Electric Moped with Swappable Batteries

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***Abstract*: The main aim of this project is to present the idea of harnessing the various energy and use it in today's existence of Human life. For human being travelling has become vital. In order to sustain in this fast forward World, he must travel from place to place. It is very important that time taking for travelling should be less, also it should be economical and easily available. With the fast depleting resources of petrol and diesel, there is need to find intermittent choice. Taking all this into account, a shift away from conventional based fuels to using a Renewable source of Energy is a must. Electric bike which will be driven with the help of battery and thus provide required voltage to the motor. This bike can be driven with the help of electricity. Therefore, the manufacturing of such bike is indispensable.**

***Keywords*: electric bike, electric moped, battery powered, electric vehicle**

INTRODUCTON

Now-a-day's people are using vehicle to travel from one place to another. With the increasing level of technology in automobile industry, the pollution is also increased. The effort required to move vehicle is produce by engine and it requires fuel source like petrol, diesel & CNG etc. These types of fuels are Non-renewable sources. These types of fuels make pollution after burning and harmful gases are also produce, which affects directly to the global warming.

The Increasing demand for non-polluting mechanized transportation has increased the interest in the use of electric power for personal transportation bike. In e-bike there is no use of Non-renewable sources. The e-bike is completely Eco-friendly bike. The system design is based on mechanically coupling a dc motor as the power source to drive the bike and electrically wiring the motor together with a rechargeable battery. Disc brake system is used in front and rear wheel of this bike, which is use to stop and slow down the bike. Suspension system is provided in order get comfortable and smoother ride to the passenger. batteries are placed under leg place in a compartment. A DC motor is a class of rotary electrical machines that converts direct current electrical power into mechanical power. A dc motor is fitted which is connected to the rear wheel of bike with the help of chain drive or belt drive mechanism. The speed of a bike is controlled by throttle which is fitted on a handle bar.

The batteries of the electric bicycles can be recharged by connecting them to a plug. In addition, a typical electric moped need 6–8 h to charge the battery and has a range of travel of 35 to 50 km at a speed of about 25 km/h (depending on rider weight). This means that, with a single battery charge, it would be enough to go to work, visit friends, and return

The electric moped as a new form of private transport has led to a new approach to mobility, especially in cities, both for countries with large populations and for countries that are concerned about the environment. The research on the electric moped is relatively new, but today, nobody clearly knows where the efforts are being focused, nor what the main points of interest of the scientific community are.

LITERTURE REVIEW

The paper presents a review on Portable Electric Bike (PEB). This was first developed in 1890's in US and those were documented within various US patents. On 31st Dec. 1895 Ogden Bolton designed a battery powered cycle. He designed using 6 pole brush and commuter DC hub motor connected to the rear wheel. He was then granted a US patent. Couple of years later, Hosea W. Libby invented electric bike which was propelled by double electric motor. This motor was so designed that it was attached with the crankset axle. Later in 1990's torque sensors and power controls were developed including some modified versions of bike with NiMH, NiCd and/or Li-ion batteries which offered lighter, density capacities batteries. But this bike faced decrease in production when petrol and diesel resources came in existence.

Taking considerations of recent events of meager resources and facilities at their disposal, over increasing traffic, snags problem of parking and the need to make automobile a more environmentally friendly, designers of vehicles are back with a view to hit upon a novel concept that completely alter the conventional design. Recent developments on Electric bike which are pedal operated are tremendously increasing all over the world market. In China 9 out of 10 Electric bikes are sold, thereby proving that they are not only energy efficient but also relative cheaper than other electric automobiles.

OBJECTIVES

1. The primary objective of this study, is to understand the need of e bikes in the current environmental scenario and act upon the climate change without compromising the basic needs of one.
2. Promote e-bikes and assess interest in them as a mode of urban transportation.
3. Stimulate people’s interest in commuting to work on e-bikes and making less use of cars.
4. Promote greater use of less polluting and energy-consuming modes of transportation.
5. To determine the impact of e-bikes on the safety of users in order to help responsible authorities decide on appropriate regulations.

