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Future Solar Electric Vehicle Charging System

[1.] RAHUL PRAJAPATI [2.] MEET PATEL [3.] KRISHNAJI SHAH [4.] DR. DIPESH M .PATEL
[1,2,3,4] *ELECTRICAL ENGG. DEPT, NEOTECH INSTITUTE OF TECHNOLOGY (Affiliated to Gujarat Technological University)*
(GUJARAT), 390022,INDIA
prajapatirahul360@gmail.com

Abstract

One of the front runners in the area of renewable energy resources today is solar power. Photovoltaic cells are used to convert solar energy in to useful electrical energy. The objective of this paper is to construct an efficient solar car, for the daily office commuters of city so that they can travel a fixed distance that they need to commute everyday on a reliable and economical car that essentially runs on free renewable solar energy. The paper illustrates how the charge generated by an array of solar panels is received and its flow in and out of a battery pack is to be controlled using a microcontroller based charge controller to ensure efficient storing of charge in a battery pack. The stored energy would be divulged to a DC motor which would run the car. The design of a motor controller to control the car's speed and forward/reverse direction of motion is shown. The mechanical construction from scratch of the chassis along with all necessary mechanical systems is illustrated. Finally the wiring of the electrical system onto the mechanical body is demonstrated.

***Keywords*:** Solar Energy, sustainable energy, Renewable energy.

I. INTRODUCTION

A. Introduction to Solar panel

The quests for a constant, safe, clean, environmental-friendly fuel is never-ending. Carbon-based fuels, such as fossil fuels are unsustainable and hazardous to our environment. Some of the alternatives are renewable energy sources which include all fuel types and energy carriers, different from the fossil ones, such as the sun, wind, tides, hydropower and biomass. Amongst these elements, solar energy is preferred since it could provide the cleanest sustainable energy for the longest duration of time the next few billion years. Photovoltaic production becomes double every two years, increasing by an average of 48 percent each year since 2002.

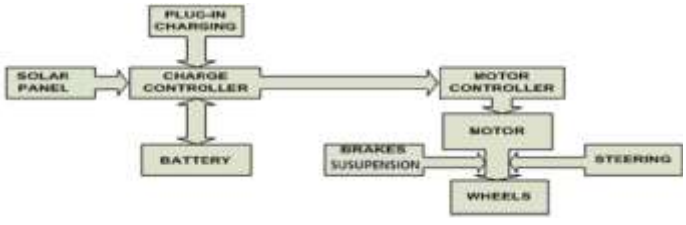

Fig 1: System architecture of the solar car

B. Pollution

The earth is suffering as a result of the destruction wreaked upon it by humanity. Whether it is the pesticides contaminating the rivers, chemicals from factories polluting the seas or the exhaust fumes from vehicles and industries polluting the air, the systematic destruction of our different ecosystems all over the world has led to a dreadful mess. Our main focus is on the transportation industry which is the second largest source of pollution and health hazards.

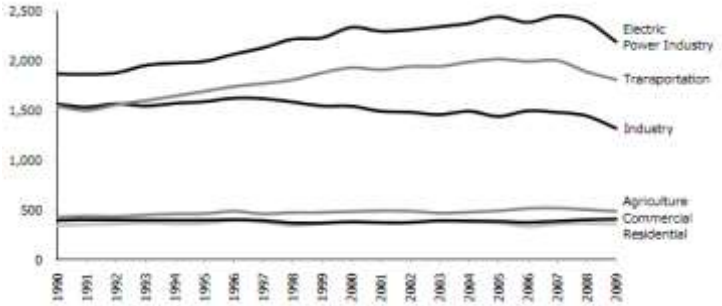

Figure 2: *CO2 Emission by various factor*

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C. Fuel prices

Fuel-based cars not only threaten the very air we breathe in but also the cost of running and maintaining them are huge and overbearing, and as the fossil fuels are gradually being depleted, the cost of these limited scare resources, the existing fuels' prices are continuously rising.

II. SOLAR CARS

Solar cars are powered by the sun's energy ergo solar panels are the most important part of a solar car since they are solely responsible for collecting the sun's energy. The solar panels used in this project are mono crystalline and flexible. They can be mounted and fitted on top of the car or on the bonnet with ease owing to their thin semi-flexible nature.

