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# Solar Operated Hybrid Bicycle

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**Abstract -** The rising fuel prices worldwide have necessitated the search for alternative energy sources. One such alternative is the solar powered electric bicycle, an electric vehicle that harnesses solar energy to charge its battery and power an electric hub motor. Given India's sunny climate for nine months of the year, solar hybrid bicycles are particularly suitable. These bicycles combine solar energy with domestic charging facility to charge the battery, making them a vital alternative to fuel-based automobiles. Our project aims to design an electric bicycle that operates on solar energy, eliminating the need for human effort or conventional fuels. The system includes solar panels, a battery, and a motor for optimal energy utilization. By maximizing solar power, we contribute to cleaner transportation and reduced environmental impact.

This hybrid (solar-powered electric) bicycle demonstrates the fusion of technology, sustainability, and efficient mobility.

***Key Words*: Hybrid Bicycle, Direct Current Motor (DC Motor), Solar Panel, Throttle**

## 1.INTRODUCTION

The solar operated hybrid bicycle presents an idea of sustainable energy and effective transportation. Here are some major features of this innovative method of cycling. Solar operated hybrid bicycles use photovoltaic (PV) panel mounted on frames. Solar panels are used to convert solar energy into electrical energy, which is stored in a battery. The solar energy reduces the charging time and providing eco-friendly and cost-effective means of propulsion. In addition, with solar energy, dynamo is also used to charge the battery. Dynamo generates electricity while pedaling. Energy stored in battery is used to power the geared Direct Current (DC) motor, which in turn rotates the rear wheel. Solar operated hybrid bicycle also helps in reducing pollution due to conventional petrol and diesel engines. Therefore, solar operated hybrid turns out be a good alternative of transportation for school and college students, office employees, senior citizens, etc. In this project as a part of dissertation work, the solar assisted bicycle is fitted with a DC hub motor on rear axle of a bicycle with power rating of 250W and with a travelling speed of around 17-28 km/h. It is provided with a pair of lead acid batteries of 8 Ah each, a photovoltaic solar panel with capacity of 50-watt, microcontroller, accelerator and motor of 24v. In poor weather conditions or in cloudy weather, the output/efficiency gets reduces therefore batteries can also be charged by 220-240 V AC charger. This paper presents a way of designing and implementing of solar module for a battery-operated bicycle. The paper shows how solar power can be utilized to drive such a motor and other convenient function on a bicycle.

## 2.WORKING PRINCIPLE

The working principle of this model/project "Hybrid Bicycle" is based on the concept of using solar energy for charging batteries of the bicycle by using solar (in addition to AC wall charger) with the help of solar panels. Charging batteries with solar energy reduces the battery charging time and also reduces the charging cost. When sunlight strikes the solar panel, solar energy gets converted into electrical energy by a photovoltaic effect. This electrical energy gets stored in the batteries in the form of electrochemical energy through chemical reactions. This energy is used to run the geared DC motor which in turn runs the bicycle. Components of Hybrid Bicycle: DC motor, battery, solar panel, controller, metal frame, throttle and chain.

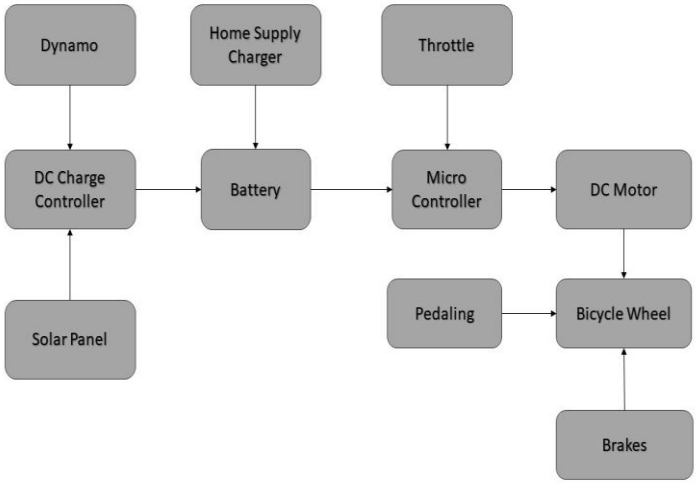


**Fig-1:** Flow Chart of Solar operated Hybrid Bicycle

## 3.DC Motor

A DC motor is a motor that is used to convert energy from direct current into mechanical energy. The first-ever DC motor was invented around the 1830's-1840's. Initially, they were unsuccessful, because these motors run on battery

power, and batteries remain very expensive and their quality was also not good (quite low quality). The quality of DC motors continuously keeps on improving, but motors of other types such as BLDC motors, have also been developed in the meantime too. As a result, the use of brushed and geared DC motors in several applications is limited today.

