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USAGE AND SUSTAINABILITY OF SOLAR HOME SYSTEM IN DHAKA CITY

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ABSTRACT

In Bangladesh, sustainable energy has been a hot topic since the country is facing long-standing electricity crisis. The government is trying to mitigate the problem through the sustainable use of the solar panel, yet there is no research directly linking sustainability and solar panel usage in the context of Bangladesh. Hence, the purpose of this study is to identify whether solar panels will be a sustainable source of energy in Bangladesh. The study was conducted with 75 solar panel users living in Bashundhara Residential Area, Dhaka. The researchers deliberately chose this area because a regulation from the authority involves binding the inhabitants to install solar home system. The findings of this study indicate that the usage of solar panel will not be sustainable in the long-run.

Keywords: Renewable Energy; Solar Home System, Solar Panel, Electricity Cost

Abbreviations: BUET- Bangladesh University of Engineering and Technology; BCAS- Bureau of Civil Aviation Security; LGED- Local Government Engineering Department; SHS- Solar Home System; IDCOL- Infrastructure Development Company Limited.

1. INTRODUCTION

Sustainable energy is a kind of energy that fulfills current demand for energy without putting it atthe risk of being expired or exhausted and can be utilized over and over again (Conserve Energy Future, 2012). It has no or limited impacts on human health, the functioning of local and global ecological systems, and the environment. It is the combination of energy savings, energy efficiency measures and technologies. Technologies that promote sustainable energy include renewable energy sources, such as hydroelectricity, solar energy, wind energy, wave power, geothermal energy, bioenergy, tidal power, etc. Hough (2005) describes sustainable energy criteria in three significant dimensions, namely *ecological, economic andsocio-cultural.* A country like Bangladesh with growing population is facing electricity crisis for the extra demand; hence, sustainable energy businesses couldbe very beneficial (Anam and Bustam, 2011). Keeping this in mind, the Bangladesh government decided to ensure mandatory installation of solar panels for the high-rise buildings in Dhaka and other major cities in a bid to beat annoying power crisis (The Independent, 2016).

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Eventually, the solar panel has emerged as a dominant concept amongst business organizations and potential users. Managers from different organizations have recognized some opportunities in this industry since it is not contested yet. Some of them have formulated their penetration strategies and entered the market with a vivid mission. However, the managers hardly examine and know the sustainability of solar panel. There has been no significant research in the country to explore this area.

The purpose of this study is to identify the sustainability of solar panel in the context of Bangladesh. Other objectives are to ascertain the impact of solar panel in Bangladesh, the social acceptance of solar panel, the financial benefit of solar panel users in the context of electricity cost and to extract the idea of the challenges, problems, strengths and weakness of solar energy system.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Electricity is a very significant factor in developing the economy and the standard of living of a country. Bangladesh largely depends on natural gas and hydro power stations to generate major portions of power. Unfortunately, the current production capacity of the country is not sufficient, which hinders development. As such, it is imperative that the government improves capacity. However, it is mere a difficult task due to the association of a higher level of financial commitment. According to Cecelski (2000), achieving sustainable development by accessing clean energy and water is rather difficult for developing nations due to the poverty trap. Therefore, the government has desperately looked for strategic solutions to sustainable energy development for the country as economic sustainability is impossible without the use of modern and efficient energy services. Eventually, it is decided to implement a policy for renewable energy to maintain a sustainable development in the energy sector.

Energy efficiency and renewable energy are said to be the twin pillars of any sustainable energy policy. It has a national security benefit as it involves reducing energy imports leading to an increase of government reserves and gradually diminishing the rate at which domestic energy resources are depleted. Farhar (1999) states that energy savings will reduce the country's energy demand-supply gap and mitigate adverse effects on climate change. Efficient use of energy should be seen as a moral issue- to use available energy resources in consideration of future generations. The deficiency of energy supply might be compensated with the help of wind power plants along the coastal regions. Ocean wave energy is generated directly from the waves of the oceans. It is another type of renewable energy which helps to decrease the harmful emissions of greenhouse gasses associated with the generation of power. It can be potentially a significant source of electricity for Bangladesh. Though the purpose of ocean wave energy is electricity generation, it can also be used for the pumping of water, water desalination, etc. According to Banglapedia (2015), “The Oscillating Water Column method is technically feasible and becoming attractive for this

purpose. This type of wave energy harnessing device is being commissioned by several countries such as the United Kingdom (500 kW), Ireland (3.5 MW), Norway (100 kW), India (150 kW), etc." Bangladesh has a potential for harnessing ocean wave energy from the Bay of Bengal.

