Charging Infrastructure for Electric Vehicles in India

Saumya Chaturvedi

Abstract— India being the fourth largest automotive market in the world lags behind for its demand of Electric Vehicles on roads, One major reason is the lack of proper charging infrastructure. In this detailed study, the ways for implementation of Charging Infrastructure in India is discussed. Furthermore understanding of the topic, need for research, pros and cons, scope and various technologies suitable for the Indian market are presented.

Index Terms— Electric Vehicles, Charching Infrastructure, Indian Market, Charging Technology, EV Chargers.

1. INTRODUCTION TO PRESENT SCENARIO OF CHARGING INFRASTRUCTURE

According to the present scenario of charging infrastructures for Indian public, the most populated cities in India like Delhi, Mumbai, Lucknow, and others, one public charging station per 4km would be required for achieving the electric vehicle mission of 2030 in which the Automotive Sector will be among the top 3 of the engineering, manufacturing and export world of vehicles and components for EVs (Electric Vehicles). In addition to that valuing over 12.5% of India's GDP (Gross Domestic Product) and generating an additional of 60 million+ jobs.

It was also said by the NITI Aayog that after 2030, only EVs should be sold in India by keeping in mind that this will expand the clean fuel technology beyond just two and three wheelers presently in the country.

As of course there is still a large dependency on oil by the transport sector in India. By this step about 100% electric vehicles sale will be there by 2030 which may have the potential to reduce the dependency by a large margin or so.

2. PROS AND CONS OF SETTING UP CHARGING STATIONS IN INDIA.

At first there are many advantages of setting up the chargers in India, as not only from conventional sources like fossil fuels but also from the other sources we can extract energy like in case of Solar Energy, which can be extracted in large quantity from Southern areas of India and from some places like Rajasthan.

But where comes advantages, disadvantages also follows the path. Talking about it the first factor is the cost; Setting up a charging station in metropolitan cities as discussed above in every 4Kms will cost in Billions of Indian Rupees. Second, Compromisation between Range and Power; in this scenario as we Indians thought about mileage while using the Internal Combustion engines we will also face Customers being asking for the range with the same mentality and hence companies have to compromise with the top speed and power which the current generation likes. So, there will be a mismatch in the marketing aspects in order to choose the selling market.

India is home for over 2 million electric two wheelers and rickshaws which is more than number of EV cars in China. Smaller vehicles sales continue to rise but due to lack of proper infrastructure in India many drivers are illegally siphoning electric power. Till now only 10% of the subsidy program is allocated for charging stations.

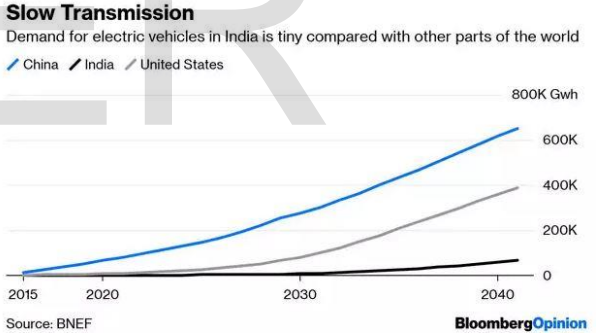

Fig. 1 - Courtesy of economictimes.com

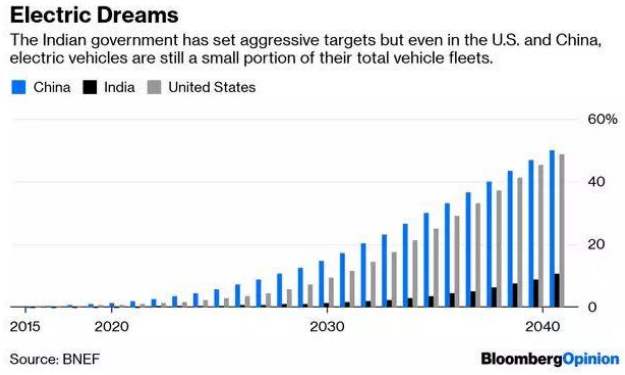

Fig. 2 - Courtesy of economictimes.com

Power stolen to charge three wheelers in India costs more than $18 million a year in Delhi alone. There are over one Lakh of such vehicles on roads, and only quarter of them

are registered with RTO. Lack of arrangements for the future i.e. the charging infrastructure have also led to the puny demand for green passenger cars. That's why due to fall in sales Mahindra & Mahindra Ltd., discontinued production of its first electric car (Mahindra e2o).

