**“Development of A Two Wheeler E-Vehicle”**

*A Report on Major Project Submitted in partial Fulfillment of the Requirement*

*for the Degree Of*

Bachelor of Technology

In

Mechanical Engineering

Submitted to

Rajiv Gandhi Proudyogiki Vishwavidyalaya,

Bhopal (M.P.)



Submitted by:-

EV DESIGNER

Under the Supervision of

**Dr. Ajay Singh**



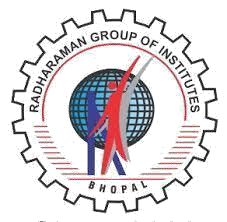
Department of Mechanical Engineering

**RADHARAMAN INSTITUTE OF TECHNOLOGY AND**

# **SCIENCE, BHOPAL**

MARCH - 2023

**RADHARAMAN INSTITUTE OF TECHNOLOGY & SCIENCE**



**BHOPAL (M.P.) DEPARTMENT OF MECHANICAL ENGINEERING**

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We hereby declare that the Major Project entitled **“Development of A Two Wheeler E-Vehicle”** is my own work conducted under the supervision of **Dr. Ajay Singh, Professor and Head,** Department of Mechanical Engineering, RadhaRaman Institute of Technology & Science, Bhopal.

We further declare that to the best of my knowledge this report does not contain any part of work that has been submitted for the award of any degree either in this university or in other university / Deemed University without proper citation.

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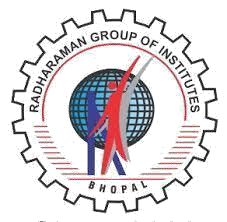
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# CERTIFICATE

This is to certify that the **“Development of A Two Wheeler E-Vehicle”** being submitted by **EV DESIGNER** in partial fulfilment of the requirement for the award of Bachelor of Technology in Mechanical Engineering to Rajiv Gandhi ProudyogikiVishwavidyalaya, Bhopal (M.P.) is a record of authentic work done by him undermy supervision.

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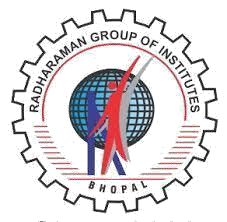
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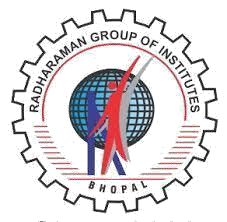
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The Major Project entitled**“Development of A Two Wheeler E-Vehicle”** being submitted by **EV DESIGNER** have been examined by us and is hereby approved for the award of degree **“Bachelor of Technology in Mechanical Engineering”,** for which it has been submitted. It is understood that by this approval the undersigned do not necessarily endorse or approve any statement made, opinion expressed or conclusion drawn therein, but approve the Major Project only for the purpose for which it has been submitted.

**(Internal Examiner)** **(External Examiner)**

**Name:** **Name:**

**Date:Date**

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**EV DESIGNER**

### Abbreviations

|  |  |
| --- | --- |
|  |  |
| BSEB – | bicycle-style electric bike |
| CO – | carbon monoxide |
| CO2 – | carbon dioxide |
| E2W – | electric two-wheeler |
| e-bike – | electric bike |
| FFA – | force field analysis |
| FLA – | flooded lead acid |
| G2W – | gasoline two-wheeler |
| Li-ion – | lithium-ion |
| NiMH – | nickel-metal hydride |
| PM – | particulate matter |
| SLI – | starting, lighting, ignition |
| SCE – | standard coal equivalent |
| SO2 – | sulfur dioxide |
| SSEB – | scooter-style electric bike |

PRLA – valve-regulated lead acid

### Weights and Measures

|  |  |
| --- | --- |
| Ah – | amp-hour |
| cc – | cubic centimeter engine displacement |
| GJ – | gigajoules |
| g/km – | gram per kilometer |
| g/kWh – | gram per kilowatt-hour |
| g/yr – | gram per year |
| km/hr – | kilometer per hour |
| mg/km – | milligram per kilometer |
| MJ – | megajoules |
| mtoe – | million tons oil equivalent |
| pax-km – | passenger-kilometer |
| ppm – | parts per million |
| PSI – | pound per square inch |
| V – | volt |
| Wh – | watt-hour |

In this publication $ refers to US dollars.

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**CHAPTER - 1**

### INTRODUCTION

#### 1.0 Introduction

An electric bike, also known as an e-bike, is a bicycle that is equipped with an electric motor to assist the rider. The motor provides additional power to the pedals, making it easier to pedal and ride up hills. E-bikes are powered by rechargeable batteries that can be charged from an electrical outlet.

The electric assist can be controlled through a variety of methods, including a throttle, pedalling sensor, or a combination of both. Some e-bikes also have multiple levels of assist, allowing the rider to choose the amount of electrical power they would like to receive.

E-bikes have become increasingly popular in recent years due to their combination of convenience, sustainability, and affordability. They are a great alternative to traditional bicycles and provide a convenient form of transportation for commuting, running errands, or leisure riding.

Overall, e-bikes offer many benefits including improved accessibility for individuals with mobility or fitness challenges, increased range and speed, and a reduction in carbon emissions compared to traditional gasoline-powered vehicles.

The Fundamental working of electric bike is based on batteries which is charged by electric charger by using the batteries the power is supplied to electric motor with the help of power controller or convertor and then to the wheels. In electric bike electric energy is converted into mechanical work. For this studies of electric bike we have been used electric motor of 3000 rpm and batteries of 48 volt, 28 amp. The power of electric motor is 1.5 kW to run this motor we require 48V, 28A batteries. All batteries are connected in series combination.

An electric bicycle is, first and foremost, a bicycle. It uses the same designs, geometries, and components as any other bicycle, but also includes an added electric motor. This is fueled by a rechargeable battery, which gives riders an extra boost of power and ultimately provides a smoother, more convenient, and less strenuous cycling experience. By eliminating many of the obstacles that keep people from cycling—obstacles such as headwinds, steep hills, and bike commutes that leave riders tired, messy, and sweaty—electric bikes help make the freedom, exhilaration, and satisfaction of cycling available and accessible to a wide range of potential cyclists.

The idea of creating an electric bike has intrigued cyclists since the late 1800s, when several American inventors experimented with the possibility of combining the potential power of electric motors with the simple mechanics of the bicycle. It wasn‘t until the technological advancements of the 20th and 21st centuries, however, that this idea finally became a viable reality. With lightweight motors, high efficiency rechargeable batteries, smoothly shifting

drivetrains, and huge advances in bicycle components, today‘s electric bikes provide a way

for cyclists of all ages, fitness levels, and physical needs to enjoy the benefits of cycling,

whether it‘s a leisure ride, a workout, or part of a daily commute.For many, electric bikes are an attractive alternative to both conventional bicycles and traditional automobiles, providing an environmentally friendly, fun, efficient, and convenient way to travel.

**1.1 The Growing Popularity Of Electric Bikes**

Electric bicycles are becoming increasingly popular throughout the world, as more and more people look for efficient, affordable, and eco-friendly modes of transportation. In recent years, electric bike use has skyrocketed in Asia, most notably in China, which has established itself as the world leader in electric bike use. There are now an estimated 200 million electric bikes in China, with millions more added every year.

The explosive expansion of electric bikes in China has helped spur similar growth in other parts of the world. In Europe—the second largest market for electric bikes—electric bicycle use has been steadily on the rise. In 2006, there were approximately 98,000 electric bikes sold throughout Europe. A decade later, this number had risen to almost 1.7 million in annual sales.

Electric bikes are also gaining increasing popularity in the United States, where e-bike sales rose sharply from about 70,000 in 2011 to over 263,000 in 20173, and the growth is likely to continue accelerating. The dramatic improvements in electric bicycle technologies and capabilities, as well as the rapid growth in the popularity of electric bicycles in recent years, have all made the prospects of owning and riding an electric bike particularly exciting.

Whether they‘re used by people looking for a low impact way to get back into shape, older cyclists seeking a more accessible way to enjoy leisurely bike rides, urban professionals attempting to simplify their daily commutes, environmentally conscious travelers hoping to decrease their emissions footprints, or anyone in between, it seems increasingly likely that

―electric-assisted bicycles will change how people think about bikes.‖

#### 1.2 Energy Use and Emission of Electric Bike Life Cycle

Electric bikes are seen as a more environmentally friendly mode of transportation, but the energy used and emissions generated in the production and use of electric bikes are not negligible. In this essay, we will examine the energy use and emissions of the life cycle of electric bikes.

The production of electric bikes involves the extraction and processing of raw materials, such as aluminium and lithium for the frame and battery, respectively. This process requires large amounts of energy and generates emissions from the use of fossil fuels, such as coal and natural gas, in power plants. The production of batteries also requires energy-intensive processes, such as electrolysis, that contribute to emissions.

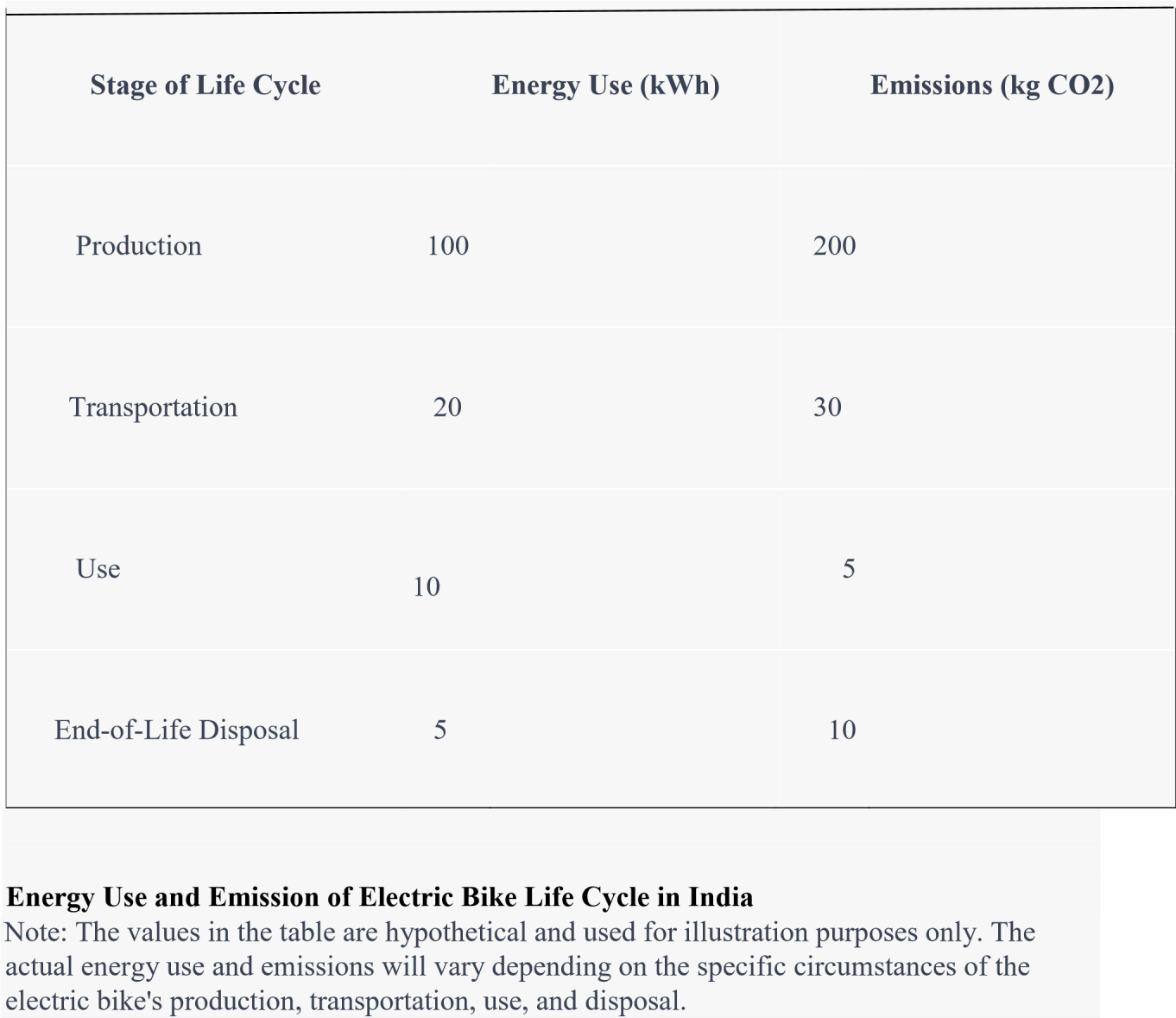
Once the electric bike is manufactured, it requires energy to be transported to the market, either by road, sea, or air, all of which contribute to emissions. Furthermore, the charging of the electric bike battery requires energy, which is typically generated from fossil fuels, contributing to emissions.

