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ACTUAL AND PROSPECT SCENARIO OF EVs MARKET IN INDIA



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ABSTRACT

This thesis aspires to bring out the economic perspective of Electric Vehicles (EVs) in the Indian market. The discussion is about the Indian economy, its growth, and its capabilities towards the emerging market for goods and services. India is one of the most culturally diverse countries with different opinions about the equivalent goods and services, varying from region to region. It motivates the study on the Indian economy's demographic abilities towards sustainable development and how a population of 1.36 billion can be poised to move sustainably.

As already known, India has the least per capita carbon emission in the world. However, in the evolving market and innovative environment, India focuses on its sustainability and pledge to reduce carbon emissions by many measures drafted and implemented phase-wise. The impact of innovation, idea generation and its capability to manufacture in large quantities makes India one of the hubs for FDI (foreign direct investment). The Indian government has taken the idea of manufacturability one step forward by the global initiative of MAKE IN INDIA, which pushes the manufacturing sector to make and produce for India and the world. Due to its strategic location and a vast coastal line, India becomes one of the auspicious places to manufacture for the global market. It connects both to the Middle East and the Asia Pacific region.

The adaptation of norms for the emission has led to various developments in mobility with EVs, hybrid cars, and other innovative forms of zero-emission vehicles being under the process of development. Since India is one of the leading manufacturers of passenger and commercial vehicles, it becomes a vital place for the electric vehicle market. It is bound to grow almost by a factor of 10 in the coming decades. In the thesis, we study how the government has drafted schemes to promote the Electric vehicle market. Furthermore, summarize the current global market and the Indian market for the changes that will evolve in the coming decade.



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CHAPTER 01: INTRODUCTION

1.1 INDIA: AN EMERGING COUNTRY

India is the second most populated country globally after China and corresponds to approximately 1.35 billion from the last census report. It is the seventh-largest country in the world with an area of 3.288 million sq. km and has a long coastline of over 7,500 km. India is a diverse country where over 22 major languages and 415 dialects are spoken. India has the highest ranges in the world, the Himalaya Mountain from the north to the valley of rivers in the south, the Thar Desert to its west, the Gangetic delta to its east, and the Deccan plateau in the south and bounded by the Indian Ocean, Bay of Bengal, and Arabian ocean.

Despite different socio-economic barriers, India outbreaks its economic growth from the last decade with its successive industrialization and constantly rising in their growth in agricultural and countering industries with the large-scale import & export all over the world. As per the survey, in 2020 India has the world's fifth-largest economy by the nominal GDP correspond to \$3.202 trillion, and the third-largest economy by purchasing power parity corresponds to \$11.321 trillion. With the successive protection of economies by government policies and intervention, India raises its annual GDP at a growth rate of 6-7% from 2014 to 2018 and therefore India becomes the World's fastest in a growing economy. In between those years, the Indian economy slowdown in 2016 because of demonetization and in 2017 because of the introduction of food and service tax.

India has a 1.3 billion population and therefore nearly 60% of India's GDP is because of domestic private consumption and apart from that Government also fuelled the GDP through government spending, investments, and export. As per the CIA world factbook, India was the eleventh largest importer and thirteenth largest exporter. India has a free trade agreement with several nations, including ASEAN, SAFTA, Mercosur, South Korea, Japan, and few others which are in effect or under the negotiating stage ⁽ⁱⁱ⁾.

India's economy depends on the agricultural sector, IT service, construction & real state service, telecommunication, and Automobile industry. Talking about the agricultural sector, India is the world's largest producer of milk, pulses, and jute and the second-largest producer of the rice, wheat, sugarcane, groundnut, vegetables, fruit, and cotton and also the leading producer of spices, fish, poultry, livestock, and plantation crops ⁽ⁱⁱⁱ⁾. With a net worth of \$2.1 trillion, India is the third-largest economy after the US and China. As of 2018 (World Bank data), India worth \$ 2134 and it ranks 139th in per capita GDP (nominal), and with worth \$7783, India ranks 122nd in per capita GDP (PPP). Agriculture accounted for 23% of GDP and employed 59% of the country's total workforce in 2016. With 25% of global production, India becomes the largest producer (25% of global production) and consumes 27% of world consumption and contributes 14% in pulse in the world as an exporter.

Real GDP or GDP growth of India at the constant price (2011-2012) in the 2018-19 year is estimated at 6.81% which had been declined with the previous year (2017-18) growth rate i.e. 7.17%. 2.92%, 6.86%, and 7.53% respectively were the GVA growth rates of agriculture &

allied, Industry, and Services sector whereas India has 8.74% of growth in the 'Construction' sector but the overall GVA growth at constant prices is 6.63% ^(iv).

At current prices, GDP growth rates for the year 2018-19 is 11.20%. GVA growth rates of Agriculture & allied, Industry, and Services sector are 3.96%, 12.24%, and 12.76%, respectively. But the overall GVA growth at current prices is 11.09% from the IMF world economic outlook, April 2019, the GDP rate of India is 7.3% and it became the 8TH fastest growing nation in the world.

From the attached figure of the new series since 2004-05.

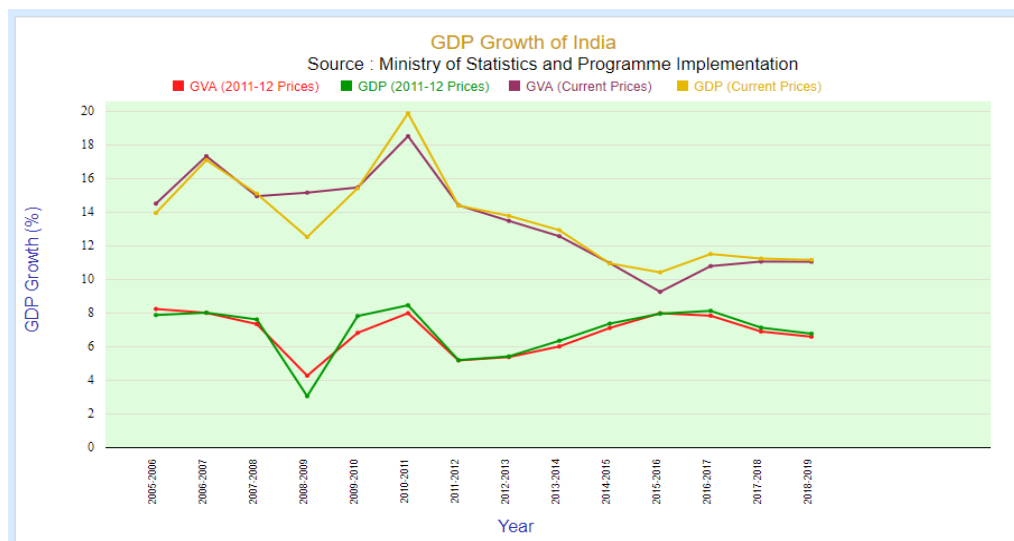


Figure 1 GDP Growth of India (2005-2019)¹

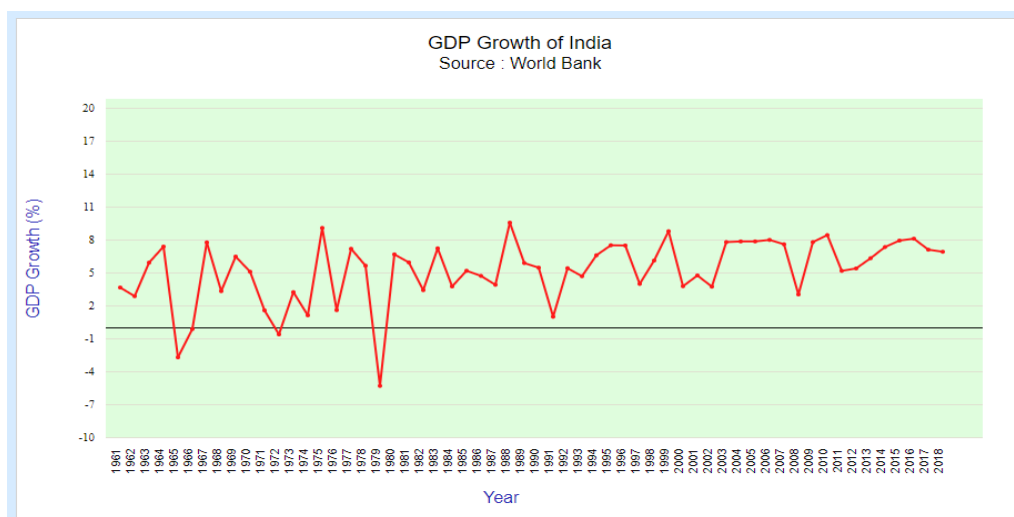


Figure 2 GDP Growth of India (1961-2018)²

¹ Source : ministry of statistics and program implementation

² Source : world bank

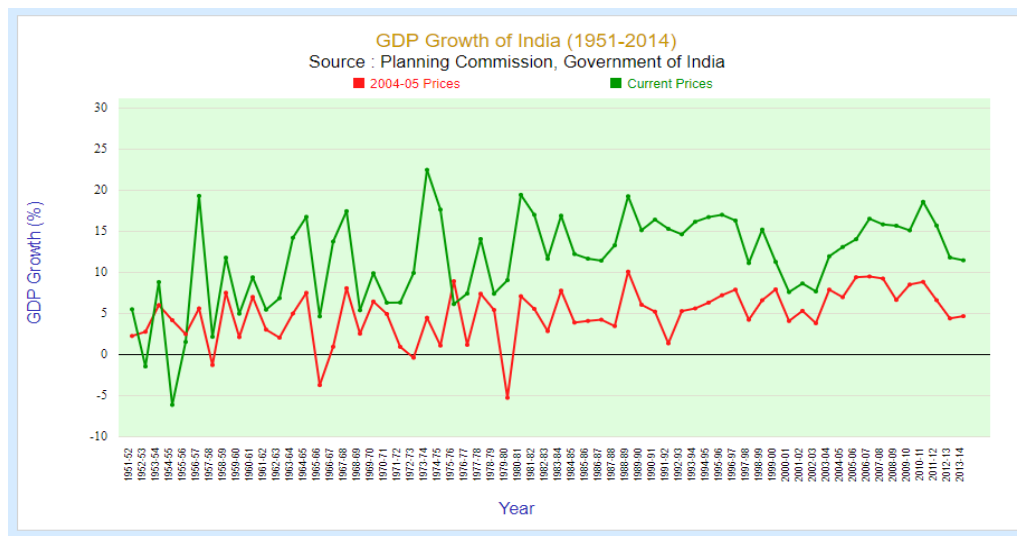


Figure 3 GDP Growth of India (1951-2014)³

1.1.1 GEOGRAPHIC CHARACTERISTIC

In the decade 2002 to 2012, India was the most promising growth market in entire Asia as GDP grew at 7.7%. This time, household consumption grew swiftly at 7% per year, but because of the recent slowdown in the market in 2009, GDP dropped from 8.3% in 2010 to 6.7% in 2012 to 4.7% in 2014. Therefore companies are advised to make a proper strategic decision to reallocate its resource to maintain the growth index and get the possibility to achieve the worthwhile market returns.

The new government's decision to strengthen India's economy via elevating the opportunities to various states at a different phase of improvement and measures undertaken to debottleneck growth. Government's efforts to reinforce enterprise self-belief.

India's core economic growth driver range exceptionally across geographic units – states, districts, and towns, creating granular, region-level information of markets. The urbanization rate of each geographic hub is a crucial indicator of showing an economical pace. GDP per capita of urban and semi-urban districts is 4 to 5 times comparative with rural districts.

The share of the GDP services is appreciably better in no longer simplest in urban districts but equally so in rural ones. Globally, the service provider can increase their 15-25 % growth per year if they account for the granular market.

Depending on the cost to serve, stage of the competition, consumer types, and current footprint, companies should focus on the eight states or entirely at the 69 metropolitan cities. Therefore, companies should understand the clear picture to know the market potential and demand across the nation, thus estimating the future demands and knowing about the high growth rate state and vice versa and knew which state is contributing to India's economy.

³ Source : Planning Commission, Government of India

Geography economy takes various approaches in a different chain of growth, i.e., industries and their localization transportation, international trade, real state, economies of urban, environment and economic relationship, and globalization.

Considering existing footprints, product culture, and also their long term goal. The companies had taken three effective approaches to dissect and maintain the value of heterogeneity: **state, cluster, and cities**. This approach is useful for understanding the macroeconomic issue and looking at the insight of microeconomic potential and income of states, cities, and district levels.

STATE:

India's 29 states and seven union territories have a different stage of demographic and economic evolution. The per capita GDP of each state and the economic variables depicts the living standard and market value across pan India. Therefore as per the 2012 per capita GDP, states have been classified into four major categories, i.e., very high performing states, high performing states, performing, and low performing states.

We classify the four city-states, i.e., Chandigarh, Delhi, Goa, and Puducherry, as a 'Very high performing' states because their per capita GDP was twice as much as from 2012. This state's faster growth because of different attributes like an investment in physical capital, superior land use, higher urbanization, & therefore they adhered to the fiscal deficit because of high skills industries automobiles and component industries, pharmaceutical, finance, and IT industries.

Concurrently, like Gujarat, Haryana, Himachal Pradesh, Kerala, Maharashtra, Punjab, Tamil Nadu, and Uttarakhand – was in between 1.2 and 2 times that of India's average. Therefore those states classify as the 'high performing' states.

Another twelve states are known as 'Performing' states, with per capita GDP between 0.7 and 1.2. With GDP in line with capita less than 0.7 times, the rest are termed as 'Low appearing' like Madhya Pradesh & Bihar.

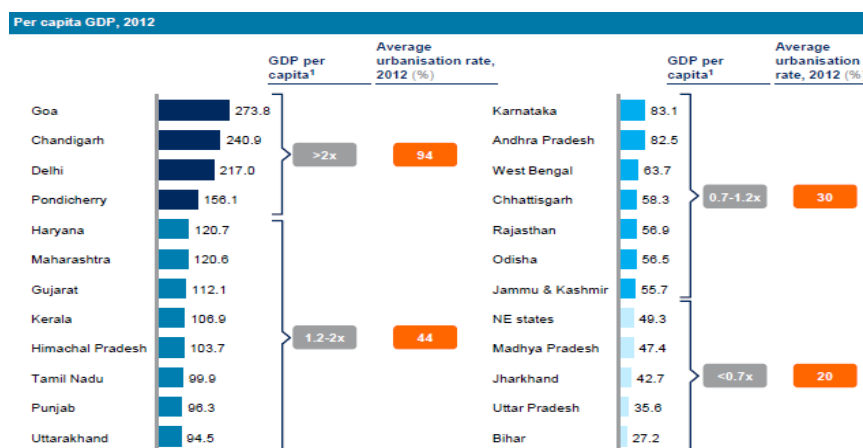


Figure 4 States based on the Per capita GDP⁴

⁴ SOURCE: McKinsey Insights India

By research estimation, 8 ‘high performing’ states will account for some 52 % of India’s incremental GDP growth from 2012 to 2025, along with four ‘Very excessive performing’ city-states. In 2012, India had 54 metropolitan cities accounted for 40% of GDP. In contrast, in step with estimation, till 2025, India may have 69 metropolitan cities, & will account for 52% of India’s incremental GDP from 2012 to 2025.

Urbanized states like Gujarat and Tamil Nadu differ in economic potential compared to rapidly emerging ones such as Andhra Pradesh, and rising states, including Madhya Pradesh and Bihar.

GUJARAT GDP grew at 10.2 percent according to a year from 2002 to 2012 at the same time as that of India grew at 7.7 percentage at some stage. The coastline, startup scheme, the deep seaport was the various factors that boosted the GDP. Gujarat's manufacturing sector contributed 31% to the nation’s GDP in 2010, corresponding to that of China in 2000. Skills & Capital-intensive industries, together with petrochemicals, pharmaceuticals, and automobiles, have driven this growth further to traditional sectors like diamond and textiles. The agricultural GDP elevated from underneath 2 % from 1980-90 to more than 6 % throughout the period 2000 to 2013 because of changes in the crop mix, adoption of hybrid seeds, funding in irrigation, and dams, improvement in energy supply to rural areas through guidelines such as Jyotigram & farm extension program through ‘Krishi raths.’

TAMIL NADU: The per capita GDP of Tamil Nadu was 0.9 times in 1980 and rose to 1.3 times by way of 2013. It has strong basics, including a professional workforce, a favorable investment climate, and reasonable infrastructure. Tamil Nadu’s increase has been pushed by way of the services sector, its proportion rising from 41% in 1981 to 73% by 2014. Chennai's emergence as an IT center during the last decade and the rise of the predominant automobile hub & Chennai is India’s most giant car cluster these days, accounting for about 30% of India's automotive production. Tamil Nadu’s banking enterprise services and communications sectors as an institution have grown at over 13%, consistent with year from 2005 to 2014.

BIHAR: Bihar one of the fastest-growing states with its GDP growth rate of 9.5 % yearly from 2005-2014, initiatives empowered the construction region to develop more than 20% per year, & different core sectors, together with production and communication, have additionally grown at 15 to 20 % yearly.

MADHYA PRADESH: Its economic overall performance is based totally on agricultural GDP growth by using 10 % per year between 2005 and 2014. The state invested in bringing greater land beneath irrigation, which rose from 7 lakh hectares in 2004-05 to 21 lakh hectares in 2011-12. The energy zone in MP grew at a charge of approximately 14 % annually from 2008 to 2013. An investment of INR 20,000 crore (about USD four hundred million) is being proposed by using the National Thermal Power Corporation (NTPC) to build a power generation capacity of approximately 4GW.

Analyzed the states across three dimensions to recognize their economic evolution and determine their future capability, *Fig 5*.

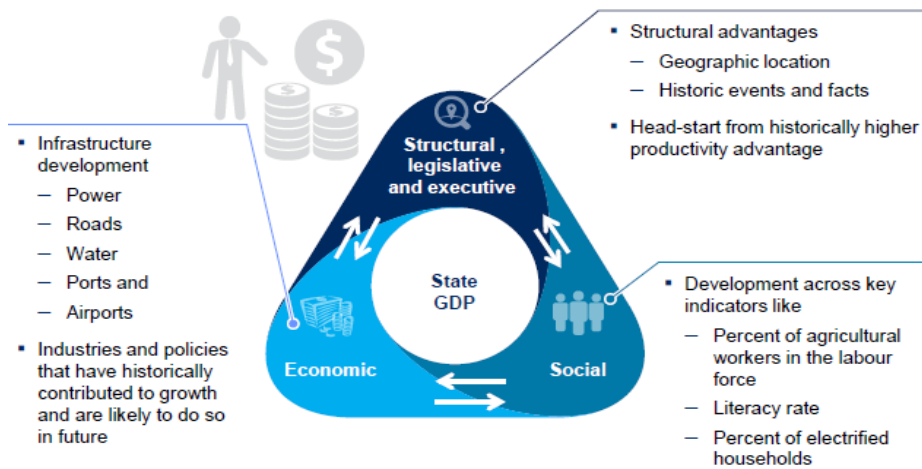


Figure 5 Key dimension to analyze the states⁵

Depending on the cost to serve, stage of the competition, consumer types, and current footprint, companies ought to focus either on the eight states or simply at the 69 towns. Therefore companies should understand the clear picture to know the market potential and demand across the nation and thus estimating the future demands and also in knowing about the high growth rate state and vice versa and knew which state is contributing to India's economy.

Geography economy takes a variety of approaches in a different chain of growth i.e. industries and their localization transportation, international trade, real state, economies of urban, environment and economic relationship, and globalization.

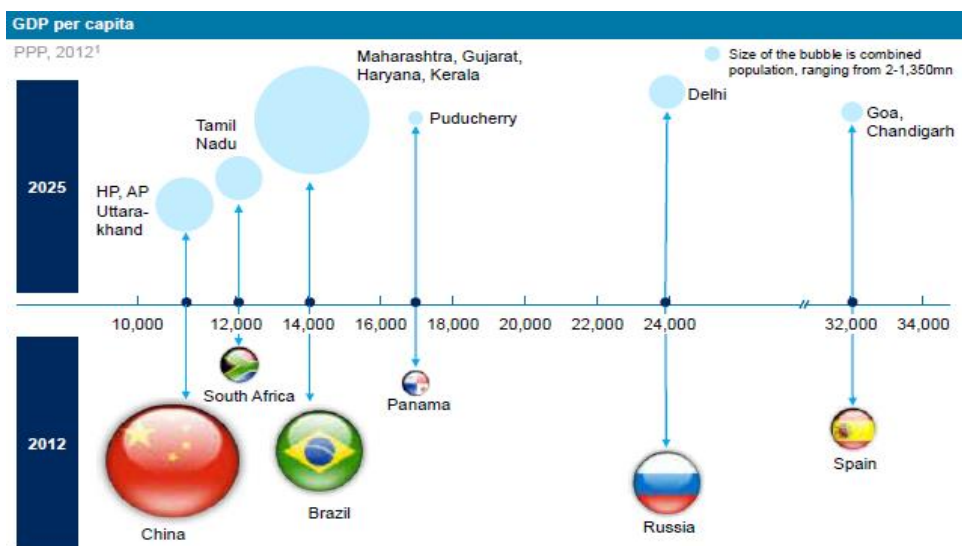


Figure 6 Comparison of the high-performance state of India with other countries

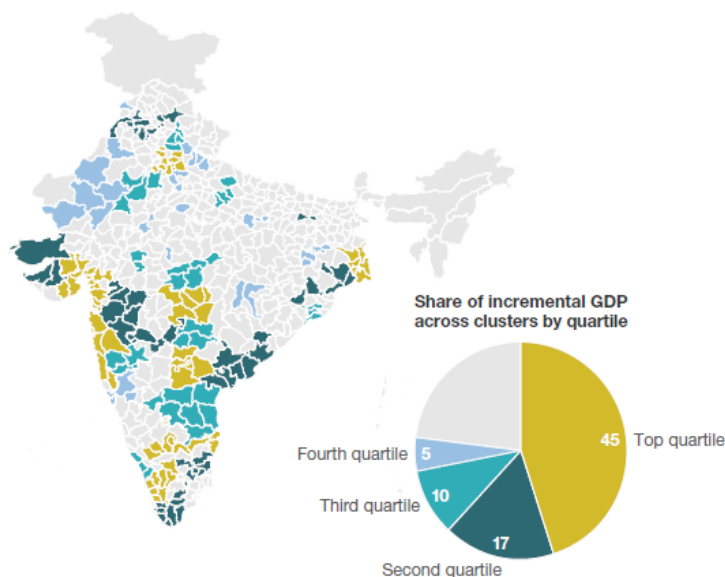
⁵ SOURCE: McKinsey Insights India

Accelerated urbanization and the incremental growth will propel the high-performing states to per capita income levels similar to those of today's middle-income nations. *Fig: 6*, in 2025, for occurrence, purchasing power parity of Maharashtra is similar to today's Brazil. Similarly, Goa and Chandigarh compared with Spain and Delhi with Russia.

CLUSTER:

After targeting the high potential metropolitan cluster, India's economy expects that just 180+ district can contribute to 77% of India's incremental GDP from 2012 to 2025. By 2025, there would be a 72% consuming class. Top-ranked metropolitan districts joint these clusters, and the adjoining high-potential districts make them operative markets with similar psychographics.

Forty-nine high-potential metropolitan clusters will account for about 77 percent of India's incremental GDP from 2012 to 2025.



Location of 49 metropolitan clusters¹ across states

Very high performing

- | | |
|---------------|---------------|
| 1. Delhi | 3. Goa |
| 2. Chandigarh | 4. Puducherry |

High performing

- | | |
|---------------|------------------------|
| 5. Mumbai | 13. Ludhiana |
| 6. Chennai | 14. Nashik |
| 7. Ahmedabad | 15. Thiruvananthapuram |
| 8. Surat | 16. Tiruchirappalli |
| 9. Coimbatore | 17. Aurangabad |
| 10. Kochi | 18. Madurai |
| 11. Nagpur | 19. Solapur |
| 12. Rajkot | 20. Kozhikode |

Performing

- | | |
|-------------------|-------------------|
| 21. Kolkata | 30. Bhubaneswar |
| 22. Bangalore | 31. Jodhpur |
| 23. Hyderabad | 32. Raipur |
| 24. Visakhapatnam | 33. Bikaner |
| 25. Vijayawada | 34. Hubli Dharwad |
| 26. Jaipur | 35. Udaipur |
| 27. Kadapa | 36. Amritsar |
| 28. Adilabad | 37. Kota |
| 29. Nellore | |

Low performing

- | | |
|----------------|--------------|
| 38. Jamshedpur | 44. Agra |
| 39. Lucknow | 45. Ranchi |
| 40. Saharanpur | 46. Varanasi |
| 41. Jabalpur | 47. Patna |
| 42. Indore | 48. Bhopal |
| 43. Bareilly | 49. Gwalior |

Figure 7 GDP Share by the state of India ⁶

In 2012, India has 49 clusters and accounts for 50% of India's population and contributes 77% of incremental GDP, 71% of consuming household class & 60% of consumption.

Of the 49 metropolitan clusters, 29 are sorted in 'Performing and 'Low performing' states which will emerge as the largest numbers of households to grow to be Aspirer families. And of these 49 clusters, 20 are 'high-growth' clusters and they were very best on profits consistent with capita and are also expected to develop at faster growth relative to remaining clusters. They may be expected to account for 44% of India's consuming class.

⁶ Source:

www.governancenow.com/files/Indias%20economic%20geography%20in%202025%20States%20clusters%20and%20cities.pdf

CITIES:

As per research, India is the third-largest economy in the World and have a real GDP of 2.37 trillion US\$ and in term of (PPP) purchasing power has a GDP of 9.45 trillion US\$. India is one of the fastest-growing economies with a growing at a rate of 7% in the world and a favorable place to make consumer potential market. Most of the economies are continued by the developing cities of India.

