

1.6. IMPACT OF MODERN DRIVES TRAINS ON ENERGY SUPPLIES

1. INTRODUCTION

Electric vehicle (EV) drives, which are generally subjected to frequent start and stop demands, are used in different climates, road conditions, and terrains. EV drives used mainly in industrial production lines are often operated at constant speeds and in controlled environments. In any EV propulsion unit, the motor drive is the most important part. The drive system mainly consists of an electric motor, a power converter, and an electronic controller. The motor drive should be designed to satisfy several characteristics, such as high torque capability, high efficiency, regenerative braking, and good thermal and cooling systems, which enable it to perform efficiently as part of the propulsion unit. Electric and hybrid vehicles are important factors for the improvement of a healthy environment owing to their beneficial effect on the environment through low CO₂ emission level. With the steadily increasing oil prices, the need for alternative energy source is growing. Electric and electric hybrid vehicles offer the best possibility for the use of new alternative energy sources.

Electric drive refers to the conversion of electrical to mechanical energy in executing various work demands and processes. About 50% of electrical energy produced is used by electric drives. Approximately 75%–80% of these electric drives operate at constant speed owing to the minimal requirement for speed control in their application. The remaining 20%–25% requires electric drives that can respond to variable speed and torque to match the mechanical load. The variable speed drive (VSD) is now popular even in

industrial and home appliances. The market of motion controls products shows a viable growth. Motion control market growth is illustrated in the histogram in Figure 1. This growth reflects that the demand for DC commutator motor drive sales decreases in contrast to the significant annual increase in AC motor drives .

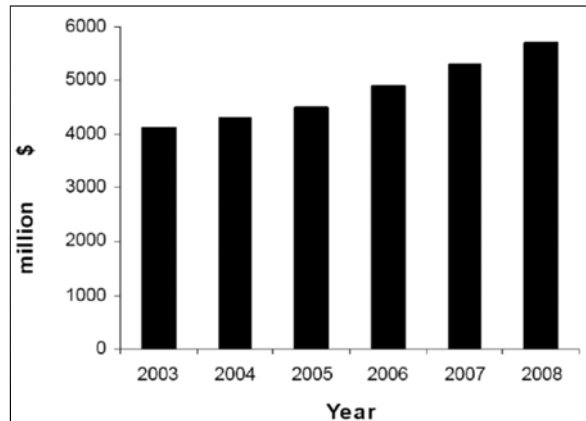


Figure 1. Motion control market growth

Owing to the rapid technological advancement in power electronic converters, AC motors are increasingly becoming attractive solutions for variable speed applications and have recorded steady growth since 1990. Figure 2 shows a major shift from traditional variable-speed DC brushed motors, which have been used for decades .

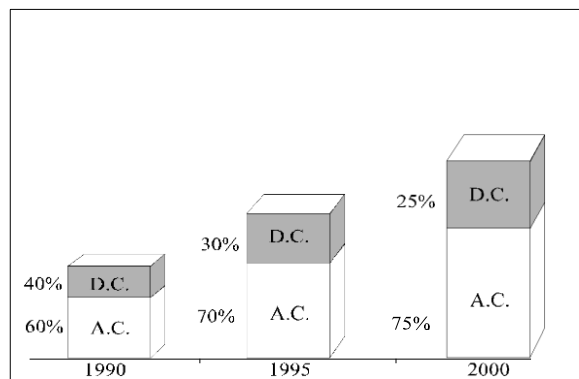


Figure 2. AC versus DC electric drive market

Electrical machines are key equipment in many industrial processes. They work either under constant or variable speed to match the unknown load torque operation. A feedback control loop must be implemented through a VSD. Information on the actual electrical and mechanical operating conditions experienced by the motor is provided and sensed by variable appropriate sensors. Then, a control algorithm processes this information and compares it with the demanded reference speed/torque. Based on this comparison, the supplied voltage or current to the motor windings is controlled through the power electronics switches as shown in Figure 3.

