Study on Sustainable Transportation Solutions and Battery Management Systems in Hybrid Electric Vehicle.

A Thesis report with prototype of Hybrid Electric Car is submitted in partial fulfillment of the requirements for the award of Degree of Bachelor of Science in Electrical and Electronic Engineering.

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DECLARATION

I hereby declare that this Project "**Hybrid Electric Vehicle's Perspective in Bangladesh**" represents our own work which has been done in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering, and has not been previously included in a thesis or dissertation submitted to this or any other institution for a degree, diploma or other qualifications. We have attempted to identify all the risks related to this research that may arise in conducting this research, obtained the relevant ethical and/or safety approval (where applicable), and acknowledged our obligations and the rights of the participants.

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APPROVAL

The Thesis entitled **“Hybrid Electric Vehicle’s Perspective in Bangladesh”** submitted by **Joty Lasker (201-33-5338), Halima (201-33-5331), Abu Nasim Tanvir (201-33-5305) & Tasnia Anjum (201-33-5335)** has been done under my supervision and accepted as satisfactory in partial fulfillment of the requirements for the degree of **Bachelor of Science in Electrical and Electronic Engineering** in **August, 2023.**

Signed

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Dedicated

To

Our Family

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LIST OF ABBREVIATIONS

BAETE	Board of Accreditation for Engineering and Technical Education
HEV	Hybrid electric vehicles
BMS	Battery management system
EV	Electric vehicles
PHEV	Plug-in Hybrid Electric Vehicles
BEV	Battery Electric Vehicles
THD	Total harmonic distortion
LUV	Light Utility Vehicle
IWO	Invasive weed optimization
VR	Voltage Regulator
PCB	Printed Circuit Board
CVT	Continuously variable transmission
ICE	Internal Circuit Engine
RESS	Rechargeable Energy Storage Systems
IEC	International Electro Technical Commission

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ABSTRACT

Hybrid electric vehicles (HEVs) are becoming increasingly popular worldwide as a means of reducing carbon emissions and increasing fuel efficiency. However, battery management is a critical issue in the operation of HEVs, as it directly affects their performance, durability, and cost-effectiveness. This paper discusses the current state of HEV battery management from a Bangladesh perspective. Bangladesh is a developing country with a high population density, limited resources, and dependence on fossil fuels for transportation. Despite these challenges, the government has set ambitious targets for reducing greenhouse gas emissions, which includes the promotion of electric and hybrid vehicles. The adoption of HEVs in Bangladesh is still in its early stages, and there is a lack of infrastructure and knowledge about battery management.

HEV batteries need to be carefully managed to ensure their optimal performance and longevity. This includes monitoring the state of charge, temperature, voltage, and current of the battery pack, as well as balancing the cells to prevent overcharging or undercharging. Battery management systems (BMS) play a crucial role in managing HEV batteries, and they must be designed to suit the specific requirements of the vehicle and operating conditions. In the Bangladesh context, the development of appropriate BMS solutions for HEVs can be challenging due to the lack of technical expertise and infrastructure. However, efforts are being made to address this issue through collaborations between academia, industry, and government agencies. For example, research institutions are working on developing low-cost BMS solutions that can be easily integrated into existing HEV models. In conclusion, HEVs have tremendous potential in Bangladesh to reduce carbon emissions and improve fuel efficiency. Battery management is a critical issue that needs to be addressed to ensure the success of HEVs. Collaboration between different stakeholders can help overcome the challenges faced in developing and implementing effective BMS solutions for HEVs in Bangladesh.

Keywords: HEV, Battery Management, BMS, EV.

CHAPTER 1
INTRODUCTION

1.1 Background

Vehicles that get their power from electricity that is stored in batteries are referred to as electric vehicles (EVs). Electric vehicles (EVs) make use of one or more electric motors in order to move forward, as opposed to gasoline-powered automobiles, which are propelled by an internal combustion engine. Battery Electric Vehicles (BEVs) and Plug-in Hybrid Electric Vehicles (PHEVs) are the two primary categories of electric vehicles (EVs) [14]. Battery electric vehicles (BEVs) get their power purely from the electricity stored in their batteries, but plug-in hybrid electric vehicles (PHEVs) also contain an internal combustion engine that can supply additional power if it's required. When compared to typical gasoline-powered vehicles, electric vehicles (EVs) provide a number of advantages, including increased fuel efficiency, decreased pollutants, and cheaper operating costs. Nonetheless, electric vehicles come with a number of disadvantages, the most notable of which are their restricted driving range, slower charging speeds, and higher purchase prices. To find solutions to these problems, a great amount of work is being put into developing more advanced battery technology, expanding the availability of charging stations, and bringing down the price of electric vehicles. As a consequence of this, the market for electric vehicles (EVs) is expanding at a rapid rate, and numerous major automakers are making substantial investments in the research and development of new models and technologies in order to satisfy the demand for environmentally friendly transportation options. In most cases, an internal combustion engine will make up one of the power sources, while an electric motor or battery will make up the other. Hybrid electric vehicles (HEVs) have a number of benefits over conventional gasoline-powered automobiles, including increased fuel efficiency and lower pollutants. The administration of the vehicle's batteries is an essential component of both the design and operation of HEVs. In a hybrid electric vehicle (HEV), the battery is the component that supplies electricity to the electric motor. This, in turn, serves to lessen the workload placed on the internal combustion engine. Battery management systems, also known as BMS, are utilized in order to monitor the performance of the battery as well as its overall health [15]. This is done in order to guarantee that the battery functions within the allotted safe parameters and supplies consistent power to the electric motor. BMS normally consists of sensors that measure several factors like voltage, temperature, and current, in addition to algorithms that manage charging and discharging of the battery. These parameters include: The remaining life of the battery can be estimated by a sophisticated BMS, which can then modify the charging and discharging cycles to ensure that the battery has the longest possible lifespan. In general, efficient battery management is essential to the performance, safety, and longevity of HEVs. Advances in BMS technology are helping to make these cars more efficient and reliable, which is a direct result of the improvements that have been made.

1.2 Problem Statement

The investigation of the battery management of hybrid electric vehicles (HEVs) in the context of Bangladesh is the problem statement. In comparison to conventional gasoline-powered vehicles, hybrid electric vehicles (HEVs) provide better fuel economy and lower pollutants, which has contributed to the rise in popularity of HEVs. On the other hand, the performance, dependability, and cost of HEVs are largely determined by the battery management system (BMS). There is an increasing demand for cleaner and more energy-efficient vehicles in Bangladesh, where the transportation sector is a significant contributor to air pollution and greenhouse gas emissions. HEVs have the potential to meet this need, but their acceptance is subject to a number of hurdles, including the availability of charging infrastructure, the price of the vehicles, and the maintenance requirements. As a result, the primary objective of this issue statement is to conduct an assessment of the current condition of HEV battery management in Bangladesh and locate areas that could benefit from being improved. This includes reviewing the performance of BMSs in local settings, analyzing the current infrastructure for charging and maintaining HEV batteries, and researching options to address any gaps or restrictions that are found. By encouraging the use of high-efficiency vehicles (HEVs) and improving the management of their batteries, the ultimate objective is to assist Bangladesh in its transition toward a transportation system that is less harmful to the environment.

1.3 Objectives

The necessity to address the growing issue of environmental pollution and the depletion of fossil fuels is the driving force behind the decision to conduct research on hybrid electric vehicles (HEVs) and the management of their batteries. Because they produce fewer hazardous pollutants and have a higher fuel efficiency, hybrid electric vehicles (HEVs) are seen as a potentially useful replacement for conventional automobiles fueled by gasoline. Yet, the performance of a hybrid electric vehicle (HEV) is heavily dependent on the battery system that it employs. When it comes to the performance and longevity of the batteries that are utilized in HEVs, the battery management system, also known as the BMS, is a very important component. Hence, in order to make improvements to the design and functionality of these vehicles, it is necessary to have a fundamental understanding of the operating principles of HEVs as well as the management of their batteries. In addition, the growing demand for hybrid electric vehicles (HEVs) and the rapid advancements in battery technology make it necessary to conduct research on the development of new battery management systems that can improve the performance, reliability, and safety of HEVs. This research must be carried out in order to meet the demands of the market. The research of hydrogen fuel cell vehicles (HEVs) and the management of their batteries has important repercussions for the automobile industry, the environment, and society as a whole. It could result in the creation of transportation systems that are both more efficient and more environmentally friendly, which would help solve the difficulties posed by climate change as well as the dependence on fossil fuels.

1.4 Brief Methodology

Hybrid electric vehicles (HEVs) use a combination of an internal combustion engine and one or more electric motors to power the vehicle. The methodology for building HEVs involves several key steps:

1. Vehicle design: The first step in building an HEV is to design the vehicle. This includes determining the size, weight, and shape of the vehicle, as well as selecting the appropriate components and materials.

2. Component selection: The next step is to select the components that will be used in the hybrid system, including the engine, electric motor(s), battery pack, transmission, and other supporting systems.
3. System integration: Once the components have been selected, they must be integrated into a cohesive hybrid system. This involves designing the control algorithms that manage the interaction between the engine, motor(s), and battery pack.
4. Testing and validation: After the hybrid system has been integrated, it must be tested and validated to ensure that it meets performance and efficiency targets. This involves both laboratory testing and real-world driving tests.
5. Production: If the HEV passes all tests and meets performance targets, it can move into production. This involves manufacturing the vehicle and its components at scale, and ensuring that quality control standards are met throughout the production process.

Overall, building an HEV requires expertise in mechanical engineering, electrical engineering, computer science, and other related fields. It also requires a deep understanding of the complex interactions between different components in the hybrid system.

1.5 Organization

This report consists of seven chapters, and this section provides insight into all seven chapters.

The first chapter contains the following elements:
An introductory presentation.
Problem statement
Objective
Brief Methodology
Structure of the article.
Chapter 2: Literature review.
Chapter 3: Describes the introduction of our thesis, the design and components of the system, the classification of hybrid electric vehicles battery and the cost management of Bangladesh and comparison USA, Germany market.
Chapter 4: Discuss about result analysis and discussion.
Chapter 5: Covers tasks, schedules, and milestones.

Chapter 6: Describe about the impact assessment of the document on global economic, social and environmental impacts.

The final chapter describes the conclusions and future recommendations of our Project.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

The capacity of hybrid electric vehicles, often known as HEVs, to combine the advantages of both gasoline and electric power has contributed to the rise in popularity of these vehicles over the past several years. Nonetheless, enhancing the energy management of HEVs is essential if one want to maximize the efficiency of these vehicles and reduce the emissions they produce.

Using advanced control algorithms that are able to optimize the performance of the powertrain components is one strategy that may be utilized to improve energy management. In order to achieve the greatest possible savings on fuel and the fewest possible pollutants, these algorithms can be programmed to coordinate the power output of the internal combustion engine and the electric motor. A further strategy would be to enhance the energy storage system that is employed in HEVs by introducing batteries or super capacitors that are of a higher efficiency. This can help to reduce the amount of energy that is wasted during activities such as regenerative braking and other processes, which in turn contributes to an improvement in fuel economy and a reduction in emissions. In addition, enhancements can be made to the vehicle's aerodynamics as well as efforts to reduce its overall weight. Because of these modifications, the overall amount of energy needed to propel the vehicle forward may be lowered, which in turn may result in increased fuel efficiency and reduced emissions. In conclusion, there are a number of different measures that may be taken in order to improve the energy management of hybrid electric vehicles. These include the use of improved energy storage systems, advanced control algorithms, and improvements in vehicle design. By the application of these solutions, we will be able to achieve improved fuel economy and reduce our overall carbon impact.

2.2 Related Research

In [1] The comparison study that was developed under the selected design scenario shows that the proposed design approach, which is based on modular battery packs and multilevel technology, has the potential to reduce inverter losses by up to 55%, motor ac-voltage total harmonic distortion by up to 65%, and rms common-mode voltage by up to 75%. In this study, the possible benefits that can be realized by a powertrain design strategy that is based on combining a modular battery bank with multilevel NPC traction inverter topologies are discussed.

In [2] This research proposes an isolated converter topology for plug-in hybrid electric vehicles (PHEVs), with the goal of maintaining battery-charging functions while using a smaller number of power electronic devices than the conventional topology requires. The results of the simulation were validated in MATLAB, and they indicated that the proposed NN–IPSO-based isolated converter topology decreases the amount of Total Harmonic Distortion (THD) to 3.69% and the amount of power losses to 0.047 KW, while also increasing the efficiency to 99.823%.

In [3] This article focuses on a comprehensive evaluation of all available information on EV configurations, battery energy sources, electrical machines, charging processes, optimization approaches, impacts, trends, and likely future development paths. The purpose of this paper is to present a comprehensive overview of existing EV technology and potential avenues for future advancement in order to facilitate future study in this field.

