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Subsystems in Electric vehicle and Impact of Electric vehicle at Global level and India

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Submitted by

SRIRAM.T

170921136

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Table of Contents

Abstract

The purpose of this report is to describe the technology used to produce an electric vehicle .The report describes the most important parts in an electric vehicle and hybrid vehicle. It compares the electric to the hybrid and internal combustion engine vehicle. It also includes the future of the electric vehicle.

The overall impact of the electric vehicle ultimately benefits the people. Compared to gasoline powered vehicles, electric vehicles are considered to be ninety-seven percent cleaner, producing no tailpipe emissions that can place particulate matter into the air.

The paper begins with a section providing a technical description of an electric vehicle, including the parts, their functions, and the theory of operation. The following section describes the hybrid car, including parts, their functions and the theory of operation. Based on this understanding, I then compare the internal combustion engine, the hybrid engine, and the electrical engine in terms of efficiency, speed, acceleration, maintenance, mileage, and cost. The next section explains the recent market trends in EV followed by insight into the EV market in India and the reasons why India needs to adopt to it, the recent EV policy implemented in India is dicussed by providing few features of it. The next section discusses few of the challenges faced by the country and respective solutions for it. The report ends with the recent organizations in India that has stepped into the EV market and what services they provide.

Description of an Electric Vehicle

The electric vehicle (EV) is propelled by an electric motor, powered by rechargeable battery packs, rather than a gasoline engine. From the outside, the vehicle does not appear to be electric. In most cases, electric cars are created by converting a gasoline-powered car. Often, the only thing that clues the vehicle is electric is the fact that it is nearly silent

Under the hood, the electric car has: [10]

- An electric motor.
- A controller.
- A rechargeable battery.

The electric motor gets its power from a controller and the controller gets its power from a rechargeable battery.

The electric vehicle operates on an electric/current principle. It uses a battery pack (batteries) to provide power for the electric motor. The motor then uses the power (voltage) received from the batteries to rotate a transmission and the transmission turns the wheels . [10]

Four main parts make up the electric vehicle: the potentiometer, batteries, direct current (DC) controller, and motor. See Figure 1.

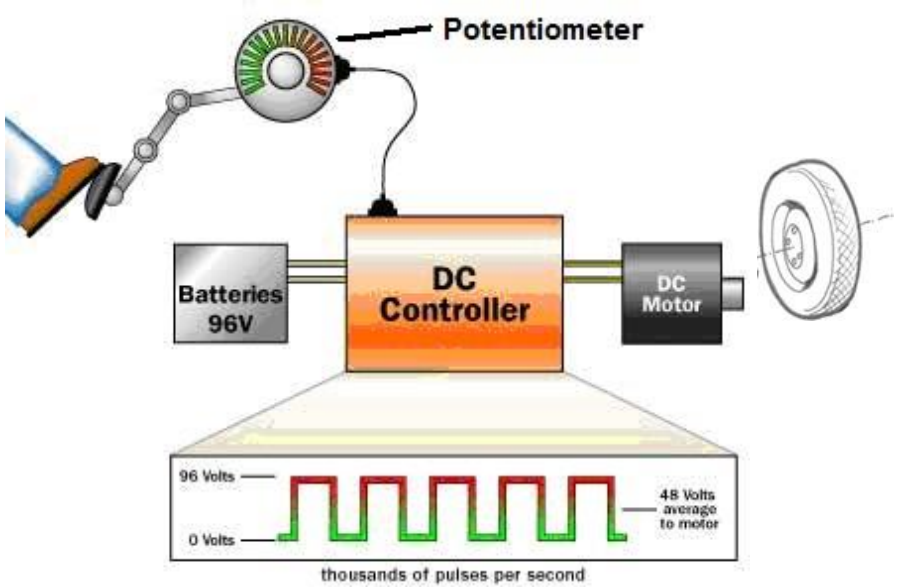

Figure 1. Parts of an electric vehicle.

Description of parts and their functions

Potentiometer. It is circular in shape and it is hooked to the accelerator pedal. The potentiometer, also called the variable resistor, provides the signal that tells the controller how much power is it supposed to deliver. [10]

Batteries. The batteries provide power for the controller. Three types of batteries: lead-acid, lithium ion, and nickel-metal hydride batteries. Batteries range in voltage (power).

DC Controller. The controller takes power from the batteries and delivers it to the motor. The controller can deliver zero power (when the car is stopped), full power (when the driver floors the accelerator pedal), or any power level in between contains twelve 12-volt batteries, wired in series to create 144 volts, the controller takes in 144 volts direct current, and delivers it to the motor in a controlled way .

