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Two- and Three-Wheeler Electric Vehicles in India – Outlook 2019

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Abstract

The author proposes to "review" the status of all types of two- and three-wheelers in India. For both these vehicles, India has a unique distinction of being world's number one producer, providing jobs to millions of people all over India in the manufacture of these vehicles, in the ancillary units manufacturing the parts, and in the distribution / service centres of the suppliers. Further, both these vehicles contribute towards a healthy growth in export and foreign exchange every year. The paper also tries to bring out the status of application of battery technology in these vehicles. There appears to be some hesitation among the two-wheeler Indian manufacturers in bringing out large number of battery-operated two-wheelers as desired by Indian Government. But fortunately, a silent revolution is taking place regarding battery-operated three-wheeler vehicles in India. In the end, a few proposals are being put forth for consideration by Central / State Governments, Public Sector Organizations and manufacturers of electric vehicles for improvement in adoption of the two- and three-wheeler electric vehicles in India.

Keywords: Road Transportation, Two- wheeler and Three-wheeler Vehicles, Electrification of Vehicles, Job Opportunities, Recommendations for Government and Manufacturers

1.. INTRODUCTION

After the world oil crisis in 1973 [1], discussions had taken place in every forum and several international efforts were made to reduce the use of fossil fuels in the two major sectors. The first sector was electric power generation, for which all the countries agreed: (a) to reduce the number of new fossil fuel based power plants; (b) to shut-down the old and inefficient fossil fuel based power plants; (c) to increase the

contribution of renewable energy in electric power generation; and (d) to introduce efficient equipment and processes in domestic and industrial applications, commonly referred to as "Demand Side Management" (DSM).

The second sector was transportation, where apart from the increased cost of fuel, the serious concern was increasing pollution in cities, affecting the health of citizen. Increased efforts were made by the governments of all countries and also the major vehicle manufacturers to introduce and ensure public acceptance for the use of battery-powered electric vehicles (EVs) in transportation. In Europe, America and many other countries, all the attention related to EVs has been on four-wheelers; because in those countries, a large section of society uses these. No effort is made in this paper to touch the topics of four-wheeler electric vehicles.

India has a different set-up with a large number of two- and three-wheeler vehicles, mostly based on internal combustion engine (ICE). Therefore, this study proposes to bring out the present status of the two- and three-wheelers in India and efforts required in India to increase the adoption of electric scooters (Fig.1) and electric three-wheelers (Fig.2).

Fig.1 Two-wheeler e-scooter

Fig.2 Three-wheeler e-rickshaw

2. PRINCIPLE OF BATTERY POWERED EV

In simplest explanation, the two- or three-wheeler EV is driven by electric motor - mostly Permanent Magnet DC (PMDC) motor - receiving power from battery pack. A controller, using either "Metal Oxide Field Effect Transistor (MOSFET)" or "Insulated Gate Bipolar Transistor (IGBT)" controls the power input to the motor to control the vehicle speed. In a modern EV, the controller also continuously monitors the condition of charge of the battery pack and displays it on the panel.

The charge of battery pack gets reduced as the EV keeps on covering distance. Thus, the battery capacity (Ah, ampere hour; or Wh, watt hour) decides the range that can be covered by the EV with a single charge. The driving range of any EV, and so also

that of two- and three-wheeler EV, can be increased by having a battery pack of higher Wh; but, that increases the size, weight and cost of the EV. Therefore, it is always necessary to select the battery capacity which would give an optimum solution of driving range versus the weight / cost of EV. The commonly used term "battery pack" is a group of multiple battery modules and cells connected in series – parallel (and put in a common enclosure) to give the required voltage and the Ah capacity.