In [4] The proposed examination of virtual prototyping has been broken up into two levels: the thermal simulation of a single cell and the CFD analysis of a whole battery module. This workflow has been utilized to provide help for the design of a battery pack for a prototype of an environmentally friendly hybrid vehicle.

In [5] The purpose of this study is to make an effort to assess various possible battery technologies and the considerations that need to be considered prior to using these battery technologies in a Hybrid Electric Vehicle (HEV) or a Plug-in Hybrid Electric Vehicle (PHEV). In the final section, an attempt is made to evaluate the efficiency of the two most common battery technologies, namely the NiMH Battery and the Lithium

Ion Battery, when applied to a hybrid electric vehicle or plug-in hybrid electric vehicle. For the sake of this discussion, a typical example will suffice.

In [6] The purpose of this research is to create a novel, patented, bidirectional direct current to direct current (DC/DC) converter (BDC) that links a main energy storage (ES1), an auxiliary energy storage (ES2), and a DC-bus with varying voltage levels for use in hybrid electric vehicle systems. An illustration of the planned BDC topology featuring dual-battery energy storage is provided. The findings indicate that the BDC that was developed can be successfully implemented in FC/HEV systems to generate hybrid power architecture.

In [7] This experiment makes use of an electric vehicle (EV) that was converted from a Chevrolet light utility vehicle (LUV), which is a truck that is roughly the same size and form of a Chevrolet S-10. The conversion took place at the Universidad Catolica de Chile. We compare and discuss the results of many different experiments conducted under a variety of settings. The primary-source voltage, automobile speed, and instantaneous currents in both terminals are among the characteristics that are measured and stored by the control system that is powered by a digital signal processor, or DSP.

In [8] This evaluation, we hope, will lead to increased efforts being made toward the development of economical, hydrogen-viable, longer-lifetime super capacitors and batteries, as well as efficient electrical interfaces and well-performed EMS for future FC HEV combinations with batteries and super capacitors. In this article, numerous features and classifications of fuel cell–HEV EMS are broken down and discussed.

In [9] A rapid transient response is realized thanks to the combination of the SMC and invasive weed optimization (IWO), which can handle a wide range of transient load variations as well as input voltage disruptions. In conclusion, the effectiveness of the manufactured electric vehicle that was fitted with the suggested controller was evaluated by practical testing in the context of the stochastic driving cycle for electric vehicles.

In [10] The proposed model requires less trip information but still manages to achieve the best improvement in fuel economy when compared to existing models that also use short-term prediction. This is shown by a comparison to the existing models. In this paper, we propose an evolutionary algorithm-driven generic framework for online EMS for plug-in hybrid electric vehicles (PHEVs).

2.3 Summary

All of the previously mentioned subjects have been extensively covered in the most recent literature, which has served as a significant source of inspiration for us as we work on this thesis report.

CHAPTER 3
MATERIALS AND METHODS

3.1 Introduction

The system design and components, block design specifications, circuit design analysis, functioning principles, and the experimental setup of our system are all covered in this chapter.

3.2 System Design and Components

Equipment for Proposed System:

- Arduino UNO
- Motor
- Bluetooth Module HC-05
- USB cable for uploading the code
- Solar Panel
- AC to DC converter
- Regulator
- Switch
- PCB Board

Arduino UNO

The ATmega328 serves as the controller for the microcontroller that is known as the Arduino UNO. This device is classified as a microcontroller. When working on an electronics project, beginners often choose to use the Arduino UNO board as their platform of choice. The only sort of Arduino board that exists is the Arduino UNO board. The Arduino board is the one that gets the most use out of all the different Arduino boards. The circuit board has a total of 15 components on it, including one power jack, one USB connector, one reset button, an ICSP header, and 14 digital input/output pins. Six of the digital input pins are analogue input pins.

Fig 3.1: Arduino UNO

Motor

As a common voltage measurement, 12v motors are used in a variety of applications and industries, including: industrial manufacturing, for use in the powering of smaller factory automation equipment; residential, to power household and home improvement tools like sanders and power drills.

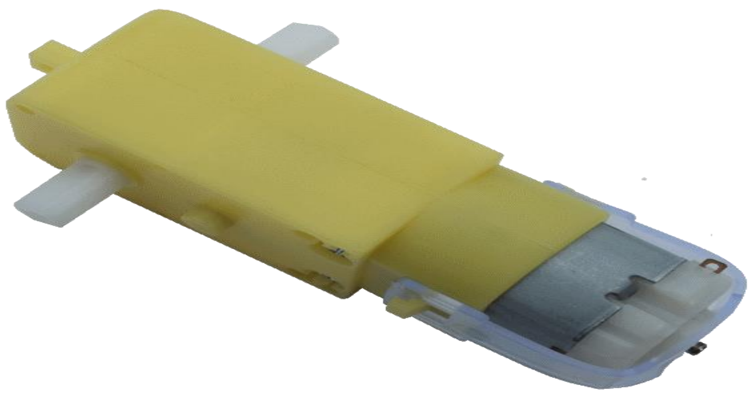

Fig 3.2: Motor

Bluetooth Module HC-06

The HC-06 Bluetooth Module enables the construction of a transparent wireless serial connection using Bluetooth SPP (Serial Port Protocol). It communicates via serial transmission, making it simple to connect to a controller or PC.

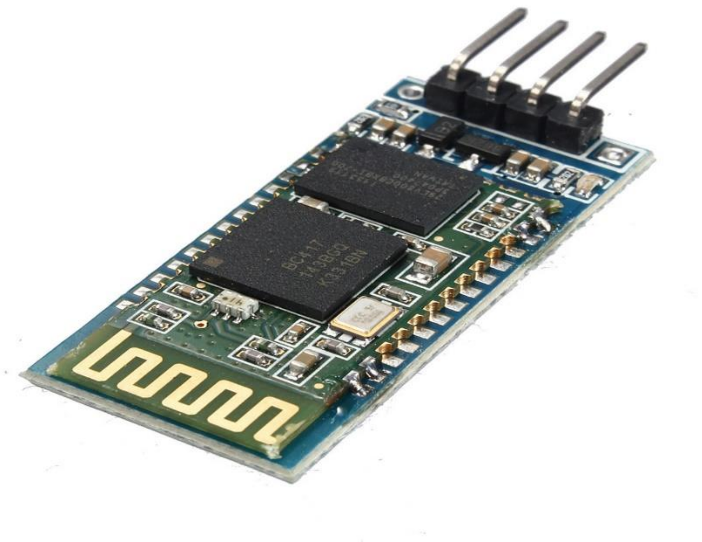

Fig 3.3: Bluetooth Module HC-06

Solar Panel

Only low-load devices, such as laptops, mobile phones, CCTV cameras, motion sensor devices, solar power banks, and solar street lights, can benefit from the use of a solar panel with a voltage of 6 volts. Consequently, if you wish to charge gadgets with a low load while you are on the go, you might consider purchasing a solar panel that operates at 6 volts.

Fig 3.4: Solar Panel

AC to DC converter

Direct current (DC) flows in just one way, but alternating current (AC) runs in both directions at the same time. An electrical device known as a rectifier is responsible for converting alternating current (AC), which flows in both directions at the same time, into direct current (DC).

Fig 3.5: AC to DC converter

Regulator

Types of Voltage Regulators and Their Operation Regardless of changes in the input voltage or load conditions, a voltage regulator is a circuit that generates and maintains a set output voltage. The voltages from a power source are maintained by voltage regulators (VRs) in a range that is compatible with the other electrical components.

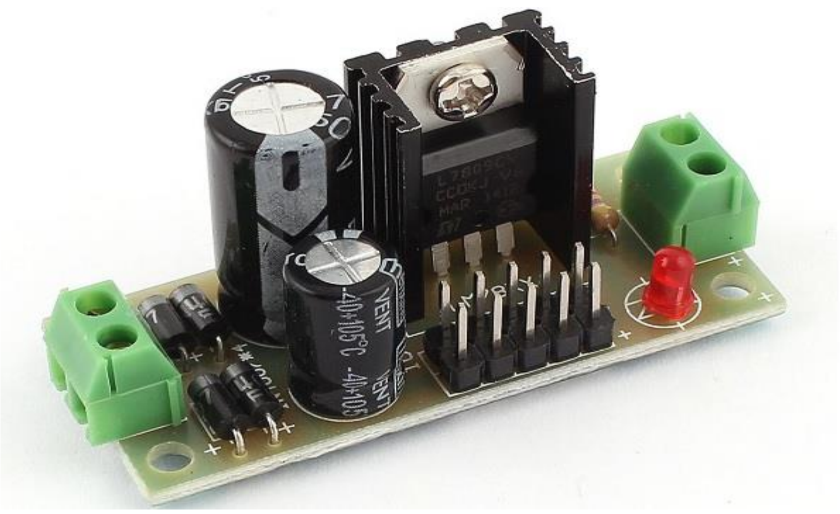

Fig 3.6: Regulator

Switch

A switch is a device that, in response to an external force, causes a change in the mechanical state of an electric signal. Electric circuits can be turned on and off as well as switched using switches. Switches are utilised for both of these functions**.**

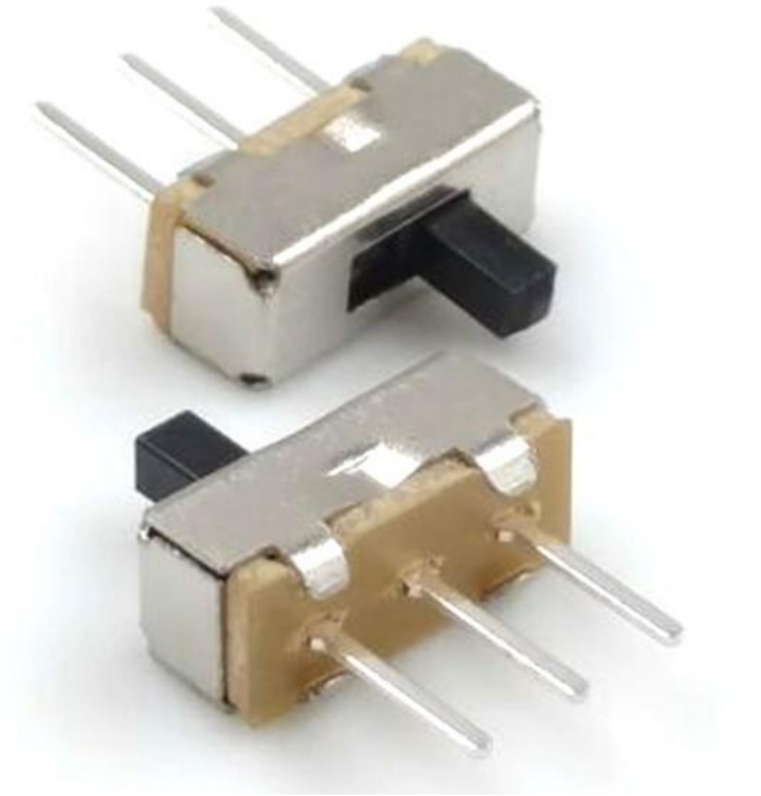

Fig 3.7: Switch

There are several types of electric vehicle batteries, each with its own advantages and disadvantages. The most common type of battery used in electric vehicles today is the lithium-ion battery, but there are also other types of batteries that are being developed for use in electric vehicles. Here are some of the most common types of electric vehicle batteries:

PCB Board

A material that is not electrically conductive but on which conductive lines have been printed or etched might be referred to as a printed circuit board (PC board), printed circuit board (PCB), or PC board. In order to create a functional circuit or assembly, electronic components are first installed on the board, and then traces connect each of the components to one another.

