

Installation of Solar Home System to improve the comfort level and living of standard of rural environment

Prof. Trupti Deoram Tembhekar [Prof. Trupti Jayant Sakhare]

Assistant Professor

Department of Electrical Engineering

Yeshwantrao Chavan College of Engineering, Nagpur, (M.S.) India.

ABSTRACT

As an alternative source of off-grid electric power, solar home systems (SHS) stand out above all other options (e.g., wind, hydro, geo-thermal, tidal systems) because of their wide-scale potential at latitudes less than 45° north or south of the Equator where daily solar irradiance is more constant throughout the year and where the bulk of the Third World's population live. The installation of an SHS was found to improve the comfort and living standard of rural dwellers. Easier access to TV, radio, cell phone, and the Internet helped the rural population become part of a more global culture. More attractive down-payment and instalment package options will allow poor target groups to adopt this system. The standard of SHS components and after-sales service should be improved to ensure sustainably and popularity among the mass population for at least 10 years at minimal cost to the consumer.

Keywords - Solar home systems (SHS), photovoltaic systems, Grid, Direct Current (DC), appliances rural health power supply systems (RHS).

Date of Submission: 11-04-2020

Date of Acceptance: 27-04-2020

I. INTRODUCTION

Solar home systems (SHS) are stand-alone photovoltaic systems that offer a cost-effective mode of supplying amenity power for lighting and appliances to remote off-grid households. In rural areas, that are not connected to the grid, SHS can be used to meet a household's energy demand fulfilling basic electric needs. Globally SHS provide power to hundreds of thousands of households in remote locations where electrification by the grid is not feasible^[1]. SHS usually operate at a rated voltage of 12 V direct current (DC) and provide power for low power DC appliances such as lights, radios and small TVs for about three to five hours a day. Furthermore they use appliances such as cables, switches, mounts, and structural parts and power conditioners / inverters, which change 12/ 24 V power to 240VAC power for larger appliances^[1]. SHS are best used with efficient appliances so as to limit the size of the array. They contribute to the improvement of the standard of living by^[2]:

- (a) reducing indoor air pollution and therefore improving health as they replace kerosene lamps,
- (b) providing lighting for home study,
- (c) giving the possibility of working at night and
- (d) Facilitating the access to information and communication (radio, TV, mobile phone charging).

II. TECHNICAL STANDARDS FOR SOLAR HOME SYSTEMS (SHS)

To assure the quality of a photovoltaic power system and its correct functioning and guarantee costumers' satisfaction, it is important that the components of the system and the system as a whole meet certain requirements^[3].

The GIZ prepared a publication which gives an overview of different standardisation activities and existing standards that are relevant for solar home systems (SHS) and rural health power supply systems (RHS)^[3].

(1) DESCRIPTION OF THE APPLICATION:-

Solar home systems (SHS) are so far the most common way to provide access to modern energy systems in rural areas. These systems have commonly a daily energy load of 50–500 Wh. Usually the loads are lights, radios, cellular phones, and, sometimes, TVs. In rare cases, people can afford a small refrigerator. Due to the fact that the users are not very rich, there is a certain price pressure. There is often a tendency to size the system too small. When the system purchase is done by tender there is a high risk of failure:

- (i) Very often the tendering organization has not enough experience to define well-designed systems.

- (ii) Because the offer with the lowest cost will be accepted, the tender limits the maximum quality of the systems.
- (iii) It is hard to organize the after-sales service, which is essential for sustainability.

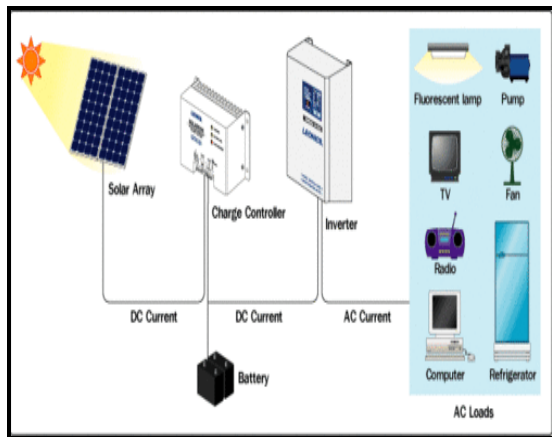


Figure 1:- Solar Power Rooftop Panel

(2) PLANNING A HOME SOLAR ELECTRIC SYSTEM

There are a number of steps to follow when planning to power your home with solar energy. After choosing which option is best for you to use solar follow the steps afterward that apply to you. Your solar energy installer and local utility company can provide more information on the exact steps you will need to take to power your home with solar energy.

- (a) Investigate your home's energy efficiency.
- (b) Assess your solar potential and any limitations.
- (c) Assess your options for going solar.
- (d) Estimate your solar electricity needs.
- (e) Obtain bids and site assessments from contractors.
- (f) Understand available financing and incentives.
- (g) Work with your installer and utility to install the system and set up agreements.

