B. TECH. PROJECT REPORT

On

Technology Transition from Petroleum based Vehicles to EVs: Policy Incentives

By

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| 180003063 |

DISCIPLINE OF MECHANICAL ENGINEERING

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Technology Transition from Petroleum based Vehicles to EVs: Policy Incentives

A PROJECT REPORT

Submitted in partial fulfillment of the requirements for the award of the degrees ***of***

BACHELOR OF TECHNOLOGY

in

MECHANICAL ENGINEERING

Submitted by:

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INDIAN INSTITUTE OF TECHNOLOGY INDORE May 2022

CANDIDATE'S DECLARATION

I hereby declare that the project entitled **"Technology Transition from Petroleum based Vehicles to EVs: Policy Incentives"** submitted in partial fulfillment for the award of the degree of Bachelor of Technology in 'Mechanical Engineering completed under the supervision of **Dr. Pritee Sharma, Professor, Discipline of Economics, IIT Indore** is an authentic work.

Further, I declare that I have not submitted this work for the award of any other degree elsewhere.

Oostwal
20/05/22

Signature and name of the student(s) with date

CERTIFICATE by BTP Guide(s)

It is certified that the above statement made by the students is correct to the best of my knowledge.

Pritee
27 5 2022

Dr. Pritee Sharma, Professor
Signature of BTP Guide(s) with dates and their designation

PREFACE

This report on "Technology Transition from Petroleum based petroleum-based Vehicles to EVs: Policy Incentives" is prepared under the guidance of Dr. Pritee Sharma. Through this work, I have tried to spread awareness about electric vehicles and analyze the hindrances to a complete shifting of the Indian public towards EVs.

The work was permanently focused on finding the bottlenecks in the EV segment which are stopping people to adopt EVs. Also, the work has been done to find out the various policies that can be implemented in the current scenario to boost the EV revolution.

This thesis shall pave a pathway for all those who wish to work in the EV segment and its Policy Incentives. I have tried to provide all the details of the work that I have done so far for the reference of the students/organizations/ entrepreneurs who wish to carry it forward. I have tried my best to explain the content lucidly, whereas if some confusion persists feel free to reach out to us in that regard. I will be happy to help.

Vineet Ostwal
B.Tech. IV Year
Discipline of Mechanical Engineering
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ACKNOWLEDGEMENTS

I wish to thank Dr. Pritee Sharma for her kind support and valuable guidance. She has always believed in me and encouraged me to achieve my goals. It was her belief in me that I was able to make this much progress in this project in the given period of time. She has always supported and motivated me to learn new things and hence helped us build a better perspective of this discipline.

Further, we would like to thank our family and friends who motivated us to achieve our goals and bear the ignorance due to our dedication towards the project. Without their support, this report would not have been possible.

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ABSTRACT

For a long time, gasoline and diesel have been utilized as automobile fuels. However, the reduction in oil availability, volatile oil costs, and environmental damage encourage people to seek alternative sources of energy for vehicle fuel. Electrical energy alternatives for automobiles will reduce carbon emissions, reduce pollution, and generate greater energy at reduced costs.

Transport accounts for around one-fifth of global CO_2 emissions, and out of this, 75% is caused by road vehicles. Instead of using Petrol or diesel as vehicle fuel, if we switch to Electricity as a vehicle fuel, we can reduce GHG emissions significantly. Also, EVs are much more economical than Petroleum vehicles in the Longer Run. Many new startups and Research organizations are working in this segment to make it more efficient and viable for all the Population income-wise. To bring this Electric Revolution Government of India has launched various schemes and provided various Tax deductions.

The primary issue is that even after the implementation of various policies to make people adopt EVs, they aren't willing to shift to EVs swiftly. So, I conducted various ground-level surveys to find out the opinions of existing EV owners about the bottlenecks present in the current scenario and took views from them regarding what more policies or incentives could be taken by the Government to boost this Electric revolution.

Keywords: Electric Vehicles, Greenhouse Gas Emissions, Policy-Making

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Chapter 1
Introduction

1.1 Background

Since urbanization, energy consumption has steadily increased. Global energy demand and consumption are increasing owing to population increase and the rapid development of transportation. Transportation is the major consumer of global oil. Approximately 60% of oil output is used for transportation. It is also the second greatest source of greenhouse gas emissions. The transportation sector accounts for around 20% of CO2 emissions. The majority of automobiles today run on gasoline. However, fossil fuels are scarce and unequally spread. Moreover, Petroleum fuels cause significant pollution. Energy security, climate change, and expanding global energy consumption are all gaining public attention these days. Many nations intend to replace conventional fuels with alternative fuels in the future in order to minimize oil reliance and achieve sustainable transportation.

