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Design and Fabrication of Solar Electric Vehicle

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Abstract : *This paper gives you a basic overview about designing and implementing the process of solar electric vehicle. A solar car does not use any combustion thus it is free from any cause for global warming. This paper proposes a method to design multi-seated solar car different from the one available in market, in a cheaper way. The most essential equipment for building a solar vehicle are the solar panels. The photovoltaic panels of 250 W are connected as a photovoltaic array to charge a lithium-ion battery bank of 48 V and 78 Ah during the day hours. With the help of this technology, we aim to make solar energy powered car in our project. The solar cells in the solar panel absorbs UV rays transmitted from sun and convert them into electrical energy, thereby powering the vehicle. In between solar panels and battery, there is a charge controller or MPPT to magnify the output from the solar panels to charge the battery efficiently.*

Keywords - *four-wheeler, electric vehicle, regenerative braking, auxiliary solar charging, li-ion battery*

I. INTRODUCTION

When This paper, we discussed about the usage of solar energy to power up the vehicle. In order to achieve the required voltage, the Photo Voltaic (PV) Module may be connected either in parallel or series, but its costlier. Hence, to make it cost effective, power converters and batteries are been used. The electrical charge are combined from the PV panel and directed to the output terminals to produce low voltage (Direct Current). The charge controllers direct this power acquired from the solar panel to the batteries. According to the state of the battery, the charging is done, so as to avoid overcharging and deep discharge. The voltage from the solar panels is increased up to a certain level that matches the level of the load by a converter viz. MPPT or charge controller, which results in driving our load for example, charging the battery or running the motor. According to the application with respect to load, the components such as the solar panels, charge controller, battery, motor, motor controller are determined. The above-mentioned components are so selected that their features are well-suited for application. When UV rays strikes the PV cells in the solar panel, there occurs a chemical reaction between the layers of solar panel (p-n junction) which results into generation of electricity. Mostly, solar panels are made of Silicon as their parent compound which gives the overall efficiency around 15-20%.

II. METHODOLOGY

2.1 Working of the system:

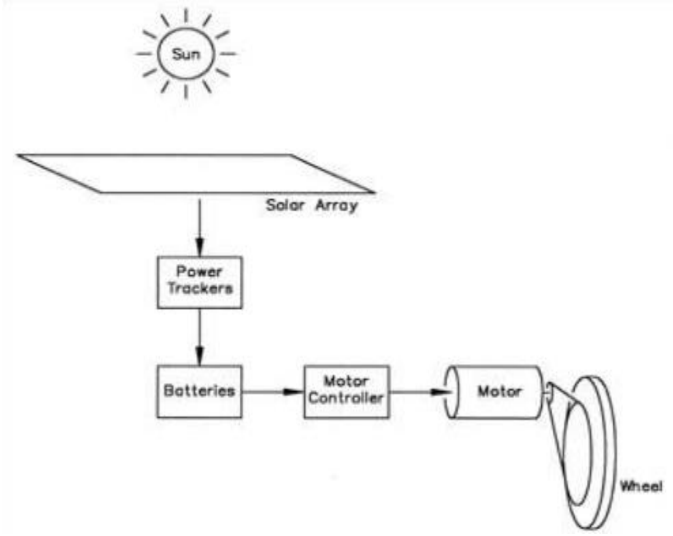

Figure 1: Block Diagram of System

When the sunlight falls on the PV panels, these panel convert the solar energy from sunlight to electric dc current. This dc current is used to charge the batteries of the system via power trackers. Power trackers basically just provide a proper and constant amount of current to charge the batteries. The motor is powered by the batteries through a motor controller. Motor controller provides the required amount of energy to the motor to run. The motor is further connected to the wheels that rotate when motor is driven. Here, we use the solar panel to charge the battery. The solar panel used in this project is of 250W polycrystalline solar panel. In solar panels by the principle of Photovoltaic effect, the PV modules generate electricity from rays absorbed. In construction of solar panels, the solar cells are prominently designed from the thin-film cells or wafer-based crystalline silicon cells. In addition to widely used rigid solar module, semi flexible solar panels are also available which are made from thin-film cells.

