

# Development of Electric Bicycle by Harnessing Solar Energy

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## ABSTRACT

In present scenario a Solar Bicycle system will help to solve the major problems of fuel and pollution. There is no doubt that the emission of carbon-dioxide from an automobile exhaust is a concern for the increasing rate of global warming. The fuel prices in India and around the world is increasing day by day thus there is a tremendous need to search for an alternative to conserve these natural resources. Promoting use of solar vehicles can reduce CO<sub>2</sub> emission and the fuel costs. Thus a solar bicycle is an electric vehicle which provides alternative by utilizing solar energy to run the motor. India is blessed with nine months of sunny climate thus concept of solar bicycle will be very useful in India. The bicycle has the most feasible solar/electric power generation system mounted on the vehicle to charge the battery during all durations. Solar panels can be mounted on the backside of bicycle to capture the sun rays. For controlling speed of the motor, an accelerator is given which controls the supply. This type of technique is to reduce the running cost and increasing the running efficiency of the vehicle. The speed of the Solar Bicycle can go up to 15 – 20 km/hr carrying a load of a person of average weight. Thus solar bicycle can become a vital and cheap alternative against the use of automobile and thus its manufacturing is essential.

**Keywords:** Solar Bicycle, Brushless DC motor (BLDC), Solar Panel, Motor Controller, Accelerator (Throttle).

## I. INTRODUCTION

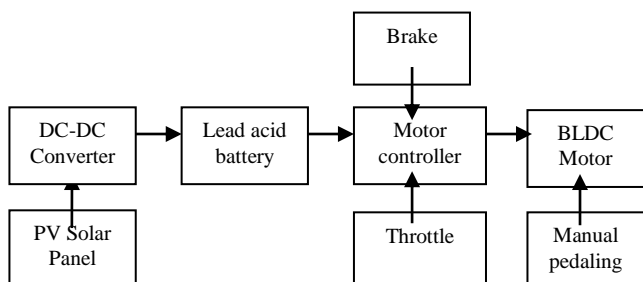
The working of the Solar Bicycle is as follows; They are four stages of working mechanism, in the first stage the solar panel play a key role, as we are running on solar energy, the sun rays contains of photons come and directly hits the solar panel which consists of schematic arrangement of solar cells, convert the photons into electrical energy using photovoltaic effect.

The second stage consists of motor controller, DC-DC boost converter, in which the electrical energy from panel is in form of uncontrolled stage which in

turns converts it into controlled state and input voltage is converted into higher regulated voltage.

In the third stage the energy from the boost converter is stored in the battery and then it is supplied to the brushless direct current motor which contains a permanent magnet and provides high torque and smooth noiseless operation which is fitted into the rear end of the cycle.

Finally in the fourth stage, the sprocket and chain drive mechanism takes place. The power from motor is transferred to the chain which is fitted in the rear end off the wheel and the chain turns moving the person in required direction.



**Figure 1.** Block diagram

### A. BLDC Motor

They are very reliable and have very long life. The main characteristic of Brushless DC Machines is that they may be controlled to give wide constant power speed ranges. A 250 watt motors are the most used motor on commercially available electric bikes. They are popular in Europe (and Asia) where in many countries there is a 250 watt power limit on E-bikes.



**Figure 2.** BLDC Motor

**Table 1:** Specification of BLDC Motor

Type of Motor	Hub Motor
Design of Motor	BLDC Motor
Model	MY1016Z
Output	250W
Rated voltage	24V DC
Rated current	14A
Rated speed	2700RPM

### B. Solar panels

The solar bicycle is operated by solar energy. The lead acid battery is charged with voltage generated due to solar energy with the help of a photovoltaic cell. Solar cells convert the solar energy directly into electricity using photovoltaic effect. The

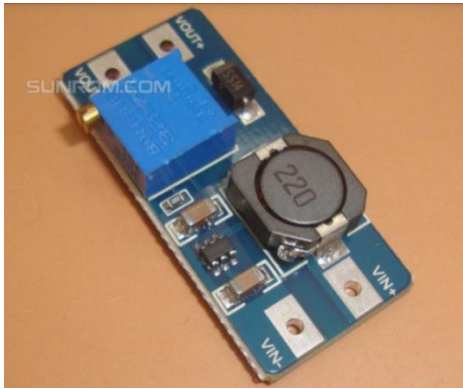
photovoltaic effect involves conversion of electromagnetic radiation into electrical energy. The photovoltaic effect involves conversion of electromagnetic radiation into electrical energy. The photoelectric and photovoltaic effects are related to sunlight, but are different in that electrons are ejected from a material's surface upon exposure to electromagnetic radiation of sufficient energy in photoelectric, and thus the electrons that are generated are transferred to different bands of valence to conduction within the material thus this results into build-up of voltage between two electrodes in photovoltaic. Solar cells are connected electrically and manufactured as a module with a sheet of glass on top to allow light to pass and protect the semiconductor from the weather.