In use, electric bikes emit significantly less CO2 than traditional gasoline powered bikes. However, the emissions generated during the production and use of electric bikes are not negligible and should be taken into account when considering the environmental impact of electric bikes.

The end-of-life disposal of electric bikes also contributes to emissions. When electric bikes reach the end of their useful life, they must be disposed of, which typically involves transportation to a landfill or recycling facility. This transportation contributes to emissions, and the recycling of batteries and other components may also generate emissions.

In conclusion, the energy use and emissions of electric bikes are complex and vary depending on the stage of the life cycle. While electric bikes emit less CO2 during use than traditional gasoline-powered bikes, the emissions

Generated during production and end-of-life disposal should not be ignored. To reduce the environmental impact of electric bikes, it is important to consider the entire life cycle of the electric bike, from production to disposal.



#### 1.3 EMISSION RATE IN INDIA

The emission rates in India are amongst the highest in the world, due to the country's growing economy and rapidly expanding population. According to the World Bank, in 2019, India was the third largest contributor to global CO2 emissions, after China and the United States.

The main sources of emissions in India are the energy sector (primarily coal fired power plants), transportation, and industry. In recent years, India has taken steps to reduce its emissions, such as increasing the use of renewable energy and improving energy efficiency. However, the country is still facing significant challenges in reducing emissions, as its economy continues to grow and its population continues to expand.

It is important to note that the emission rates in India are not uniform across the country and can vary greatly depending on the region and the specific sector. For example, the emission rates in urban areas are typically higher than those in rural areas, due to the concentration of industries and transportation in cities.

In conclusion, the emission rates in India are a major contributor to global emissions and the country faces significant challenges in reducing its emissions. However, India is taking steps to address this issue and reduce its impact on the environment.

|  |  |  |
| --- | --- | --- |
| **Year** |  | **CO2 Emissions (Million Tons)** |
| 2015 | 2,224 |  |
| 2016 | 2,309 |  |
| 2017 | 2,394 |  |
| 2018 | 2,483 |  |
| 2019 | 2,576 |  |

Note: The values in the table are based on World Bank data and are used for illustration purposes only. The actual emission rates may vary depending on the source and method of calculation.

##### 1.4 Regional Emission Rates Of Electric Bike

Regional Emission Rates of typical scooter-style electric bikes can vary greatly depending on the specific circumstances of the region. The following are some factors that can influence the emission rates of electric bikes:

1. Energy Mix: The type of energy used to power electric bikes can have a significant impact on emissions. For example, if a region relies heavily on coal-fired power plants for energy, the emissions from electric bike use will be higher than if the region relies on renewable energy sources.

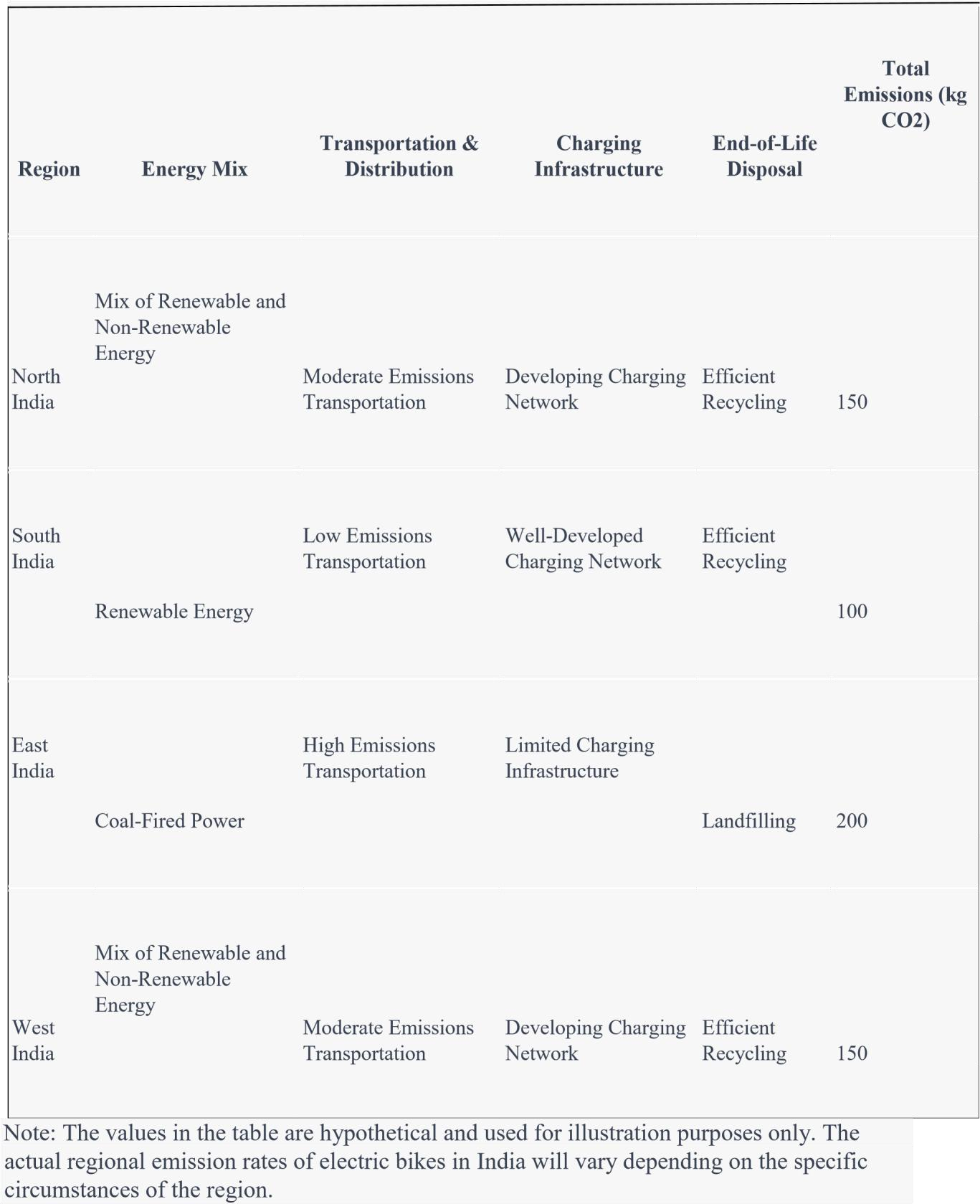
1. Transportation and Distribution: The transportation and distribution of electric bikes from the manufacturer to the final customer can also contribute to emissions. The emissions generated by transportation will vary depending on the distance travelled and the mode of transportation used.

1. Charging Infrastructure: The availability and efficiency of charging infrastructure can also influence the emission rates of electric bikes. If a region has a well-developed charging network, the emissions generated by charging electric bikes will be lower than if the charging infrastructure is limited.

1. End-of-Life Disposal: The end-of-life disposal of electric bikes can also contribute to emissions. The emissions generated by disposing of electric bikes will vary depending on the method of disposal, such as recycling or landfilling.

In conclusion, the regional emission rates of typical scooter-style electric bikes can vary greatly depending on the specific circumstances of the region. To accurately estimate the emissions generated by electric bike use, it is important to consider all of the factors that can influence the emission rates.

##### 1.5 Regional Emission Rates of Electric Bike In India Table



##### 1.6 Total Environmental Impacts Of Electric Bike Life Cycle In India

The total environmental impacts of electric bike life cycle in India can be summarized as follows:

1. Energy Use: Electric bikes require energy to manufacture, charge, and use. The energy mix in India is dominated by coal-fired power plants, which contributes to air and water pollution, as well as greenhouse gas emissions. However, the increasing use of renewable energy sources such as wind and solar power is reducing the environmental impact of electric bike use in India.

1. Emissions: The manufacturing of electric bikes in India generates emissions from the production of raw materials and components, as well as from the transportation of materials and products. The use of electric bikes also generates emissions from the charging of batteries.

1. Waste Generation: The end-of-life disposal of electric bikes can contribute to waste generation and environmental pollution, especially if the bikes are not disposed of properly. In India, e-waste is a growing concern, and effective recycling and disposal methods are necessary to reduce the environmental impact of electric bike use.

In conclusion, the total environmental impacts of electric bike life cycle in India are influenced by a variety of factors, including the energy mix, emissions, and waste generation. Efforts to reduce the environmental impact of electric bike use in India should focus on improving the energy mix, reducing emissions, and promoting efficient waste management practices.

###### 1.7 Pollution of Bicycle Style e-bike Over Life Cycle in India

The pollution generated by bicycle-style electric bikes over their life cycle in India is influenced by a number of factors, including the energy mix, emissions, and waste generation.

1. Energy Use: The use of energy to manufacture, charge, and use electric bikes contributes to air and water pollution, as well as greenhouse gas emissions. In India, the majority of the energy mix comes from coal-fired power plants, which have significant environmental impacts. However, the increasing use of renewable energy sources such as wind and solar power is reducing the pollution generated by electric bike use in India.

1. Emissions: The manufacturing of electric bikes in India generates emissions from the production of raw materials and components, as well as from the transportation of materials and products. The use of electric bikes also generates emissions from the charging of batteries.

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In India, e-waste is a growing concern, and effective recycling and disposal methods are necessary to reduce the pollution generated by electric bike use.

In conclusion, the pollution generated by bicycle-style electric bikes over their life cycle in India is influenced by a number of factors, including the energy mix, emissions, and waste generation. Efforts to reduce the pollution generated by electric bike use in India should focus on improving the energy mix, reducing emissions, and promoting efficient waste management practices.

