VIDYA JYOTHI INSTITUTE OF TECHNOLOGY

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A Project Report

on

GenZe-20

Submitted for partial fulfilment of the requirements for the award of the degree

of

BACHELOR OF TECHNOLOGY

IN

ELECTRICAL AND ELECTRONICS ENGINEERING

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CERTIFICATE

This is to certify that the project work entitled **"GenZe-20"** is a bonafide work carried out by **Mr. Krishna Vamshi (16911A0205), Mr Avinash Kumar(16911A0208), Ms. L.V.S.P.L Gayatri (16911A0226), Ms. Shraddha Kulkarni (16911A0243)** in partial fulfillment of the requirements for the award of degree of **BACHELOR OF TECHNOLOGY IN ELECTRICAL AND ELECTRONICS ENGINEERING** to be awarded by the **JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY, Hyderabad.**

The content in this report has not been submitted to any other university or institute for the award of any degree or diploma.

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DECLARATION

This is to certify that the work reported in the present project entitled **GenZe-20** is a record of work done by us in the Department of **Electrical and Electronics Engineering**, Vidya Jyothi Institute of Technology (Autonomous), Jawaharlal Nehru Technological University, Hyderabad. The reports are based on the project work done entirely by us and not copied from any other source.

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ABSTRACT

This study is based on e-bikes, mainly the 'Pedelecs' (under Swedish standards). Pedelecs is the category of e-bikes which indicates electric bicycles only, that has specific standard in terms of motor power and speed limitations. We are concerned with respect to Sweden, in the analysis, especially because though it is already defined by EU for Europeans, it still varies in some countries, within Europe itself. In this research and experiment, we have brought useful revelations about its features in terms of power, comfort and cost. Likewise, our efforts have been to test its reliability on technical grounds, geographical conditions, people's awareness and interests. Similarly, on effective grounds, ratio of bike users, import conditions, its growth and declines trends, and other influencing factors have been analysed to understand e-bike's possibilities in Sweden.

To highlights e-bike's features and importance, we have done a thorough investigation, taking comparative analysis with ordinary bicycles and normal vehicles, by using common elements like cost effectiveness, power efficiency, leisure service, easy accessibility, environment effects and so on. The findings have proven e-bikes to be the most effective solution on various grounds than any other transport alternatives especially in short distance and inner city traveling.

In theoretical details on e-bikes, we have introduced details about the components applicable in e-bike, how they operate, their importance in terms of effectiveness with respect to power consumption and energy dispatching (motor capacity), quality of performance (types of components and features) and other comparative technical aspects. To understand the ground reality better, a short survey have been conducted to give some understanding about the awareness people are having regarding e-bike, their remarks towards this product, and based on their conclusions, our predictions report on its development and popularity chances in Sweden.

While analysing facts in general, we discovered that pedelecs for US may not be pedelecs for Sweden, because of standard varies from country to country. According to European classification standard, a pedelec must have the motor capacity up to 250 W, and must stop the motor when the speed is above 25 km/h. Speaking about the popularity of e-bike, In China the number of e-bikes sold reached up to 200 million, Germany is leading the way in Europe, therefore by the favourable situations available in Sweden, we can predict high potential in Sweden. The statistics data proved that Sweden is a bicycle country, where the amount of bicycles sold in 2012 was around 525,000, among which 6,500 were e-bikes imported the same year, suggesting its potential of growth being real.

analysing mathematically e-bike's functions, the four different calculations have been analysed, keeping the weight of the person constant, but varying other common parameters that in use, in order to personify the drag in equation. By doing so taking the average power we have observed that it requires around 157 watts going up the hill when gradient is 4%, at the speed around 10 Km/h. This result have been again tried to be verified in the experimental works as well.

Based on these relevant information, in the experiment we have tested to find how much energy is dissipated in 2 minutes, taking six samples to authenticate our result. After not being successful taking angle measurements by riding outside or inside lab, it is achieved to some degree after applying it on running machine in gym with some complications. The result that have been achieved signifying that the voltage of the battery dropped to 37.8V, which in the beginning of the experiment have been recorded 40.8V when current applied have been around 4.8A. Angle measurement here precisely indicating the behaviour of e-bike on various degrees of hillsides, because there comes the angle, which is formed in relation to the plane surface. When e-bike goes uphill it creates a positive angle, that is where we have our main concern, because then the difference in power consumption suddenly increases. The angle is also form when ebike moves downhill but that is a negative angle, and cost no difference on power consumption, therefore we are giving emphasis on angle measurements to positive ones only.

The battery that has been used in the experiment rated 36V/9Ah (i.e., 0.324 kWh). Using this battery we have got the reading that it can hold (when completely charged) up to 32 Km distance (or 10 Wh/km), which is inversely proportional to rider's weight and drag.

To sum up the experiment, the results have revealed that battery performance directly depends upon whether condition, weight of the rider and area where the cycle is ridden. These are among the discovered facts found in the experiment. When e-bike is used in hilly areas the speed slows down considerably to 13km/hour, because of the disequilibrium force, and that is when excessive power is consumed. This part has been difficult to test correctly in the lab because to simulate the disequilibrium drag or pull could not be realized accurately, besides when it has been tried outdoor, we could not get stable running motor because of the pedal dependent motor system, it has also not been so fruitful for precise readings. Afterwards when it has been tried in the gym, the outcome is that at every angle the power consumed by the battery or the energy dissipated is around 3.7watt. Even then it is still not possible to calculate measurements that must be available in real like situations, because the other affected parameters like wind, friction, tire size, weather, rider's weight is not possible to take into considerations.

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Chapter-I

INTRODUCTION

1. Introduction

In transportation we have developed quite a lot by the range of hi-tech vehicles we have, still the importance of bicycle cannot be neglected. Bicycle is popular in all groups because it is easy to handle by its light weight, and do not cost money to operate as it does not require fuel to run, still very efficient in small distant traveling. It has many distinct qualities, which make it even special over other vehicles, like they do not require registration fees, insurance, or driving license. Similarly it has less prone to heavy casualties, thereby making it a safer transportation. Besides it has health benefits, just the same way as in any physical exercises. Similar to this, e-bike on the other hand is a modified version of the same. In e-bikes the difference comes by the application of the motor system, use of the controller to control the motor system, and also with battery to Power it.

The motor is used in order to give external power to make the ride comfortable. E-bike is better than the normal bike because rider can get additional power when it is required, if it is used like that. In this the rider has the choice when he is less of power and unable to drive forward easily, usually when there appears an uphill or strenuous long road, he can switch on the battery, and thereby activates the motor. Then motor compensates the required power and this way ride becomes smoother all the way. It is up to the rider as when he wants to switch on the power. He can choose motor to propel all the way for his support, or use it when he actually needs. There are again various levels which the rider can choose depending upon the condition of the road, and the amount of speed that is desired in riding.

Similarly, there is throttle to make riding adjustable, either compensating speed for less strain, or get speed for high strain, this is absolutely on the choice of the riders' strength and selection. When we try to address the best feature of e-bike, then we can say that as there is almost no strain while riding e-bike that we notice in normal bike driving uphill, therefore it is easy to sum up that when there is less strain, rider can travel a long distance very easily, there is also less perspiration making user tidier again, giving possibilities for wide range users.

Fig 1.1 Simple EBike

We should understand, e-bike has a standard specification to meet, so that it does not come in the same category as a motorbike. The standard is varied from place to place. Though the use of e-bike is a new concept in Europe, but in India and China it is growing quite fast, just in China, e-bike at this time has increased by the amount that it is outnumbering cars by four to one.

Chapter II

Literature Review

2.1. History of E-bike :

It is surprising to know that the experiment done to make bicycle to function on electricity, was done quite a long time ago. The record said that the first electric bikes were already available during 1890s. Various patents during that time prove that.

On 19 September 1895, a patent application for an "electrical bicycle" was filed by Ogden Bolton Jr. of Canton Ohio (Patent number: 552271). The bicycle ran on 10 volt battery power, in which the motor could draw power up to 100 amperes. The hub motor was used placing in the back wheel. During that time gears was still a mysterious concept for the bicycles. So, it was made without it.

