

Attitude of People towards Electric Vehicles and Problems in Acceptability

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ABSTRACT - *Electro Vehicle (EV) which were introduced in the global market a time ago. Now many countries are actively working towards changing their infrastructure. Now when most of the countries are setting goals for EV adoption and many of them are falling short, now is the time where the government needs to step in and ease the norms for EVs so that people can go for the FAME incentives. We need improvements in EV's over the predecessors and electric driving range. Cost being the main game player in India. So, what should the government come up with? Several important gaps in knowledge are identified. First, there is mixed evidence of the effectiveness of government incentives because still people are not ready to pay for so much instead of moving towards ICE vehicles. Second, it is not that people are reluctant to wait they have shown good signs but the actual-to-action gap is too much. This paper reviews important factors that will play a part in the adoption of EVs in India and problems in acceptability.*

Key Words – *Electric vehicle; Attitude; Economic benefit adoption, environmental concern.*

1. INTRODUCTION

Electric vehicles (EVs) were recently reintroduced to the global car market. Plug-in hybrid electric vehicles (PHEVs) and battery electric vehicles (BEVs), collectively referred to as EVs, reduce or entirely negate gasoline or diesel used in the vehicle itself through integration with the electric grid. EVs have re-emerged for a variety of reasons including improvement in battery technology and

heightened government vehicle efficiency and air quality standards.

EVs are a potentially important technology to help reduce greenhouse gas emissions, local air pollution, and vehicular noise. This study reviews literature about the key factors driving the recent trends in EV adoption. The purpose of this is to summaries knowledge and identify gaps in understanding related to EV uptake with the purpose of informing policy-makers and researchers.

The use of non-renewable and polluting sources for the production of energy has taken environmental pollution to a whole new level. The increasing global warming has an impending need for us to stop the use of non-renewable resources and reduce carbon emissions. Since the industrial age, the atmospheric carbon content is rising. Carbon emissions from vehicle amount for a typical passenger vehicle are 4.7 metric tons per year.^[19] The largest human source of carbon emission is from the combustion of fossil fuels. The development of electric engines in vehicles has created a replacement for the internal combustion engines paving way for the Electric Vehicles (EV). EVs have been adopted by many countries since their development creating a positive impact on the environment. India's growth prospects create the potential for developing leadership in EV in certain segments

Following is the table of Electric vehicle manufacturers in India/manufacturers of electric vehicles launched in India.

Table 1: - Electric vehicle manufacturers in India

S.no.	Vehicle type	Manufacturer
1.	Motorcycles	<ul style="list-style-type: none"> • Revolt Motors (RV400 & RV300)^[3] • Tork Motors (to be launched) ^[5] • Ultraviolet Automotive
2.	Scooters	<ul style="list-style-type: none"> • Ather Energy^[7] • Bajaj Chetak (Currently available in Pune and Bangalore) • TVS iQube (Currently available in Pune and Bangalore)^[6] • Hero Electric Photon 48V
3.	Buses	<ul style="list-style-type: none"> • Electric buses in Bangalore by BMTC • India's first electric bus was launched in Bangalore in 2014.^[8] • Ashok Leyland launched its electric bus in October 2016. • Tata Motors launched its pure electric bus 'Star bus Electric 9m' and hybrid 'Star Bus Electric 12m' in January 2017.^[11] • Goldstone Infratech supplied Himachal Pradesh Transport Corporation with 25 electric buses in September 2017.^[12] • 25 Tata Star bus Hybrid electric buses were delivered in Maharashtra in March 2018.^[13] • India's 1st intercity electric bus is inaugurated on 5 September which is operated between Mumbai and Pune by MSRTC.
4.	Mini pickup trucks	<ul style="list-style-type: none"> • ECOYAN • Mahindra • Tata Motors, Ace Electric in 2016
5.	Heavy duty trucks, tractor trucks	A Gurgaon based company; Infraprime Logistics Technologies Pvt. Ltd. launched first heavy-duty truck in India in Sep 2019.
6.	Rickshaws	<ul style="list-style-type: none"> • Entice Impex Pvt Ltd (Gaetti E-rickshaw) ^[7] • Mahindra • Kerala Neem G from Kerala Automobiles Limited
7.	Solar-electric boat	Aditya, from NavAlt
8.	Conversion of old vehicles into battery vehicle	E-trio Automobiles for Maruti Alto and Maruti Wagon R ^[17]
9.	Hybrid cars	<ul style="list-style-type: none"> • Toyota Prius • Honda Accord Hybrid • Toyota Camry • Maruti Suzuki Ciaz • Maruti Suzuki Swift • Maruti Suzuki Baleno (mild hybrid) • Toyota Glanza (mild hybrid) • BMW i8