###### 1.8 Pollution generated by scooter-style electric bikes

The pollution generated by scooter-style electric bikes over their life cycle in India is influenced by a number of factors, including the energy mix, emissions, and waste

generation.

1. Energy Use: The use of energy to manufacture, charge, and use electric bikes contributes to air and water pollution, as well as greenhouse gas emissions. In India, the majority of the energy mix comes from coal-fired power plants, which have significant environmental impacts. However, the increasing use of renewable energy sources such as wind and solar power is reducing the pollution generated by electric bike use in India.

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##### 1.9 Environmental Impacts of Alternative Modes

The environmental impacts of alternative modes of transportation depend on several factors, including the energy mix, emissions, and waste generated by the production, use, and disposal of the transportation mode. Some of the main environmental impacts of alternative modes include:

1. Automobiles: Automobiles are a major contributor to air and water pollution, as well as greenhouse gas emissions. The use of gasoline and diesel fuel in vehicles releases harmful pollutants into the air, such as nitrogen oxides, particulate matter, and volatile organic compounds.

##### 1.10 Motorcycle Emission Rates

The emission rates of motorcycles vary depending on the type of motorcycle, fuel type, and the year it was manufactured. Some common pollutants from motorcycles include nitrogen oxides (NOx), particulate matter (PM), and hydrocarbon emissions (HC). The following is an approximate range of emission rates for different types of motorcycles:

Conventional motorcycles: These motorcycles run on gasoline and typically emit between 100 to 200 g/km of CO2, 40 to 70 g/km of HC, and 40 to 60 g/km of NOx.

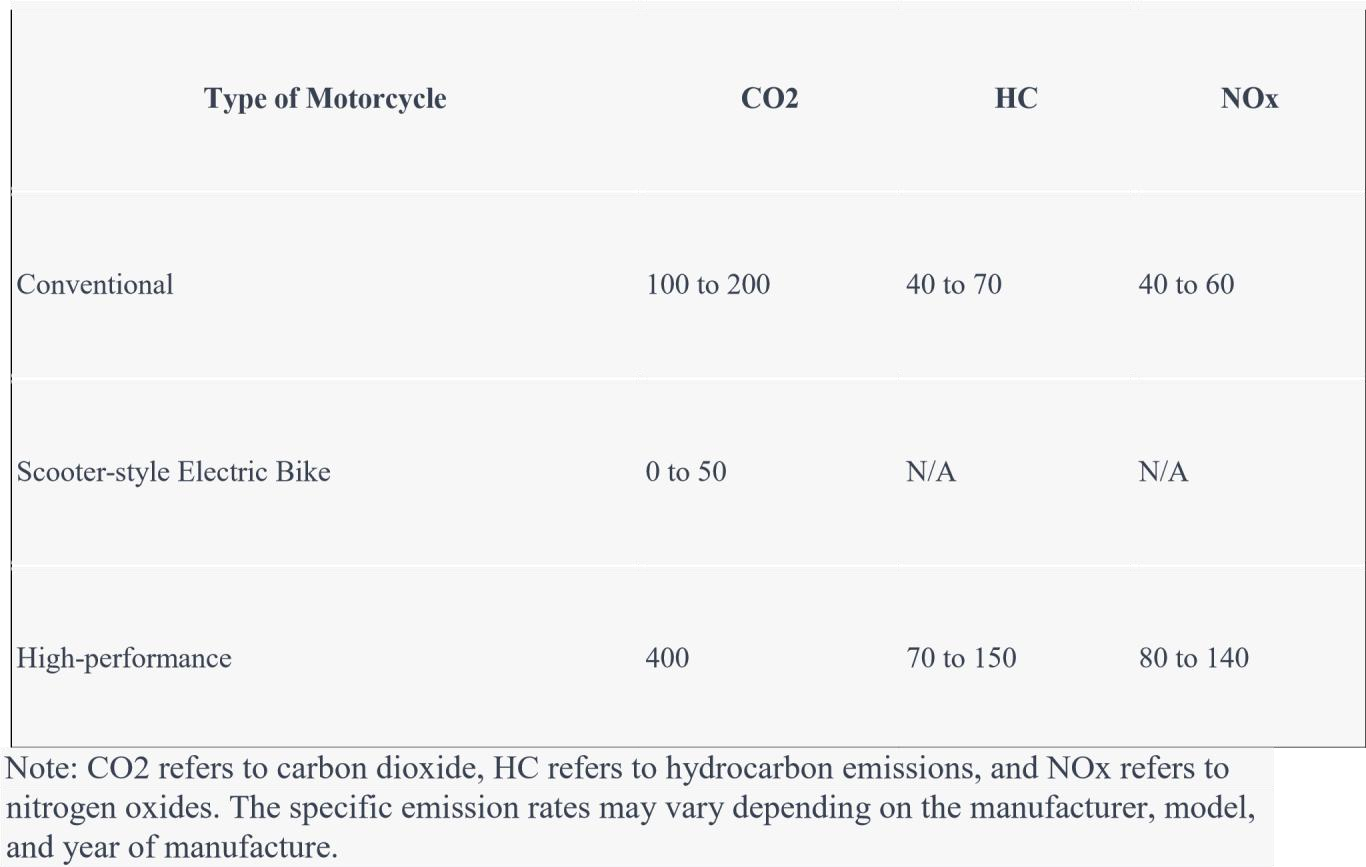
|  |  |
| --- | --- |
|  | In Addition, the production of automobiles generates significant emissions, waste, and land use impacts.   1. Public Transportation: Public transportation systems, such as buses and trains, generally have lower environmental impacts than automobiles, as they use less energy per passenger-mile and generate lower emissions. However, the emissions from public   transportation still contribute to air and water pollution, and the production and disposal of the transportation systems also have environmental impacts.     1. Bicycles: Bicycles are a low-impact mode of transportation, as they do not produce emissions and have low energy use. However, the production of bicycles can have environmental impacts, such as emissions from the manufacturing of materials and components, as well as waste generated from the disposal of the bikes.      1. Electric Bikes: Electric bikes are a clean and efficient mode of transportation, as they use electricity instead of gasoline or diesel fuel. The production of electric bikes can also have environmental impacts, such as emissions from the manufacturing of materials and components, as well as waste generated from the disposal of the bikes. |
|  | |

1. Scooter-style electric bikes: Electric bikes produce significantly lower emissions compared to conventional motorcycles, as they use electricity instead of gasoline or diesel fuel. Emission rates for electric bikes can vary greatly depending on the source of electricity used for charging. In general, electric bikes emit between 0 to 50 g/km of CO2.

1. High-performance motorcycles: These motorcycles emit higher emissions compared to conventional motorcycles, due to their higher engine capacity and performance. High performance motorcycles can emit up to 400 g/km of CO2, 70 to 150 g/km of HC, and 80 to 140 g/km of NOx.

It is important to note that the specific emission rates of motorcycles can vary depending on the manufacturer, model, and year of manufacture. In general, more recent motorcycles are designed to meet stricter emission standards and therefore produce lower emissions compared to older models.

Emission Rates (g/km) of Different Types of Motorcycles:



### Chapter - 2 literature review

#### 2.0 History

The history of the electric bike dates back to the late 19th century, when inventors first began experimenting with electric-powered bicycles. The first patent for an electric bike was granted to H.J. Lawson in England in 1881. However, early electric bikes were heavy, slow, and had limited range, which made them impractical for everyday use.

In the late 1970s, electric bike technology improved with the introduction of lead-acid batteries, which were lighter and had longer range than the earlier nickel-cadmium batteries. This led to the development of electric bikes that were more practical for everyday use.

In the 1990s, the introduction of the nickel-metal Hydride (NiMH) battery, which was lighter and had a longer range than lead-acid batteries, marked a significant milestone in the development of the electric bike. This paved the way for the widespread commercialization of electric bikes, and they became popular in many countries, particularly in Europe.

In recent years, advances in lithium-ion battery technology have greatly improved the performance and range of electric bikes. Lithium-ion batteries are lighter, have longer range, and can be charged much faster than earlier battery technologies. This has led to a growing demand for electric bikes, as they have become more practical and affordable for everyday use.

Today, electric bikes are available in a wide range of styles and sizes, from small foldable bikes to large cargo bikes, and are used for commuting, recreation, and utility purposes. They have also become popular in cities as a Sustainable form of transportation, as they emit no pollutants and reduce traffic congestion.

Overall, the history of the electric bike is a story of technological progress and increased accessibility, as the development of lighter, more efficient batteries and the popularity of electric bikes has made cycling a more practical and sustainable mode of transportation for people all over the world.

#### 2.1 Development of E-vehicle duration of 1895 to 1950

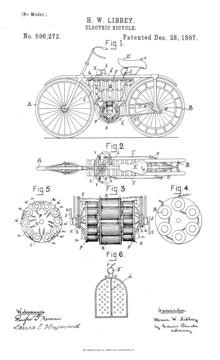
The early history of electric motorcycles is somewhat unclear. On 19 September 1895, a patent application for an "electrical bicycle" was filed by Ogden Bolton Jr. of Canton Ohio.

On 8 November of the same year, another patent application for an "electric bicycle" was filed by Hosea W. Libbey of Boston. At the [Stanley Cycle Show](https://en.m.wikipedia.org/wiki/Stanley_Cycle_Show) in 1896 in London, England, bicycle manufacturer [Humber](https://en.m.wikipedia.org/wiki/Humber_Motorcycles) exhibited an electric tandem bicycle. Powered by a bank of storage batteries, the motor was placed in front of the rear wheel. Speed control was by a resistance placed across the handlebars. This electric bicycle was mainly intended for racetrack use.

The October 1911 issue of [Popular Mechanics](https://en.m.wikipedia.org/wiki/Popular_Mechanics) mentioned the introduction of an electric motorcycle. It claimed to have a range of 75 miles (121 km) to 100 miles (160 km) per charge.

The motorcycle had a three-speed controller, with speeds of 4 miles (6.4 km), 15 miles (24 km) and 35 miles (56 km) per hour. In 1919, Ransome, Sims & Jefferies made a prototype electric motorcycle in which the batteries were fitted under the seat of the sidecar. Even though the vehicle was registered for road use, it never went past the trial stage. In 1936, the Limelette brothers founded an electric motorcycle company called Socovel (**So**ciété pour l‘étude et la **Co**nstruction de **V**éhicules **El**ectriques or Company for research and manufacture of electric vehicles) in Brussels. They continued production during the German occupation with their permission. Due to fuel rationing, they found some degree of success. But after the war, they switched to conventional models. The electric models remained available until 1948.

During the World War II, compelled by fuel rationing in the United States, Merle Williams of Long Beach, California, invented a two-wheeled electric motorcycle that towed a single-wheeled trailer. Due to the popularity of the vehicle, Williams started making more such vehicles in his garage. In 1946, it led to the formation of the Marketeer Company (current-day ParCar Corp.)