On comparing the goals with other countries' target India's start to look more unrealistic. Let's take an example of China which has been in this industry for a decade now, but still targeting for only 23% of the total sales to be either hybrid or electric by 2025.

3. DECISIONS TAKEN BY THE GOVERNMENT IN FAVOR OF ELECTRIC VEHICLES.

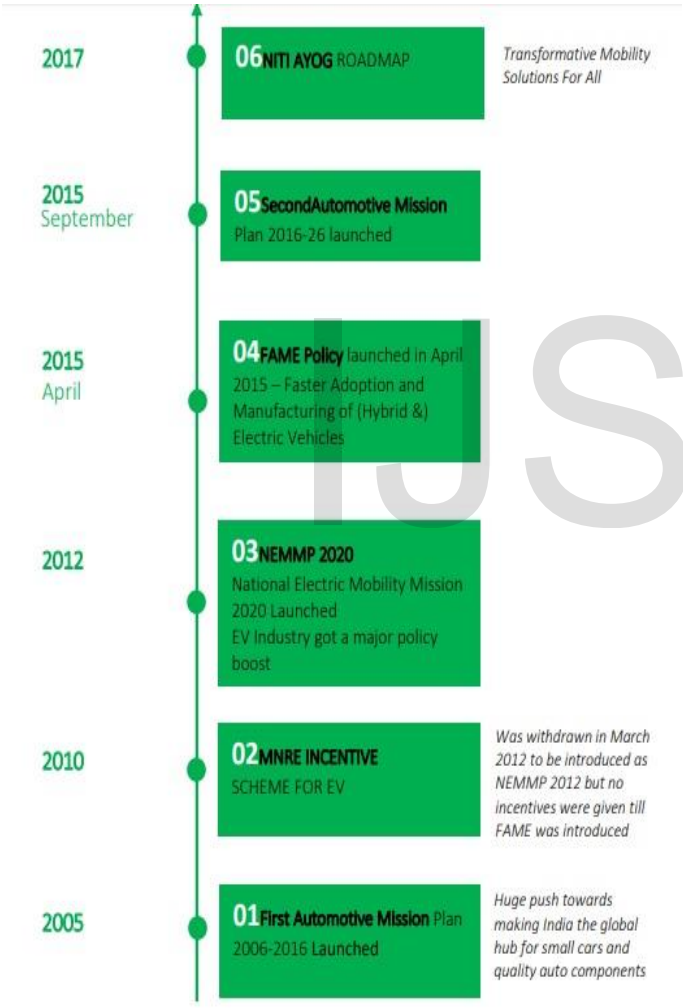

Fig. 3 - Courtesy of innovasjonnorge.no

Taking about our country, in 2010 INR 95-Crore scheme was approved by the MNRE (Ministry of New Renewable Energy) and financial model was announced for the manufacturing of Electric Vehicles to be sold in India. But soon this scheme was discontinued due to approx. 70% drop in the EV sales in the country. It was until August 2019, when the Government softens the timeframe for transition to Electric Vehicles. Many ministries like NITI Aayog, The Ministry of Road Transport and Highways, the Power Ministry etc. collaborate together for implementation of the e-mobility plan proposed by the government.

And as a result they all agree to a "softer, pragmatic, phase-wise approach". The plan was then revised and the highly populated cities are targeted first in order for a plan to ban two-wheelers which are below 2150cc and three-wheelers by 2023 and 2025, respectively and to replace them with battery-operated EVs or to convert those using EV kits.

