CERTIFICATE

Certified that Akanksha Sinha, Aphasana Khatun, Arman Ansari, Arpit Srivastava, Nilesh Kumar Srivastava, Brajesh Kumar, Shah Rukh Khan and Shoaib Hussain Khan, has carried out the project work presented in this report entitled ELECTRIC CAR for the B.Tech Final Year from Babu Banarasi Das University, Lucknow under my supervision. The report embodies result of original work and studies carried out by student themselves. And the contents of the project do not form the basis for the award of any other degree to the candidate to anybody else.

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ABSTRACT

Electric vehicle drives offer a number of advantages over conventional internal combustion engines, especially in terms of lower local emissions, higher energy efficiency, and decreased dependency upon oil. Yet there are significant barriers to the rapid adoption of electric cars, including the limitations of battery technology, high purchase costs, and the lack of recharging infrastructure. With intelligently controlled charging operations, the energy needs of potential electric vehicle fleets could be covered by existing German power plants without incurring large price fluctuations. Over the long term, electric vehicles could represent a sustainable technology path. In the short to mid-term, however, exceedingly optimistic expectations should be avoided, especially with respect to the reduction of greenhouse gas emissions. Electric vehicles as such will not be able to solve all current problems of transportation policy. Yet they may constitute an important component of a larger roadmap for sustainable transportation.

ACKNOWLEDGEMENT

It is a matter of great satisfaction and pleasure that I have completed my project work for the fulfillment of my degree at Babu Banarasi Das University. At first and foremost I offer my gratitude to the almighty whose blessings have brought this success. Then I would like to thank my heartiest thank to **Mr. Akash Varshney and Mr. Sashikant** for being my mentor during this endeavor. They have been the corner stone of my project work and have guided me sincerely during the periods of doubts and uncertainties. Their valuable comment, advice and suggestions have helped me to complete this work in a new way. I am also thankful to all the faculty members of our department for being a constant source of inspiration and motivation. My appreciation also extends to all my friends who have provided assistance at various occasions. Their views and tips are useful indeed. Unfortunately, it is not possible to list all of them in this limited space. I am grateful to all my family members.

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ELECTRIC CAR

A

Report Submitted

In Partial Fulfillment of the Requirements

For the Degree of

BACHELOR OF TECHNOLOGY

In

ELECTRICAL ENGINEERING

BY

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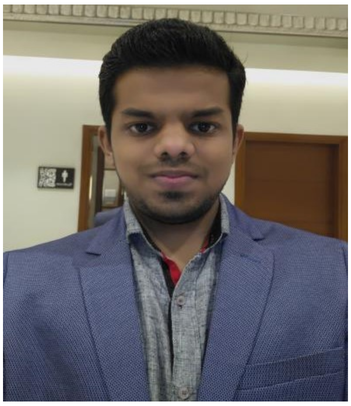

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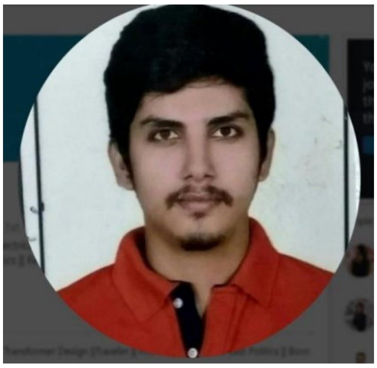

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CHAPTER 1
INTRODUCTION TO ELECTRIC CARS

An electric car uses an electric motor for propulsion rather than being powered by a gasoline-powered motor. While it is uncertain who invented the electric cars, several inventors have been given credit as early as 1828 by Ányos Jedlik who invented a small-scale model car powered by an electric motor that he designed. Others credited with their inventions include Robert Anderson, Professor Stratingh, and Thomas Davenport. It was not until the late 1800s that Americans began to devote attention to these innovations and interest in motor vehicles increased greatly. William Morrison built a six passenger wagon in 1891 and his design with a capacity for passenger is often considered the first practical EV. Then, in 1897, the first commercial EV was used as a fleet of New York City taxis built by the Electric Carriage and Wagon Company of Philadelphia (Bellis, n.d).

Once the electric starter became common in the 1930's, the electric car became almost obsolete and gas-fueled vehicles became the conventional vehicle of choice. As America's (and the world's) love affair with the automobile grew and decades passed, the dependency on oil slowly increased and gas prices rose. In the last 15 years, gas prices have increased so much that the demand for alternative fueled vehicles became not only a public cry, but also governmental policy. As Americans, we send more than $1 billion for oil overseas every day, mostly to fuel our vehicles. In 2000, the world consumed 77 million barrels of oil per day and by 2010, the consumption jumped to 87 billion barrels (Coplon-

Newfield, 2012). Due to this significant oil consumption, the Environmental Protection Agency revealed the plan to reduce this dependency with the requirement that vehicle fleets achieve a 35.5 mpg average by 2012-2016 and a 54.5 mpg average by 2017-2025 (Coplon-Newfield, 2012). President Obama has proposed new programs to dramatically boost the market for electric vehicles in order to break free from this dependency and reduce emissions. These proposals will make electric vehicles more affordable, accessible, and convenient. President Obama recently said in a speech at a Daimler manufacturing plant that he plans to promote an "EV Everywhere" experiment to make EVs "as affordable and convenient as gasoline-powered vehicles for the average American family within a decade" (Coplon-Newfield, 2012, para. 2) . Grant programs will aid American scientists, engineers, and businesses to conduct research and development that will lower the cost of EV batteries, increase driving distance range, and advance the technology for EV fast-charging. These

significant improvements will allow EVs to become mainstream (Longley, 2012). In addition, the president's proposed programs will help cities become EV ready (i.e., have charging stations, become prepared for increased electricity usage, and educate its residents about the benefits of electric vehicles). President Obama also proposes to make electric vehicles more affordable by raising the tax credit on purchasing an EV, allowing the tax credit to be available at the dealership, and removing the cap on the number of vehicles per manufacturer eligible for the credit (Berman, 2012; Coplon-Newfield,2012)

CHAPTER 2

HISTORY OF ELECTRIC CARS

1828 The first electric car was developed in Hungary

1835 The first practical electric vehicle was built in America.

1859 France developed an electric car with a rechargeable lead-acid storage battery.

1891 The first successful electric automobile in the United States was produced.

1897 Electric cars were produced in New York city and used for taxis.

1902 Electric car has topped speed of over 14 mph, range of 18 miles/charging.

1974 Electric car has topped speed of over 30 mph, range of 40 miles/charging

1997-2000 Electric cars are available for lease only.

2009 Few electric cars are available on the market such as Nissan LEAF, Chevrolet Volt, and Mitsubishii MiEV with speed 70 mph, range of 300 miles/charging for lithium ion battery and 80 miles/charging for lead acid battery.

1974 Electric car model
Vanguard-Sebring's CitiCar

The tzero on the left can go up to 300 miles (480 km) at 70 mph (110 km/h) using Li-ion batteries, while the EV1 on the right has a range of 160 miles at 65 mph using NiMh batteries, or 80 miles (130 km) with lead acid ones.

Fig2.1: Electric car models

ELECTRIC CAR

Invention: Attempts at building viable, modern battery-powered electric vehicles began in the 1950s with the introduction of the first modern (transistor controlled) electric car - the Henney Kilowatt, even though the concept was out in the market since 1890.

Function: The electric car mainly runs on motor, controller and batteries. The electric motor gets its power from the controller and the controller takes the power from rechargeable batteries.

Fig 2.2: Electric car

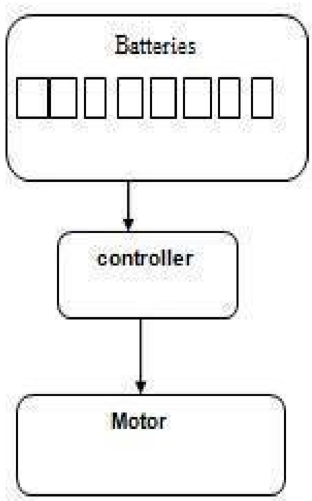


Fig 2.3: Block Diagram

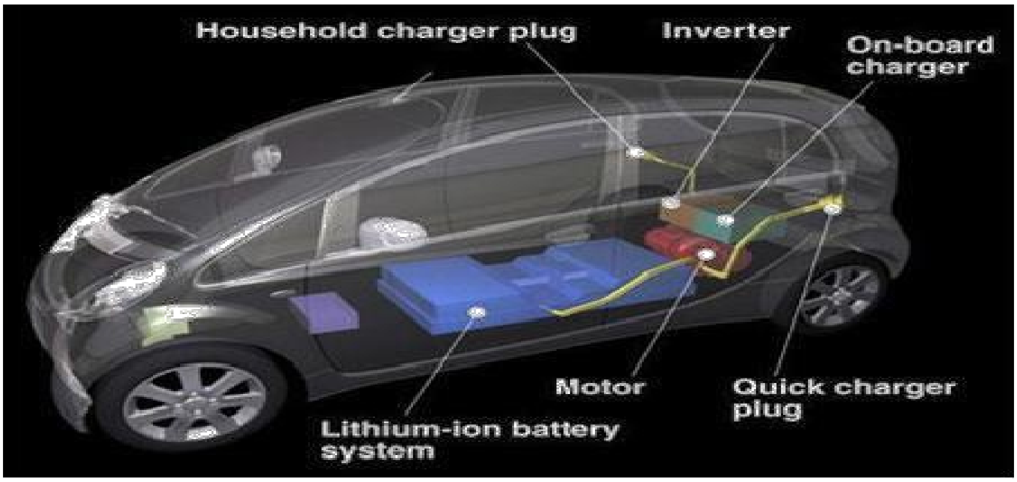


Fig 2.4: Principle Diagram

Technology used :

All-electric cars, electric vehicles (EV) or battery electric vehicles (BEV) are all name used to describe a vehicle propelled purely by means of an electric motor, powered by a controller which is powered by an on-board battery! This battery can be recharged using a standard electrical outlet or at a charging station.

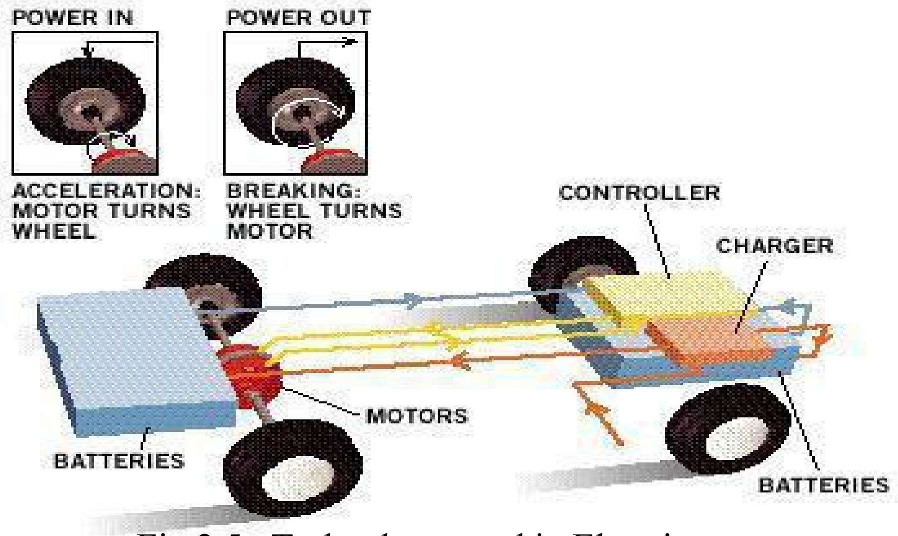


Fig 2.5 : Technology used in Electric car

HOW DOES AN ELECTRIC CAR WORK?

Fig 2.6: Charging a Detroit Electric car, 1919.

An electric car is powered by an electric motor instead of a petrol engine. The electric motor gets energy from a controller, which regulates the amount of power—based on the driver's use of an accelerator pedal. The electric car (also known as electric vehicle or EV) uses energy stored in its rechargeable batteries, which are recharged by common household electricity.

Thus an electric vehicle will have three basic components:

1) Energy Storage Unit
2) Controller
3) Propulsion system

The energy storage unit will have a way to store power. A chemical battery is the most common energy storage technology currently, although it can be different - for example - A fuel cell (which gets its electricity from hydrogen rather than a battery pack), can be use instead of a chemical battery as the energy storage unit.

The controller acts as a pipeline or gateway to the electric motor. The controller will do other things too - it moderates the power, will also act as a converter - converts power from DC to AC, or it might also increase or decrease the amperage etc. The controller is the brains of the system.

The electric motor, which is the propulsion system, converts the electric power and converts this into physical energy for movement.

The whole system is a much simpler, more efficient device than the combustion engine found in most cars, enabling you to get the most mileage for your charge.

