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Research Paper

CAR RUNS BY SOLAR ENERGY

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In Today's world global warming is being increased day by day. There are many reasons like pollution, deforestation, water contamination, etc. In coming years the major problem is depletion of ozone layer which is caused by release of CFC's from vehicles. So the implementation of solar energy cars should be progressed. This project deals with features involved in a solar energy car which plays a vital role for the upcoming energy crisis.

Keywords: Solar cars, PV cells, Power trackers, Batteries

INTRODUCTION

A solar car is a solar vehicle used for land transport. Solar cars combine technology typically used in the aerospace, bicycle, alternative energy and automotive industries. The design of a solar vehicle is severely limited by the amount of energy input into the car. Most solar cars have been built for the purpose of solar car races. Since 2011 also solar-powered cars for daily use on public roads are designed.

Solar cars are often fitted with gauges as seen in conventional cars. To keep the car running smoothly, the driver must keep an eye on these gauges to spot possible problems. Cars without gauges almost always feature wireless telemetry, which allows the driver's team to monitor the car's energy consumption, solar energy capture and other parameters and free the driver to concentrate on driving.

Solar cars depend on PV cells to convert sunlight into electricity. Unlike solar thermal energy which converts solar energy to heat for either household purposes, industrial purposes or to be converted to electricity, PV cells directly convert sunlight into electricity. When sunlight (photons) strikes PV cells, they excite electrons and allow them to flow, creating an electrical current. PV cells are made of semiconductor materials such as silicon and alloys of indium, gallium and nitrogen. Silicon is the most common material used and has an efficiency rate of 15-20%.

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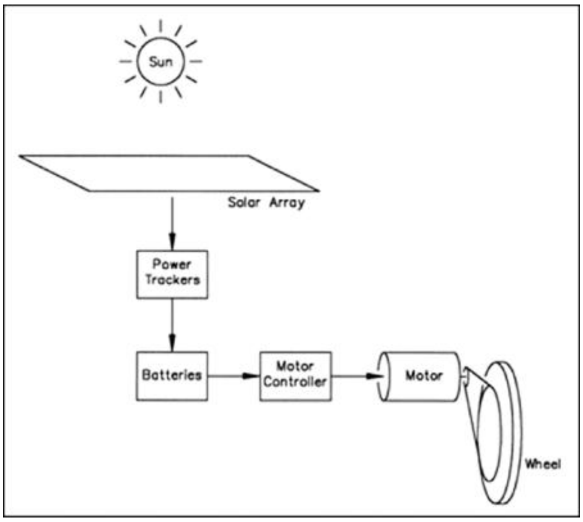
WORKING

A solar car gets the energy it needs to move from sunlight. If you look at the solar car below you can see that much of its surface looks black. This helps it to absorb the sunlight-black objects absorb most of the light that falls upon them.

Usually, black objects just get hot in the sun. But in a solar car, some of the light is converted to electricity by a device called a "solar cell." Each of the dark panels that you can see in the photograph contains many such solar cells. The electricity is used to drive the car's electric motor. Excess electricity is stored in a battery for cloudy periods.

Figure 1: Working Principle



This car was created large-20 feet long and 6 feet wide-in order to catch a lot of sun. If we could make perfect solar cells that converted all the light falling on the car, its engine would have about 10 horsepower. But even the best of today's solar cells can convert only 20% to 24% of the sun's power into electricity. Therefore, under full sunlight, the motor puts out about 2 hp. With the help of the battery, output-for short times—can be increased to 8 hp.

The Components are Solar Array, Power Trackers, Batteries, Motor and Controller, Solar car brakes.

Solar Array

Collect the energy from the sun and converts it into usable electrical energy.