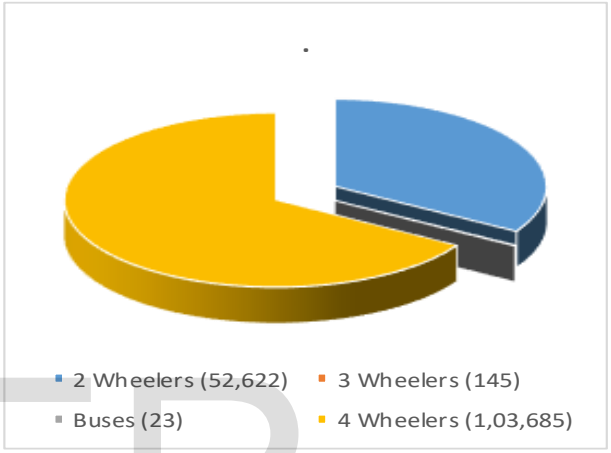

Fig. 4 - Courtesy of innovasjonnorge.no

Under the 4 Wheelers segment- nearly 99k are Hybrid SUV's and only about 4k are EV Passenger cars.

4. COMMERCIAL ELECTRIC VEHICLES IN INDIA TILL NOW

Till now there are only a handful of EVs in India. Mahindra e2o, Hyundai KONA, MG ZS EV, eVerito, e2o plus, eSupro, eAlfa, Tata Tigor EV, and Tata Nexon EV are the commercialized vehicles present till date. Few are expected to come by 2020 and 2021 like Mahindra eKUV100, Jaguar E-Pace and Wagon R EV.

5. INITIATIVES TAKEN BY CAR MANUFACTURERS AND THE GOVERNMENT OF INDIA TO SET UP CHARGING STATIONS.

Morris Garages (MG), The British Automobile brand, owned by SAIC (Shanghai Automotive Industry Corporation) Motor Corporation of China had announced to tie-up with Fortum for the installation of 50KW CCS (Combined Charging System) and Chademo DC fast public charging stations for the EVs across its showrooms in Hyderabad, Ahmedabad, Bengaluru, Mumbai and Delhi NCR. For customers, MG Motors tied up with a Delhi based startup eChargeBays in order to set up charging stations at customers' residence

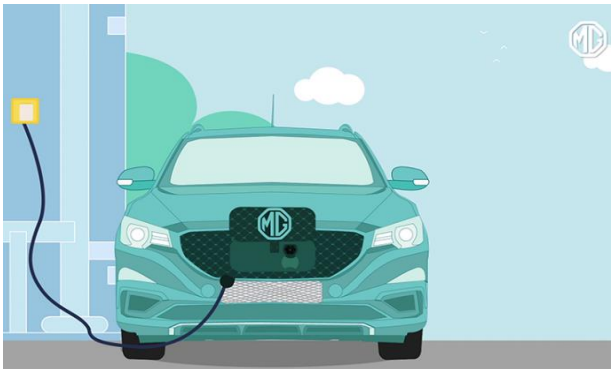

Fig. 5 - Courtesy of autocarpro.In

Tata Power also established the first set of EV Charging stations in Mumbai in support of the Indian Government to provide customers access to green energy-efficient options with ease

Fig. 6 - Courtesy of tatapower.com

NDMC (The New Delhi Municipal Council) also added 25 more EV charging stations on March, 2019 in places like Jor Nagh, Gole Market, CP, Yashwant Place and Sarojini Nagar Market.

Fig. 7 - Courtesy of theprint.in

There is also free charging service as of now and will cost around INR 60-66 per charge in near future.

National Thermal Power Corporation (NTPC) also ventured into EV-charging business and has installed charging stations at its offices in Noida and Delhi; and are currently looking for nationwide licensing which will help them to set up charging stations all over India very quickly. As for now charging stations installed by them are specific for Mahindra vehicles.

