CHAPTER – 5
ELECTRIC VEHICLE
5.1 Introduction About Electric Vehicle

Electric vehicle is an automobile propelled by one or more electric motors, drawing power from an onboard source of electricity. Electric cars are mechanically simpler and more durable than gasoline-powered cars. They produce less pollution than do gasoline-powered cars. An electric car stores its energy on board—typically in batteries, but alternatively with capacitors or flywheel storage devices.

A more recent development is the hybrid electric vehicle (HEV), which uses both an electric motor or motors and a gasoline or diesel engine, which charges the batteries in order to extend the car’s range and often to provide additional power. Regardless of the energy source, an electric car needs a controller, which is connected to the accelerator pedal, for directing the flow of electricity from the energy source to the motor.

Most electric cars use lead-acid batteries, but new types of batteries, including zinc-chlorine, nickel metal hydride and sodium-sulfur, are becoming more common. The motor of an electric car harnesses the battery’s electrical energy by converting it to kinetic energy. The driver simply switches on the power, selects “Forward” or “Reverse” with another switch, and steps on the accelerator pedal.

While the internal-combustion engine of a conventional car has many moving parts and must convert the linear motion of pistons and rods into
rotary motion at the wheels, an electric motor has only a single rotating element. Like a gasoline-powered car, an electric car has a system (called a power train) of gears, shafts, and joints that transmit motion from the motor to the car wheels. Most electric cars do not have clutches or multi-speed transmissions. In order to go backward, the flow of electricity through the motor is reversed, changing the rotation of the motor and causing the power train to make the wheels rotate in the other direction.

Most electric cars have a regenerative braking system—the braking system acts as a battery charger. When a driver ease up on the accelerator or step on a brake pedal, the drive motor acts as a generator and converts the vehicle's momentum back into electricity and stores it in the battery. Converting the kinetic energy into electric energy slows the car. Electric cars also have a brake pedal and a traditional braking system, which uses friction to slow the vehicle for quick and emergency stopping. These friction brakes convert kinetic energy to heat. In gasoline-powered cars this energy is wasted, the heat being dissipated into the surrounding air. Energy conservation in electric cars, however, is so important that engineers found a way to recover the heat and use it—for example, by heating the passenger compartment.

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An electric car stores its energy on board—typically in batteries, but alternatively with capacitors or flywheel storage devices. Or it may generate energy using a fuel cell or generator. A fuel cell is a specialized form of battery that combines hydrogen with oxygen in a chemical reaction that produces electricity and water vapor. Unlike an electric cell or battery, a fuel cell does not run down or require recharging; it operates as long as the fuel and an oxidizer are supplied continuously from outside the cell. Most current versions of electric cars use some combination of these energy sources. “Pure” electric cars, however, run only on batteries and need a charger to replenish the battery’s power from an electrical outlet.

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5.3 Need Of Electric Vehicle

Electric Vehicle (EV) technology is gaining ground and popularity rapidly. With depletion of oil reserves and a world characterized by smog, noise and all kinds of pollutants, governments and communities are awakening to the several benefits of EV technology.

Zero emission vehicles are almost noiseless and can be charged at home or work, saving commuters endless queues at petrol stations. Charging at night when consumption is low, allows for efficient use of electricity. EVs are easier to service and maintain due to the absence of spark plugs, clutch and gears. Ideal for "stop - start" city driving conditions, EVs are extremely reliable and easy to drive. With the innumerable advantages of EVs, companies in developed countries have spent huge amounts to develop electric cars that can travel longer distances, providing high levels of comfort. In spite of this technology being available now, the cost of electric vehicles to suit driving requirements in these developed countries is prohibitively high.

5.4 History Of Electric Vehicles

Few people realize that successful electric automobiles were being produced as early as the 1880's. For over 20 years, electric cars were commercially produced, and were for some years in heady competition with internal combustion and steam-powered carriages. Not until internal combustion technology and promotion, along with cheap fuel, had
outstripped all competition, did electric cars drop out of the automotive picture.

The technology required for the electric car was being developed long before the automobile was conceived. The primary cell invented by Volta in 1800, generated electricity by chemical action. Only replacing the active elements could recharge this primitive battery. Not until 1860, when Gaston Faure invented the secondary cell, could simply passing a current through it recharge a battery providing portable, renewable electric power.

In spite of earlier experimental work, a working electric motor was not built until 1833. Thomas Davenport, an uneducated Vermont blacksmith, conceived it after observing a demonstration of an electromagnet. Davenport patented his motor in 1837.