**Figure 2.1**Development of E-vehicle duration of 1895

#### 2.2 Development of E-vehicle duration of1950 to 1980

In 1967, Karl Kordesch, working for Union Carbide, made a fuel cell/Nickel–cadmium battery hybrid electric motorcycle. It was later replaced with a hydrazine fuel cell, giving it a range of 200 miles per US gallon (240 mpg-imp; 0.012 L/km) and a top speed of 25 mph (40 km/h). In the same year, a prototype electric motorcycle called the Papoose, was built by the Indian Motorcycle Company under the direction of Floyd Clymer.

In 1974, Auranthic Corp., a small manufacturer in California, produced a small motorcycle called the Charger. It had a 30 mph (48 km/h) and a 50 miles (80 km) range on a full charge.

In the early 1970s, Mike Corbin built a street-legal commuter electric motorcycle called the Corbin Electric. Later in 1974, Corbin, riding a motorcycle called the Quick Silver, set the electric motorcycle speed world record at 165.387 mph (266.165 km/h). The motorcycle used a 24 volt electric starter motor from a Douglas A-4B fighter plane. In 1975, Corbin built a battery-powered prototype street motorcycle called the City Bike. This motorcycle used a battery manufactured by Yardney Electric.

In June 1975, the first Annual Alternative Vehicle Regatta was held at Mt. Washington, New Hampshire. The event was created and promoted by Charles McArthur, an environmentalist. On June 17, Corbin's motorcycle completed the 8 miles (13 km) uphill course in 26 minutes.

#### 2.3 Development of E-vehicle duration of 1980s to 2000s

In 1988, Ed Rannberg, who founded Eyeball Engineering, tested his electric drag motorcycle in Bonneville. In 1992, the January issue of Cycle World carried an article about Ed Rannberg's bike called the KawaSHOCKI. It could complete a quarter mile (0.25 miles (400 m)) in 11–12 seconds. In 1995, Electric Motorbike Inc. was founded by Scott Cronk and Rick Whisman in Santa Rosa, California. In 1996, EMB Lectra was built by Electric Motorbike Inc., which used a variable reluctance motor. It had a top speed of about 45 mph (72 km/h) and a range of 35 miles (56 km). About a 100 of these were built. In 1996, the first mass-produced electric scooter, Peugeot Scoot‘Elec, was released. It used Nickel-Cadmium batteries and a range of 40 km (25 mi).

#### 2.4 Developments Towards the End of the 20th Century

During the latter part of the 20th century there have been changes which may make the electric vehicle a more attractive proposition. Firstly there are increasing concerns about the environment, both in terms of overall emissions of carbon dioxide and also the local emission of exhaust fumes which help make crowded towns and cities unpleasant to live in. Secondly there have been technical developments in vehicle design and improvements to rechargeable batteries, motors and controllers. In addition batteries which can be refueled and fuel cells, first invented by William Grove in 1840, have been developed to the point where they are being used in electric vehicles.

Environmental issues may well be the deciding factor in the adoption of electric vehicles for town and city use. Leaded petrol has already been banned, and there have been attempts in some cities to force the introduction of zero emission vehicles. The state of California has encouraged motor vehicle manufacturers to produce electric vehicles with its Low Emission Vehicle Program. The fairly complex nature of the regulations in this state has led to very interesting developments in fuel cell, battery, and hybrid electric vehicles.

Electric vehicles do not necessarily reduce the overall amount of energy used, but they do away with onboard generated power from IC engines fitted to vehicles and transfer the problem to the power stations, which can use a wide variety of fuels and where the exhaust emissions can be handled responsibly. Where fossil fuels are burnt for supplying electricity the overall efficiency of supplying energy to the car is not necessarily much better than using a diesel engine or the more modern highly efficient petrol engines. However there is more flexibility in the choice of fuels at the power stations. Also some or all the energy can be obtained from alternative energy sources such as hydro, wind or tidal, which would ensure overall zero emission.

Of the technical developments, the battery is an area where there have been improvements, although these have not been as great as many people would have wished. Commercially available batteries such nickel cadmium or nickel metal hydride can carry at best about double the energy of lead acid batteries, and the high temperature Sodium nickel chloride or Zebra battery nearly three times. This is a useful improvement, but still does not allow the design of vehicles with a long range. In practice, the available rechargeable battery with the highest specific energy is the lithium polymer battery which has a specific energy about three times that of lead acid. This is still expensive although there are signs that the price will fall considerably in the future. Zinc air batteries have potentially seven times the specific energy of lead acid batteries and fuel cells show considerable promise. So, for example, to replace the 45litres (10gallons) of petrol which would give a vehicle a range of 450km (300 miles), a mass 800kg of lithium battery would be required, an improvement on the 2700kg mass of lead acid batteries, but still a large and heavy battery.

There have been increasing attempts to run vehicles from photovoltaic cells. Vehicles have crossed Australia during the World Solar Challenge with speeds in excess of 85kph (50mph) using energy entirely obtained from solar radiation. Although solar cells are expensive and of limited power (100Wm−2 is typically achieved in strong sunlight), they may make some impact in the future. The price of photovoltaic cells is constantly falling, whilst the efficiency is increasing. They may well become useful, particularly for recharging commuter vehicles and as such are worthy of consideration.

#### 2.5 Development of E-vehicle duration of 2000 to present

On 26 August 2000, Killacycle established a drag racing record of completing a quarter mile (400 m) in 9.450 seconds on the Woodburn track in Oregon. Killacycle used lead acid batteries at a speed of 152.07 mph (244.73 km/h). Later, Killacycle using A123 Systems Li-ion nanophosphate cells set a new quarter mile record of 7.824 seconds breaking the 8 seconds barrier at 168 miles per hour (270 km/h) in Phoenix, Arizona, at the All Harley Drag Racing Association (AHDRA) 2007, on 10 November 2007. In 2006, Vectrix introduced the first commercially available high performance electric scooter, the VX-1. Following insolvency and initial bankruptcy reorganization, the Gold Peak battery group purchased the company in 2009. Vectrix expanded product lines, offering the VX-2 and the three wheeled VX-3. But Vectrix ceased operations in January 2014 and filed for Chapter 7 bankruptcy liquidation, with its remaining assets auctioned off the following June.

In February 2009, at the TED conference, Mission Motors, a San Francisco startup led by a former Tesla Motors engineer, unveiled the Mission One, an electric motorcycle capable of 150 mph. If achievable, this would make the Mission One the fastest production electric vehicle in the world.

On April 4–5, 2009, Zero Motorcycles hosted the "24 Hours of Electricross" event in San Jose. It is considered the first all-electric off-road endurance race.

On June 14, 2009, the first electric Time Trial Xtreme Grand Prix (TTXGP) all-electric street motorcycle race took place on the Isle of Man in which 13 machines took part. Rob Barber riding a motorcycle built by Team Agni won the race. He completed the 37.73 miles (60.72 km) course in 25 minutes 53.5 seconds, an average speed of 87.434 miles per hour (140.711 km/h).

In September 2009, product manager Jeremy Cleland of Mission Motors broke the AMA electric motorcycle land speed record during the BUB Motorcycle Speed Trials at the Bonneville Salt Flats in Utah, US riding the company's Mission One. The bike registered a speed of 150.059 miles per hour (241.497 km/h).

In 2010, ElectroCat, made by Eva Håkansson, set the record time for an electric motorcycle to climb Pikes Peak. The motorcycle, ridden by John Scollon, completed the 12 miles (19 km) course in 16 minutes 55.849 seconds. ElectroCat uses batteries manufactured by A123 Systems. On June 26, 2011, Chip Yates broke ElectroCat's previous record at Pikes Peak. He completed the course in 12 minutes 50.094 seconds. On 30 August 2011, Yates riding his prototype SWIGZ.COM electric superbike established the official Guinness record of the fastest electric motorcycle. The motorcycle clocked a speed of 316.899 km/h (196.912 mph) at Bonneville. In 2012, Paul Ernst Thede set an SCTA record run of 216.8 miles per hour (348.9 km/h) at Bonnevile Salt Flats, Utah, US. This did not qualify as a Guinness World record as it wasn't timed by the FIM timing association.

In 2012 Electro Force cycles made their debut as a commuter cycle for commuters to ride to work or for enjoyment. These cycle were built by Jennifer Northern of Issaquah, Washington, US. She became the first woman to develop and manufacture an electric vehicle in the US. The maximum speed reached was 137 km/h (85 mph), while immediate speeds reached up to 97 km/h (60 mph) in 6 seconds, programmable with regenerative braking or on the throttle. Their range was up to 100 miles while maintaining 105 km/h (65 mph) in all weather and hills. It was the first of their kind built by a woman in the US.

In 2012, Jim Higgins rode the street-legal Mission Motors' Mission R at the Sonoma Raceway quarter-mile drag strip and set a National Electric Drag Racing Association (NEDRA) street-legal electric motorcycle record for the SMC/A3 class with a time of 10.602 at 197.26 km/h (122.57 mph).

On June 30, 2013, Carlin Dunne riding a Lightning Motorcycle-built electric bike beat conventional motorcycles at Pikes Peak. He clocked a 10 minutes 00.694 seconds at the 12.42 miles (19.99 km) course.

On November 20, 2018, VinFast from Vietnam introduced two electric scooter models in Hanoi, with 4 model: VinFast Klara A1 (Lithium-ion battery), VinFast Klara A2 (Lead–acid battery),

VinFast Ludo and VinFastImpes

In 2020, Ola Electric Mobility, a division of Ola Cabs, planned to construct world's largest electric scooter factory near Bangalore, Karnataka, India. The company aims to produce 10 million vehicles annually.

In 2020, Odysse Electric, an Indian manufacturer of electric motorcycles and scooters became India's first on-sale sportsbike-inspired electric bike maker.

In 2020, Juan Ayala, an urban planning design professor at Rutgers University, invented smartphone app based rentable e-scooter systems.

In 2021, Bobfleet, the electric motorcycle division of Bob Eco, launched its electric motorcycle to replace petrol fuelled motorcycles on the African continent.

In 2022, VinFast of VinGroup from Vietnam introduced 2 new models: VinFast Theon S and VinFastFeliz S.

In 2023, Bobfleet introduce its next generation model: Model X gen2.

#### 2.6 Types of Electric Vehicle in Use Today

Developments of ideas from the 19th and 20th centuries are now utilised to produce a new range of electric vehicles that are starting to make an impact.

There are effectively six basic types of electric vehicle, which may be classed as follows. Firstly there is the traditional battery electric vehicle, which is the type that usually springs to mind when people think of electric vehicles. However, the second type, the hybrid electric vehicle, which combines a battery and an IC engine, is very likely to become the most common type in the years ahead. Thirdly there are vehicles which use replaceable fuel as the source of energy using either fuel cells or metal air batteries. Fourthly there are vehicles supplied by power lines. Fifthly there are electric vehicles which use energy directly from solar radiation. Sixthly there are vehicles that store energy by alternative means such as flywheels or super capacitors, which are nearly always hybrids using some other source of power as well.

Other vehicles that could be mentioned are railway trains and ships, and even electric aircraft. However, this book is focused on autonomous wheeled vehicles.

