Green Auto Mobile Vehicle Design

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Abstract – *The grid line power crisis is very common in a developing country like Bangladesh. Due to the development of roads and public demands, the number of electric transports are increasing. This has caused for the increase in power consumption for charging the battery of that vehicles. Therefore, to reduce the power consumption of the national gridline for charging electric vehicles, solar energy-based vehicle such as solar energy-based auto-rickshaw, auto-cars are desired. Furthermore, the global warming is increasing due to pollution, deforestation, over uses of fuel-based vehicles, running of industries and etc. Depletion of the ozone layer due to greenhouse gas releases from vehicles will be one of the world's main problems in the future. So, it would be a solution to the above-mentioned issues if solar cars were introduced. This research project aims to develop, implement and deal with the aspects of the photovoltaic vehicle that play an essential role in ensuring a future without energy crisis.*

Keywords*: Green energy, renewable energy, solar auto car*

Article History
Received 1 July 2023
Received in revised form 16 October 2023
Accepted 29 October 2023

I. Introduction

One of the most pressing engineering challenges right now is to find alternative energy sources. In most part of the world, electricity production is primarily based on coal and gas. Despite the fact that this source of energy is abundant, it was shown to be contributing to global warming [1]. Fracking and other extraction techniques have also been proved to have a negative impact on the environment, specifically earthquakes [2]. Solar energy is one energy option that has received a lot of attention. The efficiency of solar panels, which are used to collect solar energy, was previously too low for them to be a practical alternative to energy produced from fossil fuels [3]. Modern materials have made it possible to use solar energy as a renewable resource that is gradually supplying all of the world's energy needs to which society has grown accustomed. The Environmental Protection Agency (EPA) estimates that 26% of all greenhouse gas emissions in 2014 came from transportation [4]. One of the primary benefits of the solar system automobile in comparison to gasoline-powered or electric-powered cars is the decreased consumption of grid-line electricity or gasoline by which it makes the environment clean by no carbon emission both by the car and electrical power plant. So if the car runs solely on renewable energy sources, it will also be better for the environment. As stated in [5] environmental impact is diminished and exhaust emissions are eliminated in solar-powered vehicles. Additionally, they highlight the ecological sustainability and energy conservation of this type of vehicles, in addition to their effective utilization of renewable resources. Electric-power car may be an environment friendly solution for developed countries where power supply is available. But for developing countries such as Bangladesh where power production is costly and also not continuously available. Therefore in developing countries are needed others environment friendly solution such as renewable energy source as solar power. The research of appropriate experimental set-up and cost efficacy information of the use of solar panel into an auto mobile vehicles are not available. Therefore a clear research gap is available to investigate the usefulness of the solar panel as a power source of auto mobile vehicles.

A solar car concept is created and constructed on this research project with explore the potential of solar vehicles as a means to mitigate the challenge of decreasing operating expenses. In order to complete this project, a solar-powered urban application vehicle is considered. The need for gasoline would significantly decline if this kind of vehicle is to become a norm for commercial transportation. The main challenge is designing this car to be practical. The vehicle must be light in order to reduce the size of the motor necessary to meet urban transportation demands. The car is only intended to fit one driver, therefore more room would actually be needed for other passengers and cargo. Another factor to take into account when using solar energy to propel a vehicle is the solar panel's efficiency, which determines how quickly it can provide enough power for propulsion. This causes a number of choices to be made during the design process. Solar cars are combining technologies typically applied to the aeronautics, cycling, alternative energy and automotive sectors. The amount of energy input in the car is too great to be able to design a Solar Vehicle [6]. The ultimate goal of the project is to create a solar powered auto mobile car with cost effective manner. The rest of this research paper will describe literature review part, the methodology used and continuing the system design with result discussion part which finalized by conclusion.

II. Literature Review

A solar car, sometimes known as a solar electric vehicle is primarily or entirely powered by solar energy. Solar panels typically feature photovoltaic (PV) cells that convert solar energy directly into electric energy. The phrase "solar vehicle" typically implies that all or some of a vehicle's propulsion is powered by solar energy. Communications, controls, and other auxiliary operations might all be powered by solar energy. Solar cars rely on photovoltaic cells (PV) to convert sunlight into electricity. When sunlight (photons) hits a solar cell, it excites electrons to flow, creating an electric current.

