

SATHYABAMA SOLAR BASED ELECTRIC VEHICLE

Submitted in partial fulfilment of the requirements for the award of
Bachelor of Engineering Degree in Electrical and Electronics Engineering

By

ANUSURI SUBRAHMANYAM (Register No. 37140010)

D SIVA SUBRAHMANYAM (Register No. 37140023)

S VIJAY KUMAR (Register No. 37140952)



SCHOOL OF ELECTRICAL AND ELECTRONICS ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade "A" by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **ANUSURI SUBRAHMANYAM (Register No. 37140010)**, **D SIVA SUBRAHMANYAM (Register No. 37140023)** and **S VIJAY KUMAR (Register No. 37140952)** carried out the project entitled "**SATHYABAMA SOLAR BASED ELECTRIC VEHICLE** " under our supervision from December 2020 to April 2021.

Dr. A. RAMESH BABU
Internal Guide

Dr. V. SIVACHIDAMBARANATHAN
Head of the Department

Submitted for Viva voce Examination held on _____

Name:

Signature:

Internal Examiner

External Examiner

DECLARATION

We **ANUSURI SUBRAHMANYAM (Register No. 37140010)**, **D SIVA SUBRAHMANYAM (Register No. 37140023)** and **S VIJAY KUMAR (Register No. 37140952)** hereby declare that the Project Report entitled “**SATHYABAMA SOLAR BASED ELECTRIC VEHICLE**” done by us under the guidance of **Dr. A. RAMASHBABU** sir is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering degree in Electrical and Electronics Engineering.

1. *D. Siva Subrahmanyam*
2. *Anusuri Subrahmanyam*
3. *S. VIJAY KUMAR*

DATE:

PLACE:

SIGNATURE OF THE CANDIDATES

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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 project is to construct an efficient solar car, for the daily use commuters of Satyabhama so that they can travel a fixed distance that they need to commute every day on a reliable and economical car that essentially runs on free renewable solar energy. The Project 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.

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List of symbols

Symbol	Quantity	Unit
PV	Photovoltaic	N
W	Watt	J/s
kW	Kilowatt	1000 J/s
V	Volt	
Φ	Karlskona latitude	°
δ	Declination angle	°
τ	Hour angle	°
h	Solar elevation	°
γ	Solar azimuth	°
τ_{θ}	Sunrise and sunset hour angles	°
T	Duration of sunshine	h
n	The number of days in a year	day
Z	The installation inclination angle of the PV array	°
l	The distance between the solar PV arrays	cm
C_{OP}	The output capacity of each PV array each day	Ah
C'_{PV}	The value of the generation of all solar PV arrays each day	Ah
V_{PV}	The work voltage of the solar PV array	V
G'_{PV}	The generation of the all PV arrays	kWh
Cw	Capacity of battery pack	Wh
d	Continuous days without sunlight	Number of days
D	Depth of the storage batteries discharge level	%
F	Amending coefficient of discharge	

CHAPTER 1

INTRODUCTION

1.1 GENERAL INTRODUCTION

The quests for a constant, safe, easy, environmental-friendly fuel are in no way-ending. Carbon-based totally fuels, which include fossil fuels, are unsustainable and risky to our surroundings. Some of the options are renewable power resources which include all fuel kinds and strength carriers, exclusive from the fossil ones, together with the sun, wind, tides, hydropower and biomass. among these elements, solar energy is preferred for the reason that it could provide the cleanest sustainable power for the longest duration of time – the following few billion years. Photovoltaic production will become double each year's, growing by means of a median of forty eight percentage each 12 months when you consider that 2002. Due to its innumerable blessings in environmental, monetary and social components PV systems have turns into the arena's fastest developing energy technology. it is able to arguably be stated that the simplest difficulty to solar power as a strength supply is our know-how of growing efficient and price effective generation that can implement it.

Nothing on this planet is freed from value; however what if we should discover a way to put into effect loose rides? indeed it would be top notch if our cars could hold to run without us having to spend billions on fossil fuels each 12 months and to deal with natural dangers that their combustion leave behind. If we may want to force a sun-powered car, that automobile dream could come genuine. sun motors would harness electricity from the sun via solar panels. A sun panel is a packaged, linked assembly of sun cells, also known as photovoltaic cells which can be solid country devices which could convert sun power without delay into electric electricity thru quantum mechanical transitions. They are noiseless and pollution-loose without a rotating part and want minimum protection. The power as a result generated could then fuel the battery that would run the auto's motors. Therefore, we might acquire an electrically pushed vehicle that would travel on "unfastened" electricity without a dangerous emission, which could utilize its full energy at all speeds, and could have little or no protection fee.

1.2. LITERATURE SURVEY

Xiujuan, et al [1] explained the advantage of electric vehicle is that the electric vehicle has zero discharge, low noise and wide source for energy supplement the transformation efficiency of the photovoltaic cell plate is very low (i.e.) 14% because of strong maneuverability the working environment of the solar car changes frequently algorithm of max power point tracking should be increased to get high transformation efficiency condition At present, the common maximum power point tracking methods are the constant voltages tracking method, the perturbation and observation control and the conductance increment method. The tracking accuracy of the conductance increment method is the best among them. It achieves the tracking of the maximum power point.

It is obvious that the output power varying different area when we change the working voltage in the area of constant current source the sensitivity is low and in constant voltage load the sensitivity is obvious so the tracking method should be improved In order to improve the accuracy of the maximum power point tracking, when the temperature and the light intensity are definite, and the output power of the photovoltaic cell is close to the maximum power which is the most at the current condition same extent, the tracking step length will be properly lessened , in order that the maximum power point can be tracked more accurately Rattankumar, V, and N. P. Gopinath[2] Keeping the fact that there is no future fossil fuel we had think of using non conventional energy in effective manner.

We have overcome many disadvantage of normal car such as minimizing Coupling losses, BLDC minimizes field losses, smooth handling of speed and fuel cost is minimized .The major parts used while manufacturing a solar car are Photovoltaic module, Solar tubular batteries, BLDC, Ackerman steering, Mechanical structure and MCB .Some of the accessories of solar car are Ackerman steering, Mechanical structure, Miniature Circuit Breaker. At present, the designed solar car runs at a speed of 30Km/Hr for one charging which takes approximately 18 hours and successfully tested for 100Km per charge. Further work is in process to develop the vehicle with Reluctance motor as now it is run by BLDC. It is also proposes to use solar panels of higher efficiency with minimal size. Various

drawbacks of the vehicles are studied and steps are in process to eliminate them, hoping that a successful commercial model of solar car will be developed in the future.

1.3. SCOPE OF THE PROJECT

The scope of the challenge entails designing and constructing a proto-type solar powered easy automobile that could be inexpensive, reliable and environmentally pleasant. The specs of the motor driving the automobile is calculated primarily based at the intended preferred velocity and acceleration to be performed. this could in turn assist calculate the battery potential and sun panel wattage required to tour the desired maximum round trip distance of Satyabhama main gate to Department on solar strength by myself. A fee controller with the option of addition charging from AC traces, and a motor controller to manipulate the rushing and direction of movement of the automobile is designed. The chassis of the auto is constructed with key components which includes suspension gadget, a rack and pinion steerage gadget, drum breaking device all positioned into place. Subsequently an aerodynamic outer frame shape is proposed.

1.4 MOTIVATION

1.4.1 POLLUTION

The earth is suffering as a result of the destruction wreaked upon it by using humanity. Whether or not it's far the pesticides contaminating the rivers, chemical compounds from factories polluting the seas or the exhaust fumes from motors and industries polluting the air, the systematic destruction of our different ecosystems everywhere in the world have caused a dreadful mess. Our most important cognizance is on the transportation industry that's the second largest supply of pollutants and health hazards.

the arena where the roads congested with vehicles bombard the limitless hordes of human beings streaming past at the pavements with deafening noise and toxic exhaust fumes from burning gasoline in particular throughout top office hours when vehicles caught in visitors produce an increasing number of harmful emissions. As a

result, heaps of human beings are getting victims of coronary heart and lung issues, despair, reminiscence loss, asthma or even untimely deaths

1.4.2GLOBALWARMING

Certainly, individuals want to become greater privy to the outcomes in their moves and might help guard the earth by using the use of an alternative technique of transport, possibly the solar automobile, an eco-friendly, easy, inexpensive, compact vehicle, impartial of fossil fuels and toxic emissions. This electric powered vehicle may additionally in reality be a prime step in reducing traffic congestion, noise and car emissions on the road.

Solar cars might no longer make a contribution to global warming or to the manufacturing of CO₂.consequently this will lessen greenhouse gas emissions as CO₂ is the primary greenhouse gasoline and thereby decrease human health dangers. they will price 4 instances much less than fuel-based totally cars considering the fact that apart from the preliminary cost of the foremost components of installation for instance the sun panels, charge and motor controllers, there could be no more routine fees as sun power is sincerely loose. If the government and plenty of transportation industries can take the initiative to provide the fund for the research and development of the generation to provide solar energy and for that reason to the manufacturing of solar automobiles at a big scale, the usage of this modern vehicle will gain us all