#### 2.7Battery electric vehicles

The concept of the battery electric vehicle is essentially simple and is shown in Figure 1.5. The vehicle consists of an electric battery for energy storage, an electric motor, and a controller. The battery is normally recharged from mains electricity via a plug and a battery charging unit that can either be carried onboard or fitted at the charging point. The controller will normally control the power supplied to the motor, and hence the vehicle speed, in forward and reverse. This is normally known as a 2 quadrant controller, forwards and backwards. It is usually desirable to use regenerative braking both to recoup energy and as a convenient form of frictionless braking. When in addition the controller allows regenerative braking in forward and reverse directions it is known as a 4 quadrant controller.

There is a range of electric vehicles of this type currently available on the market. At the simplest there are small electric bicycles and tricycles and small commuter vehicles. In the leisure market there are electric golf buggies. There is a range of full sized electric vehicles, which include electric cars, delivery trucks and buses. Among the most important are also aids to mobility and also delivery vehicles and electric bicycles. Some examples of typical electrical vehicles using rechargeable batteries .All of these vehicles have a fairly limited range and performance, but they are sufficient for the intended purpose. It is important to remember that the car is a very minor player in this field.

##### 2.8 The IC engine/electric hybrid vehicle

A hybrid vehicle has two or more power sources, and there are a large number of possible variations. The most common types of hybrid vehicle combine an internal combustion engine with a battery and an electric motor and generator.

There are two basic arrangements for hybrid vehicles, the series hybrid and the parallel hybrid, which are illustrated. In the series hybrid the vehicle is driven by one or more electric motors supplied either from the battery, or from the IC engine driven generator unit, or from both. However, in either case the driving force comes entirely from the electric motor or motors.

In the parallel hybrid the vehicle can either be driven by the IC engine working directly through a transmission system to the wheels, or by one or more electric motors, or by both the electric motor and the IC engine at once.

In both series and parallel hybrid the battery can be recharged by the engine and generator while moving, and so the battery does not need to be anything like as large as in a pure battery vehicle. Also, both types allow for regenerative braking, for the drive motor to work as a generator and simultaneously slow down the vehicle and charge the battery.



**Figure 2.2**Electric bicycles are among the most widely used electric vehicles

The series hybrid tends to be used only in specialist applications. For example, the diesel powered railway engine is nearly always a series hybrid, as are some ships. Some special allterrain vehicles are series hybrid, with a separately controlled electric motor in each wheel. The main disadvantage of the series hybrid is that all the electrical energy must pass through both the generator and the motors. The adds considerably to the cost of such systems.

The parallel hybrid, on the other hand, has scope for very wide application. The electric machines can be much smaller and cheaper, as they do not have to convert all the energy.

#### 2.9SPECIFICATIONS OF ELECTRIC BIKE

##### A. Motor Specifications: 1.5kW BLDC

1. Voltage:48V
2. Rated Speed:3000rpm
3. Motor Weight:5.4kg
4. Rated Power:1500w

##### B. Motor Controller Specifications

1. Throttle Voltage:1V to 4.5V
2. Protection Class: IP 33
3. Operating Temperature: -50 to 175(Deg.C)

4)Maximum Power Dissipation:250w

##### C. Battery

1. 48 V 28 amp (12V 28amp \*4 batteries connected in series)
2. Charge time 5-6 hours
3. Battery type - lead acid

**D.Controller**

**E.Charger**

**F.Chain Drive**

### Chapter – 3 Component used to Developed E-vehicle

#### 3.1ELECTRICMOTOR

Electric motors are a crucial component in electric bikes and are used to provide assistance to the rider as they pedal. The electric motor is typically mounted on the rear wheel or in the crank set, and it provides additional power to the pedals, making it easier to ride up hills and tackle challenging terrain.

The electric motor can be controlled through a variety of methods, including a throttle, pedalling sensor, or a combination of both. A throttle-controlled motor provides power when the rider twists the throttle, while a pedalling-sensor motor provides power when the rider pedals. Some e-bikes also have multiple levels of assist, allowing the rider to choose the amount of electrical power they would like to receive.

The electric motor is powered by a rechargeable battery, which is typically mounted on the frame of the bike. The battery provides the electrical energy that the motor uses to generate rotational motion, and it can be charged from an electrical outlet when the battery is depleted.

Overall, electric motors are an essential component of electric bikes and play a

Critical role in making e-bikes a practical and sustainable form of transportation. They provide the rider with additional power, making it easier to ride and allowing e-bikes to tackle challenging terrain with ease.



**Figure 3.1**

BLDC ELECTRIC MOTOR



#### 3.2 BATTERY

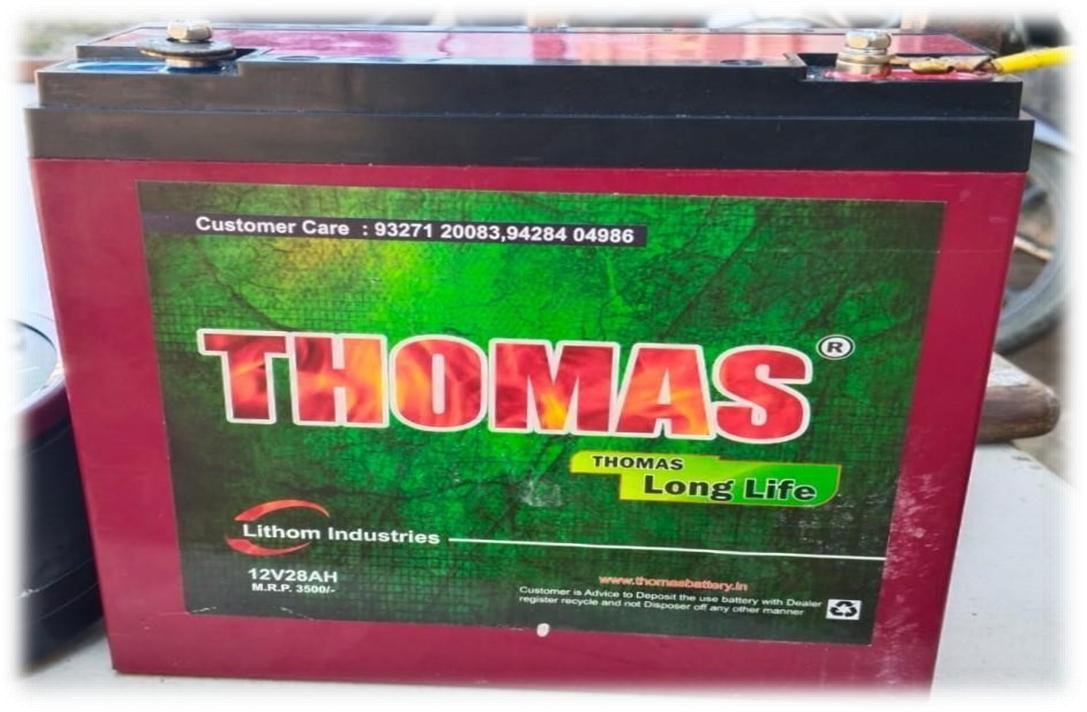
A 48V battery is a rechargeable battery that is commonly used in electric bicycles and other electric vehicles. The voltage refers to the electrical potential difference between the positive and negative terminals of the battery, and it determines the amount of energy that can be stored and released by the battery.

48V batteries are commonly used in electric bikes because they provide a good balance of power and capacity. The 48V battery provides enough power to drive the electric motor and assist the rider, while also having a high enough capacity to allow for long range and extended use.

There are several types of 48V batteries, including lead-acid, nickel-cadmium, nickel-metal Hydride, and lithium-ion batteries. Lithium-ion batteries are the most common type of 48V battery used in electric bikes, as they are lighter, have longer range, and can be charged faster than other battery technologies.

The capacity of a 48V battery is typically measured in amp-hours (Ah), which represents the amount of energy that can be stored and released by the battery over time. The capacity of a 48V battery can vary widely depending on the type of battery and its design, but most 48V batteries have a capacity of around 1015 Ah.

Overall, the 48V battery is a key component of electric bikes, as it provides the electrical energy that powers the electric motor and allows the bike to function. It is important to choose the right type of battery and to properly maintain it to ensure that it performs well and lasts a long time.



**Figure 3.2**Battery 12v 28AH

#### 3.3 THROTTLE

An electric bike throttle is a device used to control the electric motor in an electric bicycle. It is typically located on the handlebars of the bike and allows the rider to control the amount of power that the motor delivers.

The throttle works by regulating the flow of electricity from the battery to the electric motor. When the rider twists the throttle, it sends a signal to the motor controller, which in turn increases the flow of electricity to the motor, causing it to provide more power. The rider can control the speed of the electric bike by adjusting the throttle, allowing them to choose how much power they want to receive from the motor.

There are two main types of electric bike throttles: thumb throttles and twist throttles. Thumb throttles are mounted on the handlebars and are controlled by the rider‘s thumb, while twist throttles are integrated into the grip of the handlebars and are controlled by twisting the grip.

In addition to allowing the rider to control the power of the electric motor, the throttle also provides a means of controlling the speed of the electric bike. This can be particularly useful when riding up hills or in challenging terrain, as the rider can receive additional power from the motor when they need it.

Overall, the electric bike throttle is an important component of electric bikes, providing the rider with a means of controlling the power of the electric motor and the speed of the bike. It is designed to be simple and intuitive to use, making it an essential component of the electric bike experience.



**Figure 3.3**Throttle

#### 3.4 CONTROLLER

An electric bike controller is an essential component in the operation of an electric bicycle. It regulates the power from the battery to the motor and controls the speed of the bike. The controller is the "brain" of the e-bike system, receiving signals from the throttle and brake sensors and adjusting the power to the motor accordingly. Here are the key functions of an electric bike controller in more detail:

1. Power Regulation: The controller regulates the power from the battery to the motor, ensuring that the motor receives the correct amount of power for the current riding conditions. This helps to maximize the efficiency of the system and extend the life of the battery.
2. Speed Control: The controller adjusts the power to the motor to control the speed of the bike. The rider can control the speed using the throttle, which sends a signal to the controller. The controller then regulates the amount of power the motor receives based on the speed the rider is going and the power level selected. This helps to ensure a smooth and comfortable ride.
3. Throttle Management: The controller manages the throttle, which allows the rider to control the speed of the bike. The throttle sends a signal to the controller, which adjusts the power to the motor accordingly. The throttle can be in the form of a grip or thumb throttle, and the type of throttle used will depend on the specific e-bike system.
4. Brake Management: The controller also manages the brake sensors, which shut off power to the motor when the brakes are applied. This helps to improve the safety of the rider and prolong the life of the battery. By shutting off power to the motor, the controller helps to prevent the motor from continuing to provide resistance when the brakes are applied, which can cause the bike to slow down too quickly.
5. Display Control: Many electric bike controllers also have a display unit that shows information such as speed, distance travelled, battery level, and power consumption. The controller regulates the display unit, allowing the rider to easily see important information about their ride. The display unit can be mounted on the handlebars or integrated into the controller itself.

In addition to these key functions, some electric bike controllers also have advanced features such as pedal assistance, which provides additional power to the motor based on the effort the rider is putting into pedalling. Some controllers

Also have a regenerative braking feature, which captures energy from the bike's motion and uses it to recharge the battery.

