CONVERTING A DESERT BUGGY INTO SOLAR ELECTRIC VEHICLE

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Abstract:

The renewable energy became an essential demand for today's world life for all its importance in decreasing pollution and keeping our environment clean. The solar car is a step in saving our environment and energy resources. New project (supported from King Abdulaziz & his Companions Foundation for the Gifted and Technical & Vocational Training Corporation, KSA) is targeted to build a solar electric vehicle. The project was designed for talented students in the field of Vehicles & Engine Technology in Saudi Arabia. We initiated a program for one month duration, which includes different activities in designing, soldering, suspension, steering, electric motors, solar cells and batteries. The aim of this program is to prepare the students to cooperate as a team in achieving the production of the solar electric vehicle.

Starting from a very cheap desert buggy, the new solar vehicle is assembled in innovative manner with used material and component. The solar vehicle is assembled in the workshop of Riyadh College of Technology. The solar vehicle is successfully assembled, operated, tested and ran as fast as 50 km/hr for 3 hours with fully charged batteries. The solar panels will continue charging the batteries. On the other hand, the batteries can also be charged using regular 220 AC Volt. The solar cells extends the running distance by about 40%

Key Words: Renewable Energy, Solar Electric Vehicle

Introduction

As petrol price is rising day after day to a distinguished limit, acquiring a fuel vehicle become costly for everyone, meanwhile the vehicles using gasoline fuel is contributing by a high percentage in environment pollution and a bad effect on the global warming. Most of vehicles' manufacturers are doing their best for producing vehicles which can use different renewable energy sources. In this direction, we have done a contribution by achieving a solar electric vehicle in which we combined solar cells as auxiliary electric source with direct AC source as the main electric source. The AC electric source is used for charging the battery set using charger. The solar panels are covering the vehicle body to help in charging the batteries and to extend the running distance traveled by the vehicle.

Photovoltaic panels: efficiency and cost

The conversion process from light into DC electricity is based on the Bell Laboratories' researches in the 50's, where the principle discovered by Alexander-Edmond Becquerel (1820-1891) was applied for the first time (Gianfranco, 2010). The diffusion of using semiconductor technology has been growing exponentially in recent years (figure 1 and figure 2), due to the pressing need for renewable and carbon free energy (REN21, 2009).

The amount of solar energy is impressive: the 89 peta Watt of sunlight reaching the Earth's surface is almost 6,000 times more than the 15 tera Watt of average electrical power consumed by humans (Smil, 2006).

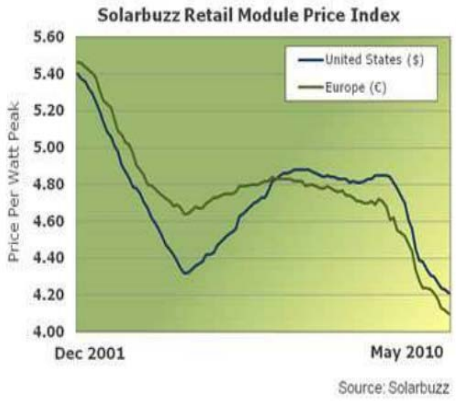

Fig. 1: Trends for cost of photovoltaic modules

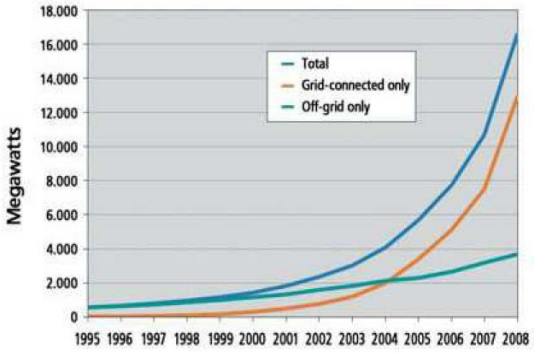

Fig. 2: Solar PV, world capacity 1995-2008

Solar Electric Vehicle Project

The program started with selection of 40 students out of 400 and then the program schedule was distributed among students. The executive team started to prepare for the vehicle whole scenario from start to end. The process started by buying a desert buggy. The problem that faced us was how to transform this very heavy machine to a car that can run by solar and direct electric power. A road map for work schedule is designed according to the availability of materials and according to the following key parts when designing a solar electric vehicle

1. Chassis, suspension and steering: how to build the frame of the car
2. Electrical System: how the solar panels will be assembled, batteries and motor work
3. Wheels, Axles and brakes: how to make wheels turn and how can you stop it
4. Transmission: how to transfer power from the motor to the wheels
5. Body Shell (profile): how the shell effects car performance

Design

The first step on the design was to get rid of the heavy wheels, and draw a complete design putting into consideration, the weight of the vehicle, the batteries location, the electric motor, the control unit, the charger, the electric wires, the solar panels and finally the final profile as illustrated in figure 3 and figure 4.

Chassis

The chassis constitutes a major problem for all its heavy metal construction, its narrow front and its small availability space to place the batteries, charger and controller. For this reason maximum cut of metal construction has been done keeping in mind that the new modification will not affect the safety of the final construction as shown in figure 5.