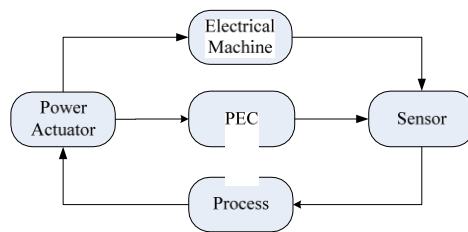


Figure 3. General scheme of VSD

The high maintenance requirement of the DC motor is a persistent problem with the DC drives. The AC VSDs have become popular and have rapidly grown since the 1980s. This growth is mainly a result of advances in power electronic switches and digital control technologies that highly affected the cost and performance of different VSD systems. The main performance parameter of pulling the movement toward AC VSDs is the rugged reliability and low cost of AC motors compared with the traditionally used DC brushed motor.

The mechanical commutation system in the DC brushed motor is the major source of inefficiency of DC drives. It has been replaced by a power electronic converter circuit called the inverter to validate the AC VSD system. Nevertheless, the uses of power electronics devices require a

sensitive and efficient digital control, which is the main difficulty in the AC VSD systems. This type of control complicates the system and increases the cost in achieving a reliable inverter circuit.

For any new technology proposed, the energy efficiency could attract new customers and help commercialize it among public users. The wide presence of power electronics converter (PEC) systems has recently caused the energy savings to pay back for the additional expenses implied by VSD implementation. Energy costs, interest rates, and inflation rise slowly every year, but this increasing cost could be forestalled to some extent by energy saving through PEC. Given that the life span of PEC drives ranges from 10 to 15 years, the principal investment in installing the PEC pays off well during this cycle. The energy savings produced by the PEC in VSDs for the PEC and motor improve energy utilization.

Regardless of the types of motor that the electrical drives are driving, the programmable microcontrollers inside the drive controller enable intelligent controls over stator and rotor flux angles, total harmonic distortion (THD) and power factor correction for optimal efficiency, and high-pitched noises associated with conventional PWM controllers.

In consideration that the electric motor is the heart of electric vehicles (EVs), the recent advances in electrical machines and their control greatly affect the development of EVs, particularly the development of AC drives and the production of highly efficient AC motors. Different types of electric motors have been used by manufacturers to implement different electric vehicles models as part of the drive system. Table 1 shows the different models of EVs by various manufacturers that are listed along with the type of motor used to implement the EV. The table shows that the AC motors are primarily used in EV implementation. The permanent magnet

PM brushless motors are specifically used owing to their dynamic characteristics and low maintenance compared with other commonly used AC motors.

2. PROBLEM STATEMENT

High dependence on the oil as the main source of energy for passenger vehicles has several effects because the number of automobiles introduced on the road increases annually. An economic factor is also Inherent in the poor energy conversion efficiency of combustion engines, but the use of EVs is still very limited compared with other types of commonly used and manufactured vehicles. One reason could be that electric cars remain more expensive than traditional cars. The high expense mostly refers to their expensive batteries. Furthermore, concerns relate to sufficiency of battery charge before traveling great distances.

For example, the transportation sector in Malaysia is considered one of the most advanced among developed countries in Asia. The fossil fuel types used in the transportation sector include natural gas, aviation gasoline, motor gasoline, aviation turbine fuel (ATF or Avtur), diesel oil, and fuel oil. Natural gas fuel is a mixture of gaseous hydrocarbons (mainly methane) that occur either in gas fields or in association with crude oil in oil fields.

2.1. Planning issue

The growing numbers of passengers and vehicles in addition to increasing trip distances result in a visible increase in the energy used by propulsion vehicle systems. Private vehicle population grows annually, which increases energy consumption. With fossil fuel as the main source, air pollution increases

because of combustion. Therefore, a high efficiency of energy use in the transport sector should be planned to minimize air pollution and address environmental concerns. Implementing energy efficient EV systems can help reduce the daily increase in petroleum oils used in the propulsion system. As a result, it can curb rising air pollution, especially CO₂ emissions in which two-thirds originate from transport fuel combustion.

