A **Brief** insight into the **ELECTRIC VEHICLES** SECTOR IN INDIA

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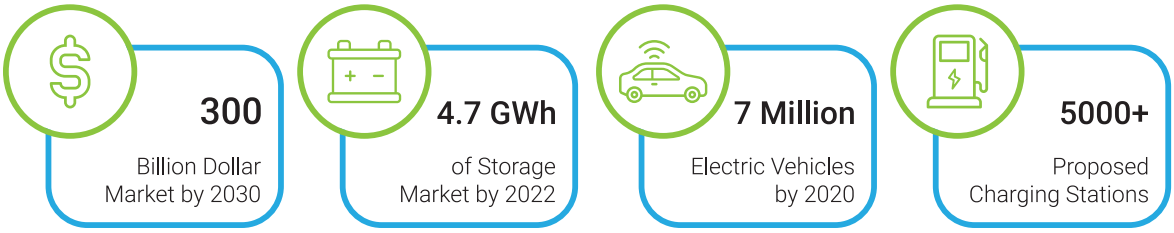
Addressable Market Size

Increasing level of air pollution in Indian cities has been a cause of concern for policy makers in India. WHO statistics show that more than 25 Indian cities are within the 100 most polluted cities in the world.

The cause of growing air pollution in cities is related to a variety of sources, yet however the transport sector makes a significant contribution. This is because the Indian automobile industry, which is currently the 5th largest in the world, is set to take over as the 3rd largest automobile industry by 2030 and the growing number of fuel-powered vehicles are the epicenter of the problem.

According to a report by PwC, the price per liter of petrol is close to 19.5% of India's daily per capita GDP, coupled with depreciation cost, tax, maintenance and insurance of a traditional vehicle. This has drastically increased the Total Cost of Ownership (TCO) and made these modes of transport unsustainable. Therefore, it was no surprise that FY2019 saw a staggering increase in electric vehicle sales from 56,000 units in FY2018 to a total of 7,59,600 units in FY2019.

NITI Aayog estimates that the Indian Electric Vehicle industry could cumulatively add about $300 billion (Rs 20,00,000 crore) by 2030. The estimation would comprise of 7 million vehicles by 2020 and over 5000+ charging stations by 2030.



Source: NITI Aayog

In India, electric vehicles (EVs, in short) are now being seen as a more favorable alternative to quintessential ICE vehicles. EVs are slowly moving from being a niche choice to being more accessible to all spectra of the economy, owing to a positive change in customer perceptions, technological advancements and greater intervention from the Central Government and State Governments.

EVs are recognized as a capable solution to pollution-causing gases such as carbon dioxide (CO2), sulphur dioxide (SO2), and nitrogen oxide (NO) produced by ICE-powered vehicles. Electric vehicles can cut CO2 emissions by about 40%, CO emissions by 99% and NO emissions could fall by up to 50%. Third, a large domestic market for electric vehicles would give Indian automakers an excellent launch pad to reach the world stage.

Sales Statistics

The Indian electric vehicles market comprises of only 1% of the total automobile sales. Two-wheelers and three-wheelers dominate Indian EV market. Society of Manufacturers of Electric Vehicles (SMEV) statistics show that over 95% of the Indian EV market is dominated by two-wheelers and three-wheelers.

In FY 2019, total EV sales in India crossed the 7,50,000 units mark and reached a total of 7,59,600 units (see sales table below). This includes electric two-wheelers (1,26,000), electric three-wheelers (6,30,000) and electric passenger vehicles (3,600), which translates into electric two-wheelers witnessing triple-digit growth (130 percent) year-on-year (YoY).

EV Sales in India

Segment	FY 2019	FY 2018
Electric 2-wheelers	126,000	54,800
Electric 3-wheelers	630,000	NA
Electric 4-wheelers	3,600	1,200
TOTAL	759,000	56,000

Source: Autocar India

However, to analyze the phasing out conventional fuel-powered vehicles will be phased out in India, the following aspects will have to be considered:

- Consumption of fossil fuels for transportation purposes
- Contribution of the transportation industry to air pollution
- The total cost of ownership of ICE-powered vehicles against e-vehicles
- The Government's focus on improving the sustainability of transport systems in the country

One of the primary challenges for electric vehicles is the development of adequate charging infrastructure across the country and the availability of charging stations/points. Along with potent infrastructural requirement, high battery cost and range anxiety contribute to a relatively slow acceptance rate of electric cars in India.

Mahindra and Tata Motors (Major EV manufacturers in India) introduced electric cars such as eVerito, Tigor electric and the e20 hatchback. None of these electric cars has the capacity of running 130 km of electric range and these are 45% more expensive than traditional cars. Additionally, longer charging time is a pertinent challenge for the Indian EV Sector. Generally, four-wheeler takes 6 to 8 hours for completely charge the batteries, which makes intercity commute very hard.