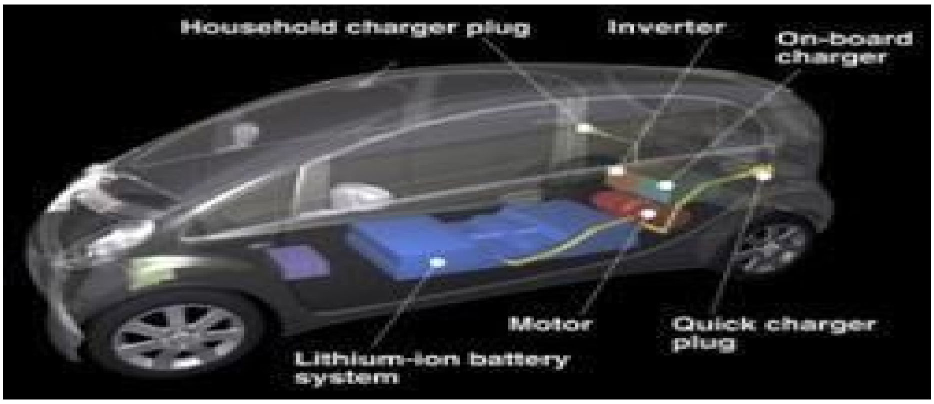


Fig 2.7:- EV internals

Historically, EVs have not been widely adopted because of limited driving range before needing to be recharged, long recharging times, and a lack of commitment by automakers to produce and market electric cars that have all the creature comforts of petrol-powered cars. That's changing. As battery technology improves—simultaneously increasing energy storage and reducing cost—major automakers are expected to begin introducing a new generation of electric cars.

Electric cars produce no tailpipe emissions, reduce our dependency on oil, and are cheaper to operate. Of course, the process of producing the electricity moves the emissions further upstream to the utility company's smokestack—but even dirty electricity used in electric cars usually reduces our collective carbon footprint.

Another factor is convenience - Let's not forget two important points: charging up at home means never going to a petrol station—and electric cars require almost none of the maintenance, like oil changes and emissions checks, that internal combustion cars require.

Electric motors develop their highest torque from zero rpms—meaning fast (and silent) zero-to-60 acceleration times.

Basic Principle

- An Electric car is powered by an Electric Motor rather than a Gasoline Engine.
- The Electric Motor gets its power from a controller.
- The Controller is powered from an array of rechargeable batteries.

The heart of an electric car is the combination of:

1. The electric motor
2. The motor **controllers**
3. The **batteries**

The controller takes power from the batteries and delivers it to the motor. The accelerator pedal hooks to a pair of **potentiometers**(variable resistors), and these potentiometers provide the signal that tells the controller how much power it is supposed to deliver. 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.

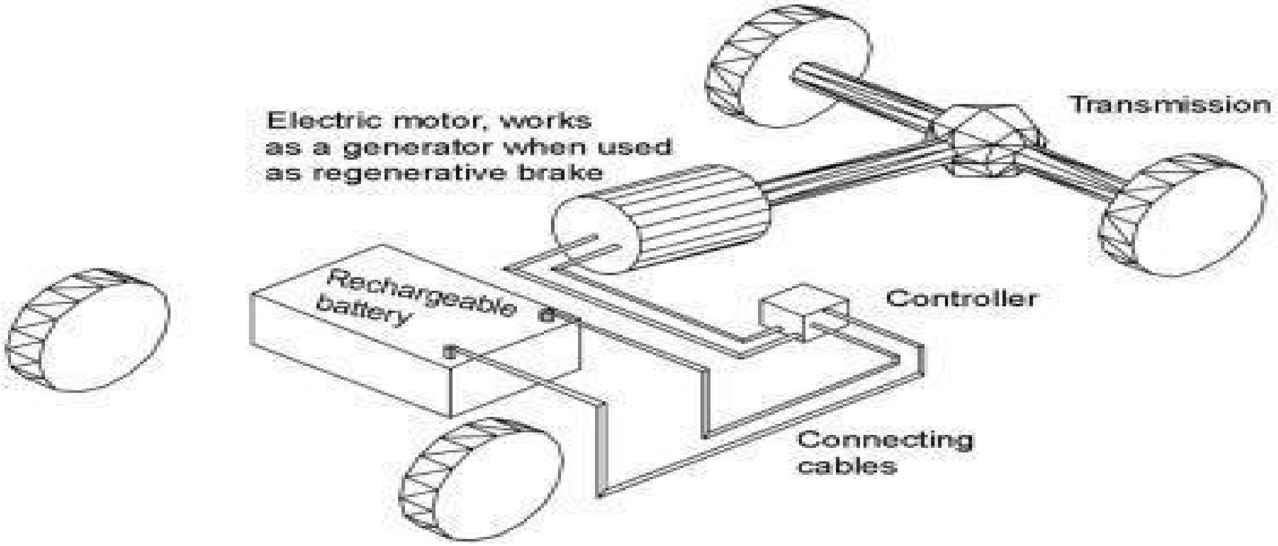
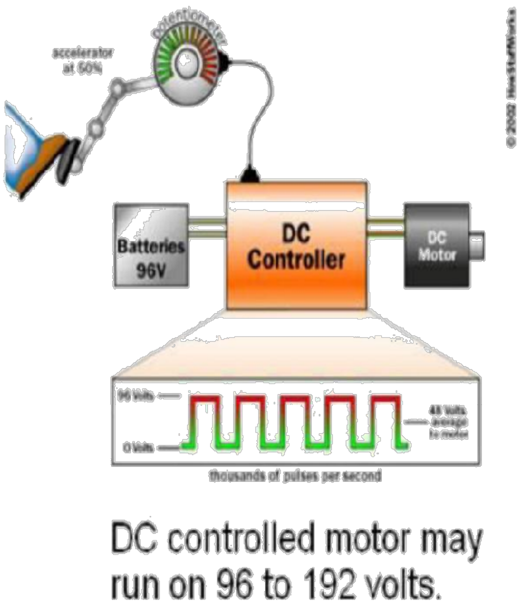
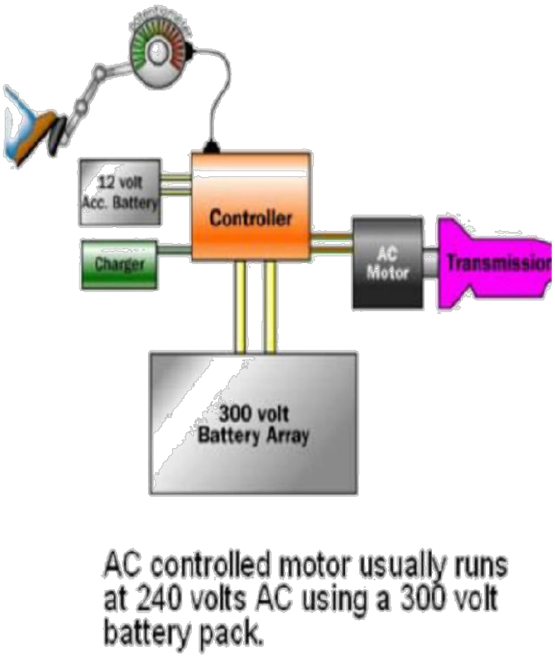


Fig 2.8:- Electric Motor





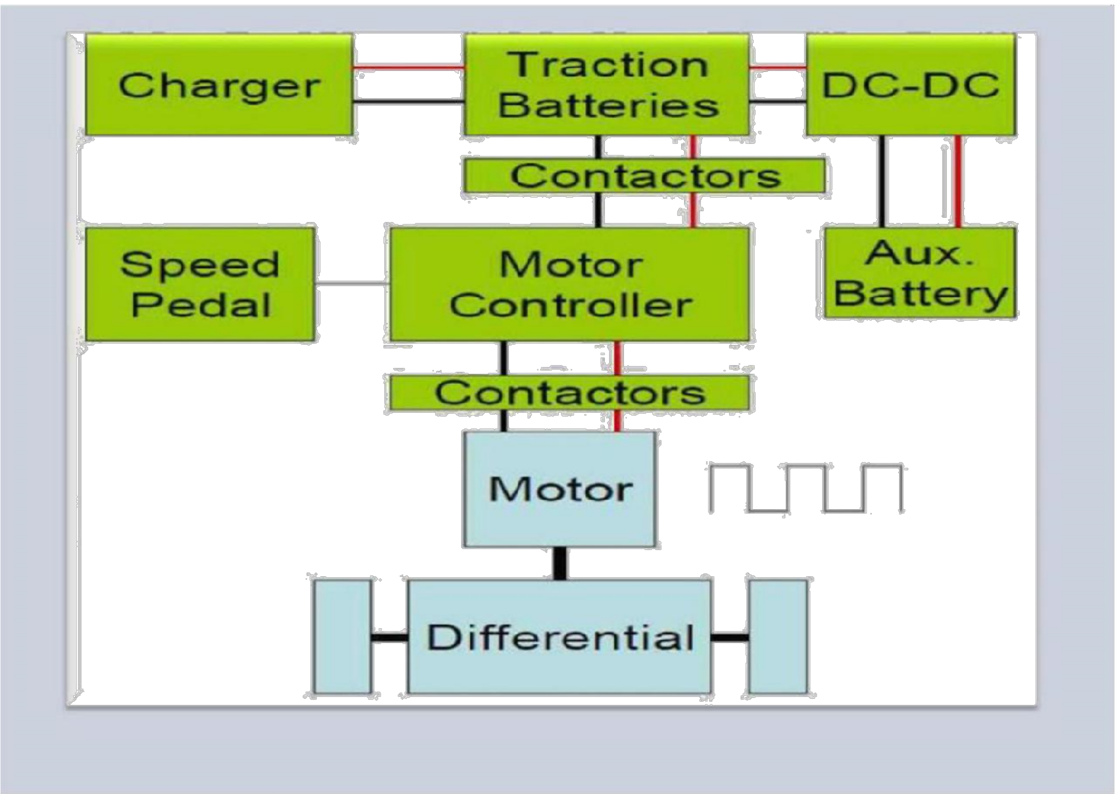


Fig 2.9: Components of Electric Car

CHAPTER 3
WORKING
3.1 ELECTRIC MOTORS

Electric cars can use AC as well as DC motors.

DC motors run on a voltage ranging roughly between 96 to 192 volts.
Most of them come from Forklift Industry.

DC installations are simpler.
Another feature of DC motors is that they can be overdriven for short periods of time (up to a factor of 10), which is good for short bursts of acceleration.

One limitation is the heat build-up. May lead to self-destruction.

Due to these limitations and other advantages provided by AC motors (like better torque and speed output, for same weight and size), DC motors are not used.
Any of the industrial 3 – phase AC motors can be used.
They allow the use of regenerative braking.

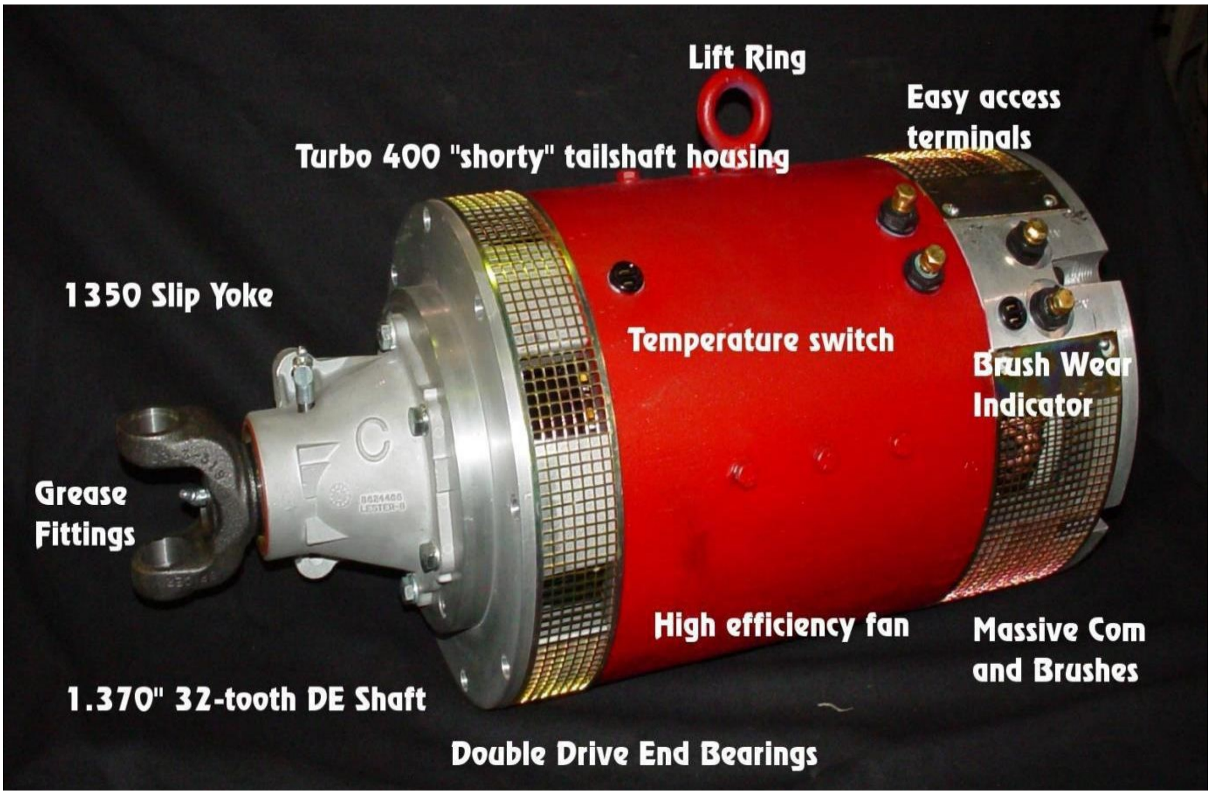


Fig3.1: electric car motors overview

3.2 MOTOR CONTROLLERS

Motor controller is a device that improves the performance of an electric motor in a prearranged manner. Motor controllers can include an automatic or manual means for starting/stopping the motor, choosing forward/reverse rotation, selecting and controlling the speed, modifying or limiting the torque, and shielding against faults and overloads. The major constituents of electric vehicle systems are the motor, power supply, controller, drive train and a charger. An EVM controller or electric vehicle motor controller is a machine that is employed to regulate the torque generated by the motors of electric vehicles by means of modifying the energy flow from the power sources to the motor.

