Review article

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Solar powered electric vehicle using maximum power point tracking

Abstract

The solar energy with its unrestrictedaccessibility is measuredas non-degradable, immortalkind of energy that discovers its mean in day by dayexercise. The utilization of solar vehicle is an initiative pace headed forplummetingcraving on the conformistenergy;exploit the non-renewable cause of control for a range of submissions. This paper majorly intended on the various applications of solar energy to gear up the utilization of electric vehicles. The Photo Voltaic (PV) elementsattached either in comparable or sequencemay be a superiorchoice, but expensive too. An electrical charge is merged from the PV panel and aimed to the output terminal to generate low power voltage. The charge controllers (CC)unswerving this power obtainedwith the solar panels to the batteries. The outcomes are based on the "design and simulation" of different constituents of the solar based electric vehicles. The PV cell has to be optimally effective at a meticulousposition to carry maximum power known asMaximum Power Point (MPP). Maximum power point tracking (MPPT) algorithm is exploited at this point. The dynamic behavior of electric motor (EM) is essential in regulate to estimate the concert of electric vehicles. These vehicles will be controlled in the forward as well as reverse direction with a speed of 48Kmph. The efficiency obtained for proposed solar vehicle is higher.

Keywords: solar energy, photo voltaic, silicon carbide (sic) device, electric vehicle.

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Abbreviations: PV, photo voltaic; CC, charge controllers; MPP, maximum power point; MPPT, Maximum power point tracking; EM,electric motor

Introduction

A solar vehicle[1] has advantages because it makes less noise, uses less energy, and emits less carbon dioxide. It comprises of an electric motor,[2] a multilayer inverter, a battery, a PV panel, and a charger controller. The p-n junction in the solar cells is constructed of semiconductor material and is produced in a thin wafer layer[3] These cells produce a photocurrent proportional to the solar radiation when they are exposed to light. A solar cell's I-V characteristics in the dark exhibit an exponential behavior akin to a diode. The fundamental idea is that power from the solar panel is used to power a battery, which in turn powers the vehicle's motor in both forward and reverse motion.[4]The modeling of solar cells, MPPT controllers, and Silicon Carbide (SiC) boost converters is the main emphasis of this work. In MATLAB, the simulations are run.[5]

Electric vehicles are utilized frequently because of its many advantages, including simple maintenance, low operating costs, and environmental friendliness. The primary way that electric motors in electric cars are propelled is through the storage of electrical energy in rechargeable batteries.[6,7] Though popularized in the 21st century as a development of internal combustion engines, the 1880s were the year of creation. The electric engine can function as a generator,[8] allowing energy to be recovered when the car is being stopped. Burke provides a general exchange of the strategy and operation of charged vehicles(Figure 1).

Figure 1 Process flow of battery electric vehicle.

Methodology

Here a process used to achieve the work is presented in this section. It includes selection and modeling of polycrystalline PV panel. For this purpose an experimental test bench was built and the results are verified with the simulation. Thereafter applied a standalone photovoltaic system under variable temperature and irradiance conditions. After that the device characteristics of SiC MOSFET is analyzed for converter.[9-13] Optimal designing of the power electronic converter is suited. At last MPPT controller used for output power simulation.To maximize the output power from a PV cell with the help of MPPT control,[14] the modeling of PV cell is necessary(Figure 2).

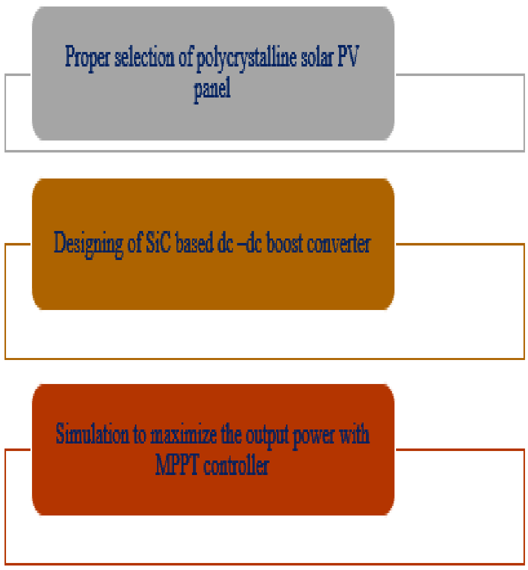

Figure 2 Methodologies used.

Modeling of PV with maximum power point

One of the most abundant and cleanest sources of energy is solar energy. Free energy from the sun is sent to the ground, where it is turned into electricity by the photoelectric effect.[15-18] So, there are numerous uses for the solar PV that is produced.The benefits of solar PV generating over other renewable technologies include: I abundance and sustainability; (ii) green, clean, and pollution-free; (iii) reliability; and (iv) lifetime. Solar PV, however, is reliant on the weather. The maximum power point, or MPP, is the only operational point where the greatest amount of PV power is offered. Additionally, the location of the maximum power point is variable and depends on the load, temperature, and radiation. The necessity of the hour is for photovoltaic panels to produce the most power possible.[19-23]

Even when voltage rises, the variance in the DC power produced by the solar cell proportionally rises with voltage and reaches the maximum point known as maximum power.[24, 25]

$$P_m = V_{mpp*} I_{mpp}$$

Analysis

PV panel specifications

The temperature at which a PV module is functioning affects its output power as well. Io, the saturation current, is strongly influenced by temperature while Iph is very marginally affected.[26] The reverse saturation current rises as the cell temperature rises, causing the open circuit voltage to fall and the peak power[27,28] to decrease concurrently (Table 1).

