

## Subscribing Solar Energy in Rural Household in Bangladesh: A Study on Saint Martin's Island

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### Abstract

*Solar power is the most potential source among renewable energy sources in Bangladesh. The main objective of the study is to investigate the socio-economic impact of solar energy on the household respondents of Saint Martin's Island of Bangladesh. Primary data were collected randomly from 119 sample household respondents by questionnaire survey method. Stratified sampling method was used to collect data for analysis. The findings of the study reveal that the majority of households using solar panel are headed by male and they are dependent on loan for installing solar panel. In view of the impact of using solar panel, it was formed that 93% of the respondents expressed that their education level has increased, 87% of them reported that their economic condition has improved and 94% admitted that their life standard has improved after installing solar panel. They also mentioned that they are getting some benefits from solar energy over the other sources of energy like kerosene, wood, charcoal etc. This study will be helpful to concerned parties in Bangladesh to emphasize the need for spreading the uses of solar panel in rural Bangladesh.*

**Keywords:** Solar energy, Socio-Economic character, Household subscribers, Off-grid island

### 1. Introduction

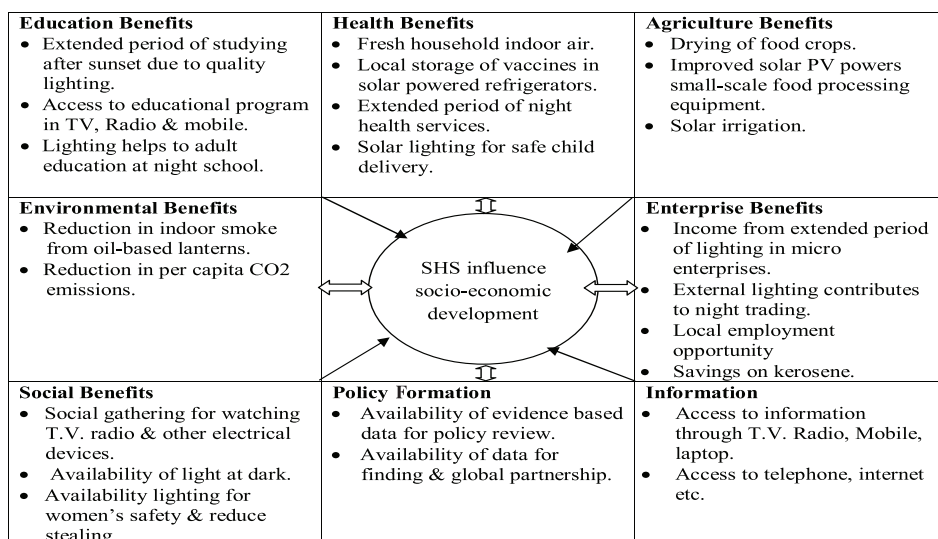
Where electricity is considered as the key success factor for the aggregate development of a country, 1.317 billion people worldwide still do not have access to electricity and 99.8% of them live in developing countries (IEA, 2011). Now a days, overall development includes socio-economic development and environmental sustainability. For this, there is no other way but to ensure improved energy supply. However, Bangladesh lays behind in the meeting demand for electricity due to shortage of available generation capacity as evidenced in 2013-14, installed capacity of electricity during this period was 10341 MW with maximum generation 7356 MW and gap in 2985 MW (Ministry of Finance, 2014). Moreover, due to greenhouse gas emissions concerns are rising and the world is searching for alternative sources of energy i.e. renewable energy. Despite having high potentiality for the use of renewable energy sources in Bangladesh, especially in rural area, the contribution of solar energy to electricity generation still remains disproportionate.