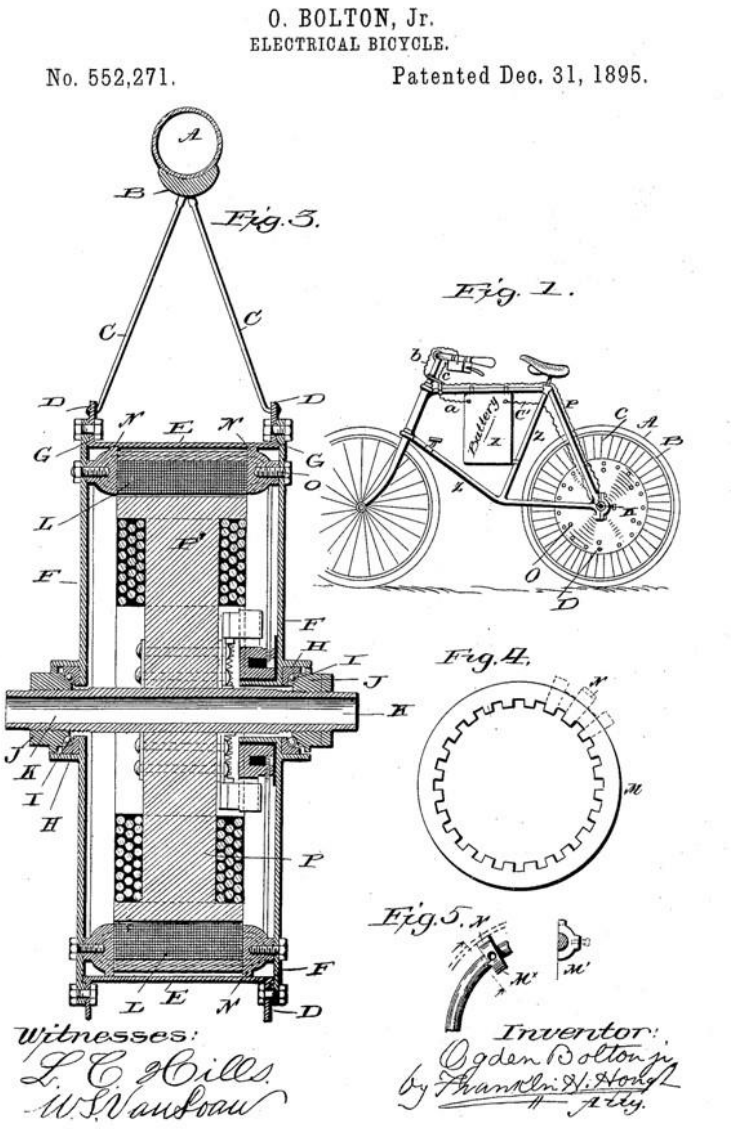
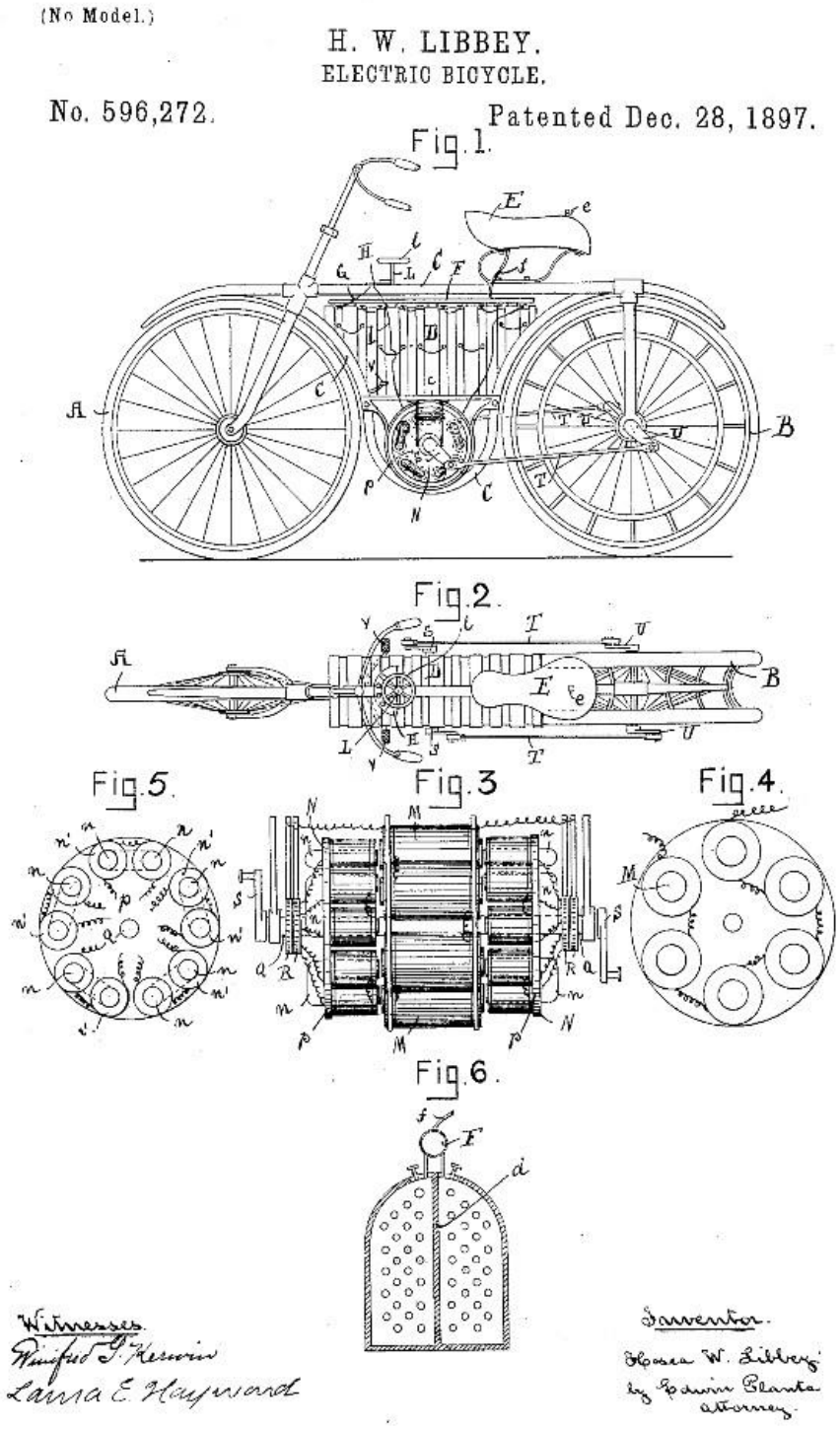


Fig 2.1.1: A patent by the name of Ogden Bolton Jr. of Canton Ohio on e-bike

On 8 November of the same year, another patent application for an "electric bicycle" was filed by Hosea W. Libbey of Boston (Patent number: 596272).


(No Model.)

H. W. LIBBEY.

ELECTRIC BICYCLE.

No. 596,272. Patented Dec. 28, 1897.

Fig. 1.

Fig. 2.

Fig. 5.

Fig. 3.

Fig. 4.

Fig. 6.

Witnesses.
Winfred T. Kerwin
Laura E. Hayward

Inventor.
Hosea W. Libbey,
by Edwin Blanke
attorney.

Fig 2.1.2 : A patent under the name of H. W. Libbey

During that time in 1897, Hosea W. Libbey from Boston state invented an electric bike that ran on double electric motor. The motor having integrated within hub of the rear wheel. This model has been reused in various latest designs of e-bikes at present times.

It was by year 1898, a belt connecting outer edge of the wheel to the motor patented in the name of Mathew J. Steffens. In the same year John Schnepf tried a back wheel friction "roller-wheel" style drive electric bicycle. It was in 1969 a modification of the same version was done consisting of 4 motors connected in series with the support of clock-wheel gears.