Suspension

Small modifications were done on the existing suspension as shown in figure 5.

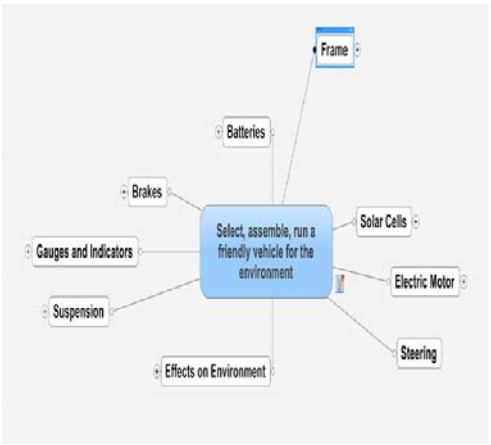

Fig. 3: Design plan

Fig. 4: Detailed design plan

Fig. 5: Chassis, front and rear suspension

Steering

Rack and pinion were used instead of the existing steering to allow more steering control as shown in figures 6 and figure 7.

Electrical System

As shown in figure 8, the electrical system includes the following parts: Electric motor, batteries, Charger, Control unit, electric cables, and electric switches for start and stop, accelerator pedal connection and the solar panels.

Electric Motor

A DC electric motor of 3.6 kW and 48 volt is used. The power delivered to the load from the electric motor was sufficient to drive the vehicle with a reasonable traction and speed as shown in figure 9.

Fig. 6: Steering

Fig. 7: Rack and pinion

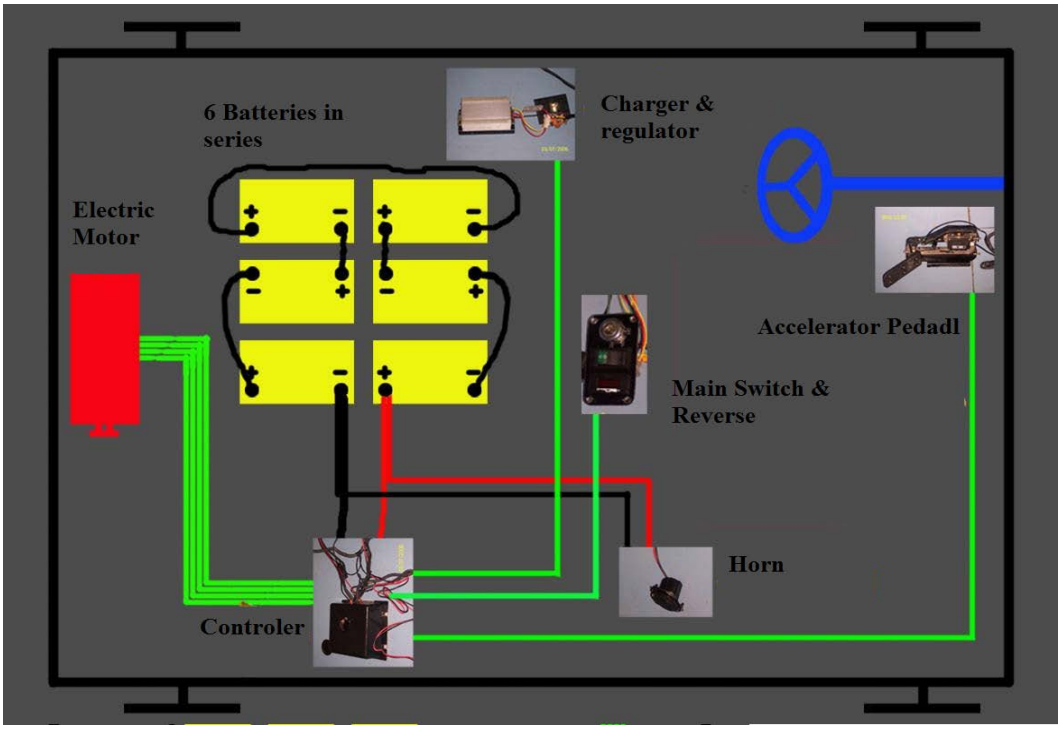

Fig. 8: Electric circuit connection system for the vehicle

Fig. 9: Electric motor installation and aligning **Fig. 10:** Batteries connection and installation

Batteries

To drive the motor of 48 Volt it needed 6 lead acid batteries with 8 volt each with capacity 180Ahr. The size of each battery and the weight was reasonable as shown in figure 10. When being completely empty, the batteries need 7 hours to be fully charged.

Control unit

A solid state control unit is used to control the electric motor speed & direction as shown in figure 11. Reversing and front driving will happen through the control unit as most DC gear motors are normally very easy to reverse; simply changing the polarity of the DC input will reverse the direction of the drive shaft. This changeover process can be achieved via a simple changeover switch.