2. LITERATURE REVIEW

This study reviews literatures about the key factors driving the recent trends in EV adoption.^[2] The purpose of this is to summarize knowledge, following table depict the objective and description of different authors.

Table 2 – Literature Review and Its Description

Ref	Objective	Author	Year	Description
[10]	Internal factors affecting EV adoption	Carley, Krause, Lane & Graham,	2013	The literature identifies the following vehicle properties as those that have the greatest effect on EV adoption: vehicle ownership costs, driving range, and charging time. The relatively high price of EVs, battery costs, limited driving range, and potentially long charging time requirements are major impediments to EV adoption.
[8],[9]	Charging networks & EV adoption	Bakker, Maat, & Wee	2014	Due to limited driving range, the presence of adequate charging infrastructure that is capable of meeting EV users' mobility needs is found to be critically important to EV adoption. This relationship is often referred to as the "chicken-and-egg" conundrum where limited infrastructure is a barrier to EV adoption yet investment in charging networks depends on the number of EVs on the road.
[9],[10]	Government Incentives for EVs	Langbroek, Franklin, & Susilo,	2016	The principal financial incentive employed by governments is tax incentives on the purchase of an EV. Non-financial incentives include benefits like access to high occupancy vehicle lanes, free or preferred parking. Understanding whether incentives create additional EV adoption is important to assess the effective use of public funds and resources.
[2]	The importance of standardization of charging infrastructure	Gass, Schidt, & Schmid	2014	Studies suggest that it may be an appropriate role for government to support EV infrastructure buildup as a public good. The authors suggest that supporting charging infrastructure could be the most critical policy to support additional EV adoption.
[11]	Raising awareness	Lane and Potter		Survey works shows that consumers are often misinformed regarding vehicle purchases, found in a study of U.K. consumers that people often lack knowledge regarding vehicle characteristics particularly related to fuel usage. While consumers may know more about fuel costs, taxes, and insurance, issues of depreciation and government incentives for cleaner cars are not well understood.

3. METHODOLOGY

The questionnaire which we used is hypothetically administered through the survey.

According to the result of the questionnaire, most of the people are biased towards buying an electric vehicle. But there is an attitude action gap. This gap refers to how consumers stated actions of preferences differ from their actual actions or revealed preferences (Lane and Potter 2007). Most of the people in India want to buy electric vehicles ranging from 5 to 10 Lakhs but this range does not exist in usually chosen cars of this range. Even after the government will incentivize the cost of the vehicle will still be high. This includes vehicle owning cost, battery cost, recharging cost.

4. DISCUSSION

Road EVs include a large range of vehicles from electric two-wheelers, three-wheelers (rickshaws), cars, and electric buses. In addition, plug-in electric vehicles can be classified into two types: battery electric vehicles (BEVs), and plug-in hybrid electric vehicles (PHEVs).^[16] EVs can go beyond the above-mentioned technology-based classification, and can be classified on the basis of their attributes such as i) charging time, ii) driving range and iii) the maximum load it can carry. Of these attributes, the two most important characteristics of an electric vehicle of concern to the consumer is:-

- Driving range (i.e. the maximum distance an EV can run when fully charged)
- Charging time of batteries (i.e. the time required to fully charge the battery) and Charging time depends on the input power characteristics (i.e. input voltage and current), battery type, and battery capacity.