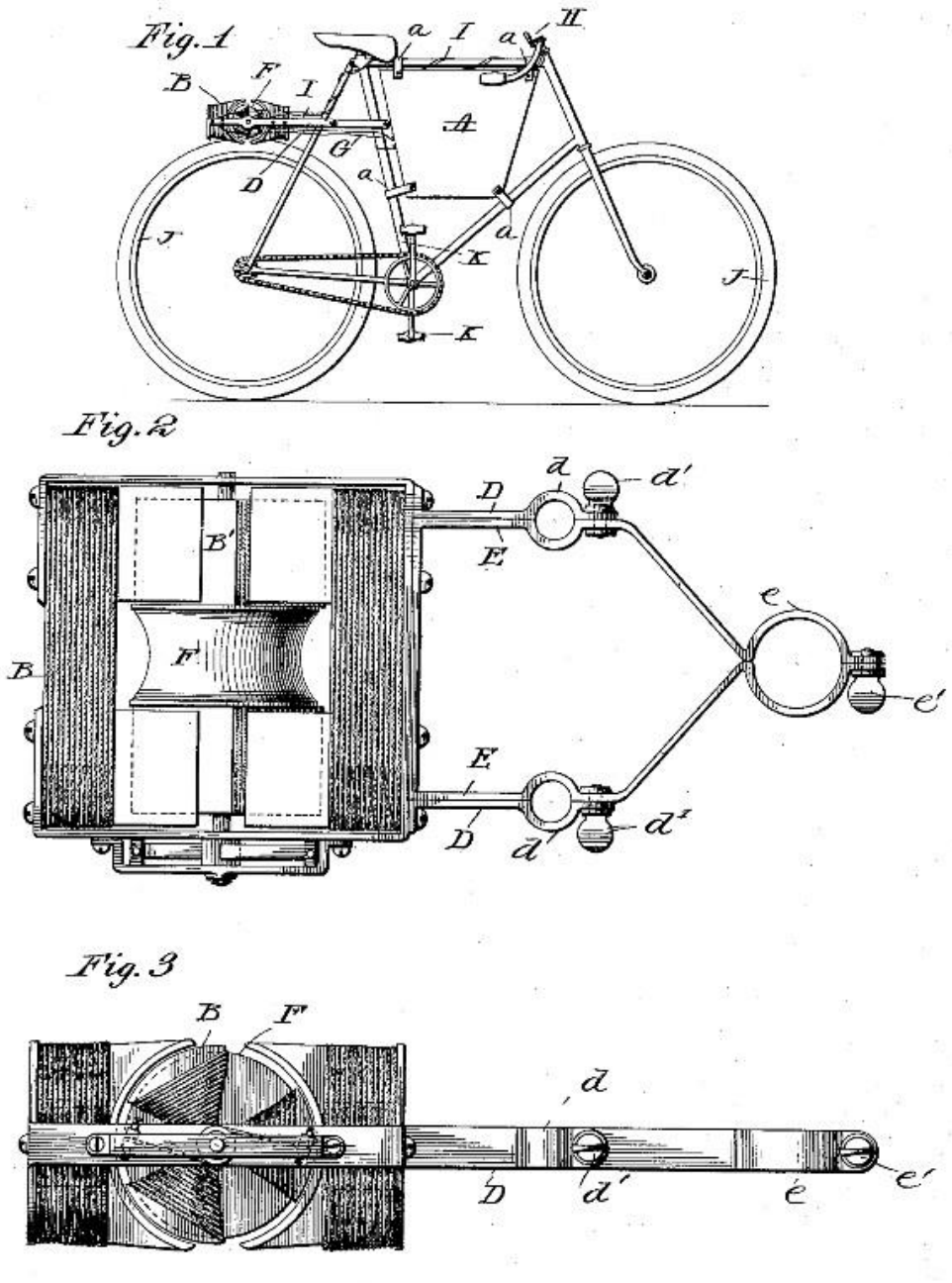


Fig 2.1.3: John Schnepf's Friction Drive e-bike

Torque sensors and Power controls were developed recently in the 90s. The well-known commercial e-bike named 'Zike' was the modern e-bike which was launched in 1992, during that time hardly any commercial e-bikes were present in the market. Japan experimented in this and one patent relating to this under the name of Takada Yutky in 1997.

It was from 1993 onwards, when well-known Japanese companies involved in producing commercial e-bikes in huge numbers, it drew other companies' attentions into this, by estimating the huge market potentials, as a result the growth towards e-bikes increased by 35%, leading to the downfall in the production of regular bicycles.

In 1989, Michael Kutter, the founder of 'Dolphin E-bikes' done the first initiation in commercially producing e-bikes in the market. After his attempt, a well-known motorbike company from Japan 'Yamaha' took the leap in developing commercial e-bikes, producing a large number of e-bikes in the year 1994, giving the name 'Power Assist'.

Fig 2.1.4: Power Assist

The earlier version of e-bikes or technically low quality e-bikes operated mostly on less effective lead acid batteries, which has less sturdiness to give full power to the motor, besides they are heavy and bulky, but in newer models there have been mostly selected NiMH, NiCad and Lithium-ion batteries, because they are light, powerful, and dense in their capacity, giving possibility to drive long and fast, giving maximum durability in terms of power and performance.

The words associated with e-bikes which are in the range of bicycles are called by many different names like 'pedelec', 'pedal-assisted', 'power-assisted' and simply 'power bike', whereas in bigger powered e-bikes they are termed as (electric motorbike or e-motorbike), having high range in speed and distance, almost can make around 80 km/h.

There are usually three variations tested in the design of electric bikes. In the first one i.e. the parallel hybrid motorized bicycle, both human and motor inputs are mechanically coupled and transferred into one of the bicycle wheels. In the second, the mechanical series hybrid bicycle, where both human and motor inputs are coupled through differential gearing. Whereas in the third, the electronic series hybrid cycle, first the human power is converted into electricity and fed directly to the motor, and then the

additional power is supplemented through e-bike battery, to support the motor to run continuously.

A typical e-bikes battery requires strictly 8 hours or something similar to completely charge it, and that power is sufficient to carry e-bike up to the distance of 48 to 60 km, at the average speed of around 20 km/h.

From the above descriptions it is clear that the desire to obtain useful e-bike was started long time ago but somehow it could not be developed to that extent where it could be the best vehicle, but as times are changing, sophisticated technologies available, we can be surely hopeful.

CHAPTER III

GENERAL INFORMATION ABOUT E-BIKE

3.1. E-Bike :

While speaking in general about e-bikes, some information included here are interesting to know, it gives some useful idea about e-bikes and their characteristics.

It still looks like a usual bicycle, by its appearance, therefore there is not much difference in the weight, may be 1.5 times the weight than an average bicycle, because of the battery use, electric motor and its supply unit.

I have used few pictures to make it clear as how e-bikes or electric bicycles are appearing in real, it is very hard to distinguish it from normal bicycles if it is pedelec (left), only that there is motor, which is also placed in such a way that it does not disturb the natural design of the bicycle, but still giving the same constructive mechanism as any ordinary bicycle is. But in the right picture it is also an e-bike, but not pedelec, because it is designed to bring additional power than normal bicycles.

In the present bicycle design, it needs to be recharged daily when it is not in use, so that it remains totally charged, then only it is ready to ride around, and when it is fully charged it can run until 4-6 HRS, depending upon its usage also. Importantly, when a battery is new, it works better and optimum performance possible as it per the specifications.

When the power of the battery is low, it means we need to recharge, but when we are already riding, then it is necessary that in order to avoid making battery completely empty, we should therefore switch into paddling, then it will be like any other normal bikes. This is also applicable in situations when we do not require to use battery, usually in slopes and easy roads, we can save power also by using such measures sensibly. This option is located usually at the handlebar, so easy to control it by hands, positioned there especially for better control.

The downhill is controlled by the brakes, which is of various types, and is arranged according to the weight of the bicycle and also the size of the tires. While riding downhill it is most likely not necessary to use the motor, which is automatic in PAS system that as when we do not do pedaling motor stopped working, the advantage mechanism. This saves power also importantly. In some advanced system this exerted force is capitalized for generating power into the system. The role of motor becomes very important when we are riding uphill roads, there the power consumption much higher. Power consummation is inversely proportional to the amount of steepness bicycle has to counter. In order to support riding, 5-7 gears help to control and maintain the speed movement. As it can consume lots of battery power while riding uphill roads, better care and control in the switch is essential, to make effective use of battery power in most cases.

It is always a risk to go at a higher speed than the normal speed which we can control it easily, that is why the motor is placed there has limited rpm (rotation per minute) speed

by the size and weight of the bicycle, that is why it is pretty safe even for riding in rush traffic, just like we do normally, besides quality brakes are used to give better grip, and in some cases when e-bike is bigger, hydraulic brake is also used for better security and control.

At present time, we are charging the battery on the normal household electric outlet, in most cases. It is still very new to think to develop a system where we have possibility to charge it outside, and we cannot think of it as an effective choice, because it takes 3-4 hours to charge it completely unlike fuel refueling. That is why until a system becomes progressive and within minutes we can charge it completely, then such a thought can be implemented effectively. The only permissible concept can be replacing filled batteries with empty batteries from a special place, like petrol station, so that while riding if battery suddenly goes empty, then we can replace with the charged one, paying some amount, can be an acceptable choice, this way it breaks the trouble which may arise when power goes empty. Anyway, it is just a bicycle and useful for limited distance traveling, therefore to make it simple and cost effective, we may not think this way until better mechanism is developed.

Chapter IV
OVERVIEW OF PEDELEC

4.1 Bicycle Vs Pedelec :

The word 'Pedelec' to indicate e-bike, was named by a German student from Heildelberg University 'Susanne Brüsch', in her thesis titled as 'Pedelecs: Fahrzeuge der Zukunft' (Pedelecs: Vehicles of the future). She used this name by considering the battery power that propels the motor when Pedaling is done. The sensor detects riders' actions and accordingly sends the signal to the controller, and controller reacts to that by toggling the motor switches. The definition of pedelecs has been given by EU, and valid across entire Europe. According to the same EU directive (EN15194 standard) for motor vehicles, a bicycle is considered a pedelec if and only if it can fulfill the following specifications.

1. The pedal-assist, i.e., the motorized assistance that only engages when the rider is pedaling, cuts out once 25 km/h is reached, and
2. When the motor produces maximum continuous rated power of not more than 250 watts (n.b. the motor can produce more power for short periods such as when the rider is struggling to get up a steep hill)

If any e-bike associates these basic and necessary conditions as they are stated here, then only it will be in the category of Pedelec, and legally classified as bicycle. Characteristically, Ebike also works the same way as any normal bicycle does, but it is distinguished actually by the use of some unique components which are there only in e-bikes and not in normal ones. It has a rechargeable battery associated with it, which power the motor when pedaling is done, and there is a controller to maneuver e-bike. Because of this motor power its capacity ranges from 25 to 32 km/h (16 to 20 mph), depending on how much watt power of the motor included therein based on models. How much powered motor be used also depends upon the national regulation of the country. It is not approved to use high powered motor in e-bike, otherwise it goes in the category of mopeds. This criteria is varied upon countries' own policies, but in Europe it is defined by EU legislation to keep the motor Power within 255 Watt for e-bikes.

