underwriting methods such as psychological tests, to provide loans to the financially underserved category.

Additionally, startups have also come up with leasing offerings that can enable fleet operators and retail customers to lease vehicles. For example, Autovert works with Ather to provide leasing services and at least 10% of Ather's vehicles are understood to be leased through this startup.

05 Other stakeholders

There are other stakeholders in the industry that have been important contributors to the EV financing industry. NITI Aayog has collaborated Bank to set up the first loss-sharing instrument. This instrument provides credit guarantees to financial institutions in case of defaults in EV loans.

EV financing has been booming globally on the back of government, OEMs, and bank initiatives

China:

Tesla has a financial leasing company registered in China. It provides car financing services to make its Model 3 and Model Y more affordable. The Chinese government also assists firms with infrastructure credits and R&D grants.

USA:

About 47 out of 50 states in the USA have initiated EV policies and provide support. state government offers rebates, purchase incentives, loan guarantees, etc. to boost EV sales

Australia:

Australia has set up a risk-sharing mechanism where public green bank partners with private banks to share risks and set up green vehicle loan schemes. The Australian Capital Territory government's sustainable household scheme offer loans at zero interest rates for electric vehicles.[20]

Indonesia:

The EV sector falls in Indonesia's priority sectors according to the Positive Investment List. Businesses with capital investments of more than ~USD 33 million will get a 100% deduction in corporate income tax, and investments of USD 6.6 million – USD 33 million will get a 50% deduction in corporate income tax. Such policies help attract more foreign investors to invest in Indonesia's EV market.[21]

[20] Guardian | [21] Entrepreneur

Further innovations and initiatives are needed from involved stakeholders to boost the sector

Table 19: Potential opportunities for stakeholders in financing

Stakeholder	Potential Opportunities
Government	**Inclusion in PSL:** Inclusion of EVs in priority sector lending would incentivise more banks to increase lending in this sector. For example, the inclusion of renewable energy in PSL in 2015 widened the scope of lending to support bigger installations and public utilities based on renewable energy. **Subventions:** Interest rate subventions, that is, a subsidy on commercially offered interest rates, can make loans more affordable for the stakeholders as done by the Delhi government. **Risk sharing mechanisms:** Full or partial coverage such as the partial credit guarantee scheme where a certain percentage of loss incurring from EV loans are covered by the government **Other incentives** such as providing tax benefits for investments
OEMs	**Leasing:** OEMs can partner with firms offering leasing services that come with no down payment and no hassle of paying road tax, insurance, registration, or maintenance. They serve as a good alternative to loans. **Captive financing:** Introducing captive finance businesses which can provide loans for the OEM's products at attractive rates Having an **open data repository** about EV product specifications, performance, and real-world costs such as operating expenditures can help financial institutions accurately assess the product and risk associated with it **Product guarantees:** Longer guarantees provided by OEMs can help financial institutions reduce the uncertainty associated with the sector
Banks	**Digital solutions** such as digital underwriting, sanctioning, and sourcing can enable wider access to EV loans **Specialised EV loans** with interest rate concessions, longer repayment periods, high loan-to-value ratios
Funds	**Private Equity/Venture Capital:** The sector has ripened for investments from private equity and venture capital funds, however, higher uptake is needed to fund charging infrastructure businesses **ESG Funds:** ESG funds in India are comparatively less compared to global sectors. Such ESG funds should tap into the opportunity presented by the Indian EV marke
Fleet Operators	**Risk sharing mechanism** where fleet operators provide partial credit guarantees to financial institutions and augment EV loans for drivers

Conclusion

Access to affordable financing options for all involved stakeholders is crucial to enable a growing EV ecosystem. There is a mismatch between the demand and the availability of EV loans in the market.

New-age startups will have a key role to play in addressing this gap. Innovative financial products that are based on non-traditional means of lending can also give a boost to the sector, with wider adoption of services such as leasing and subscription models.

As the product and technology are new, traditional banks may take time to warm up to the sector, especially for capital-intensive loss-making businesses. While startups lead the way to loan availability, it is expected that traditional firms too will follow soon.

Additionally, capital can be made available by private equity, venture capital, and foreign investments. Efforts made by the government, banks, OEMs, and more mainstream use cases of electric vehicles should enable financing further.

SUMMARY

Summary

The Indian EV industry is still in its early stages. Currently, the industry sees relatively higher penetration in the 2W scooter (8%) and 3W auto (12%) segments due to early TCO advantages as compared to the other segments. Cars, LCVs, and the 2W motorcycle segment have very low penetration (<1%). Penetration of EVs in the 2W scooter, 3W, and LCV segments are expected to improve significantly over the next few years driven by favourable TCO, improvement in charging infrastructure, and availability of financing. Rapid adoption of EVs for last-mile use cases in India is expected to further contribute to this growth.