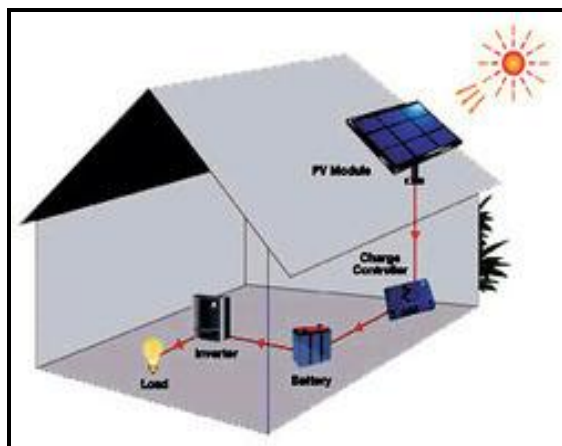


Figure 2:- Photovoltaic Grid Connected Inverter

Solar Home Systems (SHS) are small to mid-size systems using photovoltaic solar energy and battery storage to provide electricity where there is no access to the grid. Solar energy is harnessed through photovoltaic panels installed nearby the house or building and is connected to a battery bank. During night hours, the battery bank supplies the electricity to specific appliances. Such systems are individually sized to suit the end users' needs and can be used for households, offices or business entities that are scattered throughout different areas or entire villages.

A Solar Home System consists of the following components:

- (1) Solar panels that deliver electricity from the sun.
- (2) A battery set that stores the electricity produced by the solar panel and can deliver it at any time of the day
- (3) A charge controller that protects the battery from overcharging.

A Solar Home System works all year round, without the need for any other power source. The battery bank is designed to have at least 5 days autonomy, which means that even if there are five consecutive very cloudy days, the system is still able to work. We offer a variety of sizes from 20 W to 150 W and higher.

During night hours, the battery bank supplies the electricity to specific appliances. Such systems are individually sized to suit the end users' needs and can be used for households, offices or business entities that are scattered throughout different areas or entire villages.

Classical Solar Home Systems (SHS) generally cover a power output of up to 200W peak. They are normally composed of several independent components: modules, charge controller, battery and the loads. The overall energy management is done by the charge controller as the central component of the system. Important advantages of classical SHS are the DC loads like DC energy saving lamps, radios, DC TV and special DC fridges directly usable by the system. This makes SHS very energy efficient systems without any conversion losses. For bigger SHS, the integration of AC loads is possible with the use of a DC/AC inverter, however these loads are often inefficient and oversized and thus can have a long-term impact on the storage capacity, which might be quickly damaged if let in a state of permanent deep discharge.

Consequently, it requires good design and the use of an optimized charging technology. However, trained technicians for the installation and suitable operation and maintenance will easily allow the SHS to provide reliable energy supply for years.

III. COST OF A HOME SOLAR SYSTEM

The cost of the home solar power plant depends on its size and type. There are two types of solar power plants – off-grid & grid-connected. [4]

An off-grid system is a stand-alone system not connected to the main grid. In this system, solar energy generated is stored in batteries (known as deep cycle batteries different from the ones used in automobiles). The DC power stored in the batteries is converted into AC power by an inverter.

A grid-connected system is one which does not use batteries but only an inverter. Typically, a grid-connected system is governed by a statutory policy involving ‘net metering’ wherein the system records the excess electric power generated over and above the usage by the home that is fed to the grid. In this system, the home user need not worry too much about calculating the size of the power plant as any excess power generated earns revenue and any shortfall is made up by grid supply. [5]

An off-grid home solar system is an excellent cost-saving feature when planned properly and is capable of paying back the initial investment within the first 5 years of operation through savings in electricity bill. A grid-connected home solar system is both a cost-saving feature as well as a revenue earning system when planned with revenue earning as an objective. However, while off-grid home solar power plants are independent of the main grid, on-grid systems are subject to the regulations of the grid power supply provider. Thus, home users can choose an appropriate system depending on the circumstances prevailing in their localities. [5]

IV. MATERIALS AND METHOD

The system comprises solar panel, rechargeable battery, LED, glass, switch, resistance, and diode (Figure 3). The overall size of portable solar night lamp is 12 cm × 9 cm, the total weight is 100 gm, and the total manufacturing cost is Rs. 105. LED, glass cover on LED, and solar panel are kept outside, while all other components are enclosed in a plastic box. The cost, specification, and size of various equipment are shown in Table 1.