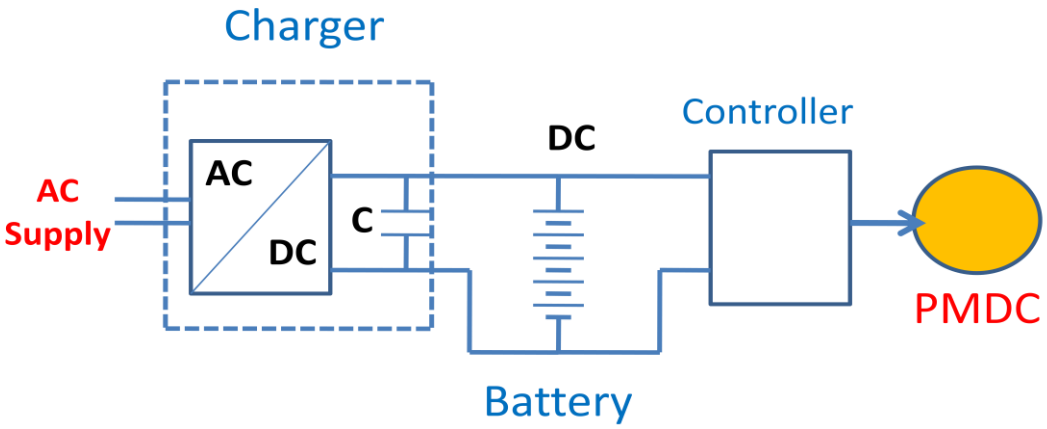

Fig.3 Schematic of a battery-powered two- or three- wheeler EV

After EV covers a certain distance, the depth of battery discharge goes down. When battery charge goes down below a certain level, the battery is required to be re-charged by connecting the battery to the AC supply through a charger (given by the manufacturer along with the EV). In case the EV controller is provided with a regenerative braking system, then whenever the vehicle goes on a downward slope or vehicle speed is reduced, the kinetic energy of vehicle converted into electrical energy is used to charge the battery. Most of the latest EVs have this regenerative braking system, and this feature extends the range covered by the EV with a single charge.

3. TWO-WHEELER EVs IN INDIA

India is a unique country with a large base of growing middle-class people living in urban and also in non-urban area. With public transport in most of the Indian cities not being satisfactory these days, the working-class persons and students are preferring to opt for self-owned transport for commutation to their destination in all the categories of cities (*A-1*, *A*, *B-1*, *B-2*, and C) [2], most of which are struggling with traffic congestion. In this situation, a two-wheeler is the chosen mode of transport, especially by ladies or young people.

In the year 2016, the number of registered vehicles (of all types) was about 23 million [3]. More than 80 per cent of the total numbers of vehicles registered were personalized ones, mostly operated by ICE, running on diesel, petrol or CNG (compressed natural gas). Of these, about 74 per cent (about 17 million) were two-

wheelers and 12 per cent were cars. More dependency on the personalized transport has resulted in increased consumption of fossil fuel, giving increased greenhouse gas (GHG) emissions, resulting in increase in pollution in all the major Indian cities.

In the calendar year 2016 [4], about 17.7 million two-wheeler vehicles were sold in India (mostly operated by ICE), with India becoming the number one country in the sale of two-wheelers, pushing China to the second place with sale of about 16.8 million two-wheeler vehicles. Scooter sales alone accounted for over 5 million of those figures in India, while commuter motorcycles in the 100 - 110 cc segment accounted for nearly 6.5 million unit sales. In 2017-18, the Indian auto makers cumulatively crossed for the first time the sales of 20 million units of two-wheeler vehicles [5]. The reasons for healthy growth in sales of two-wheeler vehicles in the recent years in India can be summarized as follows:

(a)..People do not want to waste time in waiting on roads for the public transport system, which is not able to cope-up with the increase in population of working-class and students (going for colleges / universities) even with many private-operated buses running on roads along with the buses of Government Undertakings.

(b)..It is a fact that the income level of middle-class people is rising in most of the Indian cities, particularly with growth in business of "Information Technology" and "Service Sector" companies. In most of the young families in medium and large cities, both husband and wife are "working people", and the family can easily afford a two-wheeler.

(c)..New models are being introduced regularly by all the two-wheeler manufacturers, giving higher fuel efficiency and hence lower running cost. Also, with a large number of players in the production of two-wheelers, the initial prices have become quite competitive and affordable for the middle-class people. Also, for this segment of vehicles, the banks are willing to give loan for long period, making very affordable monthly installments. That is the reason that, within a short period after joining a job, the young people want to possess their personal vehicle to reach the office in time.

(d)..A large number of "On-Line" marketing companies, food chains, courier services etc are operating in India, giving employment to a large number of young people who can drive two-wheeler vehicles for delivery of ordered materials to the customers.

(e)..A two-wheeler is quite comfortable for two persons to travel. Therefore, it is being used by middle class people (who cannot afford a car): (1) to drop the children to nearby school and pick them up after the classes are over; and (2) for "working" husband and wife to go together to their places of work.

(f)..For daily shopping to market for vegetables or grocery, finding parking place for a car has really become very difficult in every Indian city. In such a situation, a two-wheeler is a vehicle of choice which can easily be parked in a small place available near the shopping centre.