The controller reads the setting of the accelerator pedal from the two potentiometers and regulates the power accordingly. If the accelerator pedal is 25 percent of the way down, the controller pulses the power so it is on 25 percent of the time and off 75 percent of the time. If the signals of both potentiometers are not equal, the controller will not operate . [10]

Motor. The motor receives power from the controller and turns a transmission. The transmission then turns the wheels, causing the vehicle to run.

Theory of Operation for EV

When the driver steps on the pedal the potentiometer activates and provides the signal that tells the controller how much power it is supposed to deliver. There are two potentiometers for safety. The controller reads the setting of the accelerator pedal from the potentiometers, regulates the power accordingly, takes the power from the batteries and delivers it to the motor. The motor receives the power (voltage) from the controller and uses this power to rotate the transmission. The transmission then turns the wheels and causes the car to move forward or backward. [10]

If the driver floors the accelerator pedal, the controller delivers the full battery voltage to the motor. If the driver takes his/her foot off the accelerator, the controller delivers zero volts to the motor. For any setting in between, the controller chops the battery voltage, thousands of times per second to create an average voltage somewhere between 0 and full battery pack voltage.

Description of a Hybrid Vehicle

The hybrid vehicle (HV) is powered by both a gasoline engine and electric motor.

The HV runs using power from an internal combustion engine and electric motor. The engine provides most of the vehicle's power, and the electric motor provides additional power when needed, such as accelerating and passing . [12]

The hybrid vehicle operates on a gasoline and electric energy principle. A hybrid car features a small fuel-efficient gas engine combined with an electric motor that assists the engine when accelerating. The electric motor is powered by batteries that recharge automatically while you drive.

Five main parts make up the hybrid vehicle: the battery, internal combustion engine (ICE), generator, power split device, and electric motor. See Figure 2.

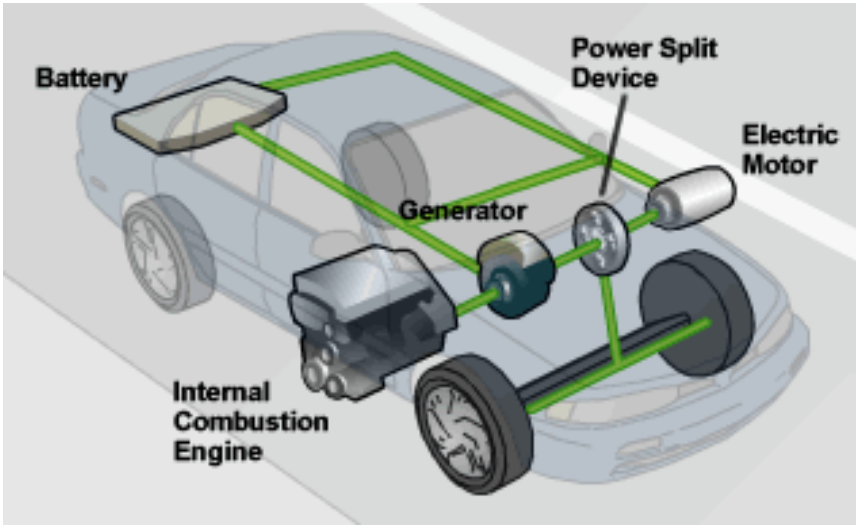

Figure 2. Parts of a hybrid vehicle.

Description of Parts and their Functions

Battery. The batteries in a hybrid car are the energy storage device for the electric motor. Unlike the gasoline in the fuel tank, which can only power the gasoline engine, the electric motor on a hybrid car can put energy into the batteries as well as draw energy from them. [12]

Internal Combustion Engine (ICE). The hybrid car has an ICE, also known as a gasoline engine, much like the ones found on most cars. However, the engine on a hybrid is smaller and uses advanced technologies to reduce emissions and increase efficiency. Receives its energy from the fuel tank where the gasoline is stored. [12]

Generator. The generator is similar to an electric motor, but it acts only to produce electrical power for the battery.

Power Split Device. The power-split-device resides between the two motors and together with the two motors creates a type of continuously variable transmission.

Electric Motor. The electric motor on a hybrid car acts as a motor as well as a generator. For example, when needed, it takes energy from the batteries to accelerate the car. But acting as a generator, it slows the car down and returns energy to the batteries.

