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Road map for electric vehicle implementation in India

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Abstract
Fossil fuel has dominated the energy sector and indispensable part of the energy mix for several decades and which has been recognized as the primary source of mobility as well as the feedstock for industrialization. But the growing environmental consciousness influence for the energy transition towards renewable and green energy. The concept of sustainable development coupled with the environment and economic blooming, co-supported by technological advancement in transition from the conventional fuel utilization to the renewable energy sources. Development of the electric vehicle plays significant role in global energy transition and sustainable development. Advancement of the electric vehicle is the juvenile stage and continuous innovations are adding value in the progress of this sector. Policies, framed by the governments of different countries, are designed with the objective to boost the entire value chain, from production to consumption. India, as highly dependent on the import of fossil fuel, dedicates a gravity towards the creation of the ecosystem for the electric vehicle implementation, nationwide, in order to mitigate the pollution challenges. In contrary to global development, India lags far behind and to a bridge the gap, the existing policies are required to be remodified in terms of a global perspective as well as the consumer car purchasing behaviour.

Keywords: energy transition, sustainable development, electric vehicle, policies, consumer behaviour

1. Introduction
The population of India is growing gradually and with this connectivity between cities, towns, villages are developing. Every village, small cities are now connected with metropolitans by means of the road. To support this rapid prosperity, the demand for four-wheelers & passenger automobiles are accelerated. Bank loan, EMI model and other commercial schemes influence common man to afford a car. Prosperity, always, costs something either good or bad. With the increased demand for vehicles, the need for fossil fuel is also raised day by day. The burning of the fossil fuel emits oxides of carbon, nitrogen, and sulfur that causes damage to the environment.

Acknowledging this fact Indian govt. aim to zero-emission mobility concept where the country will enjoy a 30% electric fleet. Govt. targeted the year 2030 to make the dream successful and India's think tank NITI Aayog puts its all effort to set up policies that promote enthusiasm among people about Electric vehicle (EV). Energy Efficiency Service (EESL) already has floated tender for 10,000 EVs for government purposes. Tata & Mahindra have initiated the production for the meeting the initial phase's target (India Business Journal, 2017) [1].

India's economic diplomacy is partially merited by oil diplomacy. On recent years country, foreign policy is driven by fossil fuel issue (Nandy 2016). BP statistics report shows that India's energy consumption grows at a rate of 5.2% per year (BP energy outlook, 2019). So the alternative fuel source is essential to keep balance in the growing energy demand and environmental crisis. NEMMP 2020 road map promotes the usage of electric vehicles and success of this plan will lower down the fossil fuel cost by 13000 crores by the year 2020 ("National Electric Mobility Mission", 2012). To promote awareness among common, government focuses on different policies but success is still indiscernible. The report, jointly presented by RMI & NITI Aayog, highlighted the three-phased approach to boost the demand for EVs. In phase one, the objective is to cultivate the solutions and develop the infrastructure for zero-emission vehicle. In phase two, the opportunities identified in phase one has to be scaled and refined and finally in phase three implement the findings. Provide non-fiscal incentives, priority access to bus lane and airports and in public parking areas, these are the policy adopted by Govt. to encourage the use of EVs. Regulations like providing a tangible incentive such as special customer class for EV users are enacted to attract customers (Juyal, Abramczyk, *et al*. 2017) [5]. Delhi government projected to avail subsidies and exemption of tax for EV users ("National Electric Mobility Mission", 2012). After adopting different strategies, the disappointing fact is that govt. fails to accelerate demand for EVs nationwide.

