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Opportunities and Scope for Electric Vehicles in India

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Abstract

Electric vehicles have seen unprecedented growth over the previous decade around the world. In this paper, we first discuss the scope and opportunities of Electric Vehicles in India. We also discuss various policies and frameworks in place by the Government of India. Then, we study the various case studies from around the world on adopting Electric Vehicles. We finally conclude with how India could implement and benefit from these strategies at the local as well as national level.

Keywords: *E-Vehicle, Battery Technology, Electric charging station, Emission*

I. INTRODUCTION

Driven by powerful environmental, macroeconomic and technological factors, the global transportation sector is in a period of historic transition. New business models such as mobility as a service and the increasing economic viability of technologies such as electric vehicles will soon change the way we travel.

According to research by the International Energy Agency (IEA), the global fleet of electric vehicles has increased from just five thousand vehicles in 2008 to more than two million in 2016. This is due to fundamental trends, including growing environmental concerns, a decrease in battery prices and the growing availability of charging infrastructure. All of this has led experts to predict rapid growth in EV use over the next decade - growth forecasts for the current year range from 27% to 33% until 2030. [1]

According to many indicators, China is at the head of the global revolution of electric vehicles. China's share of the global electric vehicle fleet reached 32 percent in 2016, surpassing the United States for the first time. Its share was only 11% in 2011. On the other hand, India's history of EV has been disappointing so far. Lack of loading infrastructure, inconsistent government support and early product failures have all led to the stagnant growth in recent years. However, the government has set a clear and ambitious goal of adopting 100% electric vehicles by 2030, and the country's leading think-tank, NITI Aayog, outlined the outlines of a long-term global mobility strategy. This has already led to concrete measures to help stimulate the growth of electric vehicles. Energy Efficiency Services Limited (EESL) has launched a tender for 10,000 four-wheel electric vehicles in 2017, the largest purchase in the world so far. In the three-wheeled vehicle and bus segments, the government plans to introduce battery replacement to separate battery costs from vehicle costs and facilitate the charging process. Standards for the first generation of public chargers for electric vehicles have been defined, and a second-generation is in preparation.

The strategy for growing electric vehicles in India revolves around two basic assumptions: aggregating demand for types similar to EESL can help scale up quickly, and the battery exchange model can help reduce initial costs of electric vehicles and improve the charging experience. Electric vehicles are five times more efficient than vehicles emitting emissions.[2]

If demand consolidation and battery exchange are successfully implemented, India expects to reach EV sales of more than 1.6 million vehicles in FY23. Public procurement and public transport will be the main drivers of this growth, through the purchase of government vehicles, three-wheeled vehicles and buses for public transport. Growth in the four-wheel vehicle market is also expected to be driven by private fleet investments such as Ola and Uber, where increased daily traffic makes electric vehicles more economically viable. The space reserved for two-wheeled vehicles will be mainly managed by private owners and by subsidies and will be characterized by the migration of lead-acid batteries to lithium-ion batteries and low-speed vehicles to high-speed vehicles. [9]

Despite this promising growth, the government's 2030 targets are expected to be ambitious and may not be met due to lack of industry and consumer preparedness, given the relative economic situation. Growth forecasts [9] suggest that electric vehicles will account for less than 2% of total vehicle sales by 2023. The government's target of 100% penetration by 2030, therefore, seems far from clear. To be achievable. Even if India achieved its ambitions by 2030, this would not necessarily result in a significant reduction in our dependence on imports. While cumulative oil imports for the automotive industry from 2017 to 2015 in the "business as usual" scenario are expected to rise to 40 lakh crore INR, India would still have an import bill of 15 lakh crore INR for lithium-ion batteries and 17 lakh crore INR for oil in case he completes his transition to electric vehicles. This translates into an economy of 8 lakh crore INR. Although India still has a long way to go to achieve its ambitions in electric vehicles, it is clear that electric vehicles offer a high growth opportunity in the short term in key segments and will undoubtedly be an inevitable break long-term; a strategy that requires a coherent strategy at the level of governments and companies.[9]

II. REVIEW OF LITERATURE

The Indian auto industry is the fourth largest in the world and is expected to become the third-largest in 2021. The industry accounts for 7.1% of India's gross domestic product (GDP) and the 2016-2026 automotive mission plan of India. The Indian government aims to: This figure is expected to reach 12%. The Indian auto industry (including component manufacturing) is expected to grow at 5.9% per year and reach INR 16.18-188 billion (251.4 to 282.8 billion US dollars) by 2026, which will make it the fastest-growing. Industry in the country.