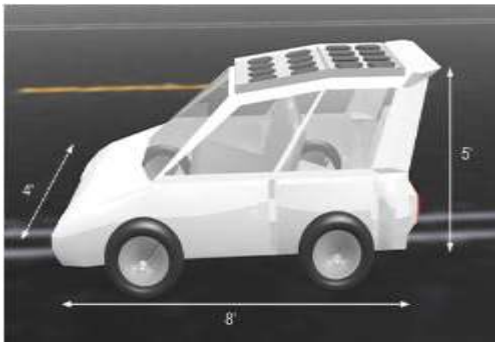

Fig 3:3D model of solar car

2.1 *Motor power rating*:

The power needed to propel a vehicle can be determined by combining the forces that needs to be applied to the vehicle to move it with the vehicle speed at which this propelling force must be sustained. The drive torque generated by the motor for the wheels produces a drive force at the tire/road contact - it is this drive force that moves the vehicle. At the design stage it's easier to frame the calculation around this drive force rather than the drive torque. Thus the calculations in this section start by determining the size of this drive force, and given a set of speed at which the vehicle should move, the drive power is found. These opposing forces are accounted for as follows:

2.1.1 Rolling Resistance:

The rolling resistance force is the force resisting the amount of deformation of the wheels, the deformation of the roadbed surface, and movement below the surface. Additional contributing factors include wheel diameter, speed, load on wheels etc. For example, a rubber tire will have higher rolling resistance on a paved road than a steel railroad wheel on a steel rail. Similarly, sand on the ground will give more rolling resistance than concrete. The rolling resistance force can be expressed as,

$$F_{ROLLING} = \mu R * W$$

Where ,W is the weight of the car and μR is the coefficient of rolling resistance and is a constant that depends on the type of tires of the vehicle and the surface on which it will roll. Rolling motion of the tires as they roll over the road surface.

2.1.2 Aerodynamic Drag Force:

The aerodynamic drag force is simply the force exerted by the air to prevent the vehicle from moving through it. The aerodynamic drag force can be expressed as,

$$F_{DRAG} = (1/2) * C_D * A_{cross} * \rho * (V)2$$

Where **CD** is the coefficient of drag of the vehicle, **Across** is it's frontal area in square feet, ρ is a constant that accounts for the air mass density and V is the vehicle's speed. To minimize drag for any given **CD**, the coefficient of drag **Across** its frontal area must be minimized.

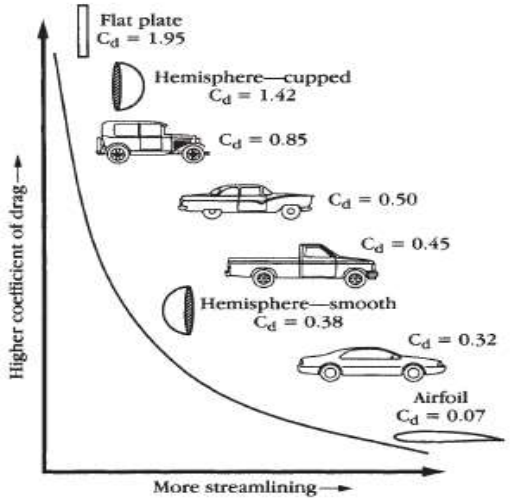

Fig 4: coefficient of drag for different vehicle shapes

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2.1.3 Force Of Acceleration:

The force of acceleration should be only accounted for when the car is accelerating and is given by Newton's 2nd law of motion

$$F_{ACCELERATION} = [m*a]$$

Where **m** is the mass of the car and **a** is the acceleration.

The total driving force thus required to overcome the sum of these opposing forces to move the car is,

$$F_T = F_{ROLLING} + F_{DRAG} + F_{AC} = [\mu_R * W] + [(1/2) * c_D * A_{cross} * \rho * (V)^2] + [m*a]$$

2.2 BATTERY CAPACITY:

Capacity is the measurement of how much energy the battery can contain (in Ampere-hours), analogous to the amount of water in a jug. The capacity required will be dependent on the cars acceleration and speed as well as the total distance the car will overcome before the battery charge is depleted.

