A PRACTICE SCHOOL PROGRAM

REPORT ON
INDUSEC-INDIAN DUAL SEAT ELECTRIC CAR

BACHELOR OF TECHNOLOGY
IN
MECHANICAL ENGINEERING

BY

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At

Rushikonda
Visakhapatnam
A PRACTICE SCHOOL PROGRAM

REPORT ON
INDUSEC-INDIAN DUAL SEAT ELECTRIC CAR

A report submitted in partial fulfillment of
the requirements of
The B.Tech Program in Mechanical Engineering
KL University

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Project work: Society deserves it.

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<td>Dialogue: We will help you, you yourself can do an electric car.</td>
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<td>Dialogue: There is enormous potential in electric cars. The short distances make them ideal.</td>
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<td>Dialogue: Begin by doing the research to make sure that an electric car is right for us.</td>
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<td>Dialogue: There is more to life than increasing its speed.</td>
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<td>Dialogue: Slowly but surely, the image of electric car is changing.</td>
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ABBREVIATIONS

A/C: Alternating current
Amp: Amperes
BEV: Battery electric vehicle
BS-IV: Bharat stage IV
CB: Circuit breaker
CNG: Compressed natural gas
CR: Compression ratio
D/C: Direct current
DME: Di methyl ether
EMI: Electromagnetic interference
ETC: Electric throttle potentiometer
EV: Electric vehicle
E-85: Ethanol 85
HEV: Hybrid electric vehicle
hp: Horse power
ICE: Internal combustion engine
Indusec: Indian dual seat electric car
LPG: Liquefied petroleum gas
MDI: Motor development international
PV cell: Photo voltaic cell
RFI: Radio frequency interference
TPS: Throttle position sensor
VPC: Volts per cell
WOT: Wide open throttle
ZEV: Zero emission vehicle
EXECUTIVE SUMMARY

Electric Cars now Is a collective venture, which will make electric cars affordable to everybody. The project’s key to success is to gain a critical mass of consumers who desire an electric car.

The project aims at bringing out the concept and model of INDUSEC, an electric car that aims at cornering the environmental issues and making the common man’s dream of buying a car with high end technologies come true.

Also electric Cars can now materialize its car by updating new and slightly used ICE cars into Zero Emission Vehicles (ZEV). The pollutant gasoline engine is being dismantled, as well as all parts connected to the engine, such as exhaust, tank etc. Then the car will be fitted with pinnacle electric technology of the present day. The assembly consists of a high quality DC / AC motor, lead acid / lithium ion batteries, and a controller, controlling the system.

Detailed information of the parts required for the conversion process and also to build up a new vehicle, each of its function, range and specifications with availability has been gathered so that it could help to easily start up your conversion process at your own garage with enough technical data.

We have also built up a model of the INDUSEC, the Indian dual seat electric car which will soon be introduced into the market.
OVERVIEW OF THE COMPANY

Organizational Structure:
Symbiosys Technologies was founded in 2001, is a 100% Export Orient Unit, registered in the Visakhapatnam Special Economic Zone (VSEZ). They provide high quality services and solutions to global clientele worldwide. The development center for Symbiosys technologies is located in INDIA with offices in the US. The company aims at developing innovative and cost effective end to end technology solutions with high performance and security.
Symbiosys technologies is a proprietary owned partnership company and has always been committed to delivering excellent results by providing highest quality of offshore development services on various platforms.
The proficient workforce at Symbiosys comprises a group of highly trained engineers, IT specialists & technicians who have developed a niche market and an appreciation for mastering solutions to complex engineering problems and software solutions. They encourage growth and development within the organization.
Symbiosys technologies provide custom services and have varied platform. It aims at customer satisfaction providing life to young engineers from various platforms. It provides engineering and software solutions across various market segments. Symbiosys is also enriched in animation and multimedia, aims at entertaining the world with their creative team. It ensures quality and brings out efficiency and efficacy of the task/project assigned. Every department has trained and creative teams, lead by efficient project heads and managers.
Products:

Like as in any manufacturing company, Symbiosys doesn’t manufacture products rather it is a service oriented company. They provide solution to a client’s problem by the process of linking different applications. They work on these projects using various tools available in the market and come up with an out-standing solution. Their services are aimed at simplifying the process of creating custom e-Applications. Solutions provided by this organization provide a market edge for customers with accelerated development and reduced costs. The animation department out here at Symbiosys says-“we provide it all you need”. Symbiosis under engineering services provide highest levels of assurance to quality, process orientation, proven methodology and innate ability to establish engineering teams. They provide services to all platforms-software development, engineering, web designing and graphics, animation & VFX, and provide you quality assurance.
**Technology:**

Symbiosys technologies are an expertise in various technologies to provide solutions. All the departments in Symbiosys are equipped with advanced technologies and they are detailed below:

**IT/ITES:**

<table>
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<tr>
<th>Operating systems</th>
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<tr>
<td>Databases</td>
<td>Oracle, MS SQL SERVER, MYSQL, MS Access</td>
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<td>Mark up languages</td>
<td>HTML, DHTML, XML</td>
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<td>Middle ware</td>
<td>J2EE, .NET</td>
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<tr>
<td>Application development</td>
<td>C, C++, Java, VB, VB.NET, C#</td>
</tr>
<tr>
<td>Web technologies</td>
<td>CGI-Perl, ASP, ASP.NET, PHP, SERVLETS, JSP, Cold fusion</td>
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<tr>
<td>Scripting languages</td>
<td>Perl, Python, JavaScript, VBScript</td>
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<tr>
<td>Distributed technologies</td>
<td>COM+, COM/DCOM, CORBA, EJB</td>
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**Animation & VFX:**

- Storyboards, Concept art, Backgrounds
- 2D Animation
- 3D Animation
- Rotoscopy & Colour correction
- 2D to 3D Stereoscopic conversion

**GRAPHICS & WEB DESIGNING:**

- Multimedia tools – Macromedia studio, Adobe suite, 3DS Max, Corel draw studio
ENGINEERING:

- AutoCAD
- PDS 2D & 3D
- PDMS
- SMART PLANT 3D
- SMART PLANT P & ID
- TEKLA STRUCTURES (X STEEL)
- FARO CLOUD
- CYCLONE
- RHINO
- 3D LASER SCANNING

QUALITY ASSURANCE:

- Apache Jmeter
- Mercury tools – Win runner, Load runner, Test director
- Seague software – Silk test, Silk performer, Silk monitor

PROCESSES:

The process involved with the various departments differs and the project could be a team or individual work. In the software development, a project is assigned to a team and after they do it, it is sent for testing, this is the process involved.

In engineering services, projects are assigned to them and they are finally inspected by the team head and then it proceeds. So, this process takes place in the rest departments.
Objectives

- The main objective of the project is to bring out the design and concept of a dual seat electric car.
- Aim is to produce a car at low cost.
- Looking into the environmental issues, we and our upcoming generation should be a part in using zero emission vehicles.
- Help the government in reducing traffic density by opting for small dual seated cars like our INDUSEC.
- To help the public save on the maintenance costs compared to the conventional vehicles.
- With a clean and better moving, Indusec aims to have the lowest dust to dirt carbon foot prints in the automotive world.
- To make every common person reach his dream of buying a car.
- Leave a mark in the upcoming automotive industry with our INDUSEC by competing the future of electric cars.
- INDUSEC is going to be India’s first dual seat electric car.
- Finally, this report should help one to build their own electric car.
HISTORY OF AUTOMOBILES

In terms of the lives of average people, there is little doubt that the automobile is the most revolutionary invention in the history of transportation since the wheel. The basic premise of the automobile is simple; choose a wheeled vehicle from the many types typically pulled by horses or oxen, add a motor and create a self-propelled, personal transportation vehicle. The earliest ancestor of the modern automobile is probably the Fardier, a three-wheeled, steam-powered, 2.3-mph vehicle built in 1771 by Nicolas Joseph Cugnot for the French minister of war. This cumbersome machine was never put into production because it was much slower and harder to operate than a horse-drawn vehicle.

The drag coefficient is a common metric in automotive design pertaining to aerodynamic effects. As aerodynamic drag increases as the square of speed, a low value is preferable to a high one. As about 60% of the power required to cruise at highway speeds is used to overcome aerodynamic effects, minimizing drag translates directly into improved fuel efficiency.

Drag coefficient varies from one vehicle to another vehicle. Reducing drag is also a factor in sports car design, where fuel efficiency is less of a factor, but where low drag helps a car achieve a high top speed. However, there are other important aspects of aerodynamics that affect cars designed for high speed, such as racing cars.

The compression ratio of an internal-combustion engine or external combustion engine is a value that represents the ratio of the volume of its combustion chamber from its largest capacity to its smallest capacity. It is a fundamental specification for many common combustion engines. A high compression ratio is desirable because it allows an engine to extract more mechanical energy from a given mass of air-fuel mixture due to its higher thermal efficiency.
This occurs because internal combustion engines are heat engines, and higher efficiency is created because higher compression ratios permit the same combustion temperature to be reached with less fuel, while giving a longer expansion cycle, creating more mechanical power output and lowering the exhaust temperature. Higher compression ratios will however make gasoline engines subject to engine knocking if lower octane-rated fuel is used, also known as detonation. This can reduce efficiency or damage the engine if knock sensors are not present to retard the timing.

In an auto-ignition diesel engine, there is no electrical sparking plug; the heat of compression raises the temperature of the mixture to its auto-ignition point. The CR will customarily exceed 14:1 and ratios over 22:1 are common.

In engines running exclusively on LPG or CNG, the CR may be higher, due to the higher octane rating of these fuels.

Motorcycle racing engines can use compression ratios as high as 14:1, and it is not uncommon to find motorcycles with compression ratios above 12.0:1 designed for 86 or 87 octane fuel. F1 engines come closer to 17:1 (which is very critical for maximizing volumetric/fuel efficiency at around 18000 rpm)

In a turbocharged or supercharged gasoline engine, the CR is customarily built at 10.5:1 or lower. This is due to the turbocharger/supercharger already having compressed the fuel/air mixture considerably before it enters the cylinders.
Depending on the country where they were built, cars are right-hand drive or left-hand drive. This refers to the location of the steering wheel and is related to which side of the road you drive the car. The terms right-hand traffic and left-hand traffic refer to regulations requiring all bidirectional traffic to keep either to the right or the left side of the road, respectively. This is so fundamental to traffic flow that it is sometimes referred to as the rule of the road. This basic rule eases traffic flow and reduces the risk of head-on collisions. Today about 66.1% of the world's people live in right-hand traffic countries and 33.9% in left-hand traffic countries. About 72% of the world's total road distance carries traffic on the right, and 28% on the left.

**Right**

- A right-hand drive car's steering wheel is on the right side of the car. This means you have to shift gears with your left hand. You drive these cars on the left side of the road.

**Left**

- A left-hand drive car's steering wheel is on the left side of the car. To shift gears, you use your right hand. These cars are made for driving on the right side of the road.
Alternative fuels

An alternative fuel vehicle is a vehicle that runs on a fuel other than "traditional" petroleum fuels (petrol or diesel); and also refers to any technology of powering an engine that does not involve solely petroleum (e.g. electric car, hybrid electric vehicles, solar powered). Because of a combination of factors, such as environmental concerns, high oil prices and the potential for peak oil, development of cleaner alternative fuels and advanced power systems for vehicles has become a high priority for many governments and vehicle manufacturers around the world.

List of alternative fuels:

- Air engine
- Battery-Electric
- Solar
- Di methyl ether fuel
- Ammonia fuelled vehicles
- Bio fuels(bio diesel, E-85, biogas, ethanol)
- Compressed natural gas(CNG)
- Hydrogen
- Auto gas (LPG)
- Liquid nitrogen gas
- Steam
- Wood gas
- Flexible fuel(methanol, p-series)
- Hybrid fuel
- Nuclear fuel(plutonium-238)
Air car:

- **Invention:** The pneumatic motor or compressed air engine was first applied to the field of transportation in the mid-19th century. The air engine is an emission-free piston engine that uses compressed air as a source of energy. The first compressed air car was invented by a French engineer named Guy Nègre.

- **Function:** The expansion of compressed air may be used to drive the pistons in a modified piston engine. Compressed air cars are powered by motors driven by compressed air, which is stored in a tank at high pressure such as 30 MPa (4500 psi or 310 bar).

- The only exhaust is cold air (−15 °C), which could also be used to air condition the car. The source for air is a pressurized carbon-fiber tank.