Future Projections

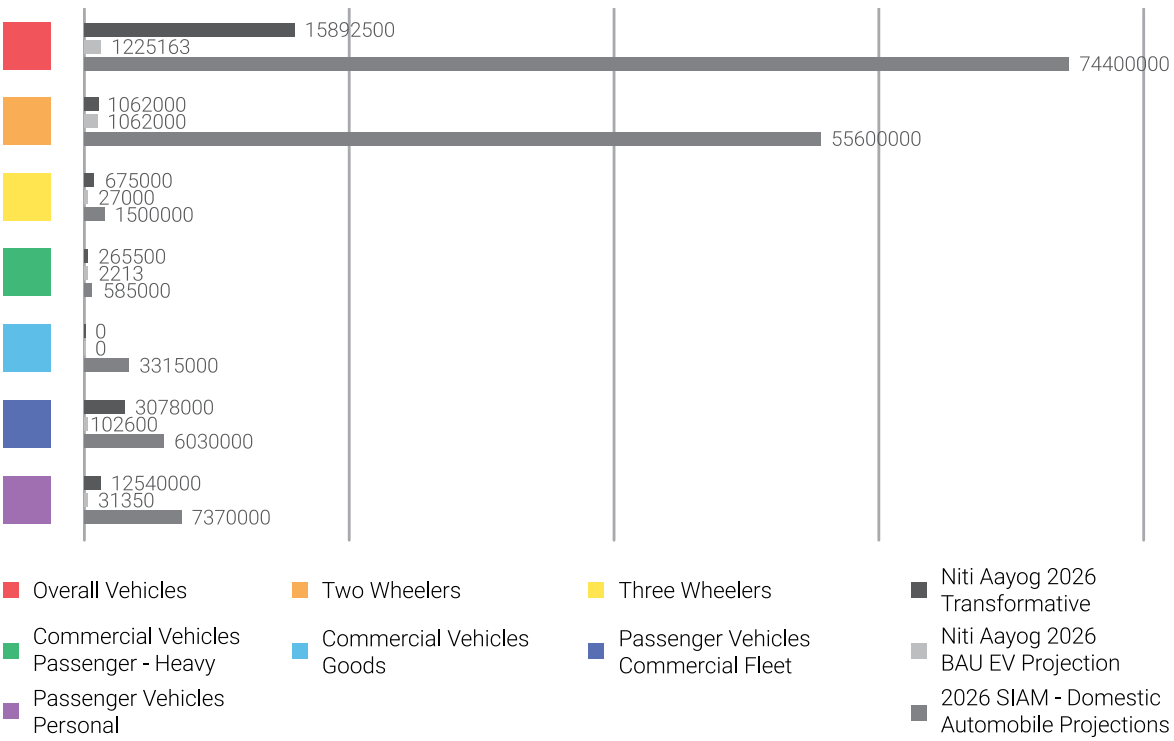
The future projections have been relatively positive compared to the present, owed to various actions being taken pro-actively by a combination of public and private sector players. According to Deloitte's "Unplugged: Electric Vehicle Realities Versus Consumer Expectations" survey, a significant share of consumers already consider electric cars as an option when choosing a new car.

Rapidly decreasing battery costs, technological advances in charging infrastructure, influx of smart digital technologies, Government policies and subsidies are certainly looking to drive the growth of electric vehicles. The Society of Indian Automobile Manufacturers estimations shows that based on NITI Aayog's EV Plan 2030, Indian EV sales could reach to 10 to 12 million by year 2026.

Aside from the known variables that will drive the growth of the EV sector, the parallel development of other industries such as e-commerce, automated logistics, and so on, will consequently increase their dependency on EVs for first-mile and last-mile delivery areas.