The definition about Pedelecs if it is a Bicycle, is not the same all over the world, and that makes a confusing ground for the manufacturing companies about designing the standard product, because if e-bike is considered as moped or motorcycle, then not just it adds risk to come in the open road where cars travel, where many of such bicycles can make difficult for easy access also, besides the necessity of licensing, tax, and other requirements will suppress its desire to have. Riders may not be pleased to pay for the mandatory motorcycle helmet, registration fee, and vehicle insurance, parking tickets, just for riding e-bike. It will discourage them and the aim to popularize this product for clean environment, will never be realized using this way. Therefore, it is necessary that such bicycles should have the access to the same lane where normal bicycles usually

have, if it is not so, then it can raise the percentage of traffic jams, accidents and injuries. But at the same time, getting that incentive, sit must be within the limitation of certain characteristics and should not affect bicycles in any way by provoking danger while using bicycle lanes, should also be equally important. It is necessary that there should be a distinct and same classification between Pedelecs and other high powered e-bikes (S-pedelecs) or motorbikes all over the world. This way it will be easier for the manufacturing companies to produce e-bikes that can run everywhere without any restrictions. This way they can give maximum energy on its design and functionality improvements. In S-pedelecs or motorbikes, maximum care is taken in the design to make them motor dependent than pedal dependent, in order to produce more power so that it makes it easier to carry heavy loads without having to use any physical efforts. As they are especially made to fulfill heavy demands, they must be placed in the category of heavy range is always right, and must be clearly distinguished from light ranged Pedelecs. There are some particularities in heavy range S-Pedelecs, may not be present in Pedelecs are as such.

1. In order to attain higher speed the powerful motor is placed which is above 250W power.
2. Because of high powered motors, they can easily cross the maximum speed 25 km/h requiring for Pedelecs, and as it may also not the limitation in them to disconnect the assistant of the electric motor within this range, therefore electric motor supports continues above 25 km/h as well before it cuts out, if it will ever cut out even. This makes them close to motorbikes than normal bicycles.
3. They may also have the features to run alone on electric motor and do not need pedaling to activate the motor.
4. In order to compensate the power, heavy batteries are placed, and in order to make it sturdy to that much power, other requirements like brake control, light, and other safety measures have to be taken care precisely, which makes the construction of the e-bikes little heavier than the normal bicycles, which is therefore wise and safe to be restricted in the bicycle lane, because if there is collision, which is very normal in bicycles, then the damage can be serious.

Because of these mentioned differences, the e-bikes which do not fulfill the conditional norms legally and righteously should be classed as mopeds or motorcycles, in order to make safely the classification for pedelecs as bicycles, so that they are made free from additional restrictions.

Directive 2002/24/EC of the European Parliament and of the Council, on 18 March 2002, declared a rule for categorizing which is a hybrid powered bicycles better known as Electric Pedal Cycles, or simply pedelecs, and which is a moped or motorbikes. S-pedelecs can have the range of 45 km/h while taking the assistance of pedaling. That is why it is necessary to distinguish it from normal bikes. The Parliament based their classifications on this by distinguishing in respect with motor capacity, which they considered must be within maximum continuous power of 0.25 kW, and the output

should progressively be reduced and finally halt completely if vehicle reaches the speed of 25kmph or around, especially when the cyclist stops pedaling.

Appearance

When we see from a distance we simply find no difference between a conventional over an ebike. We can find little change when we come closer, by the humming sound of the motor if it is in motion, otherwise as it does not produce any sounds when it is at rest so still unnoticeable by this way. Therefore by its natural appearance what it can be said that there are no significant differences between an e-bike and a normal bike. Check this picture where battery has been hidden inside the frames, so visually it does not show any differences.

Fig 4.1.1: e-bike where battery is hidden inside frames (just for evidence)
The bike in the picture is not the one who we used in the experiment

Performance :

But the difference between normal bicycles and e-bikes actually counts by its performance. An advantage of e-bike over a normal bike is that it is empowered by electric power coming from the battery, and that power propels the motor, helping e-bike to move forward. This power activates only when the rider uses the pedaling, it is only when the sensor notices this effect, and supply power to the motor to get the propulsion. The popular name of such system is called Pedelecs, which means that pedaling is assisted by a small electric motor. The motor must fulfill all basic norms, to be acceptable to use in e-bike, and it is generally classified by the amount of power it supplies. Pedelecs include an electronic controller which stops the motor from producing power if the rider stops pedaling or a certain speed is reached that is exceeding the normal speed limit, which is usually 25 km per hour. Pedelecs helps to make

riding easier, consequently the rider can climb hilly areas as the same way he can cover plain areas. Because of the assistance rider gets in pushing of the e-bike, the force that is required for the user to push reduces significantly, as a result rider seldom bears fatigue and strain even after a long drive.

It is an interesting question to know as how much does it cost to charge an e-bike, that is what we are going to analyze in this to see if it is good enough in this regard as well.

As we know it takes around six hours on a normal house socket to refill the battery completely, which goes almost the same for both normal and high powered batteries.

E-bike classification in Europe and elsewhere :

We must know the difference between e-bikes in which Pedelecs, then S-Pedelecs or mopeds. S-Pedelecs are almost like e-bikes but with a little variation by the function of the motor power, which is basically known as Power-on-demand e-bikes, because they supply motor power whenever it is required, where as in e-bikes, we can get assistance of the motor power only when we pedal, that is the important difference among these categories of e-bikes. The standard set to approve e-bikes as bicycles by various countries is different. In Austria the criteria is set to consider e-bike a bicycle, with a maximum permissible power which should not be more than 600 watts, and the speed should not exceed 25km/h, and reaching to that speed motor should discontinue its function is the essential requirement. In the US, the 750W power motor is allowed in e-bikes, but in Sweden it is limited to 250W power only.

Chapter V

IMPROVISATION AND CHALLENGES OF PEDELEC

5.1 Improvisations:

i. Suggested Outline:

In the study, doing the survey, it is found out that though it is good to have restrictions to distinguish e-bikes from mopeds or light motorbikes. But at the same time it is also suggested that there must have to be an automated system which works with motor only and no obligations on pedaling to ride e-bike. It is just in view to support those who are not able to pedal, or feel uncomfortable pedaling at regular or successive breaks, either it is due to physical complications a person is enduring or very small age group to do that with comfort.

ii. Remedy:

The system at present working on e-bike is sophisticated because it helps to save power coming from the battery, because it encourages riders to pedal most of the time. But still at some instances it is desired that rider wants to take break from pedaling, and for that occasions there is no system available that supports him to do that. He cannot able to put automated system to work to run motor continuously, without him to do anything, especially when he is tired after continuous ride or come across a difficult road. This seems to be a hindrance in those situations where the rider has to travel a long distance, or has to cross uphill most or regular instances. That can make the rider weary quickly. We know that e-bike assistance gets little weaker when there comes the uphill due to disequilibrium state of the ebike, resulting relative down pull because of the Earth's gravitational force. That makes motor to slow down considerably in speed, because the power requiring climbing uphill mounts proportionately to growing height (angle from the plain surface) and increasing distance, but as the motor stays on constant rpm, therefore the rider needs to push a little hard to the pedals to make it work efficiently. This happens due to high rpm demand on uphill roads, because the e-bike has to counter two forces, one is to move forward considerately with the load, other is to outdo gravitational pull, while carrying this forward movement. That is why it seems quite realistic to have automated system also integrated within this system, which will work when similar surge of demand arises in order to make e-bike ideal for any surfaces. The automatic power must be associated with some clear restrictions. It should not go beyond some specific speed at any situations. The maximum speed limit can be set to 19 km/h while working with motor only. The speed must remain constant either it is plain surface or hilly, and it should automatically be adjusted to the same speed. It can be monitored with speedometer, and programmed to behave as such. Otherwise such a situation can be very risky if there is no protection on breaks, therefore when the rider uses breaks, which he normally does some seconds before he wants to stop, then immediately the power must be disconnected from the motor, and as e-bike is moving at the speed of 19 km/h, therefore it can stop quite instantly. This way risk also minimized.

It should be understood that there can be various ways to introduce auto Power.

Auto Power here stands for continuous power supply to the motor, so that it functions all the time, without the rider to pedal e-bike at all. This auto power must be regulated with certain restrictions to make e-bike safer. Therefore, there must be made some additional changes when such alternatives are applied to make it safer for new users as well. The Auto Power switch can be placed on the same controller, and when it is powered on, the sensor like speedometer must be able to monitor the speed of e-bike both ways, first the motor speed and second the pedaling speed. It is necessary to read both the motions, because as e-bike is already on motor power and again when the user pedals on top, e-bike may go really fast, and that can make e-bike uncontrolled for the time when brakes need to be applied. There are two ways how the speed can be mitigated, one is by stopping the Auto Power function of the motor if the speed excels the 25 km/h mark. Secondly, once Auto Power is set then users should not allow to pedal e-bike, and if it is done then the Auto Power function should automatically stops functioning. This way it is possible to include Auto Power safely.

iii. Attention about Auto-Power:

There are some ways where it is possible to deceive the sensor, because it is the tachometer sensor which measures how fast the rider is pedaling. The sensor sends data to the controller, and similarly there are other signals coming from brake-mounted electric stop switches, hand throttle and so on. Therefore, reading all these input signals controller governs the function, speed and movement of e-bike. Therefore the input signal is important in the function of ebike. If the sensor signal is derailed, then it can result different functioning of e-bike than what it normally should do. It is precisely what is done to misguide the sensor so that it thinks that the rider is pedaling all the time or pedaling faster than it actually is. That what makes the e-bike run on throttle control only, and no need of pedaling is required to run e-bike.

The way it is done

1. If it is a brushed motor having two wires exiting the hub, then a switch is used to control the motor, in this case the controller is carefully avoided, so that it is possible to perform such restricted actions.
2. Another way is to use a new controller instead of the original controller, which does not have PAS, that means it does not require pedaling to control the motor, but has something else working in this.
3. Some tachometers are not so intelligent, therefore it is capable to detect only the rotation of the pedal and not which way it is turning. In general backward rotation is easy to do than forward rotation in comparative degree, especially when we consider the difficult steep road. If pedaling is done either way, it sends the signal to the controller that pedaling is in motion, and that results the motor to run, and it is not necessary to pedal either.
4. Sometimes it is also possible to disable PAS mode simply by unplugging the crank sensor or tachometer from the controller. Then it is not possible for the

controller to react to the changes going on. In absence of the input signal, motor can run continuously.