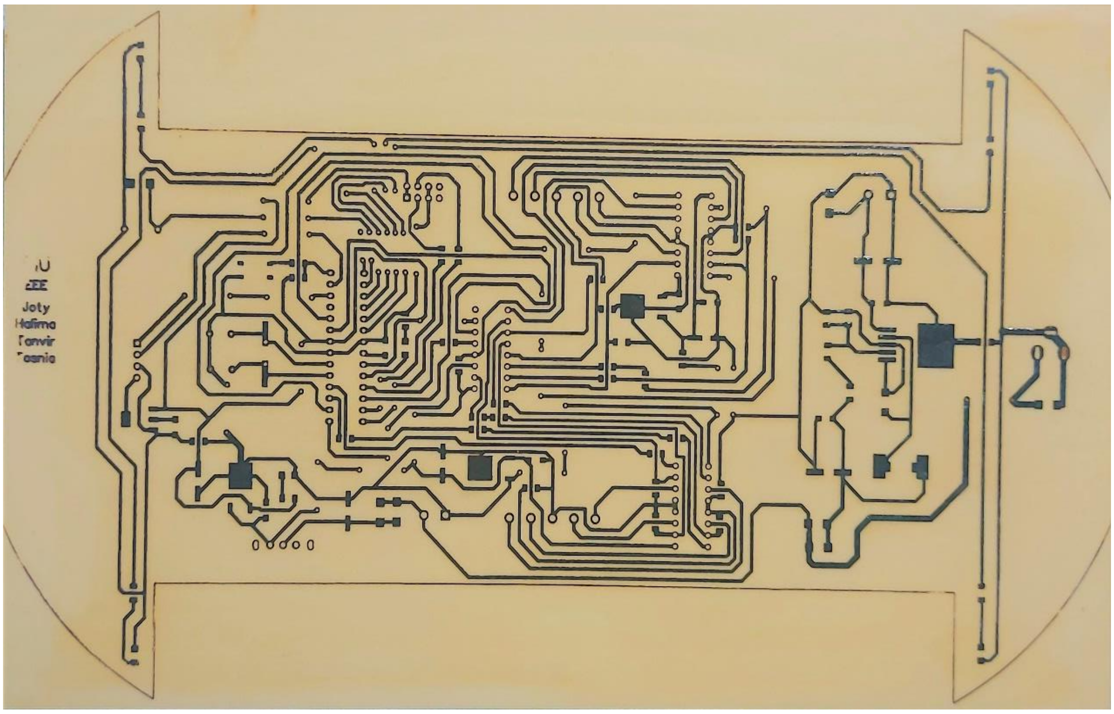

Fig 3.8: PCB Board

Lithium-Ion (Li-ion) – This is currently the most commonly used battery type in electric vehicles. Li-ion batteries offer a good combination of energy density, power output, and cycle life [13].

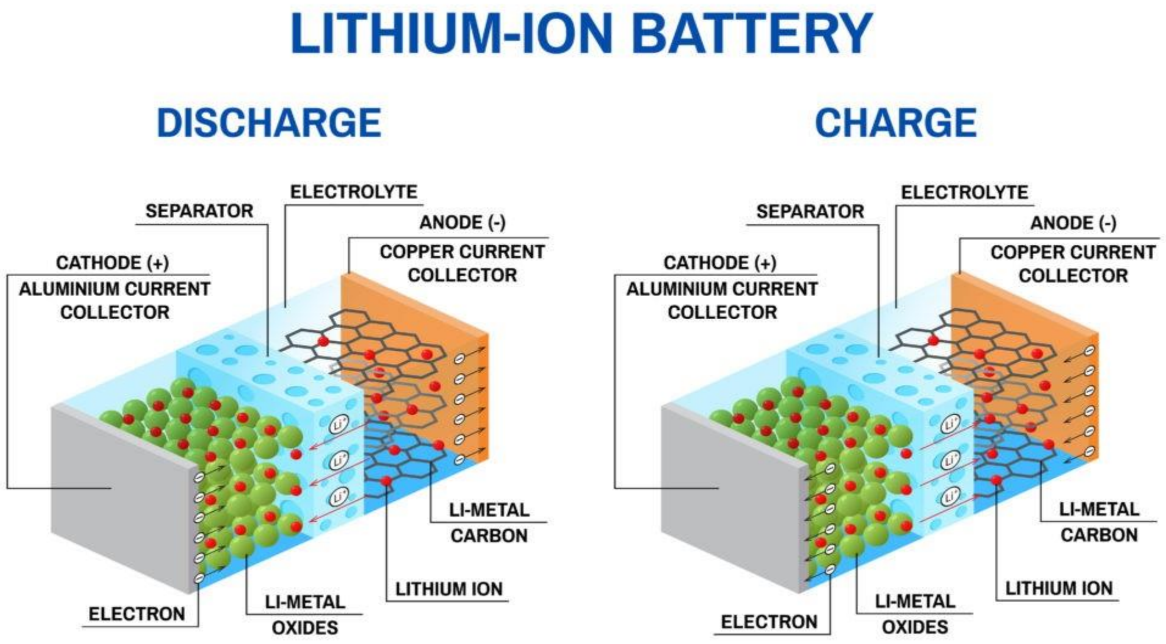

Fig: 3:9 Lithium-Ion Batteries

Nickel-Metal Hydride (NiMH) – NiMH batteries have been used in electric vehicles in the past, but they are less common now due to their lower energy density and heavier weight compared to Li-ion batteries [17].

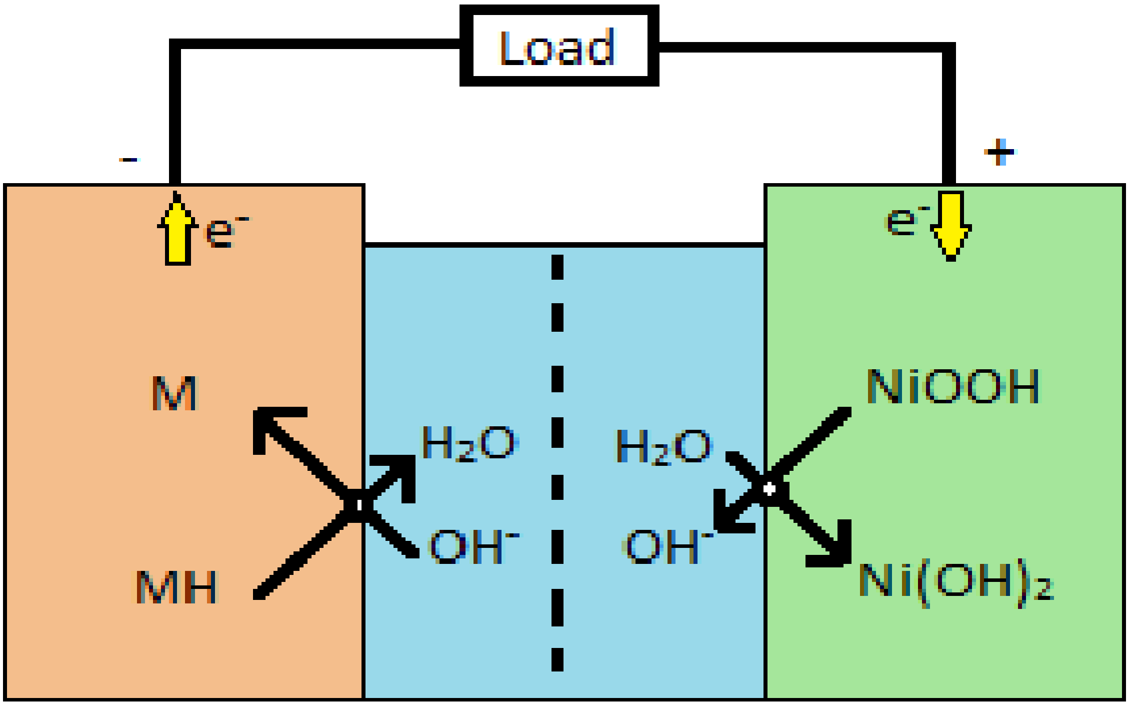

Fig: 3:10 Nickel-Metal Hydride (NiMH)

Lead Acid – Lead acid batteries are an older technology that is not commonly used in modern electric vehicles due to their low energy density and heavy weight.

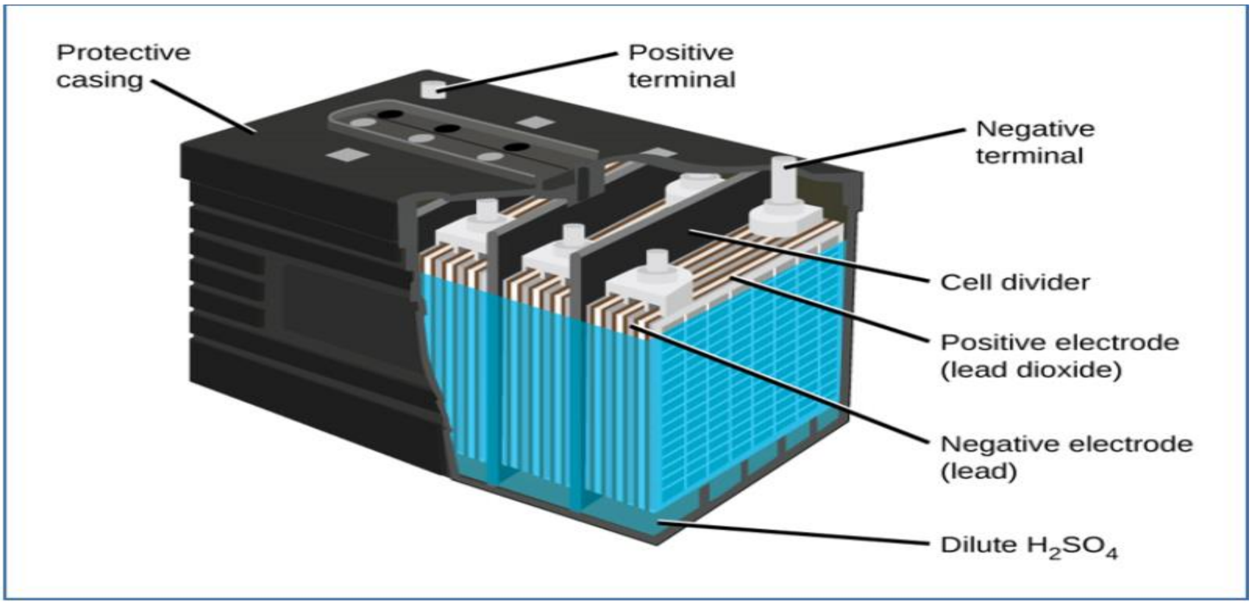

Fig: 3:11 Lead Acid

Sodium-Ion – Sodium-ion batteries are another emerging technology that could offer a more cost-effective alternative to Li-ion batteries, while still offering good performance [16].

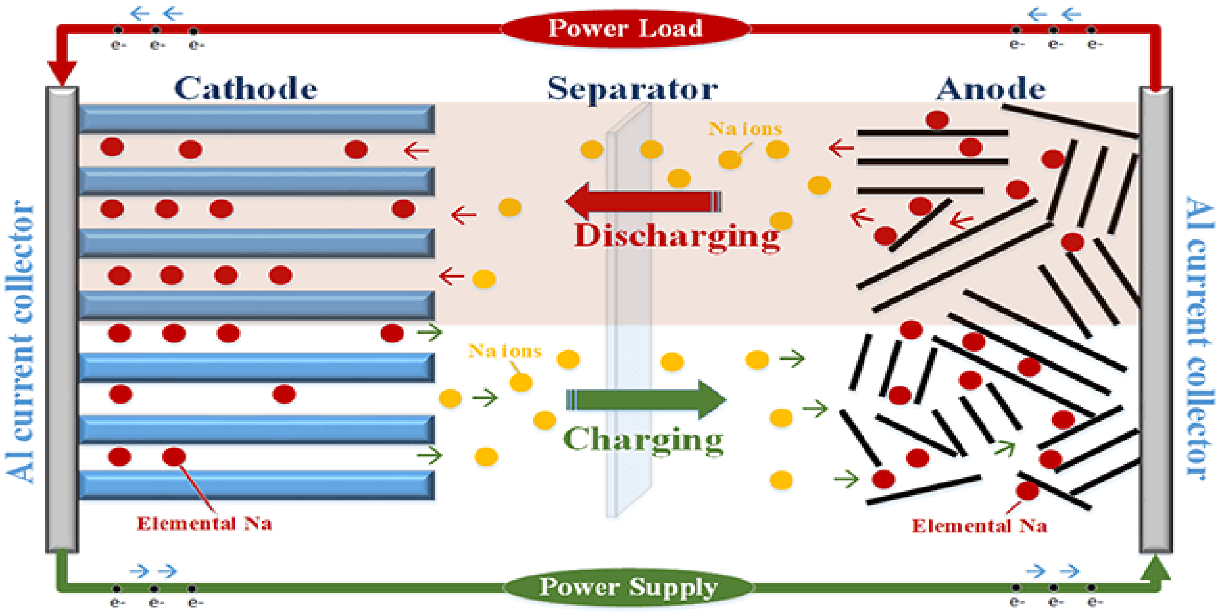

Fig: 3:12 Lead Acid

Each type of battery has its own unique set of characteristics, and the choice of battery depends on factors such as cost, performance, and safety requirements

Here is a comparison table of some popular hybrid electric vehicle (HEV) batteries:

Battery Type	**Energy Density (Wh/kg)**	**Power Density (W/kg)**	**Lifespan**	**Cost ($)**
Nickel-Metal Hydride (NiMH)	60-120	200-300	100,000 miles	$1,500-$2,500
Lithium-Ion (Li-ion)	100-265	250-340	150,000 miles	$3,000-$5,000
Lithium-Polymer (Li-poly)	130-240	150-220	100,000 miles	$4,000-$6,000
Solid State	400-500+	500-600+	500,000 miles	Still in development

Table 3.1: hybrid electric vehicle (HEV) batteries

Take into account that these are only approximations and that they may change depending on the particular model of battery and the manufacturer [12]. When evaluating HEV batteries, additional considerations including charging time, weight, and environmental impact should also be taken into account.