Theory of Operation for Hybrid

When the driver steps on the pedal the generator converts energy from the engine into electricity and stores it in the battery. The battery then provides power to the electric motor. The internal combustion engine and electric motor work simultaneously and each provide power to the power split device. The power split device combines both powers and uses it to turn the transmission. The transmission then turns the wheels and propels the vehicle. [12]

The energy used when braking is converted into electricity and stored in the battery. When braking, the electric motor is reversed so that, instead of using electricity to turn the wheels, the rotating wheels turn the motor and create electricity. Using energy from the wheels to turn the motor slows the vehicle down. When the vehicle is stopped, the gasoline engine and electric motor shut off automatically so that energy is not wasted in idling. The battery continues to power auxiliary systems, such as the air conditioning and dashboard displays.

Comparison of Combustion Engine, Hybrid and Electric

Now that there is an established concept of how the internal combustion engine, hybrid, and electric vehicle function, their efficiency, speed, acceleration, maintenance, mileage and cost are compared in Table 1. The following abbreviations are used: ICE (internal combustion engine), HV (hybrid vehicle), and EV (electric vehicle). [11]

Table 1. Comparison between the ICE, HV, and EV

	ICE	HV	EV
Efficiency	Converts 20% of the energy stored in gasoline to power the vehicle.	Converts 40%, of the energy stored in gasoline to power the vehicle.	Converts 75% of the chemical energy from the batteries to power the wheels .
Speed (average top speed)	124 miles per hour (mph)	110 mph	30-95 mph

	ICE	HV	EV
Acceleration (on average)	0-60 mph in 8.4 seconds	0-60 mph in 6-7 seconds	0-60 mph in 4-6 seconds
Maintenance	• Wheels/tires • Engine • Fuel/gas • Bodywork/paint • Electrical • Lights • Dash/instrument warning lights	Same as ICE.	Does not require as much maintenance because it does not use a gasoline engine. No requirements to take it to the Department of Environmental Quality for an emissions inspection .
Mileage	Can go over 300 miles before refueling. Typically get 19.8 miles per gallon (mpg).	Typically get 48 to 60 mpg.	Can only go about 100 to 200 miles before recharging .
Cost (on average)	$14,000 to $17,000.	$19,000 to $25,000.	Extensive range, $6,000 to $100,000 .

Advantages and Disadvantages of the EV

The greatest challenge EVs face deal with the rechargeable battery. Most EVs can only go about 100–200 miles before recharging; fully recharging the battery pack can take four to eight hours. Battery packs are heavy, expensive, may need to be replaced, and take up considerable vehicle space. Overall, the electric vehicle has more advantages than disadvantages. Advantages include no tailpipe emissions, which leads to a reduction in global warming and unhealthy people. Table 2 summarizes the advantages and disadvantages of the EV. [11]

Table 2. Advantages and Disadvantages of the EV

Advantages	Disadvantages
Fuel can be harnessed from any source of electricity, which is available in most homes and businesses.	Limited in the distance that can be driven before the complete failure of the battery.
It reduces hydrocarbon and carbon monoxide, responsible for many environmental problems, by 98%.	Accessories, such as air conditioning and radios drain the battery.
Also reduces pollution.	Heavier car due to the electric motors, batteries, chargers, and controllers.

Advantages	Disadvantages
Does not produce emissions. Important in urban cities, where cleaner air is much needed.	More expensive because of cost of the parts.

Emissions

Compared to gasoline powered vehicles, electric vehicles are considered to be ninety-seven percent cleaner, producing no tailpipe emissions that can place particulate matter into the air . [9]

Global Warming: Ozone Layer

The process of carbon dioxide emitted into the atmosphere, also known as global warming, diminishes the Earth's ozone layer, which is what occurs at this time. A factor that makes electric vehicles clean is their ability to use half the number of parts a gasoline powered vehicle does, including gasoline and oil. [9]

Affected People: Sickness

Particulate matter, carcinogens released into the atmosphere by gas-powered vehicles, "can increase asthma conditions, as well as irritate respiratory systems". The carbon dioxide released into the atmosphere by internal combustion vehicles reduces the ozone layer, which absorbs ninety-seven to ninety-nine percent of the sun's high frequency ultraviolet light . According to *Ozone Layer*, "Every one percent decrease in the earths ozone shield is projected to increase the amount of UV light exposure to the lower atmosphere by two percent". Ultraviolet light, produced by the sun, is extremely harmful to life on Earth. UV light damages the skin, causing skin cancer. It also hurts the eyes and the marine life. [9]

Few examples types of Electric Motors used in Electric Vehicles

DC Series Motor

- Advantages - Easy speed control and it can also withstand a sudden increase in load.
- The main drawback of DC series motor is high maintenance due to brushes and commutators. [13]

Brushless DC Motor (BLDC)