Table 1:- Details of parts of night solar lamp:-

Serial number	Part name	Specification	Size	Cost
01.	Rechargeable battery	3 V, general	5 cm × 2 cm	Rs. 30
02.	Solar panel (collector)	Photovoltaic (PV) cells	5 cm × 4 cm	Rs. 35
03.	LED	20 mA and 3 V (2 numbers)	1.5 cm × 0.5 cm	Rs. 5
04.	Switch	Plastic, 12 V, 0.5 A	1.5 cm × 0.5 cm	Rs. 5
05.	Glass on LED to form lamp	General thin glass	9 cm × 6 cm	Rs. 10
06.	Bottom plastic box	Light flexible thermoplastic material	9 cm × 5 cm	Rs. 10
07.	Others: diode and connecting wires	-----	Negligible	Rs. 10

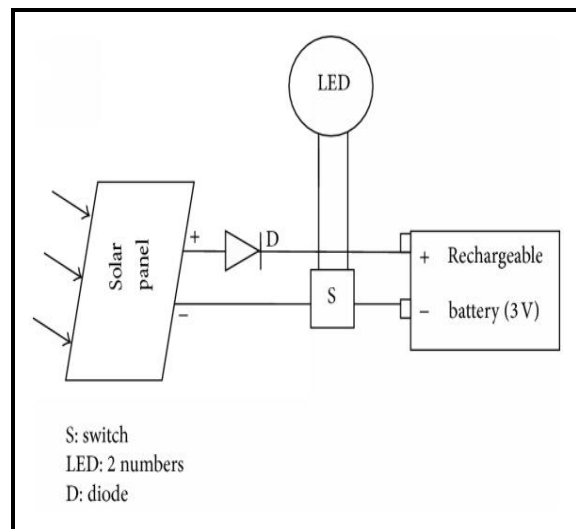


Figure 3:- Circuit diagram for solar power light

V. CONCLUSION

Solar Energy Systems have various applications, such as in household application to power lights and electrical appliances. They can also be used to power health stations located in villages, schools, small businesses, etc. Electricity generated from thermal power station is an expensive source of electricity; solar energy has turned it into an economical power source in the long-run. The amount of electricity generated from solar energy depends upon the available sunlight. [6]

It was established by testing the system during the last six months that if charged for 6-7 hrs in summer sunlight, the battery is capable of supplying stored energy to solar night lamp for 4-5

nights. The developed solar system is costing Rs. 150 only, portable, user friendly, and free from maintenance. It is established that there is need for replacement of conventional night lamp by solar night lamp in every home for the cheaper unit cost as well as solution of energy crisis at present.^[8]

ACKNOWLEDGMENT

This paper owes its completion to the guidance of many and without their help it would not have been possible to move ahead.

I would like to express our deepest appreciation to our project guide for constant guidance and support. The valuable suggestions have contributed in every way for shaping this work. Without supervision and encouragement this paper would have not been materialized.

I would thank to our Head of Department of Electrical Engineering as she has been a constant source of inspiration.

I would like to express our gratitude to Hon'ble Shri. Dattaji Meghe, Chairman, N.Y.S.S., Hon'ble Shri Sagarji Dattaji Meghe, Secretary N.Y.S.S., Hon'ble Shri Sameerji Dattaji Meghe, Treasurer, N.Y.S.S., and our Principal, Dr. Uday P.Waghe who provided us with all the facilities requires for this paper.

Finally, we thank GOD, our parents, my husband Mr.Jayant Bhojraj Sakhare and my lovely cutest daughter Runali Jayant Sakhare for their moral support and constant encouragement.

REFERENCES

- [1]. Laufer, D.; Schäfer, M., "The implementation of Solar Home Systems as a poverty reduction strategy". *Energy Sustain. Dev.* 2011, 15, 330–336.
- [2]. Mondal, A.H.; Klein, D., "Impacts of solar home systems on social development in rural areas". *Energy Sustain. Dev.* 2011, 15, 17–20.
- [3]. Khan, S.A.; Azad, A.K.M.A.M. Social Impact of Solar Home System in Rural areas: A Case Study of Rural Zone. *Energy Environ.* 2014, 1, 5–22.
- [4]. M. Gonzalez, F. J. Ferrero, J. C. Anton, and M. A. Perez, "Considerations to improve the practical design of universal and full-effective NiCd/NiMH battery fast-chargers," in *Proceedings of the 14th annual Applied Power Electronics Conference and Exposition (APEC '99)*, vol. 1, pp. 167–173, March 1999.
- [5]. M. Gonzalez, M. A. Perez, J. C. Campo, and F. J. Ferrero, "Accurate detection algorithm of battery full-capacity under fast-charge," in *Proceedings of the IEEE Instrumentation and Measurement Technology Conference (IMTC '98)*, vol. 2, pp. 755–759, May 1998.
- [6]. Kassenga, G. R. "The Status and Constraints of Solar Photovoltaic Energy Development Energy Sources", Part B: Economics, Planning, and Policy", 3:4, 2008, pp. 420-432.
- [7]. Haney, O. and Burstein, A. "PV System Operations and Maintenance fundamentals", 2013, pp. 45.
- [8]. Wamukonya, N., "Solar home system electrification as a viable technology option for areas", *Journal- Energy Policy*, Elsevier, 35, 2007, pp. 6–14.