Here is a comparison table of some popular hybrid electric vehicle (HEV) batteries and their estimated lifespans:

Battery Type	**Lifespan**
Nickel-Metal Hydride (NiMH)	8-10 years / 100,000 miles
Lithium-Ion (Li-ion)	10-12 years / 150,000 miles
Lithium-Polymer (Li-poly)	8-10 years / 100,000 miles
Solid State	Still in development, but projected lifespan is over 500,000 miles

Table 3.2: hybrid electric vehicle (HEV) batteries and their estimated lifespans

Take into notice that these are only approximations and that they may change depending on the particular model of battery and the manufacturer. Battery life can be impacted by a variety of factors, including the environment in which it is used, how often it is charged, and the temperature. To get the most out of your HEV battery and ensure that it lasts as long as possible, it is essential to follow the maintenance and usage guidelines provided by the manufacturer.

Here's a comparison table for electric vehicle production costs in USA, Germany, Italy, and Bangladesh:

Country	**Average Electric Vehicle Production Cost**
USA	$18,000 - $20,000
Germany	$22,000 - $24,000
Italy	$18,000 - $20,000
Bangladesh	$12,000 - $15,000

Table 3.3: electric vehicle production costs

these are just approximate numbers and the actual production costs may vary depending on a number of factors such as the type of vehicle, manufacturing processes, labor costs, etc.

Here's a comparison table for electric vehicle battery management production costs in USA, Germany, and Italy:

Country	**Average Electric Vehicle Battery Management Production Cost**
USA	$5,000 - $7,000
Germany	$6,000 - $8,000
Italy	$4,000 - $6,000

Table 3.4: electric vehicle battery management production costs

These are just approximate numbers and the actual production costs may vary depending on several factors. It's also worth noting that the cost of battery management systems is a significant portion of the overall cost of an electric vehicle, so manufacturers are constantly working to reduce these costs while maintaining high levels of performance and reliability [18].

Taxation is the primary tool that the government uses to have a significant amount of influence over the vehicle market in Bangladesh. Because of Bangladesh's exceptionally high import tariff on automobiles, which can reach up to 827% of the vehicle's label price, Bangladeshi [11] consumers frequently do not place much stock in the prices listed on the vehicles' window stickers.

Cylinder Capacity (CC)	Total Tax Incidence		
	CBU Gasoline	CKD Gasoline	Hybrid CBU
<= 1600	128%	89%	N/A
<= 1800	N/A	N/A	89%
1601 - 2000	212%	128%	N/A
1801 - 2000	N/A	N/A	127%
2001 - 3000	366%	212%	150%
3001 - 4000	596%	519%	212%
>4000	827%	742%	520%
CBU Electric	59%		

Table 3.5: Tax Incidence on Automobiles in Bangladesh

The Bangladesh Energy Regulatory Commission's tariff on electric usage is a major element in the uptake of EVs and PHEVs in the country. These prices are a major factor in determining whether or not the switch to electric and hybrid vehicles will save money.

User Class	Low Tension (230/400 V)	Medium Tension (11 kV)	High Tension (33 kV)
Residential	3.50-10.70	7.20-10.00	7.20-10.00
Commercial	9.27-12.36	7.56-10.50	7.47-10.38
Industrial	-	7.34-10.19	7.25-10.06

Table 3.6: Tariff on Electric Usage (BDT/kWh)

In Bangladesh, the widespread use of electric vehicles faces significant resistance from a lack of developed infrastructure throughout the country. The table that follows provides a comparison of the infrastructure for charging electric vehicles in a number of different countries:

Country	Total EV Charging Stations	Road Distance between Every Charging Station
Bangladesh	14	26365 km
United States[11]	41400	159 km
United Kingdom[12]	35000	11 km
Japan[13]	18000	68 km
India[14]	933	5036 km

Table 3.7: EV Charging Infrastructure Comparison

3.3 Design Specifications

The powertrain of a hybrid electric vehicle typically consists of an internal combustion engine and an electric motor. The engine can be gasoline or diesel-powered, while the electric motor is powered by a battery pack. The battery pack is one of the most important components of a hybrid electric vehicle. It stores the electrical energy that powers the electric motor. The size and capacity of the battery pack depend on the desired range and performance of the vehicle. A regenerative braking system helps to recharge the battery pack during braking. When the brakes are applied, the electric motor acts as a generator, converting kinetic energy into electricity and storing it back in the battery pack. Most hybrid electric vehicles have a continuously variable transmission (CVT) that allows the engine and electric motor to work together seamlessly. Some hybrids also use a dual-clutch transmission. Hybrid electric vehicles are designed to be more fuel-efficient than traditional gasoline-powered cars. The fuel efficiency of a hybrid depends on factors such as the size of the engine, the size of the battery pack, and driving conditions. The range of a hybrid electric vehicle depends on the size of the battery pack and the efficiency of the powertrain. Most hybrid electric vehicles can travel on electric power alone for a few miles before switching over to the internal combustion engine. Charging Time: The charging time of the battery pack depends on the size of the battery and the charging infrastructure available. Most hybrids can be charged overnight using a standard 120-volt outlet. Safety features such as anti-lock brakes, traction control, and stability control are standard on most hybrid electric vehicles. Some hybrids also offer advanced safety features like lane departure warning and forward collision warning. The price of a hybrid electric vehicle depends on the size, features, and brand of the vehicle. Hybrid electric vehicles typically cost more than traditional gasoline-powered cars, but they can save money in the long run by using less fuel.

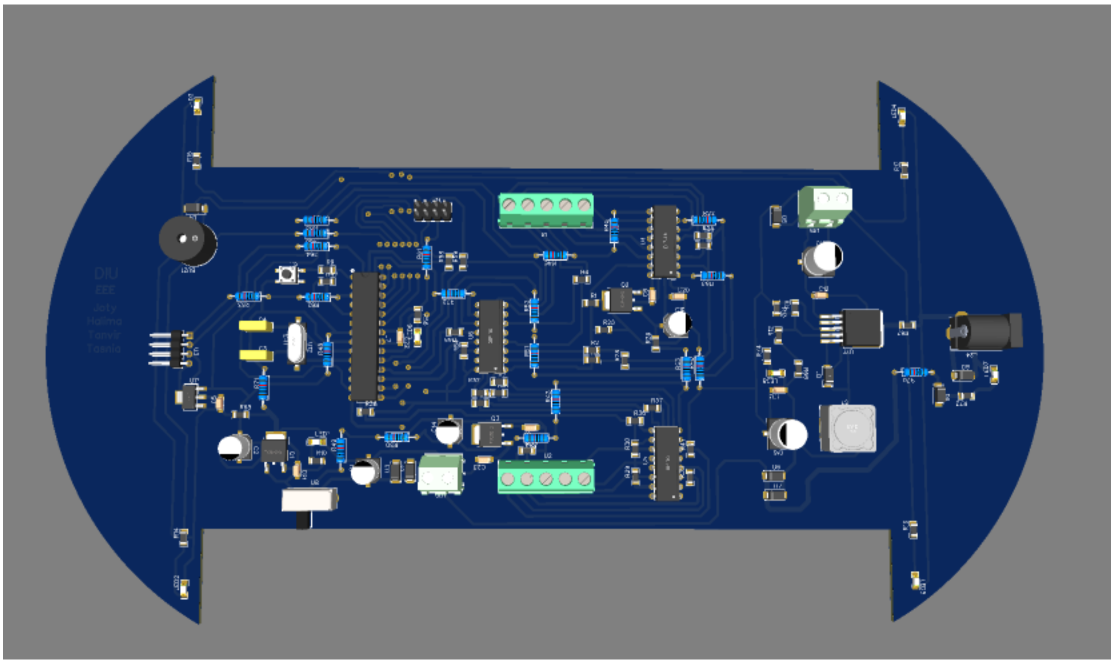

Fig. 3:13 Circuit diagram of a Torch

3.4 System Analysis

A hybrid electric vehicle (HEV) is a type of vehicle that combines an internal combustion engine (ICE) with an electric motor and battery system to provide propulsion. The goal of a HEV is to increase fuel efficiency and reduce emissions compared to a traditional gasoline-powered vehicle.

To analyze the system of a HEV, we need to consider several components:

1. Internal Combustion Engine: This is the primary power source for the vehicle, providing energy to turn the wheels and move the car forward. The engine may be fueled by gasoline, diesel, or other fuels.
2. Electric Motor: The electric motor provides additional power to the wheels and can be used to assist the ICE during acceleration or to drive the vehicle at low speeds.
3. Battery Pack: The battery pack stores electrical energy generated by regenerative braking and from the ICE generator. It provides power to the electric motor and other vehicle systems as needed.
4. Power Electronics: The power electronics system controls the flow of electricity between the ICE, electric motor, and battery pack. It also manages the charging and discharging of the battery.
5. Transmission: The transmission transfers power from the engine and electric motor to the wheels, allowing the vehicle to move at different speeds.
6. Regenerative Braking: When the brakes are applied, the electric motor acts as a generator, converting the kinetic energy of the vehicle into electrical energy that is stored in the battery pack.
7. Control System: The control system monitors and manages the operation of the various components of the HEV to optimize performance and efficiency.

By analyzing these components and how they work together, engineers can design HEVs that are more efficient, have better performance, and emit fewer pollutants than traditional gasoline-powered vehicles.