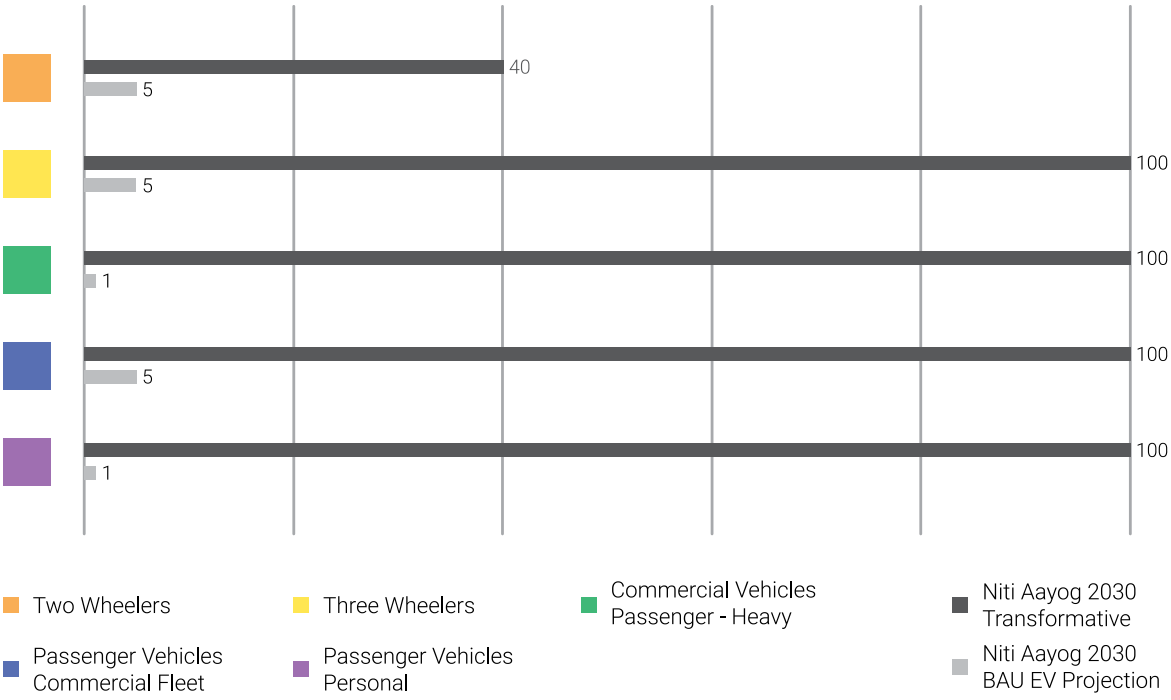
Further, the push from Government of India through incentives for companies engaged in local manufacturing as well as global commitments towards the conservation of the environment, creates additional opportunities for businesses.

Indian EV Market Projection Based on NITI Aayog EV Targets, 2026



Source: Society of Manufacturers of Electric Vehicles (SMEV)

Indian EV Market Projection Based on NITI Aayog EV Targets, 2030



Source: Society of Manufacturers of Electric Vehicles (SMEV)

CURRENT INDIAN EV ECOSYSTEM

EV Automotive Manufacturers

Founded in year 2001 & based in Bangalore, Mahindra Electric Mobility Limited (formerly known as the Reva Electric Car Company) is one of the early EV manufacturers operating in the Indian EV market. India's first electric car Mahindra Reva was launched in year 2001. After 16 years, on 21st October 2017, Mahindra launched its much awaited EV car Mahindra E20, which is currently available in Indian market.

- **Vehicle Dealers**
  33 dealers across 9 states with 60% dealers in Bangalore, Mumbai and Delhi
- **Charging Stations**
  80 locations across 10 cities with ~86% located in Delhi, Kolkata, Bangalore and Pune
- **Service Stations**
  Free charging service as of now and will cost around INR 60-66 per charge in future

Indian EV Market Ecosystem

As the Indian EV sector is at a stage wherein stakeholders in the EV marketplace have either adopted a ' Wait-And-Watch' approach or a 'Marked Maker' approach, on account of the challenges existing from an infrastructure standpoint as well as the skepticism existing on part of the consumers.

Government and regulatory bodies

Active Government bodies

- NITI Aayog
- Ministry Of Road Transport and Highways
- Ministry Of Heavy Industry And Public Enterprises
- State Government Of Karnataka, Himachal Pradesh, Andhra Pradesh and Maharashtra

Users

Public Sector Market Actors

- Energy Efficiency Services Ltd
- Bangalore Metropolitan Transport Corporation
- Himachal Pradesh Transport Corporation

Mobility Service Providers

- Ola Cabs
- Uber Technologies
- Lithium Urban Technologies
- Zoomcar
- DHL India