The major Indian cities which are driving the GDP of India are as follow:⁷

Cities	GDP (by PPP) in USD billion
Mumbai	\$310 bn
Delhi	\$293.6 bn
Kolkata	\$150.1 bn
Bengaluru	\$110 bn
Chennai	\$78.6 bn
Hyderabad	\$75.2 bn
Pune	\$69 bn
Ahmedabad	\$68 bn
Surat	\$59.8 bn
Vishakhapatnam	\$43.5 bn

Table 1 Major cities contributing to India's GDP

1.1.2 POLITICAL CHARACTERISTICS

Indian state influenced the market forces from two factors i.e. India's political economy and the global economy. So the result was the economy shift from a planned economy to desirous of liberating its economy. Different policies were made concerning India's domestic and foreign policies and upgrading the policies as per the scenario and therefore now, the Indian state is shaped by liberalization and globalization. Moreover, India needs policies to plan to reconstruct the economy by looking towards structure education, industries, transport, healthcare, poverty, etc. In the Prime Minister “Jawaharlal Nehru”, India drafted a Five-year plan (FYP) aims towards the physical planning (as per current situation), indicative planning

⁷ Source: Business World, June 2017

(providing subsidies to encourage the producer and consumer relationship) & social planning (focussed to raise the social background classes). This concept of planning started after independence and last long till 2017. This five-year plan is governed by the planning commission of India and from 1951-2017, a total of 12 Five year plans were executed in India.

Apart from this India's economic policies change 3 times after independence.

In the 1st section (1947-1974), the government started to look after the Indian industry. The mixed economy was initiated in this zone as colonialism harmed the industry. The Prime Minister of India initiated **the 1st Five-year plan** in 1951 and focused on the primary sector by funding more than 20 billion INR & along with that the Indian development and regulation act (1951) was imposed by the government as stated as taking license for any commercial start thus empowering industries and greater involvement of the state in economic activity. During the First FYP, net domestic product increased by 15%, and the growth rate was achieved by 3.6%.

The **2nd FYP** initiated for 1956-1961 and focussed on the long-term economic growth by importing the capital goods under the closed economy and nearly 48 Billion INR were invested in the productive sector. With the heavy industrialization and production, the growth rate increased to 4.27% during 2nd FYP.

The **3rd FYP** (1961-1966) worked on the same strategy as of 2nd FYP and focussed mainly on the Agriculture sector. After the war with the neighboring country in 1965-1966, India indulges in the financial crises, and draught in 1965 also worsen the economic situation, and therefore at the end of 1966, the growth rate declined to 2.4%. Policies were changed to overcome the crises and new technologies were adopted like capital intensive industrialization over agriculture development, India's economic policy aligned with bell report commissioned by the World Bank (1965), decided to devalue the rupees and liberalize imports but later both removed, no government control on some sectors like fertilizer production, public sector size decreased and foreign investment increased. Because of the failure of 3rd FYP, and condition like drought, inflation, lack of resource government were forced to initiate the three-year plan (1966-1996).

Later policies changed to finance the **4th FYP** (1969-1974), agriculture was promoted after the devaluation episode, US technological and financial assistance helped India to double the wheat output, known as India Green revolution. Indian economy expected target to reach 5.6% but because of the situation, the Indian economy grew at a rate of 3.4% (1956-1974). In this era, politics gave an economic shift i.e. from state control directed towards industrial development to a policy paradigm.

2nd section (1975-1990): The government initiated **5th FYP** from 1974-1979, focusing on the Economics policies that emphasized capital-intensive industrialization at the cost of agriculture development, food security, and the interest of the farmers. National highways drafted under this plan and in 1975, to counter the energy crises in India, the Electricity Supply Act initiated. Indian economy dependent on private firm initiation and trade promotion and because of the poor record of Human development gave notion rethink about the policies. Indian government-produced report about industrial regulation and export promotion. Licensed and approval were required for production, imports, and exports. To make the market globally competitive, FICCI

(Federation of Indian chambers of commerce and industry) advised the government for import and exports and therefore concession was granted. After industrial reform, and under the industrial policy statement of 1980, it was advised to engage with the IMF and build a relationship to reduce fund loads.

The 6th FYP initiated (1980-1985) with highly marked with self-sustainable growth and self-reliance. Under this plan, rural development was focussed along with the consumer good instead of capital intensive goods. A major problem arises in that plan was the rise of inflation, fiscal deficit, and underutilization of resources.

Therefore to eliminate this problem **7th FYP** was started (1985-1990) which controls inflation. The main objective of this plan is to focus on social justice, the productivity of farmers, improve productivity in various sectors by advancement in the technology. The growth rate achieved in this plan was 6.01%. Gradual deregulation of production was included in liberalization and therefore annual rate accelerated from 4.5% to 5.9% (1975-1990) and licensing policy were diminished, and new technological paradigm emerges and control on industrial activity by the government reduced.

3rd section (1991- 2009): Deregulation and trade promotion occurs in the late 1980s and it helped after the balance of payment crises in 1991 (where India has only 1 billion USD in foreign exchange) & gave economic benefits. **8th FYP** was initiated in 1992 till 1997 and the agenda of this plan was to focus on controlling the deficit and foreign debt by the open economy. Also focus on the decentralization & participation of people to build the nation, control the birth-rate, poverty, HR development, Employment generation, tourism, etc. Between 1991 and 1993, Industrial and trade policy changes and produced the most significant Indian private sector, competitiveness, and trade. **The 9th FYP** was initiated in 1997 till 2002 and has the replicated strategy of 8th FYP. Under this plan reformation in the direction of trade and redesigning trade policy like rationalization of exchange rate policy, changes in the tariff, liberalization of import, incentives to exports, provision of primary education, stable prices for accelerating growth rate, and simplification of procedures and transparency in taxation. This plan focus to strengthen the weakness of Nation by combining the public and private sector and have government intervention at every level to ensure the growth rate.

The 11th FYP (2007-2012) initiated to focus on population control by reducing the fertility rate to 2.1, reducing poverty by rapid and inclusive growth, education & to empower the public through skills and education. The last FYP was initiated in 2012 and later got dissolved by the Government of India and formed the new planning body “NITI Aayog”.

The main objectives of the **12th FYP (2012-2017)** were on the same strategy of 11th FYP with some new ones like eliminating the gender gap and social gap in school enrolment, electrification, and environmental sustainability & covering almost greenery by 1 Million hectares per year. It was expected to have a growth rate of 9% it was achieved less than the target. It was proposed, developed, and monitored by the planning commission from 2012-2014 but later the Government of India dissolved the planning commission in 2014, and the new body “NITI AAYOG” took the charge to implement further. In section 1.1.4 “NITI AAYOG” is discussed in brief.

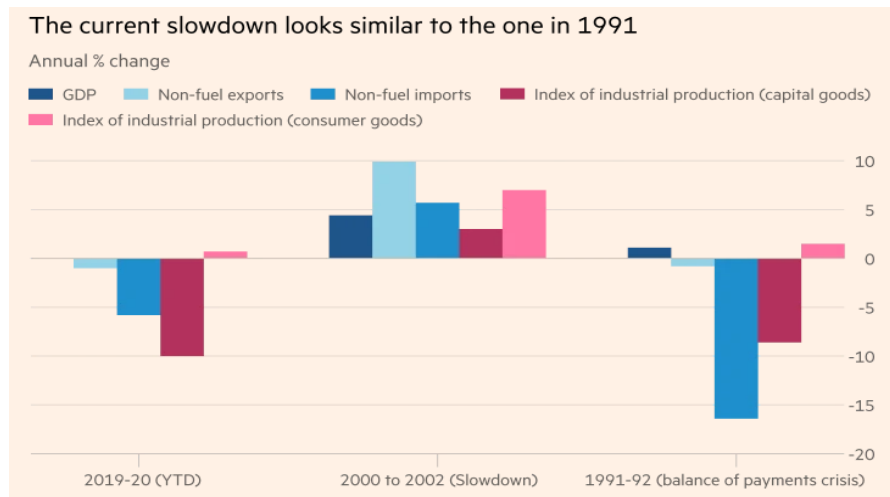


Figure 8 GDP comparison between 2019 and 1991⁸

After 2008, the growth slowdown because of unsustainable expansion of exports, demonetization despite all the balance sheet problems in the corporate sector, institutions, Government spending, and others lend money and therefore economy collapsed in 2019^(v). And therefore, from *fig 8* the current slowdown looks similar to that of 1991. And now it's challenging for India's future growth and therefore current Policymaker making their effort on reinvigorating the economy. With India three year action agenda i.e. NITI Aayog, The government of India tries to reduce the effect of the slow economy.

1.1.3 ECONOMICAL CHARACTERISTICS

India's economy is characterized as a developing economy and some features demonstrate these characteristics are as follows.^(vi)

A. Low per capita income: As compared with other countries, India's low per capita is very less. As per CSO (central statistics office), the per capita income of the country at the current price (the base year 2011-12) for the year 2019-20 is Rs.1,35,050/annum. Delhi is in second place with Rs.365, 5209.

B. Excessive dependence on agriculture and primary producing: The Indian economy is too dependent on the agriculture and allied sector. Nearly 58% of the total working population of India contributes towards 21% of the national income of India. Moreover, some of the basic problems like low productivity, lack of modernization, and diversity, and the agriculture sector suffered a lot.

C. The high rate of population growth: Since 1950 India's population maintained at a high rate and this has created high population pressure and was resulted from a very high level of birth rates coupled with a falling level of death rates as steep fall in death rate from 49 per 1000(1911-20) to 7.1 per 1000 in 2011. In India, the rate of growth of population had been increased from 1.31% annually from 1941-50 to 2.5 % from 1971-81 to 2.11 percent during 1981-91 and then finally to 1.77 percent during 2001- 2011. Thus whatever development was

⁸ Source: www.ft.com/content/81a7935c-56e0-11ea-abe5-8e03987b7b20



done was swallowed by the increasing population and therefore rapid development is a necessity to maintain the same standard of living thus required food, clothing, housing, schooling, health facilities, etc. in greater magnitude to avoid the economic burden.

D. Existence of chronic unemployment and under-employment: the rapid growth of the population leads to chronic unemployment and underemployment problem in India and this unemployment is the result of deficiency of capital, so industries can't expand their firm and therefore a large number of the labor force is engaged in the agriculture sector. Moreover, in urban areas of India, the problem of educated unemployment taken a steep turn.

E. Inequality in the distribution of wealth: as per the report of the Reserve Bank of India stated that nearly 20% of the households owning less than Rs.1000 worth of assets possess only 0.7 %of the total assets. Moreover, 51% of households owning less than Rs.5000 worth of assets holding 8% of total assets. And the top 4% possessing assets worth more than Rs.5000 and i.e. 31% of total assets. So it's clear that in India there is mal-distribution of wealth and this has resulted from the inequality in assets distribution. Thus the majority of wealth concentrated towards the most powerful business holder of India.

F. Low level of technology: Indian was limited with the technologies and used at limited scale as it is very expensive and also adopting newer technology is difficult to handle by the unskilled, untrained, and illiterate labor and therefore due to lack of insufficient technology and lower skill, the productivity of service sector of India is low. And this results in inefficient and insufficient production leading towards general poverty in the economy.

G. Demographic characteristics: India is associated with a high density of population, with a small proportion of total pollution ranging from 15-60 years are working and a large population of total population preliminary minor age 0-15 years. Moreover, lower-income level low level of living standard, low life span i.e. 63.9 years in India compared with 75 years in most developed countries of the world. All these show that the dependency burden of India's population is very high.

H. Lack of infrastructure and under-utilization of natural resources: facilities like transportation and communication, economic organization, health and educational institution, electricity generation and distribution, banking and credit, etc. are not adequate, and therefore Indian economy has been suffering till today. And because of the lack of infrastructure, the development problem in a different region of the county remains under-utilized. Although India is rich in natural resources lack of infra is also affected by utilizing natural resources. The inaccessible region, primitive techniques, shortage of capital, and the small extent of the market are other reasons too for under-utilization.

I. Inadequate development of economic organization: as the Indian economy was not satisfactory certain measure have been taken to improve the economy like mobilization of saving, proper enforcement of tenancy legislation, and to meet the other financial needs, development of the financial institution, credit agencies are required particularly in rural areas. As the Indian economy largely remain underdeveloped but after strategically planning commission achieved from the last six decade and progress attained in certain areas and therefore Indian economy can be considered as a developing economy.



1.1.4 THE GOVERNMENT POLICY & PLANNING COMMISSION

Since the independence of India, there have been three major economic reforms that have been guided by the planning commission of India. The commission is set for a term of 5 years and makes development plans for India related to almost all the sectors for automotive growth. The Planning commission was first set up in soon after independence in the year 1951 which then advised the government and made a road map for the development of infrastructures and businesses and to develop industries and logistical means there have been about 10 planning commissions so far which have shaped the Indian market and industry in India.

In 2014, the Indian Government dissolved the Planning Commission and initiated a newly-formed economic planning body “NITI Aayog”.

NITI AAYOG:

NITI Aayog was replaced by Planning Commission on 1st January 2015. The work of the National Institution for Transforming India (NITI AAYOG) was to develop futuristic planning to create an economic ecosystem for maximizing foreign investment and infrastructure development. The Aayog supports a cooperative federal structure in which the Central and the States government conclude together on the development guidelines collectively & allow states to act together for the National interest.

NITI Aayog is the primary policy of ‘think Tank’ of India’s authorities, reporting both guiding and policy inputs. Whilst scheming strategic and long-time policies & regulations for the Government of India, NITI Aayog also presents the relevant technical recommendation to the Centre and States.

The General governing council of NITI Aayog comprises of with The Prime Minister as its Chairman, accommodates Chief Ministers of all States and Lt. Governors of Union Territories (UTs). They have experts from various fields.

The main objectives of NITI AAYOG:

- To develop a common visualization of national development significances, sectors, and strategies with the active participation of States.
- To adoptive cooperative federalism through structured support initiatives and mechanisms with a state basis, recognizing a strong State that make a strong nation.
- Developing credible plans at the village level and combining these ever more at higher levels of government.
- To pay attention to those parts of society who are at risk of not getting the equal adequate benefit of economic progression.
- From designing the strategy along with long term programs & initiatives and monitor the technology and their efficiency.
- Encourage engagement of the like-minded Think tanks entities like key stakeholders and national and international, & educational and policy research institutions.
- Create knowledge, innovation, and entrepreneurial support system
- To accelerate the agenda principal, proposed a platform for resolution of inter-departmental and inter-sectoral issues.

- Monitoring the implementation and provide satisfactory resources to strengthen the prospect of success and scope of delivery
- Technological advancement for program initiatives and implementation.

MAKE IN INDIA

Make in India initiative is a brainchild and a reform of the NITI AYOOG in transforming and advertising the idea of FDI (Foreign Direct Investment) through an initiative by the government. Make in India is an initiative by the Government of India to manufacture in India for India and the global market. The initiative aims to project India as one of the major markets and production places that is ready to offer an abundance of opportunities to the FDI (Foreign Direct Investment) in India. Since India has the second-largest population on planet Earth and has a deep-rooted STEM education system hence it wants to be an ideal destination for companies that are manufacturing in China to make a shift to the other markets and offer their services to a much broader spectrum.

It aims to transform ‘Enhancing the investment’. The government of India has approved for ‘Empowered Group of Secretaries (EGOS)’ and ‘Project Development cells (PDCs)’ to attract investment in India. The Empowered Group of Secretaries (EGOS) will play a prime role in boosting key sectors of the Indian economy. To increase investments in India, EGoS will provide investment support and facilitation to global investors. The Empowered Group will also coordinate with various departments and ministries to ensure timely clearances. EGoS will also steer policy stability and consistency throughout the investment environment while facilitating investors in a targeted manner. Investments submitted by various departments will be evaluated by EGoS, which will also set targets of completion for these departments. Meanwhile, the PDC will be working with the central and the state government to develop investible projects and to increase their number in the country. The PDC will conceptualize, strategies, and disseminate details concerning investable projects. It will complete the project and give a detailed report including land details which will be picked by investors. PDC will also work on issues to settle down issues relating to and finalization of investments.

Since 2014-19 India has increased its FDI of \$284 billion in the last 5 years. This has been a success as compared to the investment received before 2014. The initiative focuses on transforming India into a much favorable destination for business by making it a place with better ease of business and eliminating Red-Tape-ism and bureaucratic hindrances which do not help the businessman and makes his efforts difficult to set up a manufacturing plant or unit to make and sell in India. On that order, India jumped a substantial rank as per World Bank annual list. In 2014 India was ranked 142 with ease of doing business which is far unsatisfactory for a growing economy, whereas in 2018 it ranked 63rd, an improvement of 79 ranks which is due to the efforts taken by this initiative.

Indian Government policies related to Electrical vehicle production and consumer scheme are discussed in detail in chapter 4.

1.2 THE AUTOMOTIVE INDUSTRY IN THE WORLD

The automotive industry is one of the world's largest economic sectors by revenue in the entire region of the world. This sector includes design & development, manufacturing & production, marketing & selling. This industry is tributary to an integrated approach along with the stakeholder to reduce the carbon emission and cleaner environment. The more technologically advanced procedure to improve engine efficiency & alternative fuel usage so to produce fuel-effective engines and thus contribute to a clear improvement in the quality of air. This trend changes with the replacement of old high carbon emission cars with new vehicles.

1796: Nicolas Joseph Cugnot built the first steam-powered automobile.

1803: Hayden Wischett designed the first hydrogen-fuelled internal combustion automobiles.

1860: successive automobiles began with internal combustion engine technology in France and Germany ranging from two-cycle to four-cycle engines.

1882: Enrico Bernardi builds the first petrol-powered vehicle.

1885: The First production Benz vehicles began when Karl Benz build petrol and gasoline-powered automobiles. In 1908, Ford Motor Company came into the race with the mass production on the assembly line of Ford Model T [Fig: 9] and Ford produced 15,000,000 units of Model T from 1913 to 1927. Between 1907 and 1912 the USA dominated the arena's automotive enterprise in production through the invention of mass production strategies for many decades after the invention of the motor car with almost 75% over-all vehicle production after WWII. From 1905 to 1914, the US era was known as the Brass Era because of the heavy use of brass in vehicle production.



Figure 9 FORD MODEL T

In 1929, the World has 32 million automobiles in the USA and the USA produced more than 90% of them. After 1975, the USA produced more than 75% of World-wide vehicle manufacturing. In 1980, the U.S. automobile industry was overtaken by Japan and in 1994, Japan became the top leader in world automobiles production. In 2012, China became the 1st leader in automobiles production with 19.3 million unit production double than the 10.3 million

units produced by the USA and Japan became the 3rd in the world with a total production of 9.9 million. In 2007, 806 million cars and light trucks were on the road consuming 980 billion liters of gasoline and diesel fuel annually.

Fig 10⁹ shows the World Automobiles production after 1950. And *Fig 11* shows the market share of the country in Vehicles production.

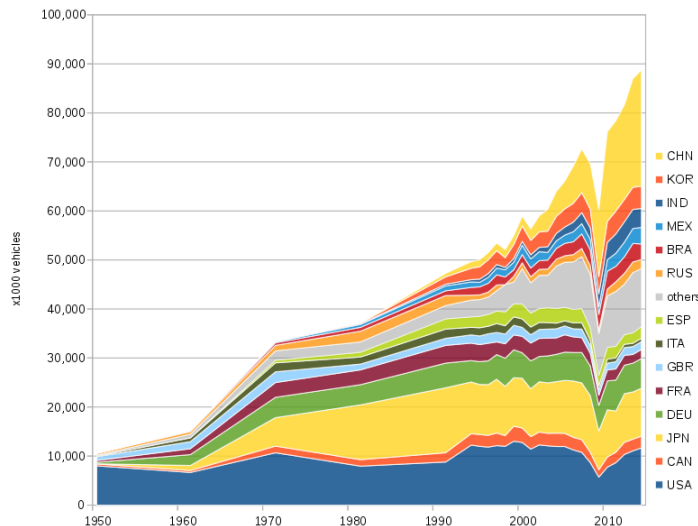


Figure 10 World Automobiles Production

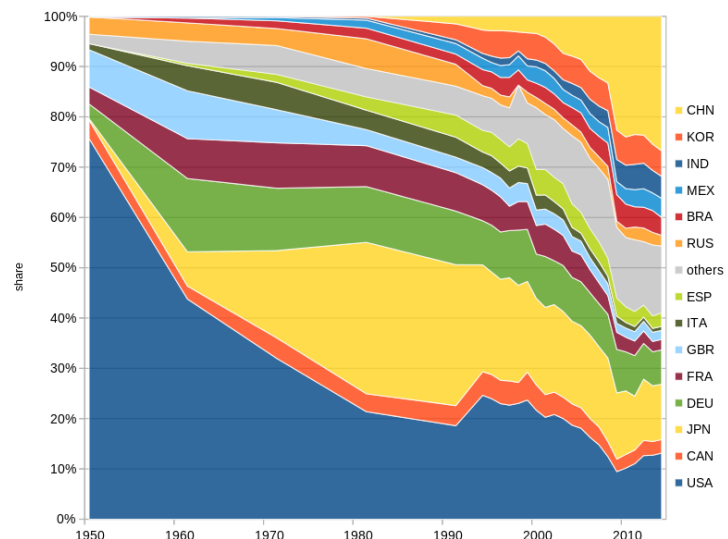


Figure 11 World share in Automobiles production¹⁰

The technological paradigm also changes after the introduction of electric vehicles and a range of automobiles that run on different fuels. Automakers are strongly committed to safety measures. Today's automobiles have greatly enhanced safety systems and many important safety features, making them safer than ever. For instance, in the USA, the availability of these safety features has risen by up to 23% from 2005.

The International Organisation of Motor Vehicles Manufacturers (OICA) represents the worldwide vehicle industry and including all major automobile manufacturing countries all

⁹ Source: https://en.wikipedia.org/wiki/Automotive_industry

¹⁰ Source: https://en.wikipedia.org/wiki/Automotive_industry

over the world. OICA play a major role in technical solutions, industrial and economic policy, and statistics and also promotes globally the manufacturer's interest, assemblers as well as importer's interest. OICA is the official auto industry representative at the United Nations and actively participates in the development of international vehicle legislation.

As per the 2019 statics report by OICA, a total number of the vehicle (CV & PC) was 91.8 million units, and the top five countries in the contribution are **China, USA, Japan, Germany, and India** but because of pandemic corona disease, and as per the OICA latest news on April 06, 2020, it seems like After 2019's automobile industry break to 10 years of industry growth, and huge 2020 crises occur in the auto industry.

The 1960 decade was considered as the golden technological era of the automobiles industry, led by GM, Ford, & Chrysler. It's been more than 100 years of automobiles. With the diversified technologies at the global level by the incumbents attracted the new entrants and led to new market trends. *Table 1* shows the World's largest car manufacturer in phrases of sales in 2019. In 2019, Toyota and Volkswagen were leading automakers worldwide in terms of revenue & the leading automakers in 2019. Toyota generated around 30 trillion Japanese yen or more than 280 billion U.S. dollars in revenue in 2019.

Top	Group	Country	Sales volume (million)	Market share
1	TOYOTA	JAPAN	8.683	10.24%
2	VOLKSWAGEN	GERMANY	6.436	7.59%
3	AMERICAN FORD	USA	4.735	5.59%
4	HONDA MOTOR	JAPAN	4.630	5.46%
5	RENAULT-NISSAN	FRANCE-JAPAN	4.366	7.7%
6	HYUNDAI GROUP	SOUTH KOREA	4.279	5.05%
7	CHEVROLET	USA	3.831	4.52%
8	KIA MOTORS	SOUTH KOREA	2.843	3.35%
9	MERCEDES	GERMANY	2.490	2.94%
10	BMW	GERMANY	2.219	2.62%

Table 2 World Largest Automotive vehicle Manufacturers in 2018¹¹

In the 1990s, the auto sector experienced the unparalleled scale of variation in the circumstance of economic Globalisation. The Automobile industry observed problems of overcapacity that necessitated M&A and strategic alliances. Therefore major Automakers formed a group or merge to continue to exist in the competitive surroundings and to strengthen their economies of scale, market proportion & growth, expansion of product ranges, technology capability, and increase their geographical routes.

¹¹ Source: <https://dailynewsegypt.com/2020/02/04/top-10-selling-international-car-companies-in-2019>

The six predominant merges & alliances in the auto sector took place, specifically GM Alliance, DCX Alliance, Ford Mazda, VW group, Toyota, and Renault Nissan. The largest US automakers—GM, Ford, and Chrysler—have undertaken M&A interest with European and Japanese automakers.

These companies are specifically expanding their operations in various developing parts of the world. *Table 2* shows the total number of passenger car sales in 2019 (country-wise) and *Fig 13*¹² shows the Global sales of passenger cars falls to 65.45 million units in 2019, down from a peak of 79.6 in 2017 although passenger cars are the largest category of motor vehicles production.

