Performance and Social Aspect of LED based Solar Home System: Bangladesh

Arafat Ahmed Bhuiyan* and A.K.M. Sadrul Islam

Department of Mechanical Engineering,
Islamic University of Technology (IUT)
Board Bazar, Gazipur – 1704, Bangladesh

* Corresponding author: arafat_iut_mce@yahoo.com

Abstract

Around 70% people of Bangladesh lives in places which is far remote from the grid electricity and unable to buy generator for their need. To help the poor population in providing electricity some GOs and NGOs have taken some projects on solar home system with subsidy and with very soft loan. LED based solar system is one of those projects and aims to address the poorest section of the population and the Local Government Engineering Department has deployed such system in 11 areas of different parts of Bangladesh. A field level survey in three places namely Saint Martin Island, Chapainababganj and Kurigram has carried out to figure out its suitability to the users considering different parameters and conditions and its impact to their social up-liftment. This study aims to minimize cost of Solar Street Light by using LED to make it more affordable and comparing its effectiveness with CFL based light. LED lamps consume very low power and provide good quality of light and it is three times cheaper than any other traditional CFL lamps.

Keywords: LED, CFL, SHS, Using hour, etc.

1. Introduction

The amount of solar energy incident on the earth every year is equivalent to 160 times the energy stored in the world's proven reserves fossil fuels and also equivalent to more than 15000 times the world's annual use of fossil and nuclear fuels and hydropower. The total solar radiation is divided into three categories. They are: 30% is reflected back to space, 47% is used to warm the earth's surf ace, and 23% is absorbed by evaporation of water [1]. Relatively small proportions are used to derive the winds & waves are absorbed by photosynthesis. Solar energy is important clean, cheap & abundantly available renewable energy.

SHS, a standalone system, has turned into very trendy among rural people. The program has changed lives in remote rural areas of Bangladesh through provided that access to electricity. So far SHS with capacity > 30 Wp are being installed under different program. The performance of these systems was established to be outstanding over the years and pastoral people are now bearing in mind solar technology as their dependable source of power. However, there are definitely demands for minor capacity SHS which is not covered under the program. Therefore, for further distribution of solar program among the lower earnings people, LGED has already taken up a program to broaden small SHS (less than 30 Wp) under different project [2]. In the present study, a survey has been conducted to determine the performance of LED based SHS.

The Objectives of the survey includes verdict the target group of small SHS, to assess acceptability and affordability of small SHS in the circumstance of socioeconomic stipulation of rustic people, to scrutinize performance and plan of small systems and hit upon options for standardizing small SHS under different Rural Electrification and Renewable Energy Development program.

2. Methodology

This analysis has been conducted with survey three different villages where a number of LED based SHS's are employed. Public cognition and attitudes towards LED based SHS are significant issues that shall be identified prior to expand the LGED's programs. Literature review results were utilized as a reference for developing questionnaire content. Interview and questionnaire were used to survey in this study. A self edited questionnaire was used to determine resident's cognition and attitudes towards LED based SHS. The questionnaires were further modified after a review by experts and academics. Questionnaires results demonstrated that the response accuracy rate was high. The survey is conducted to find out the technical aspects like performance, position, using hours, type of problems faced and the social aspects. In this survey, mainly the opinion of the people are expressed about performance of the LED based SHS, its effect on the daily life of them and the overall function of the system in the environment.

Figure 1- Location of survey area where LED based SHS installed

3. Results

The survey covered the households which are brought under small SHS. In Saint Martin Island & Chapainababganj, the SHS are distributed within a confined region but in Kurigram the SHS are distributed among the families of brilliant but poor students. The systems in these areas are: (i) solar Lanterns (6 Wp panel + 2nos LED lanterns 1W each) (ii) small solar home system (SSHS) (10Wp panel + 3 nos LED lanterns 1W each).

The survey included household's monthly income level, monthly expenses on fuel i.e. kerosene and households demand and use of small SHS. The survey data of Saint Martin, Chapainababganj and Kurigram are given in the table 1 to show the socio- economic level including occupation of the people, income range, family member, number of school going children. From the analysis it is seen that most of the people of these areas are leading a lower class occupation like daily labour or farmer. So the monthly income of these peoples is very poor under 3000 BDT. Though income is low, but leading a high number of family members. In three areas, around 50% family consist of 3-5 family members. It is quite impossible for a family to survive the basic needs. Comparing with the higher number of member, the school going children is very less in Saint Martin and chapainababganj. But it is fully different in Kurigram. The only reason is in Kurigram, the SHS are distributed among the families of brilliant but poor students. LGED has supplied various types of LED based SHS in three different areas. The use of different model and specifications and the estimated cost is shown in fig. 5 and given in table 2.

Figure 2– Distribution and use of LED based SHS in commercial areas.