2. Technology
Deciding upon policies is the one pillar of the electrify mobility plan. Another issue is the technology; especially the charging technology that is the essential part to deploy electric vehicle, because the location, availability and time will influence the buying decision of EVs. Charging stations at different locations like household, parking space, office campus and public outlets require different setup and also tariff system. Initially, the power grid has to be modified to withstand the increased demand to support the power consumption load of EVs. Smart grid technology and Grid to Vehicle technology (V2g) will help to balance the load distribution and balance the grid. The smart grid helps to monitor and secure power system operation and control. The smart metering system helps to reduce uneven tariff plan and

demand-side management by estimating peak load. Off-peak charging and use of renewable energy can be managed with the help of smart grid (Fernandez, Vijayakumar, *et al*. 2016) [7]. Charging time is a crucial factor for EVs because conventional IC engine vehicle takes few minutes to be fuelled and it is expected from the consumer's side that charging time should not be stretched longer in case of EVs. Also, it is desirable that a car should provide a better mileage with a full charge. There exists three methods of EV charging-inductive, conductive and battery swapping technology. Battery swapping technology is full of hassle and inconvenience for the users. Inductive charging needs electromagnetic transmission technology and it requires a high level of engineering and cost involvement. So the conductive method is the most effective and suitable for easy charging of the EVs. In case of conductive charging three levels are there-level one charging or "home charging that uses simple AC connection of households, level two charging or "dedicated AC charging" needs 7KW single-phase or 21KW three-phase power source and last is DC charging or "fast charging" that requires direct power source and it charges the battery up to 80% within 20 minutes (Dericioglu1, *et al*, 2018) [8]. In DC quick charging technology, the "CHAdeMO" technology is the pioneer and the first DC fast charging set up, developed by Tokyo Electric Power Company (TEPCO) and Fuji Heavy Industries along with the car manufacturers Nissan and Mitsubishi. This 2010,Japanese originated technology is widely accepted across the globe and according to 2015 data 5737 CHAdeMO charging stations were installed all around the world. It has a maximum power output of 50KW. Another technology, developed by American and European automobile companies such as BMW, Ford, and GM, is the Combined Charging System (CCS) or COMBO and benefits over CHAdeMO is CCS can be operated in both DC & AC. There are two models of COMBO. COMBO-1 is developed for USA and COMBO-2 is adopted by Europe. EU Automakers Association (ACEA) has confirmed to follow the COMBO-2 standards for manufacturing new vehicles from 2017 while CHAdeMO standard is followed in Japan (Jiménez, *et al*, 2015). In China GB/T charging standard was adopted and it is quite similar with European standard. Tesla has developed only high-speed DC charging with charging rate 120KW (Karali, 2017). Bharat EV Charger DC-001 follows the specification of China's GB/T standard as it is easy to import the technology and it is cost-effective (Mallick, 2017) [11].

Indian govt has the vision to construct the green automobile market by 2030 and NITIAayog dedicatedly focuses on deciding policies to incentivize people for adopting electric vehicles. But there are some lacking factors that pulling Indians back from bulk procurement of electric vehicles. Indian Space Research Organization (ISRO) has declared to share the battery technology on a non-exclusive basis and the charging standard has been decided. India's carmakers TATA and Mahindra & Mahindra are keen to take the market share of EVs. The country has floored its ground to touch the dream-30%electric fleet by 2030. Still, there exist few gaps that draining the enthusiasm of buying EVs.

3. Policies

3.1 Global Scenario

Technological development is one of the essential steps to encourage people to buy an electric vehicle, but policies adopted by the State is also important because policies are the road map of the development. The government uses different tools to impel its people for supporting its initiative and Hood & Margetts suggests in the book "The Tools of Government in the Digital Age (2007)" that four tools are used by the government to encourage. Four tools are:

- Legal: rules and legislation to decree any act.
- Financial: incentivize (or dis-incentivize) people, so they acquire the item or service on their own.
- Communication: persuasion, advertisement, motivation to generate public interest.
- Organization: it's a physical entity that works to implement the policy.

Different government focuses on different policies and that are related to downstream activities in the value chain like incentive, tax benefits, subsidies etc. For upstream government focuses on R&D mainly (Steen, Kotter, *et al*. 2015) [13]. Leading countries like USA, Europe, and China has developed a strong policy for upstream and downstream both to promote EVs.