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Renewable energy is, in general, generated from natural resources, such as sun, wind, water, tides and waves. Some significant renewable energy sources are solar, wind, tidal wave, biomass etc. where solar energy is produced by a solar panel. Solar panel is used as the medium of converting solar cell into the electric energy. Another obvious reason for promoting the use of the solar energy is that it is abundant in Bangladesh throughout the year. Moreover, sunlight, the only source of solar energy, is the cheapest source that can be very easily extracted. Again, it does not emit carbon-dioxide (CO<sub>2</sub>) gas to the environment. Thus it can be said that solar energy is beneficial not only on environmental ground but also on economic ground (Bahauddin & Salahuddin, 2012). As it is difficult economically and logistically to reach the millions of off-grid rural people with electricity through conventional means, Grameen Shakti (GS), a member of the Grameen family, started its journey in 1996 as nonprofit company to provide renewable energy services like solar, biogas, improved cook stove and wind energy in remote rural areas of Bangladesh. Infrastructure Development Company Limited (IDCOL) started the Solar Home System (SHS) programme in January 2003 to fulfill basic electricity requirement of the off-grid rural people of Bangladesh as well as supplement the Government's vision of ensuring access to electricity for all citizens of Bangladesh by 2021. Up to May 2017, about 4.12 million SHSs have been installed under the program in the remote areas where electrification through grid expansion is challenging and costly. IDCOL has a target to finance 6 million SHS by 2021 with an estimated generation capacity of 220 MW of electricity (IDCOL, 2017). Solar electrification in rural areas has some unique advantages that other means of energy do not have. A model describing the influence of SHS to the socio-economic development is shown in Figure 1.



**Figure 1: SHS and Socio-Economic Development Framework**

Source: (DFID cited in UNDP 2004, Fishbein, 2003, Martinot, 2004, quoted in Harun, 2015)

Figure 1 reveals that complete socio-economic development framework is presented by the Department for International Development (DFID). The frame work covers some thursting areas such as education, health, agriculture, environment, enterprise, social, policy formation and information which are positively affected by the use of SHS. Against this backdrop, solar energy is found getting much more importance in use in rural Bangladesh. Researchers, policy makers and development partners in Bangladesh acknowledged the immense prospect of solar electricity for rural transformation. As a matter of fact, the country has adopted renewable energy policy 2008, with a view to meeting up at least 10% power of the country's total needs from renewable energy by 2020. But the people of Saint Martin's Island have been using solar energy for more than a decade. The main purpose of this study is to examine in what extent the education level, life standard and economic condition of the solar energy users have been increased in Saint Martin's Island. Not much work has been done based on the same issues of Saint Martin's Island. This study might be useful by providing necessary information to those who wish to install solar energy in their areas especially rural areas. Some research works scholarly done in this regard is worth mentioning.

## **2. Literature Review**

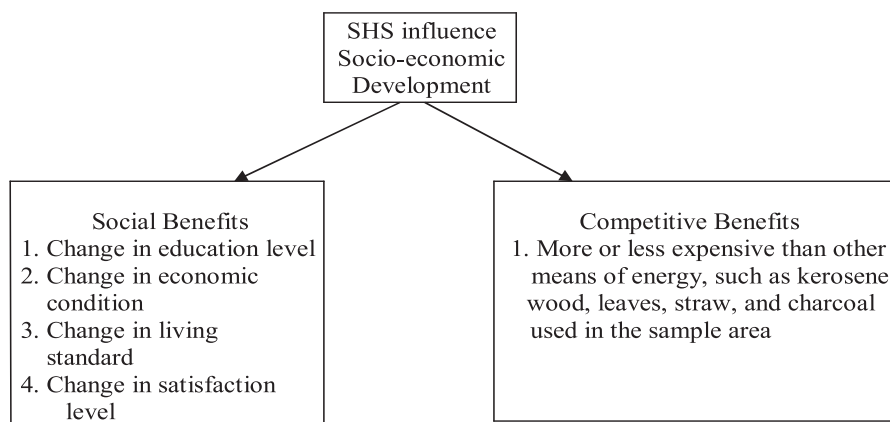
Biswas et al. (2004) showed that PV (Photovoltaic) technology is technically, economically and environmentally suitable in Gopalganj district in Bangladesh. Similarly Kanagawa & Nakata (2008) claimed energy access improvement including electrification has huge impacts on health, education and socio-economic condition. Rio & Burguillo (2009) mentioned that renewable energy sources (RES) have a large potential to contribute to the sustainable development of socio-economic benefits. Raugei & Franki (2009) narrated the photovoltaic energy has a rosy future and is likely to play a significant role in the future energy mix, while at the same time contributing to reduce the environmental impact of electricity supply. Mondal & Denich (2010) stated renewable energy encompasses a broad range of energy resources and Bangladesh is known to have a good potentiality to renewable energy. Similarly Mondal (2010) stated that SHS is financially attractive for rural business and household lighting with entertainment in Gazipur district, Bangladesh. In this regard, Chakrabarty & Islam (2011) suggested SHS is financially more attractive for lighting purpose, improving environmental standard and eco efficiency of the rural community. Linking with the statement Komatsu et al. (2011) indicated households with SHS successfully reduce their consumption of kerosene and dependency on rechargeable batteries with the cost reductions accounting for some 20-30% of monthly expenditures on SHS. Zoric & Hrovatin (2012) stated that the people in Slovenia categorized on the basis of willing to pay, age, household income, education and environmental awareness play the most important role in explaining household attitudes to green electricity programme.