(g)..For middle class families sending their children to colleges or universities, two-wheeler is a preferred vehicle by the students to reach the institution in time as the public transport is not convenient and lacks the "last-mile" connectivity.

3.1 Battery-operated two-wheelers

Government has recently proposed a new plan [6] of making all two-wheelers (up to 150 cc) electric by 2025. This range of two wheelers up to 150 cc (presently with ICE) contributes 90 per cent of the total two-wheeler market in India. This has resulted in a major face-off between the manufacturers and the government. The reason for this face-off is as follows. Earlier, the manufacturers were making two-three- and four-wheeler vehicles conforming to Bharat Stage (BS)-IV emission norms [7]. Very recently, manufacturers were asked to produce vehicles conforming to BS-VI emission norms, for which they have made huge investments. With vehicle sales (particularly the four-wheeler vehicles) going down, the manufacturers have not recovered the investments made for BS-VI and may not be able to recover even up to 2025. Today, most of the manufacturers either have or can get the technology of electric two-wheelers. But again, they have to make huge investments required now for two-wheeler EVs; because the technology of EVs is completely different than that of ICE-driven vehicles. The industries will make investments in phases after observing the growth of EVs. Therefore, with typical "hen or egg puzzle", most probably, only 25 per cent of two-wheelers up to 150 cc segment can be electrified up to 2025, provided that the sentiments remain positive, infrastructure boosts, and companies start producing electric two-wheelers for the market.

Currently, the segment of two wheelers up to 150 cc is dominated by Hero MotoCorp that commands 39.3 per cent of market share, followed by Honda (29.1 per cent), Bajaj Auto (19.3 per cent) and TVS Motor (12.3 per cent) [6]. While some manufacturers have voiced their concerns publicly, country's second largest two-wheeler maker Honda Motorcycles & Scooter has completely denied any plans for e-two-wheelers in India any time soon. Collectively, the top four manufacturers (mentioned above) produced over 1.61 million two-wheelers under 150 cc segment in May 2019 of the total monthly sales of 1.72 million units in India. Industry estimates suggest that the two-wheeler market is expected to grow at a CAGR of 6-8 per cent. This implies that about 2 million electric two-wheelers will be required to be manufactured per month by 2025.

India sold more than 21 million motorbikes and scooters in the year 2018-19. Electric scooters accounted for just a fraction of the above total, although the sales of e-scooters more than doubled to 126,000 in the 12 months, from 54,800 a year earlier,

according to the data from the Society of Manufacturers of Electric Vehicles [8]. In the Indian Budget for 2019-20, the Government has announced customs duty exemption on lithium–ion cells, which will help lower the cost of lithium-ion batteries in India as they are not produced locally [9]. That would reduce the cost of e-scooters, increasing their sales.

Today, the situation is that there are knowledgeable young people who would like to purchase e-scooters due to its lower running and maintenance costs and no tail-pipe emission of CO_2. But, the production of e-scooters in India is lower as compared to the demand; resulting in a long waiting period after booking. While there is competitive market for two-wheeler vehicles (motorbikes or scooters with ICE) offering the "Off-the-Shelf" vehicles at affordable initial cost, the prices of e-scooters are higher. Another issue with e-scooter has been that its driving power is not sufficient to go faster or climb a steep gradient. Also, as supply chain of e-scooter parts in India is not robust at present, the manufacturers have to rely on import, resulting in increased cost and uncertainty in cost estimation.

4. THREE-WHEELER EVs IN INDIA

Apart from the two-wheelers, Indian middle class people have been making extensive use of three-wheeler vehicles. Manually-driven rickshaws have been on streets for many decades; and then, ICE-driven auto-rickshaws appeared and are being used in almost all the cities for transportation of people and goods.

India is the largest manufacturer of all types of three-wheeler vehicles. The three-wheeler segment (mostly with ICE) has reported a robust 24 per cent growth in overall volume (sales) in 2018-2019, due to 49 per cent growth in exports. Total sales of three-wheelers during 2018-19 stood at 1.269 million units, against 1.017 million units in 2017-18 [10]. While the domestic sales during 2018-19 saw a 10 per cent growth to 701,011 units as compared to 635,698 units in FY18, exports supported domestic sales heavily with 49 per cent growth to 567,689 units in FY19, against 381,002 in the year-ago period, said the data from Society of Indian Automobile Manufacturers (SIAM). This could be possible primarily due to enormous demand for the low-cost Indian three-wheelers in Asian and African regions.