- **Hurdles:** When air expands, as it would in the engine, it cools dramatically (Charles's law) and must be heated to ambient temperature using a heat exchanger similar to the Intercooler used for internal combustion engines. The heat exchanger can be problematic.

- Refueling the compressed-air container using a home or low-end conventional air compressor may take as long as 4 hours, while the specialized equipment at service stations may fill the tanks in only 3 minutes.

- **Range:** MDI has recently claimed that an air car will be able to travel 140 km (87 mi) in urban driving, and have a range of 80 km (50 mi) with a top speed of 110 km/h (68 mph) on highways, when operating on compressed air alone.
• **Future advancements:** It may be possible to store compressed air at lower pressure using an absorption material within the tank.

• Absorption materials such as Activated carbon, or a metal organic framework is used to store gas at 500 psi instead of 4500 psi, which amounts to a large energy saving.

![Fig: 1.1 Air car](image1)

![Fig: 1.2 Principle Diagram](image2)

• **Technology used in air car:** Compressed engine expands in the engine four cylinders pushing down the piston without any combustion. To refuel driver plugs car into mains and electric motor pumps air into the tanks. They can also be filled by compressed air pump.

![Fig: 1.3 Technology in air car](image3)
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.

![Block Diagram](image1)

Fig 1.4: Block Diagram

![Electric car](image2)

Fig 1.5: Electric car
**Technology used**: All-electric cars, electric vehicles (EV) or battery electric vehicles (BEV) are all names 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.
• **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.

• **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.
Solar car:

- **Invention:** The first solar car invented came into existence in 1995. This solar car was made up of 12 selenium photovoltaic cells and a small Pooley electric motor turning a pulley which in turn rotated the rear wheel shaft.

- **Function:** A solar vehicle is an electric vehicle powered completely or significantly by direct solar energy. Usually, photovoltaic (PV) cells contained in solar panels convert the sun's energy directly into electric energy.

![Fig 1.8: solar car](image)

![Fig 1.9: Principle Diagram](image)
Technology used:

![Fig 1.10: Technology](image)

- Solar cars are powered by photovoltaic cells, a.k.a. solar cells, a.k.a. PV cells. These cells are built from semiconducting material such as silicon. Silicon reacts with sunlight by releasing electrons. The motion of the electrons creates an electrical current. This is the "photovoltaic effect."
- Sounds great, especially if you live in a sunny climate. But as you might guess, PV cells are not very efficient. The semiconducting material does not absorb a high percentage of solar radiation (much is reflected or passed through) and 20% is a high number for solar cell efficiency. This is why most of the solar cars that you see in competitions or at auto shows look like their primary function is to maximize surface area for solar cell placement.
- **Hurdles:** Even the best solar cells can only collect limited power and energy over the area of a car's surface. This limits solar cars to a single seat, with no cargo capacity, and ultra light composite bodies to save weight. Solar cars lack the safety and convenience features of conventional vehicles.
• Even though sunlight has no lifespan, Photo voltaic (PV) cells do. While sunlight is free, the creation of PV cells to capture that sunlight is expensive.

• Solar panels cannot currently be used to directly supply a car with a suitable amount of power at this time. As an alternative, a battery-powered electric vehicle may use a solar array to recharge; the array may be connected to the general electrical distribution grid.

• **Future advancements:** Exciting technology is happening right now with zinc that may just replace platinum in fuel cells and lithium in batteries. Future solar cars will have downsized solar panels as well as downsized storage devices plus plenty of legroom.

• Researchers are working to find a way to increase the open space available for a larger number of photovoltaic panels. As more advances are made in the research field and technology increases to advance as well, vehicles could be completely solar powered, or solar hybridized in the near future.

**Di methyl ether fuel car:**

• Di methyl ether (DME) is a promising fuel in diesel engines, petrol engines (30% DME / 70% LPG), owing to its high cetane number, which is 55, compared to diesel's, which is 40–53.

• Only moderate modifications are needed to convert a diesel engine to burn DME. The simplicity of this short carbon chain compound leads during combustion to very low emissions of particulate matter, NOx, CO. For these reasons as well as being sulfur-free, DME is preferred as an alternative fuel.
Future advancements: DME is being developed as a synthetic second generation bio fuel (Bio DME), which can be manufactured from lingo cellulosic biomass.

Ammonia fuelled vehicles:

Invention: Ammonia (NH3) can run in spark ignited or diesel engines with minor modifications. It can be made from renewable electricity, and having half the density of petrol or diesel, it can be readily carried in sufficient quantities in vehicles. On combustion it has no emissions other than nitrogen and water vapour.
**Function:** NH\textsubscript{3} CAR has two fuel tanks one for gasoline and the other for ammonia. Ammonia is a much less active fuel. It doesn't combust easily on its own. But, with a small amount of combustion enhancer (gasoline, diesel or pure hydrogen) mixed in, it burns and releases enough energy to drive the engine.
• **Technology:** The technology that makes the NH3 Car possible is the control system that manages the perfect mixture of fuel for the amount of work the engine is doing (the load). At start and idle, the engine requires the flammable properties of gasoline, but as the vehicle accelerates (increasing the load) the fuel mixture transitions to predominately ammonia.

• **Hurdles:** The main problems that are limiting the use of ammonia as transportation fuel are the size and the operating conditions of the onboard ammonia cracker unit (i.e. the reactor).

  - The size and operating conditions of the ammonia reactor are too large and too rigorous to be used onboard a vehicle. In addition, the reactors need high active catalyst to produce the required flow rates for high levels of performance and to have "cold-start" ignition.

• **Future advancements:** Another area that has room for improvement is with the polymer electrolyte membranes (PEM). The decomposition reactor and the purifier would need to either produce ammonia-free hydrogen to the cell or close to ammonia-free hydrogen with even lower trace amounts of ammonia.

• Therefore, the top research priorities for ammonia right now involve the onboard crackers, resolving the purification issues. The development of high efficiency catalysts, crackers, and reactors and also designing failsafe ammonia reactors and tanks.
Bio alcohol and ethanol:

Fig: 1.15 Bioalcohol cars

- **Invention:** The first commercial vehicle that used ethanol as a fuel was the Ford Model T, produced from 1908 through 1927.

- **Technology:** It was fitted with a carburettor with adjustable jetting, allowing use of gasoline or ethanol, or a combination of both.

- Both ethanol and methanol have been used as an automotive fuel. Both can be obtained from petroleum or natural gas, ethanol also is easily obtained from sugar or starch in crops and other agricultural produce such as grain, sugarcane, sugar beets or even lactose.

- **Capacity:** Most modern cars are designed to run on gasoline are capable of running with a blend from 10% up to 15% ethanol mixed into gasoline (E10-E15). With a small amount of redesign, gasoline-powered vehicles can run on ethanol concentrations as high as 85% called E 85. Ethanol has a higher octane rating which is beneficial to high compression ratio engines.
• **Range:** Ethanol has close to 34% less energy per volume than gasoline, consequently fuel economy ratings with ethanol blends are significantly lower than with pure gasoline, so burning pure ethanol in a vehicle will result in a 34% reduction in miles.

• **Hurdles:** There are various social, economic, environmental and technical issues with bio fuel production and use. These include: the effect of moderating oil prices, the "food vs. fuel" debate, poverty reduction potential, carbon emissions levels, sustainable bio fuel production, deforestation and soil erosion, loss of biodiversity, impact on water resources, as well as energy balance and efficiency.

• Alcohol-based fuels are not compatible with some fuel system components.

• Alcohol fuels may cause erroneous gas gauge readings in vehicles with capacitance fuel level gauging.

• **Future advancements:** Discovery of a *Clostridium*-genus bacteria, which they codenamed "TU-103", that can convert nearly any form of cellulose into butanol, and is the only yet-discovered strain of *Clostridium*-genus bacteria that can do so in the presence of oxygen.
BIODIESEL CAR:

- Biodiesel (Fatty acid methyl ester), is commercially available in most oilseed-producing states.
- Biodiesel has lower Energy Density than fossil diesel fuel, so biodiesel vehicles are not quite able to keep up with the fuel economy of a fossil fuelled diesel vehicle, if the diesel injection system is not reset for the new fuel. If the injection timing is changed to take account of the higher Cetane value of biodiesel, the difference in economy is negligible.
Compressed natural gas:

Fig 1.17: CNG Car

Fig 1.18: Principle diagram

- **Technology:** Gasoline cars can be retrofitted to CNG and become bio fuel. Natural gas vehicles (NGVs) as the gasoline tank is kept. The driver can switch between CNG and gasoline during operation.

- **Invention:** In the year of 1993, CNG had become available in Delhi.

- There is no much difference in the fuel economy.

- A natural gas vehicle or NGV is an alternative fuel vehicle that uses compressed natural gas (CNG) or liquefied natural gas (LNG) as a cleaner alternative to other fossil fuels and gasoline or diesel.
- **Hurdles:** Refuelling stations are also much more expensive to operate than CNG because of the energy required for compression.
- Compressed natural gas vehicles require a greater amount of space for fuel storage than conventional gasoline powered vehicles

**Hydrogen fuel cars:**

- A hydrogen vehicle is a vehicle that uses hydrogen as its onboard fuel for motive power. Hydrogen fuel does not occur naturally on Earth and thus is not an energy source, but is an energy carrier. Currently it is most frequently made from methane or other fossil fuels.

![Fig 1.18: Hydrogen car](image1)

![Fig 1.19: Principle Diagram](image2)
• **Technology:** However, the most efficient use of hydrogen involves the use of fuel cells and electric motors instead of a traditional engine. Hydrogen reacts with oxygen inside the fuel cells, which produces electricity to power the motors.

![System concept for hydrogen car with combustion engine](image)

Fig 1.20: Technology used

• **Hurdles:** The drawbacks of hydrogen use are low energy content per unit volume, high tankage weights, very high storage vessel pressures, the storage, transportation and filling of gaseous or liquid hydrogen in vehicles, the large investment in infrastructure that would be required to fuel vehicles, and the inefficiency of production processes.

• **Future advancements:** One primary area of research is hydrogen storage, to try to increase the range of hydrogen vehicles while reducing the weight, energy consumption, and complexity of the storage systems.

• The Wankel uses a rotary principle of operation, so the hydrogen burns in a different part of the engine from the intake. This reduces pre-detonation, a problem with hydrogen fueled piston engines.

• The attraction of using hydrogen as an energy currency is that, if hydrogen is prepared without using fossil fuel inputs, vehicle propulsion would not contribute to carbon dioxide emissions.
Auto gas (LPG):

Fig 1.21: Auto gas car

![Image of an auto gas car](image)

Fig 1.22: Principle Diagram

![Principle Diagram of a bi-fuel system (LPG)](image)

- **Technology**: LPG or liquefied petroleum gas is a low pressure liquefied gas mixture composed mainly of propane and butane which burns in conventional gasoline combustion engines with less CO$_2$ than gasoline. Gasoline cars can be retrofitted to LPG and become bio fuel vehicles as the gasoline tank stays. You can switch between LPG and gasoline during operation.
Fig 1.23: Technology used

- **Function:** A converter-mixer system uses a converter to change liquid fuel from the tank into vapour, and then feeds that vapour to the mixer where it is mixed with the intake air. This is also known as a venturi system or "single point" system.

- Vapour phase injection systems also use a converter, but unlike the mixer system, the gas exits the converter at a regulated pressure. The gas is then injected into the air intake manifold via a series of electrically controlled injectors. The injector opening times are controlled by the auto gas control unit.

- Liquid phase injection systems do not use a converter, but instead deliver the liquid fuel into a fuel rail in much the same manner as a petrol injection system.

- **Hurdles:** This is not used in diesel vehicles.
Liquid nitrogen gas:

![Image of LNG vehicle](image1)

**Fig 1.24: LNG**

![Principle diagram of liquid nitrogen technology](image2)

**Fig 1.25: Principle diagram**

- **Technology:** A liquid nitrogen vehicle is powered by liquid nitrogen, which is stored in a tank. The engine works by heating the liquid nitrogen in a heat exchanger, extracting heat from the ambient air and using the resulting pressurized gas to operate a piston or rotary engine. Vehicles propelled by liquid nitrogen have been demonstrated, but are not used commercially.

![Diagram of liquid nitrogen technology](image3)

**Fig 1.25: Technology**
• **Hurdles:** The principal disadvantage is the inefficient use of primary energy. Energy is used to liquefy nitrogen, which in turn provides the energy to run the motor. Any conversion of energy has losses. For liquid nitrogen cars, electrical energy is lost during the liquefaction process of nitrogen.