Region	China	USA	Japan	India	Brazil	Russia	Europe	Total
Sale volume (Million)	21	16.96	4.3	2.96	2.66	1.76	15.8	65.44

Table 3 Worldwide Automotive vehicle (PV) Sales in 2019¹³

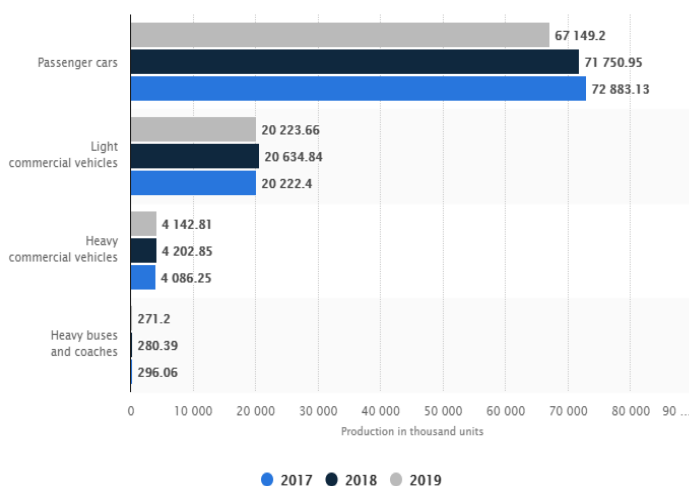


Figure 12 Estimated worldwide motor vehicle Production between 2017 - 2019

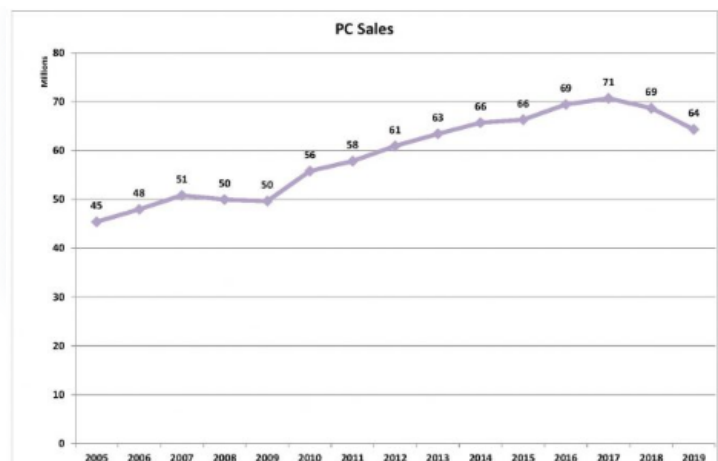


Figure 13 PV sales forecast 2005-2019

Because of the Pandemic effect, Production output in the European automotive industry could be 880,000 units lower than usual if assembly plants were kept shut for 13 business days. Many carmakers closed their plants amid the coronavirus outbreak in Europe and elsewhere.

It was also estimated that China could suffer the loss of about 1.7 million vehicles worth of production due to coronavirus-related work stoppages. Auto plants in the city of Wuhan are estimated to produce around 2.2 million Honda and Nissan vehicles. Before coronavirus hit,

¹² Source: <http://www.oica.net/>

¹³ Source: www.best-selling-cars.com/international/2019-full-year-international-worldwide-car-sales

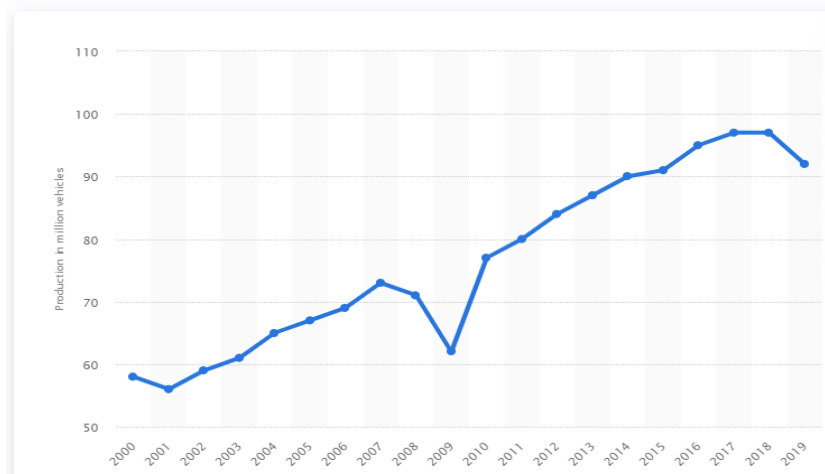


Figure 14 Worldwide production 2000-2019

the auto industry hit hard by the financial crises in 2008-2009, and GM declared 91 billion US dollar bankruptcy in the wake of the crises. ^(vii)

European and Japanese are the dominated automobile supplier industry like borsch, Denso, etc. Borsch

generated revenue of around 77.7 billion euros in 2019. Denso generated 48 billion US dollars in 2019. Automakers from developing markets like China and India were focussing on the overseas acquisition. *Fig 14¹⁴* indicates the elevation within the production (All Vehicle) from 2000-2019. In 2019, almost 92 million motor vehicles were produced worldwide. China, Germany, and Japan were the largest producer of cars and commercial vehicles in 2019.

1.3 IMPACT OF COVID-19 ON THE GLOBAL ECONOMY

The automobiles industry and autonomous automobile (AV) companies alike had been hit hard by the corona pandemic as a call for automobiles has fallen & it seems uncertainty in business. From its preliminary outbreak in Wuhan, China, the current coronavirus pandemic has swept the world & inflamed as a minimum of 6.7 million lives globally. Lockdown initiated and that gave major drawbacks in Businesses and workplaces. From China to Italy to the United States to India and no other country left behind from this pandemic virus. The coronavirus pandemic seems to be one of the most infectious pandemics in modern times.

There is no exact way to measure the actual economic damage from the global COVID 19. Before the corona became a global pandemic, it was estimated that most major economies will lose at least 2.4% of the value of GDP over 2020. But the in-ground reality, the economic damage is much more than estimated.

The economic damage because COVID-19 is largely driven by the demand steep down, work stoppages, supply chain breaks, production schedule got hindered, and marketplace uncertainty for corporations in nearly every sector and no goods & services purchased by the consumer. Major industries hit by corona 19 are travel and tourism as the government restricts movement to control the spread of the virus. So companies, reducing their staff to sustain by the mean of cutting costs. Despite all this, some sector is benefited such as e-commerce, food & retail, health care industry providing at least some economic growth to offset the damage. Before this, the government played an important role in crises like government spending i.e. they increased their monetary provision to the welfare of citizens and ensuring businesses access the funds needed to keep their staff at the time of the pandemic.

¹⁴ Source: <http://www.oica.net/>

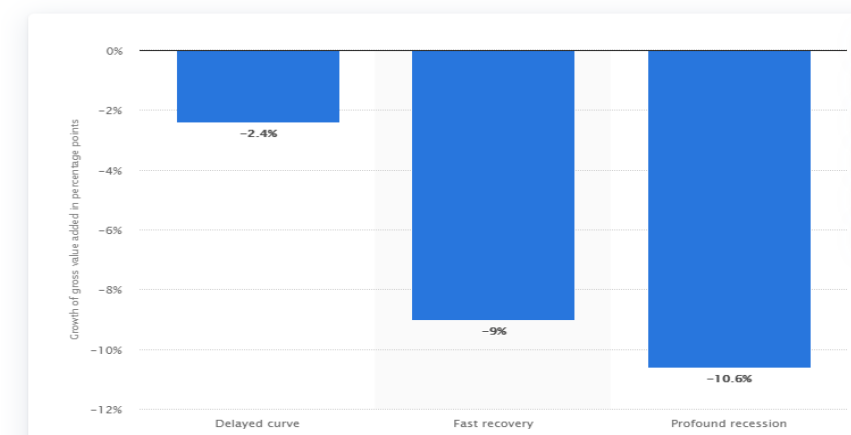


Figure 15 Covid19 impact on globe Auto sector¹⁵

Estimated impact of the coronavirus (COVID-19) epidemic on the global auto industry's growth of gross value added in 2020 and *Fig 15*, in the worst-case scenario the gross value added can down to 10.6% in 2020. As per research, the Global sale of automobiles declined by approximately 22%, i.e. about 70 million vehicles sold instead of almost 90 million.

China's manufacturing sector was contracted by 2% as of Feb 2020 and therefore EU the worst-hit region at \$2.5 billion US dollars decline in the automotive industry due to interruption in the supply chain as unavailability of automobile parts as china is one of the leading exporters in the automobile sector. Key Auto-Manufacturer players such as Ford, Fiat Chrysler Automobiles, Volkswagen Group, PSA Group, Tesla, Ducati, BMW group, GM, Rolls-Royce have postponed their production because of Coronavirus (COVID-19) pandemic.

Major European Markets have been appreciably hit like in France, Italy, Austria, Spain, Slovenia, Portugal, and Greece where the total sale volume fell from 634,600 units in March 2019 to 161,800 units in March 2020. March 2020 hit at its most because major lockdown restriction started from March only.

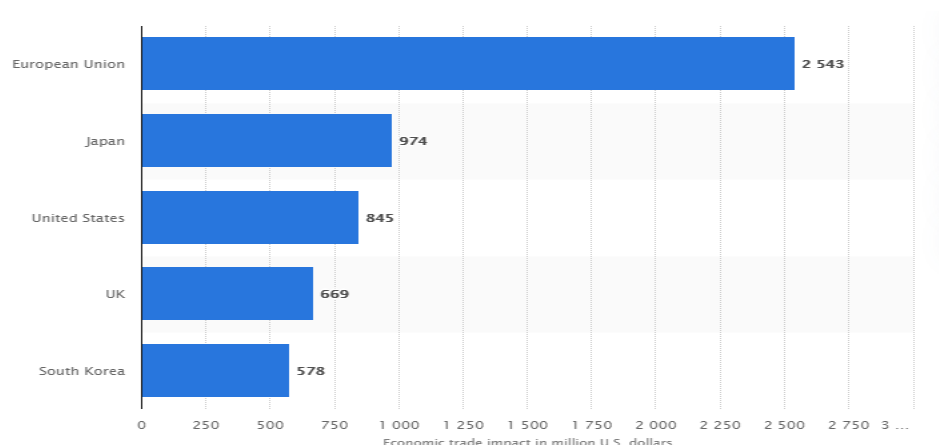


Figure 16 Economic trade impact on top players¹⁶

¹⁵ Source: rolandberger.com

¹⁶ Source: Global trade impact of the Coronavirus (COVID-19) Epidemic

The novel coronavirus pandemic is expected to impact on the global economy. The real GDP of 2019 is growing by 2.9% and it is forecasted that the global GDP will decline by 0.5% in 2020 compared with 2019 [Fig 17] with rigorously shaking the global auto-industry causing in a 12%–15% dip in the market in 2020 ^(viii)

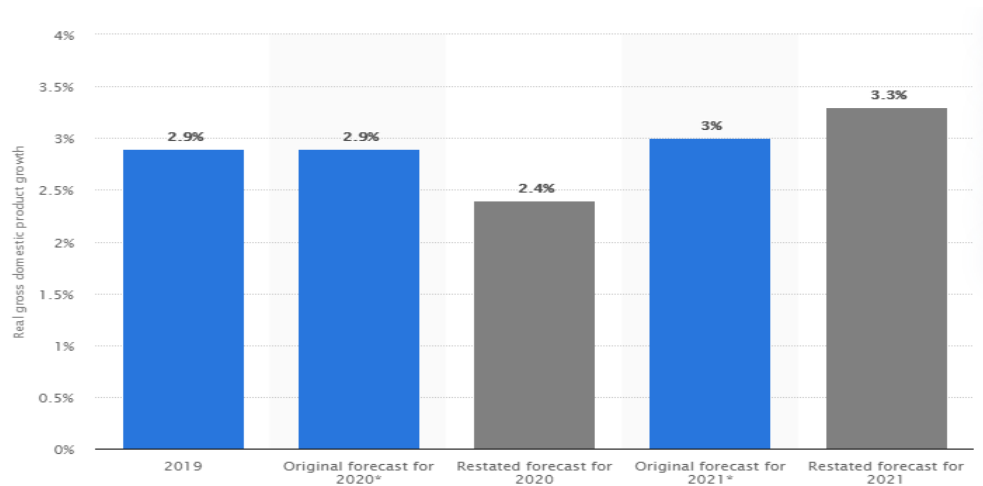


Figure 17 Forecast Global real GDP growth due to COVID19¹⁷

Pandemic Effect on Indian Auto market:

Since Mid-March 2020, India is in lockdown. The auto industry was already going through a complicated environment even before COVID-19 because of the new BS-VI law, which was set to initiate into force from April 1st, 2020. The guideline has already had an impact on manufacturing, as Supreme Court already approved about the change in a directive from BS4 to BS6 and intended that BS4 models should now not be registered and lots of producers had been left with the unsold factory and supplier inventory.

All OEMs discontinued smaller diesel engines which were specifically hard for the industry as high degrees of sales got here from diesel – Maruti Suzuki shifted to petrol and CNG when 20% in their sales formerly got here from diesel engines. Consumer demand was additionally impacted as a result, as OEMs added new and progressed models, there has been a widespread notion among customers that BS6 cars would be too luxurious & expensive and thus discouraging consumer purchasing power.

Even though after this, the pandemic started and it affects significantly on the purchasing power of the consumer. In section 2.4 pandemic effect is discussed in brief and the initiative took by the government.

¹⁷ Source: oecd.org

CHAPTER 2 THE INDIAN CAR MARKET

OVERVIEW

The very first car ran on the Indian road was in 1897 though after 3 decades small cars started imports in India. The first motor industry launched in India in 1942s i.e. Hindustan motors which later collaborated with Morris motors to manufacture i.e. HM Ambassador and Mahindra & Mahindra was established in 1945 with the assembly of the Jeep CJ-3A. Later with the help of government intervention, the part manufacturer started in India, and in late 1953, importing a complete assembled car restricted in India.

At the beginning (1950-1960s), growth was relatively slow but later, from the 1970s growth took a drastic change when licensed raj came to an end. Initially, jeeps were largely used but later commercial vehicles started in trends like a tractor for transportation as well as an agricultural purpose. And, therefore growth was mainly driven by tractors and other commercial vehicles. In the late 1980s, the Indian car market flooded with only old design car and therefore this situation forced the government to encourage and allowed new companies. The first generation Maruti-800 launched in 1980. To pull the new entrants in the automobiles industry, the government started auto expo to showcase the innovation, ideas, and new technology.

Post-1992 liberalization, automakers like Suzuki & Toyota of Japan, Hyundai of South Korea could invest in the Indian market. As a result, Maruti Suzuki was the first successful of all these new entries. Because of liberalization, in the nineties, most of the foreign companies started looking forward to the JV (joint venture) with Indian companies and thus shows a variety of vehicles for the consumer. And at the beginning of 2000, more than 12 large automobiles companies ruling the Indian car market. The industry dealing with almost all types of transport vehicles such as tractors, cars, trucks, buses, motorcycles, 2W & 3W vehicles, etc.

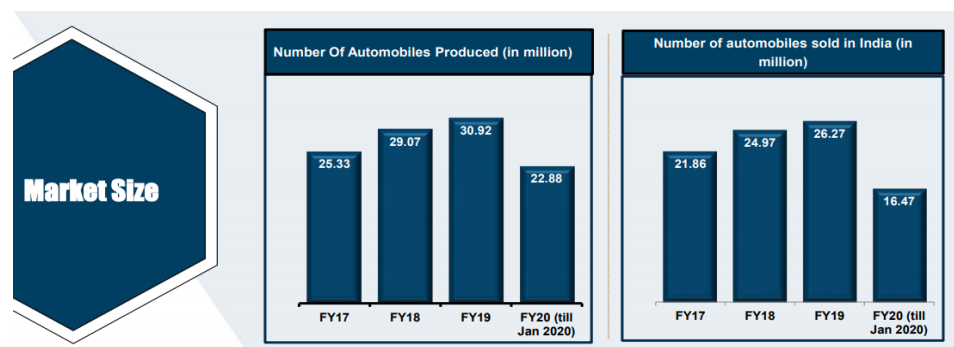


Figure 18 Market share FY17-20

Overall domestic sales increased at 6.71% CAGR between FY13-19 with 26.27million automobiles sold in FY19, *Fig 18*, whereas 30.92million automobiles were produced in FY19. In FY19, yearly growth in domestic sales of commercial vehicles at 17.55% where 10.27% on the sales of three vehicles. ^(ix)

Although with slow growth Indian markets emerge and in Q1,2020 India manufacture low-priced cars at a global level and thus become 4th largest automobiles market in the world with an increment of sales from 8.3% every year to 3.99 million and known as the 5th largest

manufacturer of commercial vehicles, heavy truck manufacturer, and passenger cars. India is currently the largest producer of 2-wheelers. *Fig 19* shows the share of the automobiles sector by volume produced in FY19.

During FY19, automobiles export grew to 14.50% and expected to grow at a CAGR of 3.05% during 2016-2026, and only passenger car exported was 676 thousand in the FY19.

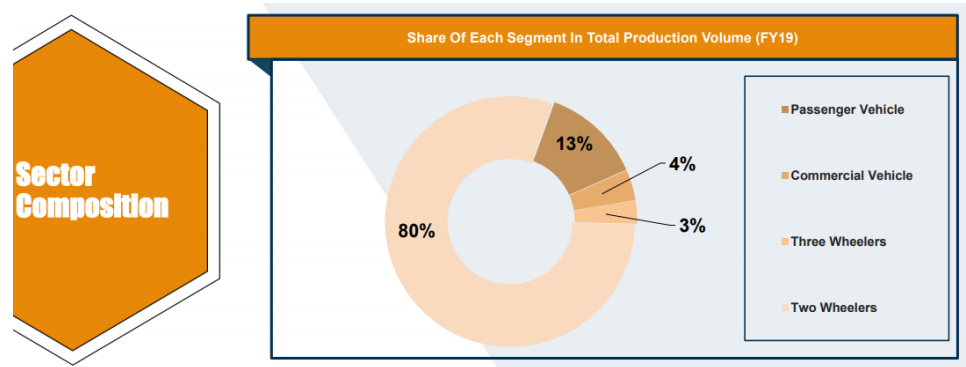


Figure 19 Sector composition in total production FY19

In January 2020, TATA Group started JV with Beijing based Prestolite electric auto company to enter the EV component market. In December 2019, Forces motor invested US\$429.25 million to develop two new models. At the same time, MG Motor India to launch MG ZS EV electric SUV in early 2020. Similarly, many other big automaker brands invested in India from the last recent years.

With several government initiatives along with major automobiles, companies are expected to make India a leader in the four-wheeler market in the world by 2020. Concerning the investment part, data released by DPIIT (Department for Promotion of Industry and Internal Trade), and automobiles industry attracted to the FDI (foreign direct investment) worth US\$ 23.89 billion from April 2000 to December 2019. Government initiatives took a major role to turn the Indian auto economy by encouraging FDI.

Some major initiatives are:

- Under NATRIP, the Government planned to set up an R&D center (US\$388.5million), so that industry can match with global standards.
- Union budget 2019-20 allowed the reduction of additional income tax of (US\$ 2146) on the interest paid on the loan to purchase EVs.
- The government shortlisted 11 cities in the country to introduce the EVs as a public transport under the FAME scheme to reduce the carbon emission and approved the FAME-II scheme with fund US\$1.39 billion for FY20-22.

Further complete details of Government policies are explained in section 4.5

2.1 THE INDIAN CAR MARKET AND ITS ROLE IN THE ECONOMY

The automobile industry in India giving a series of variety in every other day launch ranging from luxury to low-cost car in other to not to leave the common man behind. *Fig 20* shows the automobiles segment ranging from LMV to HMV, 2W to 3W & from PV to CV. In 2009, the Indian auto industry hit badly by financial crises though it was still ninth-largest in the world.

Automobile companies in India are flourishing daily because of rapid growth in India, but there are some ruling companies in the market.

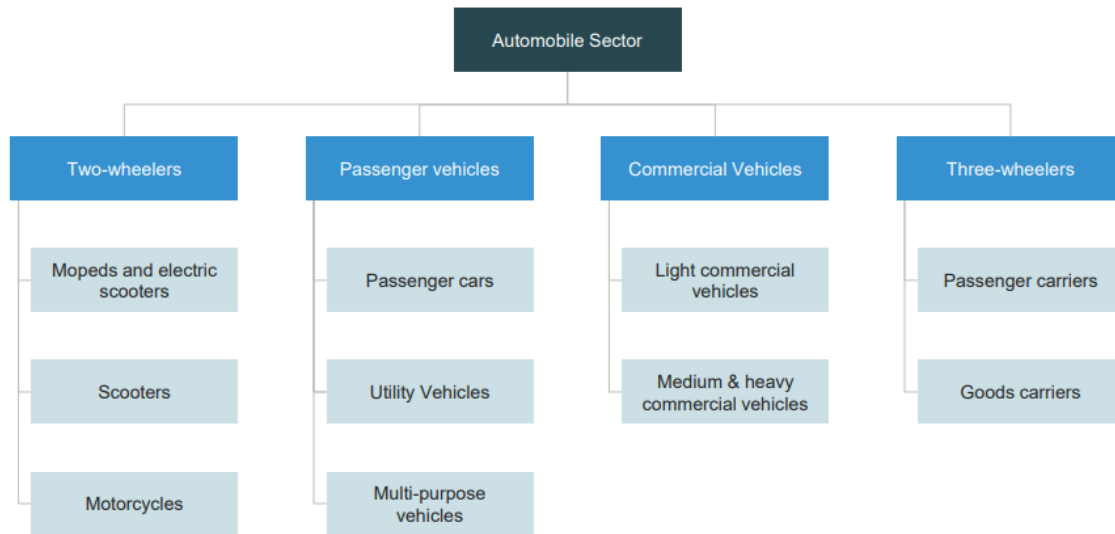


Figure 20 Automobiles segment

Top automobile companies in India are Ashok Leyland, Tata Motors, Maruti Suzuki India Limited (MSIL), Hyundai Motor India Limited (HMIL), Mahindra & Mahindra (M&M),

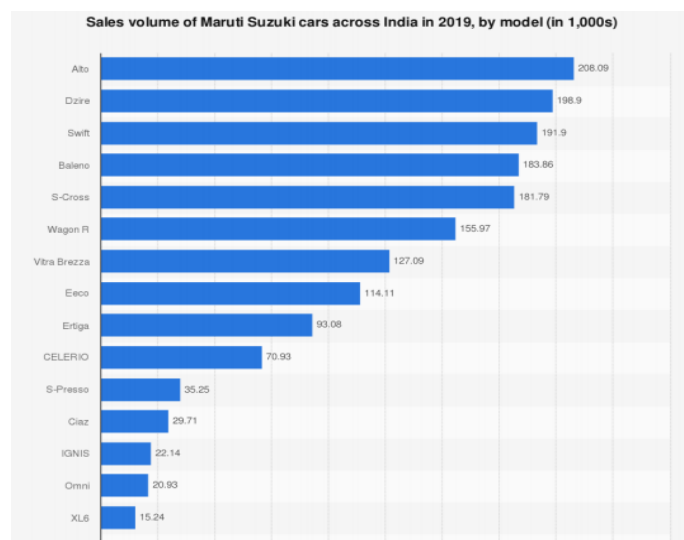


Figure 21 Sale volume of MSIL 2019

General Motors India private limited (GM India), Hero MotoCorp Limited, Bajaj auto. From Fig 21¹⁸, Maruti Suzuki is the leading passenger car company in India, in 2019 with giving more than 208 thousand units of Maruti Suzuki's Alto

The growing automotive sector is becoming more important for Indian citizens with over a million jobs directly tied to this industry. Passenger and commercial vehicles are the main segment within this industry with their 3 million sales of passenger vehicles and 1million sales of commercial vehicles in FY19 whereas the total

production of the passenger, as well as a commercial vehicle in India in 2019, are 3.6 million & 1.1 million units.

¹⁸ Source Auto Punditz autopunditz.com

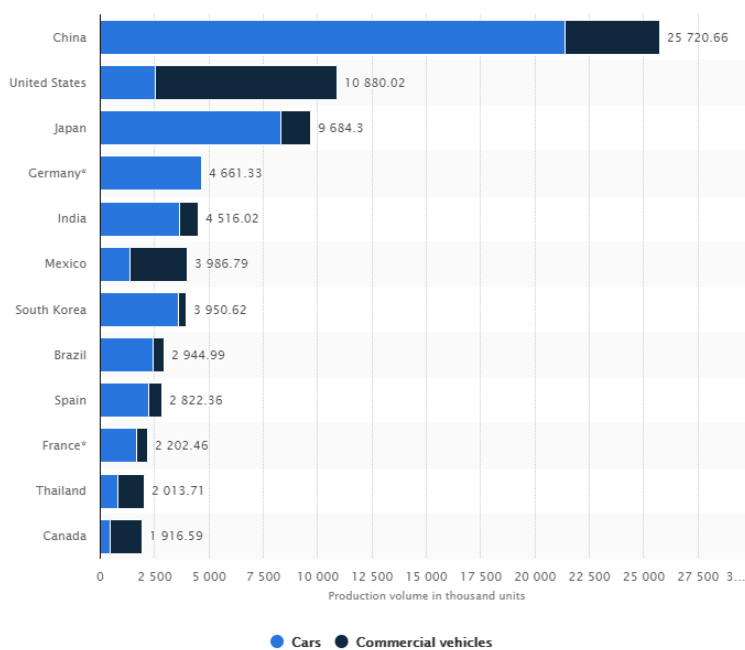


Figure 22 Worldwide CV production of automobiles

As mentioned above, India is followed by China, the US, Japan, and Germany in terms of CV producer. From *Fig 22¹⁹*, China was the leading market for commercial vehicle production with about overall world production of 25.7 million. The second-ranked United States produced more commercial vehicles than passenger vehicles.

2.1.1 THE PROPORTION OF GDP AND THE SWOT ANALYSIS OF THE INDIAN AUTOMOBILE INDUSTRY:

Globally, in 2015, with the total production of 90.8 million vehicles (PV & CV), & the overall global turnover of the auto industry was estimated at Euro 1.9 trillion and recorded a CAGR of 3.6% during the period 2008-15.

The automobile sector of India accounts for over 7.1% of India's gross domestic product (GDP) and 4.3% share in India's exports in FY20. It also contributes to nearly 22% of the country's manufacturing GDP and 40% share in Global R&D.

GDP in the current FY20 came down to 7.1% from 7.5 % in FY19 with the overall revenue for OEM slide down to 6% in FY20. As per research the overall domestic sale of all vehicles including PV, CV, 2W, 3W in FY20 were estimated to show a negative slope by 6-7 % comparing to FY19. Along with that, it was expected to see the decline of 5-6% as compared with FY19 in the sectoral revenue. ^(x)

Consequently, any decline in revenue and sales will directly impact the auto industries, and therefore to control the fall in the GDP, the government took initiative, mentioned above and as per the government's automobiles' mission plan, the contribution of the sector expected to reach 12% by 2026. Despite giving high discounts and offers, many companies failed to attract buyers and therefore the overall automobiles industry sales are expected to remain below. And therefore the domestic share of automobiles production is PV, CV & 3W is less achieved, *Fig 23*.