Li et al. (2013) conducted survey in China with 465 participants by using binary logistic regression. Three of the nine factors had positive and significant impacts on fuel cost. Komatsu et al. (2013) suggested SHS increases children's study time, higher level of satisfaction and lower dependence on kerosene in Comilla, Kishoreganj and Manikganj in Bangladesh. Moreover, in confirming with this view Holtorf et al. (2015) stated

around 20% of the world's population currently do not have access to electricity and SHSs are a competitive option for supplying basic electrification in Sunbelt countries. Kabir & Uddin (2015) stated Bangladesh has enormous prospects of renewable energy (solar energy) to meet unmet demand particularly at the remote and off grid areas. By this time, the Government of Bangladesh has planned to generate 5% of generation (i.e. 800 MW) by 2015 and subsequently 10% (i.e. 2000 MW) by 2020 from renewable sources and 20% of the total generation by nuclear, renewable and cross border by 2030 out of 40,000 MW total expected generation. So several issues related to solar energy such as its function, importance, uses have been taken as subject matter of these studies. In some studies based on survey data, main land areas were selected as sample. But the island areas in Bangladesh, most of which still remain off-grid, also have come more or less under the orbit of solar energy. So the impact of using solar energy in those areas deserve an investigation, which has been found lacking in the past studies. The current research is, therefore, an attempt to indentify the factors that influence the utilization of SHS and its socio-economic impact on rural areas in Bangladesh.

### 3. Analytical Framework

DFID model (Harun, 2015) has been followed in a moderated form to develop the analytical framework of the study, shown in Figure 2, by highlighting the social and competitive benefits of solar panel users in sample area. Figure 2 shows the research questions at a glance.



**Figure 2:** Research Questions at a glance

Source: DFID model quoted in Harun (2015)

The research framework shown in Figure 2 has been taken as the cornerstone for setting the objectives of the study. The main objective of the study is to see the impact of using solar energy by the households in the Saint Martin's Island of Bangladesh by highlighting the state of using solar energy, the perception of the rural household users as to their children's education, satisfaction, living standard and socio-economic benefit

of using solar energy, the comparison between the monthly expenses of solar panel and other means of energy used (kerosene, wood, leaves, straw and charcoal).