Davenport had in fact built a model electric locomotive as early as 1834, powered by primary cells. In 1847, Moses Farmer, from Massachusetts designed a locomotive that, powered by 48 one-pint cells, could carry two people along an 18-inch-wide track.

About the same time, Professor Charles Page of Washington, D.C., built a locomotive which, using 100 cells and a 16-horsepower motor, carried twelve people on the Washington and Bladensburg Railroad at up to 19 mph. In 1847, Lilly and Colton of Pittsburgh built a locomotive, which received its power, produced from a central station, through an electrified rail.
In 1888, electric cars suddenly began appearing on the scene both in the U.S. and in other countries. The first really successful electric automobile was the carriage built by William Morrison of Des Moines, Iowa, in 1890. Morrison's car used high, spoked wagon wheels to negotiate the rutted roads of America, and an innovative guidance system, which included patented rack-and-pinion steering.

Morrison's car was capable of running for 13 consecutive hours at 14 mph. Much of the car's success, however, was attributable to the promotional efforts of Harold Sturges, secretary of the American Battery Company.

5.5 Advantages And Disadvantages

Electric cars represent a cleaner way to convert fossil fuels—oil (Petroleum), coal, and natural gas (Gases, Fuel) produced from the remains of prehistoric plants and animals—to automotive power. The fossil fuels are burned at a power plant, or onboard in hybrid electric vehicles, to make electricity to recharge the battery. Substances that pollute the air can be controlled more easily at a power plant than at the tailpipes of millions of gasoline-burning cars, and in hybrid electric vehicles, electronic controls can be used to make the engines run only as needed and to do so more efficiently. The result is that air quality, especially in large cities, can be improved with electric cars or hybrid electric vehicles.

Today's electric cars are more efficient than gasoline-powered cars. They are considered an easy and effective way to harness existing energy sources because any energy source can be converted into electricity. Pure
electric cars do not require new ways of delivering fuel because electricity is already distributed to virtually every home and business. However, pure electric cars require charging stations, special equipment that can recharge an electric car battery quickly and efficiently. This special equipment can be installed in a home garage or in the trunk of the car. To extend the range of an electric car, charging stations would need to be placed strategically throughout a city.

Despite the advantages of more efficient energy use, pure electric cars have not been widely adopted. Pure electric cars are impractical because current battery technology limits the distance an electric car can travel before its battery must be recharged. This distance is currently less than 160 km (100 mi) in most cases, and the batteries take at least three hours to recharge using charging stations. Electric cars are not yet able to accelerate, cruise, and climb fast enough to compete with gasoline-powered cars. And accessories, such as air conditioning or radios, drain the battery even more quickly. Moreover, because electric cars have not been widely adopted, few public charging stations are in existence.

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in the vehicles are a serious environmental hazard. Environmentalists often refute these claims because the batteries can be recycled with minimal environmental impact and more advanced batteries such as lithium ion and nickel metal hydride batteries might give the cars the range of conventional gas cars. Due to lack of production volume, these batteries are currently 3-4 times more expensive than conventional Lead Acid or Nickel Cadmium batteries. Firefighters and rescue personnel require special training to deal with the higher voltages encountered in electric vehicle accidents.

5.6 Indian Electric Vehicles

India is ready and well suited for the introduction of EVs today with the existing technologies available, making EVs cost effective.

The ideal EV for India and the developing world is basic, simple and reliable - designed specially for local conditions using cutting edge technology and which is modular to incorporate and absorb newer technologies. EVs with a top speed of 40-60 kmph and a range of 50-80 km would meet over 90 percent of the city mobility requirements in India.

The first electric car in India was launched by Banglore based company REVA. REVA was conceptualized and designed to meet these needs and performance specifications. REVA is designed to be unique and stands out on the road as a genuine city car with a mature expression. The advanced technologies used, make it highly differentiated and superior to other
makes. It has all the inherent benefits of an Electric Car and is indeed a revelation in city mobility.

FIG. 5.1: REVA Electric Vehicle

It is a fully automatic (no clutch - no gears), two-door hatchback, easily seating two adults and two children. A small turning radius of just 3.5 meters makes it easy to park and maneuvers in difficult city traffic conditions. Driving REVA is easy. Just unplug after completing the charging process, turn the key, disengage the parking brake, and turn the control knob to the forward (or reverse) position. Accelerate and take off. It runs on batteries and as compared to other Electric Vehicles has an onboard charger to facilitate easy charging, which at home plugging into any 15 Amp socket at home or work can carry out. As simple as charging a mobile phone!