**Figure 3.** Solar Panel

### C. Boost Converter

It is essential to regulate the voltage output from the solar panel before it is supplied to the motor. A Boost Converter is a power converter with an output DC voltage greater than the input DC voltage. This is used to regulate an input voltage to a higher regulated voltage. Because the output of the solar panel will be varying constantly, we need a voltage regulator/boost converter that will take an input from a wide range of voltages and output a specific, constant voltage value. We have used DC-DC Boost 2A-MT3608 converter.



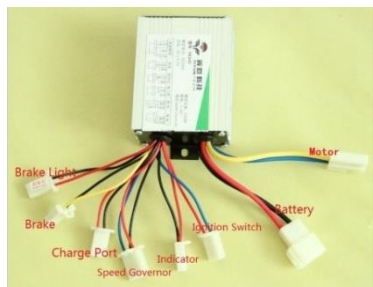
**Figure 4.** Boost converter

**Table 2:** Specification of Boost converter

Model	MT3608
Input voltage	2-24V
Output voltage	5-28V
Output current	2A
Efficiency	>93%

#### D. Motor Controller

A motor controller is an important element of the solar bicycle or can be called as the brain of the vehicle. It controls the amount of power supplied to the hub motor and also to the lights and horn if required.



**Figure 5.** Motor controller

**Table 3:** Specification of Motor controller

Model	YK31C
Rated voltage	24V
Rated power	Up to 350W
Maximum current	25A
Size	102*65*38 mm
Conversion efficiency	95%
Under voltage protection	20Volts

#### E. Accelerator (Throttle)



**Figure 6.** Acceleraton

The maximum speed of a bicycle is 20 kmph. It is required to vary the speed depending upon the road conditions & traffic. Therefore an accelerator or a throttle (Figure 6) is necessary. Throttle allows us to drive the motor from zero speed to full speed. The throttle is fitted on right side of the handle bar and is connected to controller.

#### F. Lead acid battery

Lead acid batteries (Figure 7) are one of the most popular types of battery in electronics. Although slightly lower in energy density than lithium metal, lead acid is safe, provided certain precautions are met when charging and discharging. This have a many advantages over other conventional types of batteries, the lead acid battery is the optimum choice for a solar assisted bicycle.



**Figure 7.** Lead acid battery

Two Lead acid battery of 12V, 12Ah are used. They are connected in series to get 24V.

**Table 4:** Specification of Lead acid battery

Type of battery	Sealed Lead acid battery
Number of batteries	Two batteries in series
Voltage	12V
Amp-Hour rating	12 Ah
Charging time	7-8 hours
Safety	Good
Cycle life	400

### G. Solar bicycle

The solar assisted bicycle (Figure 8) is driven by DC motor fitted in rear axle housing & operated by solar energy. The solar panel mounted on the carriage is used to charge the battery & which in turn drive the BLDC motor. When the bicycle is idle during the day, the solar panel will charge the battery. The system will make bicycle operate more efficiently.

**Figure 8.** Solar bicycle

## II. RESULTS AND DISCUSSIONS

**Table 5:** Cost analysis

Part	Unit cost	Number	Cost (Rs)
Bicycle	3000	1	3000
Solar panel	3000	1	3000
Accelerator	750	1	750

Motor	3500	1	3500
Boost converter	700	1	700
Battery	1500	2	3000
Total cost			13950

**Table 6:** Comparison of various types of vehicles

Parameter	Solar bicycle	Moped	Ordinary bicycle
Max. Speed limit(km/h)	25-30	45-50	10-15
Initial unit cost	13000	35000	3000
Weight	40	80	15
Type of energy used	Solar	Petrol	Muscle power
Driving noise	noiseless	65-70 db	Noiseless
Driver's licence required	No	Yes	No

## III. CONCLUSION

Solar bicycle is modification of existing bicycle and driven by solar energy. It is suitable for both city and country roads, that are made of cement, asphalt, or mud. This bicycle is cheaper, simpler in construction & can be widely used for short distance travelling especially by school children, college students, office goers, villagers, postmen etc. It is very much suitable for young, aged people and caters the need of economically poor class of society. It can be operated throughout the year free of cost. The most important feature of this bicycle is that it does not consume valuable fossil fuels thereby saving crores of foreign currencies. It is ecofriendly & pollution free, as it does not have any emissions.

Moreover it is noiseless and can be pedaled in case of emergency and cloudy weather. It can be driven by manual pedaling in case of any problem with the solar system. It has fewer components, can be easily mounted or dismounted, thus needs less maintenance.

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