3.1.2 Subsidies

Financial benefits encourage the customer to buy EVs because customers feel reluctant to pay for the social, environmental cost. So different countries adopt different policies to boost the interest of customers.

United States proposed the EPAct 2005 that provided benefits like a direct tax credit to hybrid EV customers and Energy Improvement and Extension Act of 2008 gave benefit on the tax credit for plug-in hybrid EV purchaser and provided a handsome credit range to the consumers. Also, the American Clean Energy and Security Act of 2009 and American Recovery and Reinvestment Act of 2009, helped the consumer with federal tax benefit and credit range based on battery capacity. At the same time, the federal government introduced incentive (monetary and non-monetary both) to exchange low-energy efficient vehicle by high-energy efficient vehicle (Zhang, Xie, *et al*. 2014) [14]. Different states provide different subsidies on buying PHEVs and BEVs. California government offers rebate $2500 on BEVs purchase and $1500 on PEVS purchase under the Clean Vehicle Rebate Project. Georgia's government provides 20%income tax credit up to $5000 on the purchase of the zero-emission vehicle (Jin, Searle and Lutsey, 2014) [15].

In 2011, UK introduced the Plug-In Car Grant programme under which low emission car purchasers were given an incentive on buying. France initiated the Bonus-Malus policy where Bonus, is a discount in premium and Malus is increased. The direct incentive of EUR 6300 for BEVs purchase and EUR 1000 for PHEVs purchase, was given under this Bonus-Malus scheme (Global EV outlook 2016). Norway provided incentive and subsidies and at the same time free parking, bus lane access like facilities were provided to the EV users. Also in Norway, free charging was availed initially to motive consumers. Europe's EV policies were dependent on the CO2 emission level (Zhang, Xie, *et al*. 2014) [14]. In 2012, Sweden introduced Super green car premium where cars that emit less CO2 (50g/km), were given one time premium of EUR 4500 and this program was conducted for two years; maximum 5000 cars were awarded (Mock, Yang, 2014) [18].

In Japan lack of natural energy resources, heavy dependence on primary energy supply and advantage from the presence of

efficient battery technology, automobiles and components motivated the heavily to adopt electric vehicle. So, to successfully adopt EV they set a goal to have 15-20% EV by 2020 and 30% by 2030. The government has provided many types of support by huge investment to provide purchase incentives to consumers, to reduce acquisition tax, to support manufacturers and in the R & D section. The electric power companies in Japan have also supported a lot in this area. By these strategies and presence of battery technology, the sale of EV in Japan has reached 150,000 and the number of charging station is around 40,000 in the country.

State given incentives influence the sales of the EVs and it reduces the effective cost of purchasing EV (Jin, Searle and Lutsey, 2014) [15]. China aims to be the global leader for the EV industry and so the initiative has been taken long before. Subsidies could help to boost the number of EVs sale. As 2016 report, local and central government China allowed subsidy up to RMB 100,000 per vehicle (Financial Times, 2017).China adopted the *leapfrogging* policy to achieve the leader position in the alternative fuel industry (Wang, Kimble, 2011) [16]. Chinese government include the EVs project under national development project and recognized as "863 projects" and in 2009 Planning for Restructuring and Revitalization of the Auto Industry was introduced and this programme aimed to convert 5% car purchase into EV purchase (Wang, Kimble, 2011) [16]. The Chinese government provided an on-time bonus (35000-60000 RMB) on purchasing EVs and fuel cell car and this program was extended till 2015. Shanghai government will provide 50% central level subsidies on EVs and 30% central level subsidies on PHEVs and this subsidy will be on the board till 2020 (Bloomberg, 2018) [20].