Caution: In some e-bikes, in order to disable PAS mode, it is necessary to permanently short two wires among three wires which it normally has, first the Signal wire, then the Ground wire are disconnected. It is the Module Power wire only which is attached with the controller, which passes the signal to the controller that crank is rotating, and no signal for crank speed. Then this e-bike functions lot flexibly than usual e-bikes (bicycle category e-bikes 'Pedelecs'), as restrictions are minimized because of no interferences by the controller. But at the same time it must be acknowledged that it is never advised to do such actions where we dismantle the function of the controller, because it is necessary that controller works the best way, therefore to make controller fooled can also be dangerous in circumstances where we go out of control, especially when motor runs on full speed and we need to stop immediately. The purpose of the controller is also to make e-bike safer, but at the same time it should also work to bring the best performance. In this regard, sometimes it is acceptable to think about the inclusion of Auto Power along with PAS, with clear restrictions set in its operations, so that e-bikes (Pedelecs) do not run out of control.

5.2 Challenges in e-bikes:

Modernization: This has been a disputable question for many years, and still going the same way, which is important 'simply enjoy now and forget whatever the consequences of the future', or 'be sensible and simple just for caring the future. The pace of life has increased so much that every second counts a value, and means a lot therefore. As a result speed has become exceedingly the prioritized element in present times. This rush and time dependence has increased so much that it becomes quite difficult to compromise speed in many instances. That is why in most cases it is considered quite acceptable to disregard even the most sensitive aspects in other affairs to achieve speed, profit and comfort. This is the worst part of fierce growing competition. That is why to introduce anything that can negotiate speed and comfort, has to confront hard challenges to make it successful in this time. Likewise, in ebike this challenge will always be available, though it is an improved version of the bicycle where pedaling is assisted by the motor, but still as it has to be in the category of the bicycle, pedaling is the essential requirement, which means it needs strength to drive along. People tend to give priority to their comfort in many circumstances, that is why it may take long time before people accept its importance.

6 **Compromising the Comfort**: It is the usual tendency in the people that they seldom like to compromise their comfort, and this race of modernization also supports this idea. Accordingly for bringing the same comfort many sensitive aspects are ignored that does not count immediate threat. We can see this by the attachment we have towards the risky choice of nuclear energy, similarly, it is also with the scarce fossil fuel for generating

power for cars and producing electricity. By doing so we knowingly for commercial sake may pushing Earth slowly towards the verge of irreparable damage. This action also costing high effects on eco life system, where many sensitive species have been going extinct day by day[1]. We sometimes simply forget this truth that as every living species constitutes an eco-cycle and eco-system, therefore undermining their existence for commercial benefits in the long run can lead to our downfall too. That is why it is necessary that we start thinking about the ideal change in every sense, by being morally sensible and tactfully rather gentle, to save this planet for future generations. It is necessary to realize our responsibility in time, to think that is good to our Planet and its life forms. We are not here alone, and being in the higher hierarchy, our responsibility is also higher, which we must comprehend well.

7 **Weather and Geography**: Sometimes it depends upon the climatic situation of the country also that makes it difficult to implement in actions. Sweden for example is a country which has good infrastructure in road transportation systems. Here it is very easy to motivate people for using e-bikes, because riding is already a popular choice and people are attracted towards bicycle, but the weather during the winter is very strong and it is not easy to ride any of such muscle driven vehicles. Although, the snows cover most of the streets in major parts of the winter, still in cities because of regular road clearance by the municipalities, it is still possible to use e-bikes mostly. But the good part is that for most of the year it is possible to

Just to illustrate the degree of biodiversity loss we're facing, let's take you through one scientific analysis...

- The rapid loss of species we are seeing today is estimated by experts to be between 1,000 and 10,000 times higher than the *natural extinction rate*.
- These experts calculate that between 0.01 and 0.1% of all species will become extinct each year.
  If the low estimate of the number of species out there is true - i.e. that there are around 2 million different species on our planet (Between 1.4 and 1.8 million species have already been scientifically identified). Then that means between 200 and 2,000 extinctions occur every year
- But if the upper estimate of species numbers is true - that there are 100 million different species coexisting with us on our planet - then between 10,000 and 100,000 species are becoming extinct each year.

use e-bike without any trouble. In some countries because of inaccessible roads and difficult geographical situations like hills and mountains, it is not easy to carry out this scheme sophistically.

4. **Economic Condition**: Another obstacle in the success of e-bike can be the current price of the e-bike. The price is relatively high in comparison to normal bike, is also because of the integration of three essential components defining e-bike, the battery unit,

motor, and the controller. But this price range can be reduced when it gains the popularity, therefore this cost is only temporary, and it declines soon if it gets the market that is high enough to reduce the cost of it. According to market study, anything that is new takes time to gain people's attention, and once that is achieved by advertisements and information sharing systems, then it should not take long, if it has the superior quality, having performance level as to the expected standard by the ratio of cost. Soon it must be able to take hold of the market, by rising interest in people subsequently.

5. **Main Components**: The main concern is technology. We do not have energy saving batteries that are equipped to deal for long time traveling. Similarly, the weight of it is again very high, and it takes long time to recharge also, when we consider fuel it is instant and we are ready to drive, but for the batteries it needs to recharge quite a length of time before we are ready. Besides, the battery durability is also short, in terms of standard power, which it should be delivering. The power which battery can supply does not remain constant to its original state, once it is in use, and it starts fading away slowly after multiple uses. Therefore the limited and unstable strength of the battery is also the weakness in achieving the objective of escalating use of e-bikes among the commuters instantly, but we must understand that there are many research activities going on for better functioning battery, therefore possibilities for improvements remain always. We may see well equipped e-bikes in the future times is always certain if we have given it a chance, because everything needs time to grow, it will also. Anyway it is already good and reliable enough for replacing any ordinary bicycles easily.

It is not easy to change immediately to other means of transportations, but we can start slowly. It is necessary to promote such clean ways. We may not be using it always, but in the summer it is possible to use for short distance traveling. We can use it also while we go shopping, traveling to friends, riding for fun, or going for fresh breath.

It has many benefits including the saving, therefore to attract people to choose this requires that they experience it first themselves, either by viewing or learning by reading the benefits on articles. To encourage them to participate in this they must know its benefits in prior, then slowly and steadily many people will come in this event of bicycle riding, fulfill their role in its promotions. The best the municipality can do is to encourage people in government jobs and schools during the summer give compensations for buying these ebikes. It will be even better when it is done in a bigger scale, like giving discount prices on these e-bikes during special occasions are some ways.

As a social responsible being, we must have the first initiation for the wellbeing of our Planet, after that only should come our preference. This is the way we can contribute meaningful towards achieving this objective of restoring Healthy Planet.

Chapter VI
PRESENT AND FUTURE STATISTICS

6.1 Statistical analysis :

The answer to the question is, by viewing the statistics and growth of e-bike's interest, we can easily predict that it is just the beginning, and it will rise constantly until decades because lots of people who can afford such vehicles are not aware of this e-bikes also is the reason. As soon as it develops into a fashion, the growth of its rise will surely be at sight. Seeing its success in places like China and India, many companies are involving in this business to get the maximum benefits. The present analysis suggests the statistics and predictions that have been listed below.

> A "Electric Two-Wheel Vehicles" 2009 report by clean-tech market company Pike Research forecasts that more than 466 million e-bikes and motorcycles will be sold worldwide during the period from 2010 to 2016.
>
> The report forecasts that e-bikes will be the largest category with 56% of the electric two wheel market

The statistics prediction on 2010

- India - 700,000 e-bike sales by 2011, up 483% from 120,000 in 2008. This is quite impressive given that it had virtually no sales at all in 2007.
- Europe - 2.5 million e-bike sales, up 355% from 550,000.
- United States - 500,000 e-bike sales, up 194% from 170,000. Best Buy began selling e-bikes in June at 19 stores.
- China - From 2008 to 2011, Chinese e-bike sales are expected to grow by 43% from 21 million to 30 million e-bikes. China had 56,000 e-bikes in 1998 and it got to 120 million in 12 years. It is a phenomenal change, even in a country as populous as China.
- Netherlands - A third of the money spent on bicycles last year went to electricpowered models. Similar growth expected in Germany, France and Italy.