Solar cells are made of semiconductor materials such as silicon and alloys of indium, gallium and nitrogen.Silico n is the most commonly used material with an efficiency of 25-30%. [7]. Currently, solar vehicles are marketed more as engineering experiments and demonstration vehicles, frequently funded by government organizations, than as everyday transportation tools. However, there are many vehicles that use indirect solar power and solar boats are available [8].

The solar panels are getting the sun's radiation and charging their batteries. The solar panel comprises of photovoltaic cells which observes heat from daylight i.e. sunlight and changes over it as current [9]. Of course, the percentage of charge may vary in the rainy day. Under this situation together with the conventional solar panel the low light solar panel can be used for more efficient application. Solar charging power station can also be built to produce the power bank battery system for the night time functioning [10]. In addition to that light weight plastic solar panel can help to increase the percentage of power generation and to store for the night time application [11]. The engine shaft rotates and make the drive shaft rotates. The wheels rotate and the vehicle moves by means of a drive shaft. The brake pedal, in conjunction with the master cylinder and thus connected to the caliper for stopping a vehicle, should be pressed when braking is required. The caliper will cut off the brake pad and stop the disc's rotation which is connected to the wheels of the vehicle. As shown in Fig. 1, forward and reverse switches is used for the operation of the vehicle on backward and reverse movements [12]-[13]. The working diagram prototype of our project work is shown in Fig. 1.

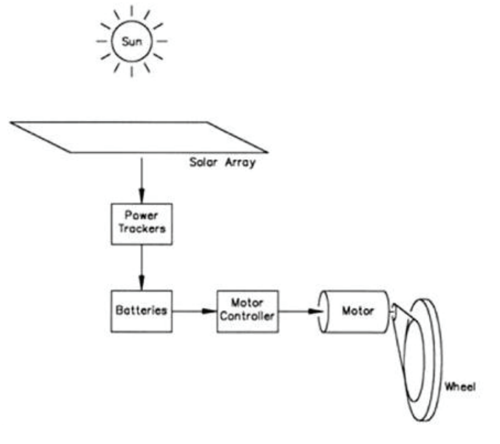

Fig. 1. The working diagram of the solar energy car

III. Methodology and System Design

In this era of technological progress, one can use more and more renewable energy sources such as wind, hydro and geothermal energy. But if we think about driving a vehicle on the road and if it's with help of renewable energy then we have to choose solar power as a source. Because we can easily draw power from it even in moving condition. Hence solar panel is one of the most important components of this research project. This solar panel uses the photo energy through photovoltaic cells to generate electrical energy for the vehicle's battery.

The categories of solar auto batteries are dry cell battery and liquid cell battery. Dry cell batteries have a paste electrolyte and are sealed so they never need to be maintained. They're more portable and easier to transport than liquid cell batteries, but their energy storage capacity is lower. The cost of dry cell batteries is higher than that of liquid cell batteries. Wet cell batteries, also known as liquid cell batteries, use a liquid electrolyte like sulfuric acid to power their devices. They offer a greater energy capacity, but are bulkier and heavier than dry cell batteries. Although liquid cell batteries are more cost-effective than dry ones, they need to be maintained on a regular basis by checking the electrolyte level and replenishing any water lost due to evaporation. In this research project the liquid cell 12V batteries are used for charging by both solar cell and grid power facilities. The solar panel (shown in Fig. 2) installed in this project is capable of producing up to 24 volts and its maximum capacity of generating power is 330 watts.

Fig. 2. The solar panel used in this research project

A. Solar Charge Controller

The next important piece of equipment in this project is the solar charge controller. The unpredictable effects of irregular sunlight depending on environmental factors (such as passing clouds overhead) and weather the produced energy is irregular pattern for regularizing the energy a charge controller is used as shown in Fig. 3. This device monitors the solar energy and voltage of the solar panel and makes necessary adjustments to stable the energy from the solar panel to a fixed level that is safe to use in our vehicles. The maximum capacity of this device is 100A and up to 48V. Correspondingly, the solar charge controller offers various minor protections including overcharge protection to avoid possible minor accidents.

Fig. 3. The solar charge controller

B. Buck-Boost DC converter

In this development a DC-DC converter is used to step up the voltage obtained from the solar panel. The maximum voltage we get from the panel is 24V where we need to charge the batteries at 48V. We have to use a buck-boost DC converter to generate this fixed 48V. Although a DC-DC converter reduces the amount of current produced as the voltage is increased, it still charges and protects our batteries. The special feature of a buck-boost converter is that it can step down or step up the voltage as required. It uses capacitors and inductors to ensure a safe current or voltage for the batteries after increasing or decreasing voltage. The converter can work between 12V to 60V as shown in Fig. 4.