• Liquid nitrogen is not available in public refueling stations nor is there a distribution system in place.

• **Capacity:** The maximum amount of energy that can be extracted from 1 kg of LN2 is 213 W-hr or 173 W-hr per liter, in which a maximum of 70 W-hr can be utilized with an isothermal expansion process.

• **Future advancements:** Theoretical future engines, using cascading topping cycles, can improve this to around 110 W-hr/kg with a quasi-isothermal expansion process.

**Steam car:**

• **Function:** The fuel is burned in a boiler and the heat converts water into steam. When the water turns to steam, it expands. The expansion creates pressure. The pressure pushes the pistons back and forth. This turns the driveshaft to spin the wheels forward.

---

Fig 1.27: Steam car  
Fig 1.28: Principle Diagram
- **Technology**: A steam car is a car that has a steam engine. Wood, coal, ethanol, or others can be used as fuel. A steam engine is an external combustion engine.

![How Steam Engines Work](image)

**Fig 1.29: Technology**

- The absence of a gearbox is more than counterbalanced by the weight of cooling and forced draft fans, fans, and boiler feed, fuel feed, and air pumps; the battery and fan to feed even a flash boiler will more than overcome the weight of a gearbox, and need to run even at idle.

- Furthermore, the radiator must be larger, since all heat engines depend on the temperature differences in the working fluid; in steam cars, this heat exchange must be larger and more rapid, and so must the radiator.

- Steam cars are ridiculously expensive.
Wood gas car:

- **Technology:** Wood gas can be used to power cars with ordinary internal combustion engines if a wood gasifier is attached.

- Wood gasifiers can power either spark ignition engines, where 100% of the normal petrol can be replaced with little change to the carburetion, or in a diesel engine, feeding the gas into the air inlet that is modified to have a throttle valve.

![Fig 1.30: Wood gas car](image)

![Fig 1.31: Technology](image)
- **Capacity:** Efficiency of the gasifier system is relatively high. The gasification stage converts about 75% of fuel energy content into a combustible gas that can be used as a fuel for internal combustion engines.

- The "fuel tank" can contain 30 kilograms (66 pounds) of wood, good for a range of 100 kilometers.

- **Hurdles:** The mobile gas factory takes up a lot of space and can easily weigh a few hundred kilograms - empty. The size of the equipment is due to the fact that wood gas has low energy content.

- Furthermore, the use of wood gas limits the output of the combustion engine, which means that the speed and acceleration of the converted car are cut.

- Indeed, the wood mobile caused severe deforestation in France during the Second World War (source). Just as with many other bio fuels, the technology is not scalable.

**Hybrid fuel vehicle:**

![Fig 1.32: Hybrid fuel car](image-url)
Invention: In the late 19th and very early 20th centuries, back when the idea that cars must run on gasoline wasn't yet set in stone, inventors tinkered with a number of ways in which automobiles could be powered including electricity, fossil fuels, steam and combinations of these things. The history of hybrid electric vehicles, however, began shortly after the dawn of the 20th century.

Technology: A hybrid vehicle is a vehicle that uses two or more distinct power sources to move the vehicle. The term most commonly refers to hybrid electric vehicles (HEVs), which combine an internal combustion engine and one or more electric motors.
• **Hurdles:** Regular maintenance not covered by warranties is going to be more expensive, given that two engines - gas-powered and electric-powered need to be serviced. For those who typically perform their own maintenance, it's not recommended for hybrids. The batteries hold high voltage, and for the untrained, risk of electrocution.

• Accidents are a distinct hazard when it comes to hybrid electrical systems. The high-voltage batteries are attached to wires that could become exposed during a collision. Severed wires can ignite leaking gasoline or severely harm accident victims.

**Nuclear fuel vehicle:**

![Fig 1.35: Nuclear fuel vehicle](image)
Technology: The particular kind of fuel inside Curiosity is called plutonium-238. It’s extremely radioactive, so it gives off plenty of heat, but the type of radioactive particles released by plutonium-238 can’t even penetrate a sheet of paper. As long as you don’t touch it or swallow it, plutonium-238 is safe, and with a half-life of 87.7 years, it decays slowly enough that a fairly small supply can power a spacecraft for a decade or more.

Plutonium-238 is really a byproduct of the process for making another kind of plutonium, known as isotope 239.
**Function:** Radioisotope power systems (RPSs) are generators that produce electricity from the natural decay of plutonium-238, which is a non-fissile isotope of plutonium. Heat given off by the natural decay of this isotope is converted into electricity by thermocouples, providing constant power during all seasons and through the day and night.

**Hurdles:** Problem with nuclear fuel is cost.

- Aging and degradation of system structures and components, such as reactor core internals, reactor pressure vessels, concrete, buried pipes, and cables.
- Fuel reliability and performance issues.
- Obsolete analog instrumentation and control technologies.
- Advanced Modeling and Simulation Tools.

**Future advancements:** Improve the efficiency of the current fleet while maintaining excellent safety performance is one of the primary objectives of life extension.

- Assist industry to improve light water reactors using existing technologies and designs
- Research and develop small modular reactors that have the potential to achieve lower proliferation risks and more simplified construction than other designs.
Why choose an electric vehicle?

- You can breathe easy beside an EV - no emissions!
- Fuelling at home requires but seconds to plug in for overnight charging followed by a few extra moments in the morning. Some find this to be more convenient than driving to obtain gasoline whose availability and cost is less predictable.
- Greatly reduced greenhouse gas emissions if charged from coal-fired electrical generation--(None if charged by Wind Power, Hydro Power, or Solar PV).
- No engine or exhaust noise--quieter streets and neighbourhoods.
- Breaks the dependence on oil, foreign or otherwise.
- Auto maintenance is far simpler, less expensive.
- 80% of daily commutes in North America would be easily handled by current battery technology.
- Announced upcoming new battery technologies extend the range to distances nearly equal to a current tank of gas, and charge nearly as fast as filling with gas.
- North America already has sufficient night-time (off-peak) electrical capacity to charge millions of cars.
- A gallon of Gasoline uses about 8 kWh just to refine. This same amount of Electric Energy can power an Electric Vehicle from 16-32 miles. This does not count the power to store, ship, transport, secure, discover, or protect, or the overhead of the overall risks associated with Oil.
Awareness of technology over the internet:

A lot of information is available over the internet about the conversion process and you can browse through a lot of videos over the YouTube with the conversion process explained clearly. Also we have electric car forums where everything is discussed and queries can be posted. You find many electric car associations over the internet where you get lot of information about electric cars and the parts.

Conversion parts availability:

All the parts required for the conversion process or even for building a new car are easily available. You find many car companies providing the complete conversion kit and also you can find these parts at many places only if you are clear with range, capability and required specifications. But what I prefer is that instead putting large amounts on the conversion kits search for the parts yourself so you can save a lot of money.

Building parts at home:

In building an EV instead buying all the parts you can fabricate them on your own at home which reduces your conversion cost. Only thing you should be aware of for making them is basic automotive operations, specifications, proper guidance.
Conversion at your own garage

It is very easy to convert a car from gasoline to electric at your own garage, all you need is this:

- A builder should be able to identify problems in a potential conversion vehicle.
- A builder should be able to fabricate small brackets for mounting sensors, switches, and relays. This can be done using simple hand tools - a small vice, hacksaw, shears, hammer, pliers, and various drills and files.
- You need to be clear with the basic automotive and electrical concepts.
- Also welding is required for making battery boxes.
## Complexity of parts required for conversion process

Table: High/complex, Medium, Easy

<table>
<thead>
<tr>
<th>Factor</th>
<th>COST</th>
<th>TECHNOLOGY</th>
<th>AVAILABILITY</th>
<th>RANGE OF OPERATION</th>
<th>WEIGHT</th>
<th>Volume</th>
</tr>
</thead>
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<td>D/C</td>
<td>A/C</td>
<td>D/C</td>
<td>A/C</td>
<td>D/C</td>
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<td>Easy</td>
<td>High</td>
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<td>high</td>
<td>high</td>
<td>High</td>
<td>Easy</td>
<td>Easy</td>
</tr>
<tr>
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<td>Medium</td>
<td>Medium</td>
<td>complex</td>
<td>Complex</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
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<td>Low</td>
<td>medium</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Circuit breaker</td>
<td>Low</td>
<td>Low</td>
<td>medium</td>
<td>Medium</td>
<td>Easy</td>
<td>Easy</td>
</tr>
<tr>
<td>Main contactor</td>
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<td>medium</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Ammeter</td>
<td>Low</td>
<td>Low</td>
<td>medium</td>
<td>Medium</td>
<td>Easy</td>
<td>Easy</td>
</tr>
<tr>
<td>Voltmeter</td>
<td>Low</td>
<td>Low</td>
<td>medium</td>
<td>Medium</td>
<td>Easy</td>
<td>Easy</td>
</tr>
<tr>
<td>Tachometer</td>
<td>Medium</td>
<td>Medium</td>
<td>high</td>
<td>High</td>
<td>Easy</td>
<td>Easy</td>
</tr>
<tr>
<td>Motor controller</td>
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<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Throttle signal</td>
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<td>medium</td>
<td>Medium</td>
<td>Easy</td>
<td>Easy</td>
</tr>
<tr>
<td>Adaptor plate</td>
<td>Low</td>
<td>Low</td>
<td>high</td>
<td>High</td>
<td>Easy</td>
<td>Easy</td>
</tr>
</tbody>
</table>
Parts used in the conversion of electric car:

Motors:
An Electric Motor main function is to convert electrical energy into mechanical energy. Electric motors in order to be able to function properly use magnetism and electric currents. Electric motors important operating principles are: Electrostatics, Magnetism and Piezoelectric.
The main advantage of DC motors over AC motors is that speed is more difficult to control for AC motors. To compensate for this, AC motors can be equipped with variable frequency drives but the improved speed control comes together with a reduced power quality. Induction motors are the most popular motors in industry because of their ruggedness and lower maintenance requirements. AC induction motors are inexpensive (half or less of the cost of a DC motor) and also provide a high power to weight ratio (about twice that of a DC).

<table>
<thead>
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<th>D/C</th>
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<td>Range of Operation</td>
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<td>Rpm=6000</td>
</tr>
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<td>Specification</td>
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<td>Hp=20</td>
</tr>
<tr>
<td></td>
<td>Voltage=0-96v</td>
<td>Voltage=0-96v</td>
</tr>
<tr>
<td></td>
<td>Torque=200n-m</td>
<td>Torque=52n-m</td>
</tr>
<tr>
<td></td>
<td>Peak power=80hp</td>
<td>Peak power=35hp</td>
</tr>
<tr>
<td>COST</td>
<td>42000</td>
<td>135000</td>
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<td>Time taken for delivery</td>
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<td>Weight</td>
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<td>22kg</td>
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<tr>
<td>Volume occupies</td>
<td>L=470mm</td>
<td>L=8cm</td>
</tr>
<tr>
<td></td>
<td>D=260mm</td>
<td>D=20.3cm</td>
</tr>
<tr>
<td>Maintenance problem</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Mechanical or electrical compatibility</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local vendors in INDIA.</td>
<td>Pune</td>
<td>Delhi</td>
</tr>
</tbody>
</table>
**BATTERIES:**

Several different combinations of chemicals are commonly used, including: lead–acid, nickel cadmium (NiCd), nickel metal hydride (NiMH), lithium ion (Li-ion), and lithium ion polymer (Li-ion polymer).

Rechargeable batteries have lower total cost of use and environmental impact than disposable batteries. Some rechargeable battery types are available in the same sizes as disposable types. Rechargeable batteries have higher initial cost, but can be recharged very cheaply and used many times.