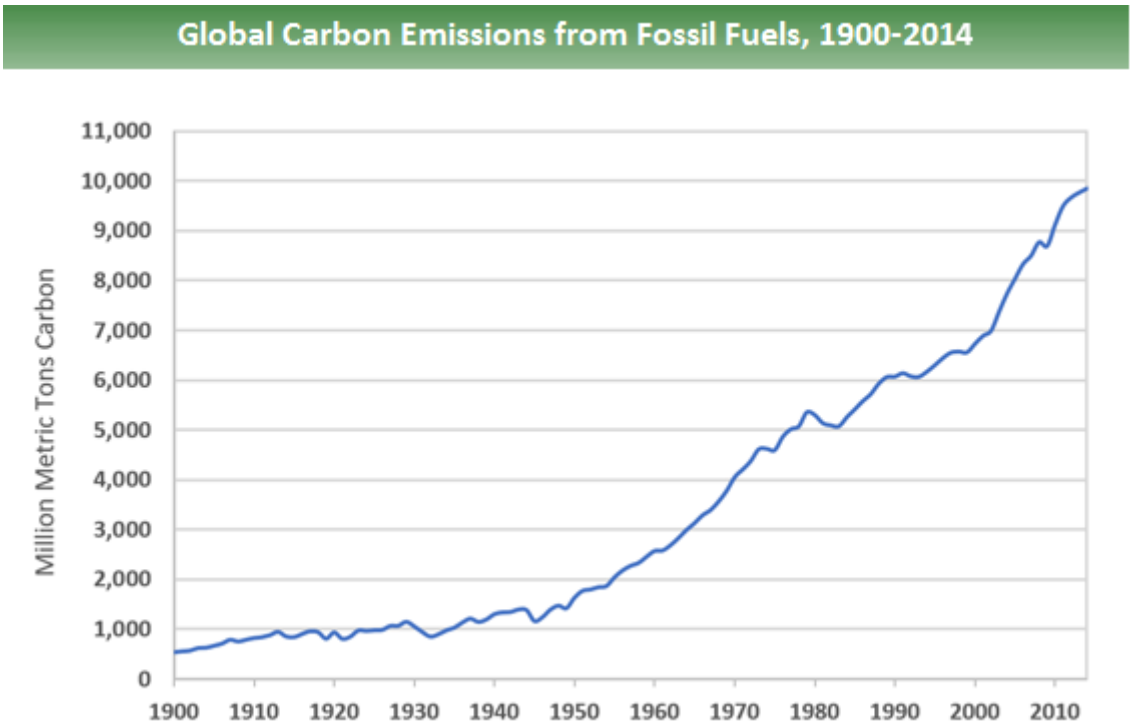

FIG 1 Global Carbon Emission

NEED OF ELECTRIC BIKES

Nowadays majority vehicles use petrol, but the efficiency of the petrol vehicles is proven that it is still low compared to the EV system in two wheelers. So, this project is based on how to prove that the EV systems are far more efficient, and develop an electro mechanical system for the same.

The heat generated from an IC engine is also more compared to an EV based vehicle with considerably fewer moving parts which reduce the cost for the further maintenance.

The EVs are expensive for common man to buy today but looking at the zero-maintenance aspect as well as the minimal per KM charges, EVs should be more concentrated over the mass buying market and this condition makes way for our project as it is focused on low cost high output concept which makes it affordable to masses.