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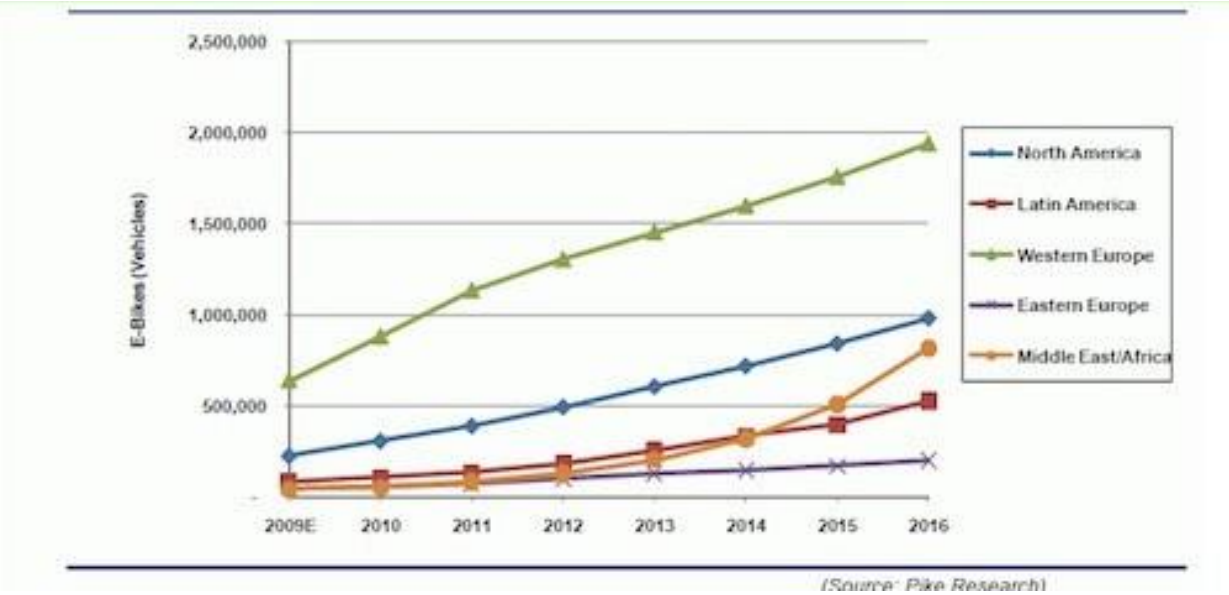
Predictions Illustration Graphically:

In the graph below you can see that the sale of e-bikes is going to double or even quadruple in almost every region of the world



Graph 6.1.1: Annual Electric Two-Wheel Vehicle Sales,
(in World Markets Excluding Asia-Pacific: 2009-2016)

Settling of cost:

There are varieties of products available, ranging from £419 to £4495, depending on models. Price is reasonable, that is why China is the big market in this, and it is slowly covering the entire globe, Sweden has also its potential, because most people like riding, but the amount of cars on the road may speak against, but as we motivate people, and make them aware of environment responsibilities it can be corrected easily. Swedish people are more obedient and responsible towards rules and regulations, therefore it can be easily expected. Gradually, entire Europe can be made adaptive to this system by the benefits it promulgates, price stabilizes by the growing competitions, and many companies are coming into this is also a good news. We can get the list of companies involving in manufacturing e-bikes at present, 150-200 companies, suggesting that a large amount of companies are now available who are involved in this business. This suggests greater probability in prevailing price to effectively calm down.

Chapter-VII

WORKING AND CIRCUIT DIAGRAM

7.1 Working Principle:

Motors is a device that converts electrical energy into mechanical energy. The principle of electric bikes motor is to generate the rotating magnetic field by using the electrified coil (that is, the stator winding) and act on the rotor squirrel-cage closed aluminum frame to form the magneto electric rotating torque.

The motor is divided into DC motor and AC motor according to the power supply. Most of the motors in the power system are AC motors. Can be synchronous motor or asynchronous motor (motor stator magnetic speed and rotor rotation speed do not maintain synchronous speed.

The motor is mainly composed of the stator and the rotor. The direction of the force motion of the electric wire in the magnetic field is related to the direction of the current and the direction of the magnetic sense (the direction of the magnetic field). The working principle of the motor is the effect of magnetic field on the current force, which makes the motor rotate.

Electric bikes motor power is different, such as the general assembly of 12AH battery four blocks of motor power is 350 W, this refers to the internal gear of the high speed motor. In the case of a brushless toothless motor, the actual power is 250 W.

7.2 Circuit Diagram:

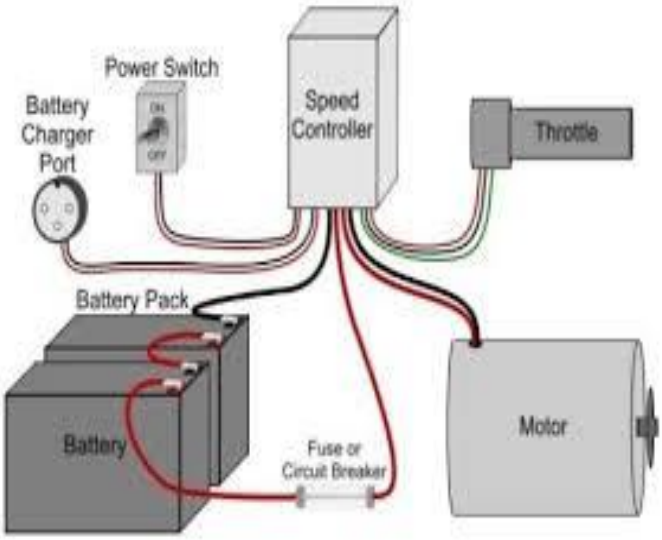


Fig 7.2.1 Simple Circuit Diagram

Chapter-VIII

DESCRIPTION AND SPECIFICATIONS OF THE COMPONENTS

8.1 Component Specifications

1. **Motor:**

Model	MY1016
Voltage	24V
Rated Speed	2750 RPM
Rated Current	14A
Output	350W

Table 8.1.1 Motor Details

2. **Battery:**

Rating	12+12(24V)
Current	18AH

Table 8.1.2 Battery Details

3. **Dynamo:**

Voltage	30V
Current	30A

Table 8.1.3 Dynamo Details

8.2 Components

8.2.1 Motor

A **DC motor** is any of a class of rotary electrical motors that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current in part of the motor.

Fig 8.2.1 DC Motor

DC motors were the first form of motor widely used, as they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight brushed motor used for portable power tools and appliances. Larger DC motors are currently used in propulsion of electric vehicles, elevator and hoists, and in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications.

8.2.2 Speed control

The mechanism of an electric speed controller varies depending on whether you own an adaptive or purpose-build electric bike. An adaptive bike includes an electric drive system installed on an ordinary bicycle. A purpose-built bike, more expensive than an adaptive bike, provides easier acceleration and affords more features. The mechanism of electric bike speed controller varies in these two types.

Fig 8.2.2 Speed Control Remote

8.2.2.1 Speed Control Basics

The speed controller of an electric bike is an electronic circuit that not only controls the speed of an electric motor but also serves as a dynamic brake. This controller unit uses power from the battery pack and drives it to the hub motor. Different types of controllers are used for brushed and brushless motors. For adaptive e-bikes, a conversion kit is used and the controller is the main component of that kit.

8.2.2.2 Function

The electric bike speed controller sends signals to the bike's motor hub in various voltages. These signals detect the direction of a rotor relative to the starter coil. The proper function of a speed control depends on the employment of various mechanisms. In a purpose-built electric bike, Hall effect sensors help detect the orientation of the rotor. If your speed controller does not include such sensors -- and the speed controller on an adaptive bike may not -- the electromotive force of the undriven coil is calculated to get the rotor orientation.

Fig 8.2.3 Speed Meter

8.2.2.3 Benefits

Once you understand the basics of your electric bike speed controller, you can easily shift between the two modes of operation -- manual pedaling and electric driven. This allows you to get a good workout without overly taxing your muscles and lungs. If you're a beginning cyclist, for instance, you might find yourself breathless during uphill climbs. You can switch to your electric speed control while climbing hills, gradually reducing your dependence on the electronic operation as your endurance increases. If you enjoy biking with family and friends, the ability to switch to electric speed controls can help ensure a comfortable ride for everyone, regardless of differing abilities and strengths.

8.2.2.4 Considerations

The aesthetics and speed controller of an electric bike varies depends on whether you buy an electric bike new or convert a standard bike. But you might find it economically and environmentally sound to use either for transportation. Electric bikes don't produce gas emissions or noises. The top speed of an electric bike is limited to 20 mph so it reduces the chances of accident and serious injuries of the riders as compared to manually operated bikes. An electric bike costs less to operate than other fuel-powered vehicles.

8.3 Dynamo

A **dynamo** is an electrical generator that creates direct current using a commutator. Dynamos were the first electrical generators capable of delivering power for industry, and the foundation upon which many other later electric-power conversion devices were based, including the electric motor, the alternating-current alternator, and the rotary converter.

Today, the simpler alternator dominates large scale power generation, for efficiency, reliability and cost reasons. A dynamo has the disadvantages of a mechanical commutator. Also, converting alternating to direct current using power rectification devices (such as vacuum tubes or more recently via solid state technology) is effective and usually economical.