<table>
<thead>
<tr>
<th>Factor</th>
<th>A/C</th>
<th>D/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range of Operation</td>
<td>6V,8V,12V,24V</td>
<td>6V,8V,12V,24V</td>
</tr>
<tr>
<td>Specification</td>
<td>96V(12V of each)</td>
<td>96v(12v 0f each)</td>
</tr>
<tr>
<td>COST</td>
<td>11000(12v)</td>
<td>11000(12v)</td>
</tr>
<tr>
<td>Technology available (build from scratch at our LAB)</td>
<td>Readily available(160ah)</td>
<td>Readily available(160ah)</td>
</tr>
<tr>
<td>Weight</td>
<td>Approx.=70kg</td>
<td>Approx.=70kg</td>
</tr>
<tr>
<td>Volume occupies</td>
<td>More space</td>
<td>More space</td>
</tr>
<tr>
<td>Maintenance problem</td>
<td>Short circuit, Cables</td>
<td>Short circuit, cables</td>
</tr>
<tr>
<td>Mechanical or electrical compatibility</td>
<td>Eletrical</td>
<td>Eletrical</td>
</tr>
<tr>
<td>Local vendors in INDIA.</td>
<td>Vizag,vijayawada</td>
<td>Vizag,Vijayawada</td>
</tr>
</tbody>
</table>
CIRCUIT BREAKER:

A circuit breaker (popularly known as CB) is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit. Its basic function is to detect a fault condition and, by interrupting continuity, to immediately discontinue electrical flow. Unlike a fuse, which operates once and then must be replaced, a circuit breaker can be reset (either manually or automatically) to resume normal operation. Circuit breakers are made in varying sizes, from small devices that protect an individual household appliance up to large switchgear designed to protect high voltage circuits feeding an entire circuit.

<table>
<thead>
<tr>
<th>Factor</th>
<th>A/C</th>
<th>D/C</th>
</tr>
</thead>
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<td>Range of Operation</td>
<td>110v, 140v</td>
<td>110v, 140v</td>
</tr>
<tr>
<td>Specification</td>
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<td>Single pole</td>
</tr>
<tr>
<td>COST</td>
<td>2000-5000</td>
<td>2000-5000</td>
</tr>
<tr>
<td>Technology available (build from scratch at our LAB)</td>
<td>Takes time for delivery</td>
<td>Takes time for delivery</td>
</tr>
<tr>
<td>Weight</td>
<td>500gms</td>
<td>500gms</td>
</tr>
<tr>
<td>Volume occupies</td>
<td>Less</td>
<td>Less</td>
</tr>
<tr>
<td>Maintenance problem</td>
<td>fuse</td>
<td>Fuse</td>
</tr>
<tr>
<td>Mechanical or electrical compatibility</td>
<td>Electrical</td>
<td>Electrical</td>
</tr>
<tr>
<td>Local vendors in INDIA.</td>
<td>Vizag, chennai</td>
<td>Vizag, Chennai</td>
</tr>
</tbody>
</table>
DC-DC CONVERTOR/12v BATTERY:
An electric car still uses a 12 volt system to power all of the original 12 volt accessories: lights, horn, etc. This may also power some control circuits for the electric drive system. However, unlike a gas car, there is no alternator to keep this battery charged. One option in the early days of EVs was to use a deep cycle 12 volt battery, as heavy duty as possible, and recharge it when you charge the main battery pack. This is not adequate if any amount of night driving is intended. As the battery drains in use, the headlights will grow dimmer and the turn signals flash more slowly. It can also affect the running of the car if some of the drive system components do not get the 12 volt signal they require.

<table>
<thead>
<tr>
<th>Factor</th>
<th>A/C</th>
<th>D/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range of Operation</td>
<td></td>
<td>Based on input we are giving</td>
</tr>
<tr>
<td>Specification</td>
<td></td>
<td>Light, fans</td>
</tr>
<tr>
<td>COST</td>
<td></td>
<td>5000-10000</td>
</tr>
<tr>
<td>Technology available (build from scratch at our LAB)</td>
<td></td>
<td>It will be easily available</td>
</tr>
<tr>
<td>Weight</td>
<td></td>
<td>1000gms</td>
</tr>
<tr>
<td>Volume occupies</td>
<td></td>
<td>Based on manufacturer</td>
</tr>
<tr>
<td>Maintenance problem</td>
<td></td>
<td>Short circuit</td>
</tr>
<tr>
<td>Mechanical or electrical compatibility</td>
<td></td>
<td>Electrical</td>
</tr>
</tbody>
</table>
AMMETER:

An ammeter is a measuring instrument used to measure the electric current in a circuit. Electric currents are measured in amperes (A), hence the name. Instruments used to measure smaller currents, in the milli ampere. The majority of ammeters are either connected in series with the circuit carrying the current to be measured (for small fractional amperes), or have their shunt resistors connected similarly in series.

<table>
<thead>
<tr>
<th>Factor</th>
<th>A/C</th>
<th>D/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range of Operation</td>
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<td>0-200amps</td>
</tr>
<tr>
<td>Specification</td>
<td>0-200amps</td>
<td>0-200amps</td>
</tr>
<tr>
<td>COST</td>
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<td>500-1000</td>
</tr>
<tr>
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<td>Readily available</td>
</tr>
<tr>
<td>Weight</td>
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<td>500gms</td>
</tr>
<tr>
<td>Volume occupies</td>
<td>Less volume</td>
<td>Less volume</td>
</tr>
<tr>
<td>Maintenance problem</td>
<td>Should be maintained perfectly</td>
<td>Should be maintained perfectly</td>
</tr>
<tr>
<td>Mechanical or electrical compatibility</td>
<td>Electrical</td>
<td>Electrical</td>
</tr>
<tr>
<td>Local vendors in INDIA.</td>
<td>Vizag, Vijayawada</td>
<td>Vizag, Vijayawada</td>
</tr>
</tbody>
</table>
**VOLTMETER:**

A voltmeter is an instrument used for measuring electrical potential difference between two points in an electric circuit. Analog voltmeters move a pointer across a scale in proportion to the voltage of the circuit; digital voltmeters give a numerical display of voltage by use of an analog to digital converter difference between two points in an electric circuit. Analog voltmeters move a pointer across a scale in proportion to the voltage of the circuit; digital voltmeters give a numerical display of voltage by use of an analog to digital converter difference between two points in an electric circuit. Analog voltmeters move a pointer across a scale in proportion to the voltage of the circuit; digital voltmeters give a numerical display of voltage by use of an analog to digital converter difference between two points in an electric circuit. Analog voltmeters move a pointer across a scale in proportion to the voltage of the circuit.

<table>
<thead>
<tr>
<th>Factor</th>
<th>A/C</th>
<th>D/C</th>
</tr>
</thead>
<tbody>
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<td>Range of Operation</td>
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<td>0-120V</td>
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</tr>
<tr>
<td>COST</td>
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<td>1000above</td>
</tr>
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<td>Readily available</td>
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<tr>
<td>Weight</td>
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<td>500-1000gms</td>
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<td>Volume occupies</td>
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<td>Less volume</td>
</tr>
<tr>
<td>Maintenance problem</td>
<td>Should be maintained perfectly</td>
<td>Should be maintained perfectly</td>
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<td>Mechanical or electrical compatibility</td>
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<td>Electrical</td>
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<tr>
<td>Local vendors in INDIA.</td>
<td>Vizag, Vijayawada</td>
<td>Vizag, Vijayawada</td>
</tr>
</tbody>
</table>
THROTTLE POTENTIOMETER:
Electronic throttle control (ETC) is an automobile technology which severs the mechanical link between the accelerator pedal and the throttle. Most automobiles already use a throttle position sensor (TPS) to provide input to traction control, antilock brakes, fuel injection, and other systems, but use a bowden cable to directly connect the pedal with the throttle. An ETC-equipped vehicle has no such cable. Instead, the electronic control unit (ECU) determines the required throttle position by calculations from data measured by other sensors such as an accelerator pedal position sensor, engine speed sensor, vehicle speed sensor etc.

<table>
<thead>
<tr>
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<tbody>
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</tr>
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<td>2000-5000</td>
</tr>
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<td>Less</td>
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<td>Link between the pedal should be taken care.</td>
<td>Link between the pedal should be taken care.</td>
</tr>
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<td>Mechanical</td>
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<tr>
<td>Local venders in india</td>
<td>Vizag, hyd</td>
<td>Vizag</td>
</tr>
</tbody>
</table>
ADAPTER PLATE:
The adapter plate adapts the standards transmission to the motor. The idea is used to produce a general design which can be taken to machine shop so they can fabricate the adapter. To help with the drawing, a computer aided design (CAD) software package (design cad 3d) was used.

<table>
<thead>
<tr>
<th>Factor</th>
<th>A/C</th>
<th>D/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range of Operation</td>
<td>Based on motor</td>
<td>Based on motor</td>
</tr>
<tr>
<td>Specification</td>
<td>Based on motor(l,dia)</td>
<td>Based on motor(l,dia)</td>
</tr>
<tr>
<td>COST</td>
<td>Based on manufacture</td>
<td>Based on manufacture</td>
</tr>
<tr>
<td>Technology available (build from scratch at our LAB)</td>
<td>We can made</td>
<td>We can made</td>
</tr>
<tr>
<td>Weight</td>
<td>5000</td>
<td>5000</td>
</tr>
<tr>
<td>Volume occupies</td>
<td>medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Maintenance problem</td>
<td>Should be careful while designing</td>
<td>Should be careful while designing</td>
</tr>
<tr>
<td>Mechanical or electrical compatibility</td>
<td>mechanical</td>
<td>Mechanical</td>
</tr>
<tr>
<td>Local vendors in INDIA.</td>
<td>vizag</td>
<td>Vizag</td>
</tr>
</tbody>
</table>
MAIN CONTACTOR:
Contactors come in many forms with varying capacities and features. Unlike a circuit breaker, a contactor is not intended to interrupt a short circuit current. Contactors range from those having a breaking current of several amperes to thousands of amperes and 24 V DC to many kilovolts. The physical size of contactors ranges from a device small enough to pick up with one hand, to large devices approximately a meter (yard) on a side. Contactors are used to control electric motors, lighting, heating and electrical loads.

<table>
<thead>
<tr>
<th>Factor</th>
<th>A/C</th>
<th>D/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range of Operation</td>
<td>Based on shunt</td>
<td>Based on shunt</td>
</tr>
<tr>
<td>Specification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COST</td>
<td>5000-8000</td>
<td>5000-8000</td>
</tr>
<tr>
<td>Technology available (build from scratch at our LAB)</td>
<td>Takes time for delivery</td>
<td>Takes time for delivery</td>
</tr>
<tr>
<td>Weight</td>
<td>2kg</td>
<td>2kg</td>
</tr>
<tr>
<td>Volume occupies</td>
<td>Less volume</td>
<td>Less volume</td>
</tr>
<tr>
<td>Maintenance problem</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical or electrical compatibility</td>
<td>electrical</td>
<td>Electrical</td>
</tr>
<tr>
<td>Local vendors in INDIA.</td>
<td>Vizag</td>
<td>Vizag</td>
</tr>
</tbody>
</table>
MOTOR CONTROLLER:
The motor controller regulates motor’s speed and limits the motor’s maximum current level. The motor speed range can vary from zero to wide open throttle (WOT), which requires the controller’s power transistor to sustain high peak currents and provides good efficiency at nominal cruise speeds. The controller has also to be self-protecting against electrical disturbances such as an intermittent battery cable or a faulty throttle position sensor.

<table>
<thead>
<tr>
<th>Factor</th>
<th>A/C</th>
<th>D/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range of Operation</td>
<td>Depends on motor</td>
<td>Depends on motor</td>
</tr>
<tr>
<td>Specification</td>
<td>To control the motor</td>
<td>To control the motor</td>
</tr>
<tr>
<td>COST</td>
<td>6000</td>
<td>6000</td>
</tr>
<tr>
<td>Technology available (build from scratch at our LAB)</td>
<td>Based on curves</td>
<td>Based on curves made</td>
</tr>
<tr>
<td>Weight</td>
<td>5kgs</td>
<td>5kgs</td>
</tr>
<tr>
<td>Volume occupies</td>
<td>Less volume</td>
<td>Less volume</td>
</tr>
<tr>
<td>Maintenance problem</td>
<td>Short circuit</td>
<td>Short circuit</td>
</tr>
<tr>
<td>Mechanical or electrical compatibility</td>
<td>Electrical</td>
<td>Electrical</td>
</tr>
<tr>
<td>Local vendors in INDIA.</td>
<td>Vizag</td>
<td>Vizag</td>
</tr>
</tbody>
</table>
Summarising of A/C motors and D/C motors:

Of all the components in an electric drive conversion, the motor is probably the most important. The motor has the most influence on the performance (speed, acceleration, efficiency) of the converted vehicle. Also, the motor influences the selection of other major components of the vehicle (controller, batteries, and indirectly the charger and DC/DC converter). The motor is a primary factor in the cost of the conversion. There are several motor types and many sizes (power) and form factors (physical shapes) of these motor types. For reasons of practicality and commercial availability in the sizes required for electric vehicle conversions, the choice of motor types is reduced to just two types: series wound DC brushed machines and three-phase AC induction machines. The advantages and disadvantages for these two motor types are listed below.