4.1 Ecosystem for Electric Vehicle

4.1.1. Market

- Testing and certification
- Vehicle Servicing
- High capital cost and Financing
- Electricity quality

4.1.2 Technical

- Efficiencies of batteries
- Driving range of EVs
- Charging time

- Safety
- Environmental Impacts

4.1.3 Policy

- Taxation of vehicles and components
- Subsidies on fossil fuels
- Electricity tariff policies

4.1.4 Infrastructure

- Charging infrastructure
- Smart Grids
- Battery recycling
- Dedicated lanes for E - 2 Wheelers ^[14]

4.2 Indian EV scenario

4.2.1 National Electric Mobility Mission Plan (NEMMP) 2020

- The target of deploying 5 to 7 million electric vehicles in the country by 2020.^[15]
- Emphasizes 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
- Lowering of vehicular emissions by 1.3 percent by 2020
- Total investment required – INR 20,000 – 23,000cr (approx. 3 billion USD)

4.2.2 e-Rikshaw

- The Government of India announced the Deen Dayal scheme in June 2014, which would help in the financing and procurement of the battery rickshaws in the country.
- In March 2015 the Motor Vehicles (Amendment) Bill was cleared establishing battery-powered e-rickshaws as a valid form of commercial transport
- 3 wheeled vehicles run by battery power of no more than 4,000 Watts
- 4 passengers, luggage of 50 kg and with a single trip under 25 kilometers
- In January 2014, Tripura became the first state in India to regulate the functioning of the e-rickshaws, and they came up with the Tripura Battery

Operated Rickshaw Rules 2014 for the purpose. Tripura Battery Operated Rickshaw Rules 2014 consists of norms / guidelines such as driver age limits, license fee, renewal fee, Road Tax, provision for vehicle fitness certificate, insurance for e-rickshaw and identification of routes for operation of these vehicles.^[17]

4.2.3 FAME India scheme

The Department of Heavy Industry is administering the scheme “Faster Adoption and Manufacturing of Electric and Hybrid Vehicles in India”, popularly known as FAME India scheme since 01st April 2015.

Under the scheme, the subsidy is being given to 11 cities for launching electric buses, taxis, and three-wheelers. The cities include Delhi, Ahmedabad, Bangalore, Jaipur, Mumbai, Lucknow, Hyderabad, Indore, and Kolkata, plus two cities – Jammu and Guwahati under the category. ^[6] The nine big cities in the list will be given subsidy for 40 buses each while Jammu and Guwahati will get for 15 buses each. Subsidy for taxis will be given to Ahmedabad (20 taxis), Bangalore (100 taxis), Indore (50 taxis) and Kolkata (200 taxis) – based on their demand. Bangalore will get subsidy for 500 three-wheelers, Indore for 200, and Ahmedabad for 20. This comes to a total of 390 buses, 370 taxis and 720 three-wheelers.^[18]

4.3 Willingness to Recommend and Purchase an EV

This construct showed strong relationships among the variables (KMO=0.725). Factor loadings of the elements in this construct (all above 0.8) are given in Table 4.^[19] The Cronbach's Alpha had the highest value of all constructs, 0.910.^[19]

The results of the analysis show that approximately 65% of respondents would recommend EV to others. Buying an EV as a next car is chosen by 27.9% of respondents, while 35% of respondents would prefer to use EV over any other car. This percentage of driver's showing a preference to use EV over any other type of cars indicates a positive attitude towards EV and acceptability of the electric car.