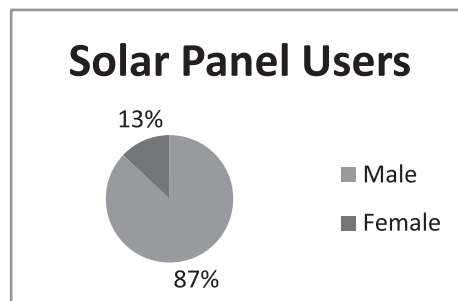
#### 4. Research Methodology

Saint Martin's Island has been selected to determine the socio-economic impact of using solar energy by the household users of that island. With an area of only 8 square Km and approximately 7,000 inhabitants, the island is located in the northern part of the Bay of Bengal (Alam, 2018). Most of the inhabitants use solar panel in their households and businesses, but their accurate numbers were not found. The primary data were collected from this island by open-end questionnaire survey method. A set of structured questionnaire was served to 119 sample household respondents under stratified sampling method. The data were converted into percentage in a table and then shown in different graphs, such as pie chart, line chart and bar diagram to make them usable for analysis. Statistical Software STATA 11 was used to compute different values of socio-economic and demographic characteristics.

#### 5. Result and Discussion

##### 5.1 State of Using Solar Panel

The state of using solar panel in the sample areas has been examined based on demographic data. The percentage of solar panel users in household by gender is presented in Figure 3 and out of Figure 3 Percentage of solar energy users by gender 119 respondents 103 are male (87%) and 16 are female (13%). That is, the majority of



**Figure 3:** Percentage of Solar Energy Users by Gender

households (head) using solar panel are male members. Respondents' age varies from 23 to 75. In this connection, an account of the total years over which the respondents by gender have been using solar energy is shown in Table 1.

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**Table 1:** Number of Years of Using Solar Energy by Gender

	1-5 Years	6-10 Years	Total
Male	71 (69%)	32 (31%)	103 (100%)
Female	9 (56%)	7 (44%)	16 (100%)
Total	80 (67%)	39 (33%)	119(100%)

Source: Household survey

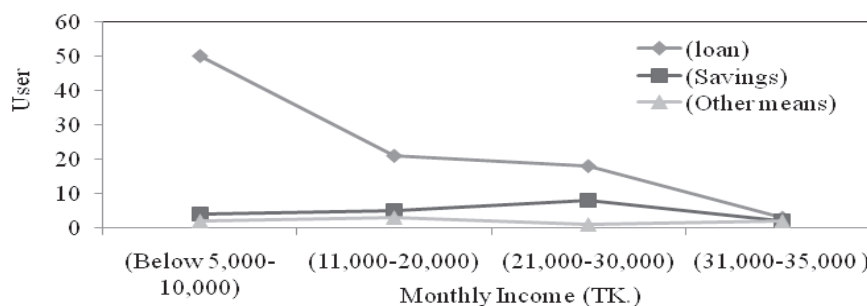
Around 56% of male and 59% of female households have been using solar panel during last 1-5 years as against only 44% male and 41% female users for 6 - 10 years. The rate of increase in the use of solar panel is found above 2 times in male and about 2 times in female users during the last 5 years. Taking male and female users together, this rate of increase is almost 2 times more during 1-5 years (67%) than 6 - 10 years (33%) of using solar panel. Table 2 depicts the financial sources of solar energy users in households by gender.

**Table 2:** Financial Sources of Solar Energy Users by Gender

Gender	Loan	Saving	Other Means	Total
Male	83 (80%)	12 (12%)	8 (8%)	103 (100%)
Female	13 (81%)	2 (12%)	1 (7%)	16 (100%)
Total	96(81%)	14 (12%)	9 (7%)	119 (100%)

Source: Household survey

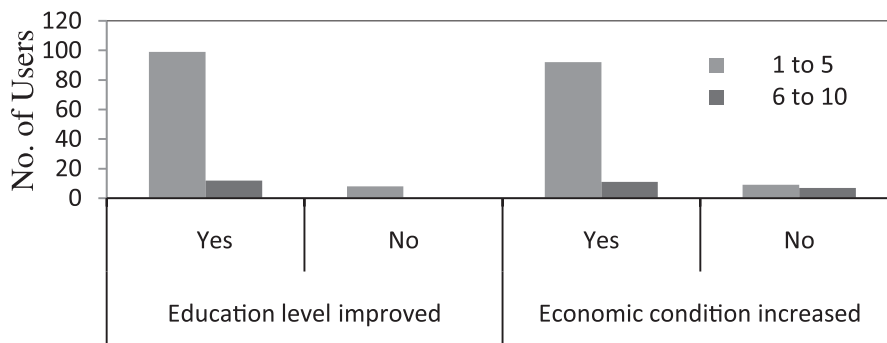
Among 103 male respondents, 80% purchased solar energy by loan, 12% by own savings and 8% by other sources of financing. Among 16 female respondents, 81% used loan, 12% used own savings and 7% used other means of financing for installing solar energy. Majority respondents used loan for installing solar energy. Figure 4 shows the sources of financing the solar panel by the respondents of different level of monthly income.