According to the report of the National Mission Plan for Electric Mobility 2020, the Indian car market is governed by two-wheeled vehicles, which account for 75% of the total number of vehicles sold in the country. And the passenger car segment is dominated by the small car segment, and it is increasingly likely that the number will increase significantly by 2030.

This information was corroborated by the report of the Society of Indian Automobile Manufacturers (SIAM) entitled "The Car Industry in General Growing Steady with Marginal Double-Digit Growth in Passenger Vehicles", which indicates that the sector has produced a total of 1.95 crore vehicles, including commercial, commercial, three-wheeled and two-wheeled vehicles and quadricycle in April-October 2018, compared to 1.71 crores in April-October 2017, recording a growth of 14.39%.

With regard to the sale of vehicles in the industry, the passenger car segment increased by 5.87%, the commercial vehicle segment by 35.68%, the three-wheel segment by 31.97% and two-wheelers 11.14% in April same period of the previous year.

Although India has seen an increase in vehicle sales year-on-year, the number of motor vehicles in the country remains low, with only 18 cars per 1,000 inhabitants, compared to nearly 69 in China and 786 in the United States. US11. This indicates that a large proportion of Indians do not own a vehicle and depend on shared or public mobility means.

In the face of the growing predominance of Indians in road and rail transport, buses and public trains have been the main mode of transport in the country. The report, Key indicators of household spending on services and Durable goods, published by the Ministry of Statistics and Program Implementation in 2016, indicated that buses are the most popular means of transportation in both rural and urban areas. According to the report, buses represent the maximum expenditure of about 66% of households in rural areas and 62% of households in urban areas. Other modes of transportation include rickshaws, taxis and trains. However, supply has not been able to catch up proportionally with growing demand due to population growth. In addition, the share of public transit buses has decreased, necessitating an overhaul of the public transit system in the country. This has led to the growth of application-based booth aggregators and is synonymous with smartphone penetration. Today, India's two largest application-based taxi aggregators provide nearly 3.5 million daily trips. This has transformed the sector in terms of mobility and is a turnkey solution. However, in the long-term perspective, an efficient public transport system in the country is needed, with vehicles running on electricity or alternative fuels, making this mode of transport efficient, convenient, comfortable and safe, and encourages people to opt for public transport. In this regard, the Indian electric vehicle industry is making great strides. The National Mission Plan for Electric Mobility (NEMMP) 2020 was launched by the central government in 2013 to stimulate the manufacturing of hybrid and electric vehicles in India and aims to produce seven million electric vehicles by 2020. This initiative has supplemented by the government, providing demand-side incentives through its FAME program (Rapid Adoption and Manufacturing of Hybrid and Electric Vehicles in India). Private auto players took up the challenge and invested in R&D facilities and the establishment of additional manufacturing units for electric vehicles. In addition, the government has decided to finance up to 60% of R & D costs for the development of low-cost local electric technologies, global players in the automotive industry invest heavily in R & D on energy technologies. Electric vehicles in India.

India's electric vehicle industry should definitely get a makeover thanks to the government's initiative. The differentiator will be how automakers will deliver unique, tailored services to different segments while meeting prescribed standards, quality and rate of innovation. This will catapult some organizations to the next league and, at the same time, will see others fall.

India EV Scenario

National Electric Mobility Mission Plan (NEMMP) 2020

- To deploy between 5 and 7 million electric vehicles in the country by 2020.
- Stresses the importance of government incentives and coordination between industry and academia.
- The target of 400,000 passenger battery electric cars (BEVs) by 2020 ~ avoiding 120 million barrels of oil and 4 million tons of CO2.
- Reduce vehicle emissions by 1.3% by 2020
- The total investment required of 20,000 to 23,000 notches (approximately 3 billion USD). [4]

Electric vehicle sales declined steadily between 2012 and 2015, before showing signs of recovery. India's electric vehicle market was dominated by two-wheeled vehicles, accounting for more than 90% of the two Lakh electric vehicles in India. Although the majority of electric four-wheeled vehicles on the road now use lithium-ion batteries, most two-wheeled electric vehicles and almost all three-wheeled electric vehicles still use lead-acid batteries (unlike 'other countries).