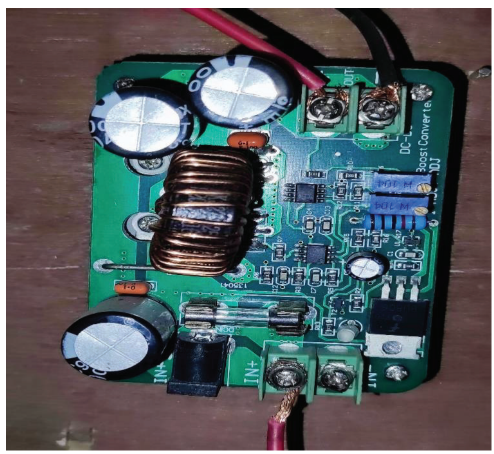

Fig. 4. The Buck-Boost used in this development

C. Implementation

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A solar car is called an electrical vehicle which primarily or completely operates on solar energy, the name of which can also be used for a Solar Electric Vehicle. Finally, as shown in Fig. 5, all discrete components are installed collectively to allow the vehicle to run on energy from solar panels. Two distinct methods of charging are supported by our system. Charging procedure accomplished using both solar panels and grid power. We kept the gridline charging mechanism under common system. In the solar charging process, we have used a solar charger controller so that the battery is not damaged due to the variation in charging. Then we used a buck booster to raise our voltage as the battery required. The buck booster's output is sent to the battery. Grid power charging system will charge the battery directly.

Fig. 5. The designed (solar panel and vehicle) Green Auto Vehicle

IV. Results and Discussion

In this research project we have developed a Green Auto Mobile Vehicle also called Solar Auto vehicle for reducing the power consumption on the gridline of Bangladesh. As shown in Fig. 6 the charge controller is working properly to regularize the power produced by the solar panel of the vehicle.

Fig. 6. Solar sharge controller in working mode

The percentage of charging capabilities both in steady and running conditions with running speed 304.88 rpm (revolutions per minute) are shown in Fig. 7 and Fig. 8 respectively. The maximum percentage of charging is occurring at middle of the day and decreasing at afternoon. Table 1 shows the percentage of charge per hour in day time where the maximum charge per hour is 6%. Daily charging time 8 hours so the total daily charging percentage of 30% which is a considerable amount of charge of full charge. Our experimental research's primary goal was to ascertain the precise amount of backup we could offer without utilizing gridline electricity. Our survey findings show that we may charge our batteries by approximately 30% depending on the amount of sunlight that occurs during the day. We could need to use alternative strategies, like gridlines or another sustainable method, for the remaining 70%.

TABLE I
IN STEADY STATE CONDITION

Sunlight Time	% Charge per hour
9.00-10.00 AM	4.17
10.00-11.00 AM	5.26
11.00-12.00 PM	4.27
12.00-1.00 PM	6
1.00-2.00 PM	3.6
2.00-3.00 PM	3.33
3.00-4.00 PM	2
4.00-5.00 PM	1.4

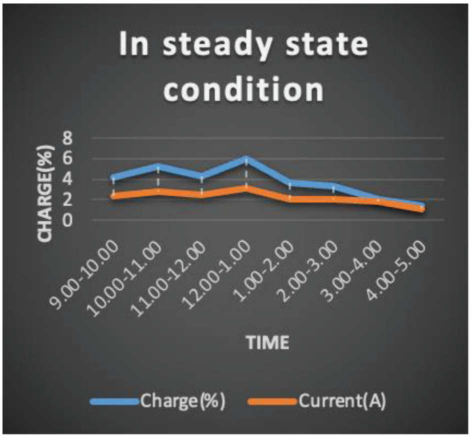

Fig. 7. Charging data in steady condition

TABLE II
IN RUNNING CONDITION

Sunlight Time	% Charge per hour	Running Speed (rpm)
9.00-10.00 AM	4.42	304.88
10.00-11.00AM	5.55	304.88
11.00-12.00PM	4.57	304.88
12.00-1.00 PM	6.3	304.88
1.00-2.00 PM	3.8	304.88
2.00-3.00 PM	3.5	304.88
3.00-4.00 PM	2.19	304.88
4.00-5.00 PM	1.54	304.88