TABLE 1

Likely future for EV Chargers in India

	2019-2021	2021-2025	Up to 2026
No. of EV Charging stations likely to be set up	50k	350k	406k
No. of AC Slow Chargers likely to be installed	240k	1470k	1729k
No. od DC fast chargers likely to be installed	60k	630k	695k
Total EV chargers likely to be installed	300k	2100k	2424k

Tata Power will be providing solutions for upcoming Jaguar models like I-Pace etc. which will be launching later half of this year because of the tie-up between them of setting up 27 outlets across 24 cities in India which will provide a range of AC and DC fast charging with a capacity of 7-50 kW.

6. COST ESTIMATION MODELS FOR SETTING UP CHARGING STATIONS IN INDIA.

It is assumed that each charging station is expected to have at least three fast chargers: a CHAdeMo, a CCS and a Type-2 AC, Additionally, the charging station will also have two slow charge points-a Bharat AC-001 (10 kW/230V) and a Bharat DC-001 (15 kW/ 72-200V).

A typical 50kWh DCFC will cost over 1.6million. Investment in DCFC of over 25 kWh would be yielding unappealing returns, unless batteries with fast charging options are rolling on roads, In this case manufacturers also have to make such batteries as soon as possible. This will eventually enhance revenues for charging infrastructure providers and will increase the capacity utilization at Public Charging stations, making investment in public charging stations will be an attractive option.

Based on the Capital Expenditure (CapEx) and Operating Expenses (OpEx), the minimum infrastructure cost can be estimated as:-

TABLE 2

Total CAPEX and OPEX Estimation

Type of charger	Power Output	Approx. cost including 18% GST
Capital Expenditure (CAPEX)		
CCS	50 kW	15,50,000
CHAdeMO	50 kW	
Type 2 AC	22 kW	1,30,000
Bharat DC-001	15 kW	2,70,000
Bharat AC-001	10 kW	78,000
New Electricity connections		7,80,000
Civil Works		3,00,000
EVSE Management Software		45,000
CCTV Setup		38,000
TOTAL CAPEX		31,91,000
Operating Expenditure (OPEX)		
Technicians (1technician@ 25k/month)		2,00,000
Site Maintenance		1,50,000
Network Service provider fees		6,500
Advertising@3000/month		30,000
Land Lease Rental @50000/month		6,00,000
TOTAL OPEX		9,86,500 +EVSE Software Fee in First Year 8,36,500 +EVSE Software Fee from Second Year.

Another model can be made based on the Net Present Value (NPV) and on Internal Rate of Return (IRR) of non-subsidized Public Charging Stations VS 100% subsidized chargers cost.

The Government may fail to encourage the3rd parties for setting up PCS in order to accelerate electric mobility adoption.

As per Delhi Electric Vehicle policy, Govt. of National Capital Territory of Delhi will be providing a capital subsidy covering the installation expenses as well as the cost of charging.

TABLE 3

Cash Flow without Subsidy

Without Subsidy on Charger Cost		
Year	Cash Flow	
	Scenario A	Scenario B
0	-3000000	-3000000
1	-535600	-452120
2	-98000	57800
3	349400	349400
4	1078400	1078400
5	1661600	1165880

Suppose, if 100% chargers are subsidized, then the Internal Rate of Return (IRR) of setting up a public charging station (PCS) in Delhi can be more attractive to the investors for making an investment on such things.

TABLE 4

NPV and IRR value

Discount Rate	**10%**	
NPV (INR)	-15,37,106.85	-16,40,258.73
IRR	-3.76%	-6.16%

One such study model can be seen below to validate the above point that if 100% charge cost is subsidized?

Based on the two different Scenarios the cash flow can be taken for consideration as:-

TABLE 5

Cash Flow with 100% subsidy on Charge Cost

With Subsidy- 100% Charger Cost		
Year	Cash Flow	
	Scenario A	Scenario B
0	-1180000	-1180000
1	-535600	-452120
2	-98000	57800
3	349400	349400
4	1078400	1078400
5	1661600	1165880

Table 6

NPV and IRR Values

Discount Rate	**10%**	
NPV (INR)	2,82,893.15	1,79,741.27
IRR	14.20%	13.03%

Since business volumes in the initial years will going to be very low, challenging situation will be there for attracting investors at the base level in the country, unless capex cost is partially or fully being subsidized.