In this car, the controller takes in 300 volts DC from the battery pack. It converts it into a maximum of 240 volts AC, three-phase, to send to the motor. It does this using very large transistors that rapidly turn the batteries' voltage on and off to create a sine wave.

A **motor controller** is a device or group of devices that serves to govern in some predetermined manner the performance of an electric motor. A motor controller might include a manual or automatic means for starting and stopping the motor, selecting forward or reverse rotation, selecting and regulating the speed, regulating or limiting the torque, and protecting against overloads and faults.

There are many types of starters:

1. Direct On Line (DOL)
2. Star delta starter
3. Auto transformer starter

DC Controller:

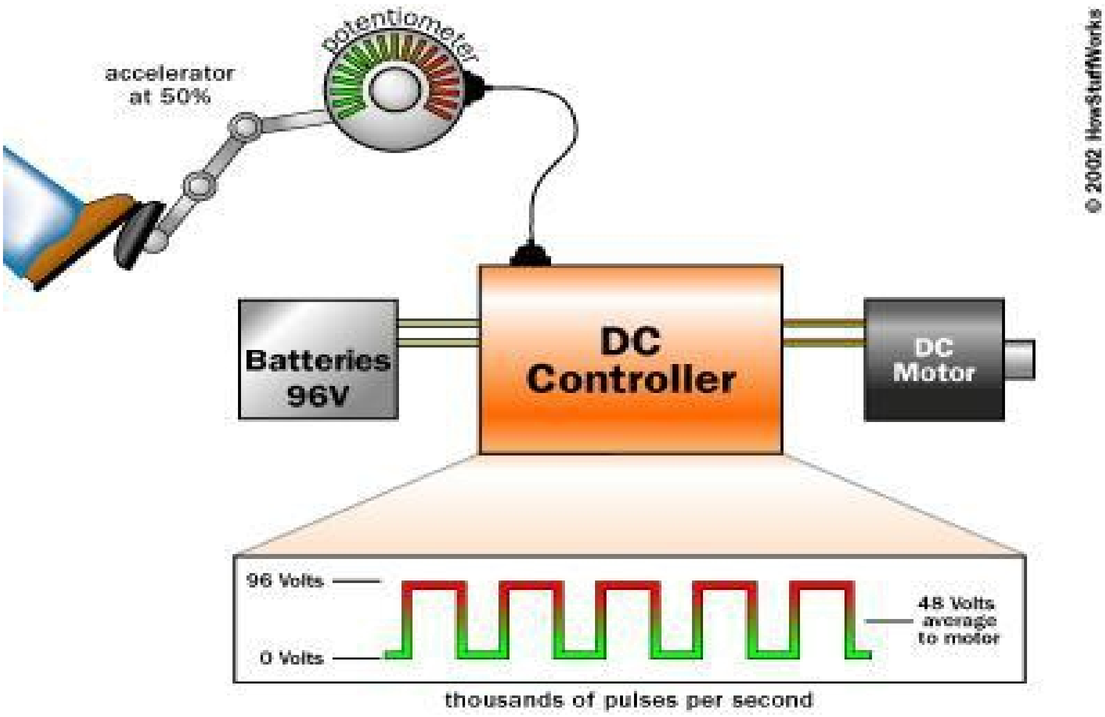


Fig 3.2: DC Controller

A simple DC controller connected to the batteries and the DC motor. If the driver floors the accelerator pedal, the controller delivers the full 96 volts from the batteries 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 96 volts thousands of times per second to create an average voltage somewhere between 0 and 96 volts.

- The controller delivers a controlled voltage to the motor, depending upon potentiometer output.
- PWM controls the speed.

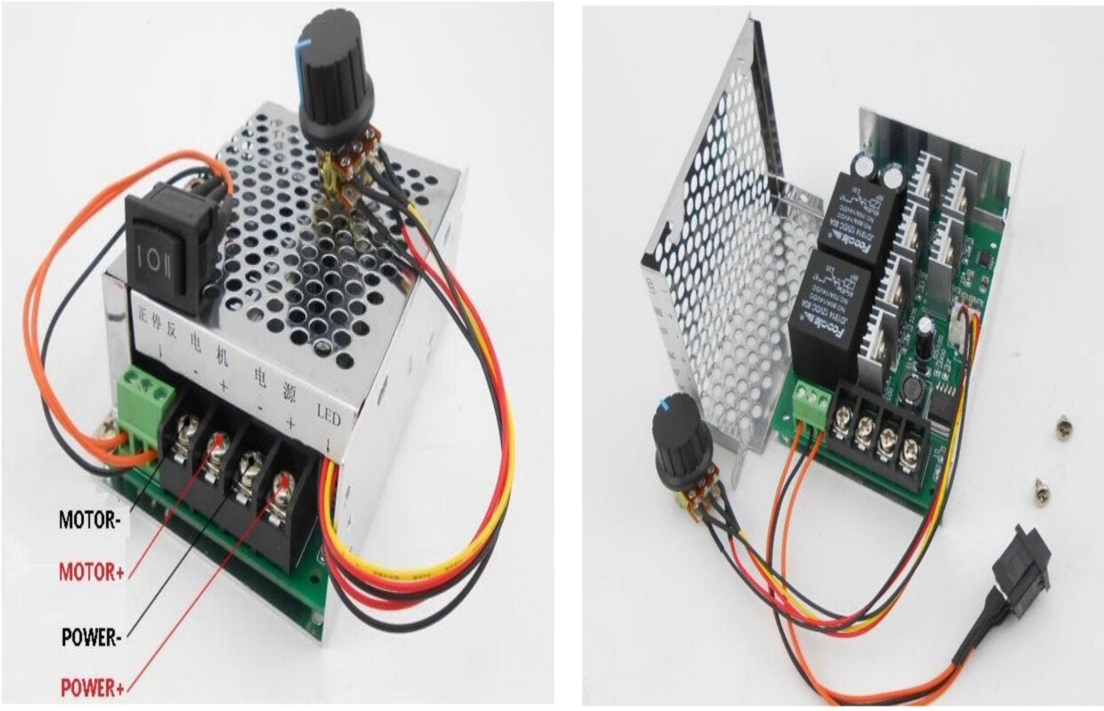


Fig 3.3 : PWM DC Motor Speed Controller

Model: DC10V-50V DC drive

40A power reversing governor.

Polarity relay switch 80A built two high-current relayModel: DC10V-50V DC drive

40A power reversing governor.

Polarity relay switch 80A built two high-current relay

Technical Parameters

Operating voltage: 10V-50V
Output voltage: Load Linear
Maximum current: 60A
Continuous current: 40A
Speed range: 0% - 100%
Forward Reverse: YES
Speed mode: potentiometer (with switch)
Speed Type: adjusting flow
Shell Size: Length 110MM * 78MM * 38MM
Product Weight: 245 grams

AC Controller:

An AC motor controller (inverter) converts DC battery power or generator power in a hybrid vehicle into three phase rotating AC current suitable for efficiently powering an AC motor. Kollmorgen vehicle motor controllers are capable of powering asynchronous induction AC motors as well as synchronous PMAC motors, brushless DC motors and synchronous reluctance motors.

Kollmorgen is the leading global supplier of AC vehicle motor controllers suitable for integration in a wide variety of battery and hybrid vehicles. With a rugged design suitable for the demanding environment in a vehicle, Kollmorgen motor controllers achieve industry leading quality and reliability through superior design and manufacturing processes. Software quality is ensured by utilizing design processes designed to measure up to the demanding Automotive-**SPICE™.**

With an ample selection of voltages, power levels, I/O and feature sets, Kollmorgen's vehicle motor controllers are well matched against the vehicle manufacturer's need for traction, hydraulic, and steering control in an electric vehicle design. Kollmorgen's extensive experience of integration into both industrial vehicles such as forklift trucks or golf carts, as well as on-road vehicles such as buses or refuse trucks has resulted in a unified controls platform. The features and functionality of the platform is shared across the entire Kollmorgen vehicle motor controller line-up.

The Kollmorgen controllers allow the vehicle motors to always operate at their optimal efficiency for a given speed/torque point by utilizing state of the art flux vector control.

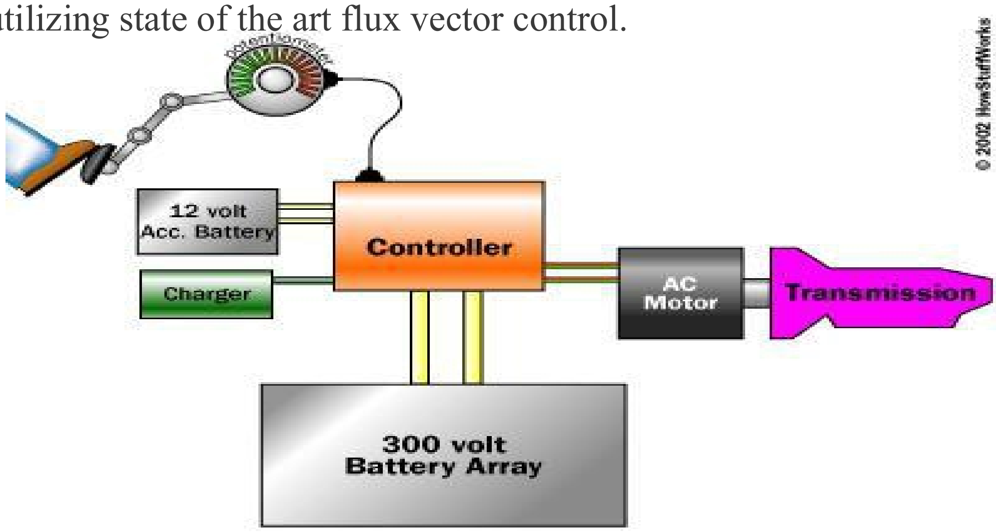


Fig 3.4: AC Controller

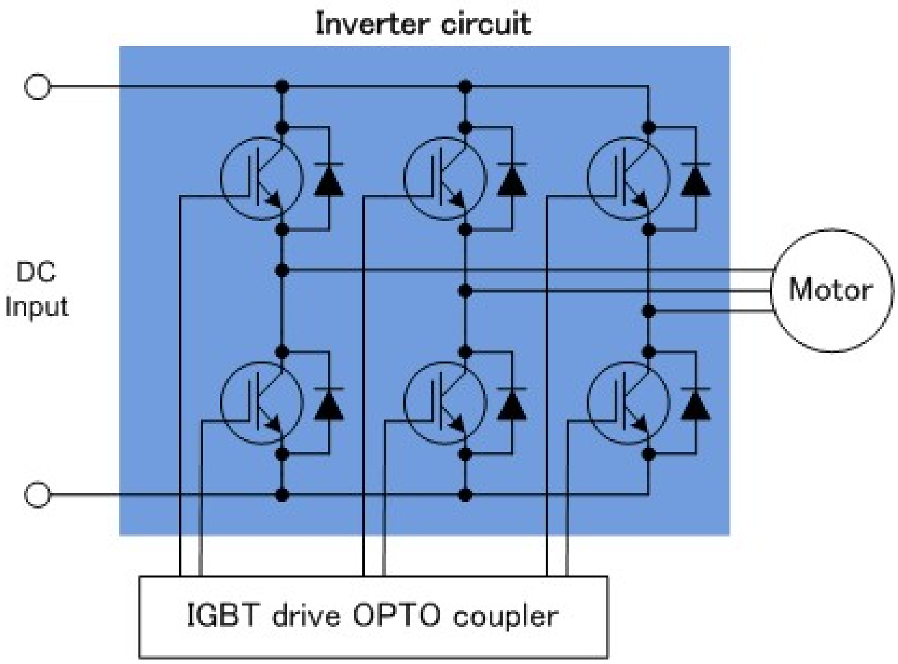


Fig 3.5: A three phase inverter

An AC controller creates 3 pseudo sine waves which are 120 degree apart (3-phase AC).