- The commutation is done electronically in this motor because of this BLDC motors are maintenance free.
- They have high starting torque, high efficiency around 95-98%, etc.
- Suitable for high power density design approach.
- The BLDC motors are the most preferred motors for the electric vehicle application due to its traction characteristics.[13]

Permanent Magnet Synchronous Motor (PMSM)

- Similar to BLDC motors. The difference is that PMSM has sinusoidal back EMF whereas BLDC has trapezoidal back EMF.
- PMSM is the best choice for high performance applications like cars, buses.[13]

Three Phase AC Induction Motors

- Squirrel cage induction motors have a long life due to less maintenance. Induction motors can be designed up to an efficiency of 92-95%.
- The drawback of an induction motor is that it requires complex inverter circuit and control of the motor is difficult.[13]

Latest growth in Electric vehicle segment

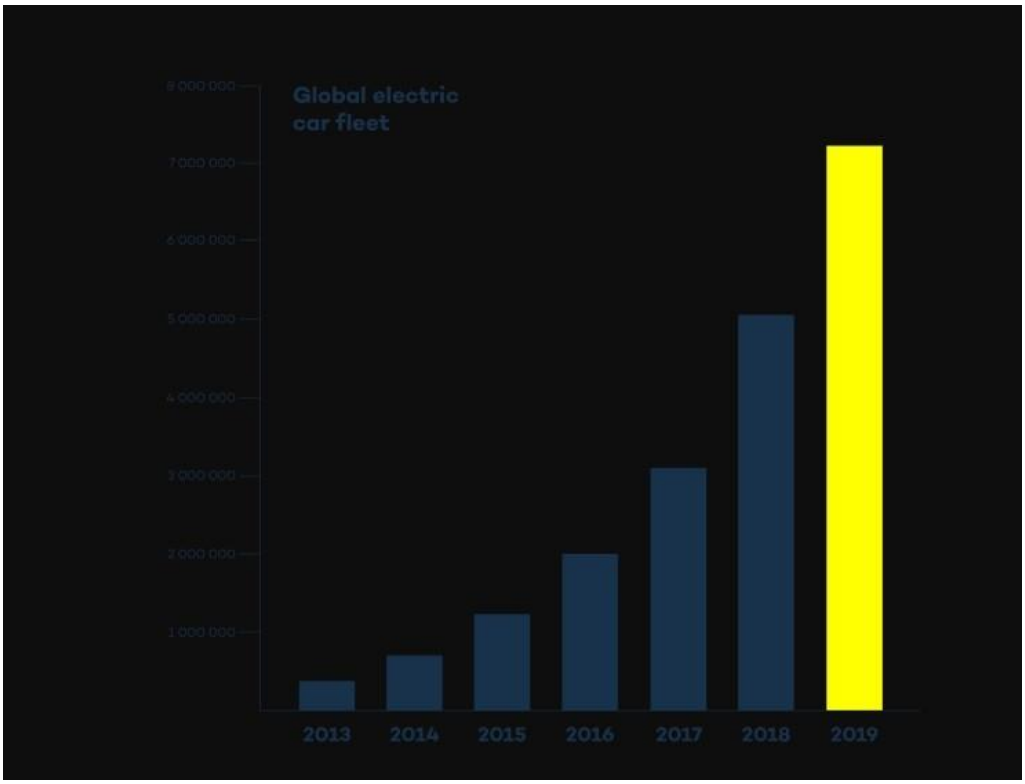

Figure 3. Global Fleet of electric cars

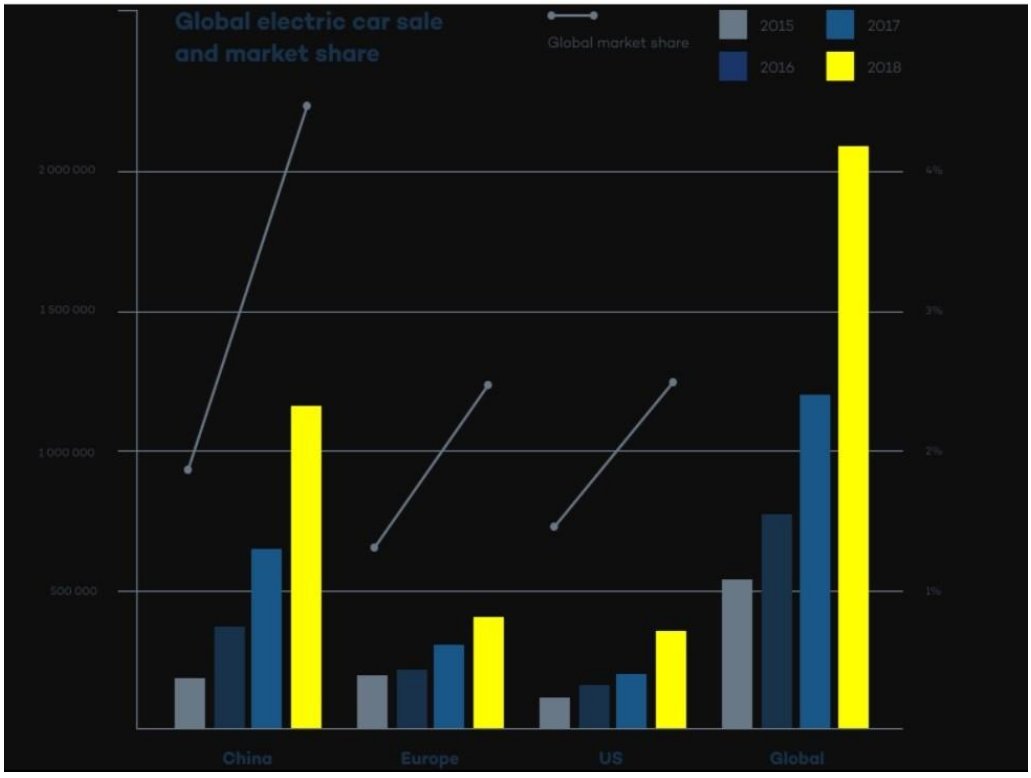

Figure 4. Global electric car sale and growth rate

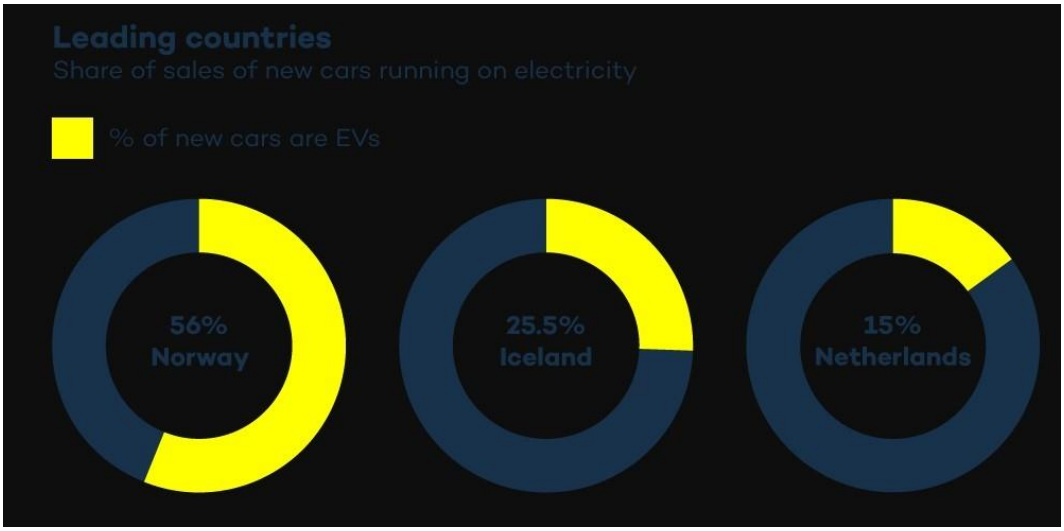

Figure 5. Leading countries running on EV's

Electric Commercial Vehicle Market Segment Highlights for 2020

- The electric commercial vehicle market is expected to post a year-over-year growth rate of -4.89%. [3]
- Stringent regulations on emissions from LCVs are increasing the demand for electric LCVs across the globe.[1]
- Market growth in the LCVs segment will be faster than the growth of the market in the buses and heavy and medium commercial vehicles segments.[3]

How do Electric Vehicles Affect Our Economy?

- Research indicates that the electrification of our transport system would generate one million
- additional jobs in Europe in 2030 and double in 2050 [2].
- These jobs relate to the production of components for electric vehicles, but they also relate to new services, such as charging infrastructure.[8]
- Electrification will also reduce our oil dependency.
- The import of oil costs the European economy one billion euros per day .
- Investing this in our own economies could mean a vast improvement in employment rates. Families could increase their purchasing power when they no longer need to depend on imported oil products.[1]
- Improved air quality will have a positive effect on the health budget, resulting in less expenses for health care and the cleaning of monuments, for example.