A variety of reasons, from infrastructure to strategies to early product failures, have contributed to this trend. Among these, note: [13]

• Charging facilities are virtually non-existent, although charging station installations have recently started modestly due to recent efforts by entities such as Tata Power and NTPC.

• Government support has been uneven so far, with reduced funding and delays in implementing EE policy.

• Local component manufacturers are few in number and heavily dependent on Chinese imports.

The first products of two-wheeled vehicles and four-wheeled vehicles suffered setbacks. For example, the first competitors in the two-wheeled electric vehicle sector in India were low-power Chinese electric mopeds that performed poorly in terms of power and durability. Mahindra Reva, India's leading competitor in the four-wheel-drive electric vehicle market, has failed due to lack of loading infrastructure and high initial costs.

III. TECHNOLOGIES

Principle: the electric motor is powered by a controller that retrieves it from a rechargeable battery. The electric vehicle operates on an electric/current principle. He uses a battery to power the electric motor. The engine then uses power (voltage) received from the battery to rotate the transmission system, thereby turning the wheels. A potentiometer is connected to the accelerator pedal that tells the controller how a lot of power has to be delivered.

Battery Technology

Over the past 15 years, lithium-ion has grown dramatically and has become widely used for portable electrical products. The most used battery in an electric vehicle is the Li-ion battery. These batteries have been tested on the road all over the world and are the most suitable for electric vehicles applications. [14]

Principle of the Li-ion battery

Lithium ions are inserted or extracted from the interstitial velocity between the atomic layers within the active material of the Li-ion battery during a typical charge/discharge cycle. In simple, in other words, the Li-ion is exchanged between anode and cathode through a lithium electrolyte.

The operation of a Li-ion battery depends on the "intercalation" mechanism (i.e. inclusion of a molecule in materials with a stratified structure). This process includes the inclusion of Li ions in the crystal lattice of the host electrode without affecting its quality crystal structure. The electrodes involved in Li-ion batteries have two essential properties:

I. They have an open crystalline structure that allows the insertion/extraction of Li-ions freely.

II. Electrodes have the ability to accept compensating electrons at the same point of time.

The efficiency of Li-ion batteries has a typical range of 95-98% in its life cycle.

Electric Vehicle Charging Methods

The efficiency of a battery charger is a measure of the efficiency of the power electronics used to convert the mains AC power supply to a regulated DC voltage across the battery terminals. The efficiency of the battery charger according to current technologies available worldwide varies in percentage from low 70 to high 90. Existing technology supports mainly three types of charging methods:

1. Alternating current and an onboard charger (normal charge) - In this charging method, the vehicle is connected to an AC power source (normal 16 A plug - domestic load) from which the alternating current is transmitted to an onboard station charger. The function of the charger is to convert the AC power to DC power and to provide the resulting current to the Li-ion battery. Therefore, it takes 6-8 hours (in the Indian context) fully charge an electronic vehicle by this method of loading, which can be carried out according to the domestic consumption of electrical units per month. It is charging source a little cheaper than the fast charging method.
2. DC power and external charger (fast charge) - This method of the load involves an external charger or fast charging equipment that directly converts the alternating current supplied by the network into direct current for the use of the battery. The fast charge

This method takes about 90 to 110 minutes (Indian context) to fully charge an electronic vehicle. This billing method requires a larger initial investment and represents a higher cost—charging method.

3. Wireless charging method - This charging method uses coupled systems magnetic field to transmit power without any physical connection. There are three types of wireless charging techniques - using the principle of electromagnetic induction, electromagnetic resonance and radiofrequency waves to transmit power.