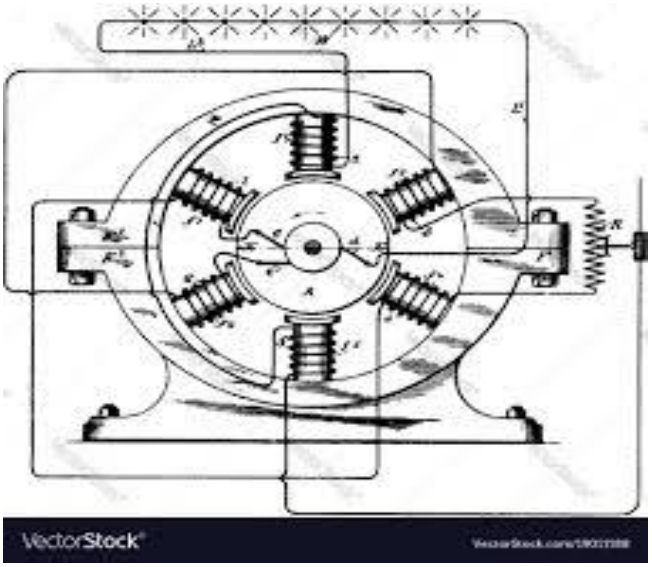


Fig 8.3.1 Dynamo

The electric dynamo uses rotating coils of wire and magnetic fields to convert mechanical rotation into a pulsing direct electric current through Faraday's law of induction and Lenz's law. A dynamo machine consists of a stationary structure, called the stator, which provides a constant magnetic field, and a set of rotating windings called the armature which turn within that field. Due to Faraday's law of induction the motion of the wire within the magnetic field creates an electromotive force which pushes on the electrons in the metal, creating an electric current in the wire. On small machines the constant magnetic field may be provided by one or

more permanent magnets; larger machines have the constant magnetic field provided by one or more electromagnets, which are usually called field coils.

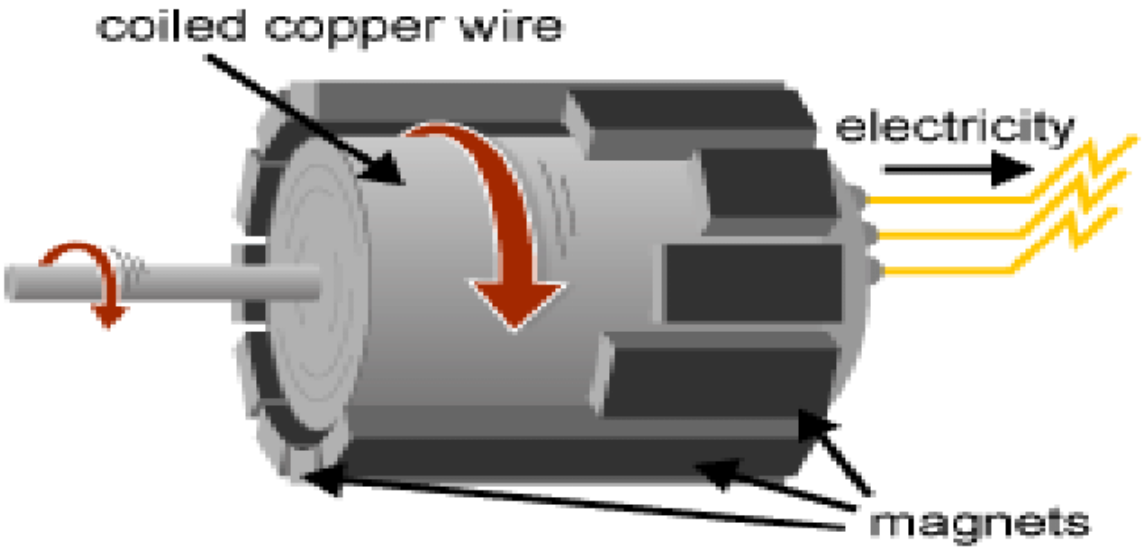


Fig 8.3.2 Working Dynamo

8.4 Battery:

A **battery** is a device consisting of one or more electrochemical cells with external connections for powering electrical devices such as flashlights, mobile phones, and electric cars. When a battery is supplying electric power, its positive terminal is the cathode and its negative terminal is the anode. The terminal marked negative is the source of electrons that will flow through an external electric circuit to the positive terminal. When a battery is connected to an external electric load, a redox reaction converts high-energy reactants to lower-energy products, and the free-energy difference is delivered to the external circuit as electrical energy. Historically the term "battery" specifically referred to a device composed of multiple cells, however the usage has evolved to include devices composed of a single cell.

Primary (single-use or "disposable") batteries are used once and discarded, as the electrode materials are irreversibly changed during discharge; a common example is the alkaline battery used for flashlights and a multitude of portable electronic devices. Secondary (rechargeable) batteries can be discharged and recharged multiple times using an applied electric current; the original composition of the electrodes can be restored by reverse current.

Fig 8.4.1 DC Battery

Batteries come in many shapes and sizes, from miniature cells used to power hearing aids and wristwatches to small, thin cells used in smartphones, to large lead acid batteries or lithium-ion batteries in vehicles, and at the largest extreme, huge battery banks the size of rooms that provide standby or emergency power for telephone exchanges and computer data centers.

Batteries have much lower specific energy (energy per unit mass) than common fuels such as gasoline. In automobiles, this is somewhat offset by the higher efficiency of electric motors in converting chemical energy to mechanical work, compared to combustion engines.

In some system it may be possible to charge the battery in three different ways, one is by using the 220V AC socket, another one is by using the solar panel attached to the bicycle carriage, (which is then used to convert solar power into electricity and that generated electricity is stored into the battery continuously, and that accumulated power helps to increase the efficiency of the battery, as it improves the durations). Finally, the experimental option of recharging the battery can also be done by using dynamo. It is placed in such a way that it starts revolving as soon as tires move, and all these rotations produce electricity to enhance battery power. It can have different variations, but it must be said that it is not applicable so widely because the power it generates is not so enough than the hindrance it creates, that is why it is still in the experimental stage.

In our bicycle, we do not use any external charging unit attached to the bicycle. It is just that battery which is charged when it seems empty, by using normal electric socket that is available in houses. We simply take out the battery and recharge when the Power is too low to drive the bicycle easily.

CHAPTER IX

ADVANTAGES OF PEDELEC

9.1 Benefits of e-bikes:

Pedelecs are rather convenient than any other ordinary bicycles, and has numerous advantages in terms of sophistications, and unique characteristics, which may not be possible in conventional bicycles. Some of them are carefully described underneath.

1. **Compensating the Power**: The main advantage of e-bike is that it brings external power, to make our task easier. We already know the usefulness of external support, which we get from the tools we normally use, to do our work done sophistically. Similarly, e-bike gives us the same advantage that we obtain in the use of external tools. As we are limited in our strength therefore the need for external support is essential, and very much so if we need to work on continuously for long durations. While riding a normal bike, we find that as roads are not plane everywhere, we sometimes have to work much harder to pull the bicycle when steep surface comes, which not just drain us out of our energy, it also drain us out from our bodily fluid because of excessive perspiration emissions, resulted due to overheated body temperatures. This can lead to dehydration most usually, besides it is not desirable to look wet, smelly and untidy, when we are going to office work. Therefore, to encourage people to ride e-bike, it is necessary that it must annihilate the disadvantage factors mostly, and e-bike in many respect is successful in doing that exactly. While riding e-bike especially when we feel short of power, or if we want a relax drive, we can choose Power mode, which immediately link battery to the motor, and motor starts working. The important point to be noted that as it is a bike and not a motorbike, it should have to maintain certain characteristics that is required to consider it as a bicycle. Therefore we must understand very clearly that until we do not pedal ourselves, we cannot get motor to run, and if it does not run we cannot get the assistance of the motor while riding e-bike. In that case we are not able to make the best use of e-bike. In its drawbacks, this option may not be conducive therefore undesirable to those who are physically less strong, having sore feet or children
2. **Speed**: As there is already assisted power coming from the motor to help the movement of the e-bike forward, and when we add our own power through the pedaling, then the total power applied to the system doubles up, accordingly the speed will rise. Because of this we reach to our destination quite quickly than the normal bike does. Besides, the effort involved to reach the destination is also significantly shortened due to increasing speed.
3. **Accessibility**: In general situations, the people living in the hilly areas cannot access the bikes because it is impractical to carry the bikes to those heights,

where it needs external power to support this. That is why the only transport means can be motor propelling transport systems. As e-bike supports the same system, therefore it suits appropriately the requirements, keeping it simple. The accessibility mounts because all groups can participate in riding this, irrespective of age, gender, strength, skill, healthy or sportive.

4. **Effort**: The effort that is required in riding e-bike is much lower than riding any ordinary bikes we can see, is just because in e-bikes motor is supplying the additional force to propel the wheels. Accordingly, the rider needs very less efforts on the pedal as is required in normal bikes. That is why riding becomes fun and easy with ebikes. Besides as there is no strain, there is no sweat again, and rider remains ever tidy.
5. **Distance**: The basic advantage of e-bike is that, in combination with less fatigue, easy riding and greater speed possibilities, even a long distance looks quite simple. But speaking in general, it is a best alternative for within city drive.
6. **Environmental friendly:** In energy efficient criteria, e-bike topples up the chart, they emit 30 times less CO_2 than a small car, emit zero emissions, a quiet means. If we introduce 100000 e-bikes, it can help to reduce 12000 tons of CO_2 per month.
7. **Climbing Hills:** A well functioning e-bike has a noticeable effect on climbing hilly roads, by the increased average speed achieved with them, thereby eliminating the 'groan' issue when gradient factor comes in. When users supply enough push, he can climb maximum gradient even, which is only achievable through cars or motorbikes.
8. **Appearance and Weight**: There is virtually no difference between a normal bike or e-bike, by the appearance it carries, and almost can disguise anyone, who are not familiar with e-bike. In some e-bikes where battery is hidden within the frames, making it even hard to conclude its identity. The appearance is enough to support this idea that it is really very simple, yet so efficient. The weight of e-bike is little enhanced by the inclusion of motor and battery, but it is not that much to trouble anyone to handle it well. As battery can easily be taken out, which is considerably the heaviest item, and after it has been removed, the weight of the bicycle becomes almost the same as ordinary bikes. This also indicates that e-bike is suitable for any class of people either they are young or old. As it is light not heavy like a motorbike, it can be parked anywhere, any bicycle stand will do, so it does not require a special garage, we can even carry it upstairs or inside our room, put anywhere safely, and use it instantly. This is also a convenient choice, to be in a position to take into action quite quickly, because it saves a good bit of time. In e-bike we have exactly the same advantage, when we need to go out, we can immediately take e-bike out, and we are instantaneously ready for our ride, making everything quick and simple.