A typical sight seen in Noida or Ghaziabad in Uttar Pradesh State of India is a battery operated three-wheeler (e-rickshaw), near most of the Metro Railway Stations, bus stands or in markets. The e-rickshaws were introduced in Delhi during the "Commonwealth Games" in India in 2010; but these gained popularity in India since 2015. Almost 300,000 battery powered rickshaws have now replaced the cycle rickshaws in key markets of the North East, Uttar Pradesh, West Bengal, Delhi and Bihar States of India [11]. These battery-powered three-wheeler vehicles have become one of the fastest growing segments in India, with a compounded growth rate of 20 per cent in the past four years. In 2015, e-rickshaw sales were 170,000 units. The figure slated to grow 25 per cent annually from 350,000 units in FY18 to a million units by FY25.

It is very popular because of its easy availability for hire wherever one requires it (almost at the "door-steps") and fixed low rates of either Rs.10 or Rs.20 (depending upon distance) for commutation between homes / offices and the nearest Metro Railway Stations or bus stands where there are no other means of travel. The e-rickshaws have already replaced cycle-rickshaws in most areas and are slowly inching out auto-rickshaws (ICE-driven). Some of the reasons for the growth of e-rickshaw are as follows [12]:

(a)..According to the notification issued on June 17, 2019 [13], the minimum charge for auto-rickshaw in Delhi will be Rs.25 for the first 1.5 km, and thereafter, the charge per km will be Rs.9.5; thus, for a travel of about 3.5 km, the people have to pay the hire charges of Rs.44. Therefore, for short distances from residence to market, or from Metro Railway Station or bus stands to the destination, e-rickshaw with low rates of Rs.10 or Rs.20 has become the mode of transport, providing the "Last-Mile Connectivity" for a large number of common people. Of course, apart from economical advantage of e-rickshaw as compared to the auto-rickshaw for a short distance, smokeless travel ("Green Transport") is an attractive feature.

(b).Most of the jobs would require some skill and its training by some trainer, along with payment of training fees. But, an uneducated and even not so young person can easily do self-learning by driving an e-rickshaw for a few days along with a friend, as the controls are very simple. That is reason that e-rickshaws have provided self-employment all over India to a large number of rural people (migrating to cities in search of livelihood), even if they are not educated. A report [14] by 8th Urban Mobility India, Conference & Expo 2015 has brought out that: (1) nearly half of the drivers of e-rickshaws are uneducated; and also (2) nearly half of the drivers are in the age group of 19 – 30.

(c)..Drivers of the three-wheeler e-rickshaw discovered that e-rickshaw is quieter, faster, cleaner and cheaper to maintain than a traditional auto-rickshaw. E-rickshaw is also less strenuous than cycle rickshaw, which requires all-day peddling. Further, while the cycle-rickshaw normally carries two passengers, the e-rickshaw can carry up to four passengers. So with more rides possible in a day and with more number of passengers carried every day, the e-rickshaw is proving more lucrative than the cycle-rickshaw. One more psychological difference the people feel is that, the cycle-rickshaw driver was looked down as a manual labourer, whereas the e-rickshaw driving is recognized as a better job.

(d)..Another favourable aspect of e-rickshaw is initial cost of about Rs.130,000 (with drive range of about 80-100 km with one charge, and no registration or insurance charges in many States of India) as compared to the initial cost of more than Rs.200,000 for the auto-rickshaw (plus registration and insurance charges, charges for

renewal of insurance every year, and necessity of "Pollution Under Control" certificate every six month).

(e)..The maximum speed of 25-30 kmph for e-rickshaw is not an issue as it is mostly being used for short distance, where people can reach in 10-15 minutes.

(f)..The maintenance requirement of e-rickshaw is practically negligible. Even the running charges are lower than the auto-rickshaw.

(g) As compared to a closed taxi (cab) going at 80 kmph, or a closed auto-rickshaw going at 50 kmph, the ladies (when alone) feel safer to travel in an open-type e-rickshaw going at 25 kmph. This is because if any unsocial person tries to create problems for the ladies travelling in e-rickshaw, then they can shout for help, so that the nearby people can stop the e-rickshaw, catch the unsocial person, and hand him over to the police.