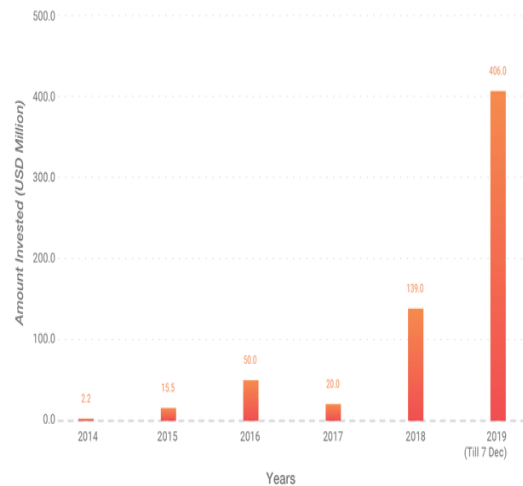
Table 3 - Willingness to recommend and purchase an EV Factor Loadings.

4.4 What Are the Challenges for The EV Market in India?

- Inadequate charging infrastructure ^[18]
- Reliance on battery imports

- Reliance on imported components and parts
- Incentives linked to local manufacturing
- Range anxiety among consumers
- The high price of EVs currently
- Lack of options for high-performance EVs
- Inadequate electricity supply in parts of India
- Lack of quality maintenance and repair options
- Affected by the broader automobile industry downturn

Investment in the electric vehicle has seen an exponential increase in 2019 from the previous year, this is shown in the following graph.



Graph 1 - Investment in Electric vehicle has seen an exponential increase in 2019 from previous year.

5. Recommendations

- Adequate capacity addition primarily through Renewables in the distribution grid in order to meet additional demand created by high penetration of EVs.^[10]
- EV charging station to be designed preferably with rooftop solar generation to minimize dependence on fossil fuels in the entire supply chain hence shifting towards clean energy.
- Encourage EV manufacturers to design vehicles with changeable batteries, so that EV owner can just move in the charging the station, replace his battery with a fully charged battery and move on.
- Use of dynamic pricing model and smart grid tools for charging stations to encourage charging at on -

peak timings hence aiding to Peak Load Management.

- Adoption of EV standards Charging connector standards is being developed by the Automotive Research Association of India. Rating of charging sockets: Does household 16A sockets are good enough for household EV charging? Or does it need industry-standard sockets?
- Identification of EV charging nodes in the existing distribution network without affecting the voltage profile of the network.
- Suitable pricing mechanism to be developed, in case the utility needs to augment the distribution grid to support EV charging.

6. Result

According to the above literatures there are some major reasons for growing market share of EV's. They are:

- GDP per capita income
- Cost & Features of Charging Infrastructure
- Driving Range
- Cost of Batteries & Battery Life
- Government Incentives
- Education about Environmental Implications

The correlation between GDP Per capital income and %age share of sales in 2018 is also positive. The data is as in following diagrams:

A. Data

Data showing: Countries, GDP Per Capita, %age share of sales in 2018

Country	Per Capita Income	%age share of sales in 2018
Japan	42659	1.1
Germany	50206	1.9
Denmark	49613	2
United States	59495	2.1
France	43550	2.11
Canada	48141	2.16
Belgium	46301	2.5
United Kingd	43620	2.53
Switzerland	61630	2.55
Austria	49247	2.6
China	16624	4.2
Finland	44050	4.2
Portugal	30258	5.6
Andorra	39147	5.6
Netherlands	53582	6.5
Sweden	51264	8.2
Iceland	52150	19
Norway	70590	49.1