In this model of hybrid bicycle we used a geared DC motor of power rating of 250 watts, 3300RPM with a reduction ratio of 9.78.

**Fig-2:** DC Motor

## 4.Controller

A DC motor controller is an electrical device that controls maintains the several devices of a hybrid bicycle and also the performance of a direct current (DC) motor. Controller is used to start and atop the motor, and control its, torque, rotational direction, and speed. A DC motor controller allows us to control the relative speed of the motor with the help of a throttle.

The motor controller is also known as the electric hybrid bicycle controller or electric speed controller. It is a circuit board in a sealed protective and insulated box with several connection wires coming out. It's mounted on a hybrid bicycle connecting and putting all key components together, like the motor, throttle, paddle assistant, battery charger, and battery, to control the motor's speed, start, and stop. The Controller acts as the "brain" of the hybrid bicycle which controls and maintains the performance of the hybrid bicycle.

**Fig-3:** Controller

## 5.Solar Panel

A solar panel is a device that is based on the principle of photovoltaic effect and it is also known as a photovoltaic (PV) panel. Used to convert sunlight into electricity. It is a semiconductor device usually made of silicon.

Germanium, Phosphorus, and Indium are commonly used for doping in semiconductor material.

**Table -1:** Solar Panel Specifications

| | |
|---|---|
| Maximum power | 50 W |
| Open circuit voltage | 22 V |
| Short Circuit current | 3.1 A |
| Maximum power voltage | 18 V |
| Maximum power current | 2.78 A |

**Fig-4:** Solar Panel

## 6.Battery

A battery is a device that is used to store electrical energy in the form of chemical energy through chemical reactions. it mainly consists of one or more electrochemical cells, electrolytes, and, two terminals (positive(anode) and negative(cathode)). When a battery is connected to an external circuit, a chemical reaction takes place in the cell, which causes electrons to flow from the negative terminal to

the positive terminal and generate an electric current. batteries are mainly used to power many devices, from small electronic gadgets like laptops, study lamps, and smartphones to larger applications like vehicles and backup devices.

Two dry rechargeable batteries of 12v, 8Ah are used which are connected in series position.


**Fig-5:** Battery

## 7.DC Charge Controller

A charge controller or regulator is a voltage or current regulator to avoid/prevent batteries from overcharging. It regulates the output voltage and current of the solar panel going to the battery. Mostly "12-volt" panels gives an output of around 16-20 volts, if there is no regulation of panel output then batteries will get damaged by overcharging.

Boost converters are devices that are used for steeping up voltages in many applications where voltage needs to be increased without conversion into Alternating Current (AC), with the use of transformer and then passing transformer output through a rectifier.

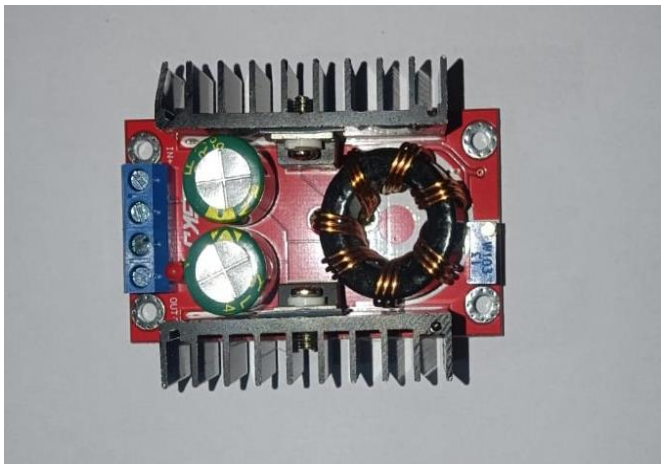

**Fig-6:** DC Charge Controller

## 8.NO LOAD SPEED CALCULATIONS

**A:**
Number of teeth on smaller the sprocket(motor)($t_1$) = 9
Number of teeth on larger the sprocket (Bicycle)($t_2$) = 18
Speed on smaller sprocket (motor)($N_1$) = 3300 rpm
By using reduction ratio (9.78), speed will be reduced to 338 rpm
Speed on larger sprocket (bicycle)($N_2$) =?

