SOLAR ENERGY PANELS IN EV TO POWER ELECTRICAL ACCESSORIES

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Abstract - *In this paper we propose that Photovoltaic solar energy panels be used in Electric Vehicles (EV) in addition to the onboard Li-ion batteries already present to increase the range of the vehicle and supply the necessary energy for operating the electrical systems. Solar panels may be mounted on the roof of the vehicle and may use this traditionally vacant area to generate clean energy. The power obtained by the above method can be used to power some of the vehicle's electrical accessories that constitute a major load on the battery such as Light system, light signalization, horn and audio system. With these accessories now running on solar energy, the batteries are now freed up to focus purely on vehicle propulsion. This could also reduce the charging time required and save an estimated 150W of battery power. As of 2020 the power that can be produced by a 48-inch x 40-inch x 31-inch solar panels which are aligned properly can provide solar electricity up to around 600 watts of maximum output power.*

Key Words: Solar energy, Lithium-ion battery, PV solar panel, supercapacitor.

1.INTRODUCTION

The main objective of an electric vehicle is to harness the power of electricity to propel a vehicle. This is accomplished by means of an induction motor or more recently a PMSM motor. Both these motors receive their power from battery packs mounted on the vehicle bed. However, because of the large cost of these Li ion batteries, the large amount of time required to charge the batteries of these vehicles accompanied with the fact that they do not have a large range in most cases leads to scarce utilization/adoption of this technology. In this paper we propose that solar energy be used to increase the range of this vehicle by mounting a solar panel of dimensions 48inch 40inchx 31 inch off grid monocrystalline panel on the roof of a vehicle to power the vehicle auxiliary systems by storing the energy in a LiFePo4 12 V battery which is less sensitive to changes in temperature.

Most electric vehicles manufactured nowadays use a Li ion battery as energy storage devices. However, as this technology is still quite expensive and the fact that it is currently not economically suitable for large scale production may prevent widespread adoption of electric vehicles due to their limited range and charging duration. People do not/ may not be able to trade their convenience to save the environment. There is a solution to this problem however and that come in the form of renewable energy namely SOLAR energy.

1.1 SOLAR ENERGY POTENTIAL OF INDIA

India is endowed with vast solar energy potential. About 5,000 trillion kWh of energy is incident per year over India's land area with most parts receiving 4-7 kWh per sq. m per day. Solar photovoltaics power can effectively be harnessed providing huge scalability in India. Solar also has the unique ability to generate power on a distributed basis and enables rapid capacity addition with short lead times. National Institute of Solar Energy has assessed the Country's solar potential to be about 748 GW assuming 3% of the waste land area to be covered by Solar PV modules. Solar energy has taken a central place in India's National Action Plan on Climate Change with National Solar Mission as one of the key Mission.

As it has been established our country clearly has tremendous potential to tap into this seemingly inexhaustible and completely renewable source of energy. The challenge however that most lawmakers and engineers are currently dealing with is finding potential space for the solar panels to go up. At present solar panels are chiefly mounted only on building rooftops and farms. Although this method does provide a fair amount of power it is often not sufficient to meet power demands.

It may therefore be feasible to reduce the power demands in other applications where even small amounts of energy produced from solar panels may have a significant impact on the power consumption of a device. One such application could very well be an EV.

1.2 BENEFITS OF ADOPTING SOLAR ENERGY

Coal and oil contain harmful substances, which are released with combustion. More to the point coal power plants emit a greater proportion of toxic substances, polluting up to 300 times more than solar panel manufacturers. The sun is an almost limitless source of energy which is still yet to gain traction for use in commercial processes. It provides an interesting opportunity to generate clean, non-polluting and sustainable electricity, thus resulting in no global warming emissions. In the last few years, the emergence of efficient techniques to capture and store solar energy has led to suggestions that it could be the key to eventually moving on from the conventional sources of energy that the world is currently heavily dependent on. This coupled with the fact that solar energy systems generally don't require frequent maintenance and that most manufacturers of solar panels provide a 20-25-year warranty means that solar energy is also a more reliable choice to generate clean energy in the long run. The absence of moving parts also crucially means there is no wear and tear. The inverter is most likely one of the only components that may require replacement after a period of 5-10 years. Apart from the inverter, the cables also need attention to ensure the solar power system runs at the best possible conditions. After covering the setup cost very little spending is required on maintenance and repair work.