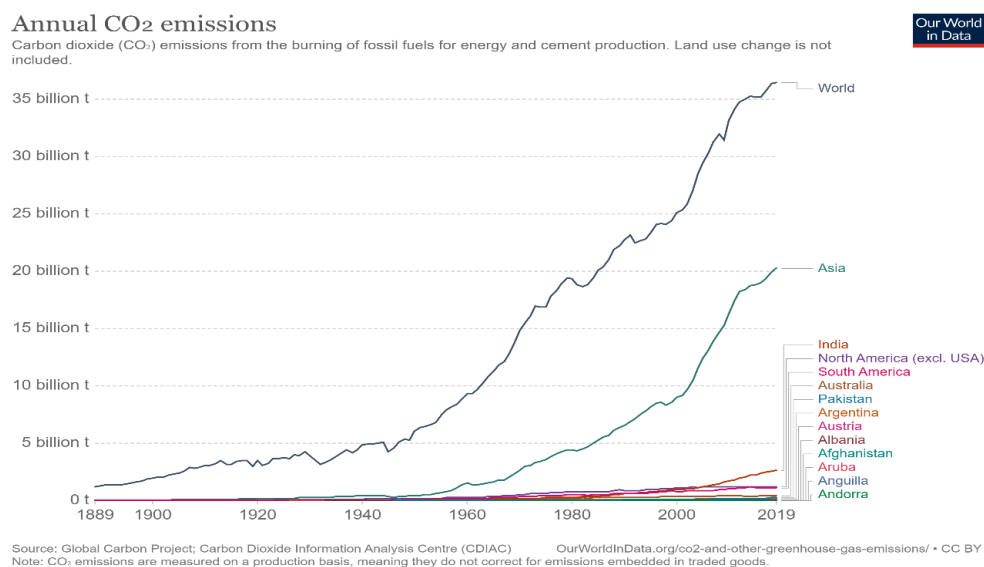


Fig no.1.1 CO₂ Annual emission

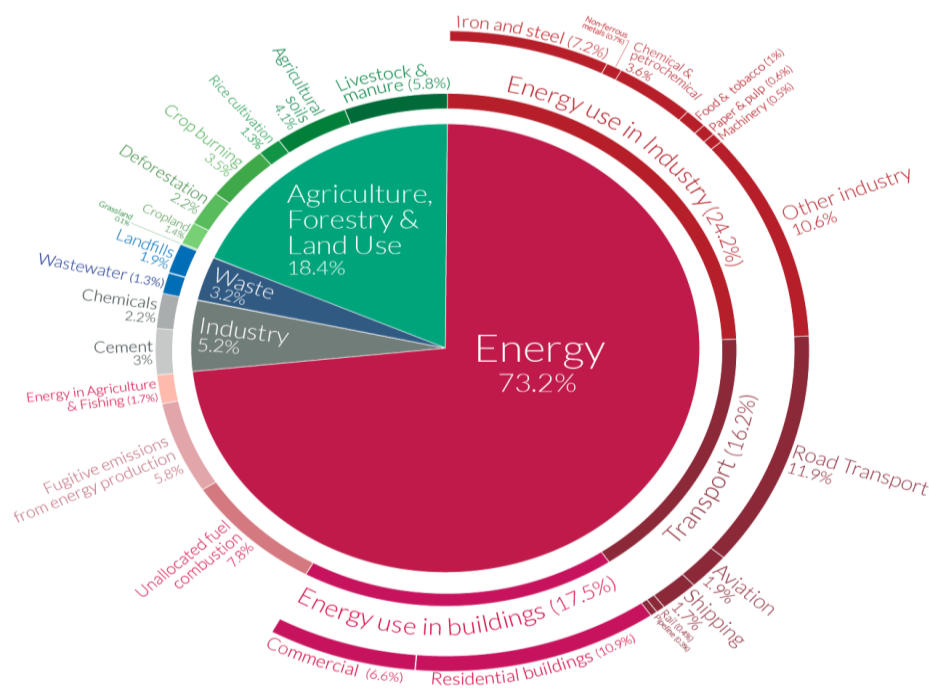


FIG 1.2: CO₂ Emission by Various Sectors

The CO₂ of the world is raising at an extremely alarming rate. The conventional cars' exhaust fumes today are one of the biggest contributors to the atmospheric CO₂. As illustrated in *FIGURE 1.2*, the global warming resulting from this causes global temperatures to increase and consequently raises the sea levels as well.

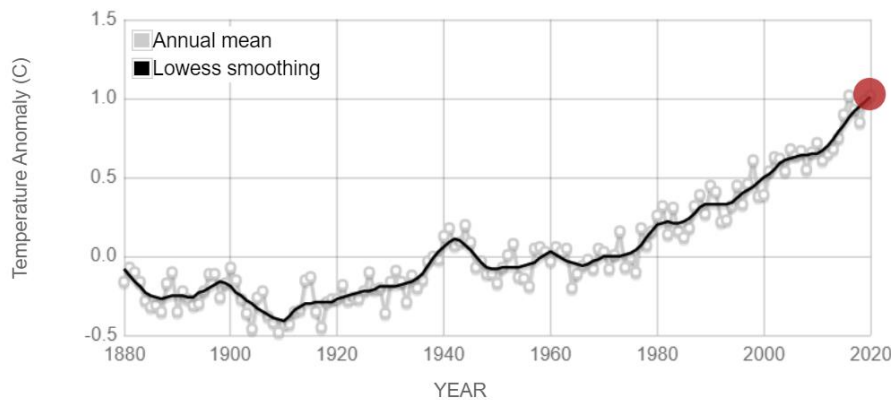


FIG 1.3: World temperature trend

This graph illustrates the change in global surface temperature relative to 1951-1980 average temperatures. Nineteen of the warmest years have occurred since 2000, with the exception of 1998. The year 2021 tied with 2016 for the warmest year on record since record-

keeping began in 1880 (source: [NASA/GISS](#)). This research is broadly consistent with similar constructions prepared by the climatic Research Unit and the National Oceanic and Atmospheric Administration.

The time series below shows the five-year average variation of global surface temperatures. Dark blue indicates areas cooler than average. Dark red indicates areas warmer than average.

The “Global Temperature” figure shows global temperature change since 1880. One gets this number by subtracting the first data point in the chart from the latest data point to 2021

1.4.3 FUEL PRICES

Fuel-based automobiles no longer only threaten the very air we breathe in but additionally the price of strolling and retaining them are massive and overbearing, and as the fossil fuels are gradually being depleted, the value of those constrained scare resources, the present fuels' fees are continuously growing.

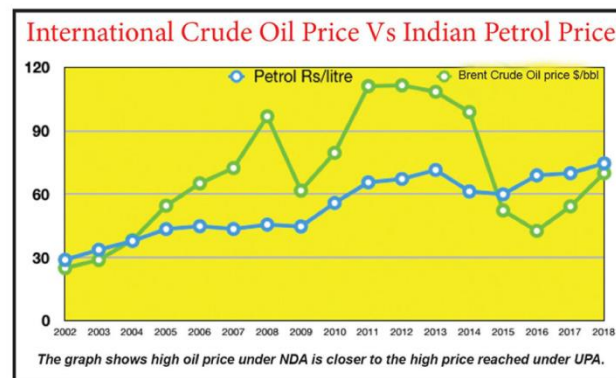


FIG 1.4 Fuel prices and trends

1.5 PROJECT OBJECTIVE

The goal of this mission is to construct a sun automobile to allow transport for human beings touring a certain amount of distance every day, for example, the workplace commuters of Sathyabhama with really no value as it will run off free renewable solar energy, moving to this eco- friendly car would be useful on an enormous scale.

The automobile might be capable of shuttle thoroughly a maximum spherical journey distance of 35km for example from Sathyabhama, that's taken into consideration to be one in every of the biggest office traveling distances in electrical department. Calculations proven later

prove that this is without problems feasible. The proto-type solar powered car to be designed and built specially for the each day workplace goers of Dhaka metropolis might be light-weight, easy, surroundings pleasant and absolutely unbiased of fossil fuels.

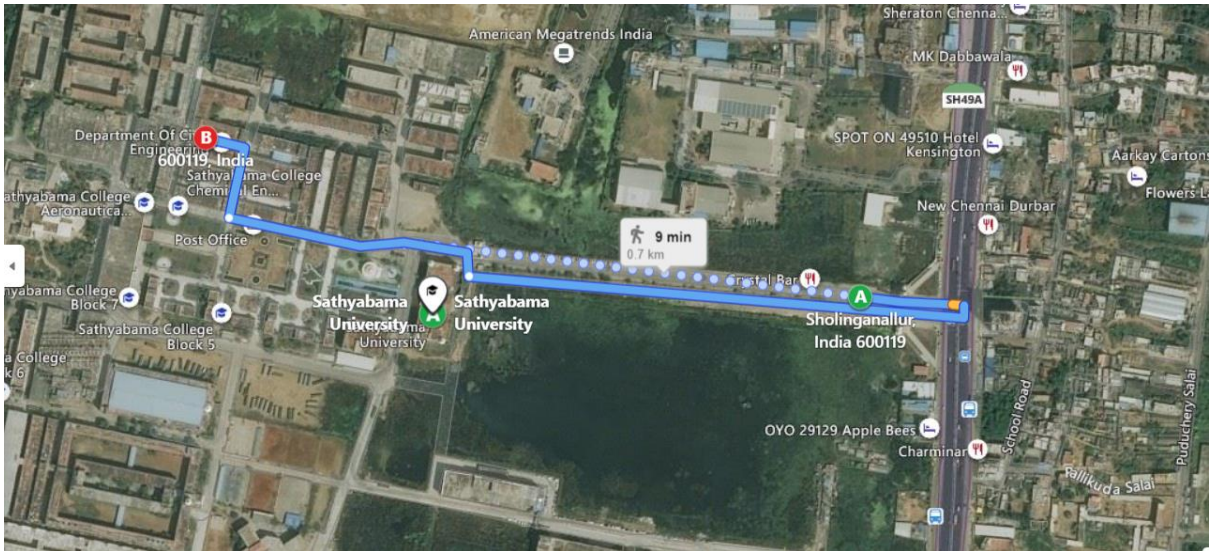


FIG 1.5 Google map of Sathyabama Institute Of Science and Technology

1.5.1 PROJECTOVERVIEW

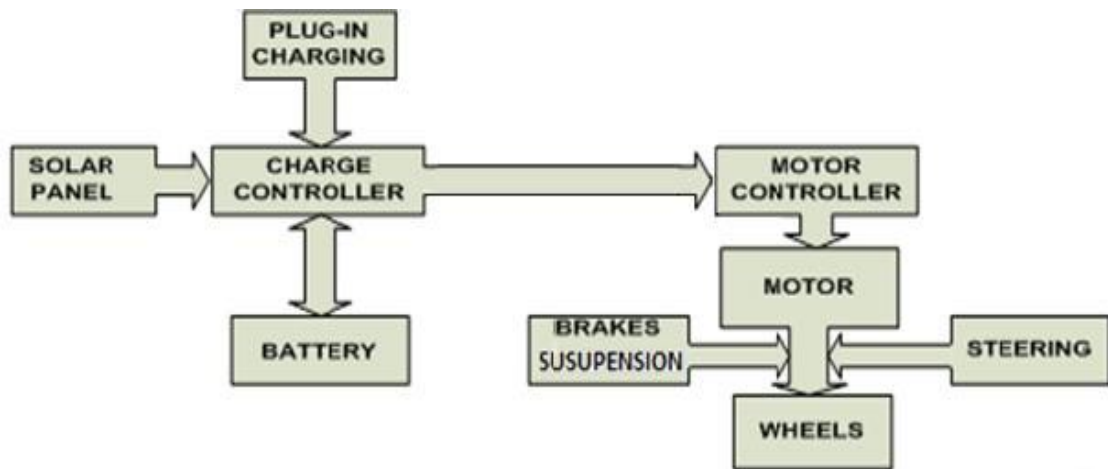


FIG 1.6 System architecture of the solar car

According to the block diagram in **FIG 1.6**,the solar car system may consist of 9 main parts.