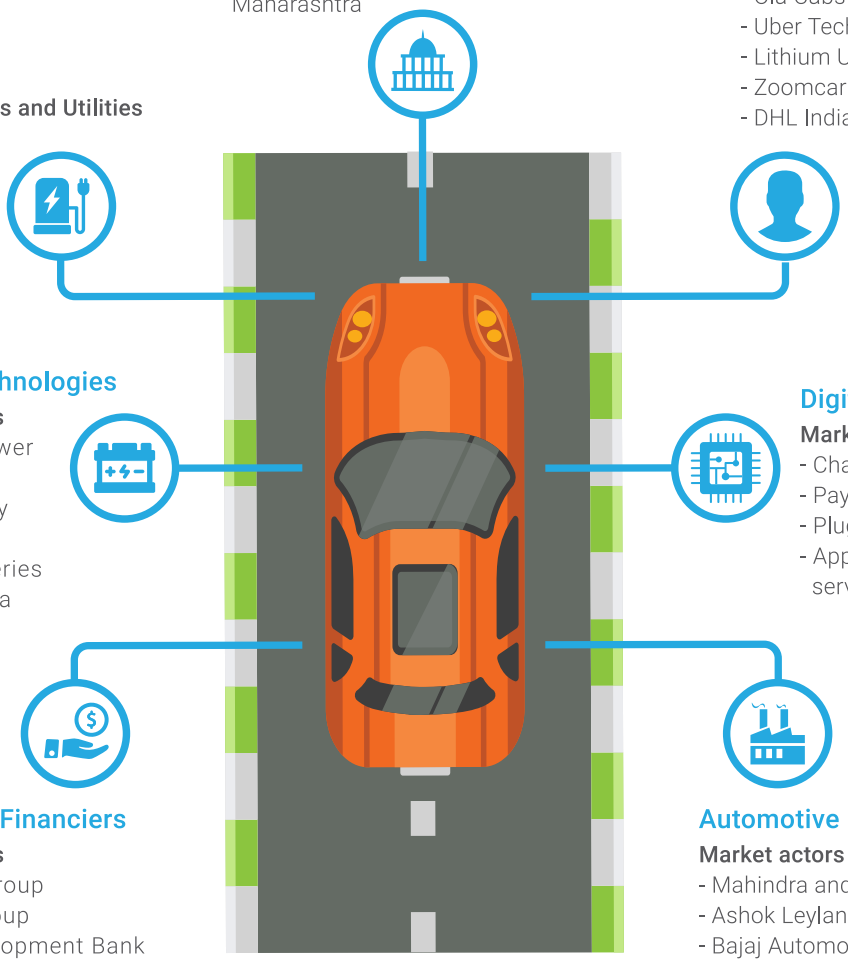
Charging Infrastructure

Charging Technology

- ABB
- Fortum
- Sun Mobility

Electricity Providers and Utilities

- Tata power
- NTPC Limited
- Engie
- Indian Oil



Battery Technologies

Market actors

- Su-Kam Power Systems
- Sun Mobility
- ION Energy
- Nippo Batteries
- DENSO India

Digital Technologies

Market actors

- Charge Now
- PayTM
- PlugIn India
- Apps of mobility service providers

Ecosystem Financiers

Market actors

- Softbank Group
- Hinduja Group
- Asian Development Bank
- Tata Sons
- Hero MotoCorp

Automotive Manufacturers

Market actors

- Mahindra and Mahindra
- Ashok Leyland
- Bajaj Automotive
- Ather Energy
- Ampere Vehicles Pvt Ltd
- Hero MotoCorp Ltd

Source: TFE Consulting Report

Tata Motors Limited is other notable EV manufacture in Indian EV market. Recently in year 2019, it introduced its first EV car "Tata Tigor" with partnership of UK based Tata Motors European Technical Centre (TMETC). Among the Indian automobile companies venturing into the EV market, Tata Motors in particular has invested significant resources not only in the four-wheeler EV segment but also in electric buses and commercial vehicles.

Charging Infrastructure

One of the largest challenges of the EV sector in India is the absence of sound electric vehicle charging infrastructure. While most of the existing stations have been installed as part of pilot projects, there is considerable R&D being done in the private sector for the development of charging infrastructure.

According to Norway Innovation, 15 firms currently supply EV Chargers in India and only 3 firms (RRT Electro Power, Chennai; Mass Tech Controls, Mumbai; Exicom, New Delhi) offer 4 Wheeler, AC Chargers so far in India. These are mostly Power Electronics & Battery Charger manufacturers who have diversified into EV Chargers. In case of 2 Wheeler AC Chargers there are 10-12 firms who supply along with their vehicles and a few OEMs for EV Chargers.

Installed Base

EV Charging stations	130
Total EV Chargers installed	270
% of AC Slow chargers	80% or 246
% of DC Fast Chargers	20% or 24

Norway Innovation predicts, at least around 400,000 charging stations are required by 2026 according to NITI Aayog EV targets.

EV Charging Infrastructure Forecast upto 2026

No of EV Charging stations likely to be set up	406000
Total EV Chargers likely to be installed	2,424,000
No of AC Slow chargers likely to be installed	1729600
No of DC Fast Chargers likely to be installed	694,400

Source: Norway Innovation

Based on the NITI Aayog plan, Ministry of Power has already taken initiatives to push EV infrastructure in Indian market

Tata Motors Limited is other notable EV manufacture in Indian EV market. Recently in year 2019, it introduced its first EV car "Tata Tigor" with partnership of UK based Tata Motors European Technical Centre (TMETC). Tata Motor is very much bullish on Indian EV market and planning to introduce new EV four wheelers in Electric buses and Electric car segments

National Thermal Power Corporation (NTPC)

NTPC plans for installing 100,000 EV charging stations in India. NTPC has installed first charging stations at its offices in Delhi and Noida. Currently NTPC is looking for a country-wide licensing.