India in Electric vehicle sector

- Electric vehicles sales, excluding e-rickshaws, grew by 20 percent in India in 2019-20 [4].
- As many as 1.56 lakh EVs were sold in the country in 2019-20 as against 1.3 lakh units in the previous fiscal.[4]
- Electric two-wheelers accounted for nearly 97.5 percent of all EVs sold in FY20.[4]
- Break-up of EV sales in India in 2019-20: 1.52 lakh electric two-wheelers 3,400 electric cars 600 electric buses And among the electric two-wheelers sold, 97.5 percent of all EVs sold in FY20. [4]
- In the E2Ws sold in FY2019-20, 97 percent were electric scooters and a very small volume of motorcycles and electric cycles filled the rest of 3 percent.[4]
- The e-taxi segment is also beginning to get some traction, though the range of electric cars and lack of charging stations are deterrents to growth.[4]

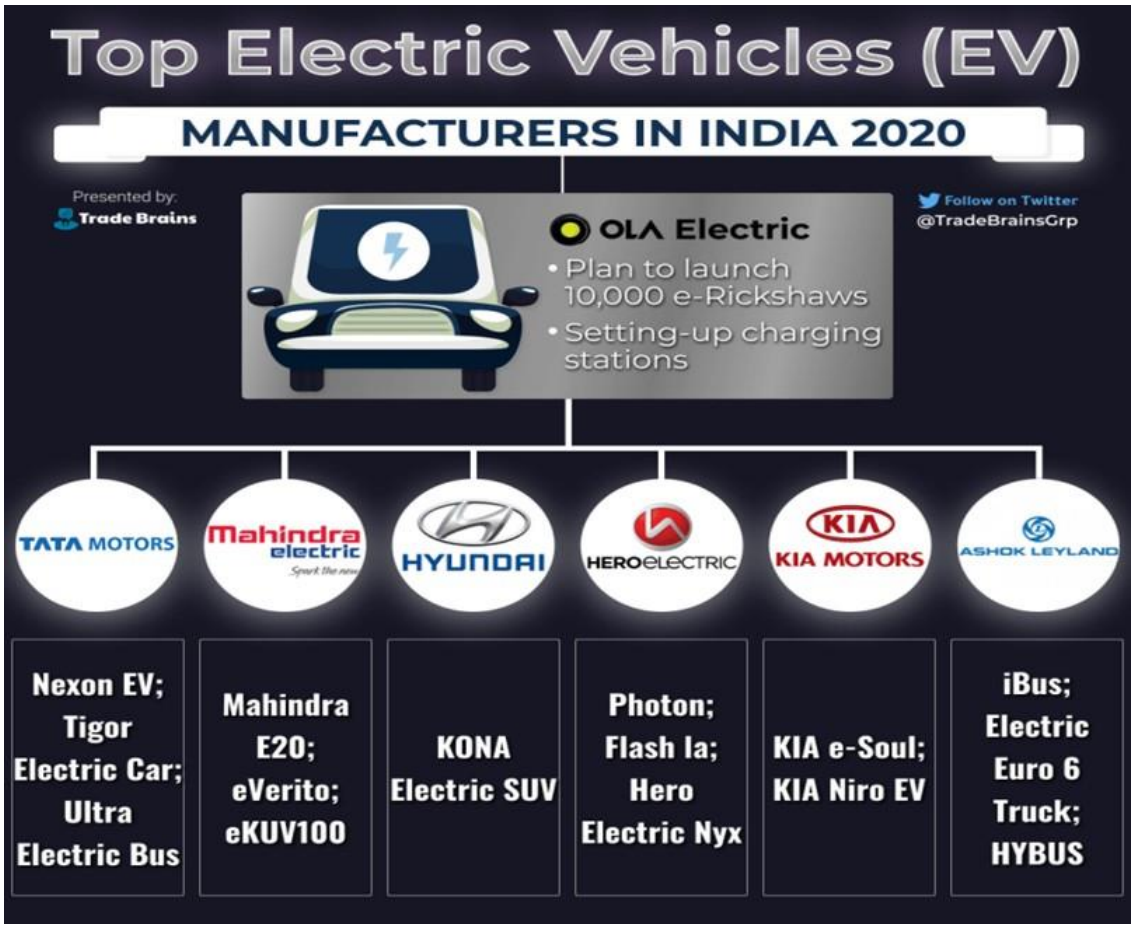

Figure 6. Top EV Manufacturers in India

India has 3 key Strategic Imperatives to consider EV's

Higher Carbon Emissions:

- One of India's major development goals is the urgent need to reduce our carbon emissions and meet our climate obligations. [4]

- EVs could reduce our CO2 emissions by 37%.

Lower Power Demand:

- Demand for power has not risen in sync with power generation capacities, leading to non- viability of the sector.[4]

- Rise in EVs could help grid stability going forward. A new source of power demand in the form of Electric Vehicles will be beneficial for the power sector.