1.7 SOLAR PANEL

Sun cars are powered by means of the sun's strength ergo solar panels are the maximum essential part of a solar automobile since they're solely responsible for amassing the Solar's strength. The sun panels used on this challenge are mono crystalline and flexible. They can be established and outfitted on pinnacle of the car or at the bonnet comfortably thanks to their skinny semi-flexible nature.

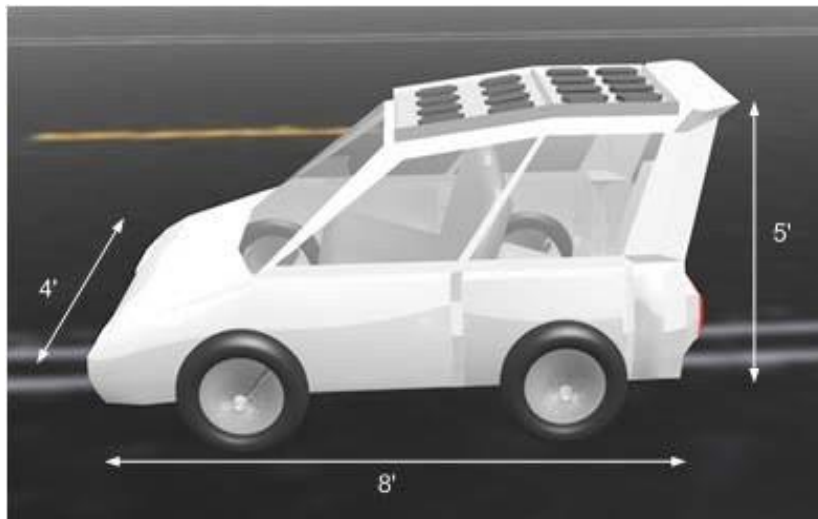


FIG 1.6 3D model of the Solar Car

1.7.1 BATTERIES

The sun panels will accumulate strength from the sun and convert it into usable electric energy, which in turn will be stored inside the lead acid batteries to be furnished to the motor whilst important.

1.7.2 CHARGECONTROLLER

The batteries are connected to a charge controller in an effort to ensure healthy lifestyles of the batteries with the aid of stopping it from over charging and over discharging. A microcontroller within the price controller is programmed to hit upon the voltages at the battery

terminal and/or the sun panel terminals and for that reason decide what charging cutting-edge the battery wishes to be supplied

1.7.3 PLUG-INCHARGING

A important factor right here is that the price controller could be available with a further enter that can be used to fee the batteries from an AC energy deliver (genuinely by plugging in). hence the sun automobile could have this plug-in charging system to be used while there is not sufficient sunshine because of fog, cloud or rain. This provision for an outside plug-in system to charge the batteries from the conventional AC power deliver will allow the car to growth its normal application.

The motor used is a DC-series excitation motor that is rated at 1 kW, 60V, 23 A. This DC-series motor is enough to get the car up and going for walks as will be shown in details later. The motor controller is designed to manipulate the speed of rotation of the motor as well as the direction of its rotation. In different phrases, it determines the automobiles velocity and forward/reverse path of movement of the wheels.

1.8 PROBLEM SOLVING

1.8.1ELECTRIC VEHICLE RATING CALCULATIONS

Solar motors in comparison to inner combustion engine cars are simpler in that they have few fundamental components. However, being an electrical system makes specific calculations of the scores of these fundamental additives of the car vital on the layout degree. The rankings of the three important additives of the car so one can be determined are

- The motor strength score required to obtain the vital velocity and acceleration.
- The battery potential which can assist the distance required to be travelled. The sun panel specifications needed to keep the battery sufficiently charged for the adventure.

The strength rating of the motor will determine the battery capacity i.e. Ampere-hour charge and voltage needed to triumph over the most distance that the solar automobile will tour on sun strength alone. therefore, this in flip will determine the panel wattage required to preserve the battery price.

1.8.2 MOTOR POWER RATING:

The strength needed to propel a vehicle may be determined by using combining the forces that desires to be applied to the car to move it with the car speed at which this propelling pressure must be sustained. The drive torque generated through the motor for the wheels produces a drive force on the tire/street touch - it is this drive pressure that moves the automobile. On the layout level it is less difficult to border the calculation around this power force opposed to the pressure torque. Therefore, the calculations in this phase start by way of determining the scale of this pressure, and given a hard and fast of speed at which the vehicle should pass, the force electricity is observed.

The overall force pressure that has to behave on the vehicle to make it circulate (or keep it moving) may be anticipated through including together individual force additives that stand up from different bodily effects. Those are pressure to conquer the rolling resistance of the wheels on the drive surface, force to overcome aerodynamic drag and force to accelerate the vehicle's mass. There can be other effects but those are typically the principle ones. These opposing forces are accounted for as follows:

1.8.3 THE ROLLING RESISTANCE

The rolling resistance force is the pressure resisting the rolling motion of the tires as they roll over the street surface. Factors that make contributions to rolling resistance are the (quantity of) deformation of the wheels, the deformation of the roadbed surface, and motion under the floor. Extra contributing factors encompass wheel diameter, pace, load on wheels etc. as an instance, a rubber tire will have better rolling resistance on a paved street than a metallic railroad wheel on a metal rail. In addition, sand on the ground will supply 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. μR is the coefficient of rolling resistance and is a constant that relies upon at the form of tires of the car and the floor on which it will roll. Thicker tires with wider treads, even though desirable for adhesion, but produce greater rolling resistance. To conserve power sun cars need to use thinner tires. Also more difficult surfaces provide lower rolling resistance force than softer ones. Some well known values are shown as follows:

μ_R	Description
0.0003 to 0.0004	“Pure rolling resistance” Railroad steel wheel on steel rail
0.0010 to 0.0024	Railroad steel wheel on steel rail. Passenger rail car about 0.0020
0.001 to 0.0015	Hardened steel ball bearings on steel
0.0022 to 0.005	Production bicycle tires at 120 psi (8.3 bar) and 50 km/h (31 mph), measured on rollers
0.0045 to 0.008	Large truck (semi)tires
0.010 to 0.015	Ordinary car tires on concrete
0.0385 to 0.073	Stage coach (19th century) on dirt road. Soft snow on road for worst case.
0.3	Ordinary car tires on sand

TABLE 2.2.1: coefficient of rolling resistance μ_R of different wheels/surface

1.6.4 AERODYNAMIC DRAGFORCE

The aerodynamic drag force may be expressed as,

$$F_{\text{DRAG}} = \left[\left(\frac{1}{2} \right) \cdot C_D \cdot A_{\text{cross}} \cdot \rho \cdot (V)^2 \right]$$

Where in C_D is the coefficient of drag of the automobile, across is its frontal place in square ft

EXISTING SYSTEM AND PROPOSED SYSTEM

To complete the simulation, the integrated power flow model is necessary to compute and update the rate of energy going in and out of battery cells, accessories, the motor, gearing components, and wheel to the road and back. Therefore, the model needs to be capable of mathematically simulating the power flow in both driving and braking as shown

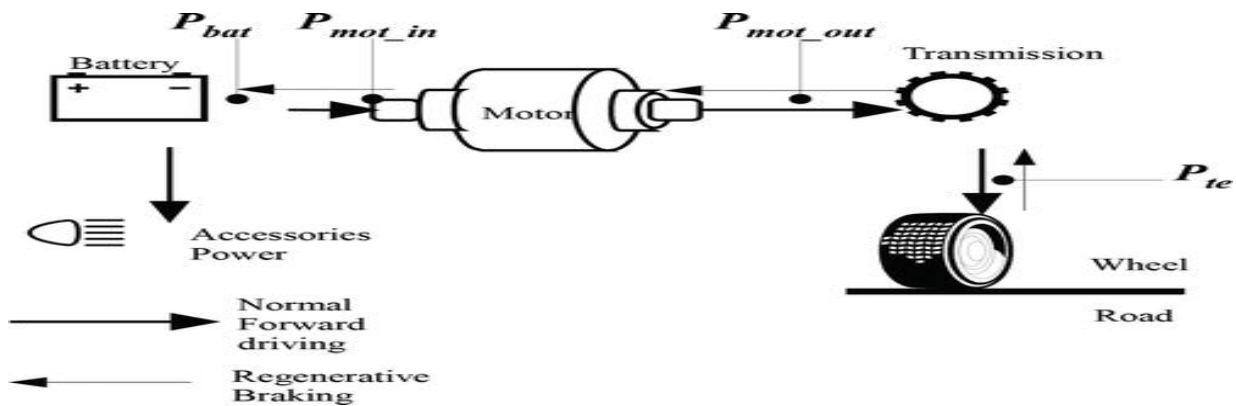


FIG2.2 GENRAL BATTERY CAR

Diagram show power flow in/out components within the EV system for both normal forward driving and regenerative braking operations

