THE SOLAR HOME SYSTEM AND ITS ADEQUATE DESIGN TO SERVE THE END USER (HOW SHOULD A SHS LOOK LIKE ? – A COMPARISON IN PRACTICE)

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Abstract

Solar Home Systems -SHS- like the name already says, are lighting systems for residences powered by solar energy. However, implicitly it means that these systems find their application in rural households. Therefore, their design and construction should not only follow the standards and norms valid for electric installations of the respective country, they should also be adapted to the installation environment found in rural houses. The users habits and expectations should be met and the provision of easy, almost non-professional installation of the components would be extremely helpful. Since those systems mostly operate under severe environmental conditions, reliability of the equipment is mandatory and trouble-free operation should be guaranteed for several years. Components should be easy replaceable and spare parts ready available in reasonable distance from the installation site.

Even though thousands of SHS have been installed all over the world, a universal SHS is still not available on the market. Several companies made attempts to come up with suitable SHS but failed to continue the development or even stopped production after a while. Mostly, SHS are a conglomerate of distinctive parts, but do not form an integrated unit where each part has to follow an overall design goal.

Based on a 10–years experience dealing with SHS by installing and monitoring several hundreds from different sources in the north eastern region of Brazil, IDER has accumulated a vast knowledge how an "ideal" SHS should look like. This experience has lead to the design of a "home made" SHS composed out of proven electric and electronic components with hundreds of those successfully implemented. Follow-up monitoring and inputs from the end users have changed our design again. The planning of a fully integrated, cost effective and technical mature unit, easy to install and in harmony with the necessities of the users is now under way.

The basic unit composed out of a standardized reinforced plastic box, housing a sealed solar battery and a special charge-discharge controller and has integrated up to five charging outlets for portable lamps and one fused wall outlet for a TV-set or radio. Each lamp is equipped with a gel-battery to provide at least 4 hours use of the built-in high efficient fluorescent lamp. Each portable lamp has its own discharge controller, and can be hooked up easily in any position and any place of the house. It is water protected and may serve for any purpose in- or outdoors. The solar panel plugs right into the basic unit and comes with a specially designed support, easy to mount to the roof of the house in question.
This unique SHS reflects the end users exigencies to get a universal lighting system and offers advantages for the producer/reseller, because it can be sold off the shelf without the need of in-field installation services.

INTRODUCTION

Solar Home Systems (SHS) are considered to be an adequate solution for rural households located far away from the grid to cover the needs of lighting, communication and other small electric equipment. Depending on the country and the habits of the population, their level of income and other factors, a SHS needs to be perfectly adapted to the encountered environment. Although, the basic components of SHS are essentially the same, one has to study carefully the local needs and expectations. There have to be observed not only technical and environmental aspects. Social-economic issues are from equal importance as well as a precise analyses of the market.

IDER has concentrated its activities in the North East of Brazil. The following assumptions are based on studies and experience in the mentioned region and may not be valid for other countries. However, several considerations can be generally applied all over the world.

In the following are summarized critically the parameters of a SHS design, what went wrong in the past, what can be learned and how to overcome those problems.

1. DESIGN PARAMETERS OF SOLAR HOME SYSTEMS

1.1. Meet Users Expectations

A SHS shall serve the end user and his family. Therefore, his expectations should govern the design and technical construction and not the today available engineering know how and technical possibilities. We see all over the world, that household equipment, washing machines, TV-sets, specifically those remote control devices with more than 20 buttons (needed are only three at most) are designed at the “green table” by skillful engineers, but mostly without or minor knowledge of what the people out there in the field really want and need.

The following items name some of the important users expectations and related difficulties.

1.1.1 Quality of light

The houses we are talking about to be equipped with lighting are small, have in the majority at most four rooms. There is no sealing, the walls are just 1.8 m high and the roof tiles and support structure is visible. The kitchen has an open fire place, furniture is very rare, except some chairs, a table and a cupboard for the radio and/ or TV-set. Water is kept in clay pots. No beds are found, the people prefer to sleep in hammocks. Without any means of electricity, the only light sources are very primitive kerosene lamps, which provide just light to see each other but are from no use to do some house work or to read. Unhealthy smoke is a common by product of those lamps.