Fuel Security Risks

- India currently depends on large scale imports of crude to meet most of its mobility fuel needs.

- India can save 64% of passenger mobility related energy demand in 2030 by pursuing a shared, electric & connected solution. This could result in a reduction of 156 Mtoe (~US $ 60 Bn.) in diesel & petrol consumption for that year. [4]

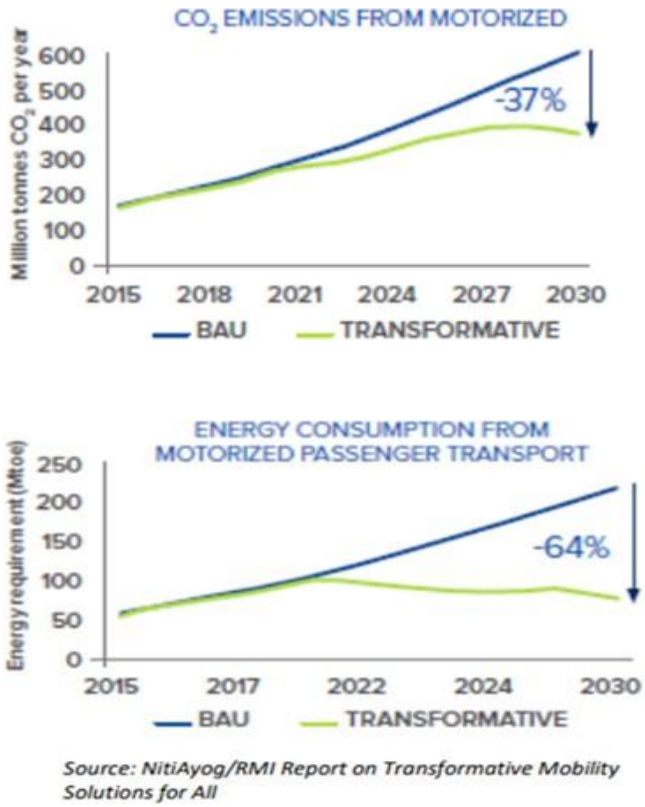

Figure 7. Images indicating to Carbon emission and energy consumption in India

Delhi EV Policy 2020 Keypoints

Features:-

- Replacement of exisiting auto rickshaws and state-run buses with E-autos and E-buses. [6]
- Increase road tax for fuel based vechicles.
- Exchange your old fuel based vechicle while purchasing a new EV.
- Government to offer low interest rate loans while buying an EV.
- State electric vehicle board will be setup for effective implementation of policy and managing the funds.[6]

Aims:-

- To reduce air pollution in the state. [6]
- To register at least 5,00,000 EV's in Delhi in next five years.
- To convert E-commerce logistics providers and couriers fleet by 50% to EV.[6]

Figure 8a. News Snippet on Delhi EV Policy

Figure 8b. News Snippet on Delhi EV Policy

Case Study-
System-level Needs and Opportunities

Summary table of proposed solutions by category

CATEGORY	PROPOSED SOLUTIONS
EV coordinating body	Greater coordination across government agencies in support of EV-related policymaking, permissions, and enforcement
Single-window clearance	Clearer, simpler processes for both registering and permitting EVs, and commissioning charging and battery swapping infrastructure
Incentives for economic market segments	Pursue opportunities to incentivize the electrification of economic market segments
Battery swapping technology	A technology-agnostic approach to registering and incentivizing EV products
Charging and battery swapping infrastructure	An optimally sized public charging network to meet the needs of EV operators
Reliable and renewable power supply	Reliable and renewable vehicle charging power supply
Attractive financing for EVs	More attractive financing options for EVs
Ease of EV operations	Preferential treatment and easier visibility for registered EVs
Education, outreach, and capacity building	Greater awareness of EVs and their environmental and economic benefits
Open mobility data	Greater understanding of transport demand, modal integration, and traffic patterns

Table 3. Proposed Solutions each category

Education, Outreach , and capacity building

In this report we will discuss on education,outreach and capacitiy building.[6]

Context:

Education campaigns and capacity-building programs can expose all segments of society to EV-related policies and the benefits of EV technology and services, including new job opportunities. These campaigns can also be designed with government audiences in mind to help inform them of new EV policies and regulations. Campaigns can range from generating EV awareness and performance characteristics of EVs for private vehicle owners to teaching industry about new policies and regulations to vocational training for new commercial-based operators of EVs, including the informal market. These campaigns will be important to encourage early adopters of EVs and to ensure that government agencies are appropriately enforcing new rules and regulations. [6]