Figure 1- Share of EVs sales in 2018

Sheet 1

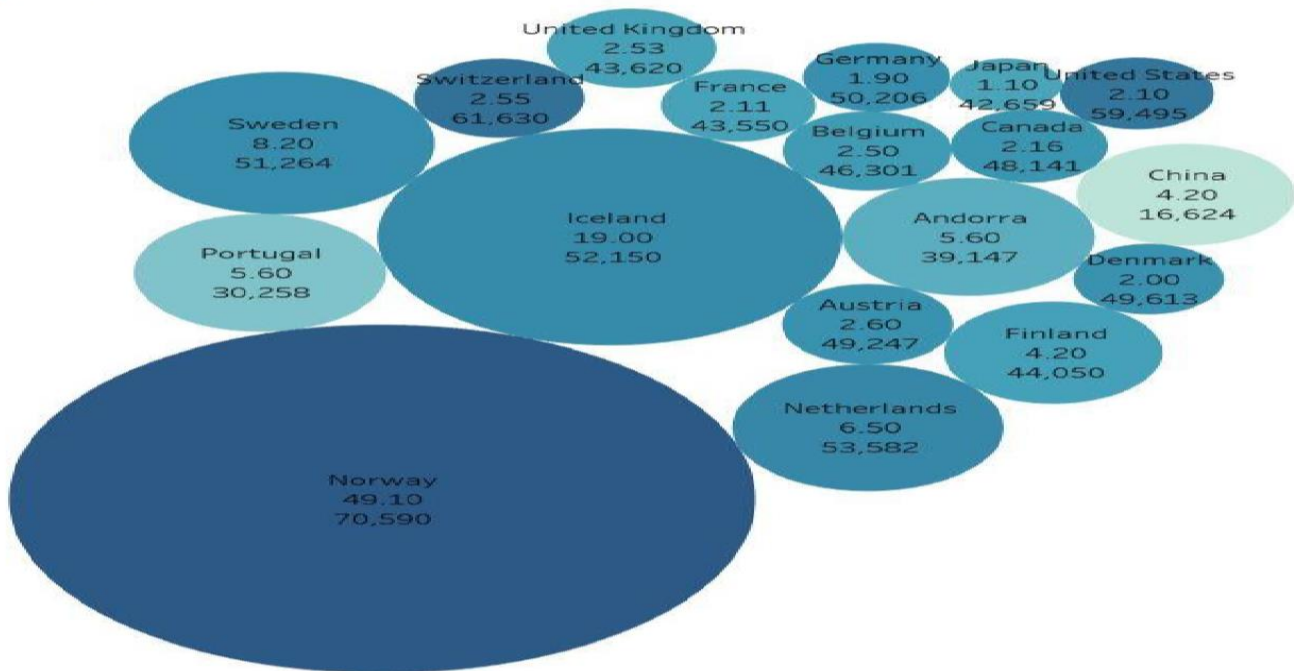


Figure 2 – Data In Table

S.no.	Items	Factor Loadings
1)	I prefer to use EV over any other type of cars.	0.911
2)	I would recommend EV to others.	0.828
3)	I would buy an EV as my next car.	0.837

7. CONCLUSIONS

We reviewed literature on facts that affect EV adoption and identified several gaps in knowledge and areas for further inquiry. First, the literature on EV adoption suggests that high purchase price is a major reason EV uptake. Moreover, though many governments offer incentives to support their thoughts and intentions. EV driving range is identified as another major reason to EV adoption.

Relatedly, studies suggest there is an appropriate role for government to support the development of charging infrastructure for EVs as a means of creating the public network. Though there are early findings that the presence of charging infrastructure significantly relates to rates of EV uptake, there is still an open question in regards to the direction of causality. In addition, the literature provides little guidance on how governments should best add the provision of infrastructure –for example, through public provision, public/private partnerships, financial incentives, or mandates. In addition, the literature has only begun to explore the kinds of public charging infrastructure that may be optimal and how that criteria may be developed per regional needs. The literature shows mixed evidence that consumer characteristics like income, education, and age can significantly determine whether a person will be interested in purchasing an EV. The survey data is the biggest limitation in interpreting the results of studies on EV uptake. The literature provides compelling

evidence that there is a substantial gap between people’s stated likelihood of EV adoption and actual adoption trends. We suggest more study should be done regarding

the magnitude of this “gap”, with emphasis on different consumer characteristics.

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