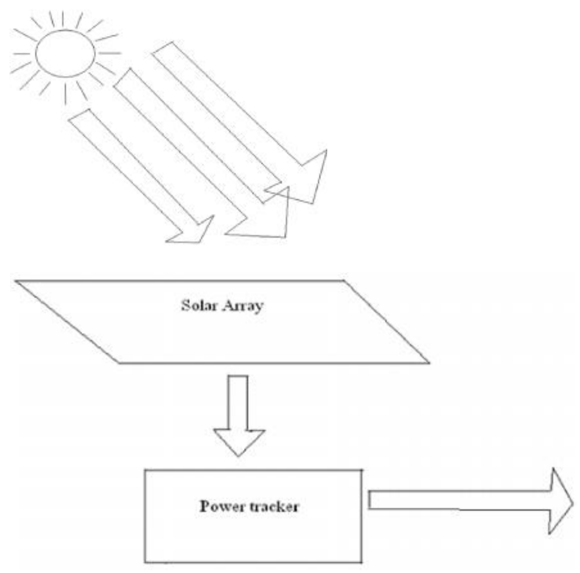
Figure 2: Solar Array

Figure 3: Solar Energy Converts into Electrical Energy

How solar array change sunlight to usable energy:

- First thing the solar array collects sunlight together.
- When sunlight is collected together. It immediately change the sunlight to electricity.
- Next step is to the power tracker.

Figure 4: Conversion of Solar Energy into Usable Energy



Power Trackers

- Power trackers convert the solar array voltage to the system voltage.
- In this step the power tracker in the car receive the energy from the solar array, and change the energy that it receive to energy that the car can be use
- After it converts energy, it send the energy to the battery.

Figure 5: Power Tracker Role

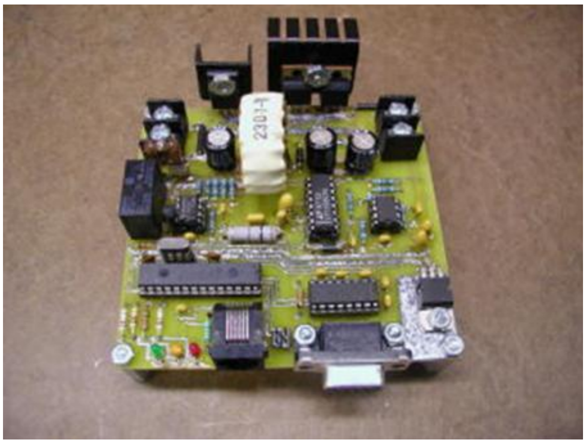
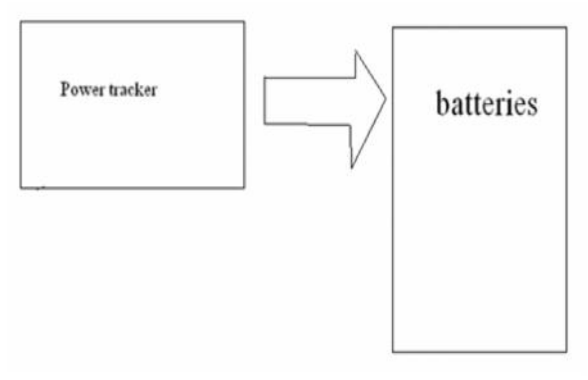


Figure 6: Line Diagram of Power Tracker



Batteries

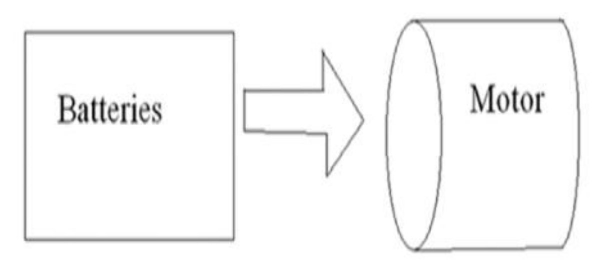
- The batteries store energy from the power tracker and make them available for the motor's use.

Figure 7: Batteries

Use of Battery

- After the power tracker converts the energy to the energy that is usable for the car, it sends to the battery then the battery store the energy.
- This energy is send to the motor and controller.

Figure 8: Use of Battery



Motor and Controller

- The motor controller adjusts the amount of energy that flows to the motor to correspond to the throttle.
- The motor uses that energy to drive the wheels.