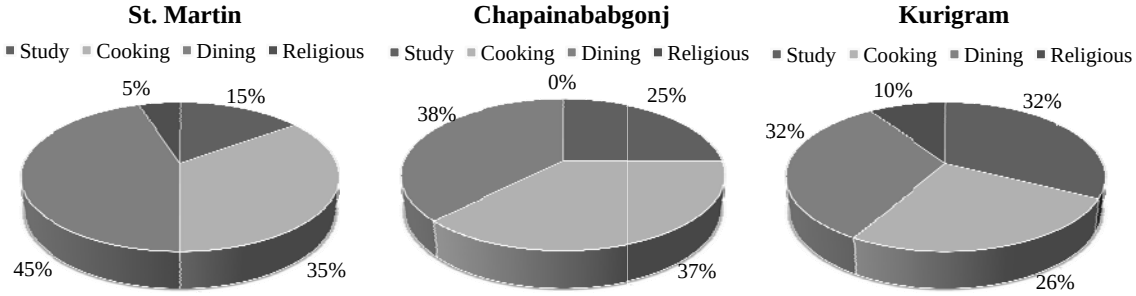

Figure 3-Using purpose by different SHS.

During the survey it has been found that, indeed there are gaps for meeting demand of lower capacity systems in the existing program. Despite the fact that, SHS are distributed amongst the poor people, but most of the small systems are sold in the commercial places like small shops, bazaar etc by the POs. However, small systems can be introduced in a large scale in the households as effective as shops if systems are designed considering their load pattern. Households have been found to use small systems mainly for study, dining and other household activities such as sewing, cooking, praying etcas shown in fig. 3. The small systems developed by POs ranging 7.5-21 Wp used combination of LED lamp and CFL together. The systems developed by LGED ranging 3 Wp- 10 Wp used different combination of LED lamp. LED lamp has been found to be very practical with SSHS since it is flexible and can be used during transportation and other activities. The systems have been installed for 4-8 months and no major technical failure was identified during assessment. Most of the people placed the solar panel on the roof facing them in 23° angle as it was instructed by LGED. But only a few people were placed the panel on a bamboo pole or courtyard .The panel position of different areas are shown in fig. 4.

Table 1: Socioeconomic level of the people of the three different areas

Criteria	*Range*	*SaintMartin*	*Chapainababganj*	*Kurigram*
Occupation	Farmer	17.2	0.00	56.0
	Daily labor	31.0	93.3	4.00
	Shopkeeper	10.3	3.33	14.0
	Ricksha-puller	06.9	0.00	4.00
	Fisherman	43.4	0.00	0.00
	Others	0.00	3.33	22.0
Monthly Income	1000-2000	48.2	84.0	4.00
	2001-3000	51.7	16.0	52.0
	3001-4000	0.00	0.00	20.0
	4001-5000	0.00	0.00	16.0
	>5000	0.00	0.00	8.00
Family members	3-5	55.17	66.0	44.0
	6-7	34.48	22.0	36.0
	>7	10.34	11.0	20.0
School going children	0	24.13	66.0	0.00
	1	31.03	20.0	12.0
	2-3	37.93	13.0	68.0
	3-5	6.890	0.00	20.0

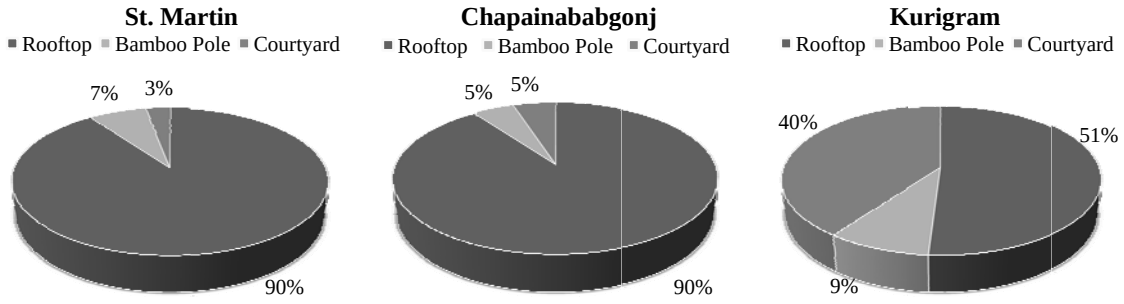

Figure 4- Different Panel positions of LED based SHS.