Also innovative ideas in this field will be required because relying solely on EV charging station network in the country as a standalone business will be difficult.

7. UPCOMING CHARGING TECHNOLOGIES FOR INDIAN MARKET

Government has confirmed that there will be three technologies in the country for charging the EVs. Along with the Bharat Standards, Combined Charging System and CHAdeMO will also be there as fast charging options.

Each technology will be having its advantages as well as disadvantages.

- Level One Charging (120Volts)
  Level one charging will use the same 120V that will be found in the standard household outlets and can be attached to the standard sockets with cords that come along with the EVs.
  Advantages:
  - No installation costs.
  - Low impact on peak demand charges.

  Disadvantages:
  - Slow Charging, about 2-8Kms range per hour.
- Level Two Charging (240Volts)
  Level Two Charging will use 240V supply system. This requires an additional EVSE unit and wirings capable of handling higher voltage.
  Advantages:
  - Faster Charge Time- 16 to 32Kms per hour of charge.
  - About 3.5% more efficient than level one charging.

  Disadvantages:
  - More Expensive than Level one.
  - Significantly Higher impact on peak KW demand charges.
- DC Fast Charging (480Volts)
  This type of charging can charge the vehicle up to 80% in 30-50minutes by converting high Voltage AC to DC for direct storage in battery pack of the vehicle. Automakers uses SAE I-1772 plugs for Level one and two charging, For the DC fast charging, the CHAdeMO, SAE CCS ports are to be used in order to increase the compatibility.
  Advantages:
  - Charging time is reduced drastically.

  Disadvantages:
  - Very expensive for installation as it requires 3 phase high voltage power supply.
  - Increased peak demand charges for commercialized localities.
  - Different plug types in the market can be confusing to buyers and for charging station operators.
  - Fast charging can be slowed during cold weather conditions, depending on the vehicle and charging equipment.

8. CONCLUSION

Investment in DCFC of over 25 kWh would be yielding unappealing returns, unless batteries with fast charging options are rolling on roads, In this case manufacturers also have to make such batteries as soon as possible. This will eventually enhance revenues for charging infrastructure providers and will increase the capacity utilization at Public Charging stations, making investment in public charging stations will be an attractive option. Since business volumes in the initial years will going to be very low, challenging situation will be there for attracting investors at the base level in the country, unless capex cost is partially or fully being subsidized.

9. REFERENCE

- https://www.driveelectricvt.com/charging-stations/types-of-charging
- https://www.innovasjonnorge.no/contentassets/815ebd0568d4490aa91d0b2d5505abe4/india-ev-story.pdf\
- https://www.tatapower.com/businesses/next-gen-power-solutions/ev-charging-stations.aspx
- https://www.drivespark.com/four-wheelers/2019/ev-charging-stations-india-locations-delhi-027667.html
- https://www.autocarpro.in/news-national/mg-partners-delta-electronics-to-set-up-charging-infra-ahead-of-zs-ev-launch-43948
- https://auto.economictimes.indiatimes.com/news/passenger-vehicle/cars/mg-motor-partners-with-fortum-to-install-public-dc-fast-charging-station-ncr/72128871
- https://www.business-standard.com/article/economy-policy/india-s-electric-vehicle-journey-so-far-a-story-of-nudges-and-trudges-119080600339_1.html
- https://www.firstpost.com/tech/auto/jaguar-land-rover-india-partners-with-tata-power-for-its-electric-vehicle-charging-solutions-8123881.html
- https://www.pluginindia.com/blogs/cost-estimates-and-revenue-model-for-a-public-charging-station-pcs
- https://economictimes.indiatimes.com/industry/energy/power/indias-e-car-plan-has-just-one-but-potentially-debilitating-flaw/articleshow/69194816.cms