2. CONSTRUCTION AND WORKING

A PV solar panel is mounted on the roof of the vehicle which when stationary rises to a height of 3.5 meters by means of actuators and is given a slight curvature of 45 degrees to ensure that the sunlight is captured accurately. When the vehicle is mobile the roof seats back seamlessly while(similar to a convertible) continuing to produce power while in motion, while storing the obtained energy in a supercapacitor pack.

The power obtained by the above method can be used to power some of the vehicle accessories that constitute a major load on the battery such as Light system, light signalization, horn and audio system. With these accessories now running on solar energy the batteries are now freed up to focus purely on vehicle propulsion. This could also reduce the charging time required and save an estimated 150W of battery power. As of 2020 the power that can be produced by a 48-inch x 40-inch x 31-inch solar panels which are aligned properly can provide solar electricity up to around 600 watts of maximum output power.

This technology requires a Photovoltaic solar panel of dimensions 48 x 40 x 31 inches which provides solar electricity with up to 600-watts of maximum output power. This system features great mobility with wheels and a foldable module and weighs 191.08 pounds. This multi-functional system is provided with an interface consisting of (2) Ac outputs and (1) USB port. This system is safeguarded from overloading, short-circuiting, overcharging and reverse currents. This off-grid solar power system produces 5-days of power at 4-hours per day. In addition to this a MPPT (Maximum power point tracker) is required to determine how much power to supply to power the vehicle accessories by means of connecting wires.

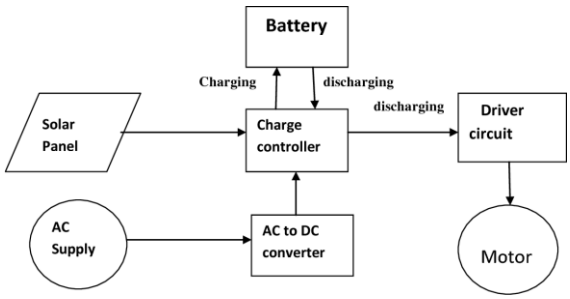

Figure 1: Circuit Connection for vehicle

The solar panels mounted on the roof of the car when stationary rise to a height of 3.5 meters with the hep of a pair of hydraulic actuators and are made to incline at an angle of 45 degrees to ensure maximum energy capture when the vehicle is stationary and when the vehicle is mobile the panel will fit back into the roof of the car and continue to generate energy at a slightly lesser output than when it is stationary due to the angling of the panel not being perfect for so obtained from the light falling on the thin film Cd-Te PV windshield and windows.

The power obtained is stored in a supercapacitor which has fast charging times and can later provide the power for a period of 3-5 hours without any hitch since this the approximate amount of time that most people typically use on-board electrical accessories on average greatly saves power while reducing the dependence on the vehicle's battery.

As charging of the battery is performed on the go it also reduces the potential charging time required by the other batteries as they do not need to provide power to the

vehicle's auxiliary components and can be used purely for vehicle propulsion, this saves both time and money. This technology can be used to reduce the load of the batteries used in an electric vehicle and thus increase their life by utilizing solar power to provide power to auxiliary components such as headlights (lighting sub systems) generally used in the night, audio systems and operations such as seat heating. As these systems consume up to 2% of the battery power it is most advantageous to use the above technology as an alternative.

Supercapacitors are used here to store the energy instead due to their high specific power and short recharge times when compared to other means of storage. Supercapacitors are also capable of charging and discharging rapidly and are suited for intermittent current loads that are typically present in most vehicle accessories like lighting system, climate control and several other systems.

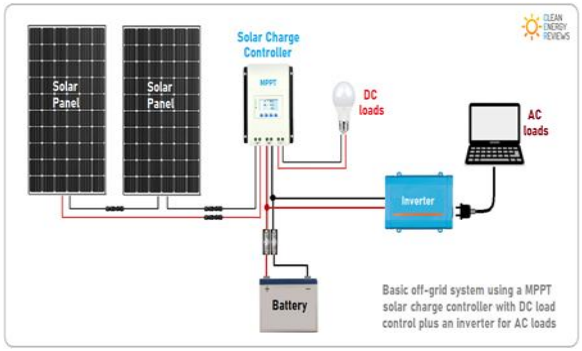

Figure 2: Typical circuit diagram.

