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# Design of Foldable and Portable Solar Panel Assembly Structure for battery charging in rural areas

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**Abstract** — *Solar energy is one of the most abundant forms of energy available through the geography of a nation. The renewable energy technology mainly focuses on the off grid power services for the areas isolated from conventional power supply system. The stand alone solar energy harnessing system has become a valid option in the recent past and times to come ahead. There are applications which are relatively less in power consumption; in some cases the solar energy in the form of sunlight may not be consistent enough to provide a reliable option to similar applications where a cost effective solution is of major consideration. This paper is an attempt to address issues in such cases and provides a design solution to have a portable as well as foldable solar panel mechanical system that can be used to charge a battery based on the availability of sunlight on that particular time of day, also to work effectively even due to obstacles of any nature which hinders continuous and direct sunlight.*

***Keywords*** - *Solar energy, conventional power supply, reliability, portable solar, foldable solar, mechanical system, battery charging, power screw.*

## I. INTRODUCTION

The need for an energy source in the rural areas which are deprived from continuous and uninterrupted power sources is one of the major challenges many developing countries are facing today. Though most of the rural areas are connected to the main power grid system, issues still persist to not having reliable and renewable power source. Renewable energy technologies are suitable for off-grid services, serving the remote areas without having to build or extend expensive and complicated grid infrastructure. Therefore standalone system using renewable energy sources have become a preferred option [1].

Solar energy has been a widely accepted form of non conventional energy source due to its abundant availability. Solar energy for relatively smaller or undersized applications can be used to charge batteries which can run portable electronic devices. In recent times, the usage pattern of electricity in rural areas is not just limited to run basic appliances but also to charge latest technological gadgets available. The abundance and widespread availability of solar energy makes it the most attractive energy sources among others. It can be converted into electricity through low power solar panel systems, for portable applications and used in rural areas. The high cost of solar panels and their low efficiency reduce solar energy's competitiveness in the energy market as a major source of power generation. However when it comes to the portability, solar energy is unarguably the most efficient compared to any other energy source.

Portable devices (mobile phones, tablets, notebooks etc.) have become increasingly popular especially with the proliferation of access to wireless technology. One of its main characteristics is to rely on battery power for its operations [2]. Batteries are nowadays the main energy provider to portable devices. They are known for their high power density and ease of use however their disadvantages limit their application. Their energy density can drop to as low as 200Wh/kg and their technology seem to improve slower than other technologies do [3].

This paper is an effort to design a systematic and portable solution to the requirement of having a solar panel system that charges a battery and can be located in the direct sunlight easily. The proposed methodology enables the battery charging despite the non-availability of sunlight because of shadows getting cast on the panel due to overhead trees or civil structures. Study of sunlight availability specific to a given location and usage pattern is required to yield efficient output from the solar system.

## II. METHODOLOGY

The initial requirement for the design consideration was to provide a battery charging solution to power relatively small electrical appliances. The main advantages of having a portable and foldable solar panel system would be cost effective with one time investment. The system would be highly user friendly to operate and control in the given scenario providing convenience during usage.

A maximum weight target was crucial so as to ensure portability and ease of relocation, the design structure was devised accordingly. Figure 1 shown is the block diagram of the basic working of the system. This includes three solar panels which are made to suit the foldable nature of the system. Charge controller / regulator is intermediately connected between the solar panel connections, battery and load as applicable. A charge controller / regulator is added to limit the rate at which current is added or drawn from battery. It prevents overcharging and also protects against over voltage, which can reduce battery performance or life span. The charge controller has the prescribed connection ports available for the battery terminals as well as the applicable load connections.