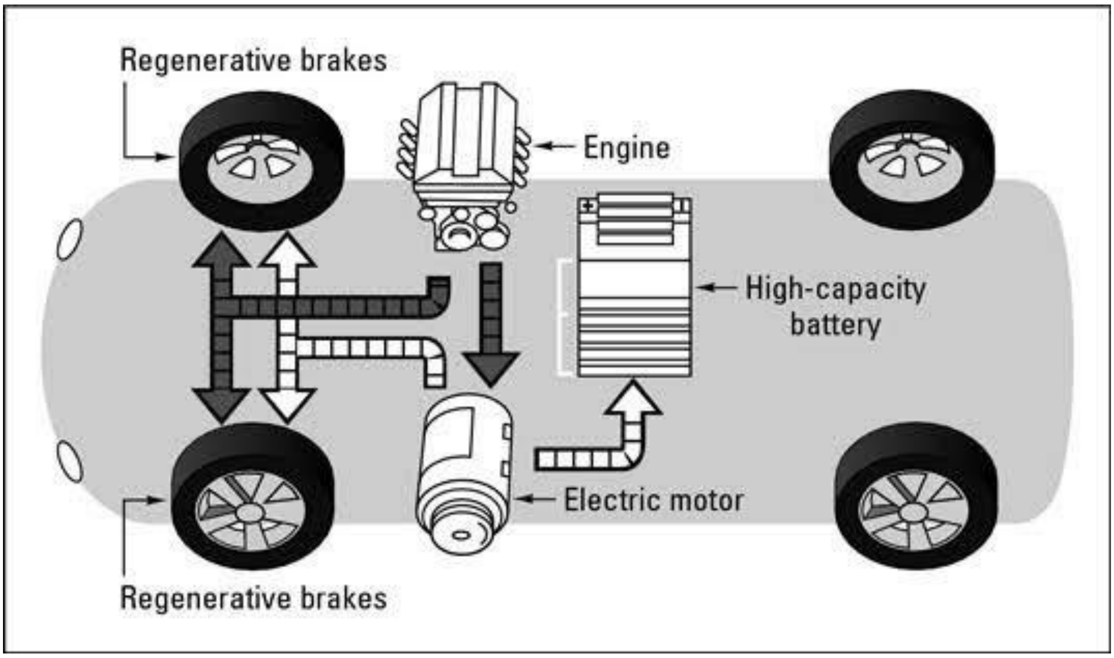

Fig: 3:14 EV Regenerative Breaks

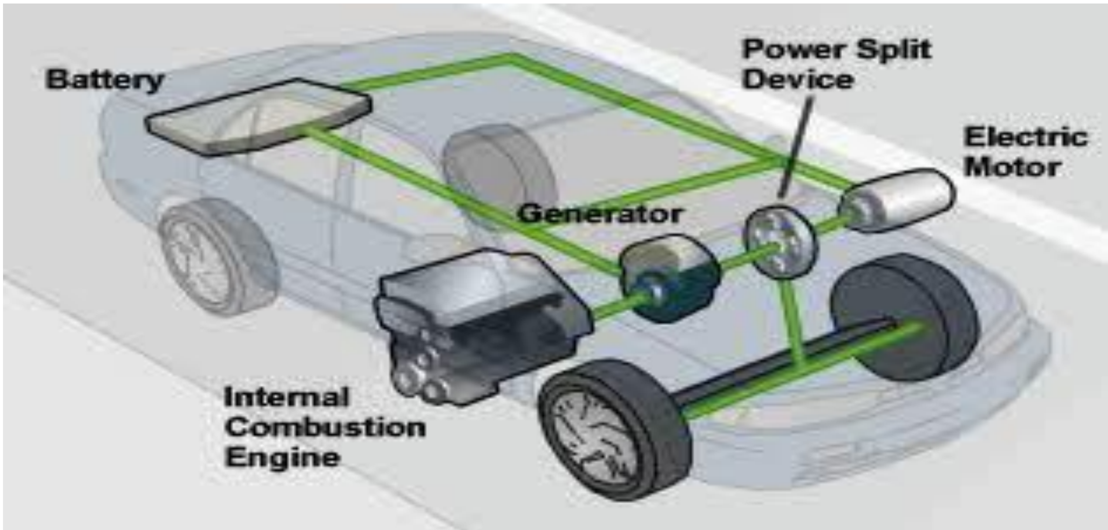

Fig: 3:15 EV Generator

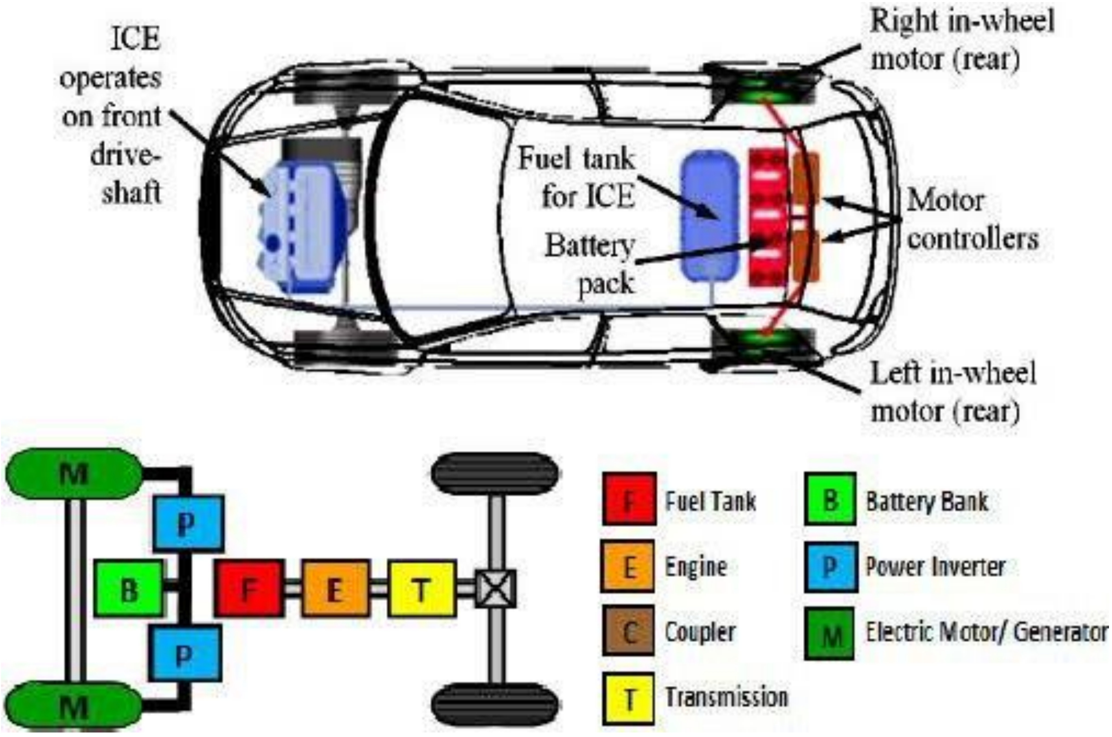

Fig: 3:16 Fuel tank for ICE battery pack

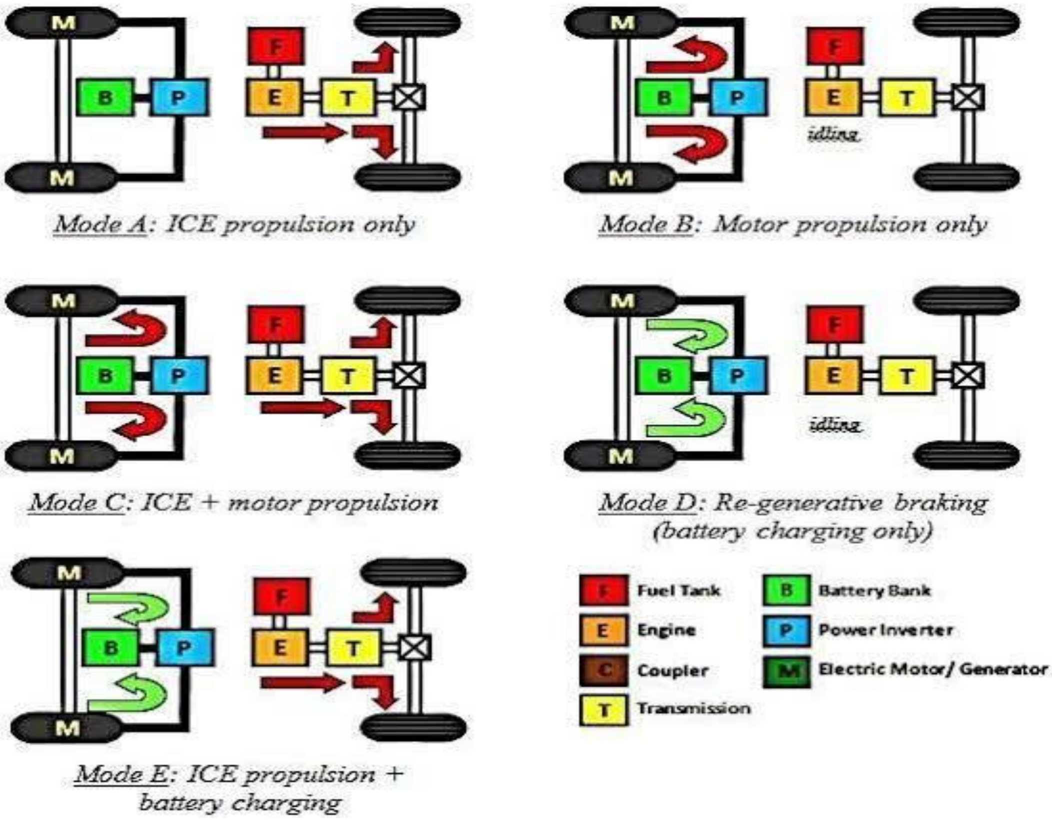

Fig: 3:17 Combination of Propulsion

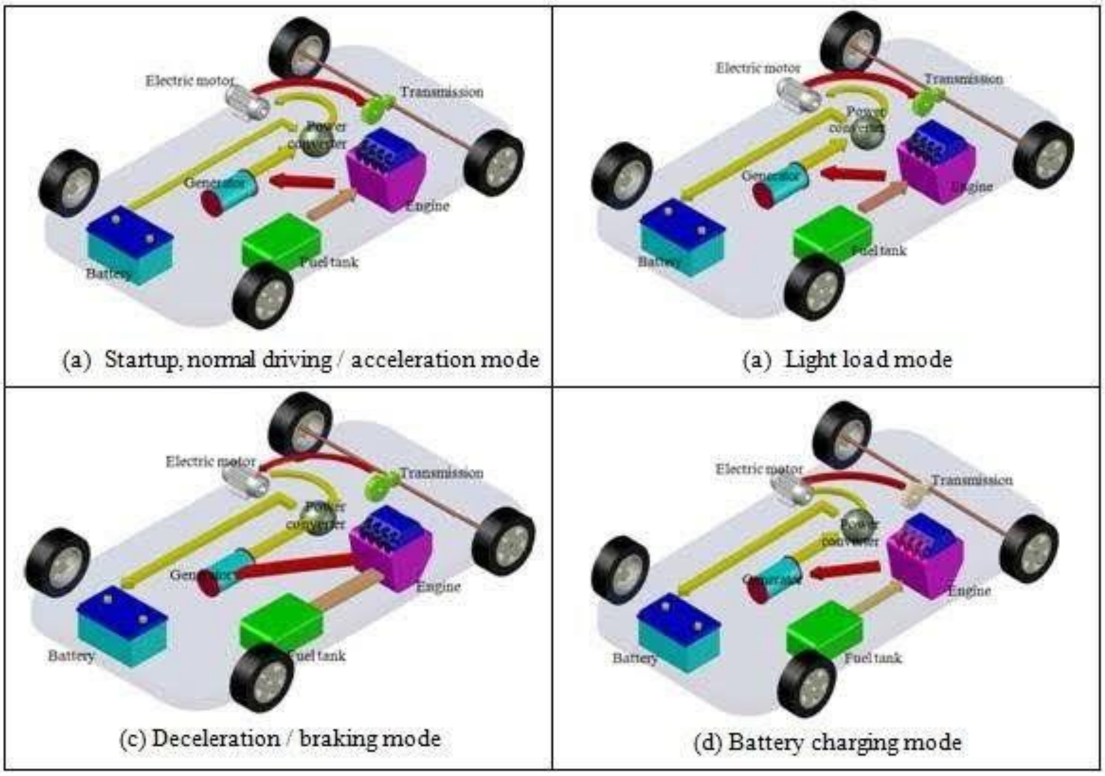

Fig: 3:18 Types of mode

Fig: 3:19 Fuel tank for ICE

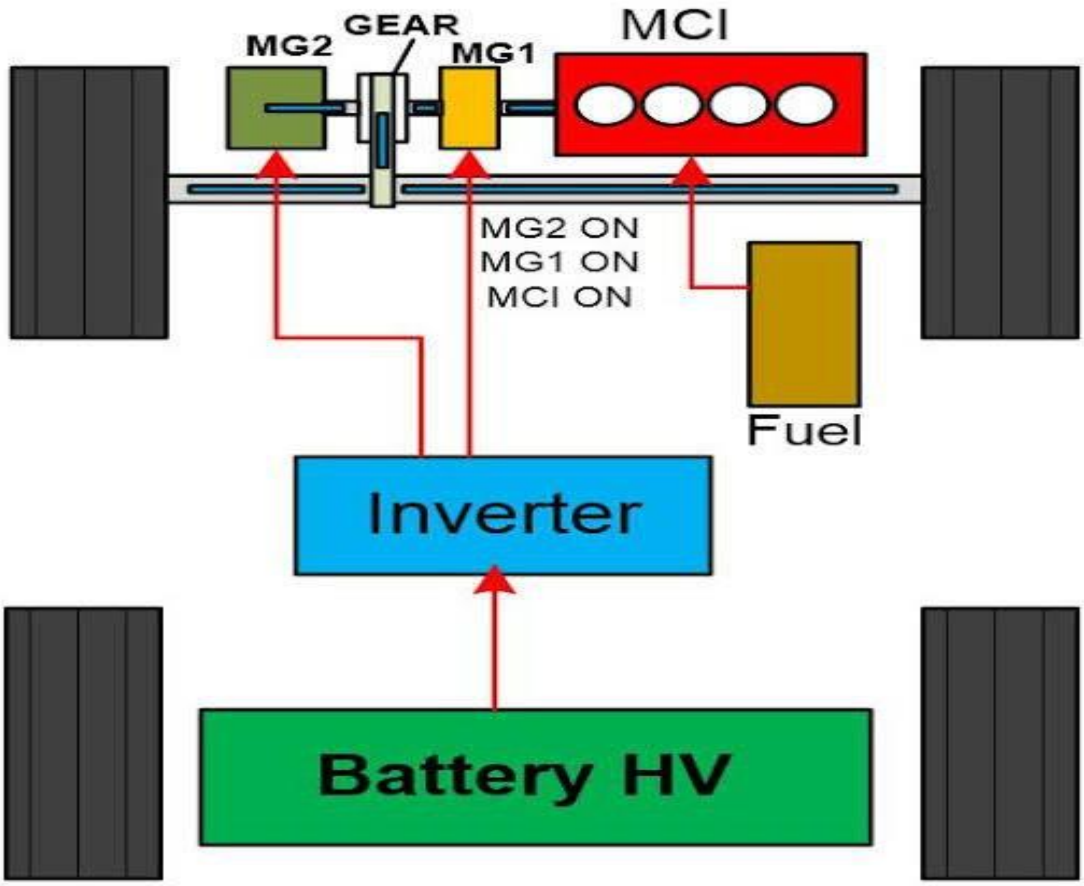

Fig: 3:20 Block diagram

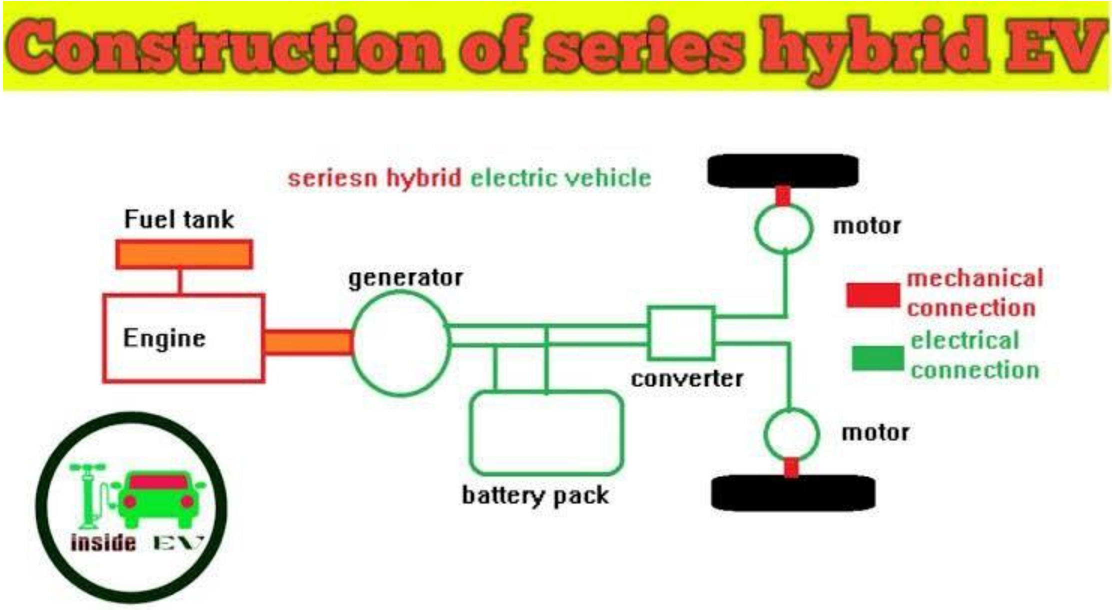

Fig: 3:21 series hybrid electric vehicle