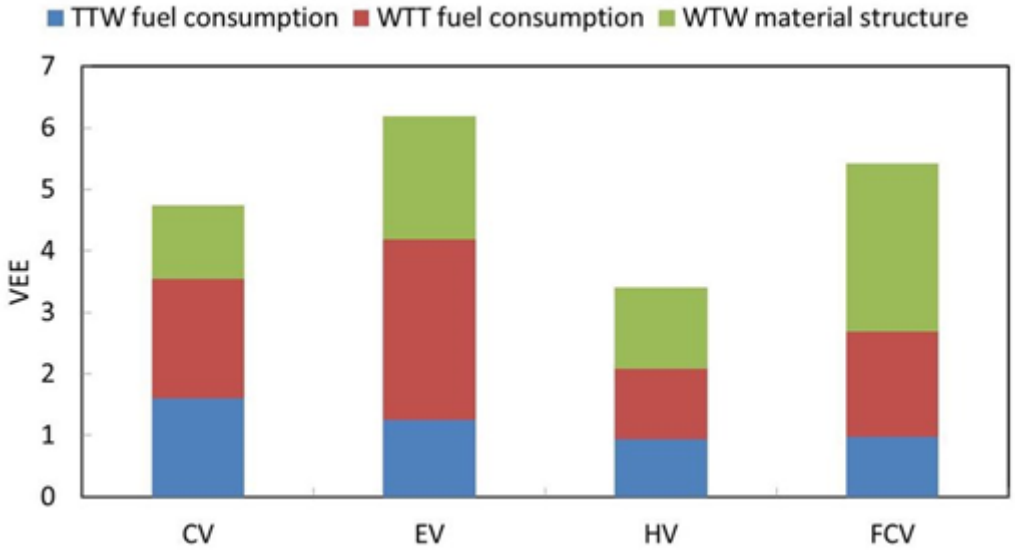

FIG 2 Vehicle Energy Efficiency

BASIC COMPONENTS

1. DC Hub Motor
2. Batteries
3. Electronic Throttle Input
4. Brake
5. Frame Raw Material
6. Tires
7. Shock Absorbers
8. Electric controller
9. Handle bar

1 DC HUB MOTOR

Hub motor electromagnetic fields are supplied to the stationary windings of the motor. The outer part of the motor follows, or tries to follow, those fields, turning the attached wheel. In a brushed motor, energy is transferred by brushes contacting the rotating shaft of the motor. Energy is transferred in a brushless motor electronically, eliminating physical contact between stationary and moving parts. Although brushless motor technology is more expensive, most are more efficient and longer-lasting than brushed motor systems.

A hub motor typically is designed in one of three configurations. Considered least practical is an axial-flux motor, where the stator windings are typically sandwiched between sets of magnets. The other two configurations are both radial designs with the motor magnets bonded to the rotor; in one, the inner rotation motor, the rotor sits inside the stator, as in a conventional motor. In the other, the outer-rotation motor, the rotor sits outside the stator and rotates around it. The application of hub motors in vehicular uses is still evolving, and neither configuration has become standard.

Electric motors have their greatest torque at start up, making them ideal for vehicles as they need the most torque at start up too. The idea of "revving up" so common with internal combustion engines is unnecessary with electric motors. Their greatest torque occurs as the rotor first begins to turn, which is why electric motors do not require a transmission. A gear-down arrangement may be needed, but unlike in a transmission normally paired with a combustion engine, no shifting is needed for electric motors.
Eliminating mechanical transmission, including gearboxes, differentials, driveshafts, and axles, provides a significant weight and manufacturing cost saving, while also decreasing the environmental impact of the product.

FIG 3 Hub Motor

2 BATTERIES

Lithium batteries are primary batteries that have metallic lithium as an anode. These types of batteries are also referred to as lithium-metal batteries.

They stand apart from other batteries in their high charge density and high cost per unit. Depending on the design and chemical compounds used, lithium cells can produce voltages from 1.5 V (comparable to a zinc–carbon or alkaline battery) to about 3.7 V.