3.2 Indian Scenario

With the changing dynamics of the global automotive sector, India, which is one of the largest markets is on the verge of revolution. The dependency of oil and gas import along with environmental issues has become a challenge and thus shoves think tank to revamp the existing transportation system. The implications of eco-friendly mobility imminences the introduction of the electric vehicle in the automobile segment. Due to disruptive trends in terms of global technology as well as business strategy (Dhawan, Gupta, *et al*. 2017) [29], the Government of India's (GoI) approach has been altering by adopting different action plans and initiatives.

AMP 2006-2016

In December 2006, GoI launched "Automotive Mission Plan 2006-2016 (AMP)" (AMP, 2006), to emerge as a destination hub for design and fabrication of automobiles and other components with the output of US$ 145 billion. This phase mainly focused on incentivizing up-gradation of the vehicle fleet by incorporating auto fuel policy to abide by BS-IV standards.

The AMP 2006-2016 has attracted a significant amount of investment from global and domestic original equipment manufacturers by surpassing the target of Rs. 1, 57,500 crores. This plan has also created employment of 25 million jobs over the past decade (PIB 155343, 2016).

The AMP 2006-2016 had worked reasonably well in the first half i.e. 2006-2011, in terms of CAGR exceeds 10% for registered vehicles in all segments. But in the second half i.e. 2011-2016, due to the global economic slowdown, the CAGR reduces to 4.6% except 2-wheeler segment. This envisaged the gap between actual performance with targeted expectation thus instigate amendments in future action plans (Review of Automotive Mission Plan, 2016).

NEMMP

In August 2012, the GoI approved the "National Electric Mobility Mission Plan 2020 (NEMMP)" (NEMMP, 2012). The main objective of this initiative was to achieve national fuel security by promoting hybrid and electric vehicles in the transportation by providing fiscal and monetary incentives to kick start mission and to achieve 6-7 million sales of hybrid and electric vehicles (2W, 3W, 4W, LMVs and Buses) from 2020 onwards (PIB 116719, 2015). The report also indicated, the in-depth study needed to estimate additional power generation required and setting up charging infrastructure for EV.

Meanwhile, the introduction of NEMMP has been counterproductive due to sales of 2W electric mobility deteriorated by 80% and thus led to close down of 75% of 2W electric vehicle companies. In 2010, expecting an attractive 4W Electric Vehicle market segment for future, Mahindra & Mahindra acquired the Reva Electric Car Company. They launched e2o EV model, in March 2013, initially able to sell 1,000 vehicles per year with a subsequent rise in sales but later, as of March 2015, they have sold only about 500 units.

In 2010, the Ministry of New and Renewable Energy recommended a 20% subsidy for electric vehicles through a scheme called the Alternate Fuels for Surface Transportation Programme and later on NEMMP withdrew of subsidy scheme allocated in 2010. This is one of the prime reason underneath the declining interest for sustainable mobility is due which implementation strategy of NEMMP flopped to stimulate the positive impact on Electric Vehicle sales and delays in the release of new subsidies (Pavaskar, 2016) [35].

To overcome the lag, the Forum of Regulators necessitates the NEMMP+ scenario to be developed with increased attention of the policy-makers towards Electric Vehicle sales. The NEMMP+ scenario has emphasized more on double 4W, triple light commercial vehicles (LCV) and 3W stock. For higher penetration of EV buses, 10% of the current stock of buses operated by public transport will switch to Electric buses in the high growth scenario (Forum of Regulators, 2017).

FAME India

On 25th March 2015, The Department of Heavy Industry (DHI) has formulated a scheme, "Faster Adoption and Manufacturing of Electric Vehicles (FAME India)" (The Gazette of India Regd No. D.L.-33004/99, 2015), to provide a major propel for early adoption and market creation of both hybrid and electric technologies vehicles. Through this scheme, the government will permit hybrid and electric vehicles as the first priority for the buyer to replace conventional vehicles that run on oil and gas (FAME India F. No. 12/89/2009-AEI (Vol. V.) (6449), 2015).