The overwhelming disadvantage to DC brushed machines (both series wound and other types) are the brushes themselves. Brushes ride on the commutator of the motor’s armature (the part of the motor that turns) and form a rotary switch that switches high currents to various sections of the armature coils. The mechanical nature of this rotary switching of high power produces considerable electrical arcing and also mechanical wear of the carbon brushes and the copper segments of the commutator. This arcing can ignite flammable vapors if they are present around the motor. Although this condition is generally unlikely, the possibility of such ignition usually excludes brushed motors from commercially manufactured vehicles. In contrast, an AC induction motor, which has no brushes, completely eliminates this risk. Besides the ignition risk, brushes produce electrical noise (EMI/RFI) that can interfere with cell phones, computers, and other electronics. Because brushes are subject to mechanical wear they should be checked annually (increased maintenance) and may have to be replaced every few years. Carbon dust is produced as they wear.
An induction AC motor avoids these problems. They are generally of higher efficiency; virtually maintenance-free operation, sealed or splash resistant, and the controllers generally provide regenerative braking. But, the controllers (each motor type requires a specific type of controller) are more complicated and more expensive for AC. So AC motor systems are typically more expensive than comparable DC brushed motor systems.

Most AC induction motors are used in industrial applications. They are designed to operate at 240 volts AC or higher. As a result, using AC motors in electric vehicles generally requires higher voltage battery packs, thus a greater quantity of batteries to obtain the higher voltage. The greater number of batteries also adds cost in more battery cables and a higher voltage charger than for a lower voltage system. Industrial motors can be rewound to operate on lower voltages, but that would be a “custom” motor and more expensive than a standard motor. The cost of the custom rewinding will be comparable to the cost of extra batteries. Higher voltage AC motors run faster than lower voltage motors (or DC motors) and are more efficient. Rewinding for lower voltage operation will increase the electrical current requirements, which means thicker cables and also a drop in efficiency.
# A/C & D/C motors: Advantages & Disadvantages

<table>
<thead>
<tr>
<th>Series DC: Advantage</th>
<th>Importance to application</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Commonly available</td>
<td>Multiple vendors</td>
</tr>
<tr>
<td>2. High peak torque for a given hp size</td>
<td>Faster acceleration of vehicle.</td>
</tr>
<tr>
<td>3. Available in lower voltage windings</td>
<td>Less batteries in series required.</td>
</tr>
</tbody>
</table>

**Series DC: Disadvantage**

| 1. Brushes (arching, wear, carbon dust)                    | Possible to ignite flammable environments, radio interference, increased maintenance, electrical shock |
| 2. “Open” motor                                            | Susceptible to damage from water spray                         |
| 3. Generally lower maximum speed                           | Uses a smaller gear ratio so tends to negate advantage          |

**Induction AC: Advantage**

| 1. “Brushless” motor                                       | More reliable, virtually maintenance free, no arching, no carbon dust |
| 2. Sealed motors                                           | Water or cleaning spray not a problem                          |
| 3. Generally higher efficiency                             | Longer run time on a given battery charge.                     |
| 4. Most AC controllers offer regenerative braking          | Returns some energy for slightly longer driving range.         |

**Induction AC: Disadvantages**

| 1. Generally 240V or higher voltage                        | Requires more batteries in series.                            |
| 2. Controller more expensive than DC                      | More expensive conversion.                                   |
Electric car conversion:

For our conversion process we have chosen a maruti 800 vehicle. Our strategy in choosing maruti 800 goes this way:

- According to latest emission norms BS-IV or EURO-IV, maruti 800 was declared polluting vehicle. So converting this vehicle to electric may reduce a polluting vehicle to the environment.
- Also, maruti 800 is considered to be middle income group vehicle. So converting this car may help middle class groups afford for it.
- In the near future, you find maruti cars getting outdated with technological advancements in the field of automobile, so instead throwing them in the junkyard; you could convert and use them.
- Technically, most important point to be considered while conversion is the weight. Maruti 800 has the least weight compared to other vehicles and it is also best commuting vehicle.
- Maruti 800 is available in the market for very lower price and this adds up to the strategy to convert this vehicle so that conversion cost could be reduced.
- Maruti 800 is a small aerodynamic car and has the least drag efficiency, so this adds up to the range of the vehicle.
- Maruti 800 after conversion gives the best range and can travel for most purpose in the city.
- In case if any parts had to be replaced, parts of maruti 800 are available easily and are also cheap.
Parts to be taken out and their associated approximate weight:

Radiator fan removal – 5kg

- Removing radiator fan can add some space in the compartment.

Engine replacement with motor – 40kg

- Engine has to be removed from the transmission line and replaced with the motor.

Detaching the motor hub from removed engine

- The motor hub from the engine has to be dismantled and flywheel is taken and put in the transmission line with the coupler and motor.

Removal of exhaust system – 15kg

- The converted car does not produce any emissions, so the exhaust system need not be required.

Remove the fuel system – 5kg

- The fuel in the electric car is the batteries. So the fuel system serves no purpose and removing it reduces some of the weight.
## List of parts and function:

<table>
<thead>
<tr>
<th>Parts</th>
<th>Function</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltmeter</td>
<td>It is used to measure the volts</td>
<td><img src="image1.png" alt="Voltmeter Image" /></td>
</tr>
<tr>
<td>Charge controller</td>
<td>It regulates the charge and control the batteries</td>
<td><img src="image2.png" alt="Charge Controller Image" /></td>
</tr>
<tr>
<td>Motor</td>
<td>Converts electrical energy in to an mechanical energy</td>
<td><img src="image3.png" alt="Motor Image" /></td>
</tr>
<tr>
<td>Shunt</td>
<td>It is used to supply the current from the circuit breaker and main contactor.</td>
<td><img src="image4.png" alt="Shunt Image" /></td>
</tr>
<tr>
<td>Component</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Main contactor</td>
<td>It is link between the shunt resistance and motor controller.</td>
<td></td>
</tr>
<tr>
<td>Motor controller</td>
<td>Used to control speed and other components</td>
<td></td>
</tr>
<tr>
<td>Dc-Dc converter</td>
<td>To supply power to accessories</td>
<td></td>
</tr>
</tbody>
</table>
Performance, range and other parameters:

- The performance of electric vehicle depends upon the motor and the battery pack.
- Higher the battery rating, higher is the range of EV
- Weight has to be taken into consideration primarily while converting to electric vehicle.
- We need to be very careful while taking batteries. Batteries play an important role in adding weight to the EV.
- Peak load demands are problems faced by EV.

<table>
<thead>
<tr>
<th>Range</th>
<th>10mph</th>
<th>20mph</th>
<th>30mph</th>
<th>40mph</th>
<th>50mph</th>
<th>60mph</th>
</tr>
</thead>
<tbody>
<tr>
<td>1\textsuperscript{st} gear</td>
<td>62.6</td>
<td>39.2</td>
<td>27.9</td>
<td>20.5</td>
<td>15.3</td>
<td>11.4</td>
</tr>
<tr>
<td>2\textsuperscript{nd} gear</td>
<td>65.6</td>
<td>41.1</td>
<td>29.2</td>
<td>21.5</td>
<td>16.0</td>
<td>11.9</td>
</tr>
<tr>
<td>3\textsuperscript{rd} gear</td>
<td>68.1</td>
<td>42.7</td>
<td>30.3</td>
<td>22.3</td>
<td>16.5</td>
<td>12.3</td>
</tr>
<tr>
<td>4\textsuperscript{th} gear</td>
<td>69.8</td>
<td>43.7</td>
<td>31.0</td>
<td>22.8</td>
<td>16.9</td>
<td>12.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>1\textsuperscript{st} gear</th>
<th>2\textsuperscript{nd} gear</th>
<th>3\textsuperscript{rd} gear</th>
<th>4\textsuperscript{th} gear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top speed</td>
<td>34</td>
<td>52</td>
<td>76</td>
<td>90</td>
</tr>
<tr>
<td>Limitation</td>
<td>Motor rpm</td>
<td>Motor rpm</td>
<td>Battery voltage</td>
<td>Battery voltage</td>
</tr>
</tbody>
</table>
Conversion parts in detail:

**MOTOR:**

![Motor Image](image_url)

Fig 2.1: Motor

An Electric Motor main function is to convert electrical energy into mechanical energy. Electric motors in order to be able to function properly they used magnetism and electric currents. Electric motors important operating principles are: Electrostatics, Magnetism and Piezoelectric.

[Diagram of Electric Motors]

Classification of the main types of Electric Motors

**DC motors:**

Direct-current motors, as the name implies, use direct-unidirectional current. DC motors are used in special applications where high torque starting or smooth acceleration over a broad speed range is required.
A DC motor has three main components:

**Field pole:** Simply put, the interaction of two magnetic fields causes the rotation in a DC motor. The DC motor has field poles that are stationary and an armature that turns on bearings in the space between the field poles. A simple DC motor has two field poles: a north pole and a south pole. The magnetic lines of force extend across the opening between the poles from north to south. For larger or more complex motors there are one or more electromagnets. These electromagnets receive electricity from an outside power source and serve as the field structure.

**Armature:** When current goes through the armature, it becomes an electromagnet. The armature, cylindrical in shape, is linked to a drive shaft in order to drive the load. For the case of a small DC motor, the armature rotates in the magnetic field established by the poles, until the north and south poles of the magnets change location with respect to the armature. Once this happens, the current is reversed to switch the south and north poles of the armature.

**Commutator:** This component is found mainly in DC motors. Its purpose is to overturn the direction of the electric current in the armature. The commutator also aids in the transmission of current between the armature and the power source.

**AC Motors:**

Alternating current (AC) motors use an electrical current, which reverses its direction at regular intervals. An AC motor has two basic electrical parts a "stator" and a "rotor". The stator is in the stationary electrical component. The rotor is the rotating electrical component, which in turn rotates the motor shaft.
The main advantage of DC motors over AC motors is that speed is more difficult to control for AC motors. To compensate for this, AC motors can be equipped with variable frequency drives but the improved speed control comes together with a reduced power quality. AC induction motors are inexpensive (half or less of the cost of a DC motor) and also provide a high power to weight ratio (about twice that of a DC motor).

Factors that influence motor efficiency include:

- Age. New motors are more efficient.
- Capacity. As with most equipment, motor efficiency increases with the rated capacity.
- Speed. Higher speed motors are usually more efficient.
- Type. For example, squirrel cage motors are normally more efficient than slip-ring motors.
- Temperature. Totally-enclosed fan-cooled (TEFC) motors are more efficient than screen-protected drip-proof (SPDP) motor.

RANGE OF OPERATION

- **DC Motor**
  - Voltage: 12V to 72V

- **AC Motor**
  - Voltage: 12V to 72V
Specifications

➢ DC Motor

- Power: 20 count-- 35 pkhp
- Voltage: 12-72V DC
- Peak Efficiency: 93%
- Max Amps (30 seconds): 400
- Continuous Amps: 230
- Max Speed: 6000 RPM
- Weight: 22 kgs.

➢ AC Motor

- Power: 20 hp continuous
- Voltage: 220v-690v
- Peak Efficiency: 95%
- Max Speed: 6000rpm
- Weight: 81 kgs
- Cost, Maintenance: 41,500

**DC Motor:**

The cost of DC Motor is very expensive compared to AC Motor. Besides the ignition risk, brushes produce electrical noise (EMI/RFI) that can interfere with cell phones, computers, and other electronics. Because brushes are subject to mechanical wear they should be checked annually (increased maintenance) and may have to be replaced every few years. Carbon dust is produced as they wear.
AC Motor:
They are generally of higher efficiency; virtually maintenance-free operation, sealed or splash resistant, and the controllers generally provide regenerative braking. But, the controllers (each motor type requires a specific type of controller) are more complicated and more expensive for AC. So AC motor systems are typically more expensive than comparable DC brushed motor systems. They are generally of higher efficiency; virtually maintenance-free operation, sealed or splash resistant, and the controllers generally provide regenerative braking. But, the controllers (each motor type requires a specific type of controller) are more complicated and more expensive for AC. So AC motor systems are typically more expensive than comparable DC brushed motor systems.