What is needed is light in each room, bright enough to read and work, independent to operate and if possible portable for out door use.

1.1.2 Handling and Control

Rugged on-off switches for the lamps are a must. A green light indicating proper operation of the system, and a red light indicating low power is sufficient. The lamp casing should survive harsh ambient conditions and could be dismantled without any tools.

1.1.3 Availability of Maintenance

Technical equipment, even the simplest ones, cannot be repaired on-site in the rural communities. It has to be transported to the next town, which is for the rural population in the North East of Brazil in general a complicated matter. Therefore, the people ask for an accessible repair and maintenance system. This is unfortunately not the case today. The construction of a SHS should take care about this matter and allow easy replacement of components without compromising the whole system.

1.1.4 Costs affordable

The mostly low income of the rural families asks for long term credits with low interest rates. The people are willing to pay over some years and are known to be good clients. Shops which sell bicycles and radios have excellent records of pay back just from these, apparently very poor people. SHS are unfortunately not classified as social matter or goal of some lobbyist. Therefore, they do not receive subsidies by the government as grid expansion in the rural area does. International financing institution should re-think their strategies in respect of SHS. Subsidies for SHS linked to health care, education or agriculture programs could be a way to stimulate the market and bring the costs down to acceptable limits.

1.1.5 Access to Warranty

When buying a bicycle or a radio, the people know to whom to talk in case of warranty. For SHS, due to the long distance to the reseller or manufacturer, obtain warrantee is a difficult matter and has lead to many complains. Higher quality standards have to be established, specifically when the equipment is working under harsh conditions and far away from a service point. Unfortunately, this is not always the case today and decline in users satisfaction could be observed.

1.2 Meet Environmental Challenge

The semi-arid and coastal regions where SHS should operate here in the North East of Brazil present extreme climate conditions to be meet by the equipment. Ambient temperatures range from 25^{o}C to 45^{o}C and under the roofs made out of palm leaves, the temperature is sometimes even higher.

During the raining seasons, the humidity is as high as 95 % with the tendency to condense at night hours.

Beside these severe conditions, the SHS installed at the sea side suffer greatly from the salinity of the air which goes along with the all and everywhere present aggressive sand and dust.

Still not enough, little insects like ants and spiders love the smell of electronic equipment, construct their nests inside of controllers and inverters, thus causing fatal damages. Lamp housings are the trap of any flying small animal, causing dirt and overheating at lamps and ballasts. Cable insulation is sometimes the preference food of rats, while hornets do not miss any opportunity to glue their nests to the rear side of solar modules.

Moreover, the users are in general not used to handle delicate equipment. Broken switches, damaged lamp covers and worn out plugs are the consequence, leading to partial or complete failure of the SHS.

All these issues have to be considered and taken in account when developing a SHS for the rural regions. Rugged design, corrosion proof materials and over sized components are mandatory. The smell of electronic parts and plastic materials should be modified in order not to be attractive for the animals described above.

1.3 Meet Market Necessities

The marketing of SHS in the rural area has to be studied carefully, since it shows remarkable differences to the marketing of other products. Not today and also not in the future can be counted on a well distributed network of resellers and shops. Medium sized cities which are visited by the rural population to cover their needs in household goods, furniture and agriculture tools should be chosen as outlet for SHS. Since electricians are rare, the design of the SHS should allow the installation by non-professionals.

Extreme care has to be taken when elaborating the installation and operation manuals. Since most of the to days SHS are imported, little efforts have been made not only to translate the manuals but adapt the content to the Brazilian user.
When it comes to complain about malfunctioning of SHS the users are often left alone. To obtain guarantee or proper repair is still a nightmare for most of the users. Spare parts are not available and have to be imported. In conjunction with the long distance to the remote houses and restricted transportation possibilities, the users sometimes try to repair the system on their own by bypassing fuses and controllers or installation of automotive light bulbs.