In order to create a market by demand incentives, in-house technology development and domestic manufacturing will help this automotive sector to reach economies of scale in the long run. For that, a collaborative approach as "Technology Platform for Electric Mobility (TPEM)" (DHI, 2016) has been taken up by the DHI and DST (Department of Science & Technology), in Research & Development of Electric Mobility.

The Government of India formulated Rs. 14,000 crore demand-side incentive plan since April 2015, in the form of discounts on Electric Vehicles under a detailed scheme titled "FAME, India". The discount amount will be the 1/3rd price of the difference of electric vehicle to its equivalent conventional vehicle. The discount will be reimbursed to dealers in 2 to 3 months by DHI, with an expenditure budget of Rs. 795 crores. This scheme also facilitates subsidies for battery operated electric buses deployment alluring expression of interest from state municipal transport authorities (Pavaskar, 2016) [35].

The second phase of the FAME model has been introduced in 2019 with the objective to boost up the usage of EV for purpose of public transport. A budget of USD 1.4 billion is allocated and it will be utilized over a three years period. The model encourages the adoption of three & four wheeler EV and also for buses. The model solely focuses on commercial vehicles and incentives are designed according to that. FAME II prioritizes the requirement of the charging station and sets a target of 2700 charging station across the nation (IEA, 2019)

AMP 2016-2026

Launched in 2016, "Automotive Mission Plan 2016-2026 (AMP)", is steadfast about achieving three objectives as "3/12/65" mentioned in its vision statement as one of the top 3 nation of the world in automobile industry; automotive components and affordable mobility of people & goods will contribute 12% growth in GDP and finally 65 million job creation by 2026. With the valuable learnings from AMP 2006-2016, the revised AMP 2016-2026 stressed on the Make in India initiatives to be applicable for indigenous technology for automobile manufacturing and components along with updated auto fuel policy and set emission standards to BS-VI. It has prioritized FAME India policy to act as a roadmap for speedy development for hybrid and electric vehicle market (AMP, 2016).

3.3 Niti Aayog

In 2016, with effect from signatory and membership of "Paris Agreement" (UNFCCC, 2016) [42], India's Policymaker, "NITI Aayog", soon after has set NITI Ambition Scenario (NAS) for 2040, in its draft National Energy Policy in 2017 (NEP, 2017), which elucidates scenario analysis on implementation of electric fleets through BAU & ambitious approach for transformation pathway which is more sustainable. NAS has given more bolster on higher energy security as well as economic growth.

3.4 Policy Conflict

After adopting different strategies, the disappointing fact is that govt. fails to accelerate demand for EVs nationwide. It is due to the lack of realistic goal setting for the proper implication of electric vehicle, by replacing existing modes of transportation in India (Shah, 2018) [44]. It is evident that due to disruptive global trends, India has adopted and amended different initiatives and schemes but no strategic policy about EV and establishment of nationwide charging infrastructure for highly desirous NITI Aayog's ambition for implementation of E-vehicle by 2030 (Business Today, 2018). Govt. of India is still toggling whether to set a specific policy for an electric vehicle or not (The Times of India, 2018). This dilemma has also restraining automobile manufacturers of India to set their vision and forecast based upon government policy and regulation (Ghosh, 2017) [47].

4. Major Challenges

Hence, Govt. of India needs to clarify a definite, realistic approach, by imposing assertive rules and regulation on an electric vehicle, which will eventually act as a roadmap and create an ecosystem for charging networks and this enables the opportunities for commercial industries including the power generation and distribution. Along with that, its utmost required to create more buyer awareness among owners & drivers, encourage users of heavy and light motor vehicles, to shift towards more eco-friendly and sustainable modes of transportation in India.