Comparison among Internal Combustion Engine, Hybrid and Electric Vehicles

Parameters	ICE Vehicles	Hybrid Vehicles	Electric Vehicles
Efficiency	Converts 20% of the energy stored in gasoline to power the vehicle	Converts 40% of the energy stored in gasoline to power the vehicle	Converts 75% of the chemical energy from the batteries to power the vehicle.
Speed (Average Top Speed)	199.5 km per hour (kmph)	177 km per hour (kmph)	48-153 km per hour (kmph)
Acceleration (average)	0-96.5 kmph in 8.4 seconds	0-96.5 kmph in 6-7 seconds	0-96.5 kmph in 4-6 seconds
Maintenance	High maintenance owing to more number of moving parts	Same as an ICE vehicle	Maintenance is minimal due to lesser number of moving parts.
Mileage (average)	Can go over 480-500 kms before refuelling. Typically achieves 10-12 kmpl	Typical achieves 20-25 kmpl	Can travel 120-200 kms before recharging.
Cost (average)	INR 0.7-1.1 million	INR 1.2-2 million	INR 0.9-6 million

Figure I. ICE, Hybrid and Electric Vehicle Comparison [3]

IV. INDIA'S STRATEGY AND POLICY FRAMEWORK

The main initiatives taken by the government for each category of electric vehicle development are: [6]

3 wheels:The Government manages public procurement via EESL. For the sake of efficiency, a consensus is being made between Original Equipment Manufacturers (OEMs) on the efficiency and specifications of modular locking batteries. This last point is essential to ensure that replaceable batteries are interoperable and cannot be tampered with. The government is working with more than 50 manufacturers to implement common specifications for modular latching batteries. The objective is to use a permutation with locked batteries with a range of 50 km and an efficiency of 35 to 45 Wh / km. The government can launch a tender for 25,000 vehicles this year in this segment.

4 wheels:In this segment, the focus is on taxi fleets, whose higher mileage makes the transition to electric vehicles more economically viable than private owners. Government initiatives have been around to allow a combination of fixed and exchangeable battery in the future. A tender for 10,000 electric vehicle vehicles was launched, won by Tata and Mahindra in October 2017. EESL recently announced its intention to launch an additional call for tenders for 10,000 electric vehicles from March to April 2018.

Buses:The Government allows the exchange of bus batteries with a range of 50 km. The effort required to charge the batteries will be one of the main challenges associated with exchanging batteries for buses. Therefore, it is planned to use robotics at the endpoints. In this segment too, the government is building consensus on efficiency specifications and locked batteries. It hired 30 manufacturers to enable the definition of common modular locked battery specifications. An efficiency of 900 Wh / km is targeted. A tender for 2,000 buses could be launched in 2018.

Public Chargers:Applying the Public Call Office Model (PCO) / Standard Toll Numbering (STD) to battery exchange would allow private participation in the purchase of batteries and the operation of public battery exchange stations. This model will be critical to achieving the scale and penetration required in load infrastructure. The government has set standards for the use of Bharat AC-001 and DC-001 chargers for 2- and 4- or 4-wheel vehicles. The standards for fast chargers for large vehicles (AC-002, DC-002) have yet to be defined. A call for tenders for 4,000 chargers compliant with AC-001 / DC-001 was launched in August 2017. An additional call for tenders for 250 chargers was launched in November 2017 [7].

E-Rickshaw:

- The Indian government announced the Deen-Dayal program in June 2014, which would contribute to the financing and acquisition of battery rickshaws in the country.
- In March 2015, the Motor Vehicle (Amendment) Bill was approved, establishing battery-powered electric rickshaws as a valid means of commercial transportation.
- Battery operated 3-wheeled vehicles with a maximum power of 4,000 watts.
- The number of battery-powered electric rickshaws in Delhi increased from 4,000 in 2010 to more than 1,000,000 in 2014 and is now an integral part of the state's transportation ecosystem.
- 4 passengers, luggage of 50 kg and with a single journey of fewer than 25 kilometres.
- In January 2014, Tripura became the first state in India to regulate the operation of e-rickshaws. To this end, they have come up with the battery-powered Tripura rules of the 2014 battery.
- The Tripura Battery Operated Rules 2014 Regulation contains standards and guidelines such as the driver's age limit, registration fees, renewal fees, traffic taxes and provisions for the vehicle's certificate of suitability. Rickshaw insurance and route

identification for the use of these vehicles.

- 22,000 licenses granted.[16]

These initiatives must support the ambitious goals set by the Indian government for the adoption of VE across the country. Key ministers' statements also announced the ambition to completely eliminate gasoline and diesel cars by 2030.

Although the government seems to be giving a big boost, there is scepticism about the possibility of achieving these goals. The International Energy Agency (IEA) praised India's ambition for 2030 targets but pointed out that they would require nearly eight times the current global stock of electric vehicles.