Overall, the electric bike controller is a crucial component in the operation of an electric bike. By regulating the power from the battery to the motor and controlling the speed of the bike, the controller helps to ensure a smooth, safe, and efficient ride.



**Figure 3.4**E-bike controller 48v

#### 3.5 CHARGER

An electric bike charger is a device used to charge the battery of an electric bicycle. It is an important component of an e-bike system, as the battery is what powers the motor and allows the bike to function. The charger plugs into a standard electrical outlet and is connected to the battery of the bike.

There are several types of electric bike chargers, each with their own unique features and specifications. Some chargers are designed to be compact and portable, making it easy to take them with you on the go. Other chargers are more powerful, allowing for faster charging times.

The charging time for an electric bike battery will depend on several factors, including the capacity of the battery, the charging voltage, and the charging current. Generally, it takes between 2-6 hours to fully charge an electric bike battery. Some advanced chargers use higher voltage and current levels to reduce the charging time, while others use a lower voltage and current to extend the life of the battery.

When selecting an electric bike charger, it's important to choose one that is compatible with your specific e-bike system. Make sure to check the voltage and current specifications of your battery, and choose a charger that meets those requirements.

Overall, the electric bike charger is an important component of an e-bike system. By charging the battery, it ensures that the bike is ready for use whenever you need it.



**Figure 3.5**CHARGER 48V

#### 3.6 CHAIN DRIVE

A chain drive is a type of mechanical drive system that uses a chain to transfer power from one place to another. It is commonly used on bicycles, including electric bikes, to transfer power from the pedals to the wheel.

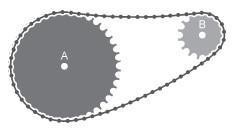
The chain drive works by using a chain to connect the pedals, or the motor in the case of an electric bike, to the wheel. As the pedals (or motor) rotate, they cause the chain to move. This movement is transferred to the wheel, which then rotates and propels the bike forward.

Chain drives are popular on bicycles because they are relatively simple and reliable. They are also efficient, as they can transfer power over longer distances than other types of drive systems, such as direct drive systems.

One key advantage of chain drives on electric bikes is that they can be easily integrated with other components, such as gears and derailleurs. This allows the rider to adjust the gearing to suit the terrain and their own preferences.

There are several types of chains used in chain drives, including single-speed chains, multispeed chains, and chain tensioners. Single-speed chains are used on bikes with a single gear, while multi-speed chains are used on bikes with multiple gears. Chain tensioners are used to keep the chain tight and prevent it from falling off the gears.

Overall, the chain drive is a simple and efficient way to transfer power from the pedals (or motor) to the wheel on an electric bike. It is a key component of the drive system, and plays an important role in propelling the bike forward.



**Figure 3.6**Chain Drive

### CHAPTER – 4 Comparative Analysis Of E- Vehicle With Conventional Vehicle

#### 4.0 Introduction

Electric bikes and petrol bikes use very different technologies to operate.

Electric bikes, as the name suggests, are powered by electricity stored in a battery. The battery powers an electric motor, which drives the wheels of the bike. The motor is controlled by an electronic controller that regulates the amount of power delivered to the motor. Electric bikes use regenerative braking technology, which converts some of the energy generated during braking into electrical energy that can be used to charge the battery.

On the other hand, petrol bikes use a combustion engine that burns fuel to create the energy needed to power the wheels. The engine is fueled by petrol, which is stored in a fuel tank. The combustion process drives pistons that power the bike's wheels. The engine is controlled by a carburetor or fuel injection system that regulates the amount of fuel delivered to the engine.

Overall, electric bikes use a simpler and more efficient technology compared to petrol bikes. Electric bikes have fewer moving parts, which means they require less maintenance and are less prone to breakdowns. They also have lower operating costs, as electricity is cheaper than petrol. Petrol bikes, however, offer more power and range, which makes them better suited for longdistance travel and high-performance applications.

#### 4.1Electric Two-Wheeler Technology

Electric two-wheeler (e-TW) technology refers to the use of electric power to propel twowheeled vehicles, such as e-bikes, e-scooters, and e-motorcycles. This technology utilizes rechargeable batteries to store energy, which is then used to drive an electric motor that powers the vehicle. E-TWs offer several advantages over traditional gasoline-powered twowheelers, including lower operating costs, reduced emissions, and improved efficiency. They also provide a more convenient and accessible mode of transportation for people living in urban areas, where traffic congestion and parking can be a challenge. Advances in e-TW technology have also led to increased range, improved battery life, and more advanced features, such as regenerative braking and GPS navigation. The adoption of e-TWs is expected to continue to grow in the coming years, driven by factors such as government support, consumer demand, and the increasing availability of charging infrastructure.

An electric bike power system typically consists of several key components:

1. Battery: The battery is the main source of power for an e-bike, providing the energy needed to drive the motor. The capacity of the battery is measured in kilowatt-hours (kWh) and determines the range of the bike.

1. Electric Motor: The electric motor is responsible for converting the energy stored in the battery into propulsion. E-bikes typically use either hub motors in the wheel or mid-drive motors that are integrated with the bike's crank set.

1. Controller: The controller regulates the flow of power from the battery to the motor, ensuring that the motor operates within safe limits.

1. Display Unit: The display unit provides the rider with information such as battery level, speed, distance, and power assist level.

1. Pedal-Assist Sensor: A pedal-assist sensor measures the amount of force the rider is applying to the pedals and sends a signal to the controller to adjust the amount of power assist accordingly. These components work together to deliver a smooth, efficient, and convenient riding experience. The characteristics of an e-bike power system, such as power output, battery life, and range, can vary greatly depending on the make and model of the bike.

##### 4.2 Process of Making E-Bike

The process of making an electric bike typically involves the following steps:

1. Design and development: This involves creating a design concept, defining the specifications and features, and selecting the components that will be used in the electric bike.

1. Sourcing components: This involves sourcing the components required for the electric bike, such as the battery, motor, frame, and wheels.

1. Assembly: This involves putting all the components together to create the electric bike. The assembly process can be done manually or with the help of machines.

1. Testing and quality control: This involves testing the electric bike to ensure that it meets the specifications and is functioning properly. Any defects or issues are identified and addressed during this stage.

1. Packaging and shipping: Once the electric bike has passed all the necessary tests, it is packaged and shipped to the customer.

The entire process can take several weeks to several months, depending on the complexity of the design and the size of the production run.

##### 4.3 Petrol Engine Technology

Building a petrol engine for a two-wheeler bike requires specialized knowledge and tools, and it's not a task that can be easily accomplished by someone without experience. However, here is a general outline of the steps involved in making a petrol engine for a two-wheeler bike:

1. Determine the specifications: Before you start building the engine, you need to determine its specifications such as its displacement, power output, compression ratio, and other important factors. This will help you decide on the appropriate materials and design for the engine.

1. Select the materials: The engine will require a variety of materials including metals, plastics, and gaskets. Choose materials that are durable, heat-resistant, and able to withstand the stresses of combustion.

1. Build the engine block: The engine block is the foundation of the engine, and it is responsible for supporting the cylinders, crankshaft, and other key components. It is typically made from cast iron or aluminum, and requires precision machining to ensure that all the parts fit together properly.

1. Assemble the engine components: The engine components, including the pistons, crankshaft, camshaft, valves, and timing belt, need to be assembled with precision to ensure that they work together smoothly and efficiently.

1. Install the engine: Once the engine is built, it needs to be installed into the bike's frame and connected to the transmission and other components.

1. Test the engine: Finally, the engine needs to be tested to ensure that it runs smoothly, produces the desired power output, and meets all safety and environmental regulations.

Building a petrol engine for a two-wheeler bike requires a significant amount of knowledge, experience, and specialized tools. If you do not have the necessary skills and equipment, it's recommended that you seek the help of a professional mechanic or engine builder.

##### 4.4 Process of Making Petrol Engine Bike

The process of making a bike typically involves several stages, including design, engineering, fabrication, assembly, and testing. Here is a general outline of the process:

1. Design: The first stage of making a bike involves designing the bike's frame, components, and overall aesthetic. This typically involves a combination of computer-aided design (CAD) software and physical prototypes to refine the design and ensure that it meets the desired specifications.

1. Engineering: Once the design is finalized, the bike's components need to be engineered to ensure that they are durable, lightweight, and able to perform under various conditions. This involves selecting appropriate materials, determining tolerances, and ensuring that all the parts fit together properly.

1. Fabrication: The bike's frame and components need to be fabricated using specialized tools and techniques. This may involve cutting and shaping metal tubes, welding or brazing the frame together, and machining the various components.

1. Assembly: Once all the individual components are fabricated, they need to be assembled together to create the final bike. This involves installing the wheels, drivetrain, brakes, handlebars, and other components onto the frame.

1. Testing: Finally, the bike needs to be tested to ensure that it is safe, reliable, and performs as expected. This may involve testing the bike on a track or in a laboratory, and making any necessary adjustments or modifications.

The process of making a bike can vary depending on the type of bike, the materials used, and the level of customization involved. However, regardless of the specifics, it typically involves a combination of design, engineering, fabrication, assembly, and testing to create a high-quality and reliable final product.

##### 4.5 Specification of Bajaj pulsar 150 and E- Bajaj Pulsar 150Power & Performance

Fuel Type:- - Petrol. Electric.

Max Power:- 13.8 bhp @ 8,500 rpm 250 W or 0.3 bhp

Max Torque:- 13.25 Nm @ 6,500 rpm. 30 Nm

Transmission:- 5 Speed Manual. Automatic

Running Cost:- ₹ 2.18/km. ₹ 0.22/km

Top Speed (Kmph) :- 110. 50

Riding Range (Km):- 705. 45

Rated Power (W) :- NA. 250 W or 0.3 bhp

Emission Standard :- BS-IV NA

Displacement(cc):- 149.5. NA

Cylinders :- 1. NA

Bore (mm) :- 56. NA

Stroke (mm) :- 60.7. NA

Valves Per Cylinder :- 2. NA

Compression Ratio:- 9.8 +/- 0.3 : 1. NA

Ignition :- CDI NA

Spark Plugs (Per Cylinder) :- 2 NA

Cooling System:- Air Cooled. Air Cooled

Transmission Type:- Chain Drive. Chain Drive

Gear Shifting Pattern :- 1 Down 4 Up NA

Clutch:- Wet Multiplate NA

Fuel Delivery System:- Fuel Injection NA

Fuel Tank Capacity (litres) :- 15 NA

Reserve Fuel Capacity (litres) :- 3.2 NA Mileage -Owner Reported (kmpl):- 47 NA

Gradeability (Degree):- NA. 12

Battery charging time (Hrs):- NA. 4-4.5

Carrying capacity (kg) :- NA. 150

Battery capacity (kWh) :- NA. 1.656

Battery type :- NA. Lead acid

No. Of Batteries:- NA. 4

Motor type: - NA. DC Hub Motor

Charger Type: - NA. Portable Charger

Charger output :- NA. 48V

##### 4.6 Brakes, Wheels & Suspension

Braking System :- Single Channel ABS. Standard

Front Brake Type :- Disc. Disc

Rear Brake Type :- Drum. Drum

Wheel Type :- Alloy. Alloy

Front Wheel Size (inch):- 17. 17

Rear Wheel Size (inch) :- 17 17

Tyre Type :- Tubeless. Tubeless Dimensions & Chassis

Kerb Weight (kg):- 148. 93

Overall Length (mm):- 2,055. 1,460

Overall Width (mm) :- 765. 610

Overall Height (mm) :- 1,060. 1,060

Wheelbase (mm) :- 1,320. 1,320

Ground Clearance (mm) :- 165. 165

Seat Height (mm):- 785. 785

Chassis Type:- Double Cradle Double Cradle

Brakes, Wheels & Suspension

Front Tyre Pressure (Rider) (psi):- 25.