The national energy policy of Bangladesh was revised in 2000 to include sustainable development and facilitate renewable energy sector. Establishing the vision of reliable and affordable energy supply at all level by 2020; Bangladesh government has improved national strategies for the development of energy sector. The ambition was to increase scopes of power generation, a reliability of supply chain, provide security and services according to the demand. The vision of resettlement of policies was to elevate the gap of energy access situation and to bring entire country under electrification by the year 2020 (National Energy Policy, 2005).

Though many power generation units have been added to the national grid to resolve the current crisis, yet the issue has not been resolved. Increasing need has created challenges for the power stations to meet the demand.

Bangladesh is a plain delta which consists three of the world's major rivers- the Ganges, the Brahmaputra and the Meghna. The Jamuna-Padma-Meghna river system creates an average water flow of 1.3 trillion m3 in a year throughout the country (Wazed and Ahmed, 2008). Many other rivers flow throughout the country are the tributaries of these rivers. About 57 rivers are trans-boundary originating from India and Myanmar. During monsoon the flow rate of most of the rivers is high, but it reduces substantially during winter. Hence the scope of hydropower generation as a source of sustainable energy is very limited in Bangladesh except in some hilly regions in the northeast and southeast parts of the country. However, there are a lot of tributaries, canals, tiny waterfalls which have the potential for establishing hydropower plants and producing more sustainable energy resources (Wazed and Ahmed, 2008). However, policies were not enforced, and initiatives were hardly taken to put the potential into practice. Bangladesh National Energy Policy, which was first introduced in 1996, only marginally emphasized environmentally sound energy development including renewables (Doraswami, 1996).

Research demonstrates that the country is suffering from acute problems regarding its power supply. The general lack of access to electricity imposes limits on the prospects of growth and increased welfare. The overall incidence of electrification for households is only 42%. About 81.4% of the total power generation depends on natural gas. The rate of increase in electricity consumption is 10% annually. If this rate continues, the reserve of natural gas may not last more than ten years (Hasan, 2012). This is an alarming situation. The situation is even worse when the supply of electricity is frequently interrupted in the urban areas of Bangladesh, especially in Dhaka city. The current crisis is not just a result of growing consumption but also a low electricity-generation capacity of the country (Bhattacharya, 2006).

Under these circumstances, the Solar Home System (SHS) could potentially be a positive alternative in providing affordable electricity. Sunlight combines with two types of energy-light, and heat. Both may be utilized, directly or indirectly by converting them into electricity. Being a tropical region, Bangladesh is endowed with sufficient supplies of solar energy. The annual amount of radiation varies from 1840-1575 KWh/m2, which is 50%-100% higher than Europe. Consumption of only 0.07% of the radiation could meet the present requirement of the country (Eusuf, 1997). It is important to mention that Bangladesh has already seen a moderate level of success in the area of renewable energy. The solar home systems program initiated by Infrastructure Development Company Ltd. (IDCOL) has been a huge success. The company has been striving hard to promote renewable energy facilities. It has installed over 1.2 million solar home systems of 20- 130Wp in the country since 2002, benefitting over six million Bangladeshis. (IDCOL, 2005). According to Marro and Bertsch (2015), as of December 2014, IDCOL provided loans and grants totaling about $594 million for the installation of 3.5 million solar home systems generating clean electricity equivalent to about 141 megawatts. The solar system program conducted by them has changed the lives of over 16 million people. This population is equivalent to about 10% of the overall population of Bangladesh and is the largest off-grid solar program in the world. Moreover, the program is also saving about 200,000 tons of fossil fuel per year and has created jobs for over 75,000 people. The program has succeeded in achieving a rapid growth rate of sustainable energy usage in a lot of parts of Bangladesh. As a result of this development, a large volume of people from both rural and urban areas are pretty much familiar with different electronic devices and equipment run by renewable sources. They involve using electric lights, mobile chargers, fans, radios, TVs (Black and White), Refrigerators, etc. (Omer, 2008)

Another successful company that is striving hard to promote the sustainable solar home system in Bangladesh including Dhaka city is Grameen Shakti (GS). Barua (2007) indicates that GS has been very successful in developing sustainable energy business using a market-based approach. GS has been successful because it has developed a unique approach that involves soft credit for consumers, adaptive technology to lower costs, maximizing income generation, and after sales service. As of June 2007, GS has installed 100,000 Solar Home Systems in major cities including Dhaka. A Nongovernment Organization (NGO) is also working on social development through sustainable energy system is BRAC. It is implementing Biogas project in one of the BRAC operated areas as an experimental scheme since September 1996 (Aktar, 1997).