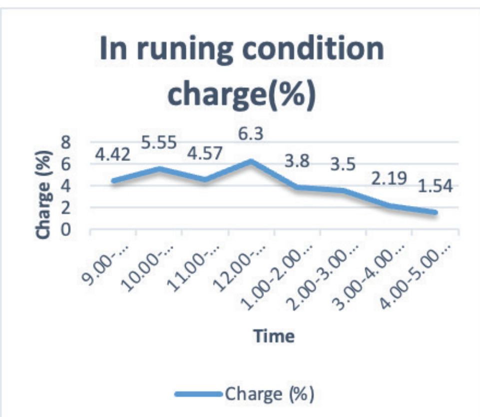

Fig. 8. Charging data in running condition at 304.88 rpm

The charge rate has been displayed by a solar charge controller system that we have integrated into our system. We then evaluated the rate of charge in low and high sunlight conditions. From Table 1 and Table 2 the average charging percentage per hour is 3.75 and daily charging time is eight hours so the total daily percentage of charge will be 8×3.75=30 percentage. We might be able to extract 30% of the charge from the solar panel. Our experiment shows 30% of full charge is possible of 48V auto vehicle using this 330W solar panel as shown in Fig. 9. The idea of the manufacturing sunlight-based vehicle is transferable to any interested company in Bangladesh and other countries.

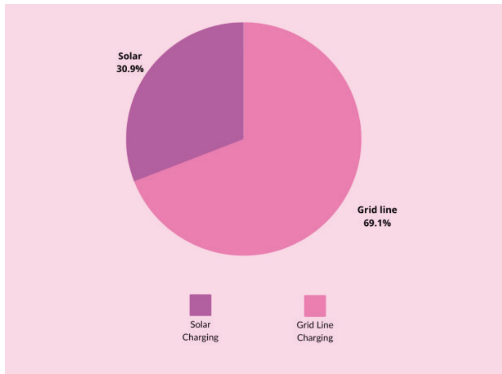

Fig. 9. About 30.9% of full charge is possible using 330W solar panel

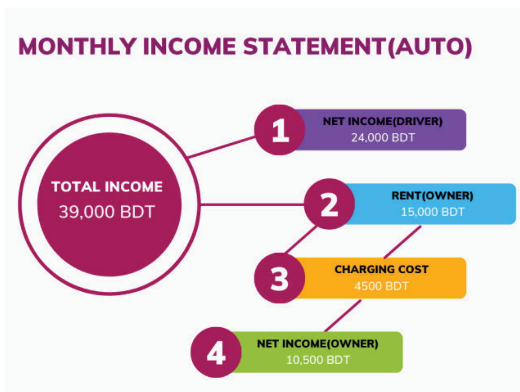

Fig. 10. Detail cost features of the conventional electric car

The Fig. 10 shows the detail cost (BDT) features of a conventional electric car. If we replace the charging sources by solar panel of the existing conventional electric auto car then according to our project observations 30% of total cost (about 1500 BDT) can be reduced per month by which both the car owner and rent driver become beneficiary.

V. Conclusion

This research project provides a useful platform of a Solar Cars which have the cleanest and easiest energy output around. A detail experimental design of a solar powered vehicle with analysis on the cost efficacy is elucidated here. A solar car is an electric vehicle powered by solar energy. 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 to run. There are many advantages of solar car such as it produces less noise, easy to maintain and it produces no harmful emissions when compared with the conventional cars. The implementation of solar energy car can carry a significant value in Bangladesh by consuming less power on gridline for charging the increasing demand of the electrical vehicles. In this project, we have investigated the charging of Auto battery of 48V by using 330W solar panel. Our experiment shows that thirty percent of full charge is possible of 48V auto vehicle using this 330W solar panel. It reduced 30% of power consumption from gridline as well as the charging cost that is about one third of the conventional electric car and it is a remarkable reduction of power from grid line for a large-scale vehicle for any developing country like Bangladesh.

Acknowledgements

The authors wish to acknowledge the UGC, Bangladesh, for supporting this research financially under Grants BMK-3257103(Ref.-RC/RPro/22/6).

Conflict of Interest

The authors declare no conflict of interest in the publication process of the research article.

Author Contributions

Author 1: Conceptualization, supervision, funding acquisition, analysis, investigation, writing – original draft preparation; Author 2: Co-supervision, draft review and editing, investigation; Author 3: Data collection, investigation, review; Author 4: writing – original draft preparation, project administration.

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