Electricity as a fuel has a potential on the higher side for vehicles because of its sustainability, economic-friendly, and accessibility to the majority of the population of a country.

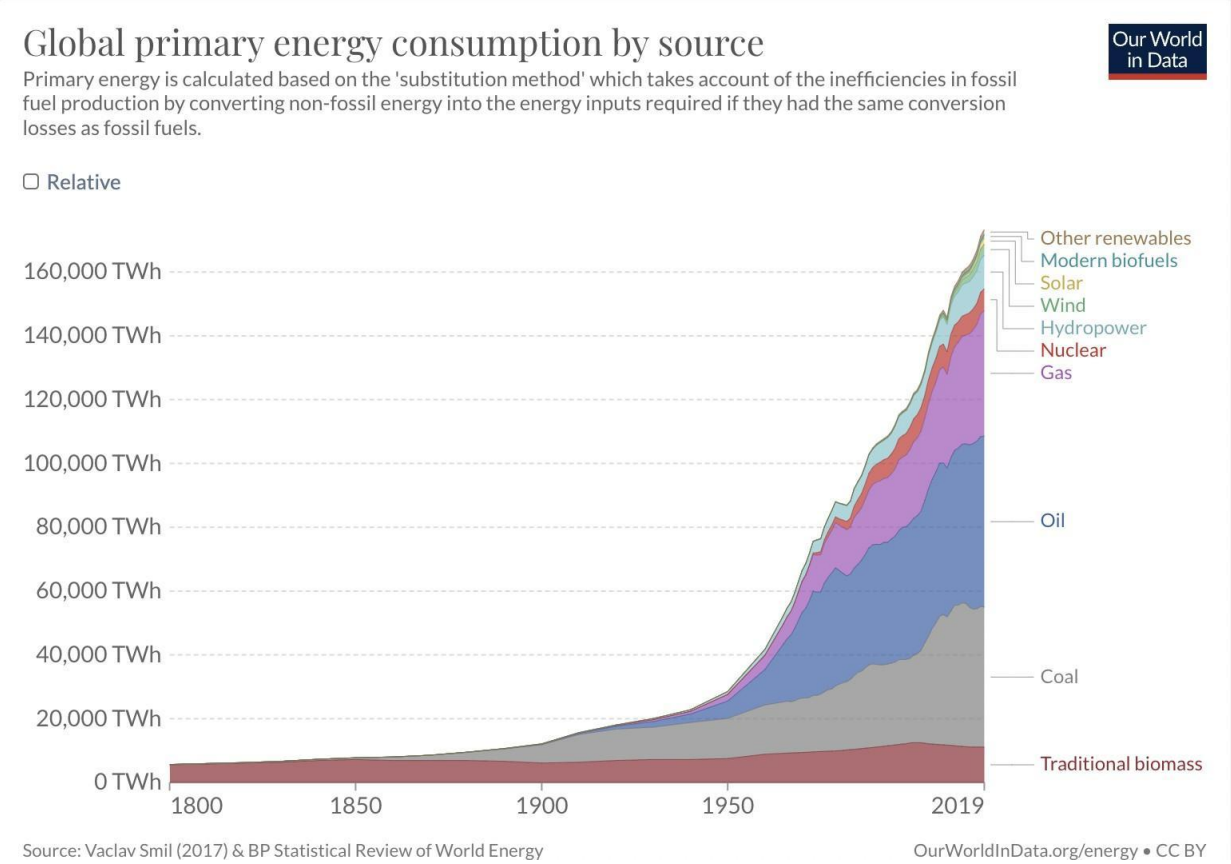

Figure 1.1 The following figure shows the energy consumption trend from 1800 to 2019.

SOURCE:- https://ourworldindata.org/

The majority of the world's energy use is reliant on fossil fuels. For example, in India, oil or other oil products account for more than 98 percent of transportation. The processing amount of oil in the next two years, 2018-19 and 2019-20 were 252.2 MMT and 254.4 MMT, respectively, with a YOY rise in the volume of crude oil imported of 226.5 MMT and 227 MMT. However, the oil will be in low supply in the next decades, and supplies are unreliable and unstable. Furthermore, oil production is limited to a few areas. OPEC (Organization of Petroleum Exporting Countries) will control 70% of the liquid oil supply and 45 percent of the entire market by 2030. As a result, oil depletion or any change in oil supply policy might have a significant impact on energy security. Since the energy crisis, energy securities have begun to align globally. Many countries are adopting policies to become energy independent and develop alternate energy sources. Vehicles' internal combustion engines release a variety of pollutants such as hydrocarbons, nitrogen oxides, carbon monoxide, and carbon dioxide, all of which can contribute to cancer, acid rain, heart disease, and global warming.