2.2. Financial issue

Gasoline refined from crude oil is primarily used to supply the automobiles and light trucks with the required fuel to power their combustion engines. The almost continuous increase in the cost of the gasoline is concerning. This issue could be addressed by development and implementation of an EV. The EV could be charged at home at night during non-peak hours because electricity is cheaper at night. Gasoline prices fluctuate even when crude oil prices are stable, thereby causing trouble and headache for customers. Factors that cause the price fluctuation normally stem from the seasonality local retail station competition and the crude oil supply disruptions.

2.3. Environmental issue

In addition to CO₂ emissions, the traditionally powered gasoline vehicle usage results in other gas emissions that can highly affect the local air quality. Three gases covered by the Euro standards include carbon monoxide (CO), hydrocarbon (HC), and nitrogen oxides (NO_x). A balanced policy that could reflect the effects of both local air quality change and global climate change is needed given the benefits and disadvantages of fuels. The basic transportation CO₂ sources as shown in Figure 5.

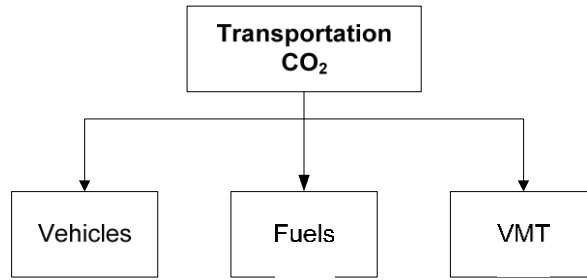


Figure 5. Transportation CO₂ sources

The light-duty vehicle CO₂ emissions are affected by vehicle use in terms of the vehicle miles traveled (VMT), fuel economy which refers to the miles per gallon, and the net greenhouse gas emissions. The fuel economy is affected by the characteristics, operating conditions, and practices of the vehicle. VMT growth affects the mounting emissions originating from the light-duty vehicle. Figure 6 shows a statistical graph of the amount of CO₂ emissions from the transport sector in Asia, which clearly illustrates the gradually increasing emission level.

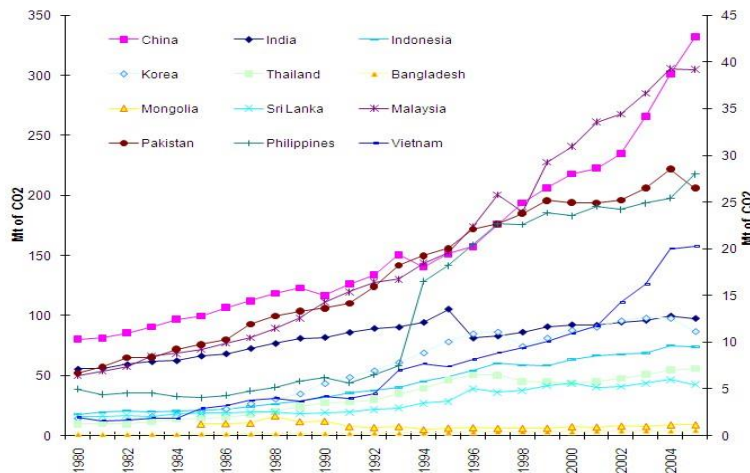


Figure 6. Trend of transport sector CO₂ emissions in Asia (IEA, 2007)

2.4. Health issue

Air pollution has a visible effect on human health and environment owing to harmful components. Air pollution components include CO, sulfur

dioxide (SO_x), NO_x, HC, and CO₂. CO reduces the blood's capability to carry oxygen, aggravates lung and heart disease, and causes headaches, fatigue, and dizziness. The combination of SO_x with water vapor in the air contributes to acid rain. NO_x causes a yellowish-brown haze and becomes a poisonous gas that damages lung tissue if combined with oxygen. HC could cause cancer and could irritate mucous membranes. Excess CO₂ can cause more sunlight to enter the atmosphere, which causes global warming.