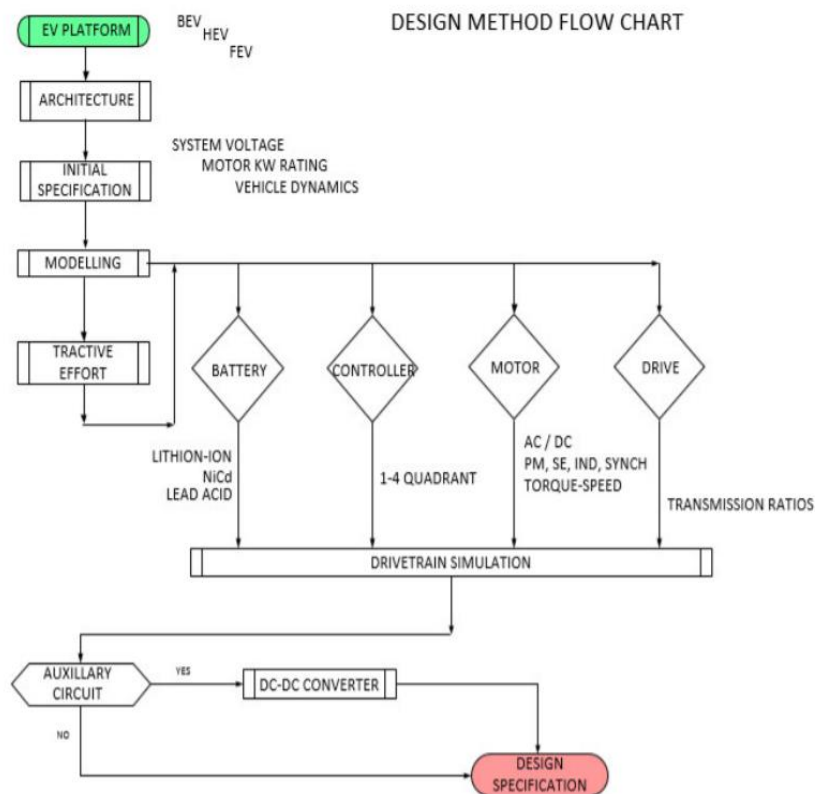


FIG 2.3 FLOW CHART OF EV CAR

2.2.1 General EV Setup

EVs can have different configurations as shown in [4]. Figure 11a shows a front-engine front wheel drive vehicle with just the ICE replaced by an electrical motor. It has a gearbox and clutch that permits high torque at low speeds and low torque at high speeds. There is a differential as well that allows the wheels to rotate at different speeds. Figure 11b shows a configuration with the clutch omitted. It has a fixed gear in place of the gearbox which removes the chance of getting the desired torque-speed characteristics. The configuration of Figure 11c has the motor, gear and differential as a single unit that drives both the wheels. The Nissan Leaf, as well as the Chevrolet Spark, uses an electric motor mounted at the front to drive the front axle. In Figure 11d,e, configurations to obtain differential action by using two motors for the two wheels are shown. Mechanical interaction can be further reduced by placing the motors inside the wheels to produce an 'in-wheel drive'. A planetary gear system is employed here because advantages like high speed reduction ratio and inline arrangement of input and output shafts. Mechanical gear system is totally removed in the last configuration (Figure 11f) by mounting a low-speed motor with an outer rotor configuration on the wheel rim. Controlling the motor speed thus controls the wheel speed and the vehicle speed. EVs can be built with rear wheel drive configuration as well. The single motor version of the Tesla Model S uses this configuration (Figure 12). The Nissan Blade Glider is a rear wheel drive EV with in-wheel motor arrangement. The use of in-wheel motors enables it to apply different amount of torques at each of the two rear wheels to allow better cornering.

2.3 PROPOSED SYSTEM

The electrical wiring system of the solar automobile is honestly a electric conversion or wiring anatomy in lieu of a traditional engine driven vehicle. In electric system it interconnects the motor, motor controller, tools container, acceleration pedal, batteries, charger, panel and in conjunction with its key protection high electricity and occasional strength instrumentation and protection dimension components. determine 8.1 indicates the gadget at a look.

The electrical device divided into two fundamental elements.

- excessive-Voltage, excessive-present day power machine
- Low-Voltage, Low-present day Instrumentation gadget

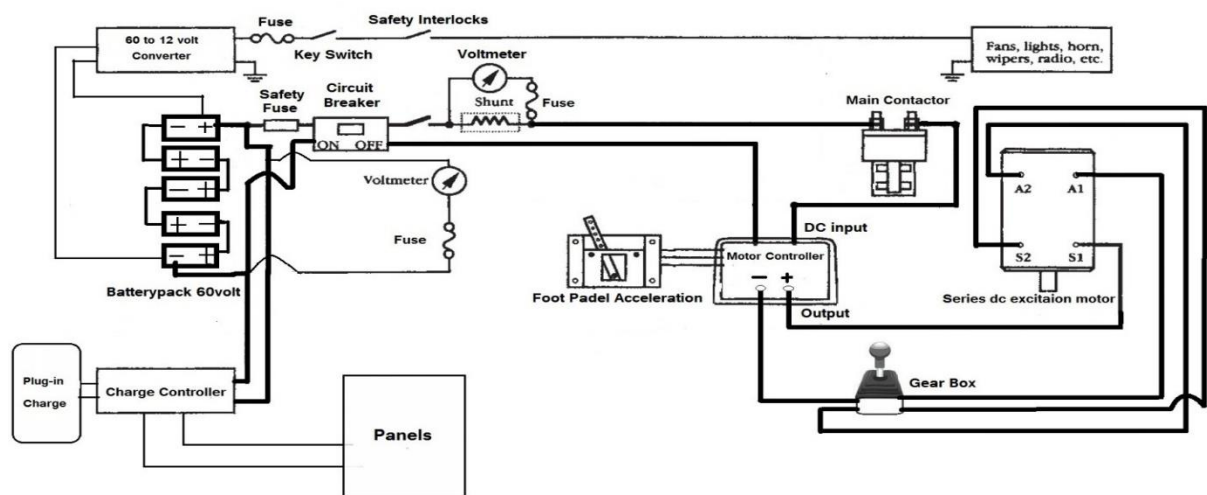


FIG 2.3.2: Solar Car Wiring Diagram

The formidable and thick traces in discern 8.1 denote the high-present day connections. In this component motor controller, motor, battery and tools container are the primary components to be prepared in sun car. Other than those some protection contraptions and voltage-cutting-edge reading circuitry is also linked. In the following section the excessive-current components are discussed in element.

2.3.1 MOTOR CONTROLLER:

The motor controller lets in the motor to rotate at exceptional velocity; it takes the enter from the battery and gives output for motor. The controller used inside the solar car has an enter

and output score of 48 to 60 volt and has a present-day score of max 30 ampere. There are outputs from the motor controller, one for the acceleration pedal and other for the motor. The inner circuitry for acceleration manipulates similarly converts the input voltage into low modern-day system.

2.3.2 Maximum Power Point Tracking

Maximum power point tracking control technique is used mainly to extract maximum capable power of the PV modules with respective solar irradiance and temperature at particular instant of time by Maximum Power Point Tracking Controller. A number of algorithms are developed to track the maximum power point efficiently. Most of the existing MPPT algorithms suffer from the drawback of being slow tracking, due to which the utilization efficiency is reduced

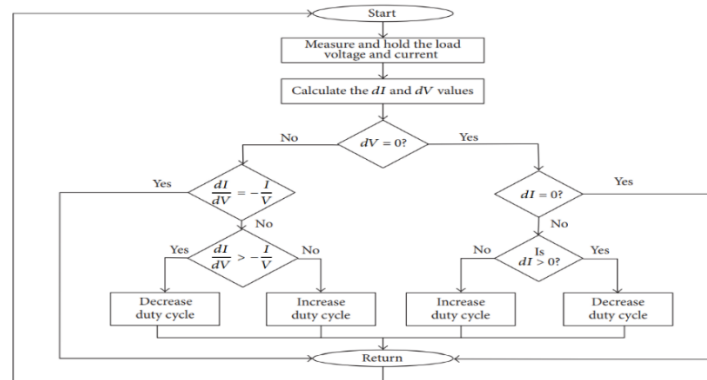


FIGURE 6: Flowchart of IC algorithms for MPPT.

2.3.3 Issues/Challenges of PV System

Although solar energy is an infinite energy source derived from the environment, its supply is intermittent; yet its availability is less than predictable and is outside human control as compared to conventional power plants. Continuous research and development are going on to meet the challenges pertaining to solar power generation, namely, high initial cost, variability, requirement of space for PV panel installation, and less efficient energy conversion to name a few.

Solar power is not always available where and when needed. Unlike conventional sources of electric power, solar resources are not dispatchable; the power output cannot be controlled. Daily and seasonal effects and limited predictability result in intermittent generation. This poses many challenges for the grid integration.

CHAPTER 3

Simulation Specification

3.1 EXISTING SYSTEM SIMULATION

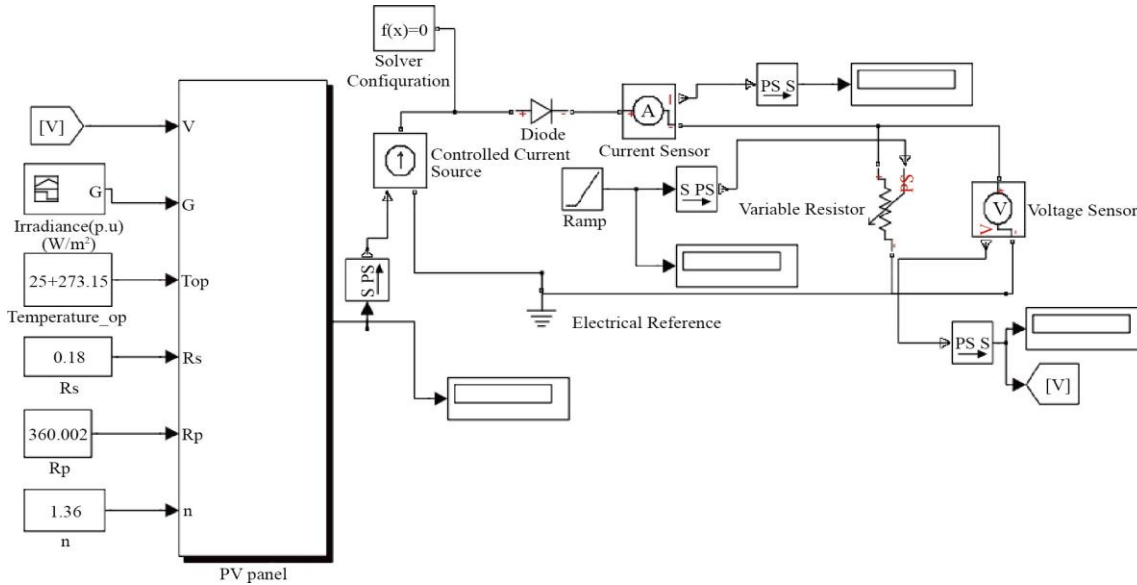
The simulation model developed in MATLAB/Simulink is presented in figure 2. A 4 kW induction motor is selected as drive. Hence, Solar PV system for 4kW is designed. A solar PV string consists 16 solar PV panels of 250 W (ASW-250P) is built. The electrical specification of solar PV module is given in Table 1. The DC-DC converter is designed to produce DC output of 816V at 4kW. The design procedure presented in [8] is followed to design the converter. The switching frequency f_s of DC-DC Boost converter is 10 kHz. The components values are calculated as follows $L=8.1$ mH, $C=10\mu\text{F}$.