**Figure 4:** Sources of Financing Solar Energy by the Users by Level of Monthly Income

It is seen from Figure 4 that the number of respondents with the income group of up to Tk. 10,000 is 56 (47%). Among them 50 (89%) respondents used loan, 4 (7%) used own savings and 2 (4%) used other means of financing solar panel. With the income group of Tk. 11,000 – Tk. 20,000, the total respondents are 29, out of them 21 (72%) used loan, 5 (17%) used own savings and 3 (10%) used other means to purchase solar panel. With the income group of Tk. 21,000 – Tk. 30,000, the total respondents are 27, out of them 18 (67%) used loan, 8 (30%) used savings and 1 (4%) used other means to install solar panel. In the income group of Tk. 31,000 - Tk. 35,000, total respondents are 7, out of them 3 (42%) used loan 2 (29%) used savings and 2 (29%) other means. Among all, 77% of the respondents used loan, 16% used savings and 7% used other means. It is also observed that the majority respondents up to the income level Tk. 10,000 used loan for financing the solar panel they are using.

The responses of the respondents with regard to their education level (upto secondary level) and economic condition change in terms of the number of years of using solar panel is depicted in Figure 5.



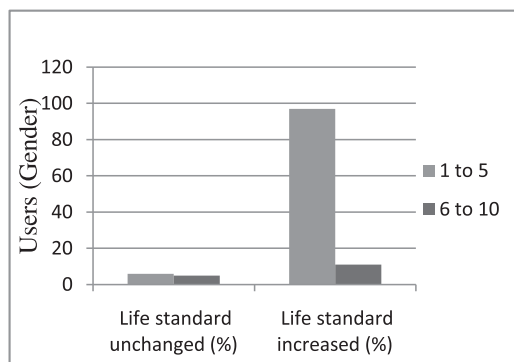
**Figure 5:** Level of Education and Economic Condition of Solar Panel Users

About 93% of the respondents who have been using solar panel for 1 - 5 years, expressed that they got an education friendly environment due to using solar panel. Similarly 100% of the respondents, who have been using solar panel for 6 - 10 years, opined the same. Now the respondents views about the changes in economic conditions in terms of the number of years of using the solar panel are explained.

Respondents who have been using solar panel from 1 - 5 years, 91% reported that their economic conditions have improved after installing solar panel. On the other hand, this rate is 61% among those who have been using solar panel for 6 - 10 years. Considering the respondents as a whole, 87% of them stated that their economic conditions have improved while only 13% replied otherwise. At this level, following section shows the respondents opinions on their living standard and comparative fuel costs following the installation of solar panel.

### 5.2 Respondents' Opinion Following the Installation of Solar Panel

Satisfactions along with fuel cost comparison from using solar panel have been explored on respondents' perception.



**Figure 6:** Living Standards of Solar Panel Users by the Number of Years of Using Solar Panel

Figure 6 reveals that irrespective of years of using solar panel, majority (94%) respondents expressed their views with a positive notation that their life standard has been improved after using solar energy. In this connection, the level of satisfaction of the respondents by gender after using the solar panel is checked in Table 3.