In 2019, transportation accounted for 24% of energy-related CO2 emissions, with road, rail, air, and maritime transportation being the most common modes of transportation. Furthermore, passenger cars were responsible for half of the emissions. Using alternative fuel cars is the most promising method. A switch to alternative energy for future automobiles might be a critical step toward meeting sustainable development goals. Alternative fuel vehicles are automobiles that run on alternative energy. Traditional fossil fuels such as gasoline and diesel are not used in alternative fuel cars. Other forms of energy resources, such as electricity,

hydrogen, biofuel, natural gas, and so on, can be used to replace conventional fuels.

1.2. Purpose of Study

In the past few years, many companies and startups have entered the EV segment to develop the technology to the next level to compete with the existing petroleum-based vehicles. Also, the government of India is also providing various subsidies and tax deductions on the purchase of EVs.

Even after all these efforts, the majority of people are not willing to go for EVs because of the existing infrastructure that is currently present in India.

Via our project, we will try to find out the bottlenecks that are present in the current scenario, which are stopping people to adopt EVs, and what more steps can be taken by the Government which will bring a major impact to this EV Revolution.

Chapter 2

Petroleum and Electric Vehicles

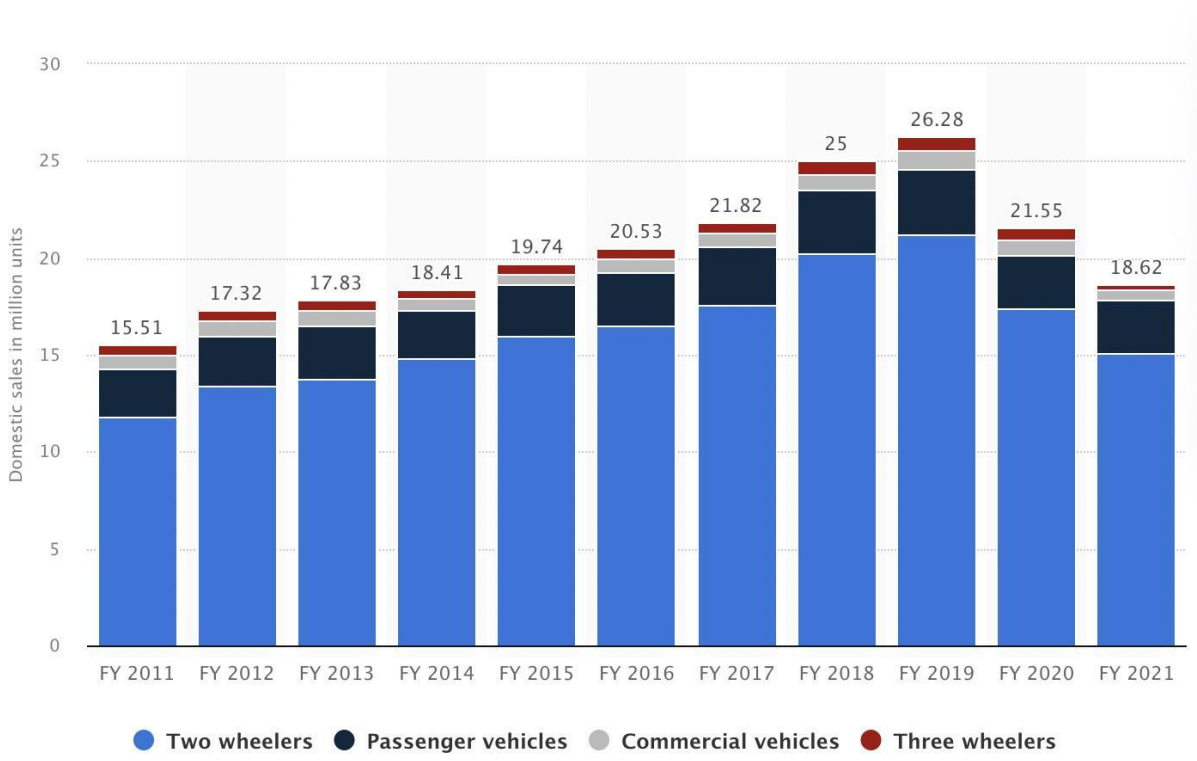

Figure 2.1 Sales of automobiles in India from the financial year 2011 to 2021, by type (in million units)