The marketing has therefore to go along with the implementation of a clearly visible guarantee system and the SHS design shall allow easy and uncomplicated replacement of its components.

1.4 Meet Technical Standards

International technical standards for electric installations, plugs, housings, fixtures and other items do exist since a long time. However, Solar Home Systems escaped somehow and little attention is given to this area. The producers invent fancy casings for charge controllers but with open terminals, accessible adjustment screws, with or without fuse etc.. Lamp sockets are either “borrowed” from the common AC lamps (E 27 screw socket) or from the automotive sector. Switches and wall outlets are commonly used AC surfaces mounted units, mostly unsuitable for DC loads. Still exist difficulties with correct cable sizing, labeling and connections and lamp ballasts are often the source of radio and TV interference. Even though norms and standards for the construction and performance of SHS already established in several countries and adaptable to Brazilian conditions, equipment sold in Brazil can do better. Since no bulk or high volume purchase by governmental programs or international projects are under way in Brazil, no real efforts are undertaken to force national and international manufactures to improve their products.

2. ADEQUATE SOLAR HOME SYSTEM FOR RURAL HOUSEHOLDS IN BRAZIL

Taking in account the described parameters and having studied during several years the users aspirations, a SHS (see Figure 1) for rural families in the North East of Brazil was developed, incorporating as much as possible the users desires and the producers exigencies.

2.1 Compact one- unit casing

The basing components such as battery, controller, fuse and a 12 Volts outlet for controlled external connection of a Radio or TV are installed in one compact plastic casing. A heavy duty plug is provided to connect the solar module. The box is sealed to prevent violation by the user. Only the fuse is accessible. At the box are provided four separate plugs to connect the portable lamps for recharging.
The battery has enough capacity to power a small TV four 4 hours per day and recharge the portable lamps at least for three days.

2.2 Portable Lamps

The users asked to provide beside the light in the house portable lamps for outdoor use. The new SHS has four portable lamps, each one equipped with a sealed battery capable to give light during at least four hours at night. A controller in each lamps prevents excessive discharge of the battery.

Since the lamps are portable, there is no extra cabling and additional installation of switches and wall outlets necessary in the houses. The user hooks up or puts the lamps at any desired place inside or outside the house. If there is more light necessary in one room for a special event, more lamps can easily placed there.

The lamp housing has special hooks on two sides to be suspended in any desired position. They can be used as indoor lamps as well as out door hand lamps. This feature allows the people to look after their animals at night, be seen in the darkness when walking at the roads. They can bring light with them for community meetings at the school or to the church, which normally are not equipped with lighting systems.

2.3 Solar module installation

The solar module from whatever manufacturer is equipped with a rugged cable and a heavy duty plug. It is mounted on the roof top of the respective house by means of a simple support. This support sits with its four feet on the tiles while flexible band steel fixtures are lead in the gaps between the tiles and screwed to the roof support structure.

There is no need to worry about the alignment in North-South direction because all houses by default are already in line. In order to prevent excessive sunshine to reach the walls of the house, the people construct their houses already directed to the North.

The installation can be accomplished by the user himself or by an inexperienced but open-minded member of the community.