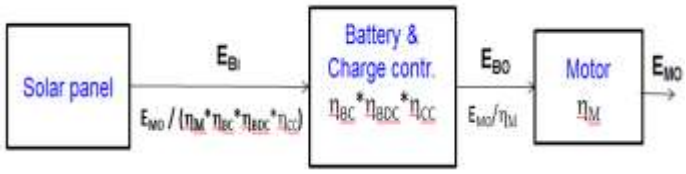

Fig 5: System diagram solar panel, battery and motor

2.3 SOLAR PANEL TEST:

Fig 6: The 50w semi flexible solar panels used

Solar panels have been around since the nineteenth century and since then till today people have been using them for a variety of applications at home, business, for transportation and even for agricultural use. Solar panels are still considered expensive and their performance needs to be verified without completely relying on the provided ratings by the company producing them. In the case of a solar car, the solar panels will be the ultimate supplier of energy for the whole car to function; for all intents and purposes it will be akin to the heart that pumps blood around the human body. Therefore, a thorough verification of the performance of the solar panels to be used for the solar car was carried out.

2.3.1 How solar panels work:

The sun gives off radiated energy in the form of light photons which is converted into electrical energy by the solar panels. Solar panels are composed of silicon based semiconductors and when the radiation comes in contact with the silicon atoms, the photons are absorbed and the electrons are separated from the rest of the atoms. These free electrons are responsible for carrying and creating an electrical current. The electricity generated is most usually stored in batteries to be used later.

2.3.2 Types of solar panels:

Solar panels today have become more efficient than they used to be before and are continuing to be increasingly efficient day by day. There are now different types of solar panels available, namely, monocrystalline silicon, polycrystalline silicon, and Amorphous Silicon 'thin film' modules.

(a) *(b)*

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(c)

Fig 6: Types of solar panel
(a)monocrystalline,(b)polycrystalline,(c)amorphous thin film

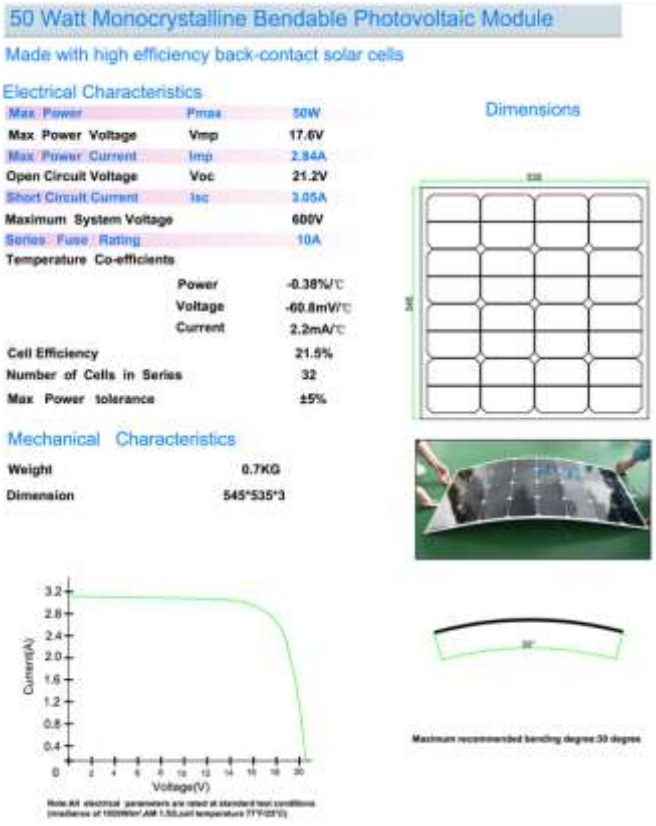

Fig7: Ratings and specifications of solar panels used

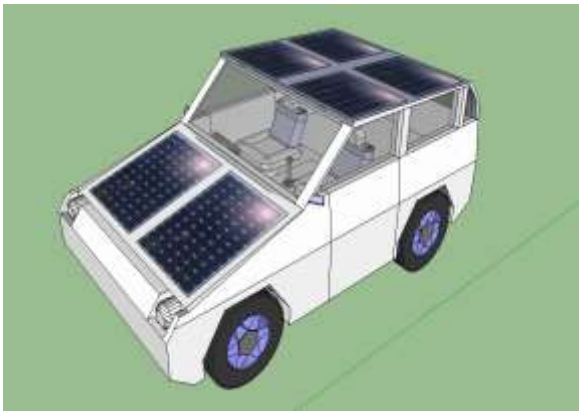

Fig8: Configuration of the setup of solar panels on the car

III. CONCLUSION

Although the solar panels bought were easily the most expensive element of the car, the most part, good quality solar panels will last for 20 years without needing to be replaced. However, there are also some factors that can affect solar panels and cause them to have a lower output even when the hardware is 100% functional. These factors include sky condition, positioning, temperature, shade etc.

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