Rear Tyre Pressure (Rider) (psi):- 28.

Front Tyre Pressure (Rider & Pillion) (psi):-25. Rear Tyre Pressure (Rider & Pillion) (psi):-32.

### Manufacturer Warranty

Battery warranty (Year) :- NA. 1

Motor warranty (Year) :- NA. 1

Standard Warranty (Year):- 5 .NA

Standard Warranty (Km):- 75000. NA

#### 4.7 performance and analysis of E-vehicle & conventional vehicle

##### (a) Performance of vehicle

Electric and gasoline powered motorcycles and scooters of the same size and weight are roughly comparable in performance. In August 2013 Road & Track evaluated a high-end electric motorcycle as faster and better handling than any conventionally powered bike. Electric machines have better 0 to 60 acceleration, since they develop full torque immediately, and without a clutch the torque is instantly available

##### (b) Rangeof vehicle

Electric motorcycles and scooters suffer considerable disadvantage in range, since batteries that fit in a motorcycle frame cannot store as much energy as a tank of gasoline. Anything over 130 miles (210 km) on a single charge is considered an exceptionally long range. Consequently, while electric machines excel for city dwellers traveling relatively short distances, on the open road riders experience inhibiting range anxiety. Electric power also trades off range against speed; for instance according to the manufacturer the long-range ZEV LRC electric scooter can travel 225 km (140 mi) at 88 km/h (55 mph), but the range drops to about 129 km (80 mi) at 112 km/h (70 mph).

Manufacturers are striving to increase range; as of 2022 a range of 259 km (161 mi) was reported. At the other end of the scale, much shorter ranges such as 64 km (40 mi) were available at very much lower cost.

###### (c) Maintenance

Electric scooters and motorcycles need very little maintenance.[[69]](https://en.m.wikipedia.org/wiki/Electric_motorcycles_and_scooters#cite_note-69) As [Wired](https://en.m.wikipedia.org/wiki/Wired_(magazine)) magazine's transportation editor Damon Lavrinc reported after an experiment of trying to go six months using nothing but a Zero electric motorcycle: "[w]ith only a battery, a motor, and a black box (i.e. the controller) to keep you moving, electric motorcycles are a breeze to maintain compared to a conventional motorcycle, what with all the lubricating and adjusting and tuning you have to do. You basically just worry about consumables: brake pads, tires, maybe a brake fluid flush. That‘s about it." Electric scooters and motorcycles equipped with [regenerative braking](https://en.m.wikipedia.org/wiki/Regenerative_braking) typically have longer brake pad life because a significant portion of braking duty can be performed with the electric motor instead of the mechanical friction brakes.

###### (d) Fuel costof vehicle

At between one and two cents per mile (depending on electric rates), electric machines enjoy an enormous fuel cost advantage. Three months and 2,800 km (1,700 mi) of commuting on an electric motorcycle cost Lavrinc less than $30 for electricity; on a BMW gasoline bike a single trip of 650 km (400 mi) cost nearly the same. In Australia, UBCO battery Electric Motorbike running cost is 88¢ per 100 km. In India, Ampere Electric Scooter's running cost is at Rs. 0.15 per km.

###### (e)Refuel timeof vehicle

Even with special equipment, charging a battery takes significantly longer than filling a gasoline tank. With the maximum number of accessory chargers, it takes over an hour to charge a Zero S ZF6.5's 6.5kWh battery to 95% capacity. This refuel time also increases with battery capacity; the Zero S ZF13.0 (which has a 13kWh battery) takes over 2 hours to charge to 95% capacity using the maximum number of accessory. This affects journeys longer than the single-charge range of a motorcycle.

###### (f) Noise

Electric vehicles are far quieter than gasoline powered ones, so that they may approach a pedestrian who is not watching unnoticed. Some are equipped to produce a warning sound as they travel. Popular Mechanics called the comparative quiet of electric motorcycles the greatest difference between them and their gasoline counterparts, and a safety bonus because the rider can hear danger approaching. Whether a loud motorcycle is safer than a quiet one due to being more noticeable is a matter of dispute. At high speed the whine of a typical electric motorcycle is said to sound "like a spaceship." On the other hand, electric make no noise pollution.

###### (g)Types

A two- (or sometimes three-) wheeled powered vehicle if ridden with rider astride is termed a motorcycle; if it has a step-through frame with rider seated with feet on a floor panel it is a motor scooter. A smaller vehicle, typically just a deck to stand on with two (or three) wheels and a handlebar on a vertical stem is also termed a scooter; such scooters if unpowered are termed kick scooters, and e-scooters if battery powered. E-scooters are made available for hire by several companies in a scooter-sharing system.

###### (h) Power source

A restriction on the range of electric motorcycles and scooters is the requirement to cram enough electrical energy into their small frames.

Most electric motorcycles and scooters are powered by rechargeable lithium-ion batteries, though some early models used nickel–metal hydride batteries.

Alternative types of batteries are available. Z Electric Vehicle pioneered use of a battery with lead electrodes and an electrolyte of a liquid low sodium silicate compound, a variation on the classic [lead–acid battery](https://en.m.wikipedia.org/wiki/Lead%E2%80%93acid_battery) invented in 1859 and still used for electrical power in internalcombustion-engine automobiles, that compares favorably with lithium batteries in size, weight, and energy capacity, at considerably less cost.

EGen says its lithium-iron phosphate batteries are up to two-thirds lighter than lead-acid batteries and offer the best battery performance for electric vehicles.

In 2017, the first vehicle in the US to use the new [Lithium Titanium Oxide (LTO) battery](https://en.m.wikipedia.org/wiki/Lithium%E2%80%93titanate_battery) nonflammable battery technology was a scooter called The Expresso. This technology allows a battery to charge in less than 10 minutes, and is capable of 25,000 charges, the equivalent of 70 years of daily charges. The technology, created by [Altairnano,](https://en.m.wikipedia.org/wiki/Altairnano) is used in China, where over 10,000 urban buses run on these batteries.

##### (i)Charging

All electric scooters and motorcycles provide for recharging by plugging into ordinary wall outlets, usually taking about eight hours to recharge (i.e., overnight). Some manufacturers have designed in, included, or offer as an accessory, the high-power [CHAdeMO](https://en.m.wikipedia.org/wiki/CHAdeMO) level 2 charger, which can charge the batteries up to 95% in an hour.

###### (j)Battery swapping

Manufacturers like Zero Motorcycles and recent entrants to the scooter market Nanu EV, Gogoro, and Unu have designed machines that allow quick [battery swapping,](https://en.m.wikipedia.org/wiki/Battery_swapping) to allow charging without the vehicle needing to be near a charge point, or, with a spare battery or an available battery network, to allow continued travelafter a battery is drained.

In the mid-1990s, Personal Electric Transports-Hawaii (formerly Suntera, now P.E.T.) was making a 113 km/h (70 mph) capable 3-wheel enclosed-electric motorcycle called the Sunray – designed by noted solar EV pioneer Jonnathan Tennyson. The Sunray's battery cartridge was on rollers and slid out of the front of the vehicle so it could be swapped out for a freshly charged battery at a battery-swap station conveniently located along a highway or in a city. P.E.T. also had streamlined 2-wheel seated motor scooters called Caballito's – designed by Budd Steinhilbur, who was a well-known designer of the [Tucker 48](https://en.m.wikipedia.org/wiki/Tucker_48) automobile. Budd's Caballito's were also adapted for battery-swapping at P.E.T.‘s future battery-swap stations. In 2000, P.E.T. added light-electric motorcycle and scooter visionary Todd Bank to their team and P.E.T. secured major funding from the Los Angeles Department of Water and Power to design and prototype the first battery-swap stations for light-electric vehicles and NEV's. P.E.T. prototypes and designs are now on display at museums across America.

Battery swapping is popular in India, with Sun Mobility planning modular batteries. "A moped would require one, a rickshaw two and a car four.

###### (k) Hybrid

Honda has developed an experimental internal combustion/electric hybrid scooter. Yamaha has also developed a hybrid concept motorcycle called Gen-Ryu. It uses a 600cc engine and an additional electric motor. [Piaggio MP3](https://en.m.wikipedia.org/wiki/Piaggio_MP3) Hybrid uses a 125cc engine and an additional 2.4 kW motor.

###### (l) Fuel cell

There are several experimental prototypes using [fuel cell](https://en.m.wikipedia.org/wiki/Fuel_cell) technology. [ENV](https://en.m.wikipedia.org/wiki/ENV) developed by [Intelligent Energy](https://en.m.wikipedia.org/wiki/Intelligent_Energy) is a [hydrogen fuel cell](https://en.m.wikipedia.org/wiki/Hydrogen_fuel_cell) prototype. The motorcycle has a range of 100 miles (160 km) and can reach a top speed of 50 mph (80 km/h). [Suzuki](https://en.m.wikipedia.org/wiki/Suzuki) has also developed a concept hydrogen fuel cell scooter based on the [SuzukiBurgman.](https://en.m.wikipedia.org/wiki/Suzuki_Burgman) Yamaha has created a hydrogen fuel cell prototype called FC-AQEL, which is considered equivalent to a 125cc vehicle. [Honda](https://en.m.wikipedia.org/wiki/Honda) has also developed a hydrogen fuel cell scooter which uses the [HondaFCStack](https://en.m.wikipedia.org/wiki/Honda_FCX)

### Chapter -5

#### CONCLUSIONS & FUTURE SCOPE

##### 5.0 Conclusion

**5.1.1**The future of electric vehicles, both in the short and the long term is very exciting. Firstly, there have been considerable developments in technology, which now allow advances in electric vehicle design to be made. Secondly, there are growing environmental concerns which are pressing society to find alternatives to IC engines alone as a source of power for vehicles. Environmental concerns encompass worries about carbon dioxide emissions and the effect of exhaust gas emissions on health. Thirdly, in the largest market for personal transport, the USA, there is an increasing realisation that fuel economy is important, for security reasons as well as environmental concerns. The Californian car market alone is about 1000000 units per year, and the rules of this state will continue to give a ‗technology push‘ to developments in this area, as they have done so strongly up to now.

There have been three main areas where substantial developments in electric vehicles are currently occurring. The first is small rechargeable battery vehicles, secondly hybrid vehicles, and thirdly fuel cell vehicles.