SOURCE:- www.statista.com

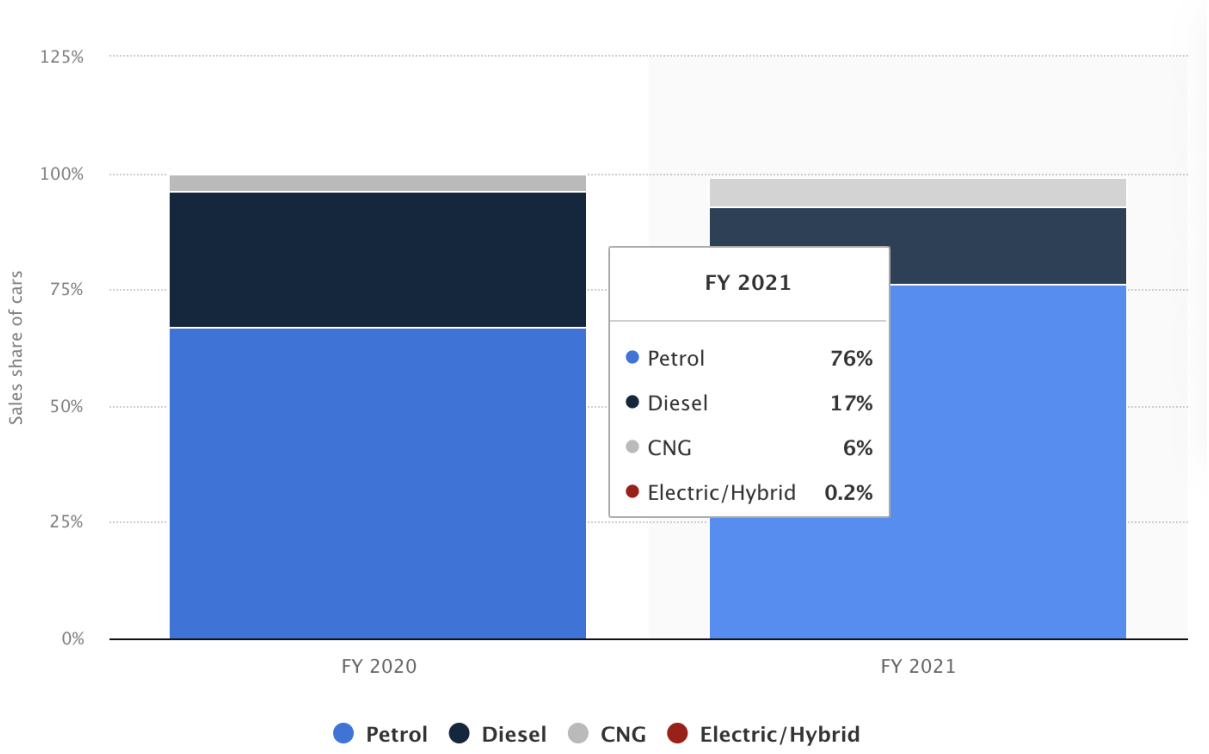

Figure 2.2 Share of cars sold in India from the financial year 2020 to 2021, by fuel type

2.1 Impact on the Environment

The exhaust emissions of pure electric cars are nil. Pollution may be effectively managed in a power plant. As a result, electric vehicles will improve city air quality. Electric vehicles are the most effective technology for reducing CO2 emissions per kilometer when compared to gasoline vehicles. According to the International Energy Agency, electric vehicles may emit 50 grams of CO2 per kilometer when driven wheel to wheel. The most efficient gasoline automobile currently emits 100 g/km of CO2. Electric cars' potential to cut greenhouse gas emissions is determined by the type of electric power plant used. If coal is used to generate energy, an electric vehicle will emit 200 grams of CO2 every kilometer. Electric vehicles are not superior to conventional automobiles.

Electricity generated in a coal plant if treated properly can cause less GHG emissions as compared to petrol or diesel vehicles where the gases can't be treated properly.

	CO_2 emissions	
	g/kWh	g/MJ
Coal	960	3456
Fuel Oil	720	2592
Natural Gas	480	1728
Nuclear	6	21.6
Hydraulic	4	14.4
Wind	3–22	10.8–79.2
Photovoltaic	50–150	180–540

Table 2.1 CO_2 emissions per unit of energy generated at different kinds of power plants

2.2 Energy efficiency

Internal combustion engines (ICEs) are inefficient. The bulk of the energy is squandered as heat during the combustion process. As a result, the internal combustion engine's efficiency is just 15-20%. Electric automobiles, on the other hand, are powered by electric motors that do not lose energy when running or stopping. Furthermore, a braking regenerative system may absorb the waste energy generated during braking. As a result, EVs have an energy efficiency of 80%. Electric vehicles also improve the electrical system. Electric vehicles may be charged at night. Thus, power plant surplus energy may be completely used during low-demand periods. It contributes significantly to the economic efficiency of power plants.