Proposed Solutions for Delhi

1. Develop educational programs to support consumer awareness and adoption of EV technologies and services.

- Create a campaign to promote the Delhi EV policy, e-mobility services, and the environmental and economic benefits of going electric.
- Host learning sessions for industry and civil society to learn about the Delhi EV policy and its inclusions.
- Host learning sessions for relevant government bodies to learn about the Delhi EV policy and its inclusions, especially with respect to the enforcement of rules and regulations.[6]

2. Develop training programs for the informal sector on new technologies, service providers, and current rules and regulation for the operation of EVs to ensure safe transportation and realize the potential of the informal sector.[6]

- Provide support to businesses that are operating in accordance with Delhi's rules and regulations.
- Engage the Department of Social Welfare within the Delhi government to identify drivers in unorganized segments, such as independent e-rickshaw operators, and offer them formalized training to ensure that they have an understanding of operational requirements and rules of the road.
- Collaborate with private companies in the e-rickshaw segment and ride-hailing industry to create formal job opportunities for drivers that are currently operating in the informal sector, including drivers and mechanics.[6]

DESCRIPTIONS OF PASSENGER MOBILITY PROJECT TEAMS

EESL ENERGY EFFICIENCY SERVICES LIMITED A JV of PSUs under the Ministry of Power	EESL aims to convert the existing internal combustion engine (ICE) fleet of the Delhi government to EVs through its project. They aim to start with 500 EVs and increase it to 1,000. Gradually, they want to enable the uptake of electric cars by private consumers. They also aim to set up 250 public charging stations across Delhi. These stations would be installed as per the Ministry of Power, Government of India guidelines. They are also tying up with fleet operators, aggregators, and OEMs for increasing the utilization of these chargers.
ezymov Mobility Simplified	Ezy Mov Solutions is India's first wheelchair-accessible taxi company and allows people to "Travel with Dignity." Their purpose is to make wheelchair taxis an essential transport service for people with limited mobility. With their specially modified cars and sensitized drivers, their mission is to improve the quality of life of millions of people across India and bring them into the mainstream.
chartr	The IIIT-Delhi team is creating an information architecture for public transit. They aim to build "an Android app (Chartr)" that helps users get from point A to B using public transportation (i.e., buses and metros) and commercial vehicles, like e-rickshaws and feeder buses for last-mile connectivity. To build this app, the team will be working on a few projects to strengthen the backend of data and information that they acquire from transportation agencies.
Li Lithium Tomorrow's Transportation.Today.	Lithium Urban Technologies intends to provide employee transportation services to IT companies and install associated charging infrastructure in private and public locations. Lithium's business model helps replace privately owned ICE commuting vehicles with shared electric vehicles. They intend to deploy 500 electric cars and 50 buses in NCR in the next six months. Lithium has already signed contracts with major real-estate providers in the NCR area, which will allow charging infrastructure at IT parks across the NCR. It will also allow private vehicles to use the charging facilities on a pay-as-you-go model.

DESCRIPTIONS OF PASSENGER MOBILITY PROJECT TEAMS

OLA ELECTRIC	ola electric mobility Pvt. ltd. was established in 2019 with a mission to work with vehicle and battery manufacturers, cities, driver partners, and the mobility ecosystem to make e-mobility convenient, reliable, and affordable. In line with this mission, they plan to deploy a fleet of e- rickshaws in Delhi to help create a reliable, efficient, and clean mode of first- and last-mile connectivity that complements the existing public transportation network and contributes towards increased ridership of these networks.
SMARTe™	smarte is working with the Delhi metro to deploy more than 10,000 electric three-wheelers across the entire metro network to provide seamless, economical, and electric last-mile connectivity services with an aim to serve more than a million commuters every day. smarte is also working to create sustainable livelihood opportunities for more than 15,000 people in Delhi. through its last-mile connectivity services, it aims to also work with the government to fight the battle against pollution.
SUN MOBILITY PIAGGIO	sUn mobility is a global leader in providing energy infrastructure and services to the transportation sector that are faster, cheaper, and more convenient. Piaggio is a leading three-wheeler manufacturer in India, with a dominant market share in cargo and more than 25 percent market share in passenger segment. sUn mobility and Piaggio have come together to integrate their respective technologies to create a sustainable electric three-wheeler-based mobility solution for intermediate public transportation. the two companies plan to jointly deploy a fleet of Piaggio's efficient electric three-wheelers powered by sUn mobility's energy infrastructure (smart battery[tm], Quick Interchange station[tm], and smart network) in Delhi for last-mile connectivity services.

Table 4. Passenger Mobility groups in India

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