Additionally: It has moral advantage also to ride e-bike, because this way one can project and participate in the safety of the planet. A responsible thinking that can inspire others also to follow the path, and this is how with similar small efforts, overcoming even a big and complicated challenges is also possible. A Power of motivation can be found in any simple deeds, only that the effort must be genuine and grandiose. Genuine means it must deal with honesty, and grandiose indicates it should not be limited to one group or community, but for the majority's interests. Pollution control is a challenge, and it is the responsibility of everybody dwelling here, and mainly from those who are financially secured and have alternative possibilities to reduce it. While speaking about the advantage, we have some indirect benefits also, because after the pollution is reduced, people become healthy, similarly productivity increases significantly. The cost that is required to maintain a motorbike or car is much higher than a bicycle, besides the buying cost is also considerably small, if we compare with these means. In a car people usually ride alone or mostly two. That suggests that the engine which is there to carry four to five people when utilized by only two, then three possibilities is wasted. That makes the efficiency to decline surely. In bicycle optimal efficiency can be achieved most of the time because it is made to ride alone. The other advantage is that if there happens an accident, it usually not so complicated, therefore maximum safe. The separate lane for the bicycle also helps it to reduce them. No fuel need, not only save the environment, but also reduces the burden on the Planet Earth.

9.2 Limitations

E-bikes bring a lot of undeniable advantages to the table. Being able to serve as a reliable means of transportation without relying on gas is almost always a welcome advantage for most motorists.

Considering the ballooning prices of petrol, you cannot really be surprised by the growing number of people who are switching to e-vehicles. And that is arguably just the tip of the iceberg benefits-wise.

That said, like any other vehicle, it is not devoid of cons tool. What are then the disadvantages of electric bikes? Some of the disadvantages of e-bikes include:

1. E-bikes are overall pricey;
2. Battery has a rather short lifespan;
3. Battery charge time is long;
4. Riding range remains low;
5. E-bikes are considerably heavier;
6. Maintenance and repairs are costly;
7. E-bikes tend to have low resale value;
8. E-bike manufacturing remains not environmentally friendly.

Compared to a standard bike, electric bikes usually cost three-fold, especially the high-end models. And this is only expected to increase with time. Costs because of a battery replacement are included in this as well. Since most standard e-bike batteries can only run for a year or so, this can really take a toll on your finances in the long run.

Factoring in short riding range and annual maintenance, you can only expect it to increase further. Of course, its downsides are not just limited to personal issues. The production of electric bikes and their batteries have also been proven to be particularly harmful to the environment.

Let us take a closer look at how each of these cons affects the general e-bike riding community.

Still rather low battery life

If we are going to talk about the primary, the relatively short battery life. And we are not just talking about how quickly the battery drains after every ride here. Rather, it also connotes how soon you will have to ultimately throw away the battery and replace it.

The reason behind this could be because its riding range has already decreased significantly. Usually, a 10-mile reduction is already a bad sign that the battery will need to be changed soon. This applies to every ride you that you do with its battery fully charged.

Lead-acid batteries were the progenitors of e-bike batteries before they were replaced by their lithium-ion counterparts. And they were replaced primarily because of their short battery life. At best, you can only expect it to last for a year.

Not to mention the fact that plenty of electric bike batteries begin to deteriorate the moment you start using them frequently. By the same token, lead-acid batteries tend to be damaged if you do not use the bike for long periods of time or if you overcharge them.

This severely affects your running costs if you look at it carefully. For one, most e-bike users may not know it, but they are probably not making the most of their bike's battery. This is especially true if you calculate the total miles you accrue in the course of a year then compare it with the estimated battery life of your e-bike.

Nonetheless, lithium-ion batteries have become the preferred option in recent models due to their comparatively longer life and lighter weight. Considering the still rising trajectory of electric bikes in terms of innovation, it will not be a longshot to expect future models to have longer battery life.

E-bikes are expensive

It is already a given that e-bikes cost way more than your average bike, and often even a scooter, or motorcycle. Many factors dictate this such as the fact that its technology still not peaked yet and most mid-range and high-end integrate additional features for user convenience.

They are also able to provide remedies to some of the primary downsides of electric bikes by having a higher battery life and riding range.

Furthermore, this con arguably does not apply to e-bikes in the lower end (such as those costing $600-$700) because they still manage to beat the prices of some petrol bikes. A lot even manage to deliver an all-around satisfactory e-bike experience with each ride.

Long battery recharge time

While this may vary in every model, electric bikes normally take a good while to charge. Most require at least 4 to 6 hours to charge completely. This might not be much of a hassle to riders who can anticipate this with every ride.

But if you suddenly run out of battery life unexpectedly, you would have no other choice but to wait for it to charge. Much worse if there is no nearby platform for you to charge your e-bike in. Would you be willing to push it around with you till you get to the nearest charging station?

Even so, there are already e-bike models that charge significantly faster than others. And it would not be a surprise if certain brands will vigorously try to address this issue in their more advanced models.

Hefty weight

Almost anyone who has ridden an e-bike will agree that a lot of them are heavier than standard bikes. Lead-acid battery-powered bikes often have this attribute, which takes a toll

on speed and the bike's ability to conquer steeper roads and terrains. If the electric bike does not have speed-boosting capabilities, then this can be a real problem.

This is certainly another major problem that manufacturers are doing everything in their power to solve. The introduction of lightweight lithium-ion batteries was one of the first steps companies made. Lighter materials that are also more durable are slowly being incorporated into the body of most e-bikes.

Low riding range

Not a lot of electric bike models can boast of supporting maximum riding ranges that exceed 30 miles (around 48 km). There may be more powerful models that can extend this average. But obviously you have to expect to pay a larger sum of money for such coveted electric bikes.

If we are to consider highly undesirable scenarios e-bikes not delivering the exact riding range that was expected from them, this problem's effect could not be felt more.

Imagine calculating a trip that will take you 15 miles (24 km) to get to one point then another 15 miles (24 km) to return to the place where you started. More often than not, e-bikes will not be able to complete this circuit without running out of battery life, as a lot of user anecdotes can attest.

High maintenance and repair costs

The notion of costly maintenance and repair of electric bikes is rooted in a lot of possibilities that might occur and affect the performance of your e-bike. From it's motor's sensors dying out and needing replacing to LCD screens and other techy features being broken, you will certainly have to have these repaired in order to make full use of your e-bike.

The fact that it can be hard to find a mechanic for your e-bike should a certain part malfunction is another con to be mindful of. You may have to scour the net or your locality just to find a suitable mechanic or repair shop for it, especially if the model is not that well known.

However, if it is manufactured by a brand that has close connections with a network of e-bike mechanics then you are definitely luckier in that regard.

Production still damages the environment

Lastly, the overall manufacturing cycle of electric bikes is actually not good for the planet as a whole. Building electric bikes require burning coal or fossil fuels, and this has been proven to be not at all environmentally friendly.

Even lithium-ion battery parts are not 100% recycled, so you can expect this problem to compound the more batteries are produced. That is not to say that manufacturers are not actively looking for more eco-friendly methods to create new models.

CHAPTER- X

CONCLUSION AND FUTURE SCOPE

Conclusion

There has never been a more exciting time than now to become an electric bike owner. Having established itself as a hugely popular, effective, and important mode of transportation in countries around the world—most notably China and several nations throughout Europe–the electric bike is beginning to take off in the United States as well.

The primary appeal of an electric bike is its unique ability to combine pedal power with motor power, giving riders an unprecedented level of control over their riding experiences. By allowing riders to choose precisely how much power the motor will provide, ebikes have quickly become some of the most flexible and accessible vehicles in the world.

Whether it's used to go on recreational rides with family or friends, as a way to get back into shape, or as a vehicle for completing your daily commutes, an electric bike is the key to easy, comfortable, and convenient travel.

Future Possibilities

This thesis is in a way defining e-bikes, trying to analyze the basic functions of various mechanisms which are available only in such e-bikes. Besides the aim is to highlight its importance in general, to promote the possibility for global Welfare, where Clean Climate plays a role. Having this basic purpose in place, it is also be said that this subject contains simple to advanced features containing all three departments, therefore very useful Thesis for Bachelor level students, just because in e-bikes all three variations of engineering is associated. Such as electronics in controller, mechanical in motor, and electrical in batteries. Therefore it can be a very resourceful work if it is possibly done using equipped labs, and somehow by using the same level of possibilities in advanced simulation software to analyze e-bike's properties better. The study of e-bikes can be done extensively, and it has been left for those interested researchers for exploring in depth of its possibilities in defining it.

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