2.3 Maintenance costs for EVs vs. fossil fuel-powered cars

Vehicle maintenance costs can stack up over time. With ICEs, engine maintenance can be a huge money sink, especially as the cars age. Changing the engine oil, coolant, transmission fluid, and belts can add up in value over time. By comparison, electric cars don't have internal combustion engines, so these costs disappear. Universal vehicle expenses like tire and brake changes, insurance, and structural repair are part of owning any vehicle, but EV owners avoid many of the repeated costs associated with combustion engine upkeep.

EVs aren't without expenses, however. The largest possible maintenance expense for an electric vehicle is a replacement battery pack. Unlike conventional batteries, EVs have large, complex rechargeable batteries that are drained and recharged constantly, which leads to degradation and range loss over time.

2.4 Life for electric cars vs. gas-powered cars

With recent improvements to combat the country's ever-growing pollution, the government has recommended that IEC-based automobiles be discarded after 15 years since they generate unacceptable levels of pollution beyond that time. There are a lot of component failures, as well as replacement and maintenance of worn-out components. The battery, on the other hand, is the most important component of an electric vehicle. While most electric car manufacturers provide a long battery guarantee (about 6-8 years), it would be necessary to replace the battery after 10-12 years if it had totally degraded and no longer provided the desired range and performance.

Currently, an EV battery costs between Rs 15,000 and Rs 20,000 per kWh in India. Assuming that an electric car has a 30kWh battery, the battery replacement will

cost between Rs 4.5 lakhs and Rs 6 lakhs. However, in the next few years, the price is projected to drop.

Chapter 3

Policies and Incentives by GOI to promote EVs

3.1. PLI(Production Linked Incentive Scheme)

Introduced in March 2020, aims to give companies incentives for incremental sales from products manufactured in domestic units. Aimed at making India a manufacturing hub for EVs. Thereby, reducing the cost for end consumers. PLI for Advanced Chemistry Cell is aimed at providing incentives for chemical research related to EVs, especially lithium battery technology.

3.2. Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME-I and FAME-II)

The FAME India programme was developed by the Indian government to reduce the use of diesel and gasoline in vehicles, and it was an important element of the country's national electric mobility mission plan.

The first phase of this plan began in April 2015, with the primary goal of the Indian government being to reduce the usage of diesel and gasoline-powered vehicles in the country.

The Ministry of Heavy Industries and Public Enterprises implemented and oversaw the programme.

The government revamped the FAME-I plan after its successful deployment,

adding more rewards and making it easier for individuals to move to EVs.

The scheme's Phase II began on April 1, 2022.

3.2.1. Objective Of Fame India

The major goal of this programme is to encourage people to buy electric vehicles. The government will pay incentives for the purchase of new electric vehicles under this programme, promoting electric mobility.

Another goal of the initiative was to encourage manufacturers in the nation to build more electric automobiles. According to the government, electric buses will be widely employed to reduce pollution and other issues. In the following few years, till 2024, the government is anticipated to invest about 10,000 crores in this project. High metropolitan cities will have a large number of electric buses to cut pollution.

How has the government changed from FAME-I to FAME-II?

- Earlier under this scheme, the government was providing a subsidy of Rs.10000 per kWh of battery and capped the maximum incentives to 20% of the total price of the vehicle.

- After the amendment in 2021, the government is now providing a subsidy of Rs.15000 per kWh of battery and has increased the maximum cap to 40% of the price of the vehicle.

- The government has also increased the scheme for two more years till

  31st March 2024 as previously it was till 2022 only.

3.2.2. Sales Of Vehicles Under Fame India Scheme

So far, 78045 automobiles have been sold under the Fame India programme. This project would be implemented with a budget of Rs 10,000 crore from the government. Only 5% of the money, or Rs 500 crore, has been spent thus far. Until March 2022, 58613 electric two-wheelers will have been sold. The government has decided to prolong the plan till 2024 in order to meet the aim of selling 10 lakh units. As of June 26, 2021, the Fame India plan has sold a total of 78045 electric cars, including 59984 electric two-wheelers, 16499 electric three-wheelers, and 1562 electric four-wheelers.

3.3. Tax deductions on loan taken for Purchase of EV

When paying off an EV loan, a total tax exemption of up to Rs 1,50,000 is available under section 80 EEB. This tax break is applicable for both four-wheeler and two-wheeler electric vehicle purchases.

Eligibility Criteria and Conditions to get these Tax deductions under the FAME-II scheme:-

- ❖ Only one who has never owned an Electric Vehicle before is eligible for such Tax Deductions.

- Individuals are the only ones who can take advantage of this deduction, if the EV is purchased under a business name he can't be benefitted from such deductions.

- The exemption is given to persons who are Financing their Electric Vehicles from NBFCs or some Financial Institution.

- Payoffs of loans done between April 1, 2019, and March 31, 2024, will be eligible for such tax savings.