¹⁹ Source: oica.net

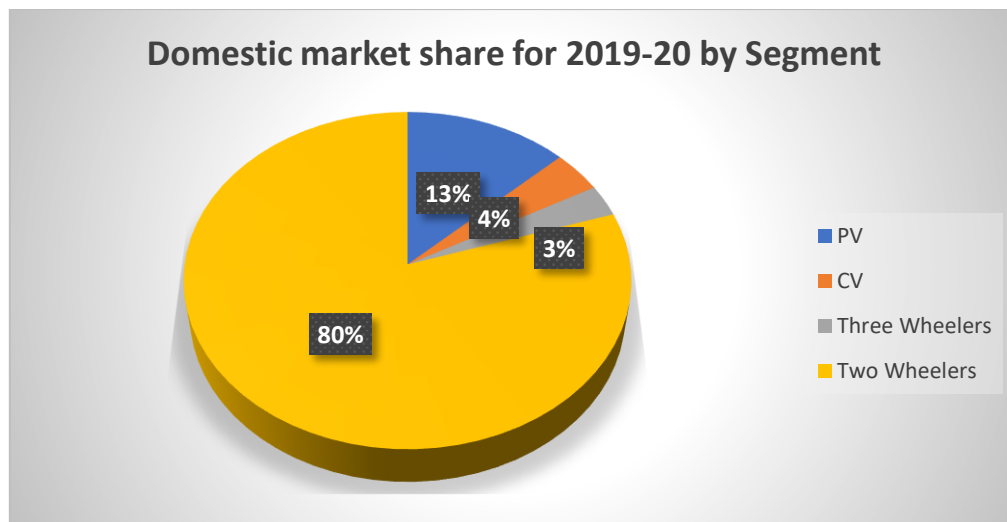


Figure 23 Domestic Market share 2019-20 by segment

Employment:

Further, according to data from the Centre for Monitoring Indian Economy (CMIE), India's unemployment rate rose to 8.5 percent in October 2020, the highest since August 2016, and up from 7.2 percent in September this year. Till now India auto industry generated 35 million jobs.

The National Sample Survey Office (NSSO) found that between July 2017 and June 2018, unemployment stood at 6.1 percent. CMIE also revealed that the country had lost as 11 million jobs in 2018 _ “Media report published in January 2019”

The automobile sector is backed by skilled labor. Considering only in Europe, around 5 million peoples are employed directly and indirectly in the automobiles supply chain as suppliers play an important role in the R&D. As per the record, half of the investment was done by the suppliers only in the European automobiles industries considering the total worth of 38 bn € is invested in European automobile industries.

In the automobile industry, the average age of labor worldwide is 50 years. Skilled labor is the main concern because the demand for new talent is required to work in the new changing technology environment. Indian auto industries were already in a slowdown phase in recent months and this complete shutdown gave the more serious shock of job losses.

SWOT Analysis of Indian Automobiles Industry²⁰:

1. Strength: Auto Industry is an evolving industry and involves continuous product innovation & improvement in technology advancement. Companies are investing in R&D to take the benefit of the next phase of growth. This industry is attractive because of increasing demands

²⁰ Source: www.marketing91.com/swot-analysis-of-automobile-industry

for VFM (value for money) product, increasing demand for luxury CV, increasing geographical market area, & government support.

2. Weakness:

- Vehicles recall in case of any technical dis-functionality.
- Market shift from demand to supply-side and customer have more bargaining power
- The growth rate of the industry is in the hand of the government as they are policy determiner and impose different regulations.
- Low labor productivity
- Disposable income supports the buying of low-cost vehicles in locals.

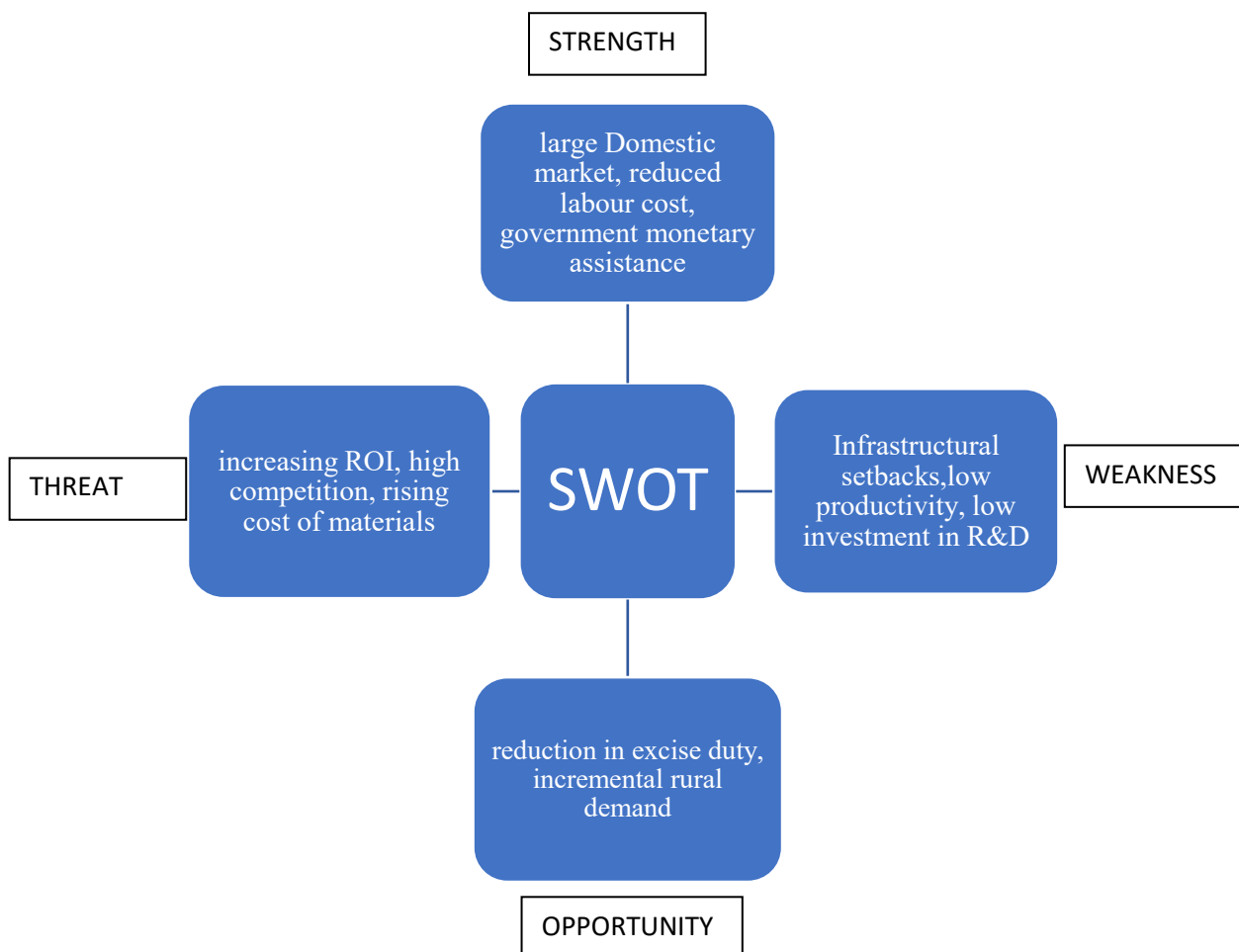


Figure 24 SWOT Analysis of Indian Automobiles Industry

3. Opportunities: Introducing the fuel-efficient and cost-efficient program can be a great opportunity in the auto market. By binding themselves with the specialized partner can drive the market and distinguish their offering. Indirectly government policies like the nuclear family concept favoring the acceptance and raising the demand for two-wheelers.

Others opportunities are as follows:

- Escalating living standard and increasing income level

- Growing rural demand
- Rising demand for better technology
- Growing population.

4. Threats: Accumulation of a large number of companies capturing the share of the market and leaving less space for new entrants. Another economic factor like Macroeconomic uncertainty, lack of technologies & relatable cost, unemployment, import tariff, recession, etc. also discourage the industry profitability.

2.2 THE DEMAND (TRENDS IN CONSUMPTION, THE ROLE OF INCREASING INCOME)

As per the report of automobiles industries, India had observed a remarkable improvement in terms of economic growth in the Q1, FY2019. The country's major demand for automobiles come from the rural part in term of both small and heavy vehicles. Despite all the disruption caused by various policy implementation like demonetization, ban on BS-III vehicles, GST, axle norms, India is expecting a growing demand in the automobiles industry because of a growing working population, expanding the middle class, and increasing disposable income of society.

Because of the stable government framework and increasing purchasing power, larger domestic market, and continuous improvement & development, India becomes a favorable country to invest more and produce more innovative products thus increasing the demand by matching the expectation of local peoples.

As of FY18, Indian automobiles industries produced the utmost 29.09mln vehicles (all type) witnessing a growth of 14.8% as they produced 25.32mln in FY17 and similarly from Fy16-FY17, growth was 5.5% ^(xi).

The average household income growth from 2010 to 2020 in 3 times and it was estimated that 72 vehicles per 1000 people will be reached by 2025 and this all account because auto industries are expanding their R&D segment as India is spending 8% of the country's R&D expenditure, is in the automotive sector.

But the automobiles sector hit badly globally by the **pandemic coronavirus**. Before coronavirus, the Indian auto sector was hit hard by the economic downturn of the Great Recession in 2008. Therefore, the demand for vehicles declined, productivity slowed, unemployment increased, and the industry suffered.

Fig 25, shows that from the start of the second quarter of FY19, the top player of the industry has reported a decline in the sale. Maruti Suzuki reported a 21.95% decline in May 2019 sales, whereas Honda cars India has shown a decline of 27.87%, Tata Motors showed a decline of 26.03%, and M&M by 1.73.

Car market sparks wider concerns

Sales change in May (YoY)

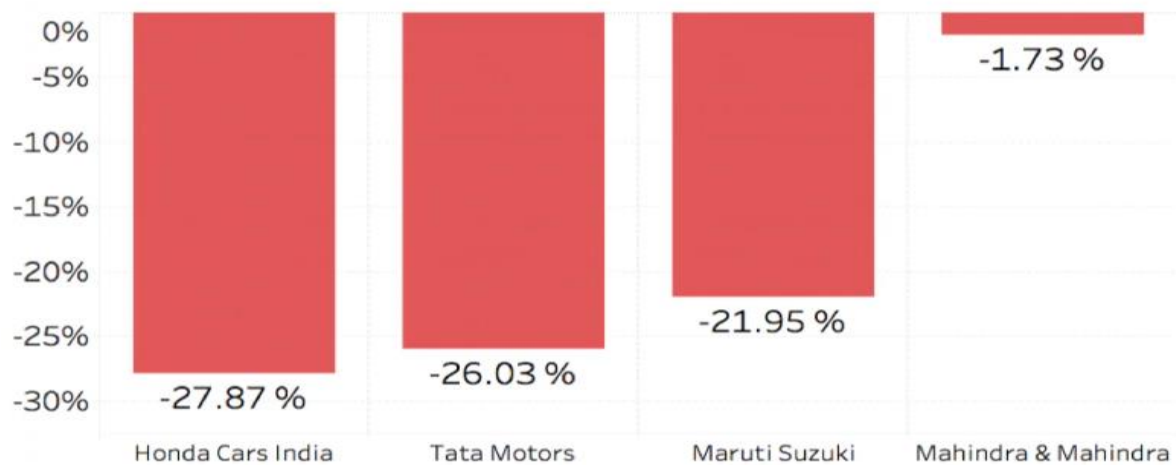


Figure 25 Sale declination FY19²¹

Fall in Automobile Sales

per cent fall compared to the last year

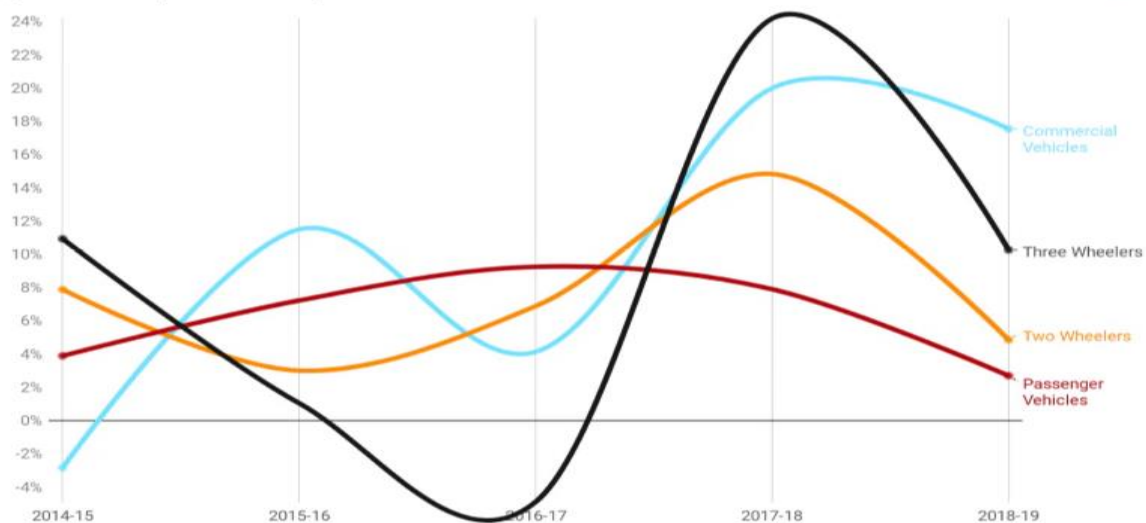


Figure 26 Sale declination 2014-2019²²

As per the report in December 2019, the Indian automobile industry saw the worst half-year performance (April-September 2019) as overall demand of automobiles dived to 17.08 % (CV dived to 39%, PV dived to 23.56%, two-wheeler dived to 22.09%) witnessing the worst fall in nearly two decades [Fig 26]. Before, it was estimated in PV to reach the goal up to 5mln as a domestic sale by 2020 is far away from the expectation as the industries shrink to 3mln units in FY2019-20 which is falling from the 3.4mln units in FY2018-19. The implementation of BS-VI norms (vehicles can only release up to 10 ppm of sulphur) affected the demand as well

²¹ Source : SIAM

²² Source: SIAM & as per the report till May 2019



as it impacts the production by the cut of up to 20% in December, January, and February of 2020 to manage inventory. And therefore revised BS norms i.e. BS-VI was about to implement from April 2020.

2.3 THE SUPPLY: DOMESTIC PRODUCTION AND IMPORT/EXPORT

Automobiles are one of the biggest global industries, so those are in the supply chain are accustomed to the following manufacturer as they continue to grow globally. Suppliers must ensure the changing and new compliance at the same time of meeting the demand from the manufacturer and their customer for the cheaper and cost-efficient component.

Despite all the methodology, strategic planning, logistics implementation, all the pressure on the suppliers and the supply chain. “Several cost-cutting programs have been initiated by OEMs and as a result, the supply chain is under constant cost pressure,” says Paul Schockmel.

With the current advanced technology in the field of electric and hybrid vehicles, the automotive supply chain trying to be restructuring to this technology, but the investment level required is demanding for the smaller supplier. Every supplier wants to maintain a technology paradigm and therefore automotive industries are known as the early adopter of the new approach. Automobiles Company wants its part supplier to be present in every dominion but to do so for the supplier is not so ease despite the government tax breaks rule or financial support.

2.3.1 DOMESTIC SALE TRENDS OF AUTOMOBILES

As per SIAM, *Fig 27*, the total sale of PV declined by 17.88% in FY20 with total sales of 2.8million units against 3.4 million units in FY19.

The overall CV sales also declined by 28.75% in FY20 with total sales of 0.72 million units against 1million units in FY19. Within the overall CV, Medium &heavy CV declined by 42.47% & 20.06% in FY20 against a year ago.

The overall sale of three-wheelers & two vehicles declined by 9.19% in FY20 with totals sales of 0.64 million units & 17.4 million units against 0.7 million units & 21 million units in FY19.

Talking about sales in the automobiles sector in India, more than 230 million vehicles registered in 2016. As mentioned above India was dominated by the 2W and considered the largest producer of the same in 2019 & 2020 by selling 21 million & 17.4 million vehicles domestically. Apart from the segregated form, the overall automobiles sold in India in FY17 was 21.7 million units, 24.92 million units in FY18, 26.1 units in FY19, and 20.5 million till January of FY20.

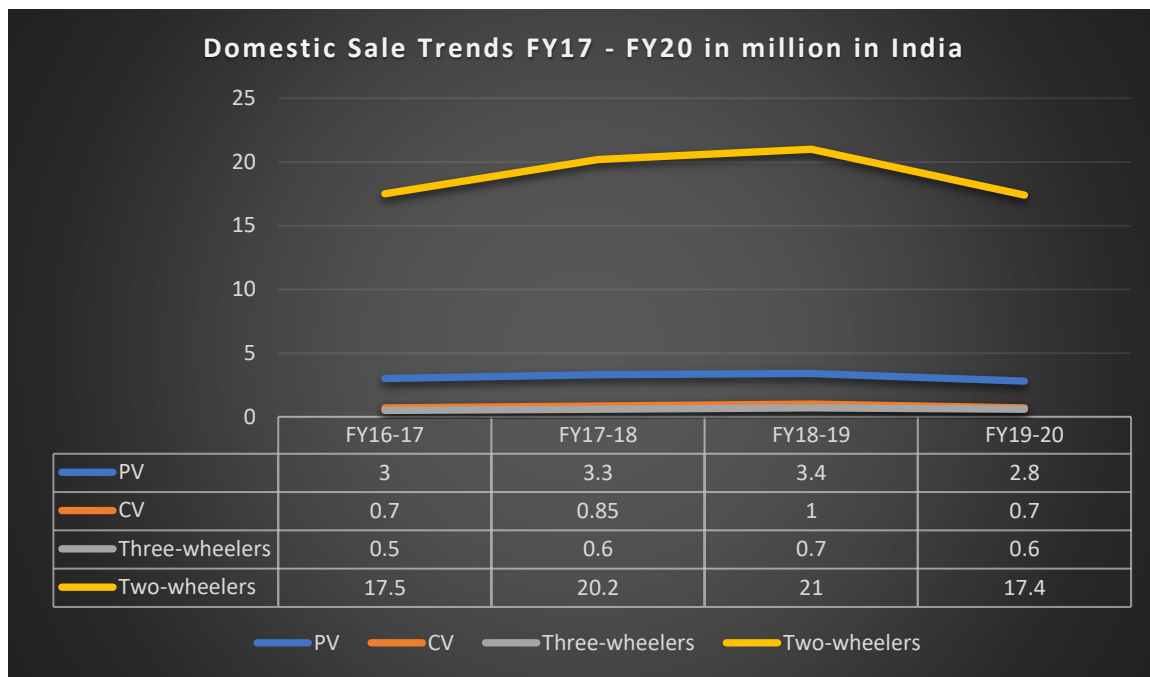


Figure 27 Sale trend in the automobile segment in India

2.3.2 PRODUCTION TRENDS OF AUTOMOBILES

Till January 2020, the automobiles industry produced a total of 26.35 million vehicles including all types of PV, CV, Three-wheelers, two-wheelers, and Indian automobiles industry was considered the worst year as it witnessed the worst downturn of the last two decades registering a de-growth of 14.73% in production against the total production of 30.90 million units of vehicles in FY18-19 and the healthy growth of 6.26% was seen from FY18 to FY19.

There was a decline of 20% in the PV production in the second half of 2019. In FY19, the growth was seen as the sale of PV has increased by 2.70%, 4.88% in 2W & 10.27% in 3W for FY18. On a contrary, in the Q1 FY20, a domestic vehicle got hit. This year saw major automobile manufacturers cutting down on production as well as on working hands and the sector rose unemployment ratio from 5.6% to 7.5%.

Some of the key player shown a major decline in the sale of vehicles like:

- Tata motors observed a dip of 30% in 2019 with a total sale in 2018 was 497, 972 units.
- Mahindra and Mahindra (M&M) sold 39,230 units in December 2019 which registering a decline of 1 percent.
- Hyundai Motor India Limited (HMIL) observed a dip of 9.8% in domestic sales in December and sold at 37,953 units.

Table 3 and Table 4 show the Domestic production (in units) of CV and PV in December month only 2019.

Make	2019		Y-o-Y (%)
	Dec.	Share (%)	
Tata Motors Ltd	29,426	47.4	-9.6
Mahindra & Mahindra Ltd	14,236	23.0	22.2
Ashok Leyland Ltd	10,069	16.2	-32.1
VECVs - Eicher	4,503	7.3	-10.6
Force Motors Ltd	1,810	2.9	-17.0
Maruti Suzuki India Ltd	987	1.6	81.1
SML Isuzu Ltd	572	0.9	-55.3
Isuzu Motors India Pvt Ltd	373	0.6	-17.3
Volvo Group India Pvt Ltd	37	0.1	-32.7
Piaggio Vehicles Pvt Ltd	8	0.0	-91.2
VECVs - Volvo	N/A	-%	-
Total Commercial Vehicles	62,021	100.0	-9.8

Table 4 CV production of Dec 2019

Make	2019		Y-o-Y (%)
	Dec.	Share (%)	
Maruti Suzuki India Ltd	114,962	44.5	7.5
Hyundai Motor India Ltd	46,670	18.1	-23.5
Mahindra & Mahindra Ltd	15,282	5.9	23.9
Renault India Pvt Ltd	12,708	4.9	62.7
Ford India Pvt Ltd	12,172	4.7	-35.5
Kia Motors India Pvt Ltd	10,742	4.2	-
Tata Motors Ltd	9,552	3.7	-24.6
Honda Cars India Ltd	9,450	3.7	-29.5
Nissan Motor India Pvt Ltd	6,770	2.6	27.7
Toyota Kirloskar Motor Pvt Ltd	5,476	2.1	-55.6
General Motors India Pvt Ltd	5,001	1.9	-13.8
Volkswagen India Pvt Ltd	4,723	1.8	-38.6
MG Motor India Pvt Ltd	3,313	1.3	-
SkodaAuto India Pvt Ltd	810	0.3	-24.9
FCA India Automobiles Pvt Ltd	587	0.2	-47.3
Force Motors Ltd	135	0.1	132.8
Isuzu Motors India Pvt Ltd	30	0.0	-87.8
Mahindra Electric Mobility Ltd	8	0.0	-
Total Passenger Vehicles (PVs)	258,391	100.0	-3.1

Table 5 PV in December month only 2019²³

From Fig 28, in 2018, domestic automobile production was boost by 7.08% CAGR from 2013 to 2018 corresponding total production of 29.09 mln vehicles in 2018.

²³ Source: Mark Lines Data Centre

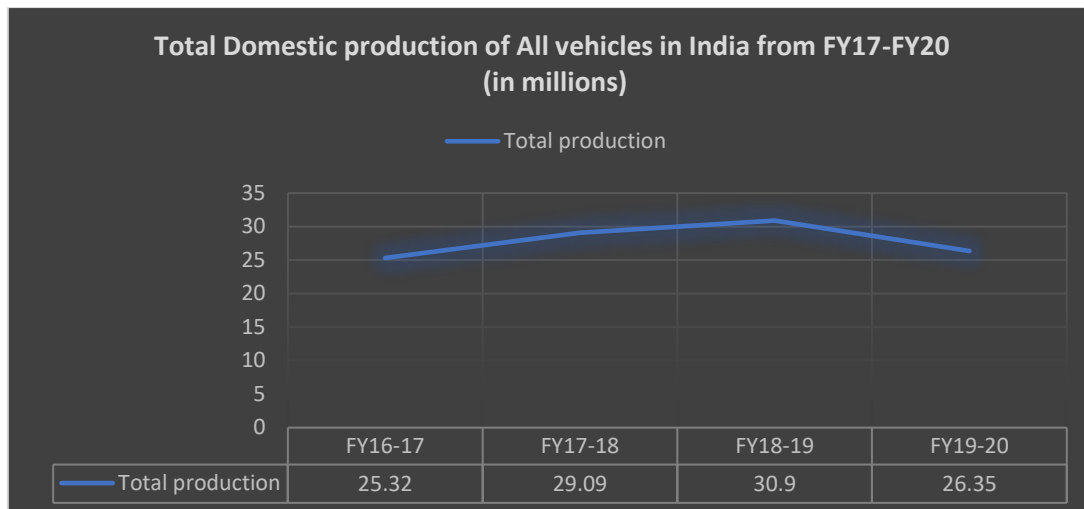


Figure 28 Domestic Production FY16- FY20

2.3.3 EXPORT & IMPORT OF AUTOMOBILES:

India exports almost all types of vehicles, and among all types of vehicles, the major export of two-wheelers accounting the two-third of major export share in 2015-16.

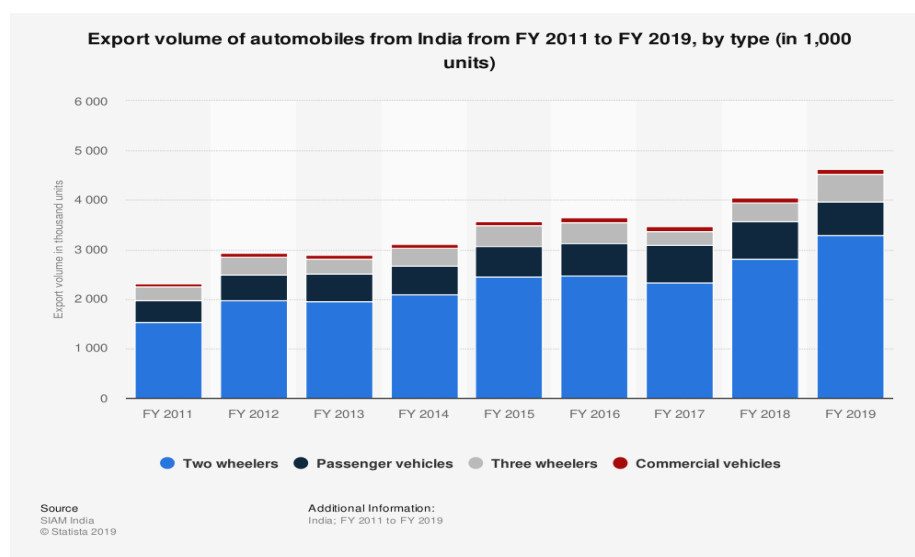


Figure 29 Statistic export volume of automobiles in India (2010-2019) by type²⁴

The export of automobiles during 2018-19 was 3.2 mln units in the total volume of two-wheelers and witnessing double-digit growth in recent years. Out of all major key producers of two-wheelers, Bajaj auto was the leading producer from the south Asian country contributing half of the Indian export share followed by the TVS motors with an export share value of 20%.