Support or suppliers or vendors in INDIA:
DC Motors: Agni Motors India
Address: No 41 & 42, Near Gadgetry Nursing College, Hanumanth Nagar, Near SunkadaKatte, Vishwanadham Post, Hanumanth Nagar, Bangalore, Karnataka 560091
Phone: 080 23586721
AC Motors: Gennext Control
Address: A-7, Dhone Height, Shinde Bridge, NDA Road, Shivne, (Khadakwasala), Pune, MH 411023
Phone: 020 6470 3009
Contact person: Mr.bhaskar-02064703009
02025293009
AMMETER:

Fig 2.2: Ammeter

An ammeter is a measuring instrument used to measure the electric current in a circuit. Electric currents are measured in amperes (A), hence the name. Instruments used to measure smaller currents, in the milli ampere or microampere range, are designated as mill ammeters or micro ammeters.

The majority of ammeters are either connected in series with the circuit carrying the current to be measured (for small fractional amperes), or have their shunt resistors connected similarly in series. In either case, the current passes through the meter or (mostly) through its shunt. They must not be connected to a source of voltage; they are designed for minimal burden, which refers to the voltage drop across the ammeter, which is typically a small fraction of a volt. They are almost a short circuit.

Since the ammeter shunt has a very low resistance, mistakenly wiring the ammeter in parallel with a voltage source will cause a short circuit, at best blowing a fuse, possibly damaging the instrument and wiring, and exposing an observer to injury.

The most useful of all your EV on-board instruments is your ammeter. The higher range enables you to determine your motor’s instantaneous current draw; it functions much like a vacuum gauge in an internal combustion engine vehicle—the less current, the higher the range, and so on.

VENDORS FOR AMMETER:
Rishabh marketing agencies- 8662424056
BATTERIES:

A rechargeable battery, storage battery, or accumulator is a type of electrical battery. It comprises one or more electrochemical cells, and is a type of energy accumulator. It is known as a secondary cell because its electro chemical reactions are electrically reversible. Rechargeable batteries come in many different shapes and sizes, ranging from button cells to megawatt systems connected to stabilize an electrical distribution network.

Several different combinations of chemicals are commonly used, including: lead–acid, nickel cadmium (NiCd), nickel metal hydride (NiMH), lithium ion (Li-ion), and lithium ion polymer (Li-ion polymer).

Rechargeable batteries have lower total cost of use and environmental impact than disposable batteries. Some rechargeable battery types are available in the same sizes as disposable types. Rechargeable batteries have higher initial cost, but can be recharged very cheaply and used many times.

Usage and applications:

The energy used to charge rechargeable batteries usually comes from a battery charger using AC electricity, although some a Charger take from a few minutes to several hours to charge a battery. Slow "dumb" chargers without voltage- or temperature-sensing capabilities will charge at a low rate, typically taking 14 hours or more to reach a full charge. Rapid chargers can typically charge cells in two to five hours, depending on the model, with the fastest taking as little as fifteen minutes. Fast chargers must have multiple ways of detecting when a cell reaches full charge (change in terminal voltage, temperature, etc.) to stop charging before harmful overcharging or overheating occurs.
Battery manufacturers' technical notes often refer to VPC; this is volts per cell, and refers to the individual secondary cells that make up the battery. (This is typically in reference to 12-volt lead-acid batteries.) For example, to charge a 12 V battery (containing 6 cells of 2 V each) at 2.3 VPC requires a voltage of 13.8 V across the battery's terminals.

**Lead acid batteries** are invented in 1859 by French physicist Gastoneplante, are the oldest type of Rechargeable battery. Despite having a very low energy-to-weight ratio and a low energy-to-volume ratio, their ability to supply high surge current means that the cells maintain a relatively large power-to-weight ratio. These features, along with their low cost, make them attractive for use in motor vehicles to provide the high current required by automobile starter motors.

The **nickel–cadmium battery** (NiCd battery or NiCad battery) is a type of rechargeable battery using nickel oxide hydroxide and metallic cadmium as electrodes. The abbreviation Ni-Cd is derived from the chemical symbols of nickel (Ni) and cadmium (Cd): the abbreviation NiCad is a registered trademark of SAFT Corporation, although this brand name is commonly used to describe all Ni–Cd batteries.

Wet-cell nickel-cadmium batteries were invented in 1899. A Ni-Cd battery has a terminal voltage during discharge of around 1.2 volts which decreases little until nearly the end of discharge. Ni-Cd batteries are made in a wide range of sizes and capacities, from portable sealed types interchangeable with carbon-zinc dry cells, to large ventilated cells used for standby power and motive power. Compared with other types of rechargeable cells they offer good cycle life and capacity, good performance at low temperatures, and work well at high discharge rates (using the cell capacity in one hour or less). However, the materials are more costly than types such as the lead acid battery, and the cells have higher self-discharge rates than some other types. Sealed Ni-Cd batteries require no maintenance.
Lithium-ion battery:
A lithium-ion battery (sometimes Li-ion battery or LIB) is a family of rechargeable battery types in which lithium ions move from the negative electrode to the positive electrode during discharge, and back when charging. Li-ion batteries use an intercalated lithium compound as the electrode material, compared to the metallic lithium used in the non-rechargeable lithium battery.

Battery vendors and its specifications:
Contacts: Exide batteries in Visakhapatnam
Hyderabad battery limited (Venkat)-9949176322
Sai Krishna batteries (Vijayawada)-9849148096

SPECIFICATIONS:
- LENGTH: 520mm
- WIDTH: 268mm
- HEIGHT: 220mm
- WEIGHT: 70kg
- COST- 11000(EXIDE BATTERIES)

Battery pack:
A battery pack is a set of any number of (preferably) identical batteries or individual battery cells. They may be configured in a series, parallel or a mixture of both to deliver the desired voltage, capacity, or power density. The term battery pack is often used in battery electric vehicles.
Components of battery packs include the individual batteries or cells, and the interconnects which provide electrical conductivity between them. Rechargeable battery packs often contain a temperature sensor, which the battery charger uses to detect the end of charging.
CABLES:

Battery cables are used in Original Equipment by India’s leading vehicle manufacturers. Manufactured from electrolytic grade, bright annealed, bunched, bare copper conductors, these cables are insulated on state-of-the-art extruders with a special grade PVC compound that is formulated and manufactured in-house. This PVC is impervious to water, petrol, diesel, acids, engine & lubricating oils and grease. It is ideally suited for extreme weather conditions. They are available in red and black colours in 25-metre and 100-metre coils / drums.

These cables are also used in other applications where batteries are used, e.g. telecommunication, power, computers, etc. where the D.C. voltage does not exceed 100 volts. These cables are long-lasting and ensure proper distribution of power in the vehicle.

Wire and Connectors:

This might be one of the last things you think about, but it’s by no means the least important. While your wire size and connector type choices on the instrumentation side are not as important as the connections you make with them, all of these are important on the power side.
Connections:
On the power side, connections are important. These occur when your wire Connectors attach to motor, controller, batteries, shunts, fuses, circuit breakers, switches, etc. Check to ensure surfaces are flat, clean, and smooth before attaching. Use two wrenches to avoid bending flat-tabbed controller and fuse lugs. Torque everything down tight. Check everything and re-tighten battery connections at least monthly.

CIRCUIT BREAKER:

A circuit breaker (popularly known as CB) is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit. Its basic function is to detect a fault condition and, by interrupting continuity, to immediately discontinue electrical flow. Unlike a fuse, which operates once and then must be replaced, a circuit breaker can be reset (either manually or automatically) to resume normal operation. Circuit breakers are made in varying sizes, from small devices that protect an individual household appliance up to large switchgear designed to protect high voltage circuits feeding an entire city. A circuit breaker is like a switch and a resetting fuse.
The purpose of this heavy-duty circuit breaker (typically rated at 300 to 500 amps) is to instantly interrupt main battery power in the event of a drive system malfunction, and to routinely interrupt battery power when servicing and recharging. For convenience, this circuit breaker is normally located near the battery pack. The switch plate and mounting hardware are useful—the big letters immediately inform casual users of your EV of the circuit breakers function.

To permit battery charging, the breaker should pass current in both directions with low loss. However, the over current trip function is not required to operate when the batteries are being charged, as this source can be assumed to have its own over current protection, or be by nature current limited (as is the solar array).

This breaker cannot provide isolation. If isolation is considered necessary, a separate mechanical isolation switch will be placed in series with the breaker. The breaker will only disconnect one terminal of the battery string that is the breaker will be single pole. This is sufficient since the breaker is internal to the sealed, insulated battery box.

**POLES:**

A single pole breaker is used with a typical 120v circuit, having one hot wire and one neutral wire. However, a double pole breaker is used with a typical 220v circuit (like for a dryer or heater) having two hot wires. If there is a short circuit to either hot wire, both poles are ganged together so both trip together.

**CIRCUIT BREAKER VENDORS AND ITS SPECIFICATIONS**

NAVEEN AGENCIES (VIZAG): 08916641809

MERCURY AGENCIES (VIZAG): 08912563210

WEIGHT: 500gms; COST: 2000-4000
MAIN CONTACTOR:

Fig 2.5: Main Contactor

A **contactor** is an electrically controlled switch used for switching a power circuit, similar to a relay except with higher current ratings. A contactor is controlled by a circuit which has a much lower power level than the switched circuit. Contactors come in many forms with varying capacities and features. Unlike a circuit breaker, a contactor is not intended to interrupt a short circuit current. Contactors range from those having a breaking current of several amperes to thousands of amperes and 24 V DC to many kilovolts. The physical size of contactors ranges from a device small enough to pick up with one hand, to large devices approximately a meter (yard) on a side. These are used control electric motors, lighting, heating, capacitor banks, and other electrical loads.

**OPERATING PRINCIPLE:**

Unlike general-purpose relays, contactors are designed to be directly connected to high-current load devices. Relays tend to be of lower capacity and are usually designed for both normally closed and normally open applications. Devices switching more than 15 amperes or in circuits rated more than a few kilowatts are usually called contactors.
Apart from optional auxiliary low current contacts, contactors are almost exclusively fitted with normally open contacts. Unlike relays, contactors are designed with features to control and suppress the arc produced when interrupting heavy motor currents.

When current passes through the electromagnet, a magnetic field is produced; this attracts the moving core of the contactor. The electromagnet coil draws more current initially, until its inductance increases when the metal core enters the coil. The moving contact is propelled by the moving core; the force developed by the electromagnet holds the moving and fixed contacts together. When the contactor coil is de-energized, gravity or a spring returns the electromagnet core to its initial position and opens the contacts.

For contactors energized with alternating current, a small part of the core is surrounded with a shading coil, which slightly delays the magnetic flux in the core. The effect is to average out the alternating pull of the magnetic field and so prevent the core from buzzing at twice line frequency.

**VENDORS FOR MAIN CONTACTOR:**
Viswanath electrical Pvt ltd, Bangalore - 08066498485
TACHOMETER:

A tachometer (revolution-counter, Tach, rev-counter, RPM gauge) is an instrument measuring the rotation speed of a shaft or disk, as in a motor or other machine. The device usually displays the revolutions per minute (RPM) on a calibrated analogue dial, but digital displays are increasingly common.

Installing a tachometer starts with deciding on a convenient location where it will not interfere with steering or vision. In making a decision on the location for the tachometer, consider what it takes to attach it to this location. A good location is on the A-pillar or post on the left side of the front windshield. No damage can be done here, and it is solid. The steering column is also a good location. Locations vary widely with different automobiles.

Wiring and Installation:
There are four wires on all tachometers. The red wire is the positive wire. This must be hooked to a switched power source so that it only comes on when the ignition switch is turned on. This can usually be found at the under-dash fuse panel or always at the ignition switch electrical connector at the bottom left of the steering column.
The black wire is a simple ground wire. This should be connected to a good clean ground such as the steering column, frame or engine.

The yellow wire is for the illumination. This can either be attached to the same post as the red wire, in which case the light in the tach would be on as long as the ignition is on, or attach it to the fuse panel or light switch. Look for a terminal on the fuse block that is only hot when the lights are on.

The last wire is the green tach wire. This wire must be routed through the firewall and attached to the negative terminal of the coil. On an HEI system, there is a tach terminal marked right on the distributor cap. On any single-coil vehicle, use the negative side of the coil. If the coil does not have a black wire for ground, check both wires for power. The wire with no power will be the negative or ground wire (that you attach the green wire from the tach to). In vehicles with distributor less ignition or coil on plug ignition systems, attach it to a coil and just make sure it is the negative side. Find the negative side by probing for the power side and the opposite will be the negative side, which is the one needed. Always make sure the ignition is turned off before checking for power at the coil.