The key point to be addressed is that car sales have almost doubled in the past 25 years. This phenomenon has considerably increased the demand for considering an alternative solution to limit and/or minimize the emissions from these vehicles.

3. EV DEVELOPMENT EFFECTS

3.1. Save money

Fuel prices continue to climb with the increase in tariff rates of electric power. Thus, the challenge for saving energy has been arising and highly concerning at a global level along with the increase in car sales as shown in Figure 7. However, electricity remains much cheaper than gasoline because it is mostly locally generated. The massive increases in gasoline prices are unavoidable because its demand is quickly overtaking the world's normal production. Nevertheless, the electricity price has not changed significantly because the electricity is locally generated. It is also generated from renewable resources (solar, wind, biomass, and geothermal), which are slowly becoming much popular with the reduction of installation cost.

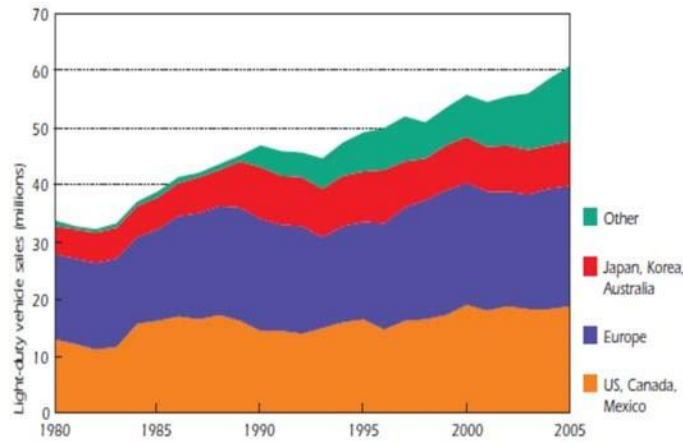


Figure 7. Global car sales (1980–2005) (IEA Data, 2007)

3.2. Finite resources

The global petroleum level is permanently dropping owing to resource constraints. The available usable energy is a finite resource, and energy cannot be repeatedly used indefinitely. Despite large supplies of coal, oil, and natural gas, the demand is increasing, but the amount of new energy supplies being discovered is decreasing. The consumption of energy by fuel type illustrated in Figure 8 shows that worldwide energy use, especially the demand for oil, continuously increases.

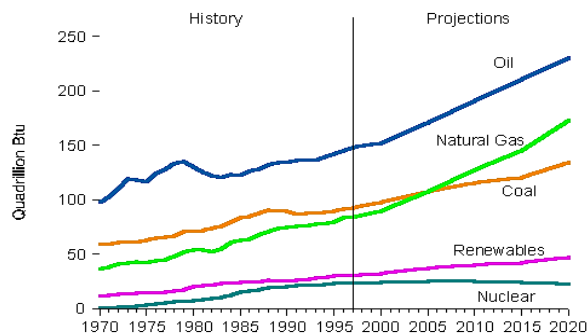


Figure 8. World energy consumption (EIA-International Energy Outlook 2000)

3.3. Clean environment

Energy conservation and environmental protection are highly important concerns worldwide. The availability of electricity is a major consideration in EV development. In terms of environmental aspects, the EVs produce zero emission at the point of use, which results in significant reduction in air pollution in crowded town areas. Air pollution causes many harmful effects on humans and surrounding environment. Therefore, quality air is a possible result of greenhouse effect. The rules and regulations that relate to practices that could affect the environment are important to encourage the promotion and movement of EVs. Some cities have implemented emission-free zones from all sources that mostly come from transport. World carbon emissions statistics are shown in Figure 9. The graph clearly shows the visible increase in carbon emissions worldwide.