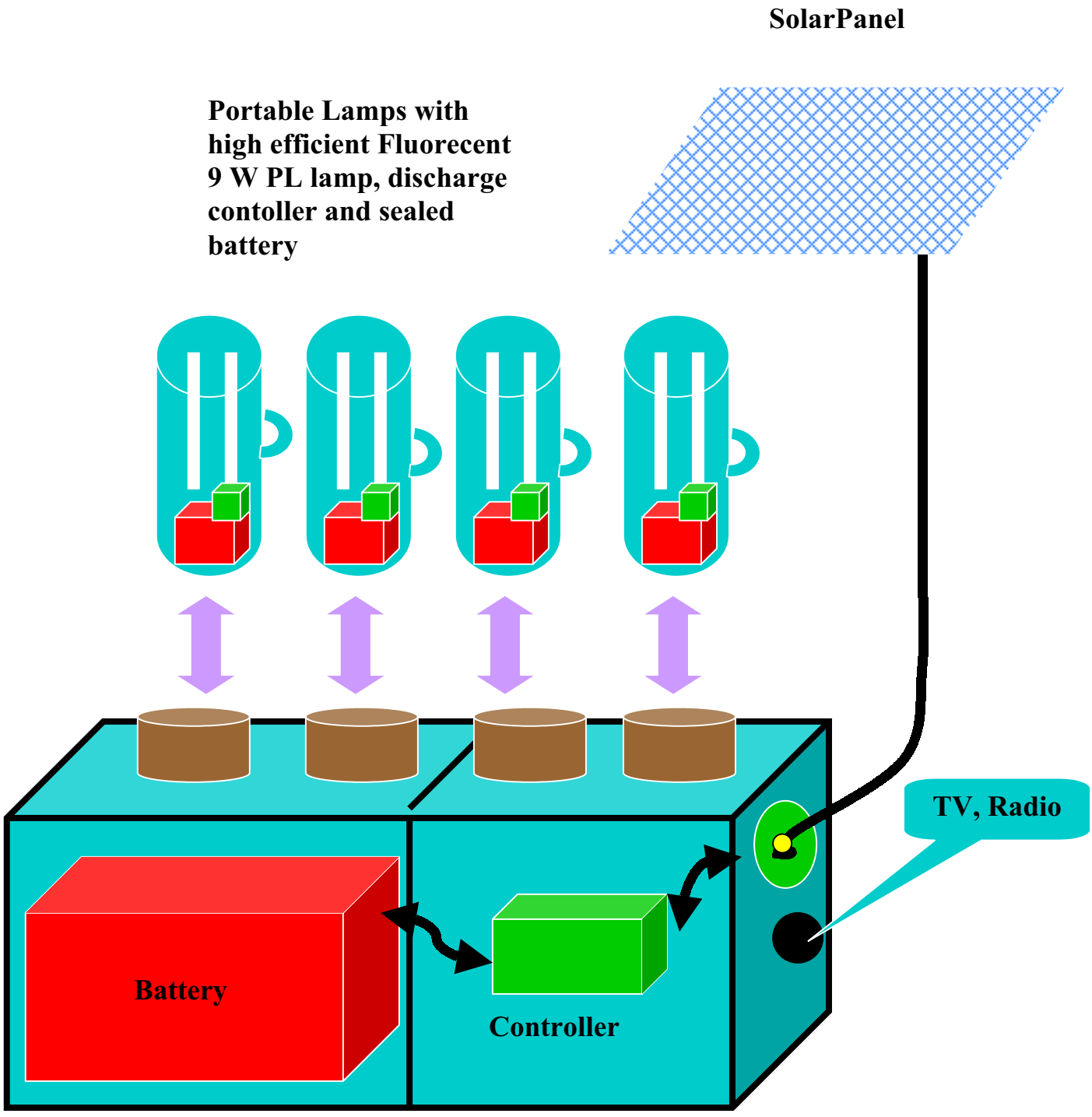
CONCLUSION

The described SHS features a simple, compact design which does not need any qualified technician for its installation. It incorporates the needs and desires of the users to have sufficient light inside their house and outdoors. Its compact design does not need any additional cabling and solar module installation is simple. The portability of the lamps makes it easy to have light anywhere. In case of failure, the whole lamp can be replaced or repaired in short time.

Since the system does not need any trained person for installation, it can be marketed “off the shelf ” like a TV-set or radio. This may lower considerably the maintenance costs because no in-field personal and transportation is needed, both highly expensive in the rural regions.

This new system, constructed out of high quality materials, corrosion proof and meeting given norms and performance standards may be the break through in Solar Home System design.

Figure 1 Proposed Solar Home System for Brazilian rural Houses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