Previously Electric Vehicles were charged at a GST rate of 12% but under this scheme, the Government has reduced it to 5% per annum.

Apart from this many states have come forward and exempted EV owners to pay complete road taxes or either make them pay reduced road taxes.

Rajasthan, Andhra Pradesh, Karnataka, Madhya Pradesh, Telangana, Tamil Nadu, Uttarakhand, Punjab, and Uttar Prademarsh are the states which have been completely exempted from paying road taxes.

While on the contrary side Petroleum-based vehicles are charged at a GST rate varying from 18% - to 28%.

→ To compare the Final on-road price of EVs and Petroleum-based vehicles, Quotations were taken from the Tata showroom of the Four-wheeler (TataNexon EV XZ Plus model), after applying all the subsidies, GST, RTO charges, etc. from them.

3.3. Tax Benefits for EVs

	Pricing of an SUV (TataNexon EV XZ Plus Model) in Jaipur, Rajasthan		
2	**Particulars**	**Petroleum Based Vehicle**	**Electric Vehicle**
3	Cost of manufacturing	878,125.00	1,570,476.00
4	Production cost	878,125.00	1,570,476.00
5	Transportation, etc.	10,000.00	10,000.00
6	Sales charge (1%)	8,781.25	15,704.76
7	Base amount for tax calculation	896,906.25	1,596,180.76
8	GST @28% / @5%	320,667.20	83,774.50
9	RTO Charges	120,490.00	12,000.00
10	Subsidy Under Fame-II Scheme	0.00	150,000.00
11	Other Charges	13,249.00	18,200.00
12	Final on Road Price of Vehicle	1,351,312.45	1,560,155.26

Table 3.1 Pricing of an SUV(TataNexon EV XZ Plus Model) in Jaipur, Rajasthan

Quotation is taken from the Tata Motors, Jaipur

Chapter 4

Survey

Analysis

To understand the real problems of people regarding electrical vehicles. I conducted a short survey where existing EV owners shared their genuine opinions. I received around 160 responses, and the results can be found below.

4.1. Main Reasons for switching to EV

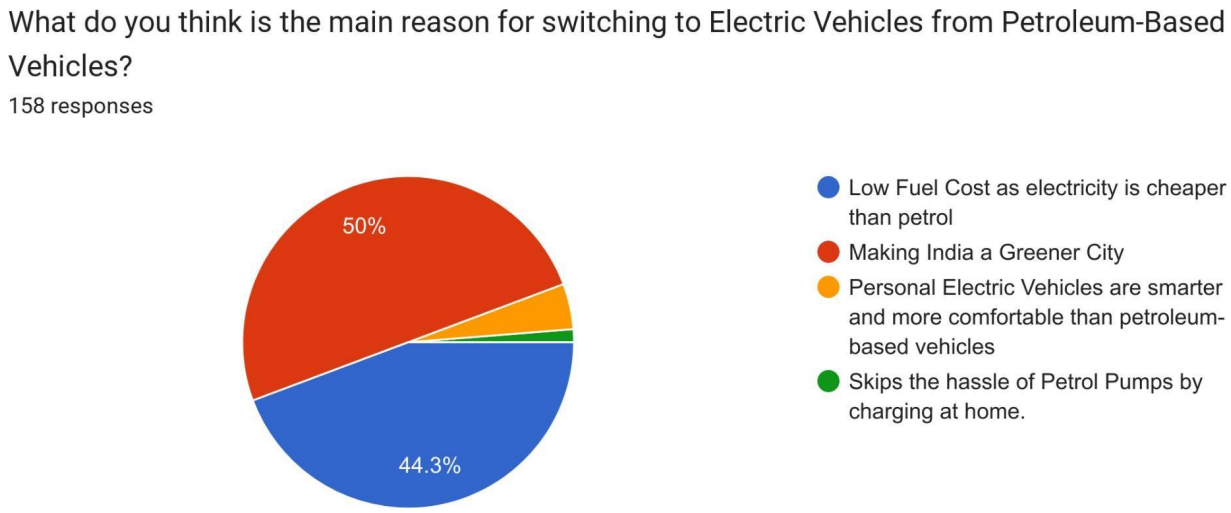

Figure 4.1 Pie chart showing the reasons for switching to EV

4.1.1. Greener India

Around half the Indian audience finds pollution from petroleum vehicles as the major driving force for switching to Electric vehicles. Such maturity by the audience must be appreciated because India is much less polluted than developed countries. Adopting greener alternatives will go a long way in the growth of the nation.

4.1.2. Low Fuel Cost

With the rising prices of crude oil every now and then, low-cost fuel has become a dire need of this time. Electricity is a promising alternative as it can be manufactured and transported much more efficiently than petrol. This reduces the fuel cost by almost 80%.