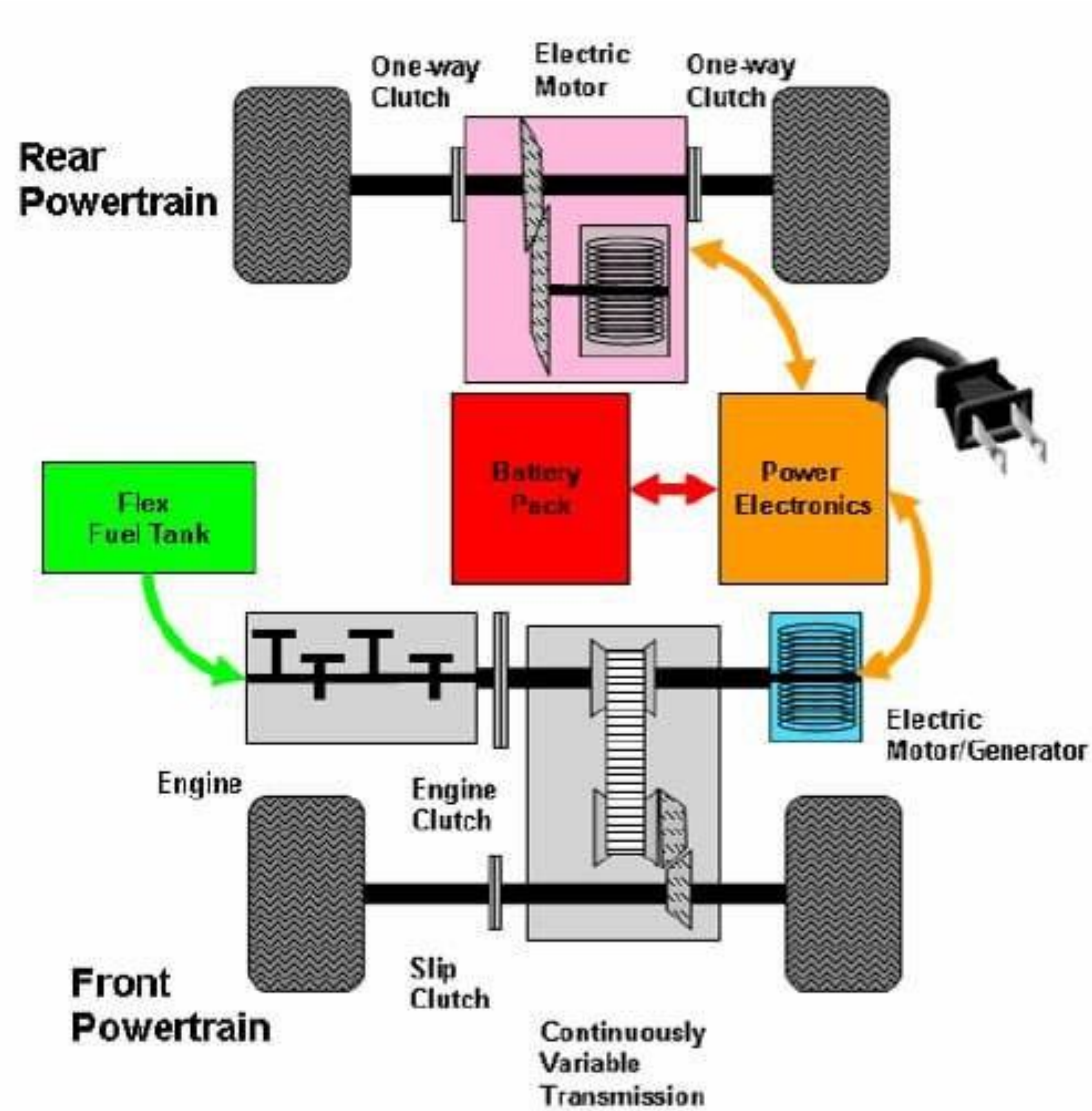

Fig: 3:22 Powertrain

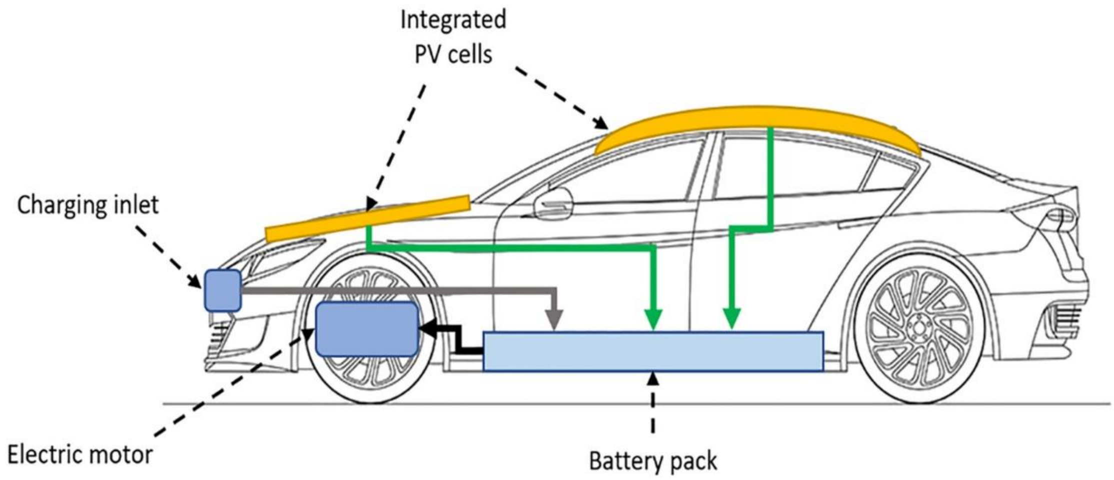

Fig: 3:23 Battery, charging and PV cells

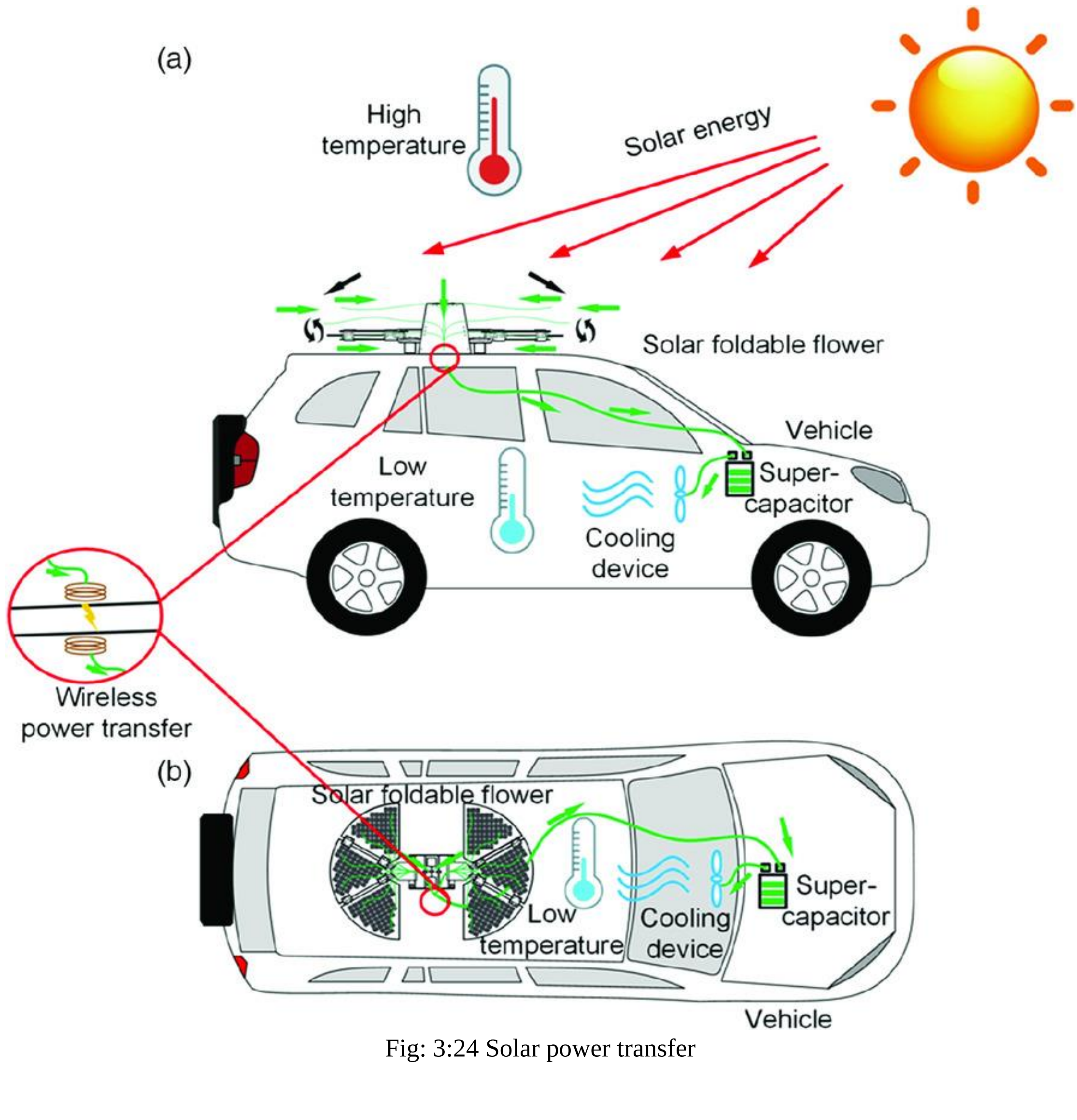

Fig: 3:24 Solar power transfer

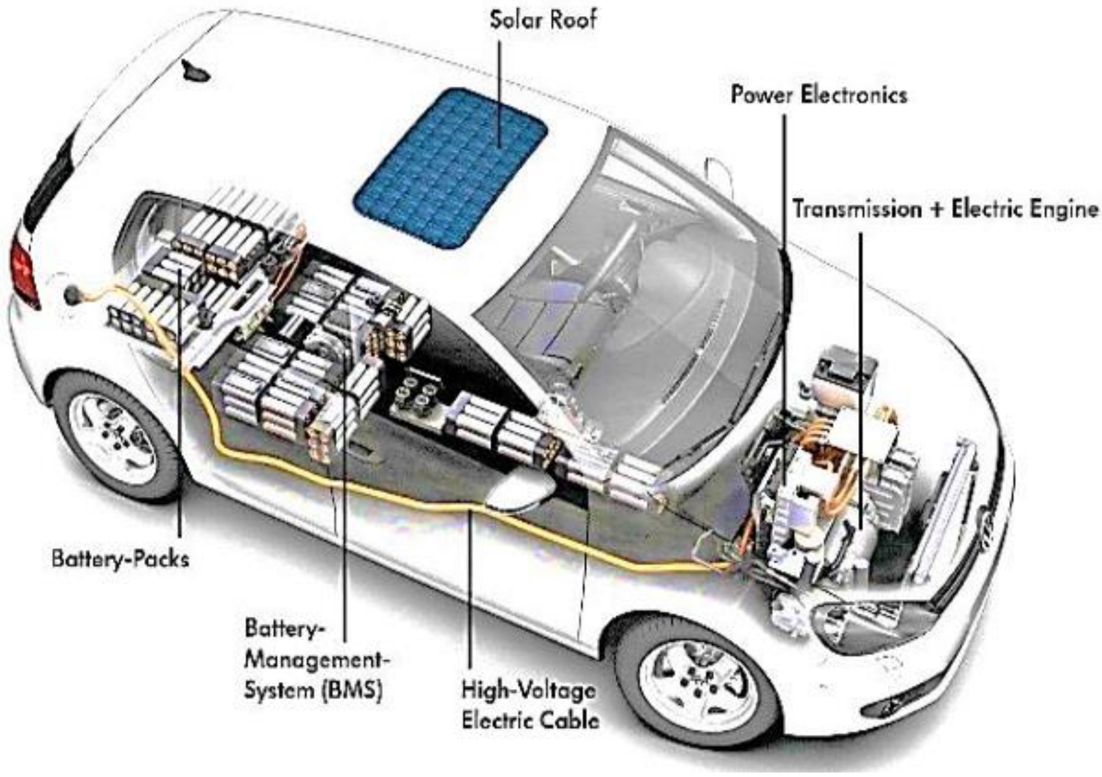

Fig: 3:25 EV

3.5 Simulation

Certainly! MATLAB is a powerful tool for simulating Hybrid Electric Vehicles (HEVs). Here are the basic steps to simulate an HEV in MATLAB:

1. Define the Vehicle Model - This includes the vehicle dynamics, mass, aerodynamics, tire models and other parameters that are necessary for the simulation.