Fig. 11: Control Unit

Fig. 12: Charger unit

Electric Charging

To recharge the batteries, a portable electric charger is used as shown in figure12. The charger specifications are as follows:

Input: AC230V 50/60 Hz 1.8KVA 8.2A; Output: DC 48V/25A; Characteristic: WSAVDE 0510 T1-3058T1-1; Protection mode: IP21.c1.1; Load: Battery working; Battery: 24 pb element/cells; Capacity: 150-210 Ah

The regulator is shown in figure 13

Fig. 13: Regulator unit

Electric switches, front, rear lights and horn

Figure 14 shows a set of electric switches that used to start, stop, reverse direction, lighting, horning, etc. Others were used to accelerate and slowing the speed. Figure 15 shows the real design of the electrical circuit.

Fig. 14: A set of cables and wires

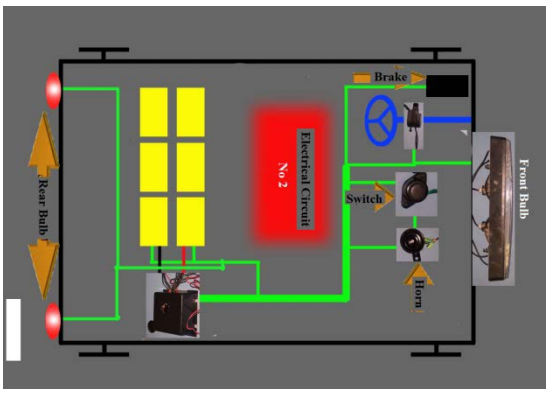

Fig. (15) Brake, front, rear bulbs, and horn wire connection

Brake system

A disk brake type is mounted on the rear axle as shown in figure 16. A hand brake beside the driver's chair is installed as shown in figure 17.

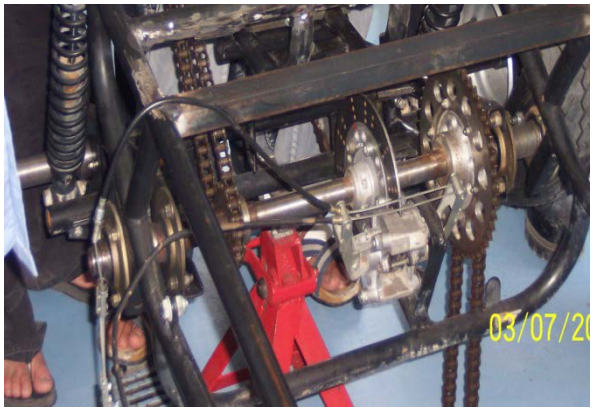

Fig. 16: Brake position in the vehicle

Fig. 17: Hand brake installation

Photovoltaic Panels

A Photovoltaic (PV) panel is an alternative name for solar panel. It consists of so many PV cells wired in parallel and in series. The parallel arrangement is utilized in increasing the current whereas the series arrangement is utilized in producing higher voltage. The front surface module is covered with tempered glass. The back surface is covered with a protective and waterproof material. An aluminum frame holds everything together in one unit. In the back of the module there are wire leads, to provide electrical connections.

Twelve solar panels each with 40 W were used as shown in figure 18 and 19. The solar panels covered the front, ceiling and the back of the vehicle. The solar panels alone were not sufficient to charge the batteries but it helped in decreasing the charging period, in addition it extended the running distance by about 40% (during sunlight period).

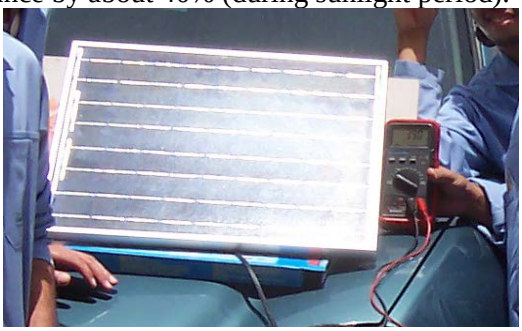

Fig. 18: Solar panel test

Fig. 19: Final Product

Profile and vehicle design specification

The profile of the vehicle is used as a support for the solar plates. After installation of the electric components, the batteries and the solar panels, aluminum sheets are cut and shaped according to the chassis and then it is assembled to the car as shown in figure 19.

Fig. 20 Team Work

Vehicle Specifications

- Length: 3090 mm
- Width: 182 mm
- Front Width: 1200 mm
- Rear Width: 1240 mm
- Base wheel Width: 970 mm
- Electrical motor: DC motor wound shunt, 3.6 KW, 48 V
- Control Unit: URTIC PMC MODEL 1244 MULTI MODE MOTOR CONTROLLER (48V)
- Batteries: 6x8V
- Maximum Speed 50 km/hr.
- Period: 3 hrs.

Conclusion

It's important to shift our energy usage into renewable and clean one. This conversion has significant positive economic and environmental effects. In this paper, the utilization of solar power in vehicle application was implemented. The selection of the appropriate components for the application was studied and assembled together to complete the system. The profile of the vehicle is designed such that the solar modules can be fitted on its surface.

According to the application (converting beach buggy into solar vehicle), the method of the power transmission to the rear axle must be changed. A rear axle with differential is used so that we can increase the speed. The assembled vehicle runs as fast as 50 km/hr for about 3 continuous hours. The solar panels extend this period by another 40%.

With further modification of the profile design and the method of fitting the solar module, we can increase our power generation from the sun.

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