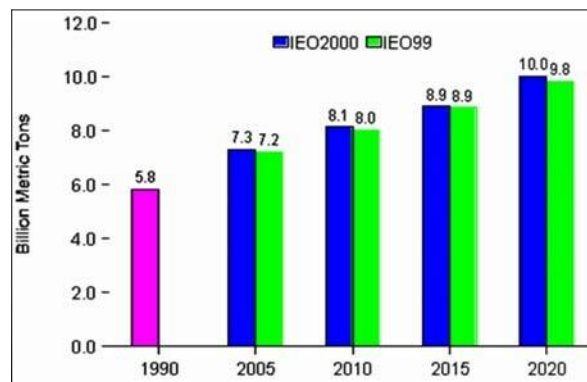


Figure 9. World carbon emissions

EVs benefit environmental protection owing to improvement in air quality, reduction in noise level, and zero local exhaust emissions. Globally, the emission from the generation of electricity for EVs is only 2% in CO, whereas that in gasoline-powered vehicles is about 76% in CO₂, 56% in NO_x, and 9% in HC. EVs operate quietly and almost vibration-free, whereas gasoline-powered vehicles are inherently noisy and have sensible vibration. The EVs powered by high-efficiency

controlled electric motors supplied by alternative energy sources are somehow clean, efficient, and environmentally friendly town transportation systems.

Moreover, the efficient potential pollution problem suppression by using the EVs has zero emissions. The aspects that influence the pattern and emission level of energy consumption from the transportation sector of Malaysia are presented. The study concludes that the total energy demand and vehicular emissions from the road transport represent one of the greatest areas of challenge for energy efficiency. The increasing usage of petrol is primarily from the consumption in the transportation sector. Petrol has been recently replaced by other fuels partially or totally in other sectors, yet the world energy demands continue growing with the population. The development of new technologies helps decrease fuel consumption in the transportation sector, which still accounts for the significant amount of air pollution in cities.

4. EV APPLICATIONS AND MARKET

EVs are used for passengers and public transportation. EVs are successfully realized in off-road vehicles market as they fulfill the application requirements. These applications include airport vehicles for passenger and ground support, recreational vehicles such as golf carts, plant operation vehicles such as forklifts and loader trucks for theme parks, vehicles for disabled persons, and so on. EVs are cost effective and lean toward green technologies. In addition, EVs have received increasing interest because they contribute to global pollution reduction. To achieve the abovementioned objectives, the following infrastructure matters should be considered: (a) Battery chargers: implementation of residential and public charging facilities and stations; (b) Standardization of EV plugs, cords, and outlets and safety issues; (c) Sales and distribution; (d) Service and technical support; and, (e)

Supply of parts. However, cost remains a major concern, and EV initial cost and battery replacement cost must be suppressed at a reasonable level.

5. EV IMPLEMENTATION

Figure 10 shows the basic EV propulsion system. Batteries or fuel cells can generally be used as energy system in EVs.

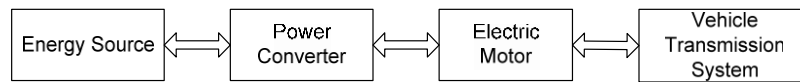


Figure 10. Basic electric vehicle propulsion system

5.1. Electric vehicle technologies

The essential technologies for EVs are: EV, hybrid, and fuel cell vehicles. Batteries are used as energy storage that powers the electric motor of the EV to achieve zero emissions. Batteries and conventional gasoline are used to power hybrid gas/EVs for propulsion. The hybrids generate less tailpipe emissions than the gasoline counterpart. The development of fuel cells could boost the EVs through generating electricity onboard, which is an emission-free source. The main difference between EV technologies is the method used to generate the electricity that powers the electric motors.

5.2. Battery EVs and fuel cell vehicles

A major concern of any new technology nowadays is energy storage. Some energy storage technologies can be implemented commercially at small-scale integration, but others must be further developed. The study highlights the challenges that prevent the commercial deployment of these energy storage technologies. The Battery Electric Vehicle (BEV) is a promising technology, but it still needs to be developed to gain social acceptance. This study reviews the technological readiness of the BEV technology and highlights the main

technological issues to be handed for visible progress. BEVs have higher efficiency and are more commercial compared with fuel cell vehicles (FCVs). BEVs and FCVs are the only two zero-emission candidates.