Disposable primary lithium batteries must be distinguished from secondary lithium-ion or a lithium-polymer, which are rechargeable batteries. Lithium is especially useful, because its ions can be arranged to move between the anode and the cathode, using an intercalated lithium compound as the cathode material but without using lithium metal as the anode material. Pure lithium will instantly react with water, or even moisture in the air; the lithium in lithium ion batteries is in a less reactive compound.

Lithium batteries are widely used in portable consumer electronic devices. The term "lithium battery" refers to a family of different lithium-metal chemistries, comprising many types of cathodes and electrolytes but all with metallic lithium as the anode. The battery requires from 0.15 to 0.3 kg of lithium per kWh. As designed these primary systems use a charged cathode that being an electro-active material with crystallographic vacancies that are filled gradually during discharge.

The most common type of lithium cell used in consumer applications uses metallic lithium as the anode and manganese dioxide as the cathode, with a salt of lithium dissolved in an organic solvent as the electrolyte.
The typical estimated life of a Lithium-Ion battery is about two to three years or 300 to 500 charge cycles, whichever occurs first. One charge cycle is a period of use from fully charged, to fully discharged, and fully recharged again.

FIG 4 Lithium Ion

Series connections involve connecting 2 or more batteries together to increase the voltage of the battery system, but keeps the same amp-hour rating. Keep in mind in series connections each battery needs to have the same voltage and capacity rating, or you can end up damaging the battery. To connect batteries in series, you connect the positive terminal of one battery to the negative of another until the desired voltage is achieved. When charging batteries in series, you need to utilize a charger that matches the system voltage. We recommend you charge each battery individually, with a multi-bank charger, to avoid imbalance between batteries.
Parallel connections involve connecting 2 or more batteries together to increase the amp-hour capacity of the battery bank, but your voltage stays the same. To connect batteries in parallel, the positive terminals are connected together via a cable and the negative terminals are connected together with another cable until you reach your desired capacity.

3 ELECTRONIC THROTTLE INPUT

The throttle mode is similar to how a motorcycle or scooter operates. When the throttle is engaged the motor provides power and propels you and the bike forward. A throttle allows you to pedal or just kick back and enjoy a "free" ride! Most throttles can be fine-tuned like a volume dial

FIG 5 Throttle

4 BRAKES

A brake is a mechanical device that inhibits motion by absorbing energy from a moving system. It is used for slowing or stopping a moving vehicle, wheel, axle, or to prevent its motion, most often accomplished by means of friction. The below figure refers to a motor hub drum brake model.

FIG 6 Brakes

5 BATTERY CHARGERS

The framework: A battery charger, or recharger is a device used to put energy into a secondary cell or rechargeable battery by forcing an electric current through it.

Charge and discharge rates are often given as *C* or *C-rate*, which is a measure of the rate at which a battery is charged or discharged relative to its capacity. The C-rate is defined as the charge or discharge current divided by the battery's capacity to store an electrical charge. While rarely stated explicitly, equivalent to stating the battery's capacity to store an electrical charge in unit hour times current in the same unit as the charge or discharge current. The C-rate is never negative, so whether it describes a charging or discharging process depends on the context

A simple charger works by supplying a constant DC or pulsed dc power source to a battery being charged. A simple charger typically does not alter its output based on charging time or the charge on the battery. This simplicity means that a simple charger is inexpensive, but there are tradeoffs. Typically, a carefully designed simple charger takes longer to charge a battery because it is set to use a lower (i.e., safer) charging rate.

Fast chargers make use of control circuitry to rapidly charge the batteries without damaging any of the cells in the battery. The control circuitry can be built into the battery (generally for each cell) or in the external charging unit, or split between both. Most such chargers have a cooling fan to help keep the temperature of the cells at safe levels.

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Fig 7 Battery Charger

6 FRAME RAW MATERIAL

Mild steel is used in the framework of the bike as it contains a low level of carbon. Mild steel contains roughly between 0.05% and 0.25% of carbon by weight. It is not an alloy steel; therefore, it does not contain large amounts of anything other than iron and ferrite.