²⁴ Source : SIAM India Statista 2019

In FY20 the overall automobiles export grew by 2.95% compared to FY19 in which a slight increment in growth is seen in PV by 0.17% & in Two-wheeler by 7.30% (from 3.28 to 3.52 mln) and declined in CV & three-wheelers by 39.25% & 11.54%.

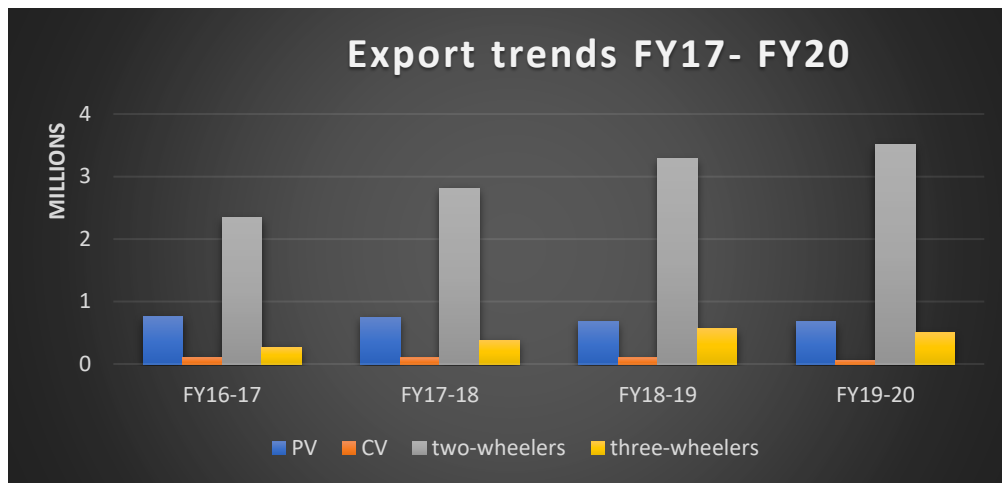


Figure 30 Export trends FY17- FY20

While as of FY19, the overall automobile exports grew by 14.5% whereas only commercial vehicle segments grew by 17.5%. Exports percentage got risen from 12.97% in 2010-2011 to 14.5% in 2018-19 indicating the growth in the capability of Indian automobiles industries to meet the global requirement. The overall export demand rose by 26% in the first quarter of FY18-19.

Exports in the PV experienced total units of 677,311 in FY19-20 against 676,311 units in FY18-19. Export segment and utility vehicles went up to 41% in the first quarter of FY19 compared to FY17-18. According to SIAM, this segment experienced a total export of 167,161 units in the same quarter compared to 118,420 units of FY17-18. With total exports of FY19 was 677,311 units against 748,366 units in FY18.

Export of PV in the 1st quarter of 2019 says Hyundai motors India exported around 39,425 units which were double than the units exported in 2018 i.e. 19,867. Ford India achieved the second position in the export with 35,358 units in the same quarter compared to 34,292 units in 2018. Similarly, India's largest carmaker "Maruti Suzuki" export almost double in the same quarter of 2019 than 2018 i.e. 25,724 than 12,862. Volkswagen exported 21,388 units in Q1 of 2019 compared to 18,143 units in the year-ago and GM exported 20,543 units in Q1 of 2019 compared to 15,954 units in Q1 of 2018. Mahindra and Mahindra (M&M) has shown its capability in the global market with a big jump from 10th position in 2018 to 8th position in 2019 with a total export range from 3,217 units (Q1, 2019) compared to 813 units (Q1, 2018).

Toyota came to declination from the 7th position (Q1, 2018) to 9th position (Q1, 2019). Renault India grew in export from 2,184 units (Q1, 2018) to 3,942 units (Q1, 2019).

Export in CV, this segment experienced a decline in exports with 60,713 units in FY19-20 against 99,933 units in FY 18-19. Tata Motors was leading with twice jumping in Q1, 2019 with 24,393 units compared to just 10,616 units in Q1, 2018. M&M saw with thrice fold jump in export from 5,692 units in Q1, 2019 against 1,618 units in the previous year quarter. Ashok

Leyland ranked down from 2nd position to 3rd position although they doubled the export from 1,924 units (Q1, 2018) to 4,009 units (Q1, 2019). Similarly, Maruti Suzuki got multi-fold in the CV market and exported almost 915 in Q1, 2019 against 147 in Q1, 2018.

Export in Three-wheelers experienced a decrease in number from 567,683 units in FY18-19 to 502,169 units in FY19-20. Export by the top 5 companies of three-wheelers multiplied three times in Q1, 2019 against Q1, 2018 with an exported number of 143,451 units against 53,265 units.

Bajaj auto exported 101,424 units against 38,852 units in Q1, 2018, followed by TVS motors who exported 31,244 units in Q1, 2019 against 10,454 units in the previous quarter year.

Piaggio vehicles exported 8,598 units in Q1, 2019 against 2,986 units in Q1, 2018, and lastly Atul Auto and Mahindra achieved an impressive position of 4th and 5th with a total export of 1,733 units against 583 units & 452 units against 390 units.

Export on two-wheelers rose from 32,80,841 units in FY18-19 to 35,20,376 units in FY19-20.

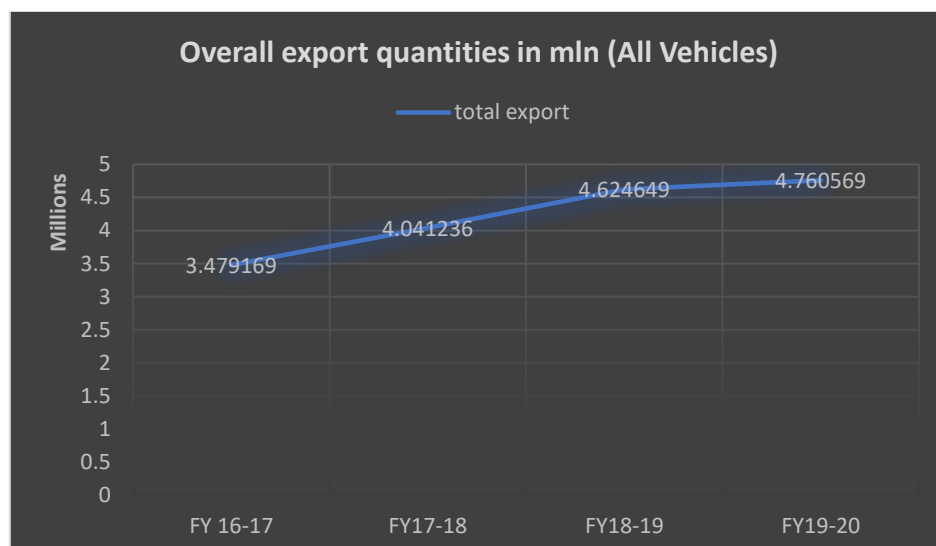


Figure 31 Overall export performance

Import in India

China, Germany, South Korea, Japan, Thailand, USA are the top import destination of India. The trends of overall import in India (all types) with the highest value of 45,730 US\$ million & lowest value of 117.40 US\$ million. The last total imported value was 17,120 US\$ million.

From research, the average value of import of vehicles in India from 1996 to 2019 is 2160.34 US\$ million with a peak of all time is 5,844.92 US\$ million in 2017 against the low of all-time in 2016 with 58.14 US\$ million. Fig 32, the import of vehicles in India increased in 2019 from 3,241.91 US\$ in 2018 million to 3,546.70 US\$ million. India import in automobiles (vehicles other than Railways) is only 1.2% of total import in all category.

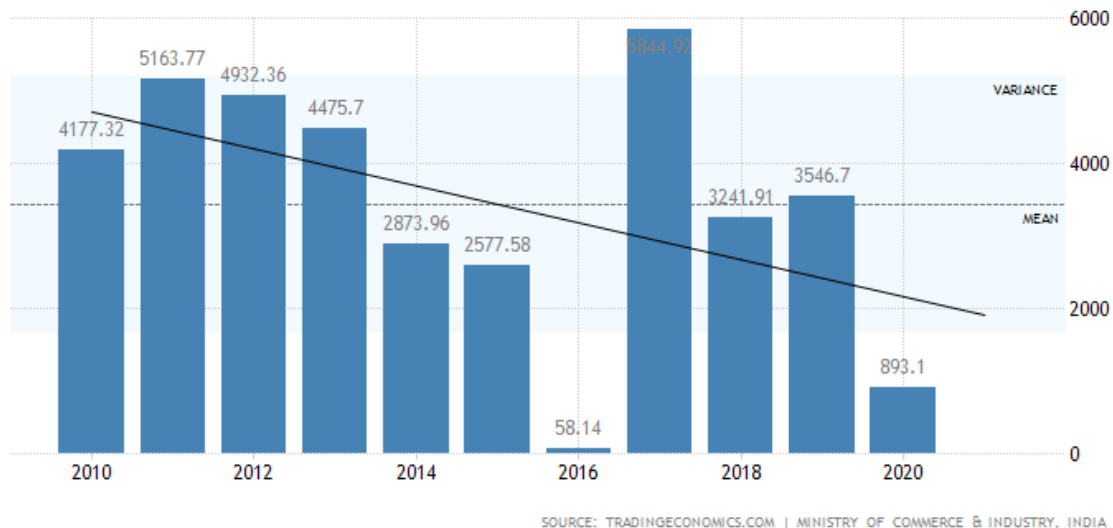


Figure 32 Import values (USD mln) of vehicles in India 2010-2020²⁵

2.4 COVID-19 EFFECT ON AUTOMOBILES INDUSTRY AND DOWNTURN:

Effect on GDP and other policies:

The auto sector's contribution to GDP to about 7.1% in FY'20 from about 7.5% in the last fiscal year. As per the investment portfolio, the industry is expected to reach \$135 billion by 2020 and \$300 billion by 2026 at a CAGR of 15% ^(xii).

As per the analysis on May 1st, it is expected that if the pandemic remains constant, the Indian auto industry may suffer the revenue loss of \$12-15billion per day due to a complete pause in manufacturing by automakers in the next 10 days. Auto industries with an annual business size of \$104 billion earn gross revenue of 2000 crore INR every day and notably contribute to 7.5% to the country's GDP.

Because of pandemic situations, automaker non-manufacturing pushed them to work from home and they have stopped production at their local plants and top automaker have no idea about the resume of work in plants.

Several government initiatives and vision for the future to upgrade the auto industries ^(xiii):

The Automotive Mission Plan 2016-26 : (AMP 2026), this initiative will clear the government's vision about the growth of the sector in size and economy, norms about the contribution by sector in national GDP up to 12%, technical maturity, and core competencies to tackle global competitiveness. Focusing to make India's automobiles sector in the top 3 in the world and exponentially growth in export to 35-40%. Also, to aim in creating jobs of at least 65 million jobs as well as 300 US\$ billion in size by 2026.

²⁵ Source : <https://tradingeconomics.com/india/imports-of-vehicles>



FAME: The government launched another scheme in 2015 was (FAME) Faster Adoption and Manufacturing of Hybrid and Electric with a capital of 122.3 US\$ million. This scheme is based on the NEMMP (National Electric Mobility Plan) 2020 road map which will cover all the segments of vehicles along with all types of HV & EV.

The government took initiative with the full potential to become the primary global manufacturer of automobiles and there 5 large automobiles cluster were made in India. Delhi-Gurgaon-Faridabad in the north, & Chennai-Bengaluru in the south, Jamshedpur-Kolkata in the east, & Mumbai-Pune-Nasik-Aurangabad in the west.

Offering BS-VI in both petrol and diesel engines across different models in our product portfolio. More detail about the subsidies and initiative is discussed in chapters 1 & 4.

Effect on Sales and Production:

In this pandemic time, the market is fast-changing and so this impact also on the demand. The customer was asking for the refund of the confirmed booking to conserve cash and maintain the liquidity. The auto industry plan to resuming production seems to have crashed as they failed to get the resource from the auto supplier, and this affected the finished products. Because of maintaining the social distancing which is affecting the productivity of worker and production lines. This all-new step in manufacturing making the production more challenging. The market analyzer stated the automobile business in the long term that its future will be determined by the demand for production. Industry in this pandemic situation focussing to build the production channel to maintain the export market because domestic demand is weak for a time being. Supply chain, as well as production, really got hampered because of pandemic COVID-19 spread in china as many automaker imports at least 10% of their auto raw material from china.

Indian automobiles sector already has seen a downfall of nearly 18% in FY20 before the Covid19. Downfall becomes worse after the lockdown scenario in India and the global world.

In this pandemic situation, big automobiles players would face the brunt of the reluctant customer. Historically, entry levels cars for middle-class people were maximum in demand but the auto economy hit in the month of lockdown scenario. Demand goes on decreasing and global automakers already facing the steep in demand as the customer was canceling the booking to maintain the liquidity and conserve cash. There is another factor in the reduction of demand like consumer footfall in showrooms, negative consumer preference, liquidity crunch & bankruptcies. New vehicle launch was kept on hold and scheduled product introduction hit a wall. In this scenario, only digital launches seem to be feasible. Because of the slowdown in sales and demand, the two-primary automaker- TATA motors and M&M losing their brand equity.

Indian companies Market Share in Cars is on a Rapid Decline



OEM	FY'2020	FY2015	FY2010
JAPANESE	59.51	59.54	51.12
KOREAN	20.54	16.17	16.15
INDIAN	11.77	14.96	23.56
EUROPEAN	4.98	4.38	2.8
AMERICAN	2.39	4.88	6.36
CHINESE	0.79	NA	NA
TOTAL	99.98	99.93	99.99

Figure 33 Rapid declination Indian Companies market share in cars in 2020²⁶

The government must revise its reforms to bring impactful results in terms of demands and job creation. From the current scenario, it seems like for Indian automobiles sector will be challenging for FY20 & FY21, and from *Fig 33*, it was estimated that the demand will go down from 15% to 11.77% in FY21 and it will be expected that this sector will start recovering from the third quarter of FY21.^(xiv) The estimated loss may be recovered to some extent if the manufacturer can utilize their working strategy with new rules to maximize their volume.

²⁶Source: SIAM

CHAPTER 3 ELECTRICAL VEHICLES OF THE GLOBAL WORLD

3.1 BACKGROUND AND EVOLUTION

Why electric cars?

For past, so many years, oil and oil derivatives were the only useful content for car and vehicles operation but with so much excessive use of fuel, decrement of oil and their derivatives was noticed and at the same time environmental effect was found and therefore electrical car introduced to overcome those related problems.

The term Electric car refers to those vehicles which use electrical energy and an electrical motor for the operation like propulsion instead of fuel consumption. From the last 100 years, so much innovation was done on Electric vehicles to bring the race of fuel vehicles and electric vehicles on the same pitch. EV is not a new concept in the automobile industry. With a different degree of energy, they consumed, EVs are classified these days, the most common EVs are the BEVs or battery electric vehicles, PHEVs, or Plug-in-Hybrid EVs and HEVs or Hybrid EVs.

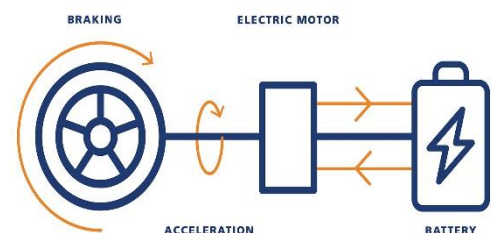
3.1.1 Types of Electrical vehicles and their working models:

1. Battery Electric Vehicles (BEVs):
2. Hybrid Electric Vehicles (HEVs):
3. Plug-in-Hybrid Electric Vehicles (PHEVs):

1. Battery Electric Vehicle, also known as the pure electric vehicle is mainly powered by batteries and so electricity, eliminating the use of petrol engines, fuel, and exhaust pipe. BEVs came in a variety of automobiles like busses, 2W vehicles, etc. The popular car makers are Tesla & Nissan. BEVs have an outlet to charge the batteries, mostly recommended to have home charging with just a 240V outlet and get full charges overnight and can travel 70-100miles with one fully charged.

Regenerative Braking is widely practiced as this is the internal source of charging batteries and uses the kinetic and heat energy for charging & thus uses the most of car waste. BEVs went to the “idle-off” condition when turning off and diminish the wasted energy and by charge the battery while braking known as regenerative braking.

In BEVs, there is an on-board high capacity battery pack, specifically designed to power a car & also used for all the electronics components in BEV along with the electric motor. DC/DC Converter is used to convert the high-voltage DC power from the Traction battery pack to lower DC power as per



vehicle accessories requirement. Electric Traction Motor uses power from the traction battery pack to drive the wheels. Onboard charger takes power from the AC supplies and converts into DC power to charge traction batteries. The power electronics controller controls the flow of electricity from the traction and also the speed of the motor and torque it produces. Out of all EVs, BEV has a more positive impact on Green values. The electricity Vehicles only produce heat-trapping gases & other trash at the cause of its generation. BEV is designed to produce instant torque, unlike the torque produce by IC vehicles.

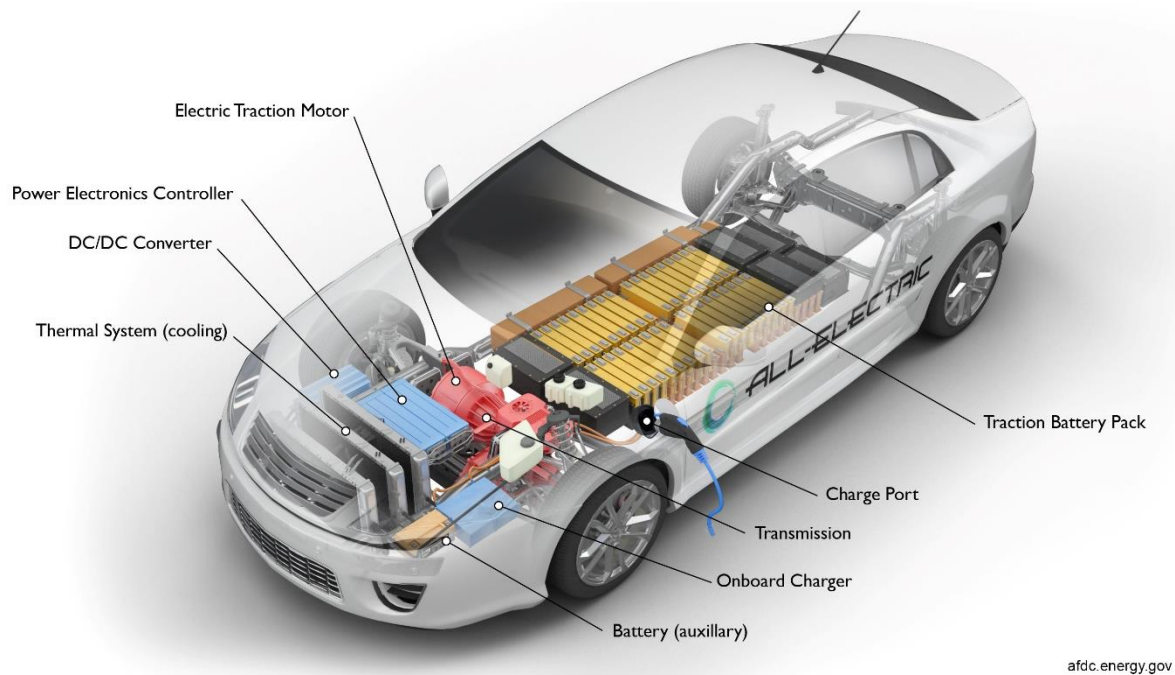


Figure 34 Electric Vehicle working Component

Some of the most popular BEVs are the BMW i3, Tesla Model S, Tesla X, Toyota Rav4, Nissan Leaf, and Kia Soul.

2. Hybrid Electric Vehicles (HEVs) are powered by one or more internal combustion engine with an electric motor which uses the energy stored in the batteries. HEV gets all the benefits of high fuel economy as well as low tailpipe emission. Usually, the vehicles with the IC engines and in meanwhile charge the battery. Once the battery gets charged, the IC engine stops, and the vehicle continues to work with the Electric motor only. So, this goes on repetition, therefore there are fewer chances of charging separately the vehicles overnight. Also, while braking, the power went to batteries and store the waste energy of vehicles. Because of this feature, HEV is slightly more expensive than others. Batteries can last long till the vehicle lifespan. For more torque and speed, the carmaker advised using both the system to power the drive. Some of the main HEVs are Toyota Prius Hybrid, Honda Civic Hybrid, and Toyota Camry Hybrid.

HEV can be a mild hybrid and full hybrid system.

-Mild Hybrid: the vehicle is powered by using a battery and electric motor and lets the engine turn off when the vehicle stop, and thus this improves fuel economy.

-Full Hybrid: this system has superior batteries and more powerful electric motors, and therefore short distances can be powered by the battery alone at low speeds. Full hybrid vehicles are costlier than mild hybrids with better fuel economy benefits.

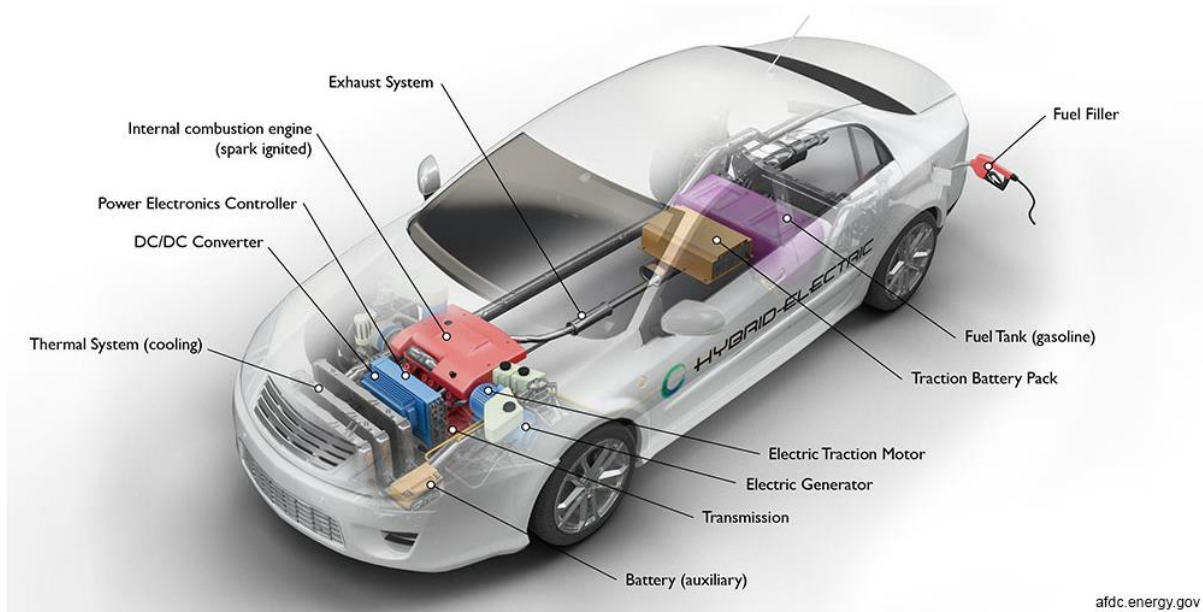


Figure 35 HEV working component

3. Plug-in-Hybrid Electric Vehicles (PHEVs) is as same as HEV with just few feature difference. PHEVs have a charging outlet & can be charged at the station through a systematic 120V outlet is generally adequate and can drive the vehicle only with the charged batteries & also with the larger battery pack than HEVs helps to drive more extended distance say 10 to 40 miles but after the batteries get discharged it becomes like a convectional vehicle and later works on a Gasoline engine.

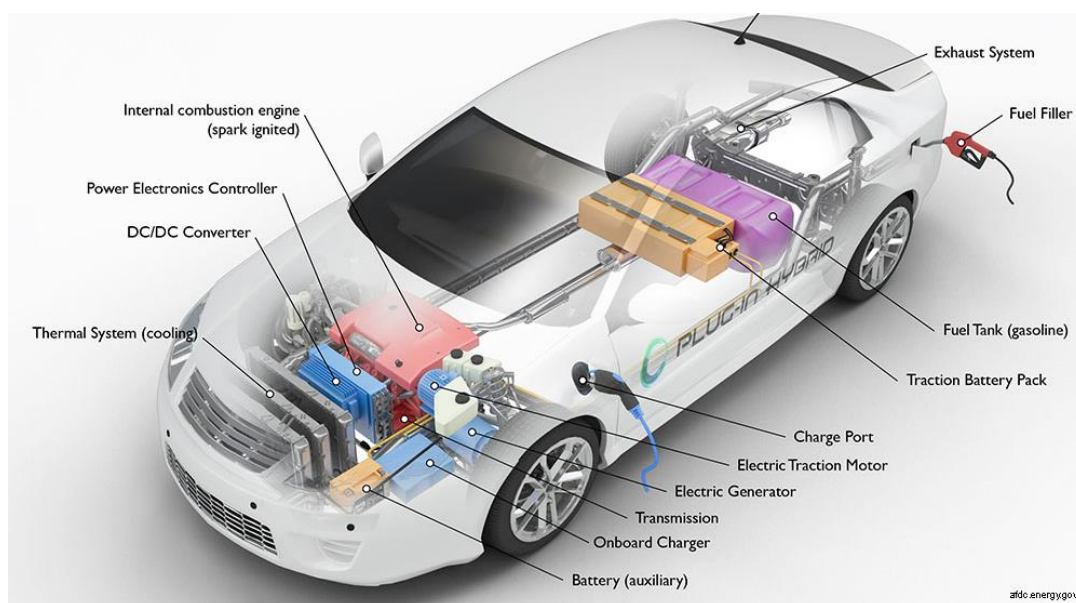


Figure 36 PHEV working component

The major difference between PHEVs and HEVs is **HEV hybrids** have an electric motor and battery, but Gasoline or diesel derive all their power and is not rechargeable by plugging in. As of this, non-plug-in hybrids or HEVs aren't equated to EVs.