5.3. EV energy sources

Energy efficiency, energy utilization, and environmental protection have attracted increasing concern in research and industry because of energy cost. A part of this major concern is to achieve a green energy efficient transportation system through implementation of EVs. The popularization of EVs on the road and the energy sources are key technologies that could possibly realize the commercial implementation of EVs. The storage system implemented in an EV should fulfill the requirement of high power density to accomplish its anticipated driving range. Typical energy storage devices for automotive applications are lead- acid, nickel metal hydride, and lithium ion batteries. Charging EVs using photovoltaic (PV) has been proposed. The following approaches are available. The first is a combination of PV and the grid, and the second is using PV as the source only, which is more popular. The final aim is to reduce the emission over the entire life of a vehicle, including the energy and material used to power it. The fuel cell operates in an electrochemical process that converts chemical energy into electrical energy. The fuel cell system has zero emission because it does not emit any exhaust gas. The wastage of the reaction results in the production of only water and heat.

SOCIAL AND ENVIRONMENTAL IMPACTS OF ELECTRIC AND HYBRID VEHICLES

The social and environmental impacts of electric and hybrid vehicles include effects on mobility and travel, electricity supply system operation, petroleum and other fuel consumption, air pollution and traffic noise. An estimated 80% of average annual vehicle kilometers can be electrified. Electricity supply systems will not need to expand capacity, and will benefit from load levelling if overnight recharging of electric vehicles is encouraged. Petroleum consumption for transportation purposes will decline, but the benefits are dependent on the type of fuel used to generate recharge electricity. The fuel mix used by power stations also determines air pollution impacts, since decreases in vehicle emissions are accompanied by increases in power plant emissions. Improvements in traffic noise are modest, with 100% electrification of light vehicles producing a 13% decrease in traffic noise impacts.

1. INTRODUCTION

Can long traffic jams lead to reduced carbon emissions? Road transport is one the major contributors to air pollution in the world. A recent report shows 24% of the air pollution is caused by road transport in the world and the situation is getting worst in India as 94% of the air pollution is caused by Road transport. This issue is taught and talked about for over decades but no major implementation of policies is seen. During the budget of fiscal year 2021-22, we saw that the government announced various schemes about the adoption of electric vehicles and hybrid electric vehicles. Hybrid electric vehicles are powered by an internal combustion engine and an electric motor, which uses energy stored in batteries. A hybrid electric vehicle cannot be plugged in to charge the battery. Instead, the battery is charged through regenerative braking and by the internal combustion engine. This regenerative braking system will

use the power lost at the time of slowing down a car and using it to recharge the car's batteries. On a normal car, braking simply wastes energy - but with regenerative braking, some of the energy is able to be reused. As, 85% of the car is made up by reused material by using the technique it could reuse the energy while on road as well.

II. RESEARCH PROBLEM

Even after so many policies announced by the government, there is still hesitation in adoption of Hybrid Electric Vehicles.

III. OBJECTIVES OF THE STUDY

To understand the Indian Automobile Production and Sales To identify the opportunities and challenges of using electric vehicles in India. To study the economic and social impact of HEV's in India and its vision for 2030.

IV. RESEARCH METHODOLOGY

The methodology adopted would be Descriptive research; which is a methodology approach that investigates research questions that have not previously been studied in depth. In India though Hybrid Electric Vehicles are talked about and many companies have started manufacturing the same but it is still a long way to go when till will be seen in every household and this will make the perfect base for my study. The data used is secondary data collected from the respective source. The survey conducted by Deloitte helps in better understanding of the research questions. (2020) 2020).

V. BACKGROUND

- The beginning: The launch of the first hybrid electric car was done in 1899 by Ferdinand Porsche. The car made used a gasoline engine to supply power to the motor. Even though it took into consideration some major issue that needed to be addressed for the future but like every other business it needed profit to run and due major losses it shut down and became obsolete for a long period

- **Renewed Interest:** As the first step is usually taken by the developed countries, USA introduced a legislation to encourage the use of electric vehicles in order to reduce air pollution. But this time like before even though the government was in favor of hybrid vehicles it didn't gather much people interest even after facing the oil crises in 1973. A major portion of Americans drove to work but as known a fact people didn't care about the environment at that time.