3. CALCULATION AND CAD DESIGN

3.1 SOLAR PANEL POWER PRODUCTION

The power consumption of appliances is given in Watts (e.g., 21" car auxiliary system, 300W on average). To calculate the energy, used over time, multiply the power consumption by the hours of use. The 300W consumed by all the systems at the maximum on for 2 hours, will take 300 x 2 = 600Wh from the battery. Battery capacity is measured in Amp Hours (e.g., 17Ah).

Convert this to Watt Hours by multiplying the AH figure by the battery voltage (e.g., 12V). For a typical electrical vehicle battery, the KW Hours figure is 100KWh.The power generation rating of a solar panel is also given in Watts (e.g., STP010, 10W).

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). As of 2020 the power that can be produced by a 48-inch x 40-inch x 31-inch solar panels which are aligned properly can provide solar electricity up to around 300 watts of maximum output power.

A solar panel of the size exposed to the sun completely at an inclined angle when the vehicle is stationary may produce in 4 hours of sunshine,

Power produced= 300 x 4 x 0.85 = 1.03KWh. This is the amount of energy the solar panel can store in the super capacitor to power electrical accessories.

3.2 SUPERCAPACITOR SELECTION CALCULATION

This application requires a super capacitor which will be able to withstand 150 hours back up time under the conditions below:

1.Vmin=2.5V
2.Vmax=5.5V
3. I(backup)=540nA(nanometer)

Requested back up time T > 150 hours, 85°C degrees ambient temperature + optional cooling system (-15°C). SMD super capacitor needed. As all the electrical systems may be operated with a 12 V battery. The Vmax may be considered as 12 volts.

The basic equation for the requested capacitance is given by:

$$C = \frac{I_{backup}\,[A] \times t\,[s]}{(V_{max} - V_{min})[V]} = \frac{540 * 10^{-9}\,[A] \times 150 * 60 * 60\,[s]}{(5.5 - 2.5)[V]} = 0.0972F$$

With all other parameters calculated, it looks like the customer will need a super capacitor with capacitance around 0.038 which may be considered as 0.1.

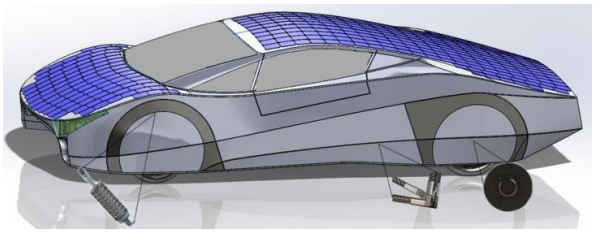

Figure 3: Cad model of vehicle.

4. CONCLUSIONS

This technology frees up the batteries from providing power to the vehicle auxiliary components and can hence be used purely for vehicle propulsion and potentially even extend the range of the vehicle. This technology requires a Photovoltaic solar panel of dimensions 48 x 40 x 31 inches which provides solar electricity with up to 600-watts of maximum output power. This system is safeguarded from overloading, short-circuiting, overcharging and reverse currents. This off-grid solar power system produces 5-days of power at 4-hours per day. In addition to this the MPPT (Maximum power point tracker) determines how much power to supply to power the vehicle accessories by means of connecting wires. The solar panels mounted on the roof of the car generally charge a supercapacitor housed in the car during day driving or when parked in open parking lots this power is then later utilized once charged. As charging of the supercapacitor is performed on the go it also reduces the potential charging time required vehicle propulsion this saves both time and money. This technology can be used to reduce the load of the batteries and reduce its deterioration due to intermittent discharge and parasitic loads caused by the electrical accessories used in an electric vehicle. This could help prolong their life by utilizing solar power to provide power to auxiliary components such as headlights (lighting sub systems) generally used in the night, audio systems and operations such as seat heating. As these systems consume most of the battery power for a maximum period of 3-4 hours at a lower current requirement.

This technology may also find an application in the popular Vehicle to grid technology where the panels may be used to feed power back to the grid when the supercapacitor is sufficiently charged. The amount of power produced by the car could then be deducted from the owner's electricity bill.

This technology could serve as a bridge between solar and electric power vehicles in the future and it is most advantageous to adopt the above technology into current electric vehicles.

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