The two main configurations of combining the power from the electric motor and engines are parallel and series:

Parallel hybrid process, the mechanical coupler is used to connect the engine and the electric motor to the wheels, and therefore wheels can be drive by both, says the electric motor and the engine directly.

Series plug-in hybrids utilize the electric motor to drive the wheels. The ICE is utilized to produce electricity for the motor. Vehicles of this sort are frequently alluded to as extended-range EVs. Mostly wheels are drive by the electric motor, but it starts to work as a parallel at a higher speed when the battery is depleted.

As per the research “The global automotive industry is on the verge of disruption. Four technology-driven trends — electrification, shared mobility, connectivity, and autonomous driving. The Indian automotive industry has started to experience these effects of global disruption.

India has great expectations of achieving a high level of penetration in e-mobility by 2030. The reason is not very surprising; the alarming levels of pollution indices which keep on rising and the colossal dollars the country must pay for annual crude oil imports. In December 2017, New Delhi (India) was in a state of red alert and came close to Beijing in terms of pollution toxicity, such are the pollution indices in India. If India successfully manages to achieve this target by 2030, it could save about 1 Giga Tonne of emissions.

Now, shifting towards the evolution and invention of cars, primarily EVs. Early electric cars were a perfect alternative to IC and steam engines. One of the 1st initiations of electrical cars was concocted by British innovator Thomas Parker in around 1884. The same year, in Germany, another popular illustration of an early electric car was the Flocken Elektrowagen produced. As the electrification rolled out within the 1910s, charging this early electric car got to be significantly simpler and enormously boosted their open appeal and their car maker began to test with electrical and hybrid cars. One outstanding car maker, Ferdinand Porsche, who created his popular P1 in 1898. Thomas Edison worked to create way better performance batteries. Henry Portage joined forces with Thomas to explore alternatives for low-cost EVs around 1914. And oil crises came in the 1970s.

Big Question, who invented the 1st electric cars?

The answer is still uncertain because like IC motor cars, there was no single innovator of EVs. Their rise and improvement ought to be considered more of the arrangement of disclosure and development. We can take 1828 as a beginning point of EVs that is the year in which Anyos Istvan Jedik made the 1st electric car as a small model car that seems to move by employing a motor.

Since needed self-contained rechargeable control sources, early EVs battery had constrained utility but late 1859, French Physicist Guston Plante created his lead-acid battery. Afterward

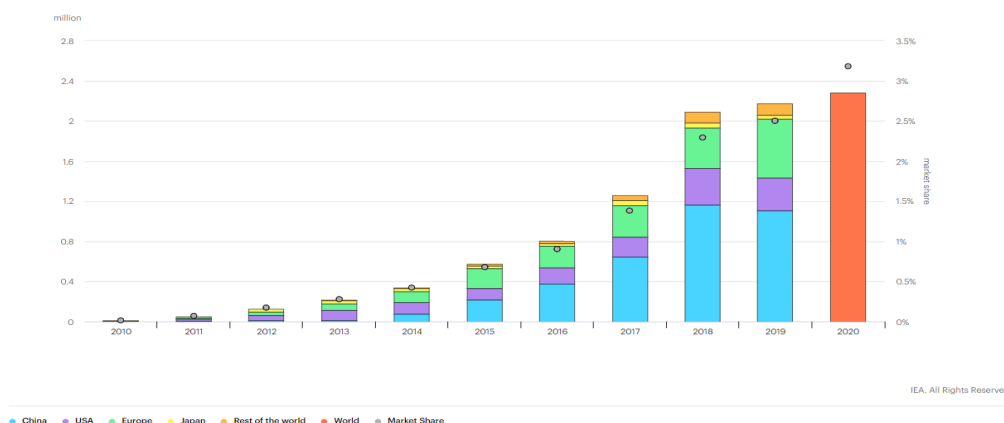
by Camille Alphonse Faure extemporized the battery in 1881. But anything Anyos concocted, it was kind of demonstrate and thus they take 1834 as a year of EVs and gave credit to American Thomas Davenport who builds a small locomotive and ran on the track. Few other inventors dabbled in the field of EVs during the decades, but the crest was 1900 and In the US every 3rd car was electric.

But in the 1920s, EVs halt being commercialized since gas control got to be a part more available and the customer wanted vehicles who can travel more distance with more HP. Henry Ford played important role in IC engine vehicles but in late 1960, gas price steep upside and people were started concern about air pollution, and therefore government introduced EVs bills in 1966. American carmaker started too introduced electricity in the car-forming hybrid vehicle but Toyota changed the game after introducing the Prius, the 1st mass-produced and hybrid car, and hit the global with the sale of 18000 units in the first year. Later another company entered, popular Tesla and in 2006, tesla unveiled the tesla roadster and in 2009 GM released 1st PHEV, known as Chevy volt. Later US energy department invested in the development of batteries for higher performance and by 2014, there were 23 plug-in & 36 hybrid cars in the market. And today the key player in EVs are Tesla, BYD, BMW, and Volkswagen & Nissan.

3.2 SALES AND PRODUCTION ANALYSIS

This complete technical paradigm is happened because of consumer acceptance and their demand to drive the new market along with government intervention. The EV's popularity has been expanding rapidly because of low-cost maintenance, subsidies, & environment-sensitive. As mentioned in chapter 2, in 2019, PEVs deliver globally 9% higher than in 2018. This increment shows a clear picture of rapid growth from the last 6 years from 46% - 69% Y-O-Y because of the 2 big car developing country i.e. China & the USA.

Globally, the cumulative sales or say global electric car fleet of light-duty PEV was reached 2 million in 2016 ends, 3 million units in 2017 ends, & 5.1 million units at the end of 2018, and by the end of 2019, the global car fleet exceeded 7.5 million units. That means a 2.4 million increase from 2018. Researcher claims that around 45% of EVs were on the road in China in 2018, a total of 2.3 million units. Similar way, 24% accounted for Europe and 22% for the US. Research says, among larger economy, China is still the world's largest electric car market where 5.2 % of plug-ins sales in 2019, followed by 3.2% UK, 2.9% in Germany, 2.8% in France, 2.7% in Canada.



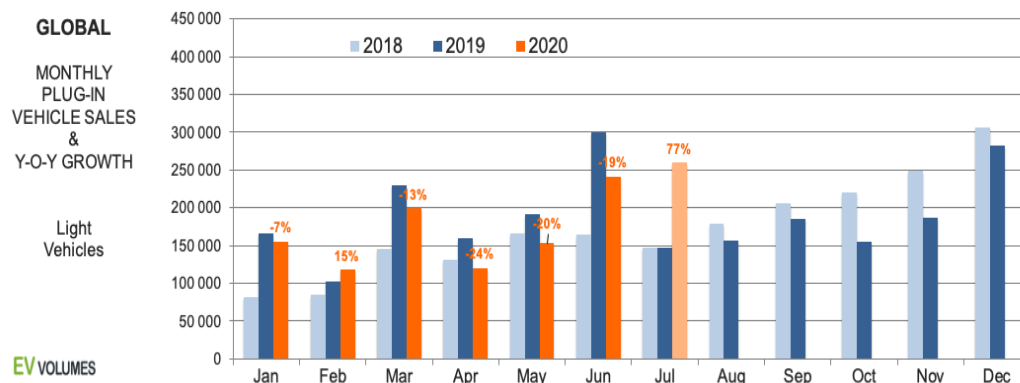


Figure 37 Global electric car sales by key markets, 2010-2020²⁷

3.2.1 ELECTRIC CAR MARKET IN 2019

The Electrical vehicle's global stock continues to inflate at a speedy tempo in 2019, attaining 7.2 million Units which is 40% higher than in 2018. Over the last decade, only in 2019, the growth of Y-O-Y is below 50%. Battery electric powered cars (BEVs) accounted for 67% of the world's electric vehicle fleet in 2019.

Almost 47% of the sector's electric-powered automobile fleet become in China in 2019^(xvi). From Fig 39, in 2019, China has a stock of 3.4millions EVs and i.e. 46% growth from the preceding year. China is still the World's largest EV market at 50% of world sales & sold 1.06 million EVs in 2019 although 2% less than the preceding year.

Europe, with a stock of 1.7 million electric powered automobiles, accounted for 25% of the worldwide stock in 2019, and Europe turned into the second-largest EVs market in 2019 with an increase of 50% comparative to 2018 and offered 561 000 units.

In Europe, the top two countries with a market share are Norway at 56%and Iceland at 22%. In the Netherlands, the electric vehicle marketplace share accelerated to 15% in 2019, compared to 6% in 2018. Germany outshined Norway in 2019 for the very best sales volume at 109000 EVs (a 61% growth relative to 2018). France, Netherlands, and the United Kingdom each have sales volumes above 50000 EVs in 2019.

With a stock of 1.5 million, the US represents 22% of the world share and becomes the third-largest EVs market with sales of 327000 units although the sale fell by 10% comparatively with 2018.

Even though with the continual expansion of EV sales, only five nations, including 4 members of the Electrical Vehicle Initiative (EVI), had an EV stock share higher than 1.5% in 2019: Norway (13%), Iceland (4.4%), Netherlands (2.7%), Sweden (2.0%), and China (1.6%) and

²⁷ Source: www.iea.org/data-and-statistics/charts/global-electric-car-sales-by-key-markets-2010-2020

Norway turned into the global leader primarily based on shares of electrical cars, at 13% of the overall stock in 2019.

Globally the marketplace percentage of electric vehicles reached 2.6% in 2019, with an all-time high jump i.e. raised from 2.4% in 2018 whereas 1.5% in 2017, but there was a Y-O-Y drop in the sales of 6% from the preceding year (2018).

Globally, BEV sales raise to 14% in 2019 compared to 2018, while plug-in hybrid EV vehicles (PHEV) sales declined to 10%. Declination of PHEVs in electric car sales dropped within the USA from 34% in 2018 to 26% in 2019. But, Europe remained strong in the PHEV sales; they dominated in Finland (76%), Sweden (61%) and constituted almost half of the electric vehicle sales within the UK (49%).

Although the sales and marketplace shares of Electrical vehicles reached new records in 2019, there was a large slowdown within the normal increase of EV sales compared with previous years. According to the International Energy Agency, out of 100% of all passenger vehicles, EVs represent only 1% to 3% till now.

There are three underlying motives: contracting automobile markets; cuts in EV buy subsidies in a few key regions; and consumer expectancies of similar technology upgrades and new EV models. Only Tesla and BJEV show the highest growth in sales in Plug-in sale in 2019. Tesla Model 3 showed approx. 53% growth in EVs in 2019 whereas Chinese company BJEV EU series showed approx. 66% of growth in EVs.



Figure 38 Enlisting the top 10 EV model -Global sales²⁸

²⁸ Picture Credit: wattEV2buy

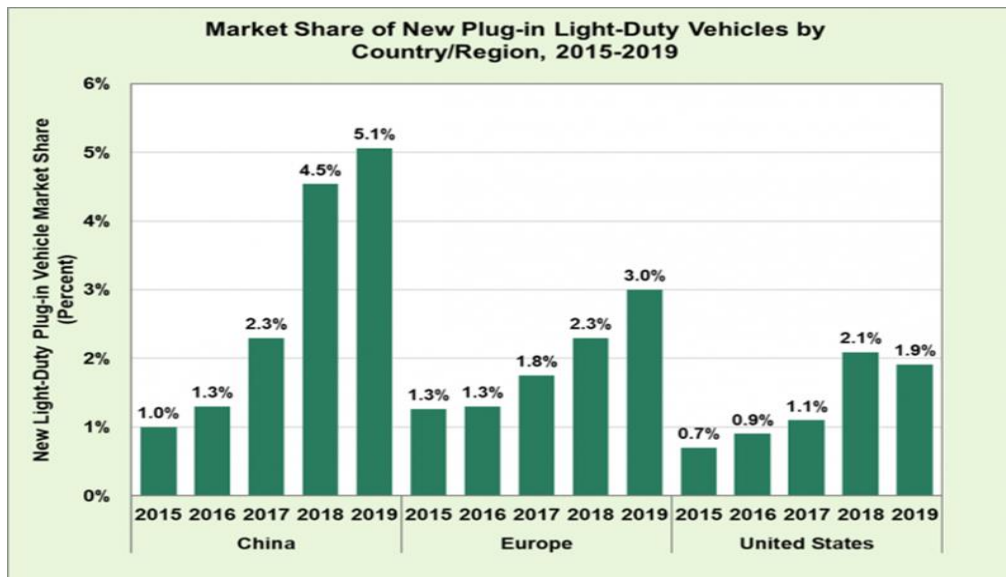


Figure 39 Market share of largest EV producer 2015-2019²⁹

3.3 CHALLENGES

Although the mobility of EVs and the sustainability, lower environmental impact and usage of EVs are very frequent and economical compliment still they are facing a lot of challenges at every step of their development and implementation like limited driving range, high costs, spotty charging infrastructure, customer preference & battery issues. This is the only reason why PHEV is more successful than pure EVs because in PHEV they have an alternative to batteries.

3.3.1 BATTERY AND CHARGING FACILITY

Instead of powered driven by ICE (internal combustion engine) in normal traditional vehicles, in EVs and PHEVs, vehicles are totally and partially reliable on the battery. In those, powered by Lithium-ion batteries, BEVs consist of three main power blocks namely:

1. Onboard charger: they fill-up the batteries from the power grid,
2. DC to DC converter: they step down the power to lower voltage, and
3. Traction inverter: this converted energy from batteries to traction motor, which helps for propulsion.

Battery life and battery cost were the two major problems. Almost 50% of the cost of BEVs is because of the battery. The analyst expects to drop the price of battery to \$100/kwh in the coming years as the cost has fallen from \$1000/kwh in 2000 to \$200/kwh in 2018 ^(xviii).

²⁹ Source: www.energy.gov/eere/vehicles/articles

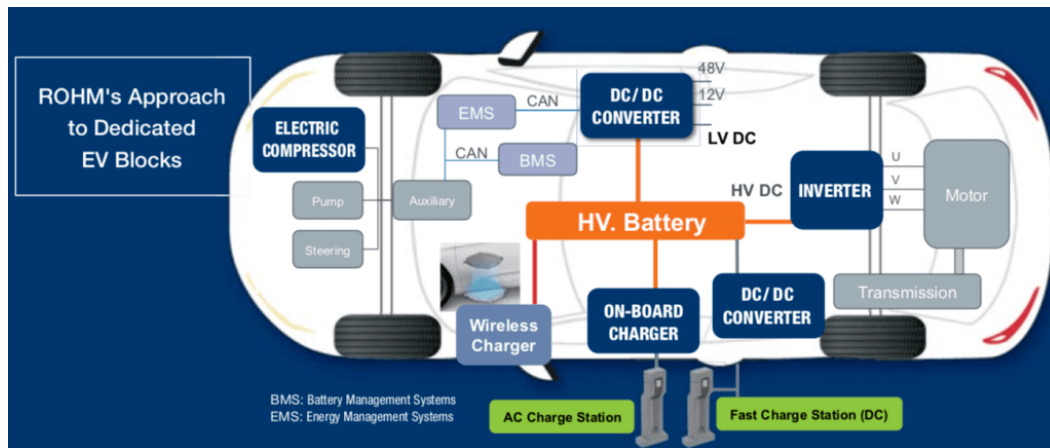


Figure 40 Inside a battery-electric car³⁰

The second challenge associated with battery is charging facility the corresponding three-level charging. L1 (car plugged into home outlet of 120V- AC & takes 17hours), L2 (plugged into 240V power & takes 3.5-7 hrs) & L3 (DC fast charging on 480V at charging station). AC charger is mostly finding an in-home or parking facility as a car parked for a longer time. And proper charging station for DC as this charge almost 80% in just half an hour.

The issue is to make a high charging station as it is space constraint, high installation & maintenance cost, capacity of power grid supply is a major government problem, and need bulk investment. Another scenario is that Day to life practices traveling is easy but longer routes constitute a problem as the charging station is mostly on the downside but not the countryside.

3.3.2 CUSTOMER PREFERENCE

Many companies along with government norms initiated and implemented to build effective EVs, but the expectation of customer analysis will give those initiatives successful, efficient, and effective.

Consumer makes decisions by using making trade-offs between attributes. EVs adoption is largely choosing an EV from the given set of options. The utility of each opportunity is commonly assumed to be a linear mixture of all of the attributes.

Individual related variables are used to consist of preference heterogeneity. These variables either immediately affect utilities or moderate the relationship among attributes and utilities.

Preference is the reflection of the attribute. The characteristics/attributes for a group of vehicles are different and that leads to doing the decision making for the EVs adoption. Here we are ignoring the CV and focussing on only EVs and how the preference shift occurs along with the change in the attribute.

The customer always prefers the maximum utility and below provided the complete framework with a different set of alternatives that can be used for vehicle adoption. Customers usually choose a different alternative in the set to achieve maximum utility.

³⁰ Source: Rohm

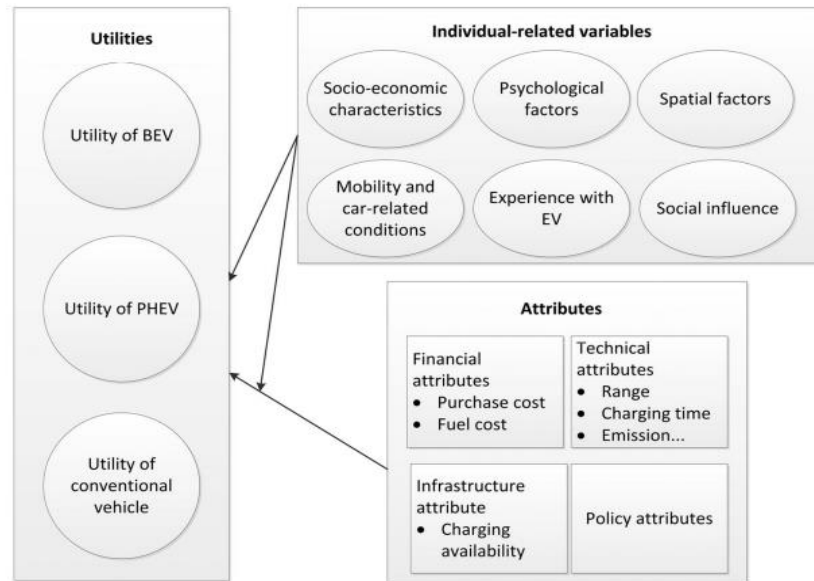


Figure 41 Customer preference framework

A review of preference attribute:

1. Financial Attribute: The purchase price is positioned to have a bad and incredibly large influence on the EV utility. An individual with different background have different Price Preference & vary among populations and this determined heterogeneity is high when the price of EV is an awful lot higher than the CV. Desired Vehicle size is proportional to price sensitivity. Operational price use energy cost as the financial attribute too: either cost per 100 km or both gas performance and fuel charge. These all negatively affect the selection & decision making to buy an EV, which gives a favorable to the EV side comparatively with CV when you consider that EV commonly has decrease energy expenses. The consumer with higher incomes usually has less sensitive to gas price. BEVs takes 30 KWH to go for 100 miles. The Li-ion battery density provides the 250-300 mile driving range whereas the customer wants a driving range of 450+ miles and consequently it leads to the high cost of Li-battery & making EVs expensive.

2. Technical Attribute: Short route range is considered to be one of the biggest boundaries to the full-size adoption of EV. The range is exposed to have a high quality and statistically giant impact on EV adoption choices. Range preference is sensitive to charging station density and charging time. In the case of PHEV, a longer all-electric vehicle range (particularly distance covered by solely by the battery) also will increase the probability of buy. The heterogeneity within the preference is higher when the overall range covered by EVs is less than a CV. Households with more than one vehicle are much less concerned about a quite low EV range because they have a CV for long-distance journeys. Recharging time depends on the power of the charging and battery ability. For everyday purposes, EV makes use of gradual charging at home or at work which takes around 6–8 hours for a full price. As for recharging in the course of long trips, fast chargers can fill the battery up to 80% within 15–16 hours. In other words, “charging time” varies greatly relying upon the situations. Performance is typically represented by engine, acceleration, or speed. Acceleration time is positioned to be heterogeneous choices

among the population: males have a tremendous desire for faster acceleration whilst women opt for slower acceleration.

3. Infrastructure Attribute: Infrastructure attributes recognition at the availability of the charging infrastructure. As in keeping with some research, the purchaser prefers to use the gap from domestic to the nearest charging station, at the same time as others present the presence of a charging station in distinct regions: at home, at the workplace, or in the shopping complex, and so forth. This attribute has a considerably fine effect due to the fact more charging stations save time and search costs for users. Most importantly, not like CV which calls for regular visits to gas stations for refueling, EV allows users to rely upon domestic charging so long as one's day by day distance is in the EV's variety. For the reason that EVs typically rely upon slow charging, so it's almost impossible to apply an EV often if there's no charging facility at domestic or worksite.

4. Policy Attribute: Research found that government-imposed many policies like tax reduction, subsidies, incentives, etc. that favor the acceptance of the EV but there are still policies like pricing and toll, etc. are in dilemma to support locals. Reducing the purchase tax is giant in all cases. As for usage price discount guidelines, annual tax discount appears to be the most effective great policy, whilst free parking and toll reduction are not extensive. The effectiveness of various styles of tax reduction reflects the distinction in perceptions consumers have closer to taxes versus other expenses. EV coverage incentives which goal to inspire the substitution of CV. And therefore, Financial, technical and infrastructure attribute is very important to make wise preference and decision. In section 3.6 different policies discussed more.

3.3.3 COMPETITORS

In 2019, the best EVs seller companies were Tesla, Ford, BMW, Porsche, Nissan, Chevrolet, Volkswagen, and Kia. The EVs manufactured by the mentioned companies are somehow the same with the usability but the major key difference among the top electric auto seller are the warranties they offer alongside their vehicles.

On the buyer note side, how do they compare with different EVs, and what will be the competitive factor for the manufacturing companies? Enlisting some parameter_

- i) Electric car range,
- ii) Miles per gallon equivalent (MPGe),
- iii) Battery life and warranties

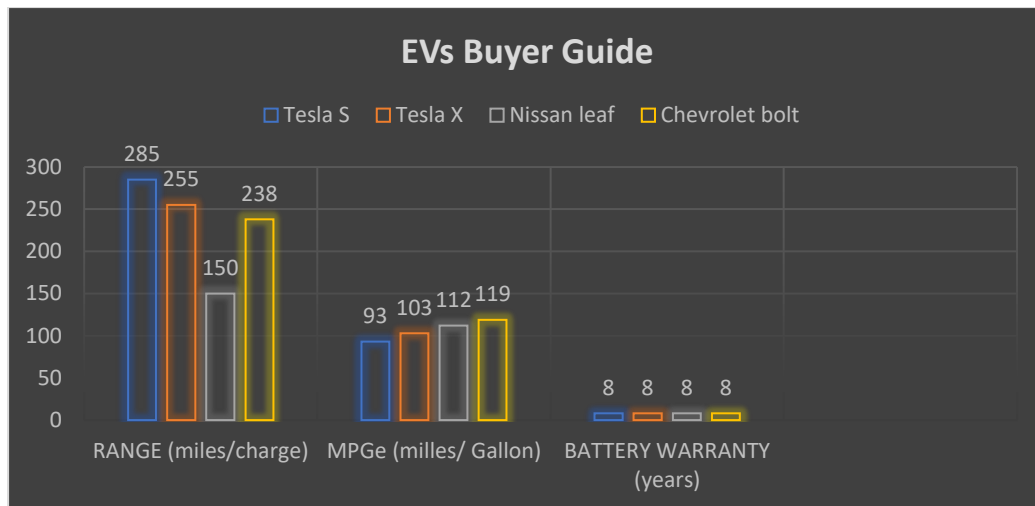


Figure 42 Buyers comparison guide

Similarly, from the company side, there are other parameters along with the mentioned above used to capture the market. Parameter is:

Car Name	MPGe	Cost	Innovation	Comfort	Top speed,	Usability	App
Tesla Model S	93	71,100	Good	5-7 seat (good)	130 MPH	Good but difficult to see interfaces	Yes
Ford Focus Electric	105	29,170	Average	(Bad) less cargo space	78 MPH	Average but displays are rated distracting	Yes
Porsche Panamera SE Hybrid	50	99,975	Average	Average & 4 seats	83 MPH	Good & dashboard displays visible	Yes
BMW i3	81	43,300	Good	Good with 5 seats	93 MPH	Good (levers located near the wheel)	Yes
Standard Fuel car	36	33,560	Average	Average	100 MPH	Average	No

Figure 43 Cost, Innovation, comfort, Top speed, Usability, & App

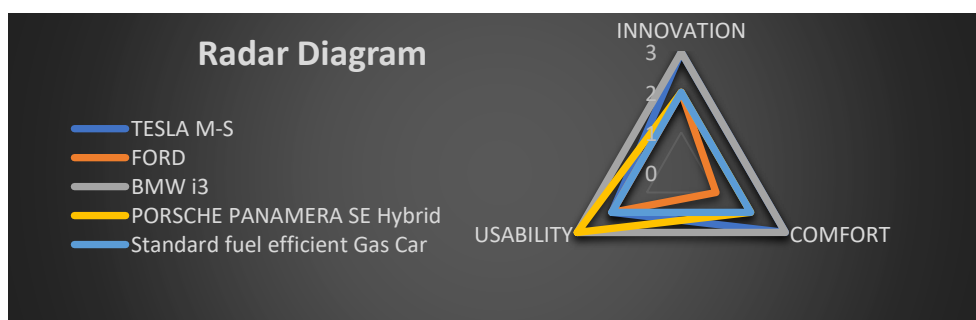


Figure 44 radar diagram with metrics Good (3), Average (2), Poor (1)

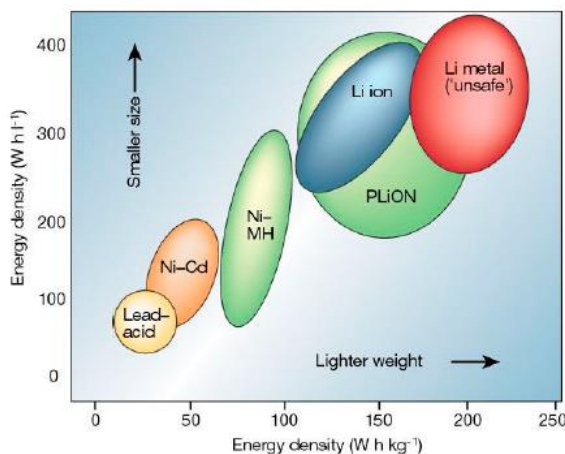
Out of all the parameters used to differentiate the EVs, the competence of a company lies at two places i.e. innovation & Usability and Application like car-sharing status and the mobility of information.