Using six sets of power transistors, the controller takes in 300 volts DC and produces 240 volts AC, 3-phase.

An AC controller hooks to an AC motor. Using six sets of power transistors, the controller takes in 300 volts DC and produces 240 volts AC, 3-phase. The controller additionally provides a charging system for the batteries, and a DC-to-DC converter to recharge the 12-volt accessory battery.

3.3 BATTERIES AND CHARGERS

- Lead acid batteries used, until recently.
- A weak link in the electric cars.
- Heavy, Bulky, limited capacity (12 – 15 kilowatt hours), slow charging rate, short life and expensive.
- NiMH batteries give double the range and last 10 years, but expensive.
- Lithium ion and NiMH batteries likely to be used if their prices can be made competitive with lead acid batteries.
- Most electric vehicles use lithium-ion batteries (Li-Ions or LIBs). Lithium ion batteries have higher energy density, longer life span and higher power density than most other practical batteries. Complicating factors include safety, durability, thermal breakdown and cost. Li-ion batteries should be used within safe temperature and voltage ranges in order to operate safely and efficiently.
- Increasing the battery's lifespan decreases effective costs. One technique is to operate a subset of the battery cells at a time and switching these subsets.
- In the past, Nickel Metal Hydride batteries were used among EV cars such as those
- made by General Motors. These battery types are considered out-dated due to their tendencies to self-discharge in the heat. Also the batteries' patent was held by
- Chevron which created a problem for their widespread development.[47] These detractors coupled with their high cost has led to Lithium-ion (Li-Ion) batteries leading as the predominant battery for EVs.

- Lithium-ion batteries' price is constantly decreasing, thus, making electric vehicles more affordable and attractive on the market.
- Lithium-based batteries are often chosen for their high power and energy density, although may wear out over a long period of time. However, there are many emerging technologies trying to combat this issue.
- There are also other battery types, such as Nickel metal hydride (NiMH) batteries which have a poorer power to weight ratio than lithium ion, but are cheaper. Several other battery chemistries are in development such as zinc-air battery which could be much lighter.

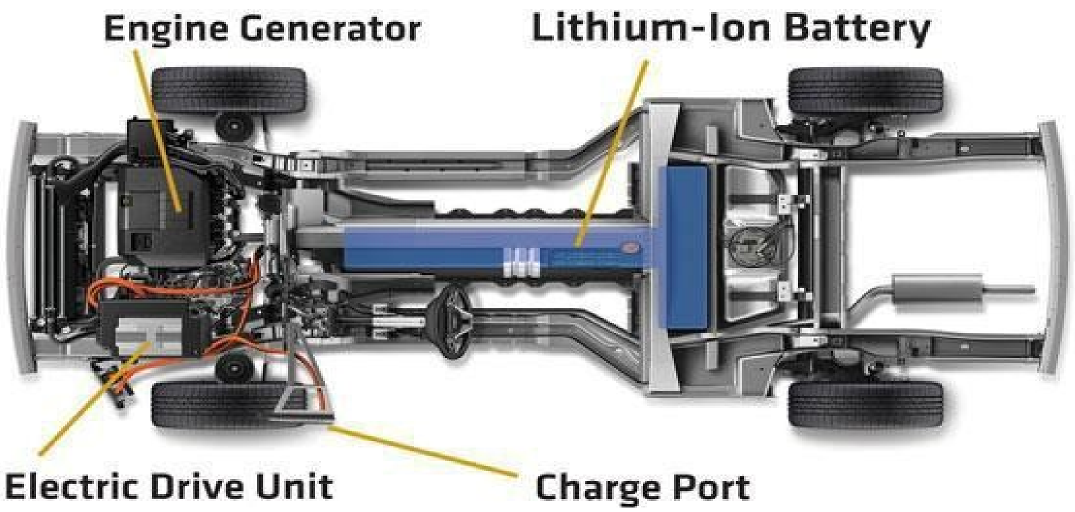


Fig 3.6: Electric Car Battery

	Lithium Ion	Nickel-Metal	Lead-Acid	Ultracapacitors
Easy Access / Inexpensive	✓	✗	✓	✗
Energy Efficient	✓	✓	✓	✓
Temp. Performance	✓	✗	✗	✓
Weight	✓	✓	✓	✓
Life Cycle	✓	✗	✓	✗

Fig 3.7: Understanding Electric Car Batteries

- Charging done from power grid (household/ charging station).
- A good charger monitors battery voltage, current flow and battery temperature to minimize charging time.
- 120/240 Volts.
- Part of the controller/separate box.
- Magna – charge inductive charging system.

Charger: Working

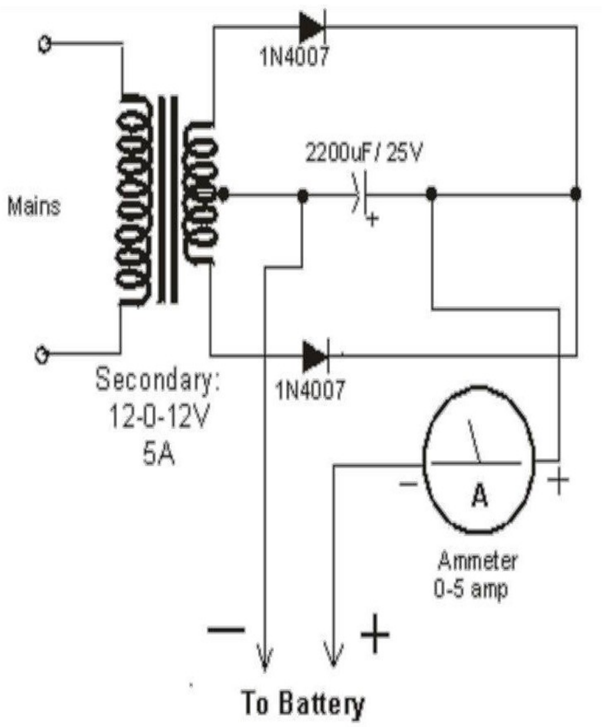


Fig 3.8: Working Of Electric Car Chargers

LEAD ACID BATTERY REACTIONS

Chemical Reactions for charge & Discharge

At the negative terminal the charge and discharge reactions are:

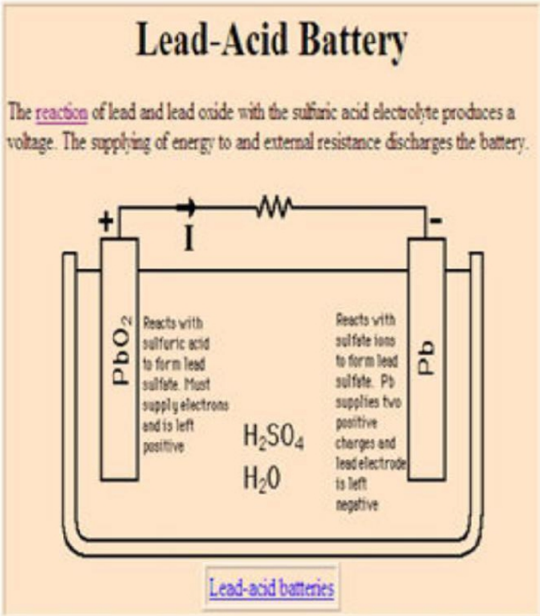
$$Pb + SO_4^{2-} \underset{charge}{\overset{discharge}{\rightleftharpoons}} PbSO_4 + 2e^-$$

At the positive terminal the charge and discharge reactions are:

$$PbO_2 + SO_4^{2-} + 4H^+ + 2e^- \underset{charge}{\overset{discharge}{\rightleftharpoons}} PbSO_4 + 2H_2O$$

The overall chemical reaction is:

$$PbO_2 + Pb + 2H_2SO_4 \underset{charge}{\overset{discharge}{\rightleftharpoons}} 2PbSO_4 + 2H_2O$$



Lead-acid battery

lead acid car battery

Energy/weight	30-40 Wh/kg
Energy/size	60-75 Wh/L
Power/weight	180 W/kg
Charge/discharge efficiency	50%-92% [1]
Energy/consumer-price	7 (sld)-18 (fld) Wh/US$ [2]
Self-discharge rate	3%-20%/month [3]
Cycle durability	500-800 cycles
Nominal Cell Voltage	2.105 V

Fig 3.9: Lead Acid Battery

Advantages & Disadvantages of Lead Acid Battery

Advantages of Lead Acid Battery

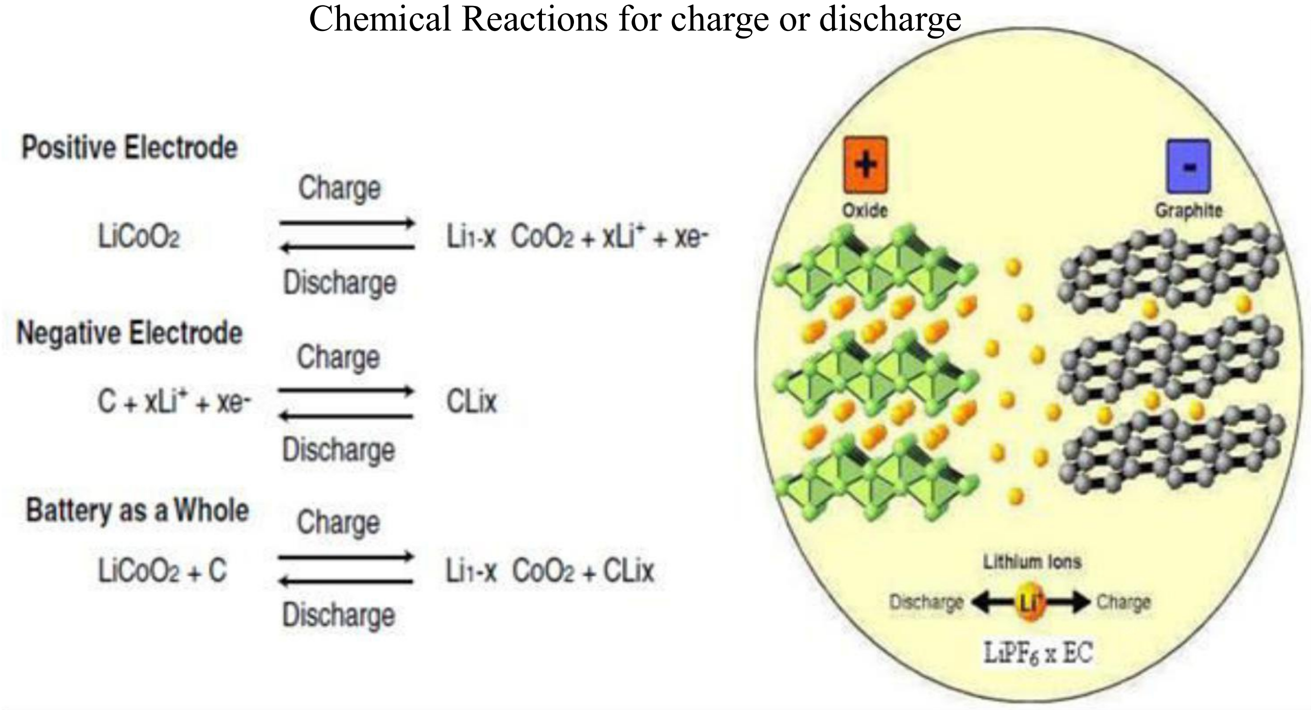
- Inexpensive.
- Reliable.
- Rechargeable battery systems.
- Low maintenance requirements.

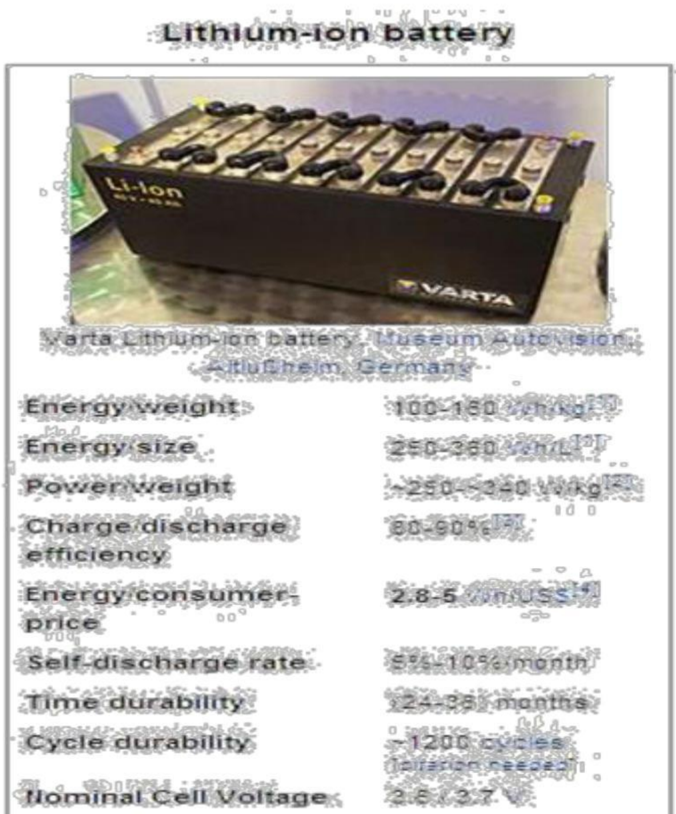
Disadvantages of Lead Acid Battery

- Low energy density.
- Limited number of full discharge cycles.
- Environmentally unfriendly.
- Taking 12hr-16hr to recharge by standard outlet (110v).