Some of the properties of mild steel are:

- Magnetic – this is due to the high amounts of ferrite and iron in mild steel bars.
- Ductile – in comparison to other types of steel, it is more ductile and therefore can be used for a wide variety of purposes.
- Weld able – due to its low carbon content, it is more malleable and suitable for welding. The less carbon in the steel, the more weld able and Machin able it becomes. (See Baker Steel Trading's mobile welding services page for more information).
- Affordable – using mild steel is relatively cost-effective in comparison to some other steels.
- Very little carbon – this makes cold-forming mild steel easier, and they are easier to handle as a whole.

FIG 8 Mild Steel

7 TIRES

The tires used in the project are 90/100-10 Radial tires. A radial tire is a particular design of vehicular tire. In this design, the cord plies are arranged at 90 degrees to the direction of travel, or radially (from the center of the tire).

The major for the selection of these tires were the advantages of radial tires that they offer:

- Flexible sidewalls
- Reduced fuel consumption due to less rolling resistance
- A softer ride because of the layout of the tire's plies and because of the flex of the sidewalls. This assumes equivalent profiles between the two tires (also, as stated above, at lower speeds radial-ply tires will react more harshly to ridges in the road such as expansion joints).
- More stable contact with the road surface.
- Steel Belted – Results in tougher overall construction
- Longer Tread Life
- Wider Footprint
- Less ground compaction and damage
- Reduction in tire replacement due to less heat generated by the tire.
- Reduced machine maintenance costs.
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FIG 9 Tires

8 SHOCK ABSORBERS

Shock absorber, also called Snubber, device for controlling unwanted motion of a spring-mounted vehicle. Shock absorbers slow down and reduce the magnitude of these vibratory motions. Modern shock absorbers are hydraulic devices that oppose both the compression and the stretch of the springs

Pneumatic and hydraulic shock absorbers are used in conjunction with cushions and springs. An automobile shock absorber contains spring-loaded check valves and orifices to control the flow of oil through an internal piston

One design consideration, when designing or choosing a shock absorber, is where that energy will go. In most shock absorbers, energy is converted to heat inside the viscous fluid. In hydraulic cylinders, the hydraulic fluid heats up, while in air cylinders, the hot air is usually exhausted to the atmosphere. In other types of shock absorbers, such as electromagnetic types, the dissipated energy can be stored and used later. In general terms, shock absorbers help cushion vehicles on uneven roads.

FIG 10 Shock Absorbers

9 ELECTRONIC CONTROLLER

The electric bike controller is one of the main parts of an electric bike, it is the brain of the e-bike, controlling the motor's speed, start, stop. It is connected to all the other electronic parts such as the battery, motor, and the throttle(accelerator), display(speedometer), PAS or other speed sensors if exist.al between low and full power

FIG 11 Electronic controller

10 HANLE BAR

A standard spec bike handle bar is used in the project vehicle made from thin diameter MS rod.

FIG 12 Handle Bar

CALCULATIONS

(Based on assumption)

Calculation for motor
The weight to carry is 120 kg at the speed of 35 km/hr.
The forces acting on the vehicle are
Rolling resistance
Gradient resistance
Aerodynamic resistance

Total forces = Rolling resistance + Gradient resistance + Aerodynamic resistance

Rolling resistance = Cr x m x a

Cr =coefficient of rolling
M = mass
a = acceleration due to gravity
=0.01x120x9.81
=11.772 N

The power required to overcome this rolling resistance
Resistance =14.715 x (velocity of body in m/s)
= 14.715 x 35(1000/3600)
= 143.06 watts (150 watts)
Gradient Resistance = m x a x Sin θ
= **0 N** (As the bike is on flat surface the angle is 0)