- Affordability is one of the key factors that drive EV adoption. Currently, only 2W scooters, 3W, and commercial cars have a favourable TCO for mass adoption. The high cost of batteries has a negative impact on TCOs. Moving forward, technological advancements and increased scale of production are expected to reduce battery manufacturing costs globally and thus improve TCO further. However, for most categories, government subsidies would remain crucial for maintaining a favourable TCO.

- Public charging infrastructure in India is highly inadequate currently, and scaling it up is crucial to reduce range anxiety. Public charging stations in India typically do not experience favourable unit economics due to lower utilisation. Combined efforts by various stakeholders such as the government, EV OEMs, and charging service providers among others are required to help overcome this issue.

- The current supply chain for EVs has high import dependence on certain critical components like battery cells and semiconductor chips. This is driven by limited technological capabilities and low access to certain key materials in the country. However, these issues are expected to be resolved over the next few years as global suppliers scale up their manufacturing capacities. Localisation would also play an important role in increasing the current scale of production and potentially reducing manufacturing costs. Initiatives by the government such as the Phased Manufacturing Program (PMP) to disincentivise imports of EV components and the Production Linked Incentives (PLI) scheme to incentivise local production of battery cells are also expected to reduce import dependence.

- The EV product options that are available to a buyer during the purchase process vary significantly by product category. A higher number of options are available in the 2W and 3W categories. However, cars, LCVs, and motorcycles remain highly underserved with very limited product choices. Catering to the underserved segments will be crucial to increasing consumer confidence in the EV industry. This issue is expected to ease out in future as more OEMs invest in this space and launch multiple products. The entry of traditional ICE players into EVs will give this a further confidence boost.

SUMMARY

- In recent times, there have been concerns about the safety and quality of EV products. Multiple incidents of EVs catching fire have been reported over the past two years, with most cases being reported in the 2-wheeler segment. Inadequate quality control, the high ambient temperature in India, and faulty charging practices are among a few of the reasons being cited. There is a strong need for better and more stringent test standards to be defined and implemented by the government. Localisation of battery cell manufacturing could also help manufacturers design better quality cells that are more suited for Indian conditions.
- Financing is crucial for end consumers to enable the purchase and more so for EVs, given the higher upfront cost. Historically, financing has been a challenge for EVs as compared to ICE vehicles due to various perceived underlying risks. These risks have been linked to untested technology and uncertainty around product life, residual value, and the bank's ability to liquidate the vehicle in case of a default. For the vehicle manufacturers, raising money from the banks has been difficult as most of them are yet to turn profitable. Venture capital and private equity funds have played a crucial role in funding the growth of this sector. Interventions from the government, such as the inclusion of EVs under priority sector lending (PSL) and interest subvention schemes, and increased investments from ESG funds, could help increase financing opportunities for involved stakeholders in the future.

While the industry faces a variety of challenges, it is well on its path to overcoming most of them. Any new product or technology will have teething issues, and electric vehicles are expected to be no different.

If we look back into history, ICE vehicles also have dealt with their fair share of challenges as they gained mass adoption. As EVs also overcome their challenges, it will set the stage for Indian EV industry to leapfrog far ahead.

Moving Ahead

The threat of climate change is upon us and tackling that is of paramount importance for the entire world. We need quicker, better and cheaper solutions if we have to leave behind a greener world. India, which is likely to be the world's third largest economy by 2030, is best placed to lead that revolution.

The solutions are not far to seek and can be easily implemented if all the stakeholders come together. Electrification of mobility lies on the core of such initiatives. EVs lie at the intersection of energy efficiency, climate positivity and cheaper mobility. While there are issues in the current supply chain like global shortage of semiconductor chips and battery cells that are strongly affecting local EV manufacturing, it is expected to stabilise as global suppliers scale up their capacities in the next 3-5 years.

Localisation and Make In India are going to be utmost important moving forward and the government is taking steps to encourage it - phased manufacturing program and production linked incentives are among them. A soft and simple tax regime always goes a long way in inducing people to make those purchases and lifestyle changes. So do steps like free charging - a model spectacularly adopted by Tesla – the world's largest EV-maker. As localisation and technology improves, EV costs are expected to reduce in the long run, making it more affordable for consumers and thereby driving adoption.

Strategic tie-ups between service and infrastructure providers, already underway, will have to be pursued more aggressively. Private and state-owned power distribution utilities, oil marketing companies will play an important to ensure a faster transition into the EV ecosystem. Role of resident welfare associations and real estate developers in developing charging stations will be important in nudging the people to shift to EVs and sustaining the momentum, once in place. Additionally, innovative models like battery swapping and removable batteries are also set to revolutionise the industry.