2. Choose the Powertrain Components - Identify the components of the powertrain such as engine, motor, battery, transmission, generator, etc. Make sure you have the specifications for each component.

3. Develop the Control Strategy - Decide on the control strategy that will optimize the performance of the powertrain components. You could use rule-based control, optimization algorithms or model predictive control for this step.

4. Implement the Simulation - Once you have defined the vehicle model, powertrain components and control strategy, it's time to implement the simulation. Use Matlab Simulink to build your simulation model.

5. Run the Simulation - Run the simulation to evaluate the performance of the HEV. Analyze the results and make any necessary adjustments to optimize the simulation.

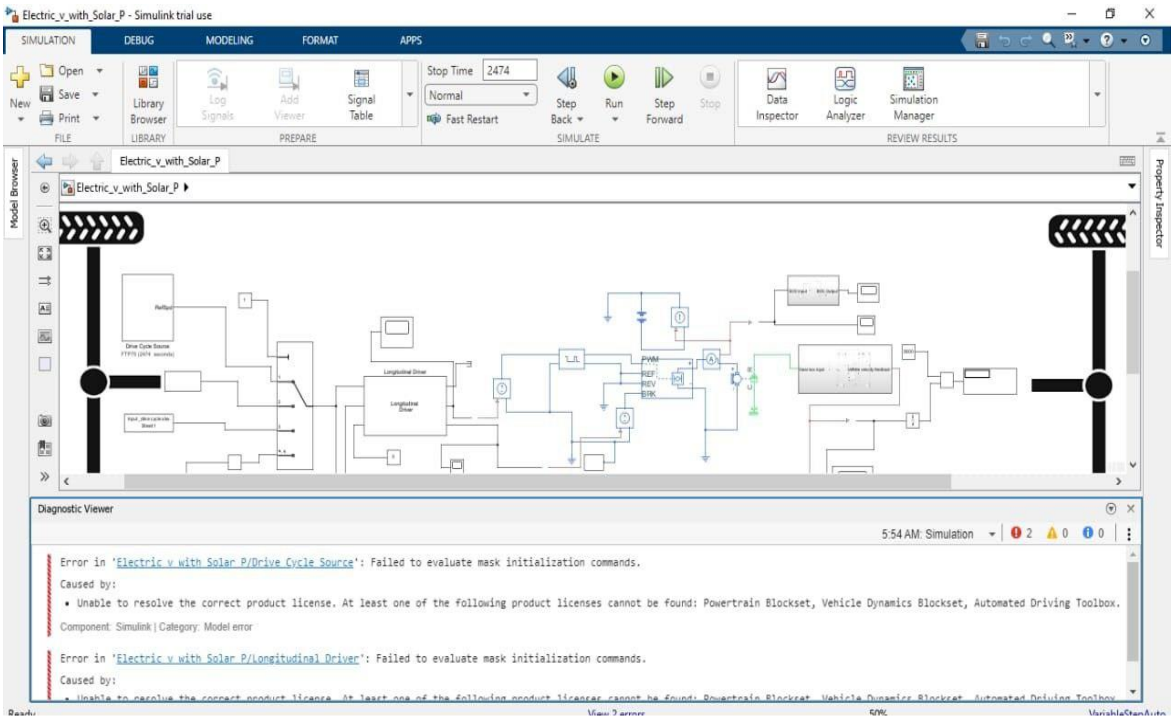

Fig: 3:26 MATLAB Simulation process

CHAPTER 4
RESULTS AND DISCUSSIONS

4.1 Results

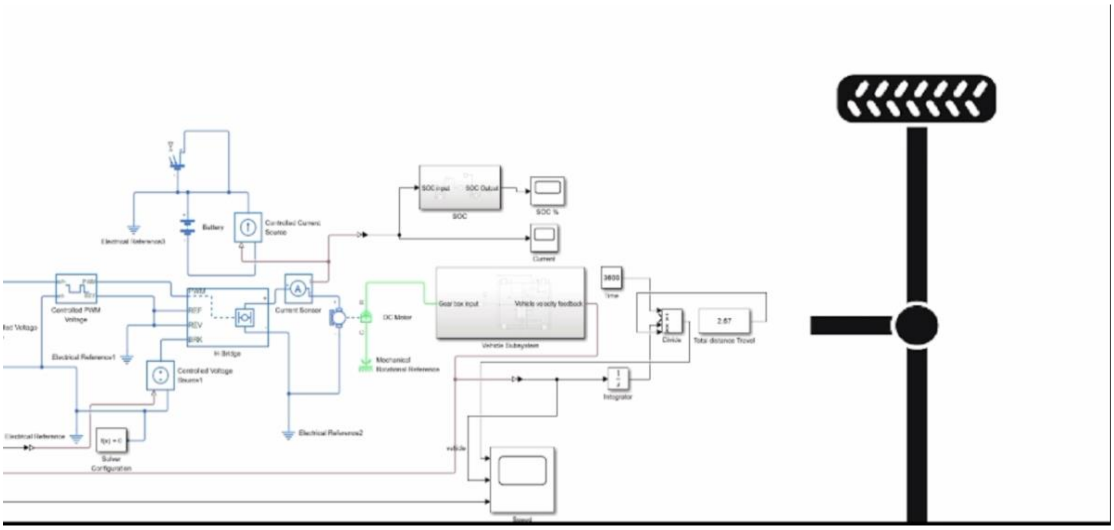

Fig: 4:1 MATLAB view

Our MATLAB simulation of an automobile looks like this. The initial speed of our vehicle was zero, but it has a top speed of approximately 150 kilometers per hour. At the moment, it is moving at a variety of speeds, and we can see the complete distance that our car has traveled.

Fig: 4:2 comparing the initial speed

Now demonstrate the speed ratio for car by comparing the initial speed to the speed at which the car was traveling afterward. You can see that the automobile is flowing at a speed that is exactly overlapping the input speed that we gave it. The blue one represents the drive cycle, and the yellow one represents the car's speed. The input for the drive cycle is very near to the in head, and the drive cycle includes 150 kilometers. The car is also flowing at that pace.

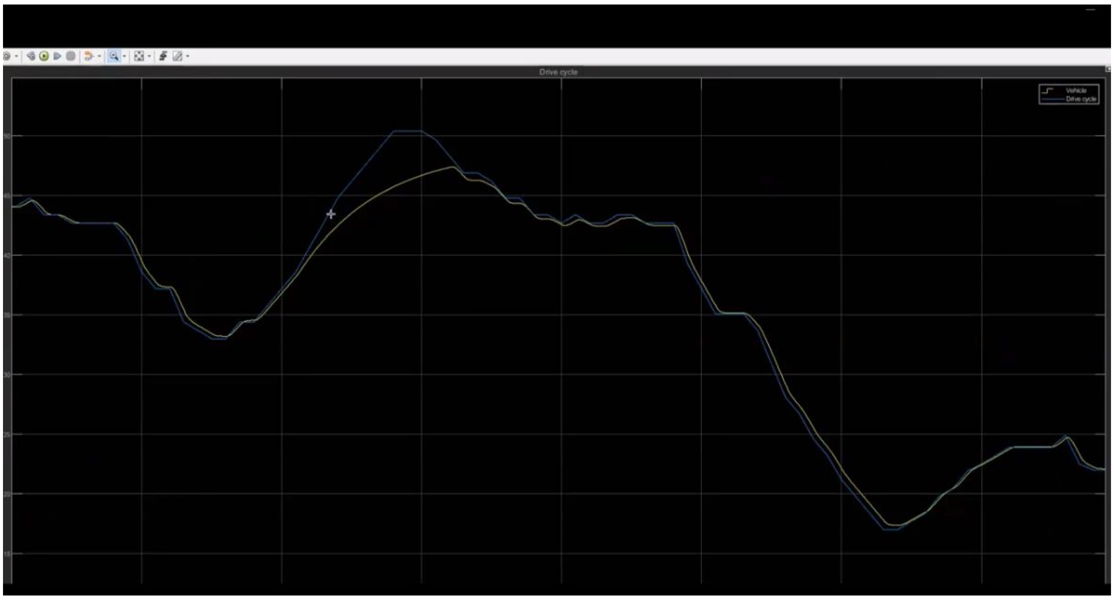

Fig: 4:3 comparing the initial speed distance

Now we will check the health of our battery to see what we found. do you have the battery? Charging discharge began you yesterday from full, and after traveling a distance of 2.81 miles,

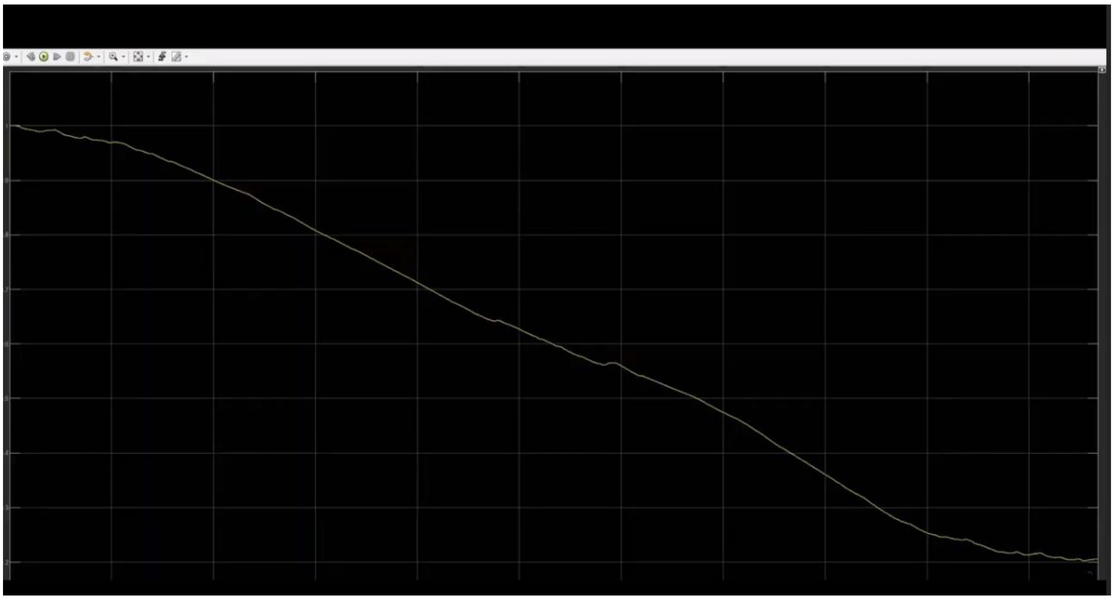

Fig: 4:4 Car battery charge

Our car's battery is currently at about 20% after we charged it yesterday. You can see from here that we get charged for regenerative breaking, which occurs frequently. We did receive a charge

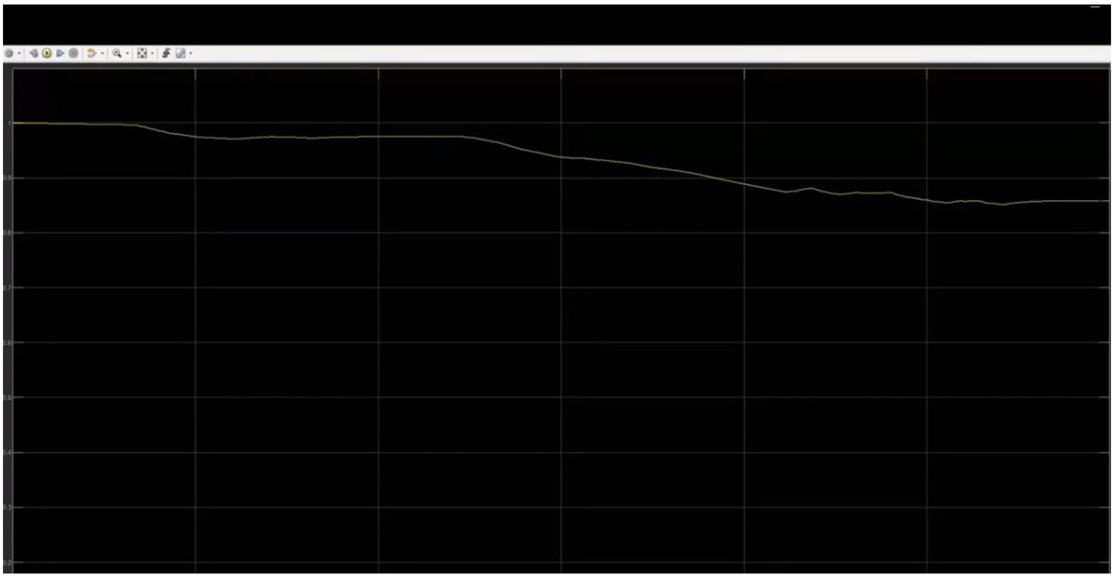

Fig: 4:5 solar connection charge

After successfully connecting the Solar. Additionally, we started with a full charge, but because to the solar connection, we only lost about 20% of that charge during the day. Now, we have 80% of our battery life remaining. From this vantage point, we are able to evaluate the performance of the Solar Panel that we carved 2,81 kilometers earlier.