**5.1.2**There has been a proliferation of small-scale commuter vehicles, bikes, delivery vehicles, mobility aids and lightweight cars that use rechargeable batteries. These have a limited range and are normally used as second vehicles. As such they encourage people to use this form of transport for short journeys and hence are reducing the use of conventional vehicles. Although there have been developments in rechargeable battery cars, such as the GM EV1, the major manufacturers seem to be fighting shy of this area, preferring to develop hybrid and fuel cell vehicles. However, there are many types of vehicle other than cars, and battery electric vehicles of different types (such as bicycles) will become more and more common.

**5.1.3**Hybrid vehicles have developed very rapidly in the last few years. The Toyota Prius has been a particular success, at least as a technology demonstration if not commercially, and nearly all major motor manufacturers are developing products in this area. This is being encouraged by regulatory changes in California, and tax breaks throughout the USA. Current practice is to use engine and battery in conjunction to maximise fuel economy, rather than to charge the vehicle from an external electric charging point. However, this may change, and grid connectable hybrids will certainly appear in the medium term. High fuel economy is obtained from these hybrids. Car makers will definitely be pushing forward with hybrids, even though they may have somewhat abandoned battery powered cars. Table 11.7 was produced by Ford ahead of the launch of their hybrid electric SUV car in 2003. It makes clear their view that with a hybrid you get many of the fuel economy and environmental benefits of a battery car, but without having to pay too much in up

**5.1.4**A comparison chart adapted from that produced by Ford,1which summarises why they think hybrid IC/electric vehicles are better than 100% battery cars, at least for the medium term

|  |  |  |  |
| --- | --- | --- | --- |
|  | Conventional | Hybrid electric | 100% Battery electric |
| Total range | 350 miles | 450–550 miles | 100 miles |
| Electric range | Nil | Nil | 100 miles |
| Gasoline range | 350 miles | 450–550 miles | Nil |
| Fuel economy | Base | 30–50% better than base | 100 mpg equivalent |
| R-fuelling | Fill-up, 5min | Fill-up, 5min, less often | Several hours recharge |
| Environmental impact | base | SULEV, 90% better than 2003 standard | ZEV, but see Chapter 10, total emissions *not* zero |
| Performance | four-cylinder | Like a V6 | Very poor |
| Price premium | Base | Not determined, but usually a few $1000 | $10000 |

front cost, and getting a vehicle that actually performs better than the standard IC engine only car.

Most major vehicle manufacturers are also currently making developments in fuel cell vehicles. Clearly they see this as an area where electric cars could be produced that would compete with conventional IC vehicles in terms of range, flexibility and cost. Fuel cell cars are further away from commercialisation than hybrids, but fuel cell powered buses are closer to the market.

In addition to developing electric vehicles close attention needs to be given to the infrastructure needed to supply power for electric vehicles. Although small electric commuter vehicles use household electric sockets at present, and current commercially available hybrid vehicles solely use gasoline or diesel, future fuel cell vehicles are likely to need sources of hydrogen. More widespread use of rechargeable battery vehicles will require charging points to be installed.

**5.1.6**The issue of energy sources also needs to be addressed. Introduction of electric vehicles undoubtedly cleans up the immediate environment where the vehicle is being used. However, in the case of rechargeable vehicles the emission of carbon dioxide is simply being transferred to fossil fuel burning power stations. Introduction of more alternative energy power stations such solar, wind and hydro to match the introduction of electric vehicles would ensure real zero emission transport.

With current technical developments in the energy sources for electric vehicles, coupled to the desire for less environmentally damaging transport, the future for electric vehicles looks extremely promising.

Rapid development of small rechargeable vehicles, electric hybrids and fuel cell electric vehicles is likely to continue over the next two decades. At the same time the infrastructure for powering electric vehicles will develop. It is hoped that more emphasis will be placed on the provision of clean sustainable energy systems to provide electric power for rechargeable vehicles, and to produce hydrogen for fuel cells.

##### 5.2 Future scope

Modern world demands the high technology which can solve the current issues and future problems. Now-a-days Fossil fuel shortage is the main problem. Considering current rate of usage of fossil fuels will let its life up to next five decades only. Because of undesirable change in climate is the red indication for not to use more fossil fuel any more. Best alternative for the automobile fuels to provide the mobility & transportation to peoples is sustainable electrical bike. Future e-bike is the best technical application as a visionary solution for the better world, upcoming generation and environment. E-bike comprises the features like high mobility efficiency, compact, electrically powered, comfortable riding experience, light weight vehicle. E-bike is the most versatile current and future vehicle considering its advantages .The electric bike (e-bike) market is expanding at an amazing rate in the People‘s E-bikes serve the enormous low-income populations who are currently using bicycles and public transport, providing an alternative transport option that has much of the mobility benefits of a personal car but is cheaper to own and operate and emits a fraction of the greenhouse gases and conventional pollutants.

E-bikes are touted as a clean form of transport and do not emit any local pollution, but they do increase demand on electricity, boost power plant emissions, and introduce a large amount of lead into the environment.

The operation of e-bikes produces a high proportion of sulfur dioxide (SO2) air pollution in the life cycle, largely because of an electricity supply network that primarily consists of coal power plants.

E-bikes produce fewer greenhouse gases and are more energy efficient than buses or motorcycles, indicating that they can be a component toward a sustainable transportation future, although their impact on congestion compared with buses and subsequent fuel use and emission implications need to be considered.

Electricity generation in the PRC is primarily from coal power plants, but electricity can be produced with renewable resources, making e-bikes more efficient. Moreover, with properplanning, e-bikes can be integrated to support public transport systems as efficient and low cost feeders.

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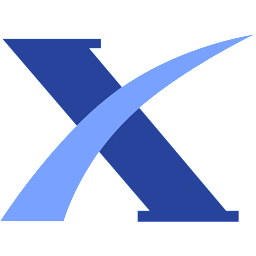
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# Originality Assessment 13%

An electric bike, also known as an e-bike, is a bicycle that is equipped with an electric motor to assist the rider. The motor provides additional power to the pedals, making it easier to pedal and ride up hills. E-bikes are powered by rechargeable batteries that can be charged from an electrical outlet.

The electric assist can be controlled through a variety of methods, including a throttle, pedalling sensor, or a combination of both. Some e-bikes also have multiple levels of assist, allowing the rider to choose the amount of electrical power they would like to receive.

E-bikes have become increasingly popular in recent years due to their combination of convenience, sustainability, and affordability. They are a great alternative to traditional bicycles and provide a convenient form of transportation for commuting, running errands, or leisure riding.

Overall, e-bikes offer many benefits including improved accessibility for individuals with mobility or fitness challenges, increased range and speed, and a reduction in carbon emissions compared to traditional gasoline-powered vehicles.

The Fundamental working of electric bike is based on batteries which is charged by electric charger by using the batteries the power is supplied to electric motor with the help of power controller or convertor and then to the wheels. In electric bike electric energy is converted into mechanical work. For this studies of electric bike we have been used electric motor of 3000 rpm and batteries of 48 volt, 28 amp. The power of electric motor is 1.5 kW to run this motor we require 48V, 28A batteries. All batteries are connected in series combination.

An electric bicycle is, first and foremost, a bicycle. It uses the same designs, geometries, and components as any other bicycle, but also includes an added electric motor. This is fueled by a rechargeable battery, which gives riders an extra boost of power and ultimately provides a smoother, more convenient, and less strenuous cycling experience. By eliminating many of the obstacles that keep people from cycling—obstacles such as headwinds, steep hills, and bike commutes that leave riders tired, messy, and sweaty—electric bikes help make the freedom, exhilaration, and satisfaction of cycling available and accessible to a wide range of potential cyclists.

The idea of creating an electric bike has intrigued cyclists since the late 1800s, when several American inventors experimented with the possibility of combining the potential power of electric motors with the simple mechanics of the bicycle. It wasn‘t until the technological advancements of the 20th and 21st centuries, however, that this idea finally became a viable reality. With lightweight motors, high efficiency rechargeable batteries, smoothly shifting

drivetrains, and huge advances in bicycle components, today‘s electric bikes provide a way for cyclists of all ages, fitness levels, and physical needs to enjoy the benefits of cycling, whether it‘s a leisure ride, a workout, or part of a daily commute.For many, electric bikes are an attractive alternative to both conventional bicycles and traditional automobiles, providing an environmentally friendly, fun, efficient, and convenient way to travel.

1.1 The Growing Popularity Of Electric Bikes Electric bicycles are becoming increasingly popular throughout the world, as more and more people look for efficient, affordable, and eco-friendly modes of transportation. In recent years, electric bike use has skyrocketed in Asia, most notably in China, which has established itself as the world leader in electric bike use. There are now an estimated 200 million electric bikes in China, with millions more added every year.

The explosive expansion of electric bikes in China has helped spur similar growth in other parts of the world. In Europe—the second largest market for electric bikes—electric bicycle use has been steadily on the rise. In 2006, there were approximately 98,000 electric bikes sold throughout Europe. A decade later, this number had risen to almost 1.7 million in annual sales.

Electric bikes are also gaining increasing popularity in the United States, where e-bike sales rose sharply from about 70,000 in 2011 to over 263,000 in 20173, and the growth is likely to continue accelerating. The dramatic improvements in electric bicycle technologies and capabilities, as well as the rapid growth in the popularity of electric bicycles in recent years, have all made the prospects of owning and riding an electric bike particularly exciting.

Whether they‘re used by people looking for a low impact way to get back into shape, older cyclists seeking a more accessible way to enjoy leisurely bike rides, urban professionals attempting to simplify their daily commutes, environmentally conscious travelers hoping to decrease their emissions footprints, or anyone in between, it seems increasingly likely that electric-assisted bicycles will change how people think about bikes.‖

1.2 Energy Use and Emission of Electric Bike Life Cycle Electric bikes are seen as a more environmentally friendly mode of transportation, but the energy used and emissions generated in the production and use of electric bikes are not negligible. In this essay, we will examine the energy use and emissions of the life cycle of electric bikes.The production of electric bikes involves the extraction and processing of raw materials, such as aluminium and lithium for the frame and battery, respectively. This process requires large amounts of energy and generates emissions from the use of fossil fuels, such as coal and natural gas, in power plants. The production of batteries also requires energy-intensive processes, such as electrolysis, that contribute to emissions.

Once the electric bike is manufactured, it requires energy to be transported to the market, either by road, sea, or air, all of which contribute to emissions. Furthermore, the charging of the electric bike battery requires energy, which is typically generated from fossil fuels, contributing to emissions. In use, electric bikes emit significantly less CO2 than traditional gasoline powered bikes However, the emissions generated during the production and use of electric bikes are not negligible and should be taken into account when considering the environmental impact of electric bikes.

The end-of-life disposal of electric bikes also contributes to emissions. When electric bikes reach the end of their useful life, they must be disposed of, which typically involves transportation to a landfill or recycling facility. This transportation contributes to emissions, and the recycling of batteries and other components may also generate emissions.

In conclusion, the energy use and emissions of electric bikes are complex and vary depending on the stage of the life cycle. While electric bikes emit less CO2 during use than traditional gasoline-powered bikes, the emissions Generated during production and end-of-life disposal should not be ignored. To reduce the environmental impact of electric bikes, it is important to consider the entire life cycle of the electric bike, from production to disposal