There are certain risks associated with EV market in India as it is in its nascent stages, which is limiting banks and NBFCs from giving credit. Inclusion of EVs under priority sector lending (PSL) can prove to be a successful way to boost lending. Increased interest from strategic investors will also assist the sector with necessary funds to support high capital investments in R&D, charging infrastructure and marketing.

As India targets to achieve high EV sales penetration by 2030, all involved stakeholders need to work in tandem to contribute to this burgeoning industry. India is a cradle for innovation and multiple startups are already eyeing the industry with huge potential and are expected to lead the initial revolution. Moving forward, incumbents are also expected to enter the market and lead the next wave of e-mobility. India is poised to witness high growth rates in the sector. The country witnesses its own set of unique challenges, but it is on a trajectory to become one of the leading markets and manufacturing hubs globally. Clearly, the world's technology engine can electrify the future of mobility.

Abhishek Kochar
Senior Director
Alvarez & Marsal India

Appendix

Appendix 1: Legend for HML classification for challenges

Key challenges to adoption	Legend
Limited charging infrastructure	**High:** Low access to home charging; high dependence on public charging infrastructure which is scarce **Medium:** Moderate access to home charging, access to alternate charging models like battery swapping with moderate dependence on public charging infrastructure which is scarce **Low:** High access to home charging, less dependence on public charging
Unfavourable TCO	**High:** TCO parity does not exist currently **Medium:** TCO parity exists for high daily usage **Low:** TCO is favourable for EVs as compared to ICE counterparts Note: Above classification includes subsidies
High upfront cost	**High:** More than 20% than ICE counterpart **Medium:** Upto 20% higher than ICE counterpart **Low:** At par or lower than with ICE counterpart Note: Above classification includes subsidies
Limited access to financing options	**High:** Higher interest rates, lower LTV in comparison to ICE counterpart due to high product risk and poor credit profile of consumers **Medium:** Comparable interest rates and LTV to that of ICE counterparts for consumers with a good credit profile **Low:** Lower interest rates and higher LTV compared to that of ICE counterparts
Limited consumer awareness	**High:** Low consumer awareness (low penetration) **Medium:** Moderate consumer awareness (moderate penetration) **Low:** High consumer awareness (high penetration)
Issues in supply chain scalability	**High:** High import dependence and supply risk for most EV components due to global supply shortages **Medium:** Moderate import dependence for EV components **Low:** Low import dependence with high localisation
Issues caused by high charging time	**High:** High charging time leading to challenges such as loss of earnings **Medium:** Moderate level of difficulty faced by the user due to charging time **Low:** Fewer issues faced by consumers due to charging time, high access to home charging
Inadequate government push	**High:** No subsidies or mandates **Medium:** Subsidies exist, but no mandates **Low:** Both subsidies and mandates exist

Key challenges to adoption	Legend
Limited product range	**High:** Fewer than two products in major categories of vehicle segment **Medium:** Between three to four products in major categories of vehicle segment **Low:** Equal or more than five products in major categories of vehicle segment
Concerns around technological obsolescence	**High:** High expectation of technological advancement in the future delaying adoption by 3-5 years **Medium:** Moderate expectation of technological advancements in the future delaying adoption by 1-2 years **Low:** Low expectation of technological advancements in the future, thereby current adoption is picking up
Servicing issues	**High:** Low availability of service centers and skilled technicians due to the complex technology involved **Medium:** Moderate availability of service centers and skilled technicians **Low:** Easy availability of service centers and skilled technicians
Safety and quality issues	**High:** High cases of quality and safety issues; high cases of EV fires **Medium:** Moderate cases of quality and safety issues; performance issues faced due to usage of low-quality EV components **Low:** Limited cases quality and safety issues

Appendix 2: Legend for HML classification for product range

Bank	Number of models
Low	=<2 Models
Medium	3–4 Models
High	>=5 Models

Note: Products that have been announced but not launched in market and products that have been discontinued as of July 2022 are not included in the analysis

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BLUE CIRCLE CONTACTS

Siddharth Anand
Founder & CEO, Blue Circle

Goutam Anand
Co-founder, Blue Circle

CONTRIBUTORS

Arshi Gupta
Senior Associate, Alvarez & Marsal, India

Mohammed KM
Analyst, Alvarez & Marsal, India

KEY CONTACTS

Manish Saigal
Managing Director

msaigal@alvarezandmarsal.com
+91 98202 81030

Abhishek Kochar
Senior Director

akochar@alvarezandmarsal.com
+91 98190 92169

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