LITHIUM ION BATTERY REACTIONS

Chemical Reactions for charge or discharge





Lithium-ion battery

Varta Lithium-ion battery, Museum Autovision, Altlußheim, Germany

Energy/weight	100-160 Wh/kg[1]
Energy/size	250-360 Wh/L[1]
Power/weight	~250-~340 W/kg[1]
Charge/discharge efficiency	80-90%[2]
Energy/consumer-price	2.8-5 Wh/US$[3]
Self-discharge rate	5%-10%/month
Time durability	(24-36) months
Cycle durability	~1200 cycles [citation needed]
Nominal Cell Voltage	3.6 / 3.7 V

Fig 3.10: Lithium Ion Battery

Advantages & Disadvantages of Lithium Ion Battery

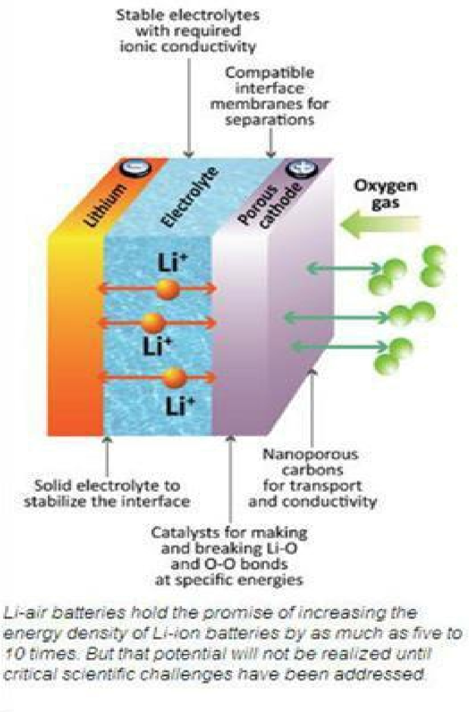
Advantages of Lithium Ion Battery

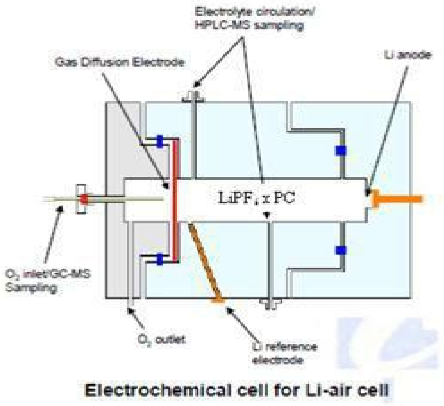
- Higher energy density.
- Operate at higher voltages than other rechargeable.
- Lower self-discharge rate than other rechargeable.
- Low Maintenance - no periodic discharge is needed; there is no memory.
- Specialty cells can provide very high current to applications such as power tools.

Disadvantages of Lithium Ion Battery

- More expensive than other rechargeable ($10,000/battery).
- Lithium Ion Batteries are not available in standard cell size.
- Damage due to overcharging or undercharging.
- Highway speed, max 70 mph, taking 8 hours to complete recharge.

LITHIUM AIR BATTERY REACTIONS:





The possible discharge cell reactions are:

$$2Li + O_2 \longrightarrow Li_2O_2 \qquad (Eo = 3.1\ V)$$

$$4Li + O_2 \longrightarrow 2Li_2O \qquad (Eo = 2.91\ V)$$

Fig 3.11: Lithium Air Battery Reactions

Advantages & Disadvantages of Lithium Air Battery

Advantages of Lithium Air Battery

- Ten folds increase in energy capacity compared to lithium ion battery cell.
- Operate at higher voltages than other rechargeable.
- Lower self-discharge rate than other rechargeable.
- Low maintenance requirements.

Disadvantages of Lithium Air Battery

- It is easy to explode in contact with water.
- More expensive than other rechargeable.

CHAPTER 4
BRAKING AND ACCELERATION

- Regenerative braking along with conventional friction braking.
- Motor as a generator
- Recaptures car's kinetic energy and converts it to electricity.

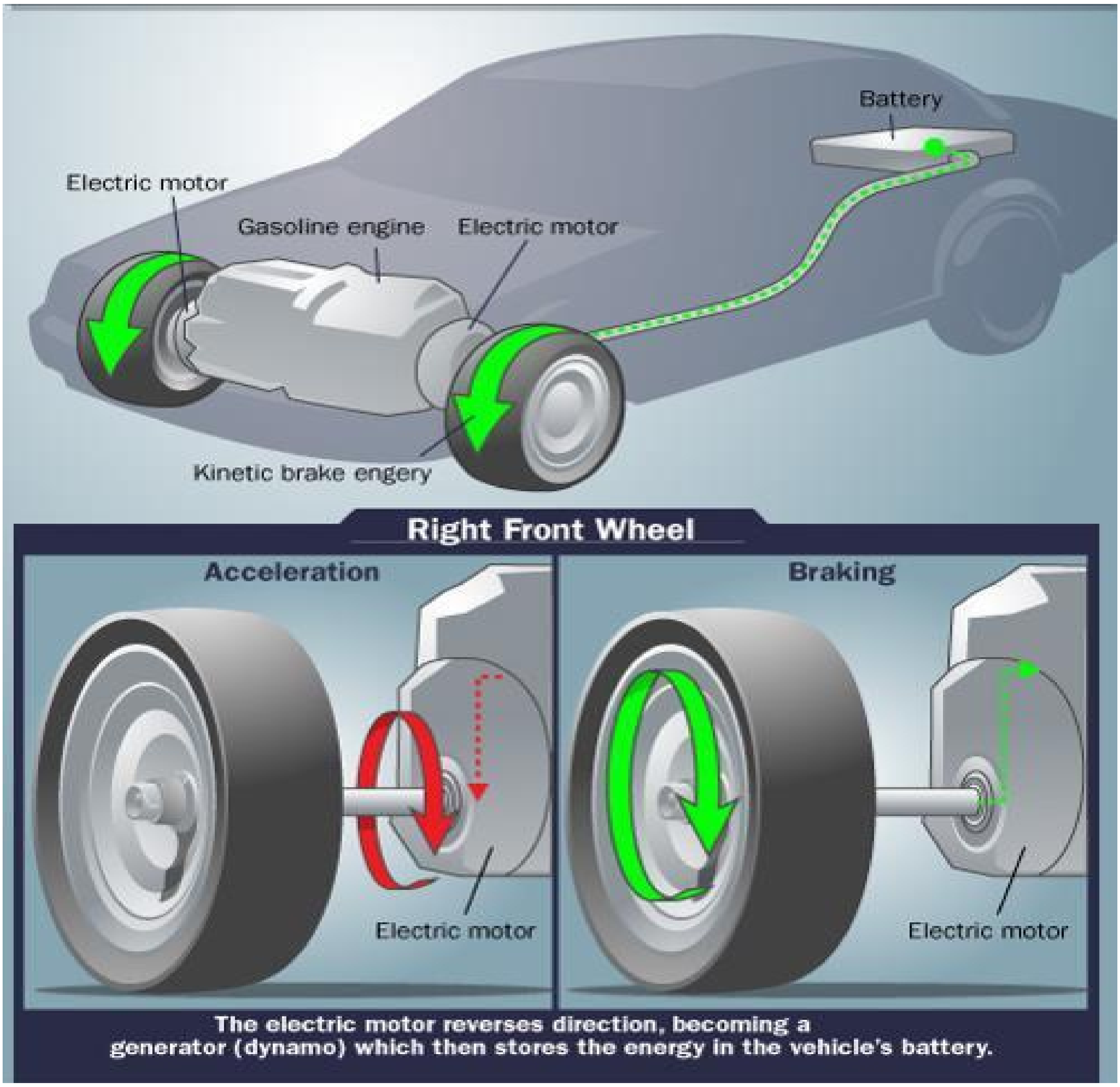


Fig 4.1: Braking and Acceleration in Electric cars

Electric motors can provide high power-to-weight ratios, batteries can be designed to supply the currents needed to support these motors. Electric motors have flat torque curve down to zero speed. For simplicity and reliability, many electric cars use fixed-ratio gearboxes and have no clutch.

Many electric cars have motors that have high acceleration, relative to comparable cars. This is largely due to the more reduced drivetrain losses and more quickly available torque of an electric motor, which often increase the acceleration relative to a similar motor power internal combustion engine. However Neighborhood Electric Vehicles may have a low acceleration due to their relatively weak motors.

Electric vehicles can also use a direct motor-to-wheel configuration which increases the available power. Having motors connected directly to each wheel allows the wheels to be used both for propulsion and as braking systems, thereby increasing traction. When not fitted with an axle, differential, or transmission, electric vehicles have less drive-train inertia.

For example, the Venturi Fetish delivers supercar acceleration despite a relatively modest 220 kW (300 hp), and top speed of around 160 km/h (100 mph). Some DC-motor-equipped drag racer EVs have simple two-speed manual transmissions to improve top speed. The Tesla Roadster (2008) 2.5 Sport can accelerate from 0 to 97 km/h (0 to 60 mph) in 3.7 seconds with a motor rated at 215 kW (288 hp). Tesla Model S P100D (Performance / 100kWh / 4-wheel drive) is capable of 2.28 seconds for 0–60 mph at a price of $140,000 [1]. As of May 2017, the P100D is the second fastest production car ever built, taking only 0.08 seconds longer for 0–97 km/h (0–60 mph), compared to a $847,975 Porsche 918 Spyder. The electric supercar Rimac Concept One can go from 0–97 km/h (0–60 mph) in 2.5 seconds. The upcoming Tesla Roadster is announced to go 0–60 mph (0–97 km/h) in 1.9 seconds.

CHAPTER 5
SIGNIFICANCE OF MOTORS AND MOTOR DRIVERS:

Motor Driver circuits are current amplifiers. They act as a bridge between the **controller** and the **motor** in a motor drive. Motor drivers are made from discrete components which are integrated inside an IC. The input to the motor driver IC or motor driver circuit is a low current signal.

A motor driver IC is an integrated circuit chip which is usually used to control motors in autonomous robots. Motor driver ICs act as an interface between microprocessors in robots and the motors in the robot. The most commonly used motor driver IC's are from the L293.
series such as L293D, L293NE, etc. These ICs are designed to control 2 DC motors simultaneously. L293D consist of two H-bridge. H-bridge is the simplest circuit for controlling a low current rated motor. For this tutorial we will be referring the motor driver IC as L293D only.
L293D has 16 pins, they are comprised as follows:

Ground Pins - 4
Input Pins - 4
Output Pins - 4
Enable pins - 2
Voltage Pins – 2

The L293D IC receives signals from the microprocessor and transmits the relative signal to the **motors**. It has two voltage pins, one of which is **used** to draw current for the working of the L293D and the other is **used** to apply voltage to the **motors**.