Figure 9: Motor and Controller

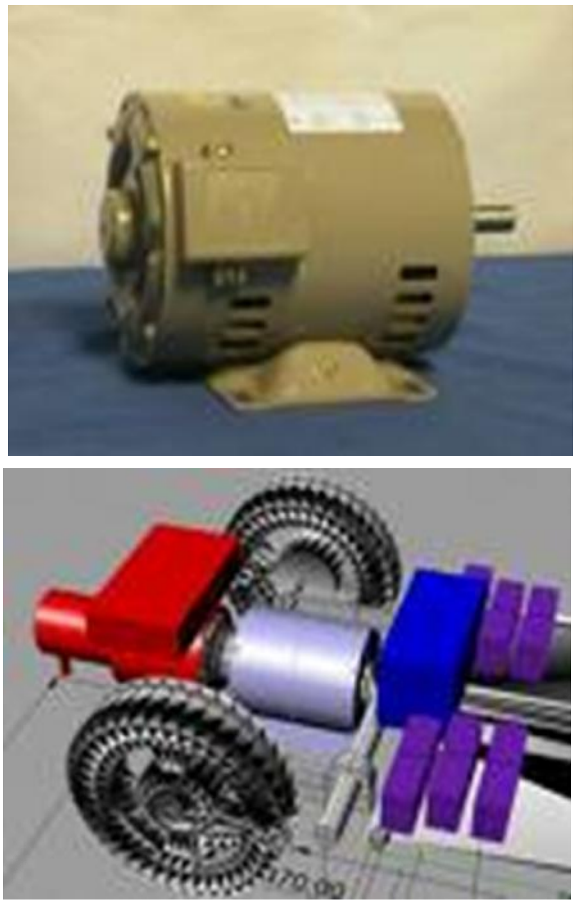
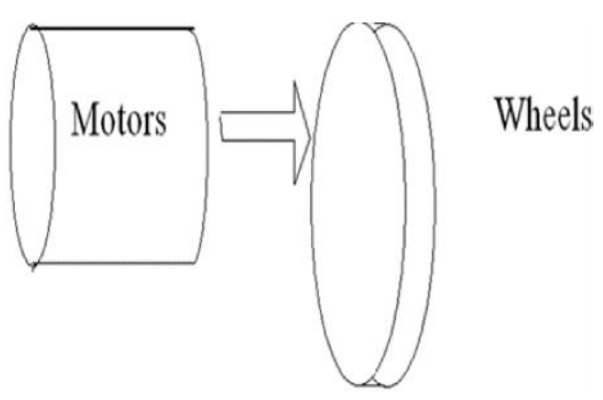


Figure 10: Solar Car Brake



How Solar-Power Car Runs

- When the energy is send from the battery to the motor, the motor adjust the amount of energy that flows to the throttle. The motors use the energy that receives to run the wheel.
- This is the process how solar car runs.
- Kinds of break:
- Friction brake is a type of automotive that restores heat in the rotating part (drum brake or disc brake) brake during the application and then releases it in the air.
- Drum brake if you press with your leg the brake is connected to the wheel that is spinning.
- Disc brake this one brake all the wheels together and make the car slow down or stop at that moment.

Hand Brake

- In cars hand brake can also help you when you park your car in shopping mall to not let someone move you.
- Another way to call hand brake is emergency brake e-brake, park brake, slide stick, or parking brake.

Figure 11: Hand Brake

Calculating Your Solar Power Requirements

There are Three Things to Consider Choosing a Solar Panel or Creating a Solar System

You need to know how much energy your battery can store and then select a Solar panel that can replenish your 'stock' of energy in the battery in line with your pattern of use.

Amount of Energy Can Your Battery Store

Battery capacity is measured in Amp Hours (e.g., 17 AH). You need to convert this to Watt Hours by multiplying the AH figure by the battery voltage (e.g., 12 V).

For a 17 AH, 12 V battery the Watt Hours figure is 17 x 12 = 204 WH

This means the battery could supply 204 W for 1 hour, or 102 W for 2 hours, i.e., the more energy you take, the faster the battery discharges.

Appliance(s) Use Over a Period of Time for Energy

The power consumption of appliances is given in Watts (e.g., 21" fluorescent light, 13 W). To calculate the energy you will use over time, just multiply the power consumption by the hours of use.

The 13 W light fitting, on for 2 hours, will take 13 x 2 = 26 WH from the battery.