**B:**
Using speed ratio formulae,

$$N_1t_1=N_2t_2$$
$$388*9=N_2*18$$
$$N_2= (388*9)/18$$
$$N_2=169 \text{ rpm}$$

**C:**
Diameter of wheel = 560mm
Circumference of wheel = 3.14*560
= 1758.4mm

**D:**
Speed of the vehicle = speed of wheel*circumference of wheel
= 169*1758.4
= 297169.6 mm/min
= 297 m/min
= 17830 m/hour
= 17.83 km/hour

## 9.POWER REQUIRED TO DRIVE BICYCLE

**A.**
Total load acting on bicycle are as follows
Normal weight of the person = 78.75kg
= 78.75*9.81
= 772.54 N
Weight of bicycle = 12kg
= 12*9.81
= 117.72 N
Other miscellaneous load = 21.5kg
= 21.5-*9.81
= 210.92 N
Total load = (772.54+117.72+210.92)
= 1101.12 N

**B:**
To find reaction on each wheel, the above total load which is divided equally on both wheels
Force ($F_{fw}$) = Force ($F_{rw}$)
= 1101.12/2
= 550.6 N
Where the reaction on rear and front wheel are as follows
$R_{fw}=R_{rw}$
= 0.2*550.6
= 110.12 N

**C:**
To find torque on each wheel
Total torque = $T_{fw} + T_{rw}$

To find torque on front wheel
$T_{fw}= R_{fw}*(D÷2)$
$T_{fw} = 110.12*[(56*10^{-2}) ÷2]$
$T_{fw} = 30.84$ Nm
$T_{fw}=T_{rw}= 30.84$ Nm
Total torque on wheel = 30.84*2
= 61.68 Nm

## 10. BATTERY CHARGE TIME FROM SOLAR

You have a 50-Watt, 18-Volt panel and 8Ah, 24 Volt battery bank, how long does it take to completely charge? The quick answer would be to figure out the Watt-hours of the battery (24*8Ah= 192-Watt hours) and divide it by the solar output. The reality is about 1.5 times longer.

There are mainly three reasons for the differences, even in ideal conditions. First, the Watt-rating of the panel is the product of the peak current and the open circuit voltage. When we connect a panel to a battery, the voltage drop takes place to that of the load. Finally, all the power that enters the battery does not gets converted into storage energy.

In field test, we are seeing that the combined loss factor is about 1.5. Divide the watt hours of the battery by the wattage of the panel and multiply by 1.5.

In our project:
Watt Rating of battery = 192 Watt
Wattage Rating of panel = 50 Watt
Charging Time= 1.5*(Watt Rating of battery/ Wattage rating of panel)
= 1.5*192/50
= 4 hours and 36 Minutes
This calculated charging could increase in cloudy weather, if panel is not pointed at the sun or panel voltage is not matched to your battery.

## 11.CONCLUSIONS

A Hybrid bicycle is a modification of an existing bicycle and uses solar energy to charge the battery. The model of Solar panels and battery used in this electric bicycle has total weight of around 9 kg. It can carry person of weight up to 75 kg and runs with the maximum speed (without solar setup) of around 25 km/hr. By combining solar power with electric propulsion, these bicycles offer reduce emission and fuel consumption.

The calculated **No load speed of bicycle (with solar setup ) is = 17.83 km/hour**
**The range of bicycle is = 23-25 km**

## 12.ADVANTAGES

1. It is environment friendly with no use of any fuel.
2. Removal batteries can be taken inside the house for charging.
3. Not dependent on other forms of energy and solar energy is a renewable form of energy.
4. Hybrid bicycles are easy to operate.

## 13.DISADVANTAGES

1. The Price of batteries, motors, and solar panels increases with the increase in energy demand of consumers.
2. Solar panels fail to charge battery at night and its efficiency gets reduced in cloudy weather.
3. Increased weight of the bicycle.
4. High initial cost.

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## PHOTOGRAPHY


**Fig-7:** Solar Operated Hybrid Bicycle

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