Bharat Heavy Electricals Ltd (power equipment PSU) plans to make batteries in India using the Lithium technology developed by ISRO.

Energy Efficiency Services Ltd (EESL – a national ESCO company, experienced in large tendering process) has already issued tenders to source 10,000 EV and about 4,000 EV chargers in India

Rajasthan Electronics (I) Ltd, (REIL) – plans to set up 200 charging stations in Delhi, Jaipur and Chandigarh.

Government and Regulatory Bodies

There was a major event which involves Prime Ministry Office (PMO), NITI Aayog (Planning Body), Department of Heavy Industries, Power Ministry, Ministry of Surface Transport & Roads, Urban Development Ministry, Petroleum and the Finance Ministry in year 2017. From this discussion it is concluded that, there is a need to look at transforming the mobility in the country and reduce the dependence on fossil fuels and reduce imports obligations.

Post this event, the Aayog has come out with a report on the plans for the Government on TranNitisformative Mobility Solutions[1] for All.

- **Systems integration**
  Enabling wide-scale adoption of mobility solutions through ubiquitous availability and sharing of interoperable transport data (ITD)
- **Scaled manufacturing**
  Facilitating market creation through policies and mechanisms that enable manufacturing of electric vehicles (EVs) and necessary components in successive segments based on their market readiness.
- **Shared infrastructure development**
  Better urban design, where a larger fraction of mobility demand is met by nonmotorized transit and public transit, and access to vehicle-charging infrastructure enables higher penetration of EVs.

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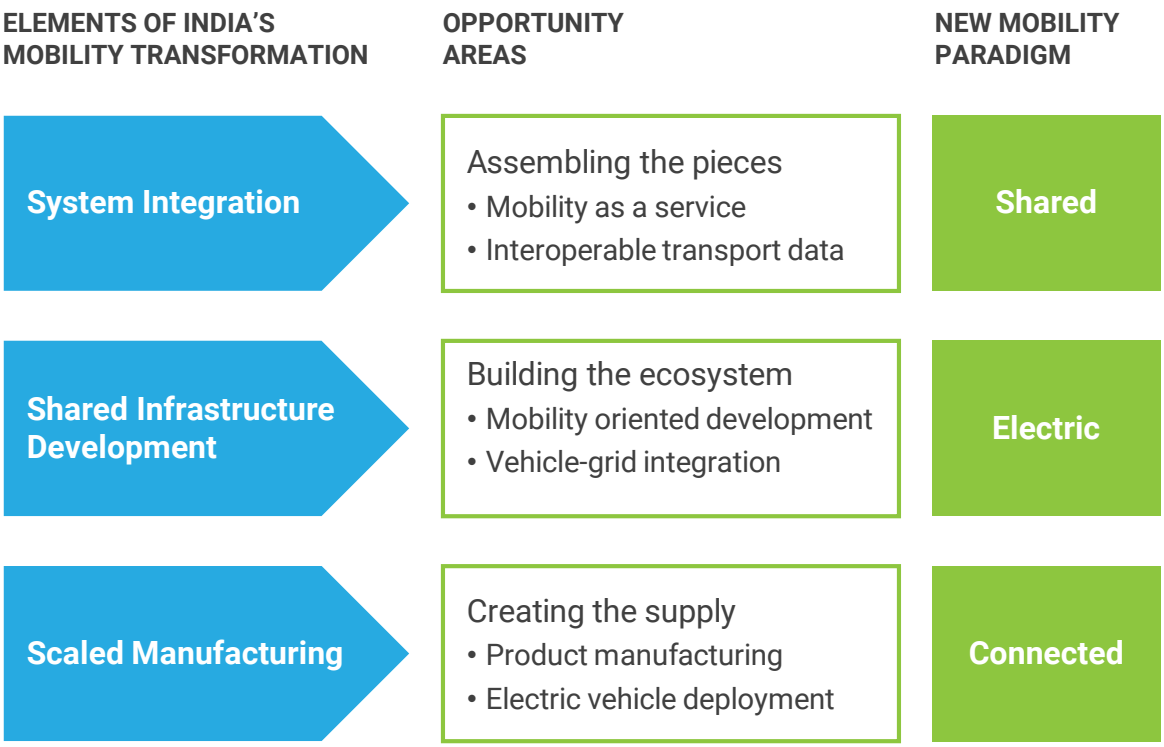
[1] ***Source: NITI Aayog***