Repeat this for all the appliances you wish to use, and then add the results to establish total consumption.

Solar Panel Generate Over a Period of Time

The power generation rating of a Solar panel is also given in Watts (e.g., STP010, 10 W). To calculate the energy it can supply to the battery, multiply Watts by the hours exposed to sunshine, then multiply the result by 0.85 (this factor allows for natural system losses).

For the Solar 10 W panel in 4 hours* of sunshine, 10 x 4 x 0.85 = 34 WH. This is the amount of energy the Solar panel can supply to the battery.

Calculating the Annual Solar Energy Output of a Photovoltaic System

The global formula to estimate the electricity generated in output of a photovoltaic system is:

$E = A * r * H * PR$

E = Energy (kWh)

A = Total solar panel Area (m^2)

r = solar panel yield (%)

H = Annual average solar radiation on tilted panels (shadings not included)

PR = Performance ratio, coefficient for losses (range between 0.5 and 0.9, default value = 0.75) r is the yield of the solar panel given by the ratio: electrical power (in kWp) of one solar panel divided by the area of one panel.

Example: The solar panel yield of a PV modules of 250 Wp with an area of 1.6 m^2 is 15.6%.

Be aware that this nominal ratio is given for Standard Test Conditions (STC): Radiation = 1000 W/m^2, cell temperature = 25 °C, Wind speed = 1 m/s, AM = 1.5. The unit of the nominal power of the photovoltaic panel in these conditions is called "Watt-peak" (Wp or kWp = 1000 Wp or MWp = 1000000 Wp).

H: You can find this radiation value here :solar radiation data.

You have to find the global annual irradiation incident on your PV panels with your specific inclination (slope, tilt) and orientation (azimut).

PR: Performance Ratio (PR) is a very important value to evaluate the quality of a photovoltaic installation because it gives the performance of the installation independently of the orientation, inclination of the panel. It includes all losses.

Example of losses details that gives the PR value (depend on the site, the technology, and sizing of the system):

- Inverter losses (4% to 15 %)
- Temperature losses (5% to 18%)
- DC cables losses (1 to 3 %)
- AC cables losses (1 to 3 %)
- Shadings 0% to 80% !!! (Specific to each site)
- Losses weak radiation 3% to 7%
- Losses due to dust, snow... (2%)

Calculating the Solar Panels Needed

1. Identify what are the power of the equipment that you want to run on solar energy and the hours to run it them every day. Take an example a 14" DC fan 20 W to run 12 hours at night and a 16 W light to run 5 hours at night.
2. The formula of the power of the solar panels needed is power of equipment X running hours X 1.5 (lost factor)/4 hours of sunshine.

   Lost factor include the humidity and high temperature in the equator zone, battery charging and discharging lost and inverter conversion lost.
3. From the example, the solar panel needed for the fan is 90 W and the solar panel needed for the light is 30W. So the total solar panel needed will be 120 W. In this case, you can buy 2 pieces of 60 W solar panels or 1 piece of 140 W solar panel.
4. This calculation will work fine if the solar panel is not place under shade.

Calculating the Batteries Needed

To package the battery needed, you have to decide how many days you want to have backup power. Taking the example 14" stand fan 20 W to run 12 hours at night and a 16 W light to run 5 hours at night. Total power a day is 320 W = 12 V 26.7 A.

1. Daily usage of the battery = Total power usage/12 V = 320 W/12 V = 26.7 A. Take note this value is only valid for sunny days.
2. To have 3 days backup battery = 26.7 A x 3 days = 80 ah.
3. Battery cannot be 100% discharge otherwise it may be permanently

damaged. The charge controller will protect the battery by reserving 10% of power and cut off the load at 11 V. The battery will have to size up 10% more in practical = 80 ah x 1.1 = 88 ah.

4. The deep cycle battery is recommended to discharge only 50% of the power stored. Over discharge the battery will shorten the life time. Normal car battery is not recommended to use in solar system because they are designed for only 10% discharge.

Selecting the Charge Controller

Example a 14" stand fan 75 W to run 4 hours at night and a 16W light to run 4 hours at night. Solar panel needed is 140 W.