Table 1. Electrical Specification of Solar PV Module

Parameters	Unit	Value
Power at STC	W	250
Power at PTC	W	227.8
Vmp: Voltage at Max Power	V	35.2
Imp: Current at Max Power	A	7.1
Voc: Open Circuit Voltage	V	43.22
Isc: Short Circuit Current	A	7.76
Nominal Operating Cell Temp	°C	43.5
Open Circuit Voltage Temp Coefficient	% / °C	-0.303
Short Circuit Current Temp Coefficient	% / °C	0.035

PV panels has non-linear characteristics and the power generated by PV varies depends on the change in weather conditions [9]. Figure 3 and Figure 4 shows the

V-I and V-P characteristics of 4kW PV string under different irradiation level respectively. The power output of PV string is 4000W at 25 °C and 1000 W/m².



3.2 PROPOSED SYSTEM SIMULATION

Modeling of Solar Cell

A solar cell is the building block of a photovoltaic panel. A photovoltaic panel is developed by connecting many solar cells in series and parallel. A single photovoltaic cell can be modeled by utilizing current source, diode and two resistors as shown in

The equation for a photovoltaic cell is given by

where I & V : Photovoltaic cell output current and voltage;

I_{os} : PV cell reverses saturation current;

T : Solar cell temperature in Celsius;

k : Boltzmann's constant, 1.38×10^{-19} J/K;

q : Electron charge, 1.6×10^{-23} C;

K_i : Short circuit current temperature coefficient at I_{scr} ; λ : Solar cell irradiation in W/m²;

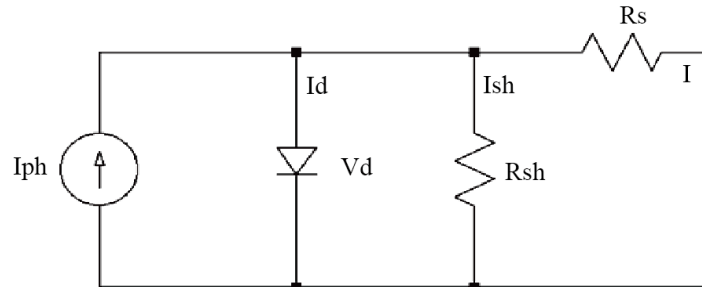
I_{scr} : Short circuit current at 25 degree Celsius;

I_{lg} : Light-generated current; E_{go} : Band gap for silicon; A : Ideality factor;

T_r : Reference temperature;

I_{or} : Cell saturation current at T_r ; R_{sh} : Shunt resistance;

R_s : Series resistance.;



It can be seen that the photovoltaic cell operates as a constant current source at low values of operating voltages and a constant voltage source at low values of operating current. Electrical specifications of solar panel are: open circuit voltage: 32.6 V, short circuit current: 8.5A, total no of cells in series: 72 and solar cell temperature: 30 degree Celsius. SIMULINK model of the photovoltaic panel is shown

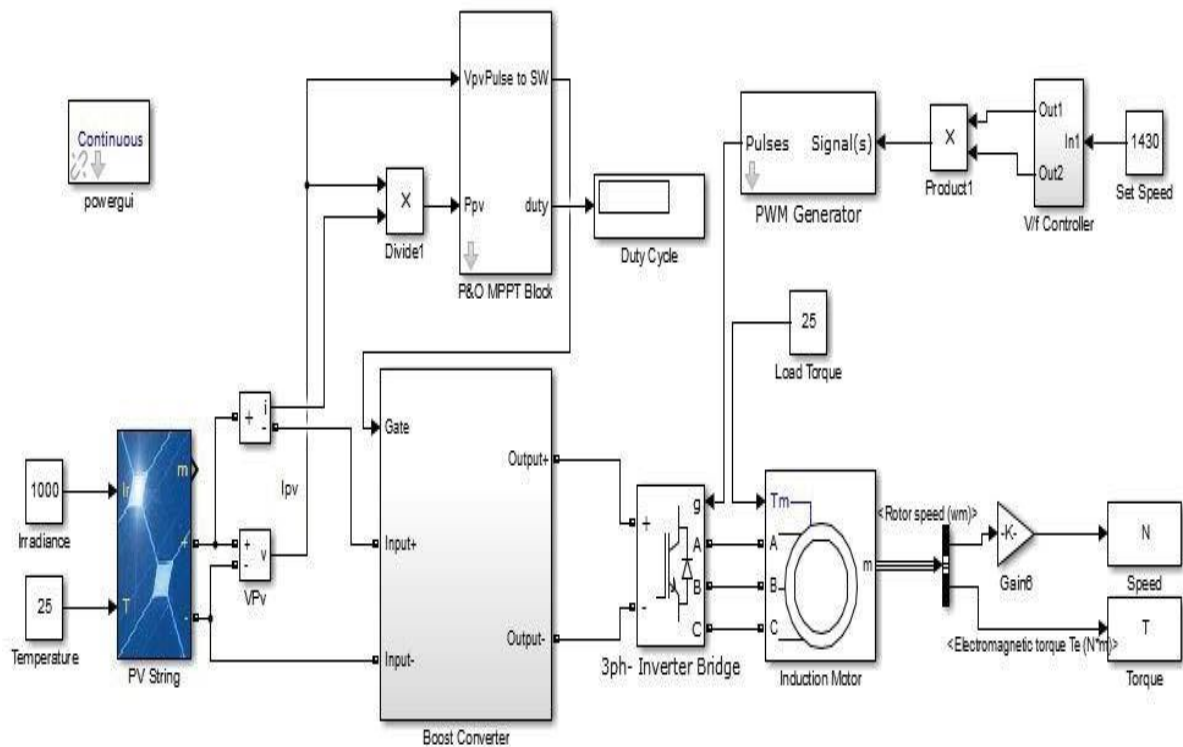


FIG3.2 SIMULATION OF THR BATTERY CAR WITH SOLAR PANNELS

The P-V output characteristics with varying irradiation at constant temperature are shown in _The I-V output characteristics of PV module with varying irradiation at constant temperature are shown _ When the irradiation increases, the current output

increases and the voltage output also increases. This results in net increase in output power with increase in irradiation at constant temperature.

The P-V output characteristics with varying temperature at constant irradiation are shown in _The I-V output characteristics of PV module with varying temperature at constant irradiation are shown in _ When the operating temperature increases, the current output increases marginally but the voltage output decreases drastically results in net reduction in power output with rise in temperature.

Fig:3.5 Proposed System Simulation circuit

Fig 3.5.1 P-V characteristics of a typical PV module for varying solar irradiance.

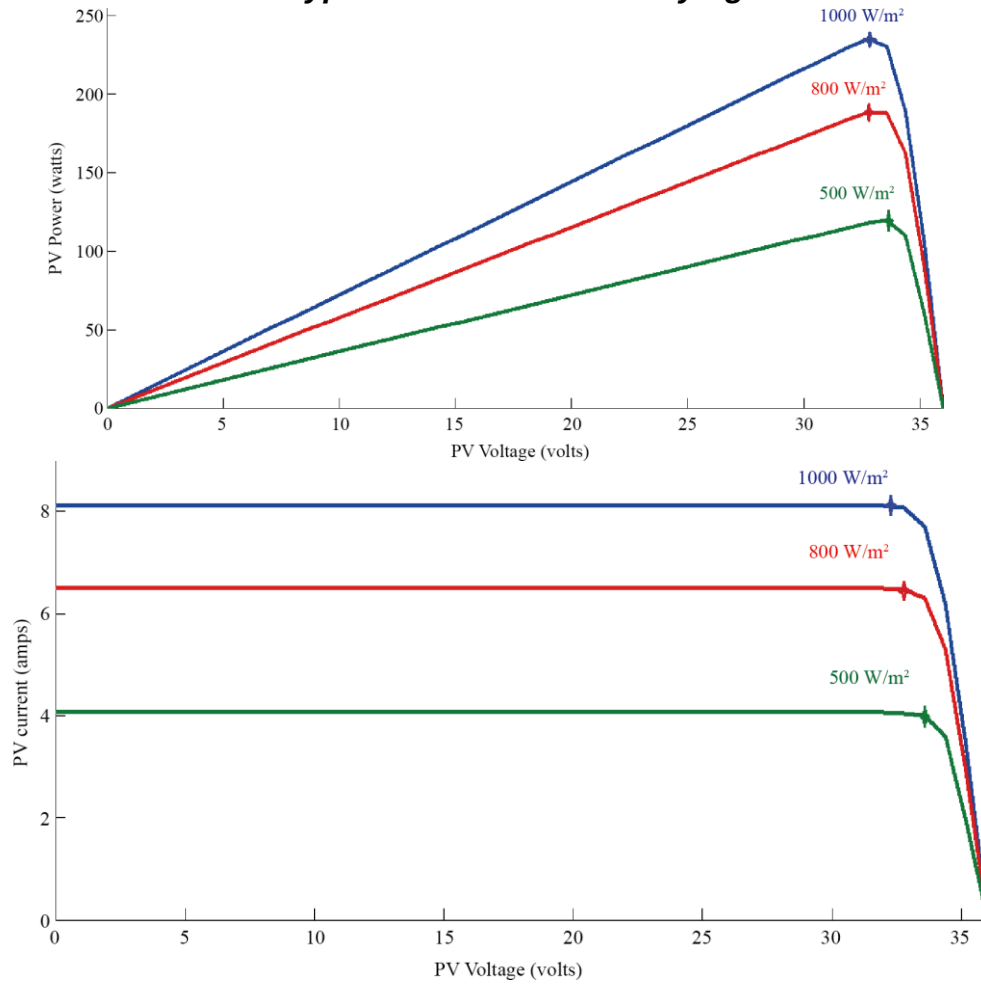


Fig 3.5.1. I-V characteristics of a typical PV module for varying solar irradiance.

Fig 3. 5. P-V characteristics of a typical PV module for varying temperature.