Key insights From NITI Aayog on India's Mobility Transformation



Source: NITI Aayog

Battery: Core Of The EV

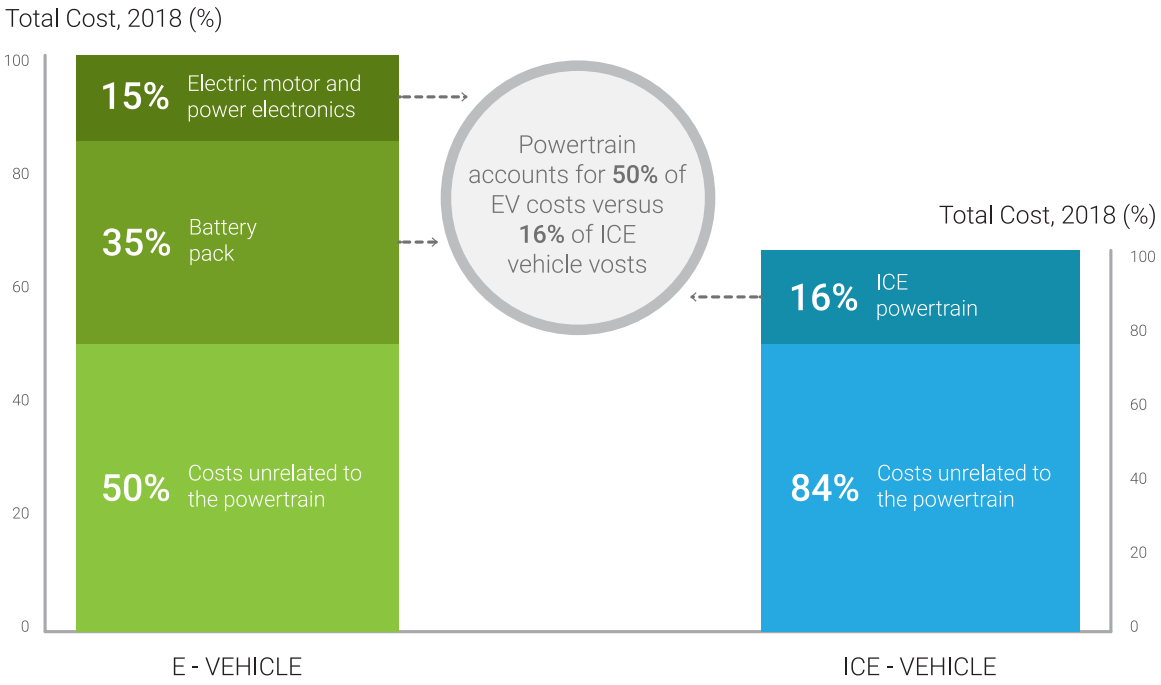
An electric vehicle's engine / drive motor can be divided into two parts:

- Power Train: The battery, the electric motor and the control algorithm.
- Drive Train: Gear box, clutch, etc. (parts of the power train excluding the engine).

Current industry benchmarks suggest that the electric power train (including the electric motor, power electronics, and battery pack) will account for at least 50% of a BEV's cost. By comparison, the ICE power train typically accounts for approximately 16% of a traditional vehicle's cost. . The battery pack (including the battery management system) is the major cost, accounting for about 35% of the overall vehicle cost.

Therefore, it is imperative for companies to start reducing the cost of battery packs. Interestingly, most large automakers outsource their cell production to battery manufacturers, the most cost-intensive component. To ensure EV's range and charging rate, modules and packs are critical and automakers want to control how the battery pack space is used and cooled.

EVs are up to 35% more expensive than ICE vehicles



Source: JP Morgan Chase & BCG Analysis

Value Chain for EV Batteries

Cells are by far the most cost-intensive components, accounting for 70% of the total costs of battery packs. Battery manufacturers from all over the globe are trying to reduce these costs through economies of scale. The value chain of the EV battery comprises of the following 7 steps[2]:

- **Component Production:** Manufacture of anode and cathode active materials, binder, electrolyte, and separator
- **Cell Production:** Production and assembly of single cells
- **Module Production:** Configuration of cells into larger modules that include some electronic management
- **Pack Assembly:** Installation of modules together with systems that manage power, charging, and temperature
- **Vehicle Integration:** Integration of the battery pack into the vehicle structure, including the battery-car interface (connectors, plugs, mounts)
- **Use:** Use during specified in-vehicle battery lifetime
- **Reuse and recycling:** Battery reuse; deconstruction and cleaning preparatory to recycling of materials and components

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2 ***Source: BCG Analysis***

EV Battery Market

Indian battery market is estimated to be worth INR 177 billion with around 80.5 million battery units. Indian battery market is highly fragmented with small market players accounting for 40% of the market in volumetric terms. Indian battery market is dominated by lead acid batteries. Overall, there are 2,500 players making lead acid batteries in India, led by Exide Industries and Amara Raja Industries.