5. Consumer Behavior

"The five-stage model" of the buying decision expresses the relevant stages that play an important role in consumer's buying decision. Problem Recognition, Information Search, Evaluation of alternative, Purchase decision, Post-purchase behaviour are the stage related to buying decision of the consumers (Kotler, Keller, 2016) [21]. If the consumer behaviour is more classified the decision making depends on economic, technological, political, natural and also consumer's personal factors like motivation, lifestyle, perception etc. lifestyle, family size and perception comes under social key factors where economic parameters are income, fuel price (Shende, 2014) [22]. Also, reliability is one of the most influencing factors behind car purchase decision. Consumers keen on those cars that have low maintenance and repair cost. On the other hand, consumers pick off the recognized brand compare to unfamiliar one. Fuel economy and price are the dominant factors for buyers because the purchasing decision is directly linked with the affordability (Lee, Govindan, 2014) [23]. In the Indian consumer context reference group many time influences the decision making of the buyer; friends, family and relatives suggestions play an important role in the vehicle buying process. If the price of the car is ignored completely then consumers opt for the performance of the car-powerful engine, millage, technology, and style (Gupta, 2013) [24]. Especially the young generation buyers heavily rely on trusted information sources because they want to spend less time in the decision making process. Gen-Y is more dependent on internet compare to Gen-X, so social media reference is a good influence but not so dominant compared to word of mouth reference. Moreover, the research (offline & online both) for buying a new car is circled around two or three brands that carry a predetermined image in the consumer's mind (Deloitte, 2013) [25].

For alternative fuel vehicle purchasing, nonmonetary attributes such as availability of fuel, recharging location, range, top speed etc., are more impacting factors and these factors motivate create either positive or negative mindset of the consumers (Nixon, Saphores, 2011) [26]. Environmental issues like global warming, air pollution, fossil fuel burning, etc. influence people to stand for green technologies. This motivation develops a strong concern about switching to zero-emission automobiles. But a study conducted by Laurence Turcksin *et al*, reveals that environmental issues have no significant contribution towards the buying decision of cars. Environmental issues become minor to the consumers while the performance, refuelling and other feature (charging time, range, top speed) act as a factor of buying decision (Turcksin *et al*, 2013) [27]

From the commercial point of view factors that influence consumer's behaviour towards electric vehicle purchase are the

price, vehicle performance, fuel economy, and reference groups' recommendation. Price of the electric vehicle, available in the Indian market, hovers around 7L-12L and fuel economy (distance covers in full charge) is not so satisfactory(110km) (car Dekho, 2018) [28]. Also, there lacks sound review on the performance of the electric vehicle and no existence of the reference group for the EVs. In short with the development of the technology and policy, commercial aspect is needed to be cultivated, in order to nurture consumers' minds and imbue them to switch to towards the green wheel.

6. Recommended Policy Reformation

In order to create an ecosystem for successful electric vehicle implementation in India, NITI Aayog should collaborate with all the mentioned ministries such as:

The Department of Science & Technology plays a crucial role in research and development works to make efficient indigenous technology so that electric vehicle can be manufactured with India.

The Ministry of Heavy Industries and Public Enterprise, which deals with automotive industries and can also set policies to regulate the market.

The Ministry of Power and the Ministry of New & Renewable Energy can encourage the power utility companies to generate more power to meet the surplus demand created by EV charging. The recently published Coal India Limited (CIL), Coal Vision 2030, expecting Electric Vehicles can result in huge power demand of nearly 160 Billion units (BU) by 2030, assuming 10000 Km of average travel per year and electric power required is 0.3 KWh per Km of travel (Coal Vision 2030, 2018).

The Ministry of Urban Development, which is currently running "Smart City Mission", should give more emphasis on setting up electric vehicle charging infrastructure and broaden the scope.

The Ministry of Finance can take up an active role by capital investment on various initiatives in EV projects and also incorporate Direct Benefit Transfer (DBT) schemes to encourage future buyers.

The Ministry of Road and National

Highways can work upon to improve the roadway system and make it compatible so that EV adoption can become smoother.

All these cumulative efforts can make EV implementation smoother in a realistic approach in India.

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