A recent White Paper from the Society of Indian Automakers (SIAM) predicted a 100% transition to electric vehicles only by 2047, with 40% of new vehicles sold being electric vehicles by 2030.

In order to reduce the gap between the projections and the successful implementation, it will be essential to identify pressure points in the current framework and proactively address them. As in China, the downward trend in lithium-ion battery prices will stimulate the Indian market for electric vehicles.

The Indian policy framework seems to be based on the assumption that affordability can be improved by aggregating demand and exchanging batteries. The aggregation of demand aims to generate economies of scale through the establishment of a single entity such as EESL anchoring activities, such as wholesale purchases. Battery exchange involves making charged batteries readily available in-vehicle distribution centres, which will reduce initial EV costs and significantly reduce charging time.

On the demand side, park operators, such as Ola and Uber, should be the first to adopt government procurement. Private vehicles should be late in adopting four-wheel-drive electric vehicles. Demand in 3 market segments is as follows: [13]

***Public procurement*:** the government pushes the adoption of electric vehicles through major tenders for private manufacturers of electric vehicles. He launched a call for tenders for the acquisition of 10,000 electric vehicles via EESL. This tender was jointly won by Tata Motors and Mahindra. A second call for tenders is expected in the first half of 2018. Similarly, calls for tender for the acquisition of buses are expected in 2018 [6].

Fleet Vehicles*:* Fleet owners such as Ola and Uber have confirmed their intention to purchase electric vehicles as part of their fleet. Ola, who manages 200 cars in Nagpur as part of a pilot program, plans to expand its fleet of electric vehicles in the future. Mahindra also announced plans to launch its own taxi aggregator business in competition with Ola and Uber, focusing on the rise of electric vehicles to be used for carpooling.

Private vehicles*:* The penetration of lithium-ion vehicles into the private ownership segment would be slow as it faced many obstacles. The initial cost of the vehicle and the battery remains high. Since the mileage of vehicles used by private individuals is much lower than that of a taxi, the possibility of recovering the cost thanks to fuel savings is less. In addition, the lack of charging stations and the worry of running out of charge make it very difficult for private owners to switch to electric vehicles immediately.

V. CASE STUDIES

A. China

In recent years, China has established dominance over the stock of electric cars, with one-third of the global stock in 2016. A plethora of research and new investments are heading towards the Chinese market. These include Daimler's joint venture with BYD and investments by SAIC, Honda, Toyota, Ford with Anhui Zotye, and so on. China has made it clear that it intends to dominate the electric vehicle market. In accordance with the Made in China 2025 industrial policy, it wishes to either dominate globally or become a major competitor in 10 high-tech industries. New Energy Vehicles (NEVs) and partially or fully electric cars are part of this goal. To this end, China has provided significant support to the industry through grants and policy decisions.

Some of the important of them are::

• ***Reduced taxes****:* NEVs were exempted from the standard consumption tax that consumers pay on new cars as of 2008.

• ***Grants to Industry****:* Billions of dollars have been provided in the form of direct subsidies to NEV manufacturers. The amount of the subsidy was such that it helped to quadruple sales in 2015 [9].

For example, Shenzhen-based manufacturer BYD received $ 435 million in grants between 2010 and 2015, making it the champion of state-sponsored electric and hybrid vehicles in China. The central government has allocated more than the US $ 15 billion to support the development of energy-efficient vehicles and electric vehicle infrastructure. Generous subsidies and sustained sales led 200 companies to announce plans to manufacture and sell motor vehicles in China.

• ***Customer Grants****:* The Chinese Government launched a consumer subsidy program in 2010, providing about $ 8,700 per car. Local governments have also created their own grant programs offering additional discounts on NEV purchases in the form of cash grants, free parking spaces or free number plates. Local and central subsidies together accounted for about 20-40% of the cost of the vehicle.

• ***Government Procurement:*** In 2014, the government imposed on NEVs to constitute 30% of all government procurement. In 2016, the figure was revised to 50%.

The infrastructure of charging stations is an important area that will require acceleration to achieve China's goal of being a world leader in electric vehicles.

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The number of charging stations in China increased from 76 in 2010 to 5,600 in 2016, for a CAGR of 104%. The number of public stacks increased from 1,122 to 150,000 with a CAGR of 126% over the same period. In addition to the public charge batteries, the total number of private charge cells in 2009 is approximately 170,000, bringing the total number of charge cells in the country to nearly 310,000 (the largest in the world).