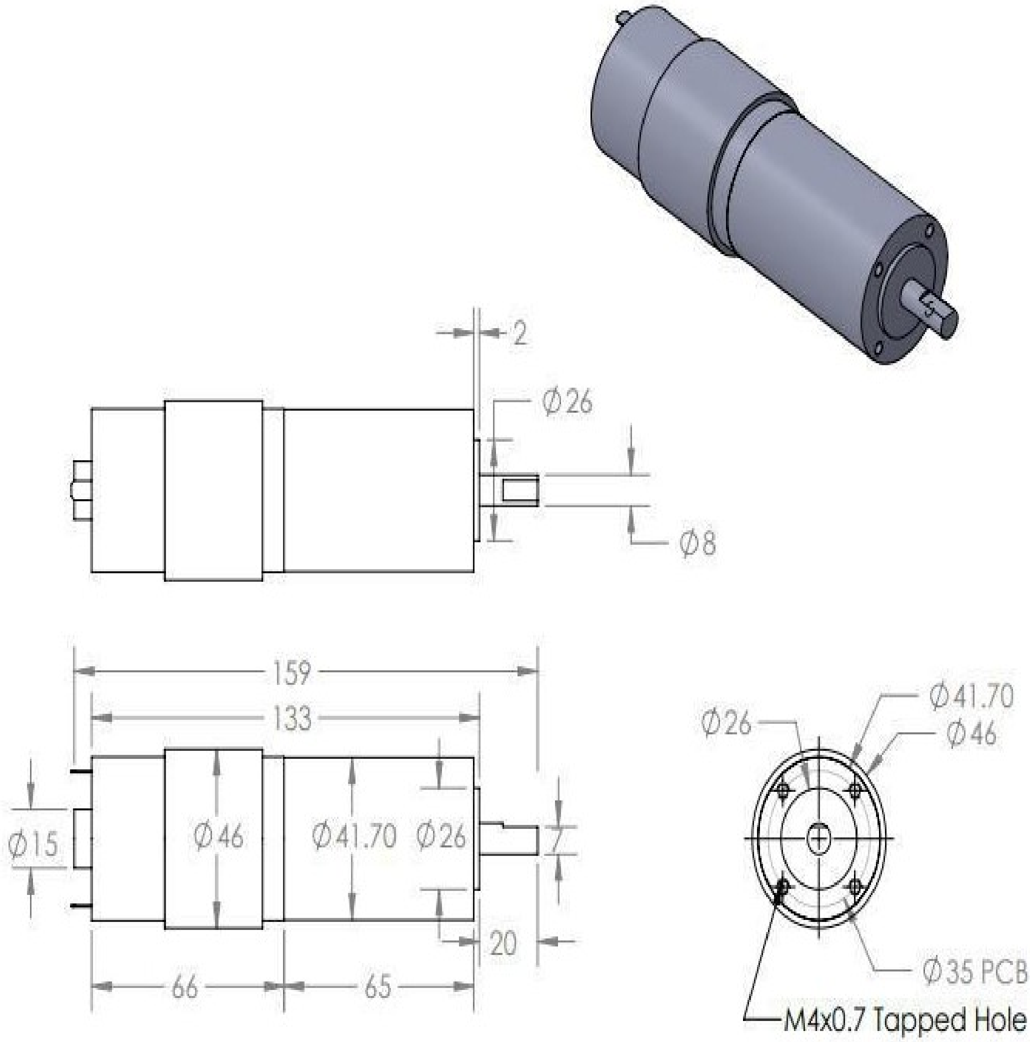


Fig 5.1 Mechanical Drawing of DC Geared Motor

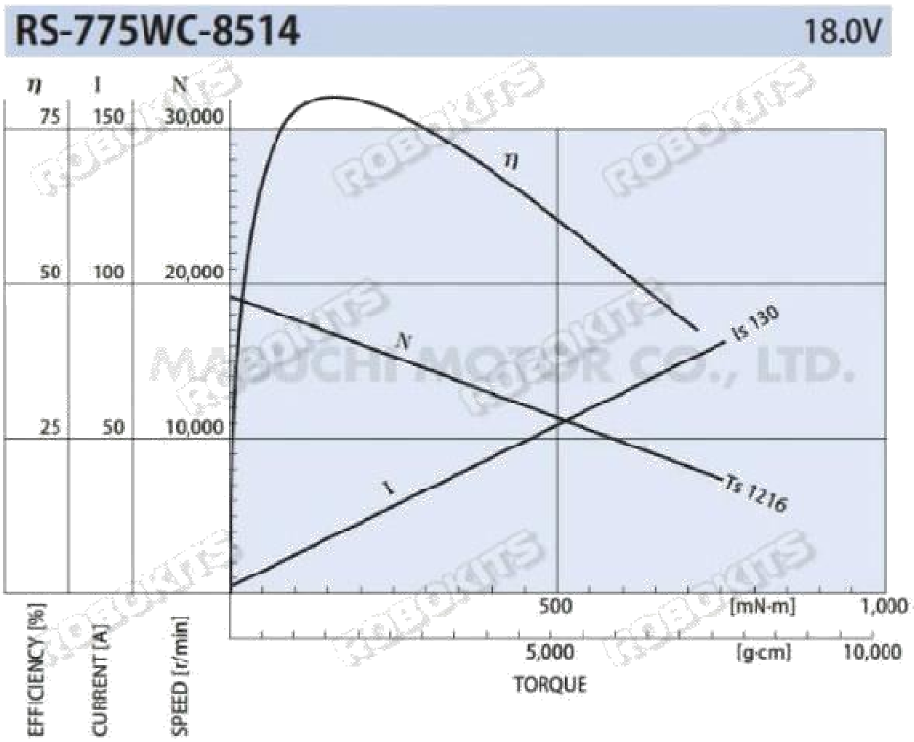


Fig 5.2 : Output Characteristics of DC Geared Motor

5.1 Specifications:

- Rated Voltage: 18VDC
- No Load Speed: 291RPM
- No Load Current: 2.7A
- Gear Ratio: 1:67
- Rated Torque: 92kgcm
- Rated Speed: 260RPM
- Rated Current: 18.7A
- Motor length without shaft: 125mm
- Shaft length: 27mm
- Motor Dia: 46mm
- Shaft Dia: 8mm
- Gearbox breaking torque: 200kgcm
- Stall Current: 130A
- Operating Voltage: 10V-50V

- Output Voltage: linear under load
- Maximum Current: 60A
- Continuous Current: 40A
- Speed Range: 0%-100%
- Speed Type: Tuning
- Material: Metal
- Forward Rotation: Yes

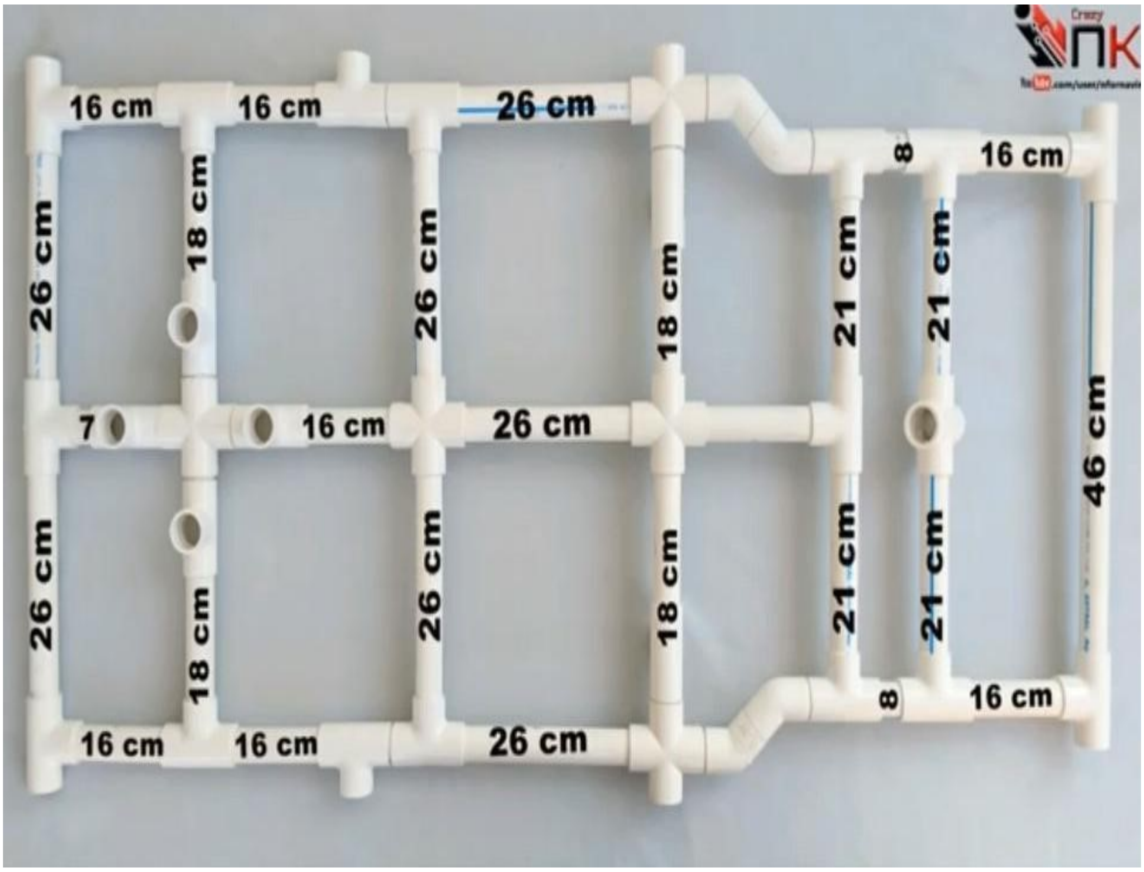


Fig 5.3 : Specification of Chessi

RPM to km/hr Converter:

Formula: $k = d * r * 0.001885$

Where

k= kilometer per hour (km/hr)

d= Wheel diameter

r= Revolution per minute(RPM)

Related Calculator: RPM to km/hr converter

Product Information:

Table 1: Product Information

Brand	Magideal
Manufacturer	Magideal
Item Part Number	38ab7187cf0abf1507o

Additional Information:

ASIN: B072KH318P

Best Sellers Rank: 64573

Date First Available: 13 June 2017

Competitor Analysis

Competitor Identification/Major Competitors

As with any emerging market, numerous direct and indirect competitors exist. While there are a substantial number of manufacturers entering the market, many less are actually in the market. With vehicles being held to much higher standards in gas efficiency, as well as a long trend of other alternative fuel vehicles, this is a much more competitive market than people realize. Currently the projections are that plug-in electric vehicles (PLEV's) will take over about 5% of the total market for vehicles worldwide by 2017 (greenretaildecisions.com, 2011).

Direct Competition

- Aptera Electric Cars
- Audi Electric Cars
- BW Electric Cars
- BYD (Build Your Dream) Electric Cars
- Chevrolet
- Commuter Cars Electric Cars
- Fisker Automotive
- Ford
- Honda
- Infinity
- Mazda
- Mercedes-Benz
- Myers Motors Electric Cars
- Mini Electric

- Mitsubishi Electric
- Nissan
- Smart Electric Cars
- Tesla
- Think North America
- Toyota
- Wheego
- ZAP Electric Vehicles

Although there are a high number of vehicles on the list of automobiles offered as electric vehicles, very few of them have actually been brought to market (Eziquiel-Shriro, 2012). While our list is very inclusive, we will keep our analysis of the competitors to vehicles that have actually hit the market at this time.

BYD Electric Cars is a Chinese based company that has seen over a half of a million vehicles delivered to date in Asia. The majority of BYD's market share in this region is based on their gas platform; however, it is a company that has substantial resources to bring to the development and marketing of their vehicle. According to Wang Chuanfu, the company's president, the manufacturer will only focus on electric cars in North America (Shirouzu, 2011). BYD has launched the E6 in China where the vehicle is used primarily for taxi service. BYD will have its first shipment of vehicles in the US by the end of 2012, with some of the vehicles already promised to the Los Angeles Metro Government. Although the vehicle is rumored to be relatively sluggish and generic, BYD states that the vehicles driven were only prototypes and the vehicles that are actually delivered will be of higher quality (Shirouzu, 2011).

Chevrolet has become one of the most recent entrants into the electric vehicle market with the release of the Volt. The Volt is largely aimed at making the electric car a more user-friendly vehicle and taking market share away from vehicles like the Toyota Prius. The Volt is not, however, a true plug-in electric vehicle. The Volt has a plug-in range of about 35 miles (Chevrolet.com, n.d.), but with its onboard gasoline generator, the range stretches to a much more reasonable 400 miles. The Volt arrived at the 2011 Auto Show as the most technologically advanced vehicle brought to market this year and ended up taking home the 2011 North America Car of the Year Award. (Eziquiel-Shriro, 2012).

The Volt has not lived up to its initial expectation. With only about 10,000 vehicles sold thus far, GM is far below its projected figures. The Volt boasts a sticker price of a little under $40,000 and dealerships have had a limited availability. GM has largely designed this shortage as they shut down production of the Volt from March into April due to lack of consumer demand. GM has restarted production after posting a better than expected March, with 2,289 Volts delivered. (Conway, 2012)

Commuter Cars Electric Cars was one of the first publicly available electric vehicles. The Tango T600 was introduced in 2006 and is built on a tandem seat platform. The vehicle was designed, somewhat, for the rich and famous who commute through the streets of LosAngeles. Boasting a prestigious group of owners, including George Clooney, the Tango T600 achieves a 0 to 60 time of about 4 seconds and also has a top speed of 130 mph. (Eziquiel-Shriro, 2012) The Tango T600 is offered with an option of a lead acid battery with a range of 40 to 60 miles or a lithium ion battery with a range of 200 miles. The vehicle is somewhat price restrictive, with the base model being priced at $108,000. Safety is a Tango hallmark, featuring a roll cage built to race car standards, a 4-point safety harness, and more protective steel in each door than a typical SUV (Commutercars.com, n.d).

The Tango 100/200 is scheduled to hit markets in the near future and is more in line with other affordable mass-produced cars. Commuter Cars began taking orders and is listing the base price for the T100 at $19,000 and the T200 at $40,000. Some are not sure if these vehicles will ever actually see the light of day (Eziquiel-Shriro, 2012).