2.2 Mathematical formula for designing:

Table 1: - Mathematical formula for designing

MECHANICAL CALCULATIONS		
Sr. no	Formula	Description
1	$F_r = Cw = C*m*a_g$	F_r =Rolling Resistance Force C = Coefficient of Rolling resistance of road
2	$F_{Acc} = GVM * acceleration*\sin\alpha$	Acceleration Force = F_{acc} α = Angle of inclination with respect to the horizontal [Degrees]
3	$F_d = C_{d*\delta*A*V}^2$	Aerodynamic Force = Drag Force = F_d C_d = Drag coefficient δ = Density of Medium v = Velocity of object in m/sec A = Frontal area of the object
4	$F_t = F_r + F_d + F_{ACC}$	F_t = Summation of all forces

MOTOR CALCULATIONS		
5	$P_{req} = F_t * \frac{V}{\eta m}$	P_{req} = Power required
6	$\Omega_w = \frac{V}{C}$	Wheel rpm = Ω_w c = Circumference of the tyre
7	Ω_M = Gear ratio * Wheel rpm (Ω_w)	Required Motor rpm of system = Ω_M
8	$\dot{T} = r \times Ft$	Required Torque of system = $\dot{T}$ r = Radial distance

BATTERY CALCULATIONS	
Sr.no.	Formula
9	Volume of cell = Vcc = $\frac{\Pi * Battery\ cell\ diameter * Battery\ cell\ length}{4}$
10	Battery Cell energy = Battery cell capacity * Battery cell voltage
11	Battery cell energy density = $\frac{\text{Battery cell energy}}{\text{Battery cell mass}}$
12	Battery pack total energy = $\frac{\text{Motor voltage} * \text{Ampere drawn} * \text{Distance}}{\text{speed (kmph)}}$
13	Energy content of string = Cells in series * Energy of battery cell
14	No. of string of battery pack = $\frac{\text{Battery pack Total energy}}{\text{Energy content of each string}}$
15	Peak current = crate * Battery cell capacity
16	Battery pack peak current = Peak current * No. of strings of battery
17	Battery pack peak power = Battery pack peak current * Battery pack voltage
18	String continuous current = Crate * Battery cell capacity
19	Battery pack continuous current = String continuous current * No. of strings
20	Battery Pack continuous power = Battery pack continuous current * Battery pack voltage

SOLAR CALCULATIONS	
21	Solar output power = wattage of solar panel * avg. no. of hours of sunlight* 0.75(losses)
22	No. of hours of backup = $\frac{BATTERY\ SIZE * BATTERY\ VOLTAGE}{MOTOR\ POWER}$
23	Battery Charging current = 1/10th of battery rating

III. FIGURES AND TABLES

Table 2: - Values of rolling resistances on surfaces

Coefficient of rolling resistance (C_{rr})	**SURFACE**
0.001 – 0.0025	Steel Wheels on Steel Trails
0.0015 – 0.0025	Bicycle tyre on Concrete
0.006 – 0.01	Truck tyre on Asphalt
0.01 – 0.015	Car tyre on Concrete
0.03	Car tyre on Tar or Asphalt
0.2 -0.4	Car tyre on Loose sand
0.004	Bicycle tyre on Asphalt

Table 3: - Solar panel specification sheet

ELECTRIC CHARACTERISTICS		
i.	Model	GSMG - 250M
ii.	Max - power voltage (Vmp)	29.9 V
iii.	Max-power current (Imp)	8.43 A
iv.	Open- circuit voltage (Voc)	37.73 V
v.	Short-circuit current (Isc)	8.98 A
vi.	Max-power (Pm)	250 W
OPERATING CONDITIONS		
i.	Operating Temperature	-40~+85 C
ii.	Maximum System Voltage	DC 1000V.
MECHANICAL CHARACTERISTICS		
i.	Tolerance	+ - 3%
ii.	Cell	Polycrystalline solar cells
iii.	Dimension	1640*990*35mm
iv.	Glass type	Low Iron, tempered glass,3.2mm thickness
v.	No. of cells	60(6x10) solar cells
vi.	Junction box	IP65

Table 4: - Features of solar panel

Sr. no.	Features of solar panel	Description
1.	High module Conversion efficiency	Up to 15.6% through super cell technology and leading manufacturing capability
2.	Positive Tolerance	Guaranteed positive tolerance 0/+5% ensures reliable power output.
3.	Self-clean Effect	Anti-reflective, hydrophobic layer improves light absorption and reduces surface dust
4.	Excellent weak light performance	- Excellent performance under low light environments to capture early morning and late evening sunlight

IV Conclusion

From this project we can save the energy wasted during braking by regenerative braking and that energy can be reused for charging the battery. Similarly, while driving in day light, the output from solar panel will also be charging the battery, and thereby increase in the range of the vehicle. In addition to charging by solar assist, this vehicle offers regenerative braking which results into recharging of the battery by a certain amount. The lower operating and environmental costs of a vehicle with Solar as an auxiliary Source regenerative braking system should make it more attractive than a conventional one. The traditional cost of the system could be recovered in the few years only. In comparison with mechanical braking, regenerative braking is very efficient because of no heating and zero combustion required for energising the braking system. Application of Regenerative braking in electric vehicles has a wide scope for future growth and technological development thereby encouraging the energy savings. These systems are used in developing countries like India wherever buses are the preferred means that of transportation within the cities.

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