However, given China's ambitious targets for charging station infrastructure, much remains to be done. China plans to build 12,000 centralized battery charging and exchange stations and 4.8 million distributed battery cells across the country by 2020 to meet the demand for 5 million electric vehicles, the goal is to reach the vehicle/battery ratio. According to the State Grid Corporation of China (SGCC), the goal is to reduce the maximum distance between charging stations within 5 km in the suburbs, 3 km in the suburbs and 1 km in urban areas. To this end, China must invest about 19 billion USD.

B. Norway[12]

Electric vehicles (EVs) are treated much more leniently in Norway. This includes certain tax exemptions as well as various driving privileges, such as the use of buses and lanes in cities, the exemption of parking fees in city centres and often the charging of batteries at a cost no. As a result of this policy, sales of electric vehicles have increased significantly in recent years. While the number of electric vehicles on Norwegian roads was only a few hundred until 2005, it accounted for 1.4% of conventional new car sales in 2011. This percentage rose to 5.5% in 2013, and the stock of electric vehicles has almost doubled—five times from 2011 to 2013.

The generous Norwegian policy on electric vehicles has been progressively implemented over the past 10-15 years and is now an integral part of the so-called "Klimaforliket" climate agreement between the parties to the Norwegian Parliament. The policy is rooted in certain laws and regulations, mainly established by the Norwegian Ministry of Finance and the Norwegian Ministry of Transport. These laws and regulations, as well as the policy measures implemented in some of the major cities, constitute the Norwegian policy on electric vehicles. It basically consists of a set of tax exemptions with certain driving and economic privileges for electric vehicle users. At present, he understands the following points:

• Electric vehicles are exempt from VAT and other taxes on car purchases and sales.

• Parking in public parking spaces is free.

• Electric vehicles can use most toll roads and several ferry lines for free.

• Electric vehicles are allowed to use bus lanes and collective lanes

• The tax on company cars is 50% lower on electric vehicles and the annual tax on motor vehicles/road tax is also lower.

• Battery charging is free in a rapidly growing number of publicly funded charging stations.

C. Amsterdam

The case of Amsterdam is a good example of how a public charging infrastructure combined with policy measures can play a positive role in stimulating electric mobility in an urban context (van der Hoed, 2013). The city currently has more than 400 charging stations. Consumers can find the location and capacity of each charging station on the website. This growth in the number of charging stations and the ease of access to information has encouraged the use of charging infrastructure in terms of the number of sessions and recharge times.

Highlights of Amsterdam EV scenario:-

- Amsterdam played a pioneering role in the development process of Dutch / European charging connectors. The defined standard applies to all Dutch and European car manufacturers.
- In 2011, the first European fully electric taxi company (Taxi Electric) was created in Amsterdam.
- From October 2014, all taxi trips from Amsterdam Schiphol Airport are made by electric car (the Tesla Model S).
- In December 2011, the city of Amsterdam implemented a new subsidy system to simulate the move to electric transport of company car users. This grant program helped 750 electric vehicles on the roads (February 2015).
- Car2Go offers 350 electric cars in Amsterdam as part of its carpool program. An international first is that all Car2Go vehicles in Amsterdam are 100% electric. Car2Go cars can use charging stations located throughout the city and are allowed to park on all city parking spaces without the driver incurring additional parking fees.
- The Amsterdam Arena stadium car park is

home to the first smart charging hub in Europe (and probably the world). The 20 charging points communicate with each other to determine which car requires the most power.

VI. CONCLUSION

Our analysis leads us to three main conclusions about the future of EV adoption in India.

If both the exchange and aggregation of demand work as expected, India could reach a volume of electric vehicle sales of more than 1.6 million vehicles in fiscal year 23, mainly because of public contracts and three-wheeled vehicles.

Public procurement is expected to be an important driver of growth in the coming years, with the purchase of four-wheeled vehicles for government offices, three-wheeled vehicles and buses for public transport. Investments by fleet operators such as Ola and Uber, as well as some operators of food distribution services, are also expected to boost the initial growth of two- and four-wheeled electric vehicles. However, the adoption of private four-wheelers and two-wheelers could also reach an inflexion point in the next five to six years, due to lower battery costs and increased battery availability. Charging infrastructure. The composition of the clientele and the determining factors for each category should be as follows:

• ***4-wheelers****:* this will be largely driven by public markets and fleet operators. Public contracts should be 30,000 vehicles until 2023, when there may be a turning point for adoption by private owners with low mileage.