Fisker Automotive was founded when designers Henrick Fisker and Bernhard Koehler decided to join forces and design an automobile that pushed the limits. The first thing that the new partners did was survey the automotive landscape and they realized that it was based on a history defined by limitations (fiskerautomotive.com, n.d.). The new partners brought a combined 51 years of automotive design experience, and in 2007 they literally started with a blank piece of paper. Five years later, Fisker has established itself as a player in the electric car market and possess what *Car and Driver* calls the most attractive looking electric vehicle on the road. Born out of their combined vision, the Fisker Karma was born (Robinson, 2012).

The Fisker Karma is a four door sport-based platform that has been in development since 2007. The Karma features exciting stats of achieving 0 to 60 MPH in just 6.3 seconds and also has a top speed of 125 MPH. The Karma does borrow a bit of technology from Chevrolet it features a GM-designed onboard gas generator that stretches the range of the Karma to an adequate 300 miles. The Karma can run on a plug-in capability with a range of 50 miles. The Karma's base model is priced at a steep $102,000. The Karma does have a "stealth mode" allowing the vehicle to run virtually silently; however, during the other times, the vehicle actually has an exterior sound system that pumps out the growls and purrs that car enthusiast love about sport cars (Robinson, 2012).

Ford has become one of the newest and, quietly, one of the most highly anticipated entrant to the electric vehicle market. Ford launched the 2011 Ford Focus-E to lead its charge into the consumer electric vehicle market. Ford has had the Transit Connect EV available for a number of years; however, this vehicle is mainly used as a fleet vehicle for transporting goods (ford.com, n.d.).

The Ford Focus-E comes to market directed at taking market share from the Nissan Leaf. Unlike the Volt or Prius, the Focus-E boasts a 100% electric operated vehicle. Part of Ford's marketing pitch for the Focus-E is "Never use a drop of gas again." The Focus-E comes equipped with onboard navigation on all models pre-programmed to help the driver find the closest charging station. The Focus-E also has an all-electric range of between 90 and 100 miles and comes with a cell phone app to help monitor the vehicle at a distance. The Focus-E is a relatively new competitor in the market, but it is priced at $39,200, still making it a bit expensive for your average consumer (ford.com, n.d.).

Myers Motors is an Ohio based manufacturer that claims it is one of the only all-American made electric vehicles on the road. Myers Motors is the first company to produce an unsubsidized, sub-$30,000, lithium battery powered, all-electric, highway speed vehicle. In addition, it aims to be the first to break the $20,000 price hurdle (myersmotors.com, n.d.)

Myers produces the Myers Motors NmG, which is a single passenger 3 wheel vehicle. The target market for this vehicle is the short commuter. The NmG has seating for one and is described as having a spherical body design (like a motorcycle helmet). The driver of the vehicle is fully enclosed and the vehicle will travel at speeds up to 70 MPH with a range of 60 miles. Myers' advertising pitch is their claim that you can drive 1000 miles on $20 of electric fuel (myersmotors.com, n.d.). While producing a more affordable version of the vehicle, the only design offered is a single seat vehicle, which can be a concern for many consumers. Myers is scheduled to launch the new two seat Duo in the near future, but specifications are not yet released (myersmotors.com, n.d.).

Mitsubishi has entered the US electric vehicle market with their 2012 of the MiEV. Mitsubishi prides itself in having over 40 years of electric vehicle experience, mostly in Asia. Positioned strongly based on the infrastructure and in the fact that they have been selling all electric vehicles globally since mid 2009, Mitsubishi brings a very strong offering to the market. The MiEV is set up to be a very strong competitor for the Leaf (Roy, 2011).

Mitsubishi beefed up the MiEV a bit before bringing it to US markets, adding 4.3 inches to the width and reducing its weight to about 2500 pounds for its curb weight. The MiEV is still about 2 inches narrower than the compact Fiat 500. About 9 inches of length is added, but none of this impacts the interior as it is all crash safety additions. The MiEV is priced from $29,125 and features a realistic range of about 80 miles between charges. Much like the Leaf, the MiEV is an all-electric plug in and Mitsubishi claims that this vehicle can travel 15,000 miles for only $495 (excluding the price of the vehicle) (Roy, 2011).

Nissan became on a major player in the electric vehicle market with the introduction of the Nissan Leaf in 2010. The Leaf quickly became the first mass available consumer electric vehicle and actually managed to outsell the more anticipated Chevrolet Volt in 2011, the first year that the vehicle competed in the market (Harper, 2011). Nissan has taken a bit of a gamble, but at the same time, is looking at a large rewarding pay off with the launching of the consumer electric car market. According to Bloomberg, this could result in distribution of several hundred thousand Nissan Leafs worldwide (Harper, 2011).

The Nissan Leaf was released in late 2010 (the 2011 model year) to decidedly positive reviews. The winner of the 2011 World Car of the Year award, the vehicle is poised to continue to capture market share. The Leaf boasts a 100% electric drive train and a range of 100 miles per charge. Nissan claims that the vehicle is rated to 99 gasoline miles per gallon, which is a bit misleading because there is no onboard gas engine (Harper, 2011). With a base price of $35,200, the vehicle is more affordable then its high priced competitors. Nissan claims that with the government rebates, the buyer could see a realized value of $27,700 if he or she actually qualified for all the rebates (Nissanusa.com, n.d.). Even in the wake of the Japanese Tsunami that halted production, Nissan delivered 11,000 Leafs in 2011 (Eziquiel-Shriro, 2012).

Tesla was launched in Silicon Valley in 2003, with the mission to accelerate the world's transition to electric mobility with a full range of increasingly affordable electric cars. Tesla founds its first success in 2008 with the release of the all-electric Roadster. Since its inception less than 10 years ago Tesla has grown to employ over 1,400 employees and have 21 retail locations worldwide (teslamotors.com, n.d.).

The Tesla Roadster has become one of the most recognized all-electric sport vehicles currently on the road. To date, Tesla has put 2,100 Roadsters into the hands of enthusiasts who now occupy the road in 32 countries (teslamotors.com, n.d.). Tesla ended production of the Roadster in late 2011 with eyes on creating a more consumer friendly vehicle that would have mass market appeal. With a price tag of $109,000 and performance rivaling that of race cars, the Tesla roadster was never going to position the company to be a player in the mass market. For that reason Tesla, has begun production of the Tesla S, which is the first all-electric vehicle to feature seating for 7 people (5 adults and 2 children). The Tesla S will see a price tag of $49,900 and have a range of 160 miles. Those who wish to increase their range can get an all-electric Tesla S with a 300 mile range for about $20,000 more (teslamotors.com, n.d.).

Recent news in the electric vehicle market has involved the Tesla, specifically raising questions about the life of the vehicles. These reports state that the life of the “permanent” lithium ion batteries being used in the electric vehicle platform likely has a more limited life than initially anticipated. This study goes on to warn that there may be trouble on the horizon for Tesla as the life of their onboard battery is being reported to be as short as 5 years and carries a replacement cost of $20,000 to $40,000 (Stanton, 2012). There is fear that once this information becomes publicly known that it will shake the already unstable consumer confidence in these vehicles.

After years of leading the hybrid market with the Prius, Toyota is the next manufacturer prepared to have a huge launch when they introduce the Rav4 EV. Toyota has already seen success in Asia with the all-electric Rav4 EV and is poised to launch the vehicle in US markets in late 2012. Interestingly, Toyota has maintained a small fleet of Rav4 EV’s since 1997 to test the feasibility of bringing this vehicle to market (Eziquiel-Shriro, 2012).

There is high initial consumer expectation of the Rav4 EV that it will be noted to be the first “high seat” crossover vehicle offered as an all-electric option. It is believed that the battery will be located near the middle of the frame which will cause the Rav4 EV to “sit heavier” on the road and will actually improve the ride quality over the gas conventional model (Eziquiel-Shriro, 2012). The Rav4 EV boasts a range of 100 miles and it is assumed that the initial move into the market for this vehicle will be as a fleet vehicle.

Indirect Competition

The alternative fuel market has been a "hot button issue" for the last 30 years. In that time, there have been a variety of alternative fuels developed along with the electric vehicle platform and all of them compete with that platform (consumerenergycenter.org, 2012).

Biodiesel is a fuel that can be mass produced using waste products from other processes that actually require little to no modification of existing diesel engines. Fuel sources for this include soybeans and used restaurant fryer grease. These products can be used independently or combined with petroleum. This is actually the only alternative fuel source that has completed the health effects testing under the Clean Air Act (consumerenergycenter.org, 2012).

Compressed natural gas is another attractive alternative and is produced both nationally and worldwide. It is a fuel that has been used for a long time, especially in fleet areas. Compressed natural gas is a fossil fuel; however, it shows an 80% reduction in ozone forming emissions over gasoline based engines (J. Larson, personal communication, April 8, 2012).

Gas to Liquid Fuels (GTL Fuels) are made from coal, natural gas, or biomass using a Fishcer-Tropsch chemical reaction. This fuel tends to operate very efficiently and similarly to compressed natural gas, it reduces dependence on petroleum based fuels. This gas does show a minor positive environmental impact, but it is less than other alternatives (consumerenergycenter.org, 2012).

Hydrogen & Fuel Cell Vehicles are the most realistic competition to electric based vehicles in the market. Hydrogen is the simplest, lightest, and most plentiful element in the universe and is compressed into a usable fuel source with a process call reforming. The vehicle is in the test phase, but there are currently 95 pilot vehicles on the road in California. Tests have shown a reduction in emissions and increase in efficiency. Ford has developed an internal combustion engine made to run on pure hydrogen (consumerenergycenter.org, 2012).

Liquefied Natural Gas is, to a certain degree, a byproduct of learning how to more safely transport natural gas. By cooling the gas to a liquid state, the fuel more stable to transport. This fuel source is currently in use; however, it makes more sense for large class 8 or large vehicles. It is not expected to be a true competitor in the consumer market (consumerenergycenter.org, 2012).

Liquefied Propane Gas is one of the oldest forms of alternative fuel in use. This fuel was adopted long ago for use in smaller equipment like forklifts ad farm equipment. There is little research available for modified use into consumer automobiles, yet, it is widely available (consumerenergycenter.org, 2012).

Technological Changes

Some technologies in electric vehicles include batteries, electricity, motors, materials, and charging stations. The improvements in battery technology over the past two decades, in particular the advances in Lithium-ion battery technology and advances made through hybrid vehicles, have allowed it to be possible to design and manufacture electric vehicles with better performance than their gasoline-powered counterparts. One of the most important technologies in any electric vehicle is the battery pack, which must be small and light for efficiency, but hold enough energy to allow for a reasonable range before recharging. Another technology that electric cars need is a stable infrastructure of electrical distribution as some towns may need to allow for additional demand on electricity. Also, while batteries replace a fuel tank, electric motors replace the internal combustion engine and exhaust system. These motors use electromagnetism to turn electricity into mechanical energy that passes through a transmission and turns the vehicle's wheels. In addition, lighter cars require less energy to drive. Cars have been made from plastics for decades, due its low cost and light weight; however, additional materials, such as aluminum alloy, fiberglass, and carbon fiber also provide light, durable materials for car parts and bodies. Another technology is the charging station. For electric cars to be practical, owners need access to fast-charging stations. Charging stations can be installed in the home using high-capacity power lines. Because they store large amounts of electricity and can fill the car's batteries more quickly, recharging throughout the day is simpler (Hartman, n.d.).

Services Required

Very little maintenance is required for these cars, due to the electric motor. The motor has roughly half a dozen moving parts, as compared to the hundreds of working parts in a gas-generated engine. There are not many parts in an electric car motor that can wear out, and when they do, they are relatively simple to replace. Regular maintenance will consist of little more than checking the air pressure in the tires and keeping the windshield wiper reservoir topped up. Long term, the car's brake pads and shocks may need replacing, along with tires (Ford, February 9, 2011). For example, one manufacturer, Tesla, recommends a standard service and diagnostic inspection once a year or every 12,000 miles (teslamotors.com). Estimates suggest that maintaining an electric car will cost much less, about one-third the current cost of maintaining a gas-powered car, until the battery begins to wear out (Lampton, n.d).

Even though electric car batteries do not require much day-to-day maintenance, the battery will gradually lose its ability to hold a charge like a laptop or cellphone. The longer the electric car is used, the shorter its driving range will become and this will start happening from as soon as the car is driven. The process will be slow and the battery will not stop working all at once. Most estimates predict that the typical lithium-ion electric car battery will be good for more than 100,000 miles, while still maintaining a decent charge during driving range however, the battery will begin to need to be recharged more often and then may need replaced at the dealership or a battery specialty shop; however, currently, these batteries are very cost-prohibitive and replacement batteries range from

$15,000 to $40,000 (Lampton, n.d). The U.S. Department of Energy has set a goal of bringing down the cost of electric car batteries 70 percent by the year 2014; however, according to the Wall Street Journal many experts don't think this will be possible (Lampton, n.d). Consumers may be able to get some trade-in value for your old battery, since the parts can be reused and people with minimal driving needs may be satisfied to buy a secondhand battery with a reduced range (Lampton, n.d).