VENDORS FOR TACHOMETER:
Risabh marketing agencies: 8662424056
Electronic throttle control (ETC) is an automobile technology which severs the mechanical link between the accelerator pedal and the throttle. Most automobiles already use a throttle position sensor (TPS) to provide input to traction control, antilock brakes, fuel injection, and other systems, but use a Bowden cable to directly connect the pedal with the throttle. An ETC-equipped vehicle has no such cable. Instead, the electronic control unit (ECU) determines the required throttle position by calculations from data measured by other sensors such as an accelerator pedal position sensor, engine speed sensor, vehicle speed sensor etc. The electric motor within the ETC is then driven to the required position via a closed-loop control algorithm within the ECU.

The benefits of ETC are largely unnoticed by most drivers because the aim is to make the vehicle power-train characteristics seamlessly consistent irrespective of prevailing conditions, such as engine temperature, altitude, accessory loads etc. However, acceleration response may occasionally be slower than with cable-driven throttle. The ETC is also working 'behind the scenes' to dramatically improve the ease with which the driver can execute gear changes and deal with the dramatic torque changes associated with rapid accelerations and decelerations.
A criticism of the very early ETC implementations was that they were "overruling" driver decisions.

Nowadays, the vast majority of drivers have no idea how much intervention is happening. Much of the engineering involved with drive-by-wire technologies including ETC deals with failure and fault management. Most ETC systems have sensor and controller redundancy, even as complex as independent microprocessors with independently written software within a control module whose calculations are compared to check for possible errors and faults.

Anti-lock braking (ABS) is a similar safety critical technology; whilst not completely 'by-wire', it has the ability to electronically intervene contrary to the driver's demand. Such technology has recently been extended to other vehicle systems to include features like brake assist and electronic steering control, but these systems are much less common, also requiring careful design to ensure appropriate back-up and fail-safe modes.

VENDORS FOR THROTTLE POTENTIOMETER:
SRI Polamamba automobile car care-9848044818(vizag)
Weight- 2kgs
Cost- 3000
A voltmeter is an instrument used for measuring electrical potential difference between two points in an electric circuit. Analog voltmeters move a pointer across a scale in proportion to the voltage of the circuit; digital voltmeters give a numerical display of voltage by use of an analog to digital converter. Voltmeters are made in a wide range of styles. Instruments permanently mounted in a panel are used to monitor generators or other fixed apparatus. Portable instruments, usually equipped to also measure current and resistance in the form of a multimeter, are standard test instruments used in electrical and electronics work. Any measurement that can be converted to a voltage can be displayed on a meter that is suitably calibrated; for example, pressure, temperature, flow or level in a chemical process plant.

General purpose analog voltmeters may have an accuracy of a few percent of full scale, and are used with voltages from a fraction of a volt to several thousand volts. Digital meters can be made with high accuracy, typically better than 1%. Specially calibrated test instruments have higher accuracies, with laboratory instruments capable of measuring to accuracies of a few parts per million. Meters using amplifiers can measure tiny voltages of micro volts or less.
Part of the problem of making an accurate voltmeter is that of calibration to check its accuracy. In laboratories, the Weston Cell is used as a standard voltage for precision work. Precision voltage references are available based on electronic circuits.

VENDORS FOR VOLTMETER:
Risabh marketing agencies: 8662424056

DC-DC CONVERTOR:
An electric car still uses a 12 volt system to power all of the original 12 volt accessories: lights, horn, etc. This may also power some control circuits for the electric drive system. However, unlike a gas car, there is no alternator to keep this battery charged. One option in the early days of EVs was to use a deep cycle 12 volt battery, as heavy duty as possible, and recharge it when you charge the main battery pack. This is not adequate if any amount of night driving is intended. As the battery drains in use, the headlights will grow dimmer and the turn signals flash more slowly. It can also affect the running of the car if some of the drive system components do not get the 12 volt signal they require.

It would seem to be simple to tap 12 volt from one or two of the main pack batteries. This is not recommended, because it will cause the pack to discharge unevenly, affecting performance and battery life. It also violates the isolation of the traction pack from the chassis, which is required by some components, and necessary for safety.

The solution is a DC/DC convertor. This taps the full battery pack voltage and cuts it down to a regulated output, similar to that from an alternator. By tapping the full pack, there is no uneven discharge. Amperage required is so low that there is little effect on range.
Isolation of the high and low voltage systems is maintained inside the DC/DC converter. This also eliminates the need for a separate 12 volt charging circuit for an auxiliary battery.

**VENDORS FOR DC-DC CONVERTOR:**
Power cube, Maharashtra - 08447574075
BSMC power systems, Haryana- 9910584666(Vinod Sharma)

**CHARGE CONTROLLER:**

A charge controller, charge regulator or battery regulator limits the rate at which electric current is added to or drawn from electric batteries. It prevents overcharging and may prevent against overvoltage, which can reduce battery performance or lifespan, and may pose a safety risk.
It may also prevent completely draining ("deep discharging") a battery, or perform controlled discharges, depending on the battery technology, to protect battery life. The terms "charge controller" or "charge regulator" may refer to either a stand-alone device, or to control circuitry integrated within a battery pack, battery-powered device, or battery recharger.

A series charge controller or series regulator disables further current flow into batteries when they are full. A shunt charge controller or shunt regulator diverts excess electricity to an auxiliary or "shunt" load, such as an electric water heater, when batteries are full.

Simple charge controllers stop charging a battery when they exceed a set high voltage level, and re-enable charging when battery voltage drops back below that level.

Charge controller circuits are used for rechargeable electronic devices such as cell phones, laptop computers, portable audio players, and uninterruptible power supplies, as well as for larger battery systems found in electric vehicles and orbiting space satellites.

Charge controller circuitry may be located in the battery-powered device, in a battery pack for either wired or wireless (inductive) charging, in line with the wiring, or in the AC adapter or other power supply module.

**VENDORS FOR CHARGE CONTROLLER:**

Arkhasakti solutions, Kolkata- 9143137563 (also serves in visakhapatnam)
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.

Every electric motor has to have some sort of controller. The motor controller will have differing features and complexity depending on the task that the motor will be performing.

The simplest case is a switch to connect a motor to a power source, such as in small appliances or power tools. The switch may be manually operated or may be a relay or contactor connected to some form of sensor to automatically start and stop the motor. The switch may have several positions to select different connections of the motor. This may allow reduced-voltage starting of the motor, reversing control or selection of multiple speeds. Overload and over current
protection may be omitted in very small motor controllers, which rely on the supplying circuit to have over current protection.

Small motors may have built-in overload devices to automatically open the circuit on overload. Larger motors have a protective overload relay or temperature sensing relay included in the controller and fuses or circuit breakers for over current protection. An automatic motor controller may also include limit switches or other devices to protect the driven machinery.

VENDORS FOR MOTOR CONTROLLER:
Motor controller available in the market is very costly.
The motor controller should be made from the motor data sheets at any lab with necessary equipment.
**Indusec**

**Indian dual seat electric car**

The prior act of behind the design and concept of this Indusec was that a conventional automobile or four wheeled vehicle has one or more rows of seats with two people in each row, and is typically about 1.6m wide. A two wheeled motor cycle seats two people front-and-back and is about 0.8m wide. In India each lane of the roadway is wide enough for accommodating one automobile or two motor cycles with enough clearances provided between the vehicles. Motorcycles are narrow enough to drive between the automobiles in adjacent lanes when traffic is congested. Automobiles are most often used to carry a single person, particularly for commuting. Considering the far greater space, material, and fuel consumed by automobiles compared to motorcycles, automobiles are less efficient at transporting people.

Despite the advantages of motorcycles in heavy traffic, parking, and efficiency, automobiles are preferred by majority of people because they are much easier and safer to drive, and their enclosed cabins provide comfort and sufficient carrying capacity. As the economy and population of urban areas grow, traffic and parking problems also increase. Our governments try to alleviate these problems by suggesting the public to use carpooling and public transportation. However these measures have only been met with limited success, because people are reluctant to give up the freedom and convenience they enjoy with their private vehicles. The only remaining solution is to expand road ways which is extremely expensive. Small body enclosed vehicles have been proposed for increasing transportation efficiency by carrying one or more people in front and back seating.
The objectives of the concept of the Indusec are:

- To be as narrow as a typical motorcycle for improved transportability in heavier traffic and easier parking.
- To be as stable as a conventional wide body automobile despite its minimal width and lack of body tilting.
- To be fast enough for free way travel and to enclose its occupants in a comfortable and safe cabin.
- To be less expensive to build and operate than a conventional automobile.
- Suppose while moving in traffic with only one person in the so called SUV's or the big cars; you find them occupying a larger space creating traffic chaos for just one single person. Instead travelling in the Indusec that is compatible and can replace the large cars with two to three of them in the same volume of area occupied by the big cars.
- Two persons travelling single in each of their 4-seated cars and the ones travelling in the dual seated car, for the same distance travelled the Indusec takes in less amount of fuel thereby reducing pollution.
- Maintenance costs are also comparatively low when compared to the other cars.
- Also, extra seats, space and other parts add unnecessary weight to the car and increase the drag resistance making it to be wider.
- Making the car small and compatible occupies lesser space and reduces traffic density.
- Not much place is also required for parking at the home.
- Small cars are more aerodynamic and have a low centre of gravity making them efficient.
- Dual seated cars are small and so efficient that they can be driven through the busy and narrow lanes.
- If you limit a car to two persons sitting in tandem, you can make it smaller with less weight. You need less energy to transport the persons, and then it can be better on CO\textsubscript{2} and fuel efficiency.
- Small cars have a low turning radius and have less tilting problems.
- Manufacturing cost of dual seated cars is less compared with the other cars. So, new technologies can be inculcated and more safety features can also be added.
- With the increasing traffic density, the dual seated cars are compatible to the Indian roads.
- Everyone has the dream to travel in a car. So instead using motor vehicles, if these dual seated electric cars are available at lower prices people prefer to buy these cars and reduce the use of these conventional cars thereby reducing emissions.
- With high speed and better efficiency, you will have fun to drive these dual seated narrow cars.
- These cars accelerate better because of their low weight and better drag efficiency.
- The future of the automotive industry is electric cars and small cars with electric fuelling technology gives a better feel.
- With a clean and better moving, Indusec’s aim to have the lowest dust to dirt carbon foot prints in the automotive world.

The Indusec was not designed to replace the family car. It was designed to add a transportation option that gives speed and convenience never available before. According to the Indian transportation Statistics, 75% of all automobile trips are single occupant, and the average round trip commute is 40km. With relatively inexpensive lead acid batteries, the Indusec can travel 2 times that far on a charge with lithium-ion batteries, over 100km is achievable.
Economic justification:
If an executive who earns 5,00,000 per year (or about RS100 per hour) saves 20 minutes each way to work and back by lane-splitting, filtering, and parking, that’s a savings of RS1,200 per month.

Convenience:
Would you rather fill your cell phone with gasoline every few days or just plug it in every night?
It’s the same for the Indusec.
Just plug it in and use inexpensive electricity. A dryer outlet will give most of a charge in an hour, or a full charge in 8 hours. With a 96-volt outlet, it’s still easily charged over night. With a 15-amp off-board charger, the Indusec can be charged to 80% in about 6 hours. Virtually maintenance-free; the Indusec car has no oil change or tune-up requirements to consume your time and money.

Parking:
An Indusec can be parked perpendicular to the curb, in left-over spaces between cars or driveways, next to buildings, or in unused corners of parking lots.

Beat traffic:
The Indusec ability to maneuver through traffic is second to none. Like a motorcycle, it can change lanes to gain advantage in traffic better than any car in history. Unlike a motorcycle, it is safe, dry, climate controlled, and can securely carry a reasonable amount of cargo. Where lane splitting is permitted (i.e., driving between lanes of stopped or slow-moving traffic), such as in Pune, Bombay, Delhi the advantage can be staggering. In extremely heavy traffic, Indusec can travel in much lesser time the distance that a car travels in 20 minutes.
**Side-by-side driving:** Indusec can drive side by side in a single lane.

**Lane splitting:** Lane-splitting is the ability to drive between lanes in stalled traffic, thus dramatically lessening long commutes.

**Energy independence:**
We are doing our part by designing a car that pays for itself purely by convenience; time saved during commuting, and cost savings from reduced parking fees while using no oil. We are not asking customers or the government to pay a time for the energy independence or environmental benefits. The Indusec would almost never be dependent on oil, foreign or domestic, as power plants rarely use oil.