- **The Rebirth:** Developed countries although introduced relevant technology and reduced the carbon emissions, it the developing countries like India which are struggling. The adoption of hybrid vehicles is still in process as many factors are to be considered when it comes to a diverse economy like India.

- **The Future:** By 2050, for the economies to go to net zero emissions it is the goals that we make for the future which are important and so by 2030, almost all automobiles will switch to electric vehicles which will make the vehicles more affordable and proper infrastructure for adoption. In Indian context, The policies introduced the Indian Government for the promotion and adoption of Hybrid Electric vehicles include:

- **Auto PLI Scheme:** In September, the Union Cabinet approved a Rs 26,058 crore production-linked incentive (PLI) scheme to boost local manufacturing of electric and fuel cell vehicles, as well as drones, in India.

- **FAME II Amendment:** Under it, the government reduced the price gap between petrol-powered two-wheelers and electric two-wheelers by raising the subsidy rate for electric two-wheelers from Rs 10,000/kWh to Rs 15,000/kWh and capping incentives at 40% of the vehicle's cost, as opposed to 20% previously.

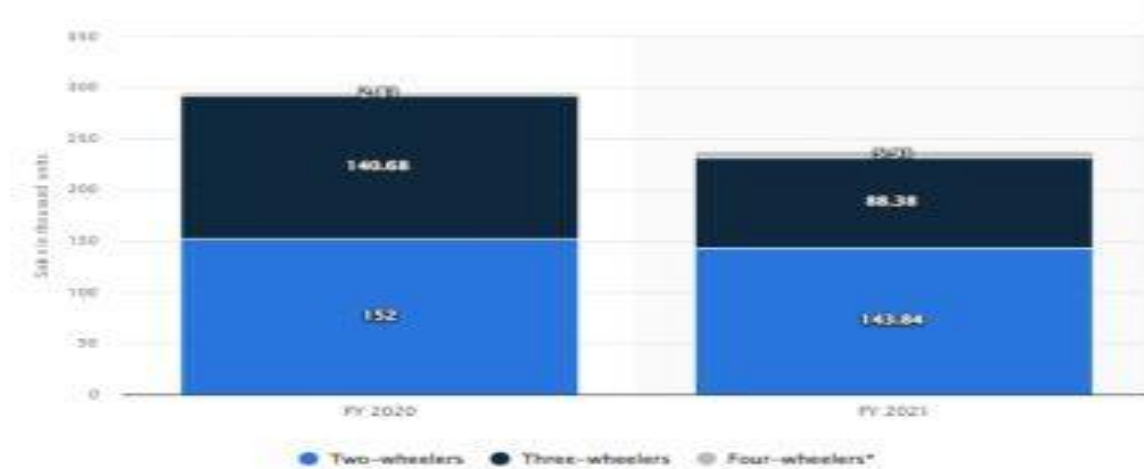
- **The Centre's Scrappage Policy:** In August of this year, Prime Minister Narendra Modi virtually announced the Vehicle Scrappage Policy at the Gujarat Investor Summit. In an environmentally beneficial manner, the strategy attempts to phase out unfit and polluting automobiles. Vehicles will be scrapped not only

because of their age, but also if they are judged to be unfit through automated testing. In 2024, the scrappage policy for private vehicles will be adopted. (News18.com 2020) As a result, "Maruti Suzuki and Toyota are collaborating on self-charging hybrid vehicles." There are currently no electric automobiles available for less than Rs 10 lakh. Mahindra & Mahindra (M&M) had planned to unveil the eKUV100, which was supposed to be India's cheapest electric car, however due to a shift in product strategy and a scarcity of semiconductors, the introduction has been postponed significantly. The Tata Nexon is India's best-selling electric car, with a market share of 70% and a wait time of 14-16 weeks. The Nexon electric car costs Rs 14 lakh (excluding State subsidies)