By Oct 2018, there were about 1.5 million battery powered three-wheeler vehicles in India. As many as 11,000 new e-rickshaws hit the streets every month [15], and annual sales are expected to increase faster, according to consulting firm A.T. Kearney. Three-wheeler EVs make up more than Rs.100 billion market, and manufacturers of electric versions include Mahindra & Mahindra Ltd and Kinetic Engineering Ltd, along with smaller outfits. Many small manufacturers find it convenient and financially lucrative to import only the low cost parts from China and assemble the e-rickshaw with FRP body in India. "This is once-in-a-lifetime, transformational opportunity that we're looking at," said Goldie Srivastava, chief executive officer and co-founder of SmartE, an Uber-style app using 800-plus e-rickshaws around New Delhi. India's dominant ride-hailing startup, Ola, plans to place 10,000 e-rickshaws in its service by April 2020. SmartE partnered with Delhi Metro Rail Corporation is providing charging points near 10 Metro Railway stations, with plans to expand throughout the 214-station system by the end of 2020.

Most of the State Governments in India are encouraging the deployment of e-rickshaws. Many cities in the State of Haryana are presently having small or medium-scale industries for the manufacture of parts of all types of ICE vehicles. But, in the last few years, a large number of medium-scale manufacturers have come-up in Haryana for producing or assembling e-rickshaws. A number of e-rickshaw manufacturers have their distribution centres in all the major cities of Haryana, making it very convenient for the buyers to see and choose the e-rickshaw. This has made e-rickshaws popular throughout the Haryana State. The same is the situation in Noida and Ghaziabad cities of Uttar Pradesh State.

Also, Gujarat Government [16] had announced in Oct 2018 that subsidies worth Rs.30,000 for e-rickshaws with lead acid batteries and Rs.40,000 for vehicles with lithium-ion batteries will be provided to manufacturers for the year 2018-19.

Many news reports are mentioning that the actual number of e-rickshaws will be much more than the officially known figure; because e-rickshaws do not require registrations in a number of States in India. Various agencies are just procuring a large number of e-rickshaws directly from manufacturers and offering on rent or monthly contract to poor e-rickshaw drivers, who cannot afford to purchase the e-rickshaw but find it a convenient way of earning their livelihood even after paying rent to the agencies.

There are now a number of manufacturers of e-rickshaw in India [17]. Most of these are manufacturing a range of e-rickshaws catering for various segments of use; such as, (a) passenger carrier, that is, the transport of children to nearby schools (closed-type EV keeping safety of children in mind), or transport of general public from Metro Railway stations or market to their nearby destination (mostly open type), and (b) goods carrier, that is transport of goods (both closed type and open type). Passenger carriers are the maximum selling e-rickshaws and are expected to continue holding a larger market share, in terms of both value and volume, because of the increasing demand. Delhi National Capital Region (NCR, which includes Delhi city and also parts of neighbouring states of Uttar Pradesh and Haryana) has been the largest market for the e-rickshaws.

Most of these e-rickshaws have fibre-glass body (giving strength, durability, aesthetic look along with light weight construction and low maintenance). While many of the old suppliers use “Lead Acid Battery Pack”, the latest designs are all based on “Lithium-ion Battery Pack”, giving driving range of more than 100 km on a single charge. Most of these manufacturers are using “Brushless DC (BLDC) Motor” for driving the e-rickshaw. These EVs have a top speed of about 25 kmph. The new e-rickshaws come with various features like internal LED light for passenger and driver (required during evenings & nights) and USB mobile charger for driver, side curtains and inclined back support for passengers.

5. VERY LITTLE INFORMATION ON TWO- AND THREE-WHEELER EVs IN INDIA

With all the above figures, it is quite sorry state to see that very little information or technical literature is available to the general public on battery-powered two- and three-wheeler EVs in India. One reason could be that these EVs are popular in a few Asian countries only. Another reason could be that the technology being used in battery-powered two- and three-wheeler EVs is simple (battery operated electric motor with a controller). Although there is healthy growth rate for these EVs, the vehicle manufacturers are also not doing much marketing to encourage their use. The information available is either from the websites of manufacturers / suppliers or the news items.

For four-wheeler EVs (cars and buses), the lack of charging infrastructure within cities or highways is being cited as the main reason for their slow growth in India. But, for the battery-powered two- and three-wheeler EVs, the battery charging can be done conveniently during night hours at home. For the two-wheeler vehicles being used by On-Line delivery persons covering many km per day, the battery charging can also be done at their base offices when the vehicles come back after one trip and delivery boys collect the materials and make papers ready for delivery of the next materials.