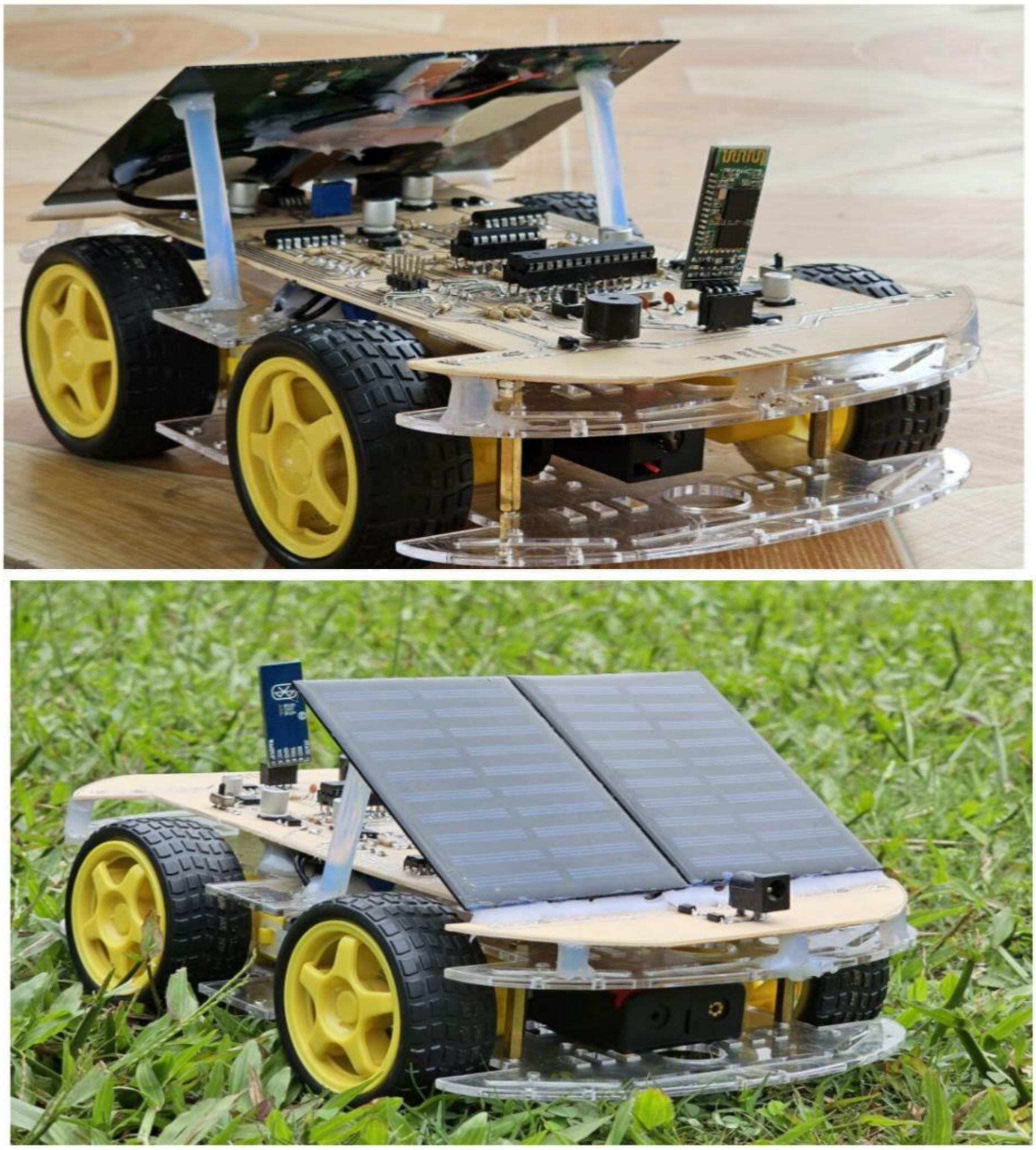

Fig: 4:6 Prototype of HEV

4.2 Discussions

The introduction of a new electric car could have positive effects on the country's environment, ethics, economy, and worldwide impact. Electric vehicles play a significant and important part in the overall development of the country. When I was working on the thesis paper here, I ran across quite a few challenges, but with the help of the supervisor, Sir, I was able to overcome all of those challenges and finish the paper.

CHAPTER 5
PROJECT MANAGEMENT

5.1 Task, Schedule and Milestones

This section describes the start and finish of a project, and mark the completion of a major phase of task. Justification can be made on how the schedule/milestone is different from the mentioned one in introduction chapter.

Task	Starting Date	Duration	End Date
Planning	5 Sept 2022	28	3 Oct 2022
Proposal	8 Oct 2022	21	29 Oct 2022
Analysis	6 Nov 2022	62	7Jan 2023
Literature Review	10 Jan 2023	18	28 Jan 2023
Implement	4 Feb 2023	23	27 Feb 2023
Testing	6 Mar 2023	10	16 Mar2023
Review	27 Mar2023	12	8 Apr 2023
Thesis Book Ready	6 May2023	32	7 Jun 2023

Table 5.1: Task Date Duration

5.2 Resources and Cost Management

HEV projects often require significant funding for research, development, and testing. It's important to establish a realistic budget and ensure that all expenses are accounted for. Projects require specific materials and components, including batteries, electric motors, and control systems. It's important to research suppliers and ensure that all necessary materials and components are available projects can be complex, involving multiple teams and stakeholders. Effective project management is essential to ensure that all tasks are completed on time and within budget.

5.3 Lesson Learned

Hybrid Electric Vehicles (HEVs) are becoming increasingly popular due to their fuel efficiency and lower emissions. Here are some key lessons learned about HEVs:

1. HEVs are more efficient in stop-and-go traffic
2. Battery technology is improving
3. Different types of HEVs
4. Maintenance requirements
5. Cost considerations

Overall, HEVs offer a promising solution for reducing fuel consumption and emissions. As technology continues to improve and costs come down, we can expect to see more HEVs on the road in the coming years.

CHAPTER 6
IMPACT ASSESSMENT OF THE PROJECT

6.1 Economical, Societal and Global Impact

The economy, society, and ecology could all be significantly impacted by hybrid electric vehicles (HEVs). HEVs can boost the economy by reducing reliance on imported fossil fuels and by generating new jobs in their construction and upkeep. HEVs have the potential to minimize noise pollution and enhance air quality from a social standpoint, both of which can benefit public health. HEVs can also assist combat energy poverty by giving low-income households access to dependable and cheap mobility options. On a worldwide scale, HEVs can contribute to reducing greenhouse gas emissions and mitigating the effects of climate change. Battery management systems (BMS) can improve HEVs' performance and longevity while also encouraging environmentally friendly practices in the automobile sector. The use of HEVs with effective BMS can be very advantageous for Bangladesh, a nation with significant problems with air pollution and traffic congestion. To encourage cleaner and more environmentally friendly transportation options, the government might offer incentives for HEV production and use. Additionally, this may open up positions in domestic HEV manufacturing and maintenance. Overall, the adoption of HEVs with effective BMS can benefit Bangladesh's economy, society, and environment as well as the rest of the world.

6.2 Environmental and Ethical Issues

The rate of pollution in the environment is climbing steadily higher by the day. Smoke emitted by motor vehicles driven by fossil fuels is one of the factors that contribute to environmental pollution. We had to ride the tram in order to get to that location. This will result in a lower concentration of carbon in the atmosphere. The quality of the environment will improve. Electric vehicles have made a significant contribution to the reduction of a variety of types of pollutants around the country. HEV manufacturers are introducing techniques like as recycling programs and developing batteries with longer lifespans in order to reduce the environmental impact of battery management. These strategies include producing batteries with longer lifespans. By minimizing the demand for the mining of new materials, recycling initiatives can assist in the recovery of important components from used batteries. Batteries that last longer can cut down on the number of times they need to be replaced, which in turn helps reduce waste. Furthermore, some companies are working on developing more sustainable battery chemistries, such as solid-state batteries or sodium-ion batteries, which may be less damaging to the environment as a result of their reduced reliance on rare earth metals. These batteries are examples of technologies that are currently under development. In conclusion, the battery management of hybrid electric vehicles can have an effect on the environment; however, manufacturers are taking steps to mitigate this impact through the development of more sustainable battery technologies, recycling schemes, and longer-lasting batteries.

6.3 Utilization of Existing Standards

In Bangladesh, the utilization of existing standards for hybrid electric vehicles (HEVs) and battery management is still in its early stages. However, with an increasing interest in sustainable transportation solutions, it is important to consider the implementation of established standards. One such standard is ISO 6469-3, which provides requirements and recommendations for the safety performance of rechargeable energy storage systems (RESS) for HEVs. This standard outline guideline for testing RESS components and systems, as well as for ensuring their electrical, mechanical, and thermal safety. Furthermore, the International Electro Technical Commission (IEC) has developed several standards related to battery management, including IEC 62660, which outlines safety tests and specifications for lithium-ion batteries used in HEVs.

By utilizing these established standards, manufacturers and regulators in Bangladesh can ensure that HEVs and their battery systems meet international safety and performance requirements, promoting the development of a sustainable and safe transportation system.

CHAPTER 7
CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

It is anticipated that developments in the technology of electric vehicles, as well as the contribution that electric vehicles make to global renewable energy sources and bases, will lead to an improvement in the global reputation of electric vehicles. Have fun riding the tram while it's on the road. The energy Internet of the future will also be a cutting-edge network, as it will make use of the most recent energy framework tables to carry out an exhaustive calculation of the energy frame. The conceptual underpinning for the development of electric vehicles is laid out in detail in this paper. It is necessary for consumers to have a general awareness of electric vehicles on the market after the fundamental concepts underlying these vehicles have been presented to the globe. The paper also makes suggestions for more research that could be able to help turn the tide. According to the findings of a letter concerning the untapped potential of electric vehicles in the future, the area of investigation needs to be rethought

7.2 Experiences Learned

The process of modifying this system taught me a lot. After beginning a thesis, we gain an understanding of the duties that must be completed, such as:

- Thesis preparation
- The mapping of the thesis,
- Management of time,
- Thesis evaluation.
- The completed thesis.

7.3 Future Recommendations

In Bangladesh, as the demand for automobiles continues to rise, there is a growing need for sustainable transportation alternatives. Hybrid electric vehicles (HEVs) can be an excellent option due to their improved fuel efficiency and reduced emissions compared to traditional gasoline-powered vehicles.

Here are some future recommendations for HEVs in Bangladesh from a battery management perspective:

1. Promote the use of Lithium-ion batteries
2. Establish charging infrastructure
3. Develop Battery Management Systems (BMS.
4. Educate consumers

In conclusion, Bangladesh has great potential for the adoption of HEVs due to its growing urban population, rising fuel prices, and increasing environmental concerns. By promoting the use of Lithium-ion batteries, establishing charging infrastructure, developing advanced BMS, and educating consumers, HEVs can be a viable and sustainable option for providing clean transportation in Bangladesh.

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