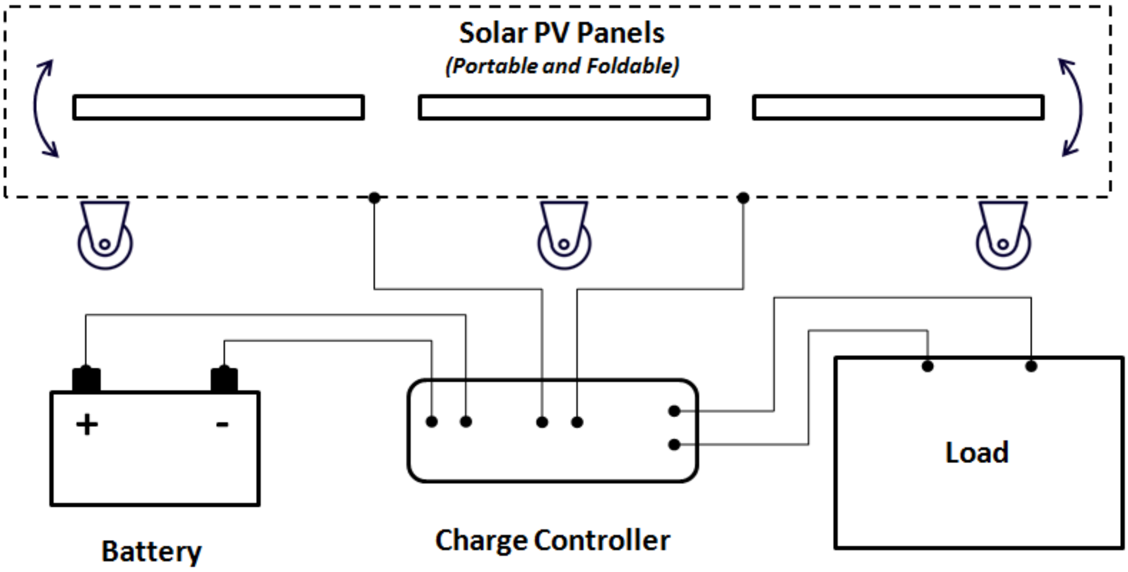


*Figure 1: Block Diagram of the system*

### 2.1. Battery Charging

Most modern electrical appliances receive their power directly from the utility grid. A growing number of everyday devices require electrical power from batteries in order to achieve greater mobility and convenience. Appliances that use rechargeable batteries include everything from low-power cell phones to high-power industrial forklifts. The sales volumes of such products has increased drastically in the past decade.

Rechargeable batteries store electricity from the grid for later use and can be conveniently recharged when their energy has been drained. Battery charging is carried out in two ways based on the time required to charge the battery. Quick charging is 20% of the battery output current and charging current in normal conditions is 10% of the battery output current i.e. for 5A/hr battery the charging current would be approximately 0.5A [4].

### 2.2. Mechanical System Design

The core functionality of mechanical structure designed in the present work is to permit the solar panels to fold-unfold and relocate based on the sunlight availability and on the end user usage patterns. The design of such mechanical linkage structure is very critical and highly significant in efficiently adjusting solar panels to best utilize the solar energy.

The proposed mechanical structure as shown in Figure 2 consists of adjustable linkages made of steel. It is mandatory to consider the mass of each solar panel to be adjusted (to raise or lower from its mean position) to design these linkages. At the same time the total mass of the system should not be too heavy only to sway away from the very purpose of such design. The mass of one solar panel used in this application is of 5W capacity weighs 200grams. A total of three 5W solar panels are used in this assembly as shown in Figure 1. A base plate of 6mm thickness, reinforced with one inch square tubes is taken as the foundation for the structure. A motor of 10W capacity is used to drive the power screw which rotates at 18rpm. A square thread power screw (M20 x 6) is employed to transform the rotary motion of the motor shaft to the linear motion of linkages, by considering mechanical loads in static and dynamic conditions. The motor that runs the power screw draws power from the battery that is being charged. However due to the momentary usage of the motor during the day time, the power consumed by it is relatively less when compared to the power generated by the solar panels.

The linkages are connected to the base of the solar panels mounted at the two ends of the assembly structure. The nut running over the power screw raises the panels over a length of 300mm. The center panel is fixed on the vertical pillar and cannot be adjusted. The two panels which are mounted sideways are connected to the linkages which are joint to the sliding bush on the main pillar, this in turn raises or lowers the panels to orient them in the direction of sunlight. The sliding bush is connected to the power screw nut with the help of a fork. The fork is further extended and connected to the vertical slider which runs on the guide pillars. The guide pillars are solid rods of diameter 10mm; they are welded on the stand raised on the base plate.

 

To facilitate the system portability two 3 inch caster wheels and two 3 inch rigid wheels are mounted at the base of the assembly structure in the proposed design. The selection of the caster wheels is done based on the total weight of the structure to enhance mobility with ease. Wheels made up of rubber material may be alternatively considered to dampen the system from vibrations and shocks that may occur during transit. After optimal sizing of all the components and welded joints the total weight of the assembly structure is 14.6kg. A tubular cross section handle is welded to the assembly system to assist in relocating the assembly whenever and where ever required shown in Figure 2.

Figure 2 and Figure 3 shown are the depiction on the virtual assembly generated with the help of Computer Aided Design Tool. Figure 2 denotes the assembly structure in folded condition. The folded condition helps the user to dismount the system from working; it also helps to rest aside the assembly whenever it is not required, this assembly consumes very less space. Figure 3 denotes the assembly structure in open condition. This is the condition at which the power screw nut locks up at the top of the power screw along its length. In this condition the panels are suggested to be placed facing north-south direction to ensure maximum exposure to the sunlight throughout the day. However the orientation and the opening angles of the panels greatly varies with the latitude and geographical conditions [5].