**Table 3:** Level of Satisfaction of Solar Panel Users by Gender

Gender	Not Satisfied (%)	Less Satisfied (%)	Satisfied (%)	Over Satisfied (%)	Total (%)
Male	4 (4%)	12 (11%)	79 (77%)	8 (8%)	103 (100%)
Female	2 (13%)	2 (12%)	10 (63%)	2 (12%)	16 (100%)
Total	6 (5%)	14 (12%)	89 (75%)	10 (8%)	119 (100%)

Source: Household survey

Table 3 shows that among 103 male respondents, 79 (77%) are satisfied, 8 (8%) are over satisfied, 12 (11%) are less satisfied and 4 (4%) are not satisfied. Out of the 20 female respondents, 10 (63%) are satisfied, and remaining 6 are over satisfied, less satisfied, and not satisfied with equal proportion of 2 (12-13%) in each category. Taking all the respondents together, it is found that 89 (75%) respondents are satisfied, 10 (8%) are over satisfied, 14 (12%) respondents are less satisfied and 6 (5%) are not satisfied.

A comparative study in this stage has been done by taking into consideration i) the comparative benefits of using solar panel and the other sources of non renewable energy such as kerosene, wood, leaves and straw, and charcoal etc. by the household consumers and ii) the comparative benefits received by the household consumers before



and after the use of solar panel. Table 4 illustrates the comparative positions of using solar panel and other sources of energy (kerosene, wood, leaves and straw, and charcoal).

**Table 4:** Comparing the Monthly Expenses of Solar Panel to the Other Sources of Energy Used

Other sources of energy used	More expensive than solar panel		Less expensive than solar panel		Total	
	Number	Percentage	Number	Percentage	Number	Percentage
Kerosene	61	97%	2	3%	63	100%
Wood	22	81%	5	19%	27	100%
Leaves and straw	6	67%	3	33%	9	100%
Charcoal	20	100%	0	0%	20	100%

Source: Household survey

Table 4 reveals that 97% of the respondents who use both kerosene and solar panel as the sources of energy opined that kerosene is more expensive than solar panel and only 3% said that kerosene is less expensive. Among those who use wood and solar panel, 81% remarked that wood is more expensive and 19% said that wood is less expensive. Among the users of leaves and straw, though were not significant in number (9, 7.6%) in the sample, 67% favored Solar panel and 33% favored leaves and straw considering their expenses of these sources of energy. Charcoal users gave their entire response in favor of solar panel in terms of expenses.

## 6. Conclusion and Recommendations

There is no doubt about the high potentiality of solar energy in a tropical country like Bangladesh as the sun light, the sole source of solar energy, is available over 300 days a year (Anik et al., 2013). This natural advantage comes out as a blessing to the rural people of this country, especially to those who are completely disconnected from the national grid (NG) electricity, and of course, sometimes, bringing those areas under the NG is very difficult. In such a case, they get an opportunity to enjoy the benefits of electricity by dint of solar energy. This study has showed that the rural people are getting enormous benefits from using solar energy. Despite their financial constraints, they argued in favor of the promotion of solar panel in the rural areas especially in the off- grid areas for meeting the energy demand. A vast majority of them (94%) expressed that their education level improved, 79% reported that their economic condition improved and 99% admitted that their life standard improved after they had installed solar panel. The respondents also opined that they were satisfied with the use of solar panel as it had been providing them with some benefits over the other sources of energy. These benefits were low cost, suitable working environment, increase in labour productivity, increase in monthly income and increase in daily work hours.

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Since there is a significant amount of fixed cost involved for installation of solar panel, some initiatives on long-term basis should be taken by the rich individuals, entrepreneurs, concerned organizations and by the government as a whole so that the rural people do not find any difficulties in installing the solar panel in their homes as well as in businesses. As no significant research so far has been undertaken on a broader scale in this field in Bangladesh, particularly in the island areas of Bangladesh, this study may bring some useful ideas to the concerned individuals or bodies, specially to the policy maker and researchers, who may think of further study so that the use of solar energy can be made more cost-effective as well as user friendly to the marginal people of the country who do not have easy access to the national grid electricity. As a result of that, the mass people of the country will get more opportunities to build their fortune and play their roles in the socio-economic development of the country by using electricity.

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