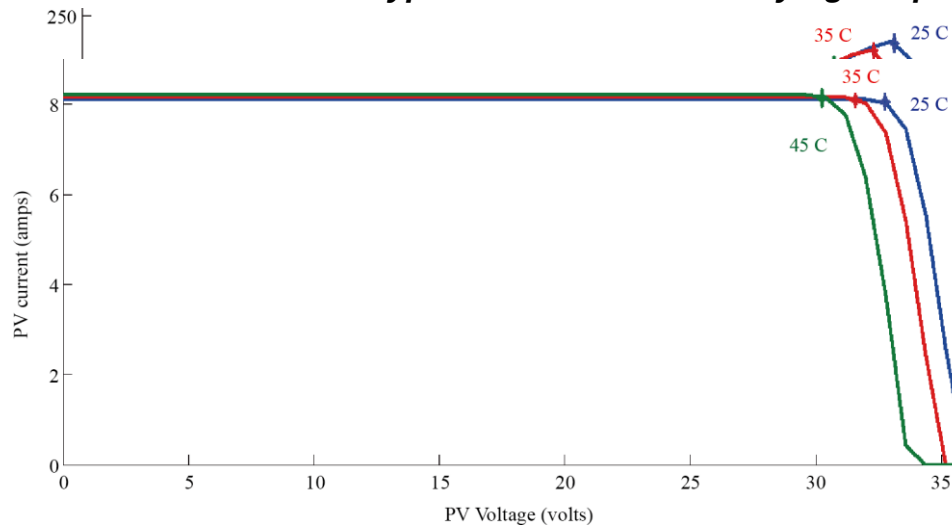


Fig 5. P-V characteristics of a typical PV module for varying temperature.

A single photovoltaic cell produces voltage of about 0.6V. In order to boost up the voltage, a DC-DC boost converter is used. It is used to step up the input voltage to a required output voltage without the use of a transformer. The control strategy lies in the manipulation of the duty cycle of the switch which results in obtaining a variable DC output voltage. The circuit diagram of the boost converter is shown in

The active switch in the boost converter is a MOSFET. A fast recovery diode is used as the freewheeling diode. The input and output capacitor is selected as $C_1 = 470 \mu\text{F}$ and $C_2 = 330 \mu\text{F}$, 450 V. The inductance value is 2 mH, 15 A. For a DC-DC boost converter, the conversion gain for continuous conduction mode is given by:

3.5.2 Battery Modeling

The lead-acid battery are studied in an intensive way for automotive and the renewable energy sectors. In this paper, the principle of the lead-acid battery is presented. A simple, fast, and effective equivalent circuit model structure for lead-acid batteries is implemented. The identification of the parameters and the battery model is validated by performing the simulation in MATLAB/SIMULINK.

The general equation for modeling the battery is Discharge:

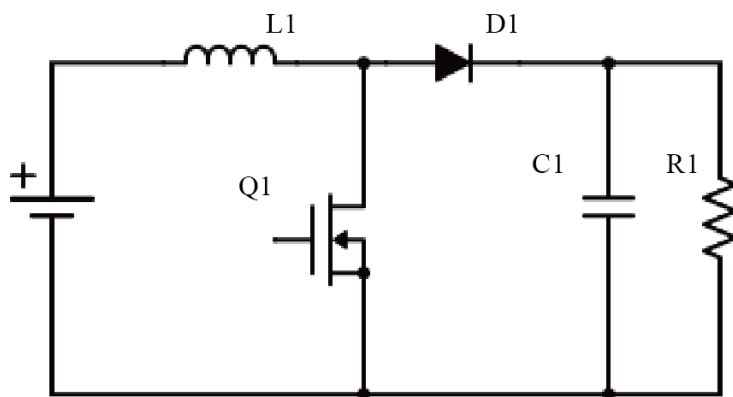


Fig 3.5 Circuit diagram of boost converter

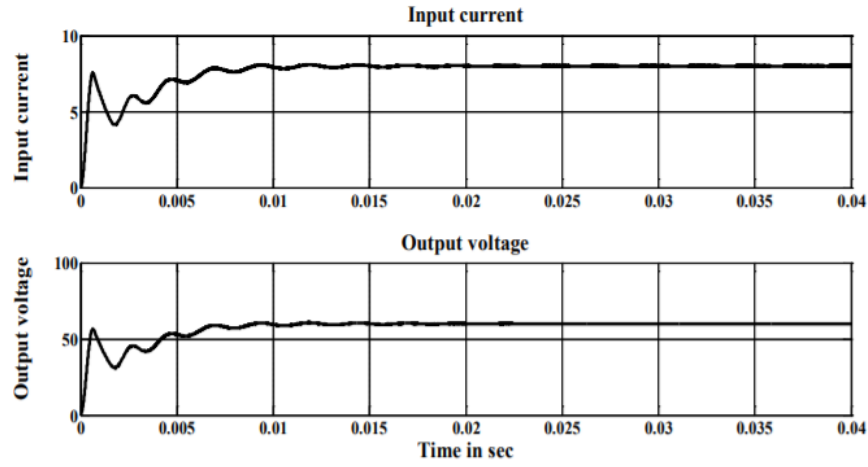


Fig 3.5.1 Input current output voltage of boost converter

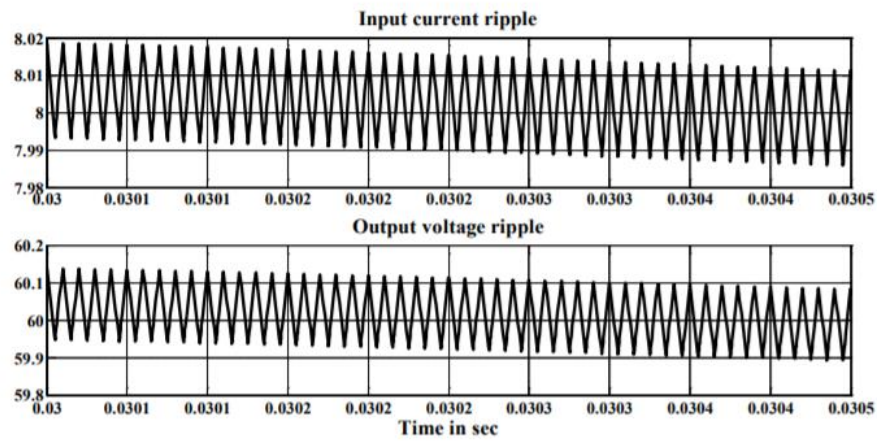


Fig 3.5.2 Output current of boost converter

$$V = E_o - K \frac{Q}{Q - it} - K \frac{Q}{it - 0.1Q} i - R \cdot i + C \quad (9)$$

- where
- V: Battery voltage (V);
- E.: Nominal voltage (V);
- K: Polarization resistance (\$2);
- Q: Battery capacity (A.h);
- it: Actual battery charge (A.h);
- 4: Exponential zone amplitude (V);
- B: Exponential zone time constant inverse (A.h");

- R: Battery internal resistance (Ω);
- C: Exponential voltage (V).
- From the manufacturer's datasheet, the above parameters can be obtained. But, polarization resistance, exponential zone amplitude and exponential zone time constant inverse should be calculated from the discharge curve
- of the battery which is calculated as follows is shown .
-

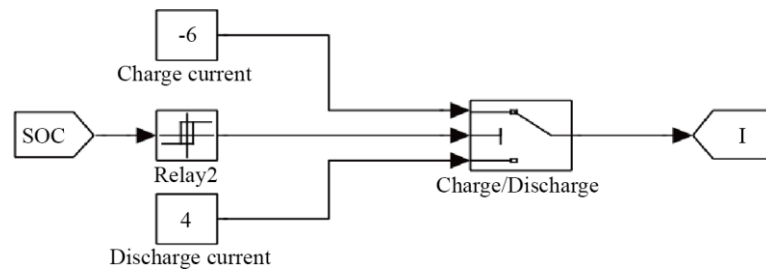


Figure 3.5.3 SIMULINK model of current block.

Figure 3.5.4. SIMULINK model of state current.

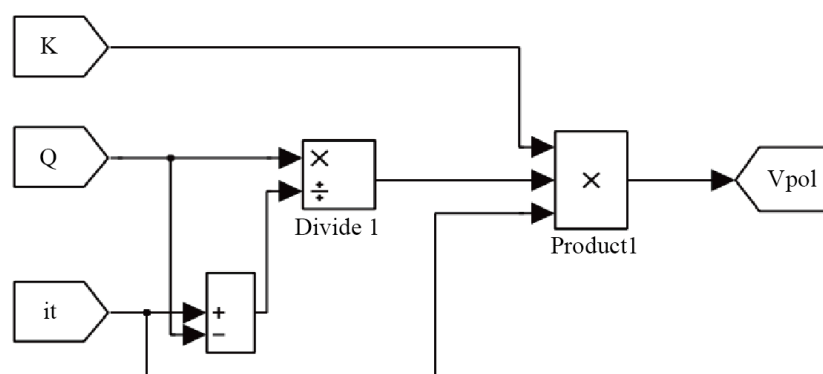
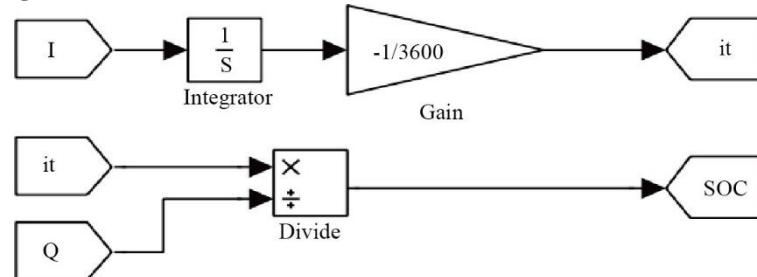


Figure 3.5.5 SIMULINK model of polarization voltage block.