1. There is no formula needed for the charge controller. You need to get a charge controller with the current more than the maximum current of the solar panel or the maximum current of your load.
2. From the example the 140 W solar panel selected will need a charge controller of more than 8.2 A (maximum current that a 140 W panel produced) input. The Phocos charge controller selected will be the 12 V 10 A. The output power from the charge controller will be limited (12 V x 10 A) 120 W. The charge controller will alarm and cut off the output if the current drawn is more than 10 A. If your equipment has a high startup current or power, you will need to select a higher range charge controller to suit your equipment.
3. Maximum Power Point Tracking (MPPT) charge controller is designed to maintain the solar panel voltage at the optimum voltage to charge the battery, even when the sun light is low. Thus stored more power to the battery compared to normal charge controller. Not popular to use in the lower power system because of high in price.
4. There are 24 V and 48V range of charge controllers available for you to configure to your needs.

SOLAR ENERGY CALCULATION

One single solar panel from type standard 150 Watt/24 volts can deliver a power of 150 Wattper hour, considering full sunshine. Knowing that the sun shine vary during the day, the effective sun power of one day is equal from 4 to 6 hours of a maximum measured at midday.

Since this maximum at midday is not the same every day, it should be taken in consideration, that more or less heavy cloud reduces the possible power. The electrical power is stored into batteries, similar to the one used in cars.

Example: One solar panel of 150 W/24V produce between 150 W x 4 h = 600 Wh and150 W x 6 h = 900 Wh.

One battery of 12 V/110 Ah has a capacity of 12 V x 110 Ah = 1320 Wh

For technical reasons, it is not recommended to empty a battery more than 70%. The usablecapacity of this type of battery is around 924 Wh, what match to the produced electricalenergy of 600 Wh to 900 Wh.

We are offering 24V-systems, using 2 batteries with 12 V/110 Ah. Using an inverter 24 V to 230 V connected to the batteries, it is easily possible to get apower source of 230 V, driving different types of electrical appliances like a fan, energysaving lamps or a television.

But Notice: There are different types of inverters. The type of inverter advised has an output ofpure sinus. Using them will avoid troubles that can occur on critical devices like television orpersonal computers. If the inverter has a modified sinus output or (worst case) a rectangularoutput, a significant part of the stored electrical energy will be wasted, and on long-termrunning critical devices may damage.With the stored power of 600 Wh to 900 Wh (one solar panel, see example above), it ispossible to use the following devices:

- 4 energy saving lamps 11W, time of use 4-6 hours (4 x 11 W x 4 h = 176 Wh)
- 1 fan 75 W, time of use 3-5 hours (1 x 75 W x 3 h = 225 Wh)
- 1 television 100 W, time of use 2-3 hours (1 x 100 W x 2 h = 200 Wh)

Total consumption = 601 Wh

We recommend the usage of two solar panels to get a buffer capacity in case of less sun. The main thing is to get an idea of the electrical power needed for the devices that aresupposed to be powered by solar energy, and also an idea of the duration of use of eachdevice. With this two information's, it is possible to calculate the size of the solar panelrequired to obtain good results.On most electrical devices, the power consumption is written on it, and these specificationsare based on one hour of usage.

ADVANTAGES

- Unlike regular cars, solar energy powered cars are able to utilize their full power at any speed.
- Solar powered cars do not require any expense for running.
- Solar cars produce less noise.
- Solar cars essay to maintenance.
- Solar cars produce no harmful emissions.

DISADVANTAGES

- Solar cars don't have speed or power that regular cars have.
- Solar powered cars can operate only for limited distance.
- If there is no sunlight.
- If it is dark out for many days, the car battery will not charge and this can be aproblem. This is the main reason why people don't rely on solar cars.
- Good solar powered car is expensive. It cost around $200,000 or more.
- Parts used in solar cars are not produced in large quantity so they are expensive.

Figure 12: Hand Brake

If there is no sunlight, the emergency batteries will be used. Example in the situation that there was a large cloud cover the sky, these emergency batteries will be used.

CONCLUSION

Solar Cars have the cleanest and easiest energy output around, yet our technology is still far... A solar car is really an electric vehicle powered by solar energy.

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