Table 2- Different model Specifications supplied by LGED

Model	*Specification*	*Estimated cost*
A	SPV module 3Wp, 12 V, 3W LED lantern	6800.00
B	SPV module 6Wp, 12 V, 2 nos of each 1W LED lantern	4850.00
C	SPV module 6Wp, 12 V, 3 nos of each 1W LED lantern	6650.00
D	SPV module 3Wp, 6 V, 1 nos 2.5W LED lantern	3450.00
E	SPV module 10Wp, 12 V, 3 nos 1W LED bulb+ one LED lantern	9100.00
F	One 10Watt TFL and one LED lantern	13000.0

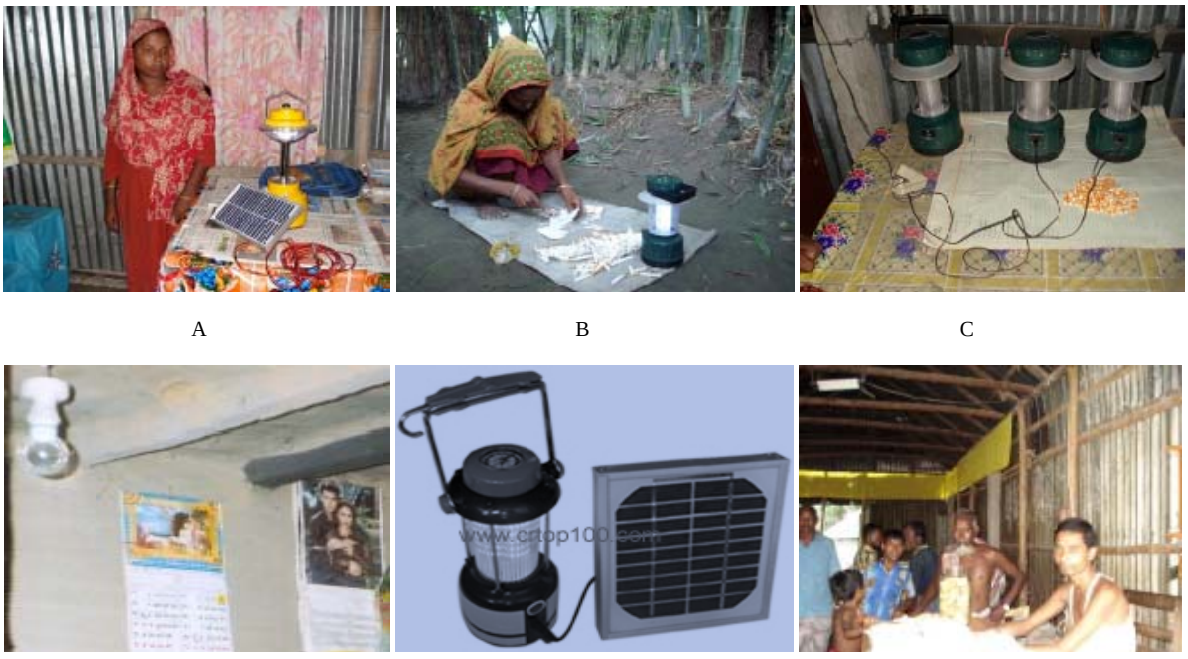

Figure 5 – Pictorial views of different model supplied by LGED amongst people

The SHSs are distributed in the remote areas where three to four hours using in night is much more than adequate. The users are much happier about the light quality which is much brighter than previous Kerosene Lamps. In the previous system, the average using hour was 3-4 hours. But LED based solar system has increases the using hour twice. The using hour of previous and LED based SHS are shown graphically in figs. 6 and 7.

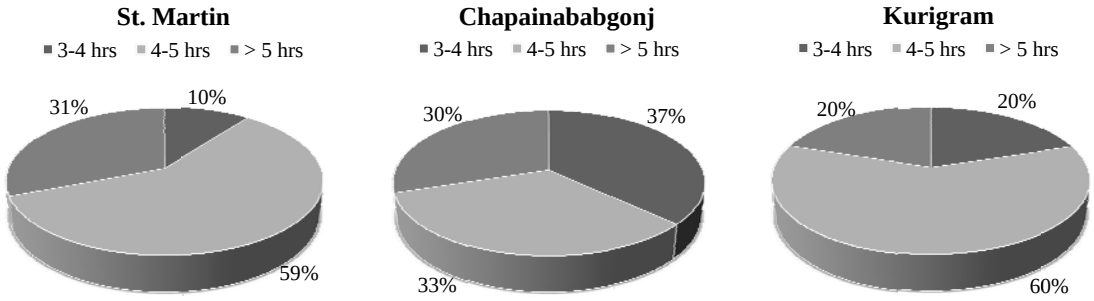

Figure 6- Using hours by previous SHS.