3.4 BATTERIES

Projection explores that the world will have more than 125 million EVs on the road by 2030. and at the heart of EVs these advanced lithium batteries are inserted to maintain the sustainability of EVs (G). EVs grows their power straight from a big pack of batteries. One pack of batteries comprised of thousands of individual lithium-ion cell and work together. Chemical changes occur while charging and when the vehicles start on the road, these changes reversed to produce electricity.

3.4.1 RESEARCH & DEVELOPMENT

Fig: illustrated the development of batteries.



In early 1859, lead-acid was developed by Gaston Plante and applied in EV. Later in 1899 Ni-Cd introduced and made a significant storage capacity but lag with voltage suppression techniques at battery aged. Research continued and at the beginning of the 20th-century Li-ion batteries were came into the application. And Li-ion battery commercialized more appropriately and currently it wave in every EVs because of specific energy (WH/kg), life-cycle,

and high efficiency. Batteries have a storage medium made up of two electrodes immersed in an electrolyte, which acts as an exchange medium for ions.

3.4.2 LI-ION BATTERY TECHNOLOGY:

Most EVs used Li-ion batteries as the have NMC & NCA technologies that have higher energy density i.e. compatible with the space constraint than other batteries say Ni-cd or lead-acid and thus used for Light duty battery market whereas LFP (Lithium iron phosphate) used for the heavy-duty EVs. LFP has a lower density than others but has a greater advantage in the lifecycle. Some other feature makes lithium batteries more acceptable like the weight of li-ion batteries, safer than others. Li-ion energy storage is characterized by the reaction of the negative electrode (made up of carbon or lithium Titanate $\text{Li}_4\text{Ti}_5\text{O}_{12}$) inserted in the li-salt (LiPF_6) and organic solvent. Lithium nickel manganese cobalt (NMC), Lithium nickel cobalt aluminum oxide (NCA), Lithium manganese oxide (LMO) are some cathode material used as an electrode. The Separating membrane is used to allow the flows of lithium ions from the negative electrode to the positive while battery power generation and reversed while battery charging, while preventing the occurrence of short circuits.

Li-ion batteries have the highest coulombic efficiency (CE) rating, say 99% and CE is the ratio of total charge dig out from batteries to the total charge positioned into the battery over a life cycle. The performance degradation of Li-ion batteries may be characterized by the loss of either capacity or power and caused by the transformation of active material to inactive material due to parasite reaction. The temperature may be another factor that affects battery performance. Overheating of the batteries can result in a thermal runaway where temperatures can reach as high as 500°C. EVs employed a Thermal management system to reduce the drastic change in temperature while charging and discharging & this system includes a passive and active cooling system.

The scaling up of manufacturing facilities for battery production has a beneficial cost effect, as the construction costs can be spread over a wider battery market, allowing economies of scale. Our research shows that the actual average plant capacity varies from about 0.5 GWh / year to 8 GWh / year, although most of the largest plants have capacities of around 3 GWh. Currently, batteries factory have a capacity of up to 8GWh/Year

3.4.3 BATTERY SPECIFICATION:

Different EVs player uses different composition and their specification vary as per the size and type of vehicles. Players like Nissan Leaf, BMWi3, and others used an LMO battery whereas Tesla uses an NCA battery that delivers 248Wh/kg.

Small vehicles use the battery range from 16 -23Kwh with a driving range of 90km -160km. Mild size batteries are from 22Kwh-60Kwh with a driving range from 130km-275km whereas heavy vehicles use the battery with a range from 60-90Kwh with a driving range from 275-360km. EV manufacturer estimates the driving range as per the best condition and as per research, the driving range /distance traveled in the real scenario can be 30-35 % of the given advertisement.

The price of an electric-powered car battery is determined by using its ability in kilowatt-hours (kWh), which elaborates its variety and the power degree of the motor that it materials. According to analysts at Bloomberg NEF, in 2015 the price of the battery of an EV accounted for extra than half (57%) of the vehicle's production cost.

In 2010, the average price per kilowatt-hour became 1,037 euros whereas by 2018 it turned into less than 160 euros. So through 2024, it may drop under 90 euros. In 2016, the price of an EV battery changed to about \$350/kWh.

Price is dropping and Bloomberg (December 2017) says that the common EV battery prices now \$209 in step with kWh. Specialists are expecting that the EV battery will drop below \$100 /kWh by 2025. If we cognizance exclusively on the price of a battery by its strength potential, as said via Bloomberg NEF in 2019, we should count on a price rate of around a 140 euros/kWh; a purchase price that has been dropping year after year.

Taking in an account minimum state of charge: To get the information for the minimal state of charge we needed to use value for the proposed variety. Collectively with the values for the expected range, battery size, and energy consumption, we could calculate the minimal state of charge with an equation.

Minimum state of charge = 1 - (Energy consumption. Estimated range / Battery size)

3.5 GREEN EFFECT AND ENVIRONMENTAL

Acceptance of EVs in the real world leads to keep your town and the world free from pollution as it produces fewer emissions because of electricity generation instead of burning fuel than conventional vehicles which produced approximately 1.5 tons of CO₂ per year.

There are two types of vehicle emissions: Direct emission and Lifecycle emission. Direct emission occurs through the tailpipe producing the smog-forming pollutant, Green House gas like CO, and another harmful pollutant for human health. The most common emitted gases are NO_x (nitrogen oxides), CO (carbon monoxide), HCHO (formaldehyde) & HC (Hydrocarbon). And the lifecycle emission includes all the emissions from fuel production to the manufacturing of the vehicle with maintenance, use, and disposal/recycle.

The major benefit of using EVs is the downfall in the GHG (Green House Gas) emission. Also, it represents the reduction of 62% emission of a petrol car and a 53% reduction in emission as compared to a diesel car. So, when evaluating the impact of EVs on the environment, major factor keeps in mind like Tailpipe emission, well to the wheel, the energy source for charging, & car efficiency ^(xix). As per analyst at ICCT (International Council on Clean Transportation), the overall lifecycle emission of electric cars produced half of the GHG of average emission by CVs. Same way, taking account of well-to-wheel emission, all EVs produced 4450 pounds of CO₂ equivalent per year which is half of CVs emission. From the analysis by ICCT analyst, it was found that the battery manufacturing lifecycle emission paid off in the 2-year duration compared to driving CVs. Battery manufacturing emission is similar in magnitude in manufacturing the average IC engines and it is quarterly lifetime EVs emissions ^(xx).

3.6 GLOBAL ROLE IN THE DEVELOPMENT OF EV

To reduce the dependency on Gas-fuel and make the environment pollution free, the federal government has promoted the development of EVs (BEVs & PHEVs) technology. It was started by the US President Bush in 1993 by the creation of Partnership for a New Generation Vehicles (PNGV) aiming to open a government-owned laboratory to research on fuel cell to power the EVs and to bring the 80mpg vehicles to the US market by 2003.

Through many forms, the government supported the adoption & continuation of EVs, HEVs, & PHEVs. During the presidency of Obama, PHEVs & BEVs become the main focus in the R&D investment in the Automobiles sector for the fuel effectiveness, limits on emission, tax or other discounts to buy of Hybrid vehicles, initiation of the carbon tax, and funding to build the infrastructure, such as charging point. To protect the population from health problem as well as an economic problem, federally funded in the EVs initiation to achieve zero-emission by vehicles and also this technology need more technical person thus created jobs for fresh graduates and attracted more people to move in the downside. The federal government promoted the EVs by utilizing the vehicles in the military and government use.

EVI (electric vehicle initiatives) under IEA is a multi-governmental forum focussing on the accelerating and adoption of EVs and it was launched under CEM(Clean energy ministerial) and thirteen countries (Canada, France, Japan, Norway, Chile, Germany, the Netherlands,

Sweden, China, India, New Zealand, United Kingdom, and Finland) were took part in EVI. Under the EV30@30 campaign, a set of goals were declared to all EVI members should have a 30% market share for EVs in total vehicles and expected to reach the sale of 44million units by 2030.

BUYER OBSTACLES

The buyer faces the challenge to become the owner of EVs as the upfront cost is much higher than conventional vehicle so major policies were launched by the government to attract more buyers.

a) EV incentive/subsidies: The US federal government provides subsidies of \$7500 for the first 200,000 EVs produced. Some cities like Austin, Texan have the additional incentive of \$500 on the purchase of EVs. Incentives or Tax credits are ranged from \$2500 to 7500 depending upon the size of the battery (4KWh to 16KWh)

b) Battery leasing: Battery OEM provides the leasing the Battery to buyers and offers monthly lease payment of the battery and thus reducing the load of the upfront cost of the buying the EVs.

c) Charging infrastructure: Owing a charging station is high cost intensive therefore private providers avoid to enter so the government provides subsidies or free charging to users and in the UK & Singapore, the government allocated the budget for the charging infrastructure so that they cut the cost of user and attract more buyers.

Lastly, the EV charging infrastructure tax credit is 30% up to the \$1000 for a user and 30% up to \$30,000 for business.

3.7 FUTURE AND PROS & CONS OF EV

One of the biggest questions on the buyer perspective before buying BEVs, PHEV comparing with CV. Though the buyer has numerous reasons to take next-generation EVs at some point they must be more concerned while choosing BEV, PHEV, OR gasoline car.

PROS OF ELECTRIC VEHICLE:

- BEVs are more efficient than Gas-Powered Vehicles and convert almost 59-62% of energy into vehicles movement.
- BEVs used rechargeable batteries, so from an economical point of view, it is much lower than the money spent on fuel along with the reduction of emission. Even at longer travel, switching from battery to gasoline-driven, nearly 30-60% less fuel is used than conventional vehicles.
- In BEVs, shows high performance and low maintenance and it is just one-time big investment than convectional vehicles but with the rest of lifetime fuel-saving, tax credits and government incentives with help to offset these starting cost and production of PHEVs increasing these price are coming down too.



CONS OF ELECTRIC VEHICLE:

- BEVs is used for shorter travel as pure Battery vehicle have ranged between 60-120 mile/charge w.r.t 300 miles/full tank in Gas-powered vehicles.
- EVs take a longer time to re-fuelling as Level 1 & level 2 take almost 8 hours to fully charge.

FUTURE OF EVS:

There is a calm insurgency beneath way within the car world: the move to the moon and no-emission vehicles. More than 40 plug-in half breeds and completely electric vehicles are already on the showcase within the US – just like the Nissan LEAF– and our choices will continue to grow over the following few a long time, with hydrogen fuel cell vehicles just like the Hyundai Nexa and the Toyota next-generation Mirai. By 2025 there will be 130 electric vehicles (EV) models from which clients can choose. These modern zero-emission cars, hybrids, and SUVs are the result of gigantic speculations by auto producers, and they're contributing \$225 billion over the other five a long time to zap their fleet.

The typical obstructions to far-reaching client acknowledgment of unused items cost, quality, and comfort – are consistently being overcome. Battery costs are a division of what they were ten years ago, but still have a few ways to go to be competitive. Auto companies have seen the long-term and the end of this electric era.

Several nations integrate to make incredible innovations in Electric vehicle development that can bring riches of benefits to the environment.

CHAPTER 4 ELECTRICAL VEHICLE IN INDIA

4.1 EV MARKET IN INDIA

The changing paradigm in the automobiles industry and the previous Global automobiles is on the brink of disruption. The four technologies trends namely – Electrification, Shared mobility, Connectivity, and autonomous driving were driving the auto sector. India automobiles industry experienced this change in the automobiles sector and out of four trends, Electrification is having a significant impact on the auto industry.

As per the research, India plans to achieve high insight in e-mobility by 2030. The Indian EVs market marked at \$71.1 millions in 2017 and is anticipated to reach \$707.4 million by 2025, seeing a CAGR of 34.5% during the estimated period. The government was also involved in this innovative decision, not on only one factor, and to do so, the central and state government launched many schemes and regulations in the electric field to promote e-mobility. The major reason supported Indian auto industry to look forward to electrification is the rise of pollution level and as per the report of December 2017, the capital of India, New Delhi was in the red alert zone because its pollution came closure to Beijing in term of toxicity and according to planning & survey, if India successfully manages to make India as an e-mobility dependent by 2030, then in it would decrease at least 1 giga tonnes of emission ^(xxi).

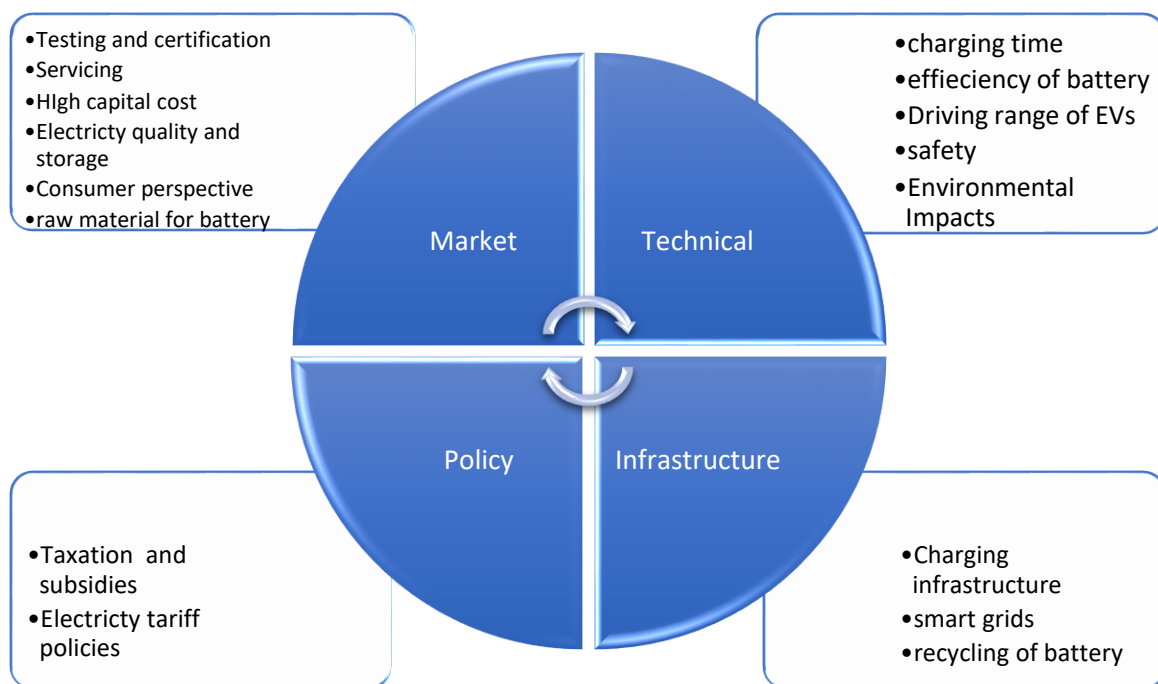
This will favorable in many aspects, as the dependencies on the oil and derivatives were reduced as thus if a more renewable source of energy were coming in the trends, this will too save the future energy. So, the Indian automobile industry could get an advantage and took this paradigm not as a threat but as an opportunity. The country stands to get benefits in a large way to switching from IC engine to electrification in the auto industry but there are some challenges associated with this transformation like the heavy initial cost and lack of the resources like renewables source of energy to produce electricity which is further used for charging the EV. The virtuous cycle is somehow costly, low demand, and considerably low supply but in the coming decade, this cycle will be reverse in low cost, high demand, and consequently high demand. The policymaker already imposed a policy on “FASTER ADOPTION AND MANUFACTURING OF HYBRID AND ELECTRIC VEHICLES”- FAME- I in 2015 and FAME-II in 2019 to adopt and geared up some faster move-in adoption of electric vehicle trends. Till now, India is in the developing phase, and many firms like e-commerce, app developers to build app-based technology to capture maximum network, car manufacture have entered this sector and they are slowly building the e-mobility service, capacity, and visibility. Further, the Government’s aim of 100% electrification by 2030 would provide immense growth to BEVs.

Through the data received by EPI (environmental Pollution Index) 2018, India lies in the bottom of five countries in the environmental category and it was ranked 178 out of 180. And as per the survey by US AQI, the average value of India is 152 in 2019 ^(xxii). In 2017, 4.6% is the estimated increment in India’s CO₂ emission. The PM_{2.5} (ultra-fine particular) concentration over the past decades has been increased in the air and it was around 1,640,000 dealt annually.

Innovation changing, cost improvement, and local manufacturing of lithium-ion batteries are anticipated to catalyze the development of the EV market in India.

4.1.1. THE ECOSYSTEM OF ELECTRIC VEHICLE

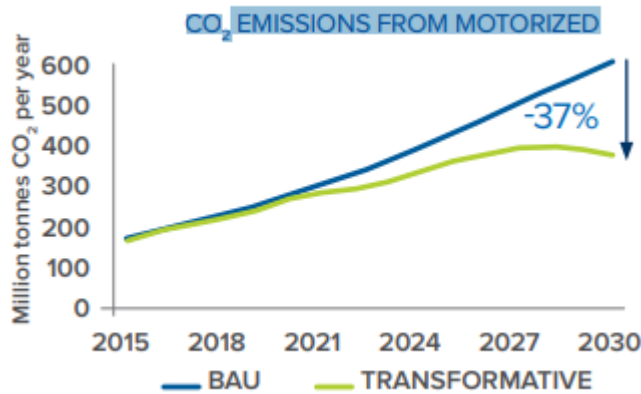
An ecosystem of the EVs market provides detailed information in terms of driving factors the market, trends, technology development, policies, and key players. As per research, during the forecast period of 2019-2030, the EVs market is anticipated to grow at the CAGR of 43.13% with additional charging installation at all four zones will grow at the CAGR of 42.38% ^(xxiii). And with the entry of local battery producers such as TATA chemical and BHEL along with the outsourcing of battery from global players and therefore the electrical battery market is expected to grow at the CAGR of 60.15% during the same forecast period.



4.1.2. INDIA HAS THREE KEY STRATEGIES REQUIREMENTS TO LOOK AT THE EVs:³¹

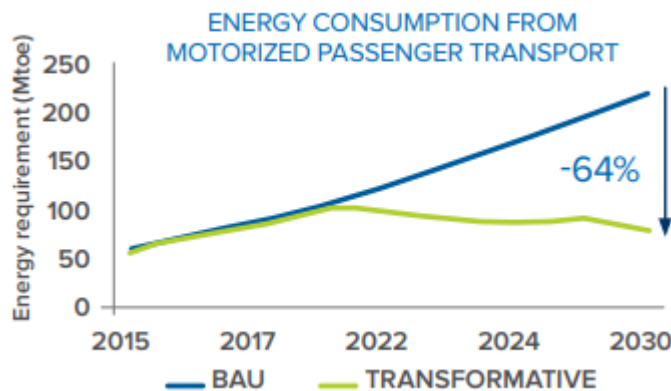
- 1) Higher carbon Emission:

³¹ Source: NitiAyog/RMI Report on Transformative Mobility Solutions for All



One of India's development objectives is to reduce the urge of carbon footprint emission and to meet the climate obligation. And through the development of EVs, carbon emission can be reduced by 37%.

2) Fuel security Risks:



Currently, India wanted to reduce the dependencies on crude oil imports. And with the development & pursuing shared and incremental connectivity of EVs, India can save up to 64% of passenger mobility-related energy demand in 2030.

3) Lower Power Demand:

A new source of power in form of electricity and electric driven vehicles can be beneficial for the power sector and may lead to stable demand and a paying customer segment.

4.1.3. MARKET SEGMENTATION AND THE KEY PLAYER

The Indian EV market is segmented based on road EV types (Electric two-wheelers, Low-speed three-wheelers, High-speed three-wheelers, Personal EV, Commercial fleet EV, Electric busses), EV Batteries, and Electric Vehicle Charging Infrastructure and region. More precisely charging infrastructure segmented like type1, type 1 & type 3 as an AC (upto 3.3KW), AC (up to 22KW), and fast charging (up to 150KW).

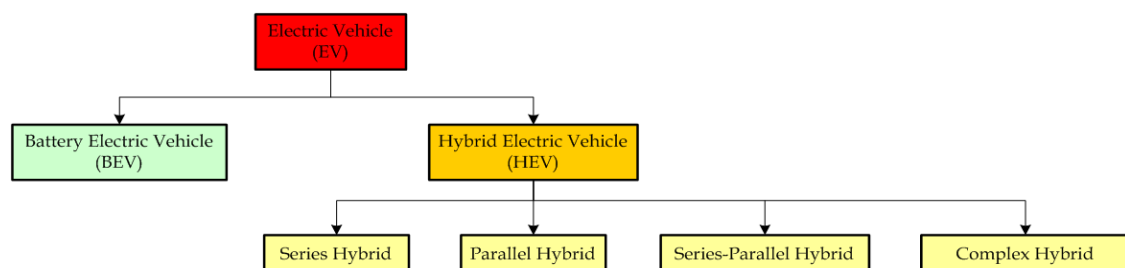


Figure 45 Categorization of EV

Based on Plug-in-EV classified into two types: PHEVs and BEVs. Furthermore, EVs can be classified based on their features such as 1) charging time, 2) driving range, and 3) load capacity.

PHEV (Plug-in-hybrid-electric vehicle) uses more than one power source and they are surplus for giving fuel efficiency, more power, and minimum CO₂ emission. They use power from multiple sources like regenerative braking systems and engines and conserve energy during the shutdown condition.

The overall volume of PHEV in the auto market is increasing and their demand goes on increasing because of less emission and optimal power. With the industry analysis, it is seen that with the greater effort done by the government and their norm intervention, PHEV got immense opportunities for growth in the developing country, India. The government of India provided US\$ 446 approximately for the purchase of PHEV & BEV.

With the 70% sales volume in 2017, BEV was categorized as the largest share market in India, and BEV was continuing to dominate the Indian E- market in both, volume and value and therefore owe the highest subsidies by the government on the purchase. Incremental innovation on the battery technology consequently drops the battery price along with lowering the upfront cost that benefited the market.

The Indian EV market is further classified based on the battery as Lithium-Nickel-Manganese cobalt oxide (LI-NMC), Lithium-iron-Phosphate (LFP), Lithium-Nickel-Cobalt-Aluminium oxide (NCA) battery, Lithium-Titanite oxide (LTO) battery, Nickel-metal hybrid (NiMH) battery, and lead-acid battery. LFP battery-based BEV contributed the largest in the market with 65% sales in volume in 2017 because of Thermal stability, high current rating, and safety levels.

4.1.4 KEY COMPANIES:

As of now, the Indian EVs market is highly solidified by the few players. Mahindra electric mobility ltd. is the only producer of BEVs and leading the market within the nation. Other companies such as Toyota Kirloskar Motor Pvt. Ltd. BMW AG, Honda Motor Co. Ltd., and Volvo Car Corporation are also offering the PHEV models in the market. However, the government of India also boosting the attractiveness of EVs through several initiatives and subsidize.

Companies' advent in the market such as TATA Motors Ltd, Hyundai motor company, and others will be expected to intensify the competition during the period of forecast. Mahindra & Mahindra and TATA motors ltd are even now to manufacturing EVs by outsourcing the half component.

The parents of India's largest carmaker i.e. Suzuki Motor Corp. were expected to produce 35K EVs annually in India from the starting of 2020-21. As Suzuki is linking the venture of electrical vehicle lately, therefore, the company desired to make sure the job to be supportable and progressively gain the volume. Suzuki forecasting to set up the full system,

starting with a lithium-ion battery plant, and plan to do all tasks before Maruti begins selling the vehicles in India.

4.2 SALE AND PRODUCTION

With the recent research, it was found that E-cars do not match the expected hype and in the E4Ws segment, only 3400 units were sold in FY20 compared to a 5% declined from the FY19. Table 6 has shown that in the passenger's segment of EVs, only 1309 units were sold in the first eight months of FY19 and contributed merely 0.07% of total PV sales during the same period ^(xxiv)

CARS	Sale from April-November (units),2019
Mahindra e-Verito	513
Tata Tigor EV	491
Hyundai Kona EV	280
Mahindra E2O	25
Total	1309

Table 6 EV sales in India during April-November 2019³²

According to the Economic survey 2019-20, the sales of E3Ws that run on lead-acid batteries in India reached to 280,000 units till November. Though after this, intervention by the union government to stop the subsidies to lead-based vehicles and it will be restarted once they got fitted with Li-ion batteries.