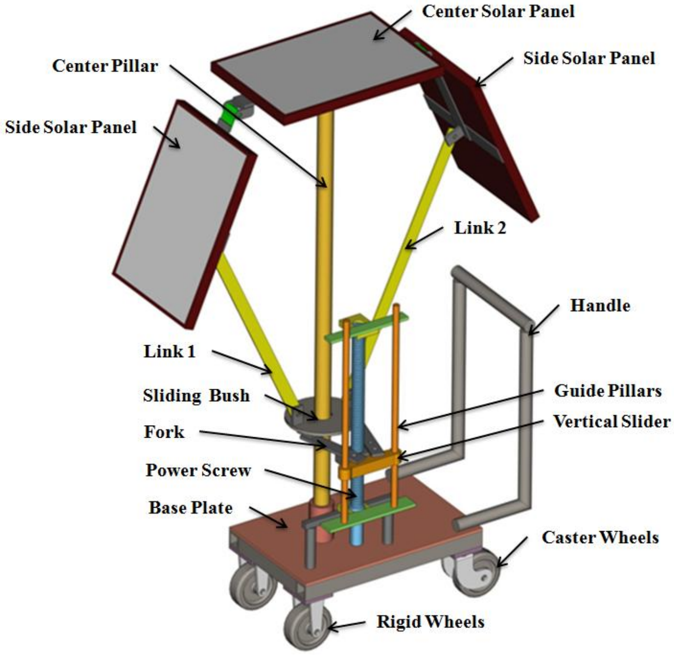


***Figure 2: Structure Design CAD Model in folded condition***

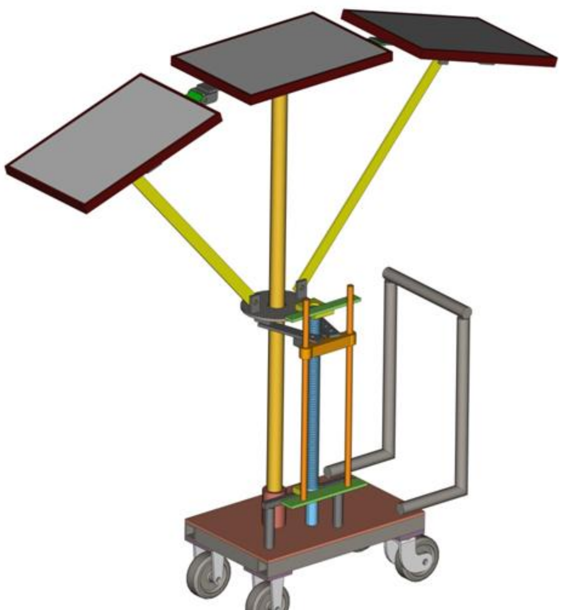

***Figure 3: Structure Design CAD Model in open condition***

Figure 4 shows the actual solar system equipped with the proposed mechanical linkage assembly. Three solar panels that charge the battery are adjusted using the linkages to orient themselves in the sunlight direction.

***Figure 4: Portable and Foldable Solar Panel Assembly Structure***

## III. FUTURE SCOPE

The renewable technologies have come a long way in terms of research and development. However there are still certain obstacles in terms of their efficiency and optimal use. A large amount of the work done thus far has had to do with catering the requirements of the use of solar system in conditions which may not be very advantageous practically. The solar energy technology is constantly getting better in terms of its efficiency, durability, and size of solar panels. Such advancements in technology can severely impact the design of the proposed system with regards to the power requirement. Environmental testing will be essential for this system prior to its critical design review.

Following are the future explorations that can be done in the system design for further improvements:

- The assembly structure employs physical interference for optimum sunlight exposure, thus a system can be developed which enable the panels with a solar tracking device to enhance its efficiency.
- The assembly structure can also be made suitable to have a power driven mechanism to relocate the panels which can reduce the handling effort to be made by an end user.
- The manufacturing cost of renewable energy sources needs a significant reduction because the high capital cost leads to an increased payback time [1].

## IV. CONCLUSION

This paper presents a design solution for a portable and foldable solar panel system that can charge a battery and can be located in the direct sunlight easily. The presented design enables battery charging despite the non-availability of sunlight because of shadows getting cast on the panel due to overhead trees or civil structures. Aspects of mechanical system with power screw and its working methodology are evaluated in this proposed design. The electric current flow pattern in the circuit from the solar panels to the load connected is studied which plays a role in the functioning of the system.

 

**REFERENCES**

[1] Swati Negi and Lini Mathew, "Hybrid Renewable Energy Sysree : A Review," International Journal of Electronic and Electrical Engineering, ISSN 0974-2174, Vol. 7 Number 5, 2014, pp. 535-542
[2] Geist T, Kamath H, Porter S, "Designing Battery Charger Systems for Improved Energy Efficiency," Prepared for the California Energy Commission, Sep 28, 2006.
[3] P. Görbe , A. Magyar, K. M. Hangos, "Reduction of power losses with smart grids fueled with renewab le sources and applying EV batteries," J. Cleaner Production 34, 2012, 125-137
[4] Yousif I. Al-Mashhadany, Hussain A. Attia, "High performance for real portable charger through lowpower PV system," International Journal of Sustainable and Green Energy, 2015; 4(3-1): 14-18 Published online November 12, 2014
[5] http://www.mpptsolar.com