VI DATA ANALYSIS In this section,

I have taken data of domestic sales trends in India from the year 2015 to 2021 and sales of Electric vehicles across India for the year 2020 to 2021 to compare and analyze the results. Automobile Domestic Sales Trends (In Numbers) (siam.in 2021)

Category	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Passenger Vehicles	2,789,208	3,047,582	3,288,581	3,377,389	2,773,519	2,711,457
Commercial Vehicles	685,704	714,082	856,916	10,07,311	717,593	568,559
Three Wheelers	538,208	511,879	635,698	7,01,005	637,065	216,197
Two Wheelers	16,455,851	17,589,738	20,200,117	21,179,847	17,416,432	15,119,387
Quadricycle	0	0	0	627	942	-12
Grand Total	20,468,971	21,863,281	24,981,312	26,266,179	21,545,551	18,615,588



In financial year 2021, the leading type of electric vehicles sold in India was two-wheelers, reached around 144 thousand units. This was a five percent decrease from the previous year's 152 thousand units. The only section that saw growth was four-wheelers. In order to understand the Indian automobile sales with the introduction of Electric vehicles in the Indian market, I have done linear regression analysis: $y = a+bx$ Where, y = dependent variable = monthly automobile sales in India in 2021 x = independent variable = monthly sales of electric vehicles in India in 2021 Hypothesis: H_0 : There is a no impact on automobile sales with the introduction of Electric Vehicles H_a : There is impact on automobile sales with the introduction of Electric Vehicles. After conducting the regression analysis in Excel it was found that there is 35% correlation existing between the two variables and 12% variation in the sales of automobile sector is explained by the sales in electric vehicles. Thus, rejecting the null hypothesis and accepting the alternate hypothesis as there is a variation in automobile sales due to the introduction of electric vehicles. As there is potential seen in the transport sector so the government is also spending major portion of R&D in the transport sector as depicted in the graph chart below, where the government has allocated 8.7% of its total funds in R&D to transport.

Deriving the Social and Economic Impact of Hybrid Electric Vehicles on Environment on India

In India, the economic difficulty is a big issue for HEV. HEV adoption and big market growth are tough in India. Economic issues come in a variety of shapes and sizes. Because of the higher initial investment, petroleum is more expensive than electricity, while the cost of infrastructure installation is higher for hybrid electric vehicles. Charging infrastructure is required. Public charging infrastructure is available to the whole public and is commonly located at public parking areas, whereas semi-public charging infrastructure is restricted to a specific set of people. The charging infrastructure built in a private garage or home is referred to as private charging infrastructure. One of the issues in developing countries like India is the high starting cost. The scarcity of raw materials has made it difficult to manufacture and develop energy storage devices for electric vehicles. This is because an electric vehicle's energy storage system is made of high-grade components to assure great performance and safe operation free of corrosion and explosion. Given the available energy, a modern hybrid electric vehicle system is designed to properly manage all of the possible energy resources. The size and expense of present energy storage devices are also important issues. The energy storage system accounts for one-third of the entire cost of the hybrid electric vehicle. Materials, packaging, power conversion, replacement, operation, maintenance, and labor all contribute to the high cost of the energy storage system. Instead of using fuel, HEVs use energy storage devices such as batteries, which must be recharged. This, in turn, necessitates the delivery of additional energy from the current power grid and power plants. As a result, renewable energy sources such as wind and solar energy must be utilized. This means that the technology employed in power grids and the charging infrastructure itself may have an impact on the charging price. Consumer perceptions of cost, benefits, and attitudes toward new

technologies and social impact are all psychological aspects. Range anxiety is a condition in which HEV drivers are always concerned about being stuck with a depleted battery due to the vehicle's restricted range. Consumer attitudes play a significant role in determining whether or not they should invest in HEVs. The attitude of HEVs regarding new technology has a significant impact on their decision. Despite the fact that many early adopters are investing in HEVs, the majority of consumers are hesitant to accept new technology.