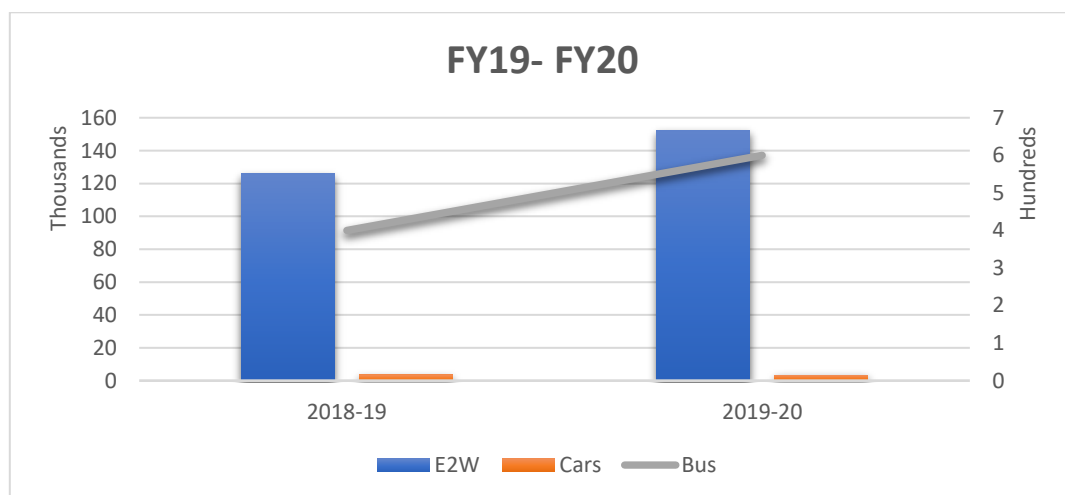


Figure 46 Growth in sales FY19-FY20

However, as per the survey by SMEV (Society of Manufacturing of Electric vehicles) overall EVs sales grew by 20% in FY20 with 1.56 lakh units shown in Fig 46, and the major market is driven by the E2Ws. Out of total sale, E2W sold 1.52 lakh units, 3400 cars, and 600 buses. While the total EV sales in FY18-19 were 1.3 lakh units with major driven by E2W i.e. 1.26

³² Source: ET Auto Findings

lakh units & 3600 cars and 400 buses. This figure does not include e-rickshaw. Despite COVID-19, the Director of SMEV announced that FY20-21 will be the year of the EV market.

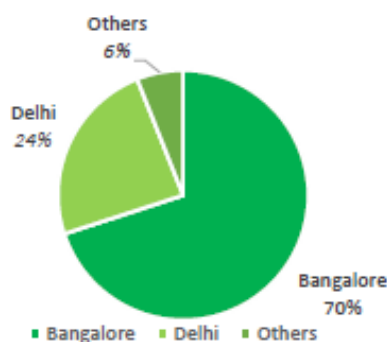
Under the FAME-India Scheme, in FY17-18, about 171,000 EVs were sold, out of which 1,200 units were passenger segment of Electric vehicles. The majority of sale is driven by the E2W with the 54,800 unit sold. With the early adoption accomplishment of the E2W and E3W segment and noted the supreme acceptance from the inception of the FAME scheme.

As per the SMEV, since 2015, the E2W sales were approximately 475,000 units. Though the sales of E2W is mainly constituted by (LS) Low-Speed EV so much, so for the FY 2017-18 out of the 54,800 E2W sold, 49,000 were LS E2W and only 5,800 were High-Speed (HS) E2W

E2W SALE TRENDS:

Uttar Pradesh has the highest uptake of E2W in India, followed by Haryana, Maharashtra, and Gujarat. Though, the bulk of the E2W sold in Uttar Pradesh is powered by lead-acid. Under the FAME scheme, Gujarat has gained the highest sold number of high-power lithium battery E2W, followed by Uttar Pradesh, Maharashtra, and Haryana. Out of all the states where there is substantial uptake E2W, Karnataka has the best sales ratio between the battery's technologies based on lithium and lead. With every 1.4 li-ion E2W sale trends upon every 1 lead-acid battery powered. Most of E2W is powered by lead-acid technology in West Bengal and Tamil Nadu & have comparatively higher sales. The lead to lithium ratio batteries EVs for Tamil Nadu & West Bengal are 0.16 and 0.19 respectively.

As of now, the Electric car market is at a promising stage with few serious players shown in a bar chart.



About 7,100 cars were on the road since the introduction of the first EV by REVA in 2001. And currently, in India, the base installed in the diverse region, and out of the major cities, Bangalore and Delhi were the largest regions.

Source: feedback analysis

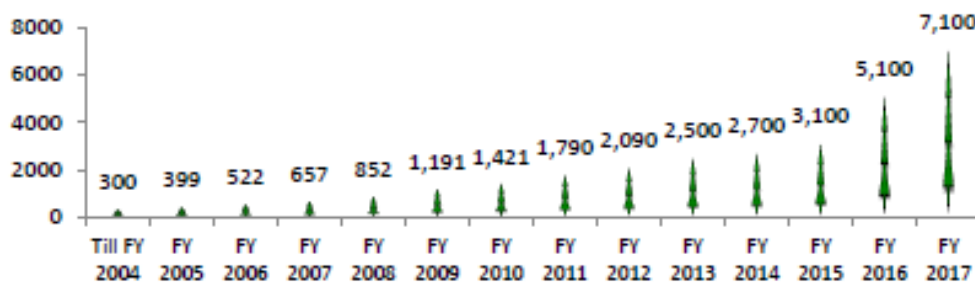


Figure 47 EVs running on road from 2004-2017 in India

Indian carmakers should adopt tesla business strategies to increase their attractiveness and growth in the EV segment. Tesla is a world leader in EVs. Companies should invest in the high end of technology backed by a team of experienced industry professionals.

Adoption of “make-in-India” right from the commencement along with localization targets and their preference. With this approach, companies will have 100% local contented with zero imports

Do not just sell the vehicle but deliver the end to end mobility solution to the customer. Several impacts of COVID 19 in the auto sector and therefore the world is no more attracted to import from china and this is a good opportunity for Indian to pick up the shift in commerce. With the limitation of crude oil, the world is shifting towards the alternative and cheap source of power and in this circumstance, EVs have the potential to take this alternative position.

4.3 SITUATION AND CHALLENGES OF CONSUMER & SUPPLIER

As per the report of DHI (Department of Heavy industry), till June 2019, a total sale of 168,633 E2W was sold under the FAME-India scheme in India.

Under the FAME subsidy in the past E2W was classified into three categories.

Two-Wheeler category	Sale (DHI,2019)
L1 Category (CMVR) – vehicle maximum speed not exceeding 40 kmph and max power not exceeding 0.5 KW	27,701
L2 Category (CMVR) – other than L1	27,508
Max speed not exceeding 25 kmph and max power not exceeding 0.25 KW	113,424
total	168,633

Table 7 Electric two-wheeler sales through FAME subsidy³³

Out of total E2W sales, 67% were not classified as motor vehicles under CMVR and therefore did not required a helmet and driving licensed and they powered by the lead batteries.

The FAME phase II did not offer subsidy under this low-speed category because they were promoting the substandard quality product and showing very low performance and range compared to ICE two-wheelers. EVs subsidies are discussed briefly in section 4.5.

Apart from this, there are several challenges in the adoption of electric vehicle cars by the Indian consumer. These major challenges include:

-Charging infrastructure

³³ Source FAME

- Battery performance
- Supply-demand gap
- Creating the closed-loop

4.3.1 BUILDING CHARGING INFRASTRUCTURE

Incumbent consumer-facing a lot of trouble in the charging infrastructure and to eliminate this challenge the infrastructure needs to be combined with the existing refueling station along with an alternative location closer to the home. This will eliminate the wait time for charging. To enhance the available range, infrastructure should be standardized. And, it will make the optimal price for charging.

4.3.2 BATTERY MANUFACTURING AND BATTERY PERFORMANCE

The risk of trade deficit increasing due to the absence of a battery manufacturer in India. Most the manufacturer relies on the imports from the leading countries such as China Europe, and because of Make-In-India initiatives market need to encourage for indigenous technologies.

Electric charging set-up will take significant time to be duplicated and the ubiquity of the fuelling framework in India, it is fundamental that batteries got to be far more durable to way better compete with the internal combustion motor vehicles.

4.3.3 SUPPLY-DEMAND GAP

Another main challenge avoiding larger-scale acceptance of EVs nowadays is the range is quite limited, thereby constraining the use of EVs. Again, this is largely solved by increasing the scale of supply with more cost-effective batteries that provide a better overall range.

4.3.4 MANUFACTURER IS FILLING THE GAPS BETWEEN PRODUCTION AND ADOPTION OF EVS IN THE INDIAN AUTO ECOSYSTEM

With the technology advancement and government incentive plans, the manufacturer was able to bring down the cost of manufacturing, thus encouraging more adoption. The Indian consumer is the price as well as quality sensitive too. So, the manufacturer is required to shape high-quality EVs models at parity with global incumbents. As per research, India imported lithium batteries worth \$1.23 billion in 2018-19 from china, Taiwan & South Korea. So, cost reduction can achieve if the initiative of battery manufacturing took place. Even though, if the raw material is imported, it would bring down the reduction of import value up to 30%. And this will reduce to dependencies in other countries thus boost our economy.

4.4 FUTURE PROSPECTS

Despite several schemes initiated by the Government of India, electrification in the automobile industry will still take time to evolve to the fullest. Per government along with Industry were

planning to make India follow low carbon footprints like the big car markets like China and the USA. Despite the ambiguity in this electrification sector, we have some domestic car players like manufacturer and OEM in the EVs market, and others are testing and forecasting to unveiling their own EVs in the next successive years. However, the initial push has already taken in E2W and E3W, but a bigger step is required in electric public transportation and cars.

With those plans, India's focus on next-gen mobility. The NEMMP (National Electric Mobility Plan) 2020 was revealed in 2013 and that pushes the nation across green mobility and electric cars. Currently, India is planning to adopt a 360-degree tactic and make EV nation.

The climate risk index 2020 released by the environmental think tank and India found at the urge of vulnerability ladder with the 5th position in 2018 compared to 14th position in 2017, and this reason also making India look forward to circulating more EVs and make the auto industry not dependent in fossil fuels.

Research says that the early adoption of electrification along with the existing vehicle, enhancement in the range, & growth in the charging infrastructure will change the paradigm and this will make the pollution reach a catastrophic level in the metropolitan cities like Delhi, Bangalore, etc. Major challenges faced by the local audience are the charging facilities, battery performance, range, supply-demand gap & others as discussed in the situation of customer and supplier. Government of India imposing several subsidies and countering these all problems to make this sector more attractive.

4.4.1 ELIMINATING THE GRID CAPACITY ISSUE

10GWH of cells is the minimum requirement till 2022 and expected to expand this to 50GWH by 2025 and therefore department of energy were more emphasized to look forward to the implementation of solar dependencies and as per research, it is found that India is the path to become one of the largest solar and energy storage marketplace by 2025. And with the combination of solar-grid resolution, India can improve the charging infrastructure.

Electricity Demand By EVs in 2030

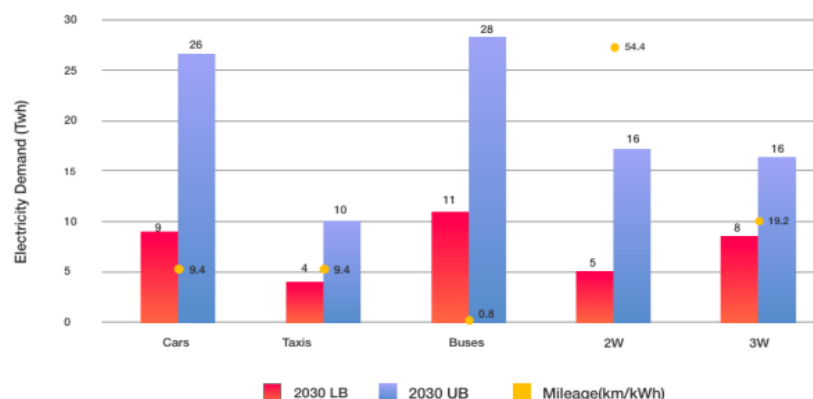


Figure 48 Demand forecast for EVs³⁴

³⁴ Source: brooking institute India

4.4.2 SWITCHING TO ELECTRIC CARS

As of now, research says that the penetration of the EVs market is just 1% of total automobile sales in India and even though in 1%, 95% were the sales of E2W in the first 6th month of FY19-20, only 1,500 EV was just sold for personal use.

India is a price-sensitive market as the cost structure of EV is comparatively less than the IC vehicles. As per the survey, it was found that only a two-wheeler segment (scooter) sold approximately 79% of all vehicles in 2018 because this shift is not only economic & noiseless, but this will also generate impetus for cars shifting. With the optimistic behaviour of carmakers as they believe that the market will be going to shift very soon because the incumbent industry and new entrants were making a rapid advancement and substantial improvement in the EV segment.

4.4.3 FUTURE IS GREEN BY 2020

Last year, there were so many ups and downs in the sales and adoption of the EV because of the higher customer situation, manufacturer higher upfront cost because of the import of parts. But in 2020, the situation seems to expect a green future. With a phase-II plan of FAME and introduction of e-scooter with a top range of 80km per charge along with 40kmph as a minimum speed and 50% local manufacturing boosting the adoption. Under the FAME scheme, approximately INR360 Crore were subsidies to the first 285,000 buyers of EV/PHEV. In 2020, we expect to see the re-birth of EV with the positive image of driving sales, incentives plan, the number of sales is less but the excitement in the customer is high, the e-rickshaw market is still dominated by the unorganized sector, this year would a kind of test year for electric buses and as per the BIS research says that between 2020 and 2030, the EV market is anticipated by the compounded growth of 43.1%, the battery market growth at the rate of 60% and the charging infrastructure grow at the rate 42.5%.

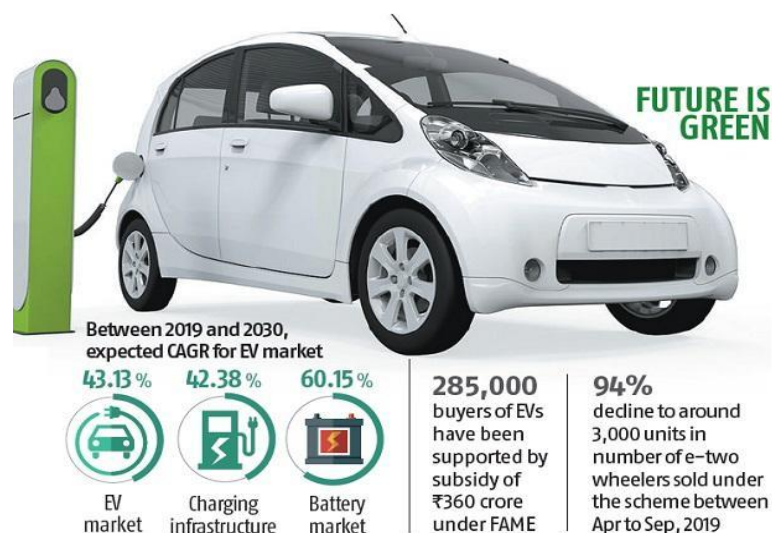


Figure 49 The future is green³⁵

³⁵ Source: business standard

Ride-sharing public-private transport company Ola recently announced their vision “Mission: Electric” and aiming to launch 1 million EV on road by 2021. Delhi only is whispered to have nearly a lakh e-rickshaws exercising its roads, whereas Kolkata will see an elevation from totos to e-rickshaws. The recent elevation in electric vehicle sales also points to a growing preference for personal EVs.

4.4.4 PREDICTED SALES OF EVS TILL 2026

2016-17 revised classification as per NitiAyog classification	SIAM Data	Feedback estimate	Feedback projection based on the explanation earlier	
	2016-17 domestic sales (all Types)	2016-17 domestic sales (only EVs)	2026 Business As usual (BAU)	2026 Transformative
Passenger Vehicles - Personal	2,132,709	2,000	31,350	1,254,000
Passenger Vehicles - Commercial / fleet	914,018		102,600	3,078,000
Commercial Vehicles - Goods	616,106	-	-	-
Commercial Vehicles - Passenger	98,126	20	2,213	265,500
Three Wheelers	511,658	50	27,000	675,000
Two Wheelers	17,589,511	22,000	1,062,000	10,620,000
Overall vehicles	21,862,128	24,070	1,225,163	15,892,500

Figure 50 Expected sales of EVs until 2026³⁶

The international energy agency cites that globally 20million EV will be potentially on road by 2020 & it is expected to grow to 70 million by 2025.

4.5 SUBSIDIES AND MAKE IN INDIA INITIATIVE FOR EV's

The government of India took different policies to achieve sustainability and aiming to contribute to the green revolution of the automobiles sector. Some of the policies taken by the Indian government over the last decades which has given full-fledged support and push the market for EVs.

India is taking a step forward to a sustainable & cleaner ecosystem. Because of environmental degradation, pollution level, and health-related issue due to pollution, and therefore India is expected to jump from (Bharat stage) BS IV to BS VI fuel standard in 2020

³⁶ Source: SIAM – Society of Indian Automobile Manufacturers

and skipping the BS V norms. Though India was already following the BS-IV emission standard... therefore, it is expected in a reduction in the practice of fuel-based vehicles, consequently, it will increase the EVs demand. With BS-VI approaching, India would originate at parity in the automotive sector with the U.S and other developed European countries.

Under the Make-In-India agenda, India's GDP is expected to grow up to 25% by 2022 in the trade and manufacturing of e-vehicles and their related components.

Make in India for Automobile and Automobile components is one of the major sectors which employ a large number of engineers and labor which makes it far more important. The automotive industry holds about 7.1% of the Indian GDP and India is projected to be the 3rd largest automotive market in terms of volume by the year 2026. The automobile sector manufactured around 30.9 million vehicles including passenger, commercial, and two and three-wheelers in FY 2018-19 of which 4.6 Million were exported to different countries. The FDI equity received in the auto sector from April 2000 to December 2019 is about \$23.89 Billion.

There are a lot of plans and drafts on which the Indian government is focusing on the manufacturing and Research and Development facilities in India. India's "Make in India" initiative has played a vital role in elevating the country's position. Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles and the National Electric Mobility Mission Plan (NEMMP 2020) have been initiated to support hybrid/electric vehicles market development and ecosystem.

4.5.1 KEY MILESTONES IN THE EVS POLICIES

1. National Electric Mobility Mission Plan (NEMMP) 2020

The NEMMP 2020, was launched in 2013 by the Ministry of Heavy Industries and Public Enterprises. This plan aims to support (primarily through financing) and promote the electrification technologies in vehicles.

The four principles of NEMMP to support the penetration of EVs – Developing the infrastructure to backing the ownership of EVs, Acquisition & development of EV technologies, Generating the local manufacturer capability, and lastly producing the consumer acceptability for EVs.

The primary objectives of NEMMP are to boost the EVs industry in India and to achieve its target, planned to combine with the global leadership of vehicle manufacturing also Government of India announced the incentive scheme like subsidies on the purchase of EVs

The Plan anticipated the total likely demand for a full range of EVs, from pure E2W to PHEV & BEV, and accounted for 5 –7 million units in vehicle sales by 2020.

2. Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME - India), 2019 Phase 2

FAME Phase-II aims to enlarge the commercial automobile fleet. It was announced with an overall budget of INR 10,000 crore in March 2019 for the demand incentives, IEC activities, etc. FAME -II scheme is the derivatives of FAME-I in the reason of demand incentive allocation. Unlike the FAME-I, FAME-II does not concern with the vehicle model but based on battery size.

FAME-II proposed a uniform incentive of INR 10,000/kWh of battery for E2W, E3W & E4W. For buses, it suggested a subsidy of INR 20,000/kWh. The effort of FAME remains to be encouraging the purchase and sale of EVs with almost 86% of this scheme's budget actuality assigned for demand incentives. FAME-II aims to provide the purchase subsidy to INR 1,000,000 E2W, INR 500,000 E3W, for 3 years. FAME-II is mainly concern with public transport or those registered for commercial purposes in 3-W, 4-W & bus segments and excludes the subsidy for privately owned vehicles. The central government also presented Income tax reimbursements to customers who were using zero-emission vehicles. In accumulation, to take ownership of zero-emission vehicles more reasonably priced, GST was condensed to just 5% in comparison to 28% related to IC vehicles.

3. National Energy Storage Mission, 2018

The primary goal of this NESM is to endeavour the leadership in the energy storage sector by empowering the policy and regulatory framework which boosts innovation, deployment, manufacturing, and cost reduction. NESM emphasized more on the renewable source of energy and electrification and integrating renewable energy with grids and distribution. NESM gave a three-stage solution, which is as follow

- Environment creation for the growth in manufacturing of battery
- Scaling the strategy for supply chain
- Scaling up battery manufacturing.

4. NITI AYOOG ROADMAP, 2017

The NITI Ayog plan will act as a key driver for the EV chargers. PSU companies like NTPC, BHEL, EESL, REIL took the initiative to boost the EV Infrastructure.

- National Thermal Power Corporation (NTPC) - strategies to set up 100,000 EV charging stations in India
- Bharat Heavy Electricals Ltd (BHEL) – manufacturing of batteries using the developed technology in lithium by ISRO
- Energy Efficiency Services Ltd (EESL) - issued tenders for 10,000 EV chargers in India
- Rajasthan Electronics (I) Ltd, (REIL) – plans to set up 200 charging stations in a major state like Delhi, Chandigarh, and Jaipur

These initiatives will help set up the basic infrastructure and bring in interest from the private players. A private key player like Tata Power already took initiative to set up a pilot project of EV charging.

5. Faster Adoption and Manufacturing of Hybrid & Electric Vehicles (FAME - India), 2015 Phase 1

The government of India has apprised the FAME India scheme to support the manufacturing and development of the hybrid/ electric vehicle market. This scheme has aimed to incentivize the E2W, E3W, and passenger 4-wheeler Electric vehicle, light, and commercial vehicles. Apart from this, FAME also incentivizes the hybrid and electric technology like Mild Hybrid, Strong Hybrid, Plug-in Hybrid & Battery Electric Vehicles. Technology development, Demand Creation, Pilot Projects, and Charging Infrastructure are the 4-focus scheme of FAME.

Phase-I is being implemented from 1st April 2015 and it lasts for 2 years (FY 2015-16 and FY 2016-17). During this period INR 795 Cr was allotted in FY 2016-17 under various plan heads like 120 Cr only in the technology platform. Later the outlay increased to Rs895 crore due to the extension of phase I.

Component of Scheme	FY2015-16	FY2016-17
Technology Platform	INR 70 crore	INR 120crore
Demand Incentives	INR 155 Crore	INR 340 crore
Charging infrastructure	INR 10 Crore	20 crore
Pilot Projects	INR 20 Crore	50crore
IEC/Operation	INR 5 Crore	5 crore
Total	INR 260 Crore	535 crore
Grand Total		795 crore

Table 8 Components and Outlay under FAME Scheme

CONCLUSION

India is the fifth-largest economy as per nominal GDP and has a potent environment for growth. Having a country with 3rd largest purchasing power parity it is poised to grow as a market, with 2nd highest population to China and a very distinct demography India has a substantial approach to the Global market and could be one of the key manufacturing hubs in the world. India also has cheap labor and a wide variety of human resource with an average age of just 24 years, which can be developed and tapped by industries to “make in India”.

India has the largest middle-class population in the world with a very big STEM population which is an important attribute for a company to fortify its manufacturing sector and produce World Class Manufacturing products on likes of China. In recent times India has been able to attract a large FDI (foreign direct investment) from the US and the EU who have set their major production units in India for global as well as the local market.

The Planning commission for India was substituted by the NITI AYOOG which made a wide variety of changes in approach to make India a manufacturing hub. NITI AYOOG for that matter not only makes a short term 5-year goals but also long-term goals which will be achievable in 10-30 years’ timeline.

The NITI AYOOG has developed a lot of long-term goals which the government as to achieve in the next few decades of which one of the most important is related to the automotive sector which accounts for about 7.1% of India’s GDP and employs millions of people directly or indirectly.

NITI AYOOG the eminent body for the government’s action plan for the development of Indian industries made various reforms and developed some action plans related to the Automotive industry which focused majorly on the safety, environmental effects of automobile comprising of movement from gasoline engine BSIV to BSVI (similar to EURO VI) which paved the architecture for the next generation of engines which would be efficient. On the other hand, a futuristic development plan for Hybrid and Electric vehicles was also confirmed to promote the use of electric vehicles in India and make India a global market and a manufacturing hub for electric vehicles.

The policies which were framed to promote the electric vehicle market and manufacturing were:

- FAME INDIA SCHEME II PHASE
- AUTOMOTIVE MISSION PLAN 2016-26
- NATIONAL AUTOMOTIVE POLICY 2018
- NATIONAL AUTOMOTIVE TESTING AND R&D INFRASTRUCTURE PROJECT
- NATIONAL ELECTRIC MOBILITY MISSION PLAN 2020
- GREEN URBAN TRANSPORT SCHEME 2017

Apart from the initiatives, the government encouraged the manufacturers with R&D incentives which were tax deduction, the state government also offered various additional benefits for setting manufacturing units like exemption in various tariffs, land costs, relaxation in stamp duty exemption, etc.



These initiatives have made an impact on the overall setup of industries and a lot of startups have sprung up which are working in domains for electric vehicles, which include battery manufacturing, connected cars, and autonomous vehicle.

With all the available resources and policies by the government, the projection for the electric vehicles in India is (fill the data). As the manufacturing sector gets to boost the cost of components and battery would reduce (feed data) from (cost) in 2014 to (cost) in 2018.

Meanwhile, a projection says the Indian EVs market is estimated at \$71.1 millions in 2017 and is anticipated to reach \$707.4 million by 2025, seeing a CAGR of 34.5% during the estimated period. Which is a positive sign leading to a higher investment opportunity in the sector.

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