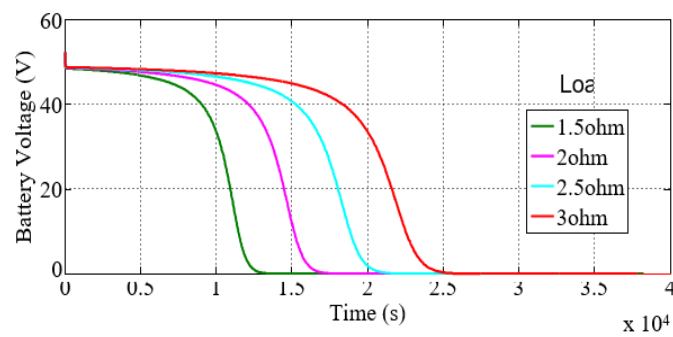
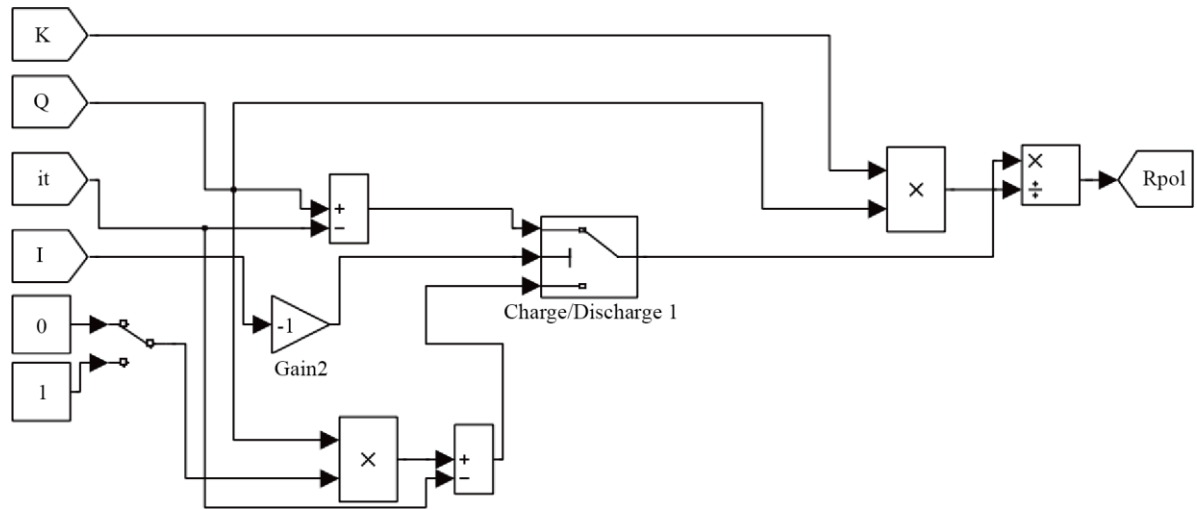


Fig 3. 5.6 P-V characteristics of a typical PV

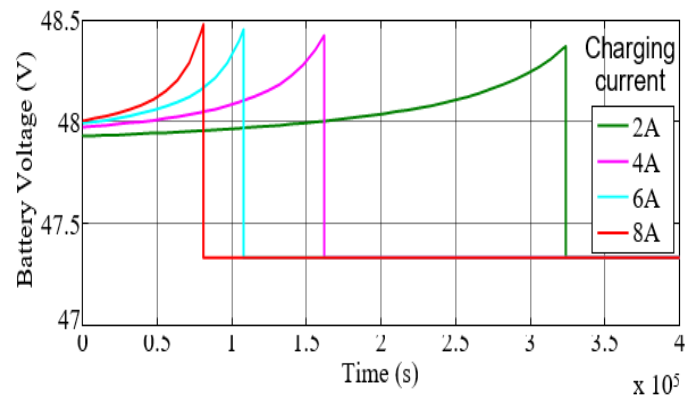


FIG3.5.7 Simulation results for battery's voltage and various current

HARDWARE RESULTS

The electrical wiring system of the solar automobile is honestly a electric conversion or wiring anatomy in lieu of a traditional engine driven vehicle. In a electric system it interconnects the motor, motor controller, tools container, acceleration padel, batteries, charger, panel and in conjunction with its key protection high electricity and occasional strength instrumentation and protection dimension components. determine 8.1 indicates the gadget at a look.

- excessive-Voltage, excessive-present day power machine
- Low-Voltage, Low-present day Instrumentation gadget

The diagram illustrates a 60V DC power system for a vehicle. Key components and their connections are as follows:

- Power Source:** A 60V battery pack is connected to a 60 to 12V converter. A charge controller is also connected to the battery pack and a 'Plug-in Charge' source.
- Safety and Control:** A 'Key Switch' with 'Safety Interlocks' is connected to the battery pack. A 'Circuit Breaker' with 'Safety Fuse' and 'Fuse' is also connected. A 'Voltmeter' is connected across the battery pack.
- Motor and Actuator:** A 'Foot Pedal Acceleration' switch is connected to a 'Motor Controller'. The 'Motor Controller' has a 'DC input' and an 'Output' connected to a 'Series dc excitation motor'. The motor has terminals A1, A2, S1, and S2.
- Other Components:** A 'Main Contactor' is connected to the battery pack. A 'Gear Box' is connected to the motor. A 'Panels' box is connected to the battery pack.

The formidable and thick traces in discern 8.1denote the high-present day connections. in this component motor controller, motor, battery and tools container are the

primary components to be prepared in sun car. other than those some protection contraptions and voltage-cutting-edge reading circuitry is also linked.

in the following section the excessive-current components are discussed in element.

MOTOR CONTROLLER:

The motor controller lets in the motor to rotate at exceptional velocity; it takes the enter from the battery and gives output for motor. The controller used inside the solar car has an enter and output score of 48 to 60 volt and has a present day score of max 30 ampere. There are outputs from the motor controller, one for the acceleration pedal and other for the motor. The inner circuitry for acceleration manipulate similarly converts the input voltage into low modern-day system.

DESIGNING THE CHASSIS AND MECHANICAL SYSTEM **INSTALLATION**

INTRODUCTION:

In trendy, while to layout, it is good to hold the exclusive elements in mind. preserving the load of a sun Powered car's bodywork down is nearly as critical as ensuring it slides via the air gracefully in which the mass of the automobile determines the rolling resistance, and the rate of acceleration. The shape of the bodywork determines the aerodynamic drag, which above 25 mph can upward thrust substantially.

in the assignment we're operating by using a hard and fast sun panel. consequently our layout at the measurement of the panel

duration-545 cm Width-535 cm Thickness- three cm

Weight- 0.7 KG

some other consideration is weight and stiffness. To make the car mild in weight the body material need to be as mild as viable. on the other hand the fabric have to be enough stiffer to hold the load.

4.2)TYPES OF SOLAR PANELS

Solar panels nowadays have come to be more efficient than they used to be before and are persevering with to be an increasing number of efficient every day. There are actually

special kinds of sun panels available, particularly, monocrystalline silicon, polycrystalline silicon, and Amorphous Silicon 'skinny movie' modules.

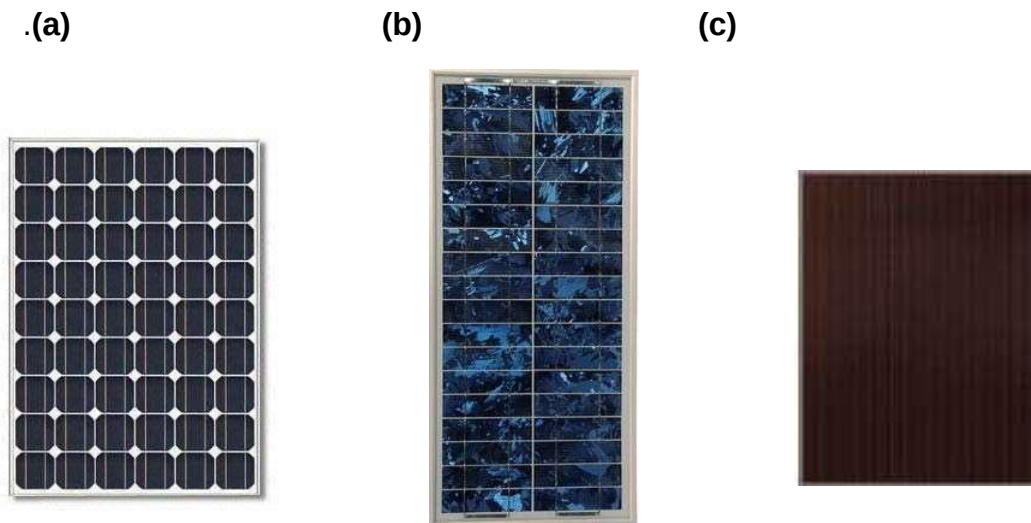


FIGURE 4.2.1: types of solar panels (a)Monocrystalline (b)Polycrystalline (c)Amorphous thin film

4.2.1.MONOCRYSTALLINE SILICON

Monocrystalline silicon solar panels have rectangular-formed cells and are one of the most efficient forms of solar panels. those gadgets have the most silicon content out of all of the one-of-a-kind panel sorts, which makes them extra highly-priced to make however conversely takes up pretty much less relative area. those sun panels are typically used in excessive reliability programs like telecommunications.

4.2.2POLYCRYSTALLINE SILICON

Polycrystalline silicon solar panels use much less silicon, which makes them rather less green. however, the unique design, which capabilities strips of silicon wrapped around square conduit wires, lets in them to characteristic greater efficaciously. positive circumstantial use of polycrystalline silicon sun panels which includes when used on rooftops can yield performance as close to as the ones of monocrystalline silicon sun panels.

4.2.3 THIN FILM AMORPHOUS MODULES

Thin film solar panels are one of the cheapest types of panels, but also are the least efficient. The efficiency of amorphous modules to transform daylight to strength is 1/2 of polycrystalline or mono crystalline panels. those aren't suitable for reliable domestic or industrial use. However, while the focus is on amount rather than nice i.e. wherein big numbers of solar panels are required to produce a massive amount of power (e.g. in huge array solar farms), because of their cheap mass production cost they emerge as crucial.