HURDLES:

- Protection of persons against electrical hazards.
- One limitation is the range, which would make it impossible to take an electric car on a long vacation, or road trip, where you do nothing but drive all day.
- The cost of buying an electric car is comparatively high and on top of it the batteries need to be replaced after every 3-4 years.
- **Range:** The electric car capacity or range varies from 60km (commercial vehicles) to 395km (tesla roadster) depending on the capacity of motor and the battery pack size.

CHAPTER 6
FUTURE PRESPECTIVES

The world is quickly adopting to electric vehicles and in the next couple of decades, EVs are going to be more mainstream than internal combustion vehicles. More automotive manufacturers are now devoting a rather large chunk of their resources towards the research and development of electric vehicles. This begs a question though! Where does India fit in the overall scheme of electric vehicles globally? The government of India had a plan of converting the entire fleet of vehicles to fully electric by 2030, which is barely 12 years away. But in January, 2018, it was sort of scrapped. If this actually happens, then India will be one of the largest markets for electric vehicles in the world, possibly only behind China.

But a recent report prepared by Bloomberg New Energy Finance has some doubts on India being a big player the EV market. One of the biggest reasons for this is the very low average vehicle prices in India. For example, if we talk globally, people in US, EU would not mind spending around $35,000 on a new car. That figure is about $15,000 for people who buy a new car in China. But India, the average price of a car is less than $10,000. And therefore, people will be looking to buy an electric vehicle only when the prices of EVs will fall in that range.

And therefore, the report by Bloomberg New Energy Finance (BNEF) says that India will have better progress on electric two-wheelers, rickshaws and electric buses over the next 10 years. The report believes that by 2040, EVs will constitute only 40 per cent of the total passenger vehicle fleet in India. At the end of 2017, there were just 6,000 highway capable electric cars plying on Indian roads, which is a minuscule number when compared to the overall numbers of total cars on Indian roads. The BNEF study says that the annual sales of EVs will reach 30,000 units in 2022 as opposed to 2,000 units in 2017. And if the sale of EVs grows as the study has predicted, they will constitute about 6.6 per cent of annual vehicle sales by 2030 and go up to 27 per cent by 2040. Also, by 2040, about 13 per cent of the passenger vehicles plying on Indian roads will be electric by 2040.

- **Future advancements:** The future of battery electric vehicles depends primarily upon the cost and availability of batteries with high specific energy, power density, and long life, as all other aspects such as motors, motor controllers, and chargers are fairly mature and cost-competitive with internal combustion engine components.

- In the future, by 2020 it is predicted that one in 10 cars globally will run on battery power alone. It is estimated that by the year 2020 30% of the cars driving on the road will be battery electric or plug-in hybrid.

- Experimental super capacitors and flywheel energy storage devices offer comparable storage capacity, faster charging, and lower volatility. They have the potential to overtake batteries as the preferred rechargeable storage for EV's.

WHAT THE GOVERNMENT NEEDS TO DO:

The government needs to implement significant subsidy schemes and put up mandates which will encourage car buyers to look at electric vehicles. The next most important thing is to develop a good network charging infrastructure across the country. A good idea will be to involve private players in this as well although that is easier said than done because factors such as unreliable electricity supply, lack of co-ordination between different government levels and lack of demand for EVs keep private players away from investing in charging infrastructure.

CHAPTER 7
MATERIALS AND COST ESTIMATION

Table 2 : Materials and Cost Estimation

S.No.	Materials	Price(In Rupees)
1	Motor (2)	12107
2	Couplings & Controller	1643
3	PVC Pipe	2177
4	Ply with Carpenter Charges	1250
5	Bearing(10)	180
6	Wheel	400
7	Patch, Nut Volt, screw & Blade	697
8	Battery & Liver	1720
9	Charger	1000
10	Hexa frame& Blade	80
11	Wrinch	45
12	Bedding & Wielding	264
13	Door Hinge	700
14	Miscellaneous	800
	TOTAL	**23063**

CHAPTER 8
ADVANTAGES OF AN ELECTRIC CAR

An electric car is a great way for you, as a consumer, to save a lot of money on gas. However, there are so many different reasons why you should invest in an electric car in the modern day of technology.

1. **No Gas Required:** Electric cars are entirely charged by the electricity you provide, meaning you don't need to buy any gas ever again. Driving fuel based cars can burn a hole in your pocket as prices of fuel have gone all time high. With electric cars, this cost can be avoided as an average American spends $2000 – $4000 on gas each year. Though electricity isn't free, an electric car is far cheaper to run.

2. **Savings:** These cars can be fuelled for very cheap prices, and many new cars will offer great incentives for you to get money back from the government for going green. Electric cars can also be a great way to save money in your own life.

3. **No Emissions:** Electric cars are 100 percent eco-friendly as they run on electrically powered engines. It does not emit toxic gases or smoke in the environment as it runs on clean energy source. They are even better than hybrid cars as hybrids running on gas produce emissions. You'll be contributing to a healthy and green climate.

4. Popularity: EV's are growing in popularity. With popularity comes all new types of cars being put on the market that are each unique, providing you with a wealth of choices moving forward.

5. Safe to Drive: Electric cars undergo same fitness and testing procedures test as other fuel powered cars. In case an accident occurs, one can expect airbags to open up and electricity supply to cut from battery. This can prevent you and other passengers in the car from serious injuries.

6. Cost Effective: Earlier, owing an electric car would cost a bomb. But with more technological advancements, both cost and maintenance have gone down. The mass production of batteries and available tax incentives have further brought down the cost, thus, making it much more cost effective.

7. **Low Maintenance:** Electric cars runs on electrically powered engines and hence there is no need to lubricate the engines. Other expensive engine work is a thing of past. Therefore, the maintenance cost of these cars has come down. You don't need to send it to service station often as you do a normal gasoline powered car.

8. Reduced Noise Pollution: Electric cars put curb on noise pollution **as** they are much quieter. Electric motors are capable of providing smooth drive with higher acceleration over longer distances.

Many owners of electric cars have reported positive savings of up to tens of thousands of dollars a year. Considering the demand for oil will only be going up as the supplies run out, an electric car will most likely be the normal mode of transportation in the coming future. Companies like Nissan and Tesla offer great electric models with an outstanding amount of benefits for people who decide to invest. You'll be saving not only yourself, but also your family a huge amount of money. The environmental impact of an electric car is zero, as well – meaning you're reducing your carbon footprint **and** positively affecting the economy.

DISADVANTAGES OF AN ELECTRIC CAR

Although the evidence of the positives has become very clear, there are also some downsides that each individual needs to consider before they decide to make an electric car their next big investment. These reasons are:

1. **Recharge Points:** Electric fueling stations are still in the development stages. Not a lot of places you go to on a daily basis will have electric fueling stations for your vehicle, meaning that if you're on a long trip and run out of a charge, you may be stuck where you are.

2. **Electricity isn't Free:** Electric cars can also be a hassle on your energy bill if you're not considering the options carefully. If you haven't done your research into the electric car you want to purchase, then you may be making an unwise investment. Sometimes electric cars require a huge charge in order to function properly – which may reflect poorly on your electricity bill each month.

3. **Short Driving Range and Speed:** Electric cars are limited by range and speed. Most of these cars have range about 50-100 miles and need to be recharged again. You just can't use them for long journeys as of now, although it is expected to improve in future.

4. **Longer Recharge Time:** While it takes couple of minutes to fuel your gasoline powered car, an electric car take about 4-6 hours to get fully charged. Therefore, you need dedicated power stations as the time taken to recharge them is quite long.

5. **Silence as Disadvantage:** Silence can be a bit disadvantage as people like to hear noise if they are coming from behind them. An electric car is however silent and can lead to accidents in some cases.

6. **Normally 2 Seaters:** Most of the electric cars available today are small and 2 seated only. They are not meant for entire family and a third person can make journey for other two passengers bit uncomfortable.

7. **Battery Replacement:** Depending on the type and usage of battery, batteries of almost all electric cars are required to be changed every 3-10 years.

8. **Not Suitable for Cities Facing Shortage of Power:** As electric cars need power to charge up, cities already facing acute power shortage are not suitable for electric cars. The consumption of more power would hamper their daily power needs.

9. Some governments do not provide money saving initiatives in order to encourage you to buy an electric car.

10. Some base models of electric cars are still very expensive because of how new they are and the technology it took to develop them.

Just because there is a variety of factors doesn't mean they have to be overwhelming. Doing a fair bit of **research** into different models, and maybe even hybrids, will help you make an accurate decision moving forward. However, no matter how you look at it, an electric car can save our precious environment.

CHALLENGES FACED BY ELECTRIC CAR INDUSTRY:

The electric car industry is poised to launch a number of new products over the next two years -- everything from compact cars, like the Mitsubishi i-MiEV, to work vans, like the Ford Transit Connect Electric. But, the success of electric cars is far from assured. The electric car industry, like any new industry, is facing a number of challenges. Unfortunately, those challenges are tangled in a giant ball -- a ball that'll be tough to unravel.

The major challenge is costs. Battery technology is expensive, and because batteries in electric cars need to be able to hold massive amounts of charge to make the cars practical for most drivers, they have to be built using expensive materials, most of which are tough to procure. Because electric cars cost a lot to build, they also cost more than comparable gasoline cars to buy. That makes consumers reluctant to adopt them. It's a free-range-chicken-and-organic-egg problem. Electric cars could be less expensive if electric car makers could ramp up production volume and use economies of scale. But, for that to happen, lots of consumers need to buy electric cars -- something that likely won't happen without prices coming down.

Beyond the costs, electric car makers have a lot of convincing to do with consumers. Not everyone is sold on the idea that electric cars make sense for their life. That's because of range anxiety. Electric car makers are finding that people are worried about how far they can travel in electric cars before their batteries peter out. In a gasoline-powered car, running low on gas is really no big deal; just pull into a gas station, fill up and in about five minutes you're back on the road. Charging and electric car isn't quite so simple. Most production electric cars about to hit the market can only go about 100 miles (160.9 kilometers) on a single charge. And, unless you have access to a specialized charging station (which are currently in short supply), getting a full charge takes around eight hours. While most people drive less than 40 miles (64.4 kilometers) a day and could easily charge their electric cars overnight, electric cars still aren't useful for road trips. And, let's say you drive 80 miles (128.7 kilometers) in a day, come home and find out that there's an unexpected emergency and you need to drive another 30 miles (48.3 kilometers)? Consumers thinking of situations like that make for a big hurdle that electric cars still have to clear.

Those charging stations are another challenge -- they can alleviate a number of concerns consumers have about electric cars. Electric cars represent a vast change to the country's infrastructure. While some charging stations are out in trial phases (Best Buy is trying some out at their stores so consumers can recharge while they shop), most charging still needs to be at home, in a garage. That means that people who live in shared housing or use street parking will likely have the hardest time charging. Of course, if infrastructure was improved and more charging stations were available, more people would buy electric cars. But, of course, changes to infrastructure won't be made until more people buy electric cars and call for it. See? It's the chicken-and-the-egg thing again.

A growing number of manufacturers, consumers, government agencies, investors and urban developers believe that the electric vehicles (EVs) can have better outcomes for the industry and environment. Cleaner, safer and simpler electric vehicles now span categories ranging from two-wheelers and rickshaws to cars and mining vehicles, as well as fleets of buses.

The ‘glue’ connecting the mix includes startups in IoT (Internet of Things) and solar energy as well as mobile operators and blockchain players. It will not be individual corporate players who win the game, but whole ecosystems of partners and competitors coming together to define standards and roll out electric charging infrastructure.

CONCLUSION:

Clearly, there is no one solution to the world's potential energy problems. By using hybrid-electric technology, we are better able to use our available resources over longer distances and longer periods of time. While this technology has shown advancements such as the development of more sophisticated batteries, our research has shown that this technology is really just beginning to explode in terms of development and research.

As Hybrid-Electric vehicles become more popular, the advances on its technology has become further and further towards an even more environmentally-safe, efficient, and affordable alternative transportation source.

The development of batteries that do not deteriorate or damage the environment is progressing towards a battery that can run a vehicle for longer periods of time but also won't weigh the vehicle down.
The prices of these vehicles is also being taken as a factor to develop more economic-friendly vehicles that more people can afford to drive.

It is amazing to see just how much one person can do by switching from a gas-guzzling SUV to a smaller, more practical Hybrid-Electric Vehicle. In most cases today, there is simply no need for most of the large cars that are on the road. By using hybrid-electric technology, we are able to capture heat (transformed into energy) created by normal acceleration and braking in energy to be used in our cars.

With these changes in the way cars are manufactured and run, we are a step closer to developing an alternative source of transportation that can cut back on oil use and lessen the effects of car emissions on the earth's atmosphere.

While hybrid technology is certainly not the answer to the world’s energy problems, it is a step in the right direction. One of the easiest ways we can reduce the amount of energy we use is by conservation, and that is exactly the goal the creators of hybrid-electric vehicles have in common. Combined with the incentives of a cleaner running vehicle, tax incentives, and HOV lane privileges, it is no wonder why hybrid are flying off the lots nearly as fast as they are being produced.

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