4.1.3. Comforts of Electric Vehicles

There are a lot of changes going on in the automotive sector. With the rise of embedded systems, vehicles are getting smarter and EVs are the prime object due to their inherent high battery capacity. As such, EVs provide several features like smart locking, location tracking, safety sensors, etc, that most petrol vehicles lack.

4.2. Hesitations towards EV

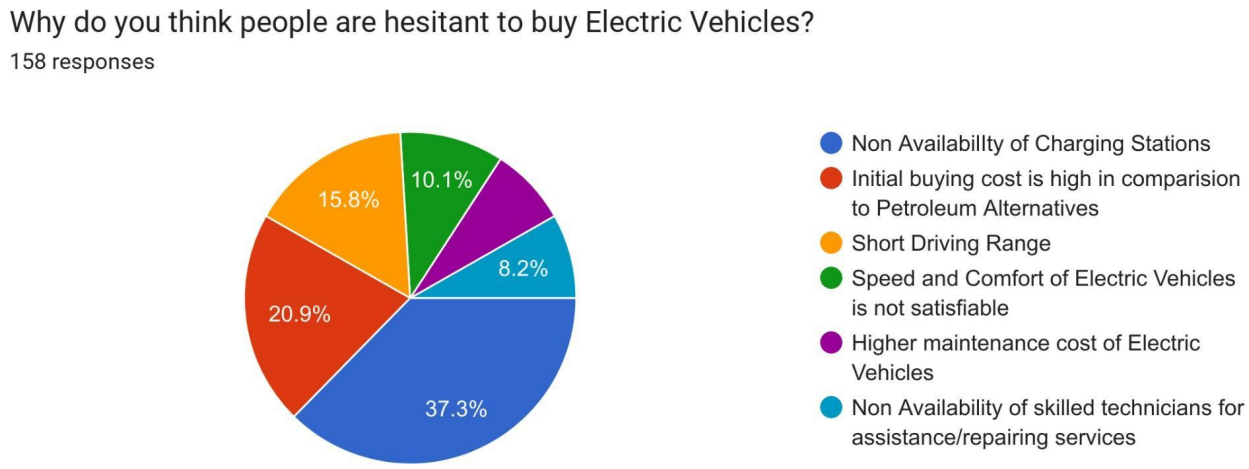

Figure 4.2 Pie chart showing the hesitations of people to switch to EVs

4.2.1. Charging Stations

There are more than 80 thousand petrol pumps all over India. On the other hand, due to being a recent phenomenon, there are only around 2 thousand charging

stations and mostly centered around metropolitan areas. Combined with a short driving range per charge, EVs are at an obvious disadvantage. Around one-third of the people feel this is a dealbreaker.

4.2.2. Initial Buying Cost

Most of the Electric Vehicle companies are importing ready-made products from other countries. This makes EVs inherently costly. The embedded systems that make these vehicles smarter also add up the cost price of EVs.

4.2.3. EVs are of bad quality

Poor quality of cheap vehicles has significantly biased people against EVs. There were several incidents of the initial versions of electric vehicles getting burned due to electric faults or battery overheating in summers. We have moved far from those times, but people have a deep-down fear about EVs.

4.2.4. Bad Customer service

Again, EVs are a very recent technology. As such, there is less demand, which is indirectly affecting supply. This has become a deadlock that has affected almost one-third of people and will need some external help to drive out of the situation.