On account that sun motors have lots less energy to paintings with to power the automobile as compared to mention electricity provided by way of internal combustion engines, it's far important that this small electricity is as efficaciously applied as possible. additionally, the lesser the distance the solar panels soak up over the body of the car the higher it is. therefore, judging from the characteristics of the

sorts of sun panels as described above it turned into maximum prudent to go along with the mono crystalline form of solar panels. considering solar panel cost, sturdiness, assurance, size and wattage, 5 monocrystalline bendy solar panels, sold from Chinese language based totally organization "Shenzhen Shine sun Co. Ltd" changed into used in this thesis. it is very crucial to be aware that each of the panels were semi flexible which allowed the roof of the car (where the panels are to be located) to have a greater curved and aerodynamic shape alternatively being flat. The scores of the five sun Panels had been given by the organization become as follows:

4.3 MPPT HARDWARE SPECIFICATION

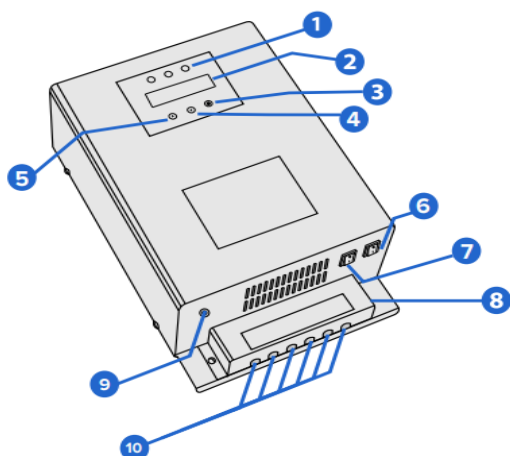
SOLAR MPPT CHARGE CONTROLLER

ASHAPOWER® APOLLO-40 Vers.6 Solar MPPT Charge Controllers are multi voltage range devices with unique features. The same device can be used for battery banks ranging from 2 Batteries (24V) up to a battery bank of 6 batteries (72V) in series. The battery voltage is selected by the device itself when we connect the battery bank across its terminal. The device gives a configurable charging current up to 40A. The Max PV panel input open circuit voltage up to 230V makes it easier to group the panels conveniently. Also, sleek & stylish design of the product gives a better aesthetic view so that you can wall mount the product in a visible place inside your home or office.

SALIENT FEATURES

- ⚡ Compatible for 24V/36V/48V/60V/72V Battery Bank
- ⚡ Auto-Detection and setting of Battery Bank.
- ⚡ 3 stage Smart charging for prolonged battery life.
(Bulk-absorption-float)
- ⚡ Programmable Initial limited ampere charging facility
- ⚡ Ultra-fast & efficient (98.9%) power point tracking.
- ⚡ PV panel reverse polarity protection.
- ⚡ Automatic disconnection of PV panels at night.
- ⚡ Over voltage and overload protection from PV panels.
- ⚡ Protection for battery against hardware failures.
- ⚡ 10 menu custom function settings and inbuilt settings keys
- ⚡ Grid power Control to the connected inverter

4.3.1MPPT DEVICE RATINGS



1	LED INDICATORS
2	2x16 LCD
3	SETTINGS BUTTON [ENTER]
4	SETTINGS BUTTON [v]
5	SETTINGS BUTTON [^]
6	MPPT ON/OFF SWITCH
7	GRID BYPASS SWICH
8	TERMINAL COVER
9	SOLAR/GRID MONITOR PORT
10	I/O POWER TERMINALS

INDICATOR	ON	OFF	BLINKING
BLUE SOLAR / GRID POWER STATUS	LOAD IS ON SOLAR POWER	LOAD IS ON GRID POWER	BATTERY LOW WARNING TO DISCONNECT HEAVY LOADS
GREEN SOLAR PRESENCE	PV PANEL VOLTAGE IS HIGHER THAN BATTERY BANK VOLTAGE / PV PANEL CONNECTION IS READY	PV PANEL VOLTAGE IS LOWER THAN BATTERY BANK VOLTAGE / PV PANEL CONNECTION NOT READY	-
RED SOLAR CHARGING STATUS	SOLAR CHARGING CURRENT IS ABOVE 2AMPS	SOLAR CHARGING CURRENT IS BELOW 2 AMPS. CHARGING IS STILL GOING ON IN LOW AMPS	BULK CHARGING INDICATION

4.2 SOLAR PANNELS INSTALTION WITH GEO TAG

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Department of Mechanical & Production
Engineering, Sathyabama University
Campus, Extended Campus, Kamaraj Nagar,



4.2.1 BEFORE INSTALLATION OF SOLAR PANNELS

WORK DONE FOR THE INSTALATION 4.3.1



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Semmancheri, Chennai, Tamil Nadu 600119,





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Chennai, Tamil Nadu 600119, India



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FINAL OUT PUT OF PROJECT 4.3.3



4.4 Hardware results of the project



FIG 4.4.1 UNITS PRODUCED BY SOLAR PANELS

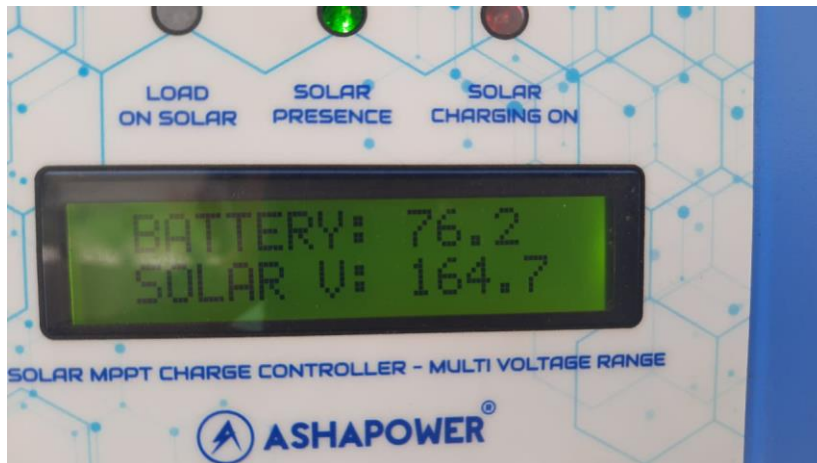


FIG 4.4.2 CHARGE OF THE BATTERY AND VOLTAGE OF SOLAR PANNELS

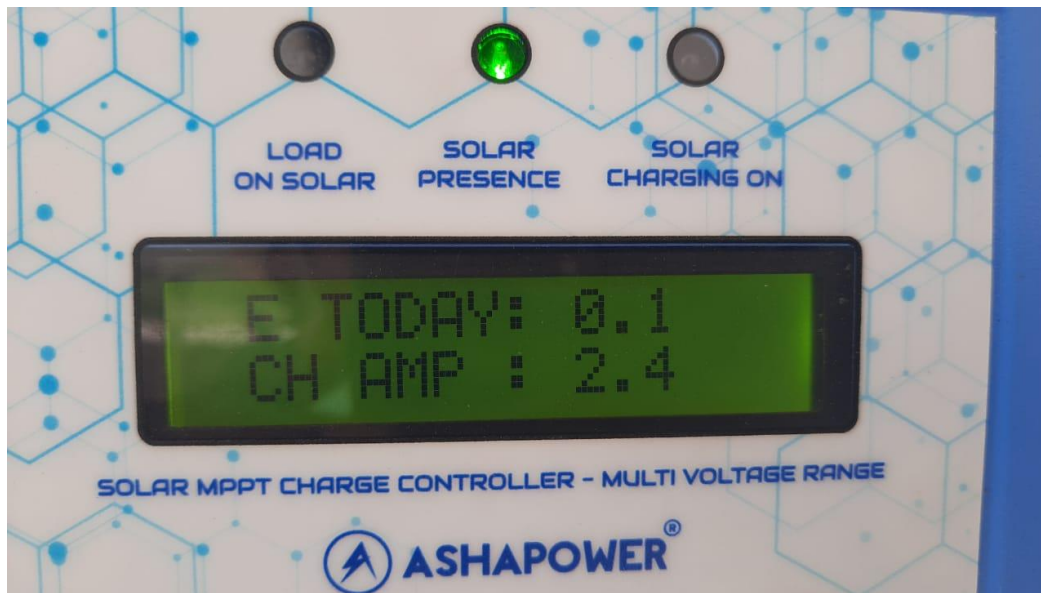


FIG 4.4.3 UNITS CONSUMED BY E vehicle PER DAY

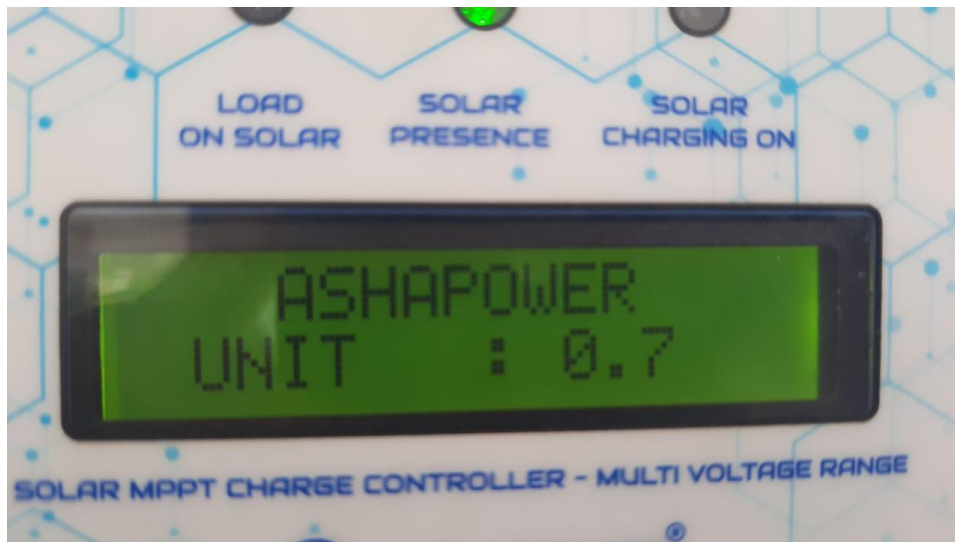


FIG 4.4.3 UNITS CONSUMED BY E vehicle ON WHILE ITS RUNNING

CHAPTER 5

CONCLUSION

A good way to address the growing demands for fuel and the disastrous surroundings pollutants because of driving carbon-based cars, it is quite necessary to interchange to a new supply of energy, i.e. the sun electricity which could be a reasonably-priced, green, endless and of direction an eco-friendly alternative.

Sun-powered electric automobiles are secure with no risky gas or hot exhaust structures. they're zero emission automobiles, odorless, smokeless and noiseless. They require minimal protection, are greater reliable with very little transferring parts and can be correctly charged almost anywhere. pointless to say it's miles very lots fee efficient.

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- <http://publications.lib.chalmers.se/records/fulltext/167306.pdf>
- <http://www.mpoweruk.com/soc.htm>
- <http://www.chargingchargers.com/tutorials/charging.html>
- <http://www.batterystuff.com/blog/3-stages-of-smart-chargers.html>
- <http://www.electrovehicles.co.za/understanding-battery-charging>
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- <http://www.wseas.us/e-library/transactions/systems/2008/28-217.pdf>
- <http://www.morningstarcorp.com/en/support/library/8.%20Why%20PWM1.pdf>
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