Mahindra and Tata will continue to increase their presence to meet government contracts and growing private demand. Multinationals such as Nissan, Hyundai and Honda are also expected to enter the next few years.

• ***Two-wheeled vehicles****:* the segment will be privately owned and subsidized, and will be characterized by migration from lead-acid batteries to lithium-ion batteries and from low-speed vehicles to high-speed vehicles. For example, all major equipment manufacturers such as Hero, Ampere, TVS and Lohia have two very powerful electric wheels. Many startups focusing on higher-performing vehicles are also appearing and will begin sales in 2018, such as Ather, Tork and Emflux. However, most of these manufacturers will continue to import electronic components.

• ***3-Wheelers****:* Electric rickshaws are probably the fastest-growing segment - manufacturers such as Mahindra, Kinetic Green and Autolite have already launched models or will launch models in 2018, which will strengthen the application of standards and registration, thus creating a powerful driver market. Electronic car sales are also expected to increase due to the arrival of OEMs such as Bajaj and TVS, although they will continue to represent a relatively smaller share of the overall category of three-wheeled electric vehicles. Aggregation of demand through government procurement and battery exchange is expected to play an important role in early adoption.

• ***Bus****:* Major OEMs such as Ashok Leyland, Tata and BYD will continue to test and test in the coming years. The battery exchange will reduce initial costs and increase purchases from EESL and STUs. However, the increase in load may be slower than that of 3-wheeled vehicles.

In the long run, the innate economic and social attractiveness will make an electric vehicle boom inevitable in India.

The continued decline of lithium-ion batteries will significantly reduce initial costs. Improved battery technology will make EVs more affordable and more efficient. Private investment in infrastructure will likely be a function of demand related to the above. To remain cost-competitive and enable faster ramp-up, electric vehicle manufacturers will increase their domestic purchases.

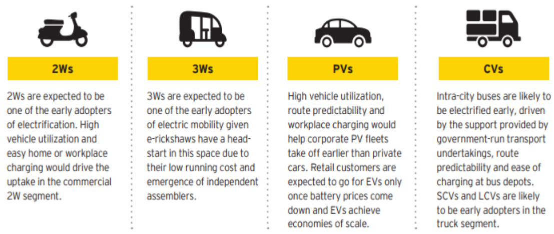

Figure II [8]

If the government's 2030 targets are met, India could save 8 INR lakh Cr (a 20% saving over a BAU scenario) on gasoline and diesel imports for the industry during the period considered, after considering a certain level of batteries. Thus, switching to electric vehicles will not necessarily reduce our import dependency. However, the impact on the environment will be significant.

There could be two possible scenarios: a Business as Usual (BAU) scenario, in which fossil fuel dependence for the automotive industry or a scenario in which the country would achieve its 2030 EV goals.

• ***BAU scenario****:* In the BAU scenario, India would need more than 1.6 billion tonnes of gasoline and diesel to supply its automotive industry from 2017-30 [10]. With a crude oil price estimated at 52 USD / barrel, this would represent a value of 670 billion USD or 44 INR lakh Cr. If India imports 90% of its oil, its imports of oil for the automobile industry amount to 40 lakh Cr.

• ***Scenario where India meets its ambitions for 2030****:* Achieving the Government's targets for 2030 will require at least 3,500 GWh of batteries, for a total value of US $ 300 billion, which equates to about 20 Cr lakh. Indian manufacturers can take 25 to 40% of the value of this market if they assemble packaging in the domestic market. Thus, cell imports would total 12-15 INR lakh Cr. Imports of gasoline and diesel should be reduced to 17 INR lakh Cr, which will create an opportunity for savings of 8 INR lakh Cr.

Electric vehicles are an inevitable disruption that is changing the way we travel around the world. Developing an aggressive strategy for the adoption of EVs in India and ensuring a well-executed implementation is both a challenge and an imperative for the government. The geography and diversity of this country will present problems that require thoughtful solutions that are not yet visible in the field.

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