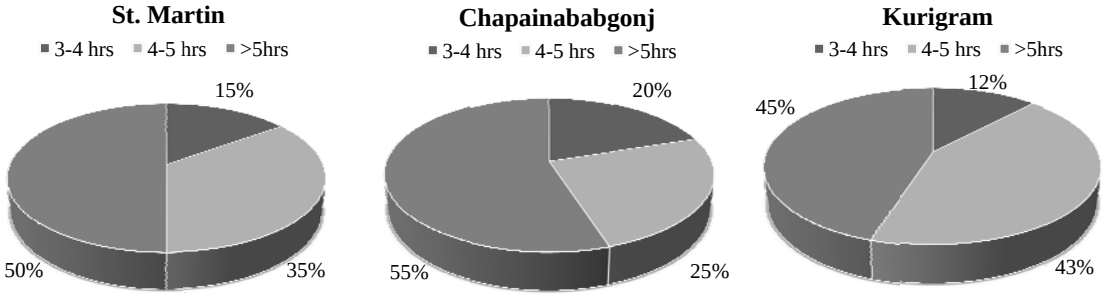

Figure 7-Using hours by LED based SHS.

The cost analysis of the LED based solar system indicates that the overall cost of CFL Lamp can be reduced to one third by replacing a LED based solar system considering the equal life cycle. The comparison life cycle cost between LED and CFL based solar home system. (Life time 20 years) are given in table 3. The survey revealed that user who has income of Tk. 2,000 to 3,000 per month can afford to buy a small SHS in credit. Depending on system capacity (10 Wp to 20 Wp), the price of the system varies in the range of Tk. 6,500- 13,000 and monthly instalment fee of Tk. 175- 350. Households' average fuel (i.e. kerosene) requirement was found to be 5-6 liter per month and they used to spend Tk. 200-250 on an average in each month as fuel cost. Therefore users of small SHS are able to provide instalment fee in place of fuel cost i.e. kerosene. Most of the users previously used kerosene lamp and kupi. But solar lantern and solar light with LED is ideal replacement of the previous sources. The SHSs result less pollution, less darkness, less hassle & less work for cleaning. As the light quality increases greatly it is very useful for the students, the families use the light source for dining and kitchen purpose also.

Table 3: Life cycle comparison cost between LED and CFL based SHS

SHS-1 (3 CFL lamp)		SHS-2 (3 LED lamp)	
Component	Cost , tk	Component	Cost, tk
1 module (36Wp)	12000	1 module (36Wp)	2000
4 solar batteries	10880	10 motorcycle batteries	4640
2 charge controller	1680	2 charge controller	1680
30 CFL lamp	13920	3 LED lamp	2400
Mounting and accessories	800	Mounting and accessories	800
Total cost	39280	Total cost	11520

As we surveyed the places after three months of installation only and monsoon is not yet started, so that we did not hear too much about shadow problem. Around 20% users complained about less brightness problem in one lantern compared to others. But the overall performance of the system is satisfactory as around 60% facing no problem in using it. This is shown graphically in fig. 8.

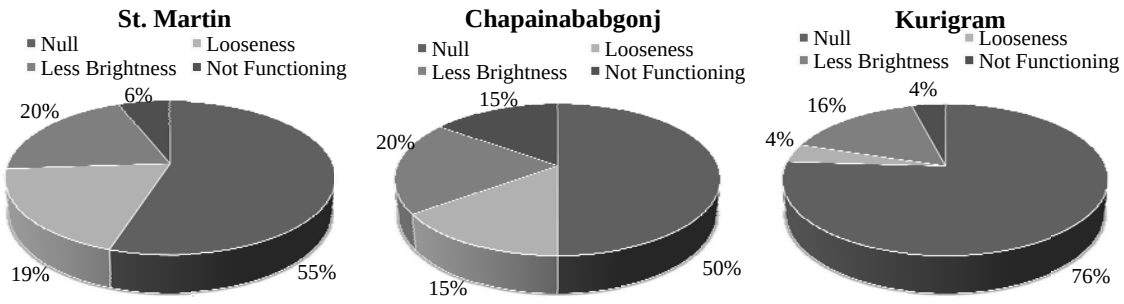

Figure 8-Problem facing using LED based SHS.

4. Conclusions

The survey revealed that the systems that used LED and CFL lamps together, in those systems LED lamp was found to be underutilized in the presence of CFL. Both CFL and LED based systems have some advantages over another. CFL has wider illumination angle but overall system price would become higher because of reduced durability of CFL. On the other hand, LED has comparatively lower illumination angle but overall system price would become lower due to high longevity of LED. Overall system size would also be reduced using LED. Therefore, for small SHS complete LED based systems can be one of the suitable options. From the above analysis, the following things have to be considered to design LED based small SHS such as: Quality of LED has to be ensured, proper design of LED lamp/ lantern has to be selected, to prevent LED from damage, a proper LED lamp controller circuit has to be designed, in case of LED lamp fixed at the roof, height of roof cannot be more than 6 feet from the ground.

5. References

[1]. Ian Rowlands, "Evaluating and comparing the sustainability of Natural gas versus active solar energy to heat the Physical activities complex pool" pp 129-144, ERS 218, December 7, 1998.
[2]. http://www.reein.org/solar/.