Whereas in the case of EV, most Lithium Battery units are imported. The absence of rare material resources in India results in either the complete import of Li-ion batteries or as it has been in the recent past, only raw materials as battery packaging companies have commenced operations in India on account of the fast-growing mobile phone industry.

Lithium Ion or other advanced batteries market

- Most Lithium batteries were being imported from China, South Korea Vietnam, Singapore and Japan predominantly
- There are some major announcements being made by global private and public sector units to look at Lithium Ion Battery production in India

Some key Lithium ion battery manufacturers in India

ISRO has signed an MOU with BHEL to manufacture low-cost lithium-ion batteries for EVs in India. In March 2019, ISRO also shortlisted 15 companies to transfer the manufacturing technology of lithium-ion (Li-ion) batteries. ISRO has been using this lithium-ion battery technology in several of its missions over the years, on its space launch vehicles including the PSLV, GSLV, GSLV MK-III as well as the GSAT 19 satellite.

India's second-largest traditional battery maker, Amara Raja Batteries Ltd. Is in the process of building a 100 megawatt-hour assembly plant in the Southern state of Andhra Pradesh and the company is working closely with the Indian Institute of Technology in Chennai.

HBL Power Systems Ltd. is a leading battery and power systems company based in Hyderabad, India. HBL Power Systems is looking forward to grow business in railways, solar, e-mobility and defense. The company has also initiated a plant to manufacture prismatic lithium ion cells and batteries in its ongoing efforts to reach the goal. EON Electric Ltd. (formerly Indo Asian Fusegear Limited) is a medium scale company which manufactures lighting equipment. EON electric has started production of lithium-ion batteries at its state-of-the-art plant at SIDCUL, Haridwar as it looks to capture the potentially lucrative EV battery market in India.

On 27 June 2018, Exide Industries Ltd. announced its joint venture agreement with Leclanché to build lithium-ion batteries and energy storage solutions to power the growth of India's electric vehicle market. Exide, already a well-known brand in the traditional battery segment, seeks to capture the Indian market for EV batteries.

India: A Unique Opportunity

India uses a diverse variety of motorized vehicles and auto-segments presents a very unique proposition, for producers and consumers alike. NITI Aayog compiled data for vehicles on Indian roads for the past six years:

1. Two-wheelers: 79% of the total number of vehicles
2. Three-wheelers (passenger and goods), including tempos: 4% of the total number of vehicles
3. Buses and large goods vehicles like trucks: 3% of the total number of vehicles
4. Economy four-wheelers (cars costing less than ₹1 million): 12% of the total number of vehicles
5. Premium four-wheelers (cars costing higher than ₹1 million): 2% of the total number of vehicles.

Global Leaders in Economy Segment Vehicles

Clearly, India represents a very unique business opportunity as the market is dominated by two-wheelers (79%) with economy four-wheelers a far away second with 12%. Globally, most of the technological advancements are done in the premium four-wheelers which represent only 2% of the total number of vehicles.

Since India has more manufacturers and consumers in the economy sector (vehicles costing less than INR 10 Lac), this provides a perfect opportunity for India to take technological and manufacturing leadership in the economy segment of the market.

The prevalence of two-wheelers, three-wheelers and economy four-wheelers in India is unique among large countries. This presents an opportunity for India to make itself the frontrunner in the production and technological advancements in the small electric vehicle sector.

The objective will be met when technological expertise and industrial capabilities are used to cater to domestic and international consumer demand.

Moreover, with the greater emphasis laid down by the government to ‘Make in India’, this also presents a potentially fruitful opportunity for foreign players to invest in and/or produce electric vehicles and their related components in India.

SUMMARY

Porter's 5 Forces On Indian EV Sector

The five forces model is an analysis of how five competitive factors can determine a company's profitability and a firm's success in connector industry. Porter's five forces focus on rivalry amongst existing firms, threat of new entrants, threat of substitute products, bargaining power of buyers, and bargaining power of suppliers.

Rivalry among existing competitors : *Low*

Indian electric vehicle market has relatively few established players in its ecosystem. These companies currently offer a limited product range with different product positioning.

Indian electric vehicle industry has limited product offerings due to it being in a nascent stage as compared to the traditional Indian automotive industry. Considering all these factors, the competitive intensity of the Indian electric vehicle industry is low.

Bargaining power of buyers : *Medium*

The bargaining power of the buyers is quite strong in Indian electric vehicle industry. In this stage compared with traditional cars, electric cars have cost and price disadvantages, although the Government is trying to offset this with subsidies under FAME scheme. The FAME scheme is part of the Government's effort to boost electric mobility through greater indigenization. The second phase running from fiscal 2020 to fiscal 2022 has a budget of 10,000 crore.