Aerodynamic drag = 0.5 x density of air x V^2 x C_a x A_f
V = velocity in m/s (35km/hr = 9.72m/s)
C_a = coefficient of air resistance for bike is 0.88
A_f = front area of bike
How to find front area of bike
1 draw the front view
2 measure height and width
3 multiply the height and width
A_f = (1.63 x 0.78) x 0.70
= 0.89 m^2 (adjusting value for Car 85% Bike70% Truck 100%)

Aerodynamic drag = 0.5 x density of air x V^2 x C_a x A_f
= 0.5 x 1.23 x 9.72^2 x 0.88 x 0.89
=45.50 N
Power required to over come this drag is 45.50 x 9.72= **442.26 Watts**

Total power required for moving the bike is =150 + 0 + 442.26 = **592.26 (600watts)**

To design electric bike of 120 kg with speed of 35km/hr. we need 600watts motor
Range calculation for batteries for electric bike
The motor 48v 600 watts hub motor how much ampere hour battery will be needed?

Find out amps needed to run motor
Power = voltage x current
600 = 48 x current
Current = 600/48 = **12.5 amps (theoretically)**

Find watt hour of battery
600 x 1 hour = 600Watt hour
600/0.8 = **750 watt hour (80% is the battery efficiency)**

Power = voltage x current
750 = 48 x current
Current = 750/48 = 15.625 =**16 ampere hour**
To run the electric bike for one hour 48V 16 Ampere hour battery is need

Battery Pack Calculations
The battery need is 48V 16Ampere hour
Lithium Ion Cell is of 3200amh 3.7v
Capacity Desired / Capacity of Cell
= 16000/3200
= 5
Derired Voltage / Voltage of Cell
= 48/3.7
=12.97 (13)
To make Battery of 48V 16Ampere we need 13 Cell in Series and 5 Cell in Parallel

ROLLING RESISTANCE	11.772 N
GRADIENT RESISTANCE	0 N
AERODYNAMIC DRAG	45.50 N
POWER REQUIRED	592.26 (600watts)
CURRENT REQURED	16 AMP
WATT HOUR	750 WATT/HR
BATTERY VOLT	48V
TOTAL BATTERY POWER	16 AMP/HR

APPLICATION

The bike can be use by postman in local area
The vegetables vender can also use this bike
Food delivery boys can use electric bike for delivering food
People can use electric bike in day to day life

ADVANTAGES & DISADVANTAGES

1 ADVANTAGES

- Allows seniors or those physically unable to far travel longer distances.
- The downtube battery keeps weight low and Enhances balance.
- It is compact and requires very little maintenance.
- Easy to maintain, it's just an ordinary bike with an added battery and motor.
- Very useful for commuting quickly and avoiding traffic.
- High mobility & versatility - overcomes off-road, dirt, snow.

2 DISADVANTAGES

- Which difficult to charge up if you run out of battery power.
- Short battery life and long charging time, likely limited to around 50 km (depending on the battery and motor specifications used).

CONCLUSION

With the increasing consumption of natural resources of petrol, diesel it is necessary to shift our way towards alternate resources like the Electric bike and others because it is necessary to identify new way of transport. Electric bike is a modification of the existing cycle by using electric energy and also solar energy if solar panels are provided, that would sum up to increase in energy production. Since it is energy efficient, electric bike is cheaper and affordable to anyone. It can be used for shorter distances by people of any age. It can be contrived throughout the year. The most vital feature of the electric bike is that it does not consume fossil fuels thereby saving corers of foreign currencies. The second most important feature is it is pollution free, ecofriendly and noiseless in operation. For Offsetting environmental pollution using of on-board Electric Bike is the most viable solution. It can be charged with the help of AC adapter. The Operating cost per km is very less and with the help of solar panel it can lessen up more. Since it has fewer components it can be easily dismantled to small components, thus requiring less maintenance.

FUTURE SCOPE

The bike can be given some high volt motor as per need and the battery pack can be bigger to increase the distance of travel. The moped speed can be improved. The battery can be swap at charging station which are powered by solar power.

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