The onboard charger ensures the safety of the car in case of any voltage fluctuation or any electric spikes. The auto cut off mechanism ensures that
the customer does not have to worry about overcharging or any other issues related to charging.

A full battery charge takes less than seven hours and gives a range of 80km. In quick-charge mode (two-and-a-half hours) 80% charge is attained, good enough for 65km. A full charge consumes just about 9 units of electricity.

REVA requires extremely low maintenance because of the minimum number of moving parts. From service point of view, advanced systems such as the two onboard computers and remote diagnostic capabilities enable quick vehicle analysis, prompt service and improve REVA’s performance and efficiency.

5.6.1 Major Parts In Reva Car

I. Motor
The prime mover in REVA, is the motor. It is comparable to the engine in a conventional car. REVA has a 13 kW separately excited DC motor with a high torque of 70 Nm at zero speed. When in use, the motor converts the energy stored in the Power Pack into mechanical motion. The high torque electric motor ensures a quick acceleration. The power from the motor is delivered to the wheels through the Trans-axle that propels the vehicle. While braking, the motor acts like a generator (regenerative braking) and recharges the Power Pack.

II. Power Pack
REVA's Power Pack consists of eight 6-Volt EV tubular type lead acid batteries that attain 80% state of charge (quick-charge mode) in under 2.5 hours. A complete charge is achieved in less than seven hours and gives a range of *80km. The Power Pack is housed beneath the front seats, which lowers the center of gravity, thus increasing the safety of passengers. Charging REVA is a safe and easy process - just plug into a 220 Volt, 15 Ampere socket - at home or at work. A full charge consumes just about 9 units of electricity.

**III. Charger**

REVA has an on-board Charger, which converts AC into DC power to charge the power pack. The charger is computer controlled with an in-built stabilizer and auto shut-off mechanism. The smart charger's output is connected to the Power Pack and ensures that optimum current and voltage is maintained at all times.

**IV. Controller**

REVA also has a computerized Motor Controller. This regulates the flow of energy from the Power Pack to the Motor in direct relation to pressure applied on the accelerator. It ensures perfect speed control and optimum use of energy in both forward and reverse directions.
V. Ems

The brain of REVA is the Energy Management System (EMS) that monitors and controls all vital functions. The EMS is a computer-based system that optimizes charging and energy output of batteries to maximize operating range and improve performance.

The system also predicts available range for a given state of battery charge and is a standard feature on the REVA. The EMS also maintains an electronic log of the vehicle performance, enables service personnel to run diagnostic checks on the car to give service information about the car.

![Diagram of Energy Management System](image)

**FIG. 5.2: Energy Management System**

5.7 Why Evs Are Not Popular

Evs available in market are having great features and can compete with the conventional gasoline vehicles. But still it is not as successful as gasoline-based vehicles specially in India. There are some myths attached with the EVs.

5.7.1 Safety And Reliability Of Evs:
The general perception among people was that EVs are not safe. To counter this RECC took extra precaution in the design to incorporate many safety features – like the steel space frame, side impact beams, dent-proof ABS body panels, low voltage system, and dual braking system. All these features lead to a very high level of reliability and safety. Today all our customers are convinced of the fact that EVs are safer than any of the conventional vehicles available on the road.

5.7.2 Fear Of Running Out Of Charge In The Middle Of The Road:

Many customers had this fear that without proper warning the car will run out of charge leaving them stranded.

To counter this REVA incorporates a number of warnings to ensure that the customer gets ample warning signals in the form of a warning display on the IP. For example, when the charge is down to 35%, REVA will move into the Economy (E) mode automatically. At this point, the “Low Battery Light” will come on.

This is due to the pre-programmed software in REVA’s Energy Management System (EMS) and motor controller. These warning signals ensure, as far as possible that the customer is never stranded on the road due to insufficient energy in the power pack.

When the charge in the power pack reduces to 25% state-of-charge the “Low Battery Light” starts flashing. At 15% state of charge, REVA automatically switches to Limp-Home Mode, limiting your acceleration and speed, enough to help you reach home or the nearest charging point.
5.7.3 The Most Prominent Reason Behind The Low Demand Of Evs

The most important point, which is to be considered, is the low efficiency of the car. Since a fully charged car can run up to 70-80 km and after that it is required to charge again and for that one need a charging station. To charge the battery fully it takes about 6-7 hrs. So such cars are not suitable for the long journey. But there are some possible ways to improve the efficiency of the EVS. And by increasing the efficiency one can travel for longer distance after charging once.