6. ASPECTS REQUIRING ATTENTION OF CENTRAL / STATE GOVERNMENTS, PUBLIC SECTOR UNDERTAKINGS AND SUPPLIERS FOR TWO- AND THREE-WHEELER EVs

(a)..Presently, most of the multi-storey apartments and commercial malls have parking of vehicles in basements or ground floor parking spaces. There is no provision in basement or ground floor parking spaces to provide electric supply points for charging of EVs. The existing apartments and malls must immediately take care of this aspect and all the future constructions must necessarily have this provision. In malls having enough parking for two-wheeler EVs in open ground floor space, the installation of charging points would not be a problem. The electricity distribution companies (DISCOMs) must also look into the matter as there may be necessity to increase the sub-station capacity, if the number of EVs being charged simultaneously is large. For independent houses, there is no problem as the house owner can easily provide a charging point in the parking space in the house.

(b)..It is suggested that in commercial malls, having electric charging points for two-wheeler EVs, the energy consumed can be charged at low rates and then parking fee need not be charged (as existing in many European countries).

(c)..In order to encourage their employees to purchase two-wheeler EVs, apart from providing interest-free loans (or loans at low interest rates), all the medium and large private and government organizations must have sufficient number of free charging points in their office complex. This may not be any issue with most of the Government and Public Sector organizations, who have sufficient funds for welfare of their employees. Only private organizations must be persuaded to offer these benefits to their employees.

(d)..With effect from August 01, 2019, the GST (Goods & Service Tax) Council has reduced the GST to 5 per cent on electric vehicles and also on chargers [18]. But, the manufacturers must look carefully and bring to the notice of government in case there are still any items remaining related to two-wheeler and three-wheeler EVs, where the GST still remains more than 5 per cent.

(e)..As transport remains under the control of State Governments, the manufacturers must try to persuade all the Indian States and Union Territories to bring uniform legislations to encourage the general public regarding the adoption of two-wheeler and three-wheeler EVs. Particularly, the aspects related to driving license and registration of three-wheeler EVs are still not clear in most of the States and Union Territories.

(f)..It is well known that there is very little awareness among general public in India about the long-term economic and environmental aspects of electric two- and three-wheelers. As mentioned earlier, the suppliers of EVs are not very enthusiastic about the adoption of electric two-wheelers in particular. Therefore, as they may not be spending money on marketing of these products, the NGOs or Government / Public Sector organizations have to spread awareness among the society.

(g)..During festival seasons (which are different in different States), the road transport department gets over-crowded even with additional buses introduced both by government agencies and private operators. Therefore during festival periods, many low income people are forced to travel to their nearby villages (may be even 150 to 200 km) on two-wheeler EVs. In such situations, they would need intermediate charging points on the roads to reach the destination.

(h)..As is being planned by SmartE to provide charging points on most of the Metro Railway Station in Delhi, many NGOs can come forward to help the poor e-rickshaw drivers by providing charging stations at some central points, so that these drivers can get the battery re-charged, if necessary and can have longer running hours, if required during some special occasions.

7. DISCUSSION

The battery-operated three-wheeler (e-rickshaw) is already on the path of rapid growth in India, mainly because it is able to provide livelihood to a large number of poor, young and uneducated people (as a driver). However, presently it is being purchased mostly by the contractors who give it to the driver on some conditions. It would be nice if the State Governments or the Public / Private Sector organizations can come forward with some schemes to distribute these e-rickshaws directly to the poor drivers with some incentives and bank loan at very low interest rate, as has been done a few times in the past by some State Governments. A large number of medium scale manufacturers in north India are using this opportunity to manufacture or assemble the e-rickshaws using imported parts, also providing jobs to thousands of the semi-skilled people in the production of EVs, in the ancillary units and in the distribution centres of e-rickshaws all over India. With great improvements taking place all over the world in the technology of lithium-ion batteries, the batteries will

become lighter, driving range with a single charge will be more and the life of batteries will also become longer.

It is mainly the two-wheeler e-scooters, which require great supports both from the Government and from the manufacturers in India if these e-scooters have to compete with scooters or motorcycles operated by ICE. As mentioned in Section 3.1, production of large number of e-scooters requires huge capital investments by the manufacturers, which they are not willing to make now and may make the capital expenditure in stages. Therefore, unless the Indian Government and the manufacturers discuss the issue threadbare and come out with a win-win solution, the present situation in India is giving a very disturbing trend regarding the growth of e-scooters.

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