Apart from prices, the limited charging infrastructure and battery issues are also increasing the buyer's power significantly. Currently, the demand for electric vehicles is limited as compared to total car sales (less than 1%), so every single buyer is important for the enterprise sales. Due to these factors, consumers possess a dominant position in the market.

Thread of substitutes : *High*

The threat of substitutes to the electric vehicle industry comes mainly from the traditional automobiles because they have similar functional value and an existing widespread distribution. Indian consumers are highly price-sensitive and electric vehicles have price disadvantages (currently) as compared to traditional ICE-powered vehicles. Here, Government subsidies will play a vital role in the EV pricing strategy.

Bargaining power of suppliers : *Low to Medium (dependent on differentiation)*

Suppliers in Indian electric vehicle industry can be categorized in to two groups. The first is the traditional vehicle equipment suppliers such as window glass, car seats & frames, etc. Their bargaining power is also low because India is arguably the manufacturing hub of the world and there are number of suppliers available in the market.

The second group suppliers of electric vehicle battery, charger, vehicle super capacitor & electric automobile engine, etc. These suppliers have their own limitations such as the number of suppliers is plenty but are either SMEs or MSMEs. These two factors limit the suppliers' bargaining power especially with the large-scale automobile manufacturers.

Suppliers offering differentiated products in the market allows them to gain the competitive advantage on their peers. So, the bargaining for supplier is low to medium in the EV market.

Threats of New Entrants : *Medium to High*

There is a lack of complete industry standard and national standard for electric vehicles. The existing technology is not mature, so there is a huge potential space for new entrants. The barrier for new entry is also high because the market is concentrated. New electric vehicle companies require huge scale of capital. New companies also need to establish their own distribution channels or need to form joint ventures with existing players.

Building distribution channels or joint ventures also has long-term benefits. Businesses in the space can be developed based on existing supplier networks, production lines, distribution channels, and existing technologies and experiences. Besides, the core technologies of electric vehicles are similar among different companies, so product differentiation is key and can be a significant barrier for new entrants. Lastly, economies of scale can play a key role for any new market entrant.

The most favorable factor for the new entrants is the market attractiveness. The Government wants to grow the electric vehicle industry, and it encourages automobile companies to develop electric vehicles and offers financial & policy support and because the core technology is similar and established, barriers to entry are low and the nature of industry is capital-intensive. So, the threat of new entrants in the electrical vehicle industry is medium to high.

Conclusion

NITI Aayog recommends the sale of only electric vehicles (EVs) post 2030, with plans to ban all internal combustion three-wheelers by 2023, and two-wheelers below 150 cc with internal combustion engines by 2025.

This ambitious goal is backed by India's relative abundance of exploitable renewable energy resources, high availability of skilled manpower and technology in manufacturing and IT software, and a universal culture that accepts and promotes sharing of assets and resources for the overall common good. While the government's aim to clean up the environment may be noble, there is no denying the fact that India faces momentous challenges such as a poor EV charging infrastructure, gaps in the supply chain for EV components, low levels of localisation, high prices of batteries, absence of a stable EV policy..

The Indian EV market is at an embryonic stage, comprising of only 1% of the total automobile sales. India sold more than 21.1 million motorbikes and scooters in FY2019 out of which only 0.13 million units were EVs. However, this number is double of the total two-wheeler EV sales in FY2018, which were around 54,800, indicating relatively more acceptance of electric two-wheelers. The prevalence of two-wheelers in India, which represent 79% of the vehicles on road, offers a unique business opportunity for India to become the technological and manufacturing leader of electric two-wheelers. This vision is supported by FAME II which mandates that only those companies using more than 50% locally-produced parts will be eligible for incentives and subsidies under the scheme. Under FAME II, the Government will also set up 2,700 charging stations across the country, with the idea of having at least one station in a grid of 3 square kilometers.

However, sustainable mobility is not just about replacing ICE vehicles with vehicles powered by electricity. A very integral part of the process would the shift from private to public transport as well as a significant reduction in the production of ICE vehicles in favor of EVs. In the very nascent stage of the proliferation of EVs in India, shared mobility (public and private) will play a huge role in the future course of EV adoption. Public Transport provides a unique value proposition to all the stakeholders involved - manufacturers get huge volumes of production, operators of shared mobility get better total cost of ownership due to higher utilisation of the vehicle, and the end-consumer enjoys financial benefits as she pays lesser money per km. Additionally, this entire process will lead to better adoption and awareness among the general population once they perceive EVs to be generally accepted and commonplace in the country.

Indeed, the progress that the electric vehicle industry makes in the coming years is not only extremely welcomed, but highly necessary in light of the increasing global greenhouse gas levels. Given the high cost of using fossil fuels, economically and environmentally, EVs are the ecological and economical future of mobility in India.

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