Table 1 PV panel specifications

S.No.	Parameters	Specifications
1	VOC	31.6V
2	IOC	8.57A
3	Pmax	250W
4	Insolation W/m^2	1000 W/m^2
5	Fill Factor (FF)	76.72%

Figures 3 and 4 depict the PV and VI properties for varied irradiance at constant temperature. The output current and output voltage both raise as the irradiation does. As a result, there is an overall increase in output power while maintaining a steady temperature.[29]

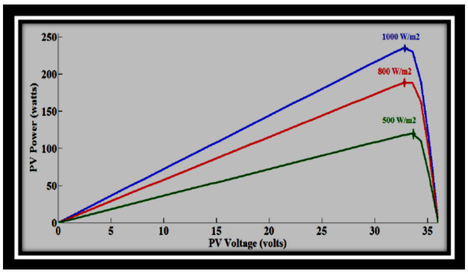

Figure 3 PV characteristics for variable irradiance.

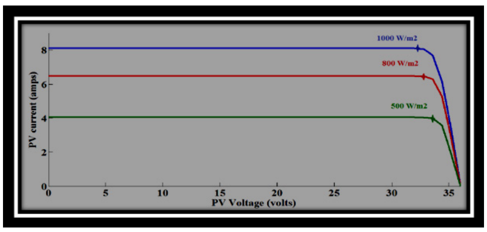

Figure 4 VI characteristics for variable irradiance.

Figure 5 displays the PV power and current with variable temperature and constant illumination.

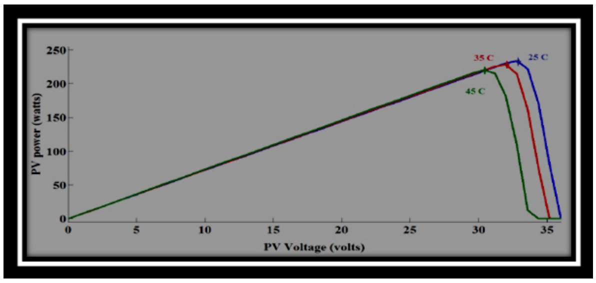

Figure 5 PV characteristics for variable temperature.

Solar PV is one of the cleanest and most abundant sources of power available to supply all of the world's energy needs. It has been a key component of renewable energy systems. The user's knowledge and ability in selecting the appropriate rule base-which depends on the chosen membership functions—determines the method's efficacy, though.

The PV power utilizing AFLC is shown in Figure 6. The obtained power value with an irradiation of 500W/m^2 is approximately 185 W. Similarly, the value of PV power in AFLC is larger than in the traditional MPPT[30-36] for 600W/m^2 and 800W/m^2.

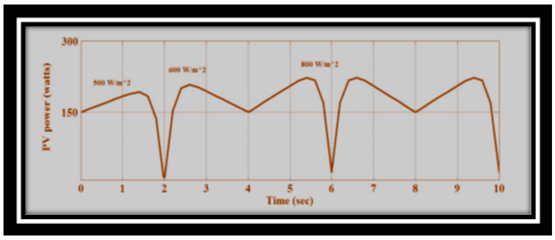

Figure 6 PV power using MPPT.

The PV power utilizing AFLC is shown in Figure 7. For an irradiance of 500W/m^2, AFLC yields a current value of around 6 A. Similarly, the value of PV power in AFLC is larger than in the traditional MPPT for 600 W/m^2 and 800 W/m^2.

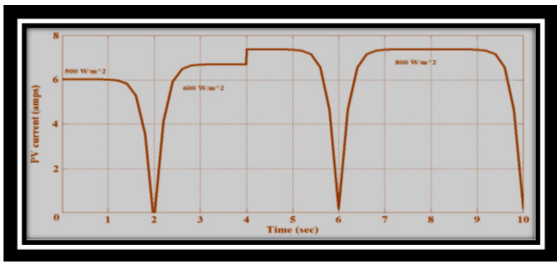

Figure 7 PV current using MPPT.

The analysis has given an AFLC MPPT method that combines adaptive and fuzzy algorithms to help detangle complexity without sacrificing the goal of high performance(Table 2).

Table 2 Calculation of efficiency

S.No.	MPP Technique	800W/m^2	Output Power (W)	Efficiency (%)
1	AFLC	230	215	93.5
2	FLC	230	190	82.6
3	I&C	230	175	76.03
4	P&O	230	150	66.21

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Conclusion

The research effort has summarized adaptive fuzzy logic control for solar system tracking of maximum power point. A boost converter for solar applications built on a SiC MOSFET has been created. SiC MOSFET properties are examined, and performance is contrasted with that of the conventional Si MOSFET. It has been found that the suggested SiC converter reduces input current and output voltage ripple. In addition, compared to a Si boost converter, SiC's efficiency and loss reductions are superior. As a result, the SiC boost converter is preferable for solar power systems. The lead-acid battery's effective equivalent circuit was put into practice. Experimental verification is done for the battery's charging and discharging characteristics. The recommended control strategy for the fault tolerant capability maintains neutral-point voltage balance and generates a steady and continuous output for both open circuit and short circuit instances when a single device fails.

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Conflicts of interest

The author hereby declares of having not conflict of interest in this article.

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