4.3. Government's top priority

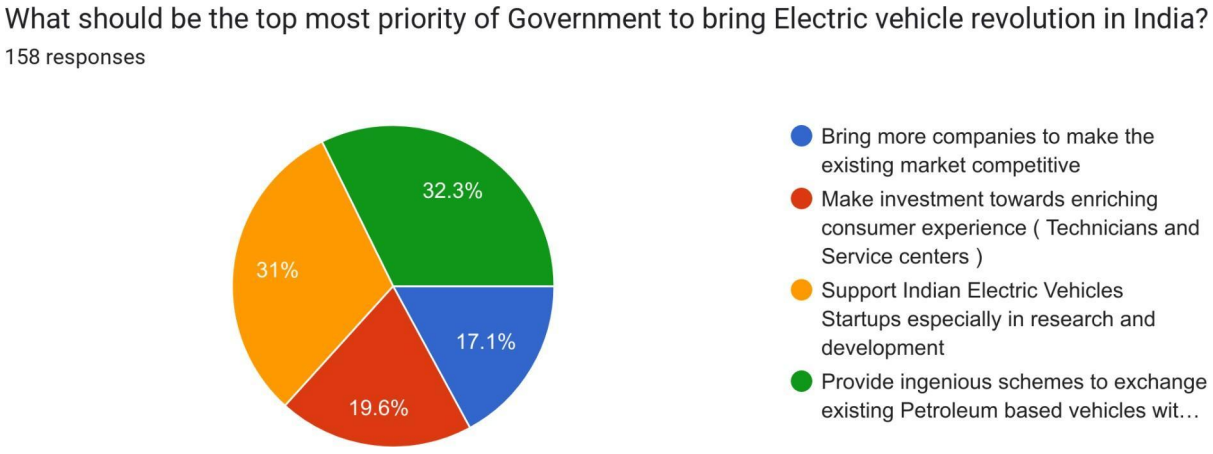

Figure 4.3 Pie chart showing the government's top priority to bringing Electric vehicle Revolution in India

4.3.1. More Govt. Schemes

About 32.3% of people want more ingenious schemes so that they can exchange their existing vehicles for EVs swiftly. Also, the government can make schemes to finance EVs at low-interest rates. Niti Aayog has proposed to include EV loans in RBI's priority-sector lending. If this bill is passed it will boost the EV revolution.

4.3.2. EV startups

About 31% of people think that more investments should be made by the government in Startups that are doing Research and Development in the field of EVs. Regular reports of EVs burning due to heat should alert the government to invest more in the R&D of EVs.

4.3.3. Investments in EV experience.

About 19.6% of people think that the government should make investments in enriching the consumer experience. People aren't buying EVs due to a lack of service centers, and Companies aren't opening Service centers due to a lack of customers. This Deadlock situation has to be solved by an external agency by financing service centers initially.

About 17.1% of people think that the government should bring more companies to make the existing market more competitive. There are numerous companies that are constantly pushing a competitive product market. However, some guarantees regarding long-term support have to be made by the company to gain customers' trust.

4.4. Long Term Ownership Costs

A long-term ownership cost comparison was done for 2-wheelers and 4-wheelers in both the EV segment and Petrol vehicles segment.

Prices of the vehicles are taken from vehicle showrooms in Indore.

EVs vs Conventional Vehicles								
	Ex-Showroom Price(in Rs.)	Average 5-year Insurance cost (in Rs.)	RTO Charges	Average 5-year service cost (in Rs.)	Price per km (in Rs.)	50,000 km fuel cost	1,00,000 km fuel cost	Total Cost (5 yr + 1 lakh km)
2-Wheeler								
INTERNAL COMBUSTION ENGINE								
Honda Activa 6G	71,920	7,954	5,201	**NA**	1.90	95,000	190,000	275,075
Hero Splendor	69,290	7,043	5,337	**NA**	1.20	60,000	120,000	201,670
ELECTRIC VEHICLE								
Hero Electric Atria	71,690	3,056	7,235	**NA**	0.20	10,000	20,000	101,981
Ather 450X	133,390	4,483	3,114	**NA**	0.43	21,500	43,000	183,987
4-Wheeler								
INTERNAL COMBUSTION ENGINE								
Maruti Suzuki Swift	591,962	25,718	51,731	23,500	4.80	240,000	480,000	1,172,911
Hyundai Creta	1,044,000	52,424	110,300	16,000	5.80	290,000	580,000	1,802,724
ELECTRIC VEHICLE								
Nexon EV	1,479,000	63,285	59,160	20,000	0.96	48,000	96,000	1,697,445
Hyundai Kona	2,384,000	95,658	95,360	6,000	0.80	40,000	80,000	2,655,018
ASSUMED PRICE/LITRE Of PETROL:100 & COST OF ELECTRICITY PER UNIT: 10								

Table 4.4 EVs vs Conventional vehicles cost comparison

SOURCE:- SHOWROOMS OF INDORE

By the figure we can see that in the long run, EVs are much cheaper than Petrol based vehicles. It is the duty of the government as well as the companies to clear this misconception of the people.

Chapter 5

Conclusion and Future Work

5.1. Conclusion

The goal of this project was to analyze the bottleneck that is present in the current scenario in India regarding Electric vehicles. A thorough study was done at the ground level researching both the positives and negatives of the situation.

Government contributions and existing policies were critically analyzed. The implementation of some policies was found to be lacking from the goals set at the origin.

Further steps that can be taken by the government to boost EV revolution were also discussed.

5.2. Future Work

I have analyzed existing scenarios regarding EVs thoroughly. Future work can cover:

- Frame new policies that better fit the needs of the customers.
- Analysis should be done to find the flaws in the implementation pipeline of existing policies.
- Make a smart contract with EV manufacturers to ensure consumer satisfaction and safety.

- Standardize charging stations so that any electric vehicle can be charged at any station.
- Find more ways to replace existing petrol vehicles with electric vehicles.

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