**Air quality:**
An all-electric car like the Indusec is the only currently practical true zero-emission vehicle. If charging from the grid, emissions are minimal due to the current mix of power sources. In addition to the much higher efficiency of an EV, there are more sophisticated pollution control devices on power plants than can be afforded on individual cars. Hydro, wind, geothermal, and tidal are some of the clean and renewable sources of energy. As the grid gradually changes over to these, there will be less pollution yet.
About the vehicle:
The Vehicle: Small is a relative word, and in saying that the Lean Machine is a small vehicle. We mean that it is smaller than conventional vehicles. In prototype form it weighs about 1000kgs, has a tread width of about 39inches and a length of about 102inches, the wheelbase is about 48cms.
Our Indusec car concept offers consumers several advantages that are inherent in its design. Driving the Indusec car is an experience comparable to skiing, since the passenger compartment of the vehicle leans into turns to reduce the centrifugal force on the driver and passenger (if any) and to reduce or minimize the turning radius of the vehicle. Furthermore, the fixed rear axle provides a measure of safety by ensuring vehicle stability through turns to prevent rolling the car only the front wheel rotates off vertical as the passenger compartment leans into the turn. Operating and capital cost savings are estimated to be fairly significant for the Indusec car, since the vehicle would be smaller and lighter than a full-size automobile.

Approach:
The objective of this assignment is to gather and analyze information on vehicles, generate possible market penetration rates, and derive the benefits and costs to the public that would result from the sale of the Indusec car. In addition to assessing the commercial potential of the vehicle, public investments to stimulate the Indusec car markets were explored to determine a basis for public sector costs and likely returns on investment.
Estimate Indian Market for the Indusec Car:

Estimating the market for the commuter car, a vehicle unlike any other car sold in recent memory, proved to be a challenging task. Without the benefit of a comprehensive market study or detailed public opinion surveys, we were forced to extrapolate available data and rely on business judgment to characterize customers that may be attracted to the commuter vehicle.

In view of the uncertainty inherent in this task, our approach here was to develop three different market penetration scenarios based on three different methodologies. From these three scenarios, high and low market cases were generated to model the range of penetration rates likely for the commuter car.

Develop Benefit-Cost Analysis:

The benefit-cost analysis illustrates the impact that the Indusec car depends upon

- Energy consumption
- Environmental effect
- Congestion/traffic levels

The results of the analyses are directly dependent on the market size estimate, Current congestion and traffic levels, established emission inventory models, and the fraction of commuter cars driving in and around major cities.
Using the existing information, a profile of the electrical car customer can be developed. The electrical car, as its name implies, offers substantial benefits to those who travel to work by automobile and who typically drive alone.

A small vehicle is far more preferable than a full-size automobile and, like a motorcycle, can accelerate and brake quickly. These factors can reduce travel time for a small vehicle compared to a full-size car. Furthermore, the economics of the vehicle, low purchase price and low operating costs will attract an economy.

The electrical car is also well suited to multi-car households. The electrical car may be able to replace that second or third vehicle used to drive to a train station or to run around town. Second and third cars in a household are often older, used cars which have higher emissions and lower fuel economy than more recent models.

One of the main attributes of the electrical car is its lower ownership costs compared to standard width automobiles. And will have lower operating costs due to its high fuel economy, low weight and mechanical simplicity.

To make the operating costs more comparable, parameters such as mileage accumulation and vehicle life were assumed to be identical for both the electrical and conventional cars. An important factor included in the analysis is fuel economy, with the electrical car consuming five times less fuel than the standard automobile.
Specifications:

Length-259.08cm
Width - 99cm
Height-152.4cm
Ground clearance-16cm
Chassis metal sheet thickness-3mm (mild steel for light weight vehicles)
Batteries - 520(l)*26.5(b)*22(h)
Battery box - 54cm (l)*99cm (w)*48cm (h)
Seat - 42cm (l)*125cm (h)*5cm (w)
Tire - 48cm (dia)*12cm (w)
Steering dia - 35cm
Differential dia - 20.3cm
Front tire to tire distance - 75cm
Suspension
Springs - 6cm (from tire to spring)
Axle dia - 5cm
Motor - 20cm (dia)*40cm (L)
Gear box - 8.25cm (w)
Distance of rear axle to front axle - 230cm
Distance from pedal to seat - 72cm
Distance from steering to seat - 60cm
Distance from steering to floor - 70cm

Flow charts describing the functioning:

The flow chart below describes the flow of electrical and mechanical energies in the vehicle. The flow chart explains clearly how the power is being utilized in the rolling of an automobile in a sequential manner. All of the power is not utilized to move the automobile; some of the energy is wasted due to friction and drag forces.
Results:

Interior body of INDUSEC car
Indusec - Indian Dual Seat Electric Car
Views of INDUSEC car
Discussions & Limitations:

- The project describes the concept and usage of electric cars.
- The electric cars are a better future to the world in the coming days.
- INDUSEC is made available in the market at lower price reaching the public interest.
- Either A/C or D/C motors can be used but for an A/C motor, the controller and the wiring get complicated. An A/C motor involves the concept of regenerative braking.
- High end technologies have to be used to increase the range and performance of the electric cars.
- Create awareness among the people about the advantage of electric cars.
- Availability of motors with required specifications in India.
- High cost of DC motors if available.
- No proper response from industries if said it is a student project.
- Electric cars give less efficiency compared to the fuel engine cars.
Conclusions:

- The basic design of the INDUSEC has been completed along with the concept of building an electric car.
- Detailed information of the parts with specifications and vendors has been collected.
- This study gave us a clear idea regarding the electric cars and also building at your own garage with enough technical stuff.
- This report brings awareness about the importance of electric cars and its future advancement.
- INDUSEC will be soon ready for market introduction and will meet the consumer acceptance in terms of safety, standardisation, environmental aspects and affordability.
<table>
<thead>
<tr>
<th>Sl No</th>
<th>PART &amp; Model No</th>
<th>Make/Company</th>
<th>Specification</th>
<th>Vendor- Name, Email &amp; cell No</th>
<th>Location &amp; Address</th>
<th>Cost</th>
<th>Lead time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Motor (DC)</td>
<td>Moin Engine Parts &amp; Motors</td>
<td>length=&gt;8cm diameter=20.3cm voltage range=12-72v torque=52n-m peak power=35hp continious power=20hp rpm=6000</td>
<td>B.Rakesh, <a href="mailto:rakhi.rakesh3@gmail.com">rakhi.rakesh3@gmail.com</a></td>
<td>Medak, Hyderabad</td>
<td>Rs30,000/-</td>
<td>15 days</td>
</tr>
<tr>
<td>2</td>
<td>Batteries</td>
<td>12v ,160 ah or 200 ah Exide lead acid battery LENGTH: 520mm WIDTH: 268mm HEIGHT: 220mm weight-70kg</td>
<td>Sai krishna Batteries</td>
<td>Vijayawada</td>
<td>Rs80,000/-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Motor controller</td>
<td>To be calibrated based on motor and voltage used.</td>
<td>Self-made</td>
<td></td>
<td>Rs7,000/-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Charge controller</td>
<td>Depends on battery voltage</td>
<td>Arkhasakti solutions</td>
<td>Kolkata &amp; Vishakhapatnam</td>
<td>Rs5,000/-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Adaptor plate</td>
<td>Based on the dia of the motor</td>
<td>Self-fabrication</td>
<td></td>
<td>Rs5,000/-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Contactor</td>
<td>Depends on motor</td>
<td>Viswanath electrical pvt ltd, 08066498485. Raj enterprises, 02222082752.</td>
<td>Bangalore, Mumbai</td>
<td>Rs3,000/-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Throttle potentiometers</td>
<td>Depends on the accelerator and clutch plates.</td>
<td>Polomamba automobile service care, 09848044818.</td>
<td>Vishakhapatnam</td>
<td>Rs3,000/-</td>
<td></td>
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</tr>
<tr>
<td>8</td>
<td>Ammeter, voltmeter, and other electrical parts.</td>
<td></td>
<td>Rishabh marketing</td>
<td>Vijayawada</td>
<td>Rs5,000/-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Motor mounts</td>
<td>Depends on motor dimensions and available space.</td>
<td>Self-design and fabrication</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
This project aims at transforming Society. Outdated auto CAR conversion to Electric Car. Highly polluting to Zero Emission. Maruti800 to Lovely EV.

Estimated total cost of conversion parts – 1,38,000/-
Maruti 800 car required for conversion – 40,000/-
Total cost – 1, 78,000/-
Appendices:

we have gathered information regarding the scrap details the scrap yards at few places where automobile parts are available at low cost and also cars that are not in use and those which emit lot of pollution. These cars can be taken and converted and put them back into use. Also, parts are available at low cost which adds to the reduction of cost in conversion process. Below are the details of the scrapyard.

Range Auto mart, Rajahmundry
(like suspension springs, steering, tires etc)
For four wheeler drive

Two wheeler second hand parts,
Aazeed,
Near mudaliar sang ham hospital,
Ford road,
Bangalore.

Moin engine parts & motor parts
d.no : 15-5-74/4,
Afzal gunj, opp: bharat boyyle store,
afzal gunj, Hyderabad

Merajuddin & sons
Shop no: 910
Chatta sheikh mangloo,
Motor market, jana masjid,
Gate no 1, Delhi
Bibliography:

- Build your own electric vehicle, Seth Leitman and Bob Brant.
  [Note](http://www.edn.com/design/automotive/4368192/Engineer-shares-how-to-build-an-electric-vehicle-from-the-ground-up-Part-1-Design-choices)
- Best and simplest car creations
  [THINK: SIMPLET CAR Door concept](http://hacknmod.com/hack/screw-gas-build-an-electric-car/)
- [http://www.youtube.com/watch?v=vcr1xBgQO20](http://www.youtube.com/watch?v=vcr1xBgQO20)
- [http://www.indiacar.com/roadtest/roadtest_new/800ac_a_june05/techspec.html](http://www.indiacar.com/roadtest/roadtest_new/800ac_a_june05/techspec.html)
- [http://www.getit.in/dc-motor/?at11=hindustan|bch|kirloskar-motors|crompton-greaves|alstom|nf|larsen_tourbo|schneider-electric|siemens|elecon&at12=dc-motor&at15=new|used&result=ca](http://www.getit.in/dc-motor/?at11=hindustan|bch|kirloskar-motors|crompton-greaves|alstom|nf|larsen_tourbo|schneider-electric|siemens|elecon&at12=dc-motor&at15=new|used&result=ca)
- [http://agnimotors.com/home](http://agnimotors.com/home)
- More information on understandings...
- Parts and other details..
  [http://evfinder.com/siteconverters.htm](http://evfinder.com/siteconverters.htm)
- Link about the short and direct steps on EV conversion
  [http://auto.howstuffworks.com/electric-car7.htm](http://auto.howstuffworks.com/electric-car7.htm)
Good Link talks about products, specifications and its cost..... useful for getting feel and find alternate company products which will be cheaper...

http://www.metricmind.com/

AC Conversion for Honda CAR.... good to understand at each level

http://www.metricmind.com/ac_honda/main2.htm


http://www.speedmasti.com/indian-cars/reva-electric-car/reva-small-car-big-savings/

http://www.dieselserviceandsupply.com/

http://www.markelektriks.com/

http://www.rotomag.com/

http://www.gennextcontrol.net/profile.html
Glossary:

- **Alternating Current**: The standard type of electricity in homes and the most effective way of powering an EV. In AC circuit the voltage swings between positive and negative meaning current flows in both directions.

- **Alternate Fuel Vehicle**: A vehicle powered by fuel other than gasoline or diesel. Examples of alternative fuels are electricity, hydrogen, and CNG.

- **DC**: A form of electricity where current only flows in one direction. This is the form of electricity produced by batteries and the most common system used in EV conversions.

- **Kwh-"Kilowatt-hour"**: a unit of energy equivalent to the energy transferred or expended in one hour by one kilowatt of power. Electric car battery size is measured in kilowatt-hours, so think of it as the electric car's equivalent of litres of fuel in a petrol tank.

- **Regenerative Braking Systems**: An EV with a braking system that uses the braking RPM load to charge the onboard batteries.

- **Range**: The distance you get out of a full battery.

- **Throttle**: A device using with a variable resistor or the magnetic "Hall effect" to send a signal to the controller which is then interpreted to send power to the motor. Allows variable speeds and acceleration at a chosen rate.

- **Zero Emissions Vehicle**: ZEVs have zero tailpipe emissions are 98% cleaner than the average new model year vehicle. These include battery electric vehicles and hydrogen fuel cell vehicles.