However, Bangladesh largely depends on natural gas and hydro power stations to generate a large volume of power and unfortunately, the country is lagging behind. Bangladesh gets the sunshine all year around. The government is working very hard to make the use of solar panel accepted among the people of Bangladesh and also wants to make this practice sustainable. For this, the government has enforced laws concerning the mandatory

establishment of the solar panel in new highrise buildings in Dhaka and other major cities. Both Grameen Shakti and BRAC are working collaboratively with the government to make solar panel socially acknowledged and received among the inhabitants of the country, especially the ones living in Dhaka city.

So, the motive of the discussion is to demonstrate how sustainable energy produced by solar panel can resolve the electricity crisis in Dhaka city. It also shows how solar panel users are benefited regarding electricity cost. Hence, government initiative as well as strategy in the context of solar panel will be sustainable. They will also gradually increase the number of solar panel users. It is hard to find relevant research material regarding solar panel and its sustainability issues in the context of Bangladesh. This article is unique of its kind and will help the reader to find out about the concepts of solar panel, government philosophy, and business initiatives for proper panel design to produce sufficient electricity for SHS and flexible use.

3. RESEARCH DESIGN

3.1 Sample Selection of the Study

The respondents of this research study are from Bashundhara Residential Area of Dhaka city, and all of them are users of solar electricity panel. They are randomly selected from the chosen area. However, the area is deliberately chosen because Bangladesh government has made installation of rooftop solar panel mandatory for the new houses constructed here. Thousands of new buildings have been developed so far since this regulation was put into practice. Hence, the research site ensures the availability of the solar panel user which is relevant to the study. A total number of 75 (n=75) respondents have been asked by the researchers for their approval and valuable answers to the questionnaire.

3.2 Sampling Method

Random sampling method has been used to obtain a more scientific result that could be used to represent the whole of the population.

3.3 Questionnaire

The questionnaire contains information about whether the users of the solar panel are financially benefited in term of electricity cost; whether they are installing solar panel because of the government pressure or their preference; whether the government strategy makes the solar panel business sustainable. It also has questions related to acceptance of the solar panel in the society, the cost of this technology, and the extent to which it reduces electricity crisis in Dhaka city. Above all, there are items regarding the problems conformed by the business and may come across in the future.

4. RESULT AND DISCUSSION

It is evident that there is a huge electricity crisis in Bangladesh, especially during summer when the usage of electricity increases. All of the respondents of this study use solar panel regularly because of the statutory law enforced by the government and regulatory notice by Basundhara Residential Area authority (Daily Sun, 2016). However, while conducting this survey, it is found that most of the buildings use the solar panel exclusively for corridor or bathroom power supply. Interestingly, Table 1 indicates that a large group of people (31%) does not use it at all, although they have installed one. They are just having it because the government enforced laws. Pressure never gives pleasure in doing something, and the above result is a good example of this. About the electricity cost associated with the solar panel, 41% of the users think that solar panel is cheaper as compared with regular electric supply. Other 36% are not sure about the comparison of cost, while the rest (23%) believe that regular power supply is more cost effective than solar panel based electricity. This finding hint at the efficiency of the solar panel as a good source of sustainable energy and it is, of course, affluent if the product design and service are reliable and easier to use. When electric supply cost is rising, using solar panel can dramatically reduce it. Nevertheless, some of the users believethat they are not sure about the cost effectiveness because they are less likely to compare their regular bill with the solar electric bill.

The respondents are asked some questions to determine the challenges in popularizing the use of the solar panel. The answers mostly include negative information. For instance, 33% of the users think that solar panel is not affordable at all and 27% of them a lack interest in it. On the other hand, some of the respondents have a lack of trust in its ability and find this inconvenient, approximately 26% and 13% respectively. As solar panels are expensive and people do not want to bear the cost, the government might think of supplying them at an affordable price or arranging bank loans (as happening in the village area). Thisfacility will increase the number of solar home system users. Subsequently, a significant amount of respondents are not happy with the solar service system, and the reasons for their dissatisfaction came out through four important factors, which are – low supply of electricity, difficulty in maintenance and cost associated with this, and poor battery life. Finally, information has been gathered about social acceptance of the system, which is another challenging factor. Results indicate that 58% of the respondents believe that solar panel has not gained a significant level of social acceptance yet. However, 42% of them have a different thought. They opine that it has received a high level of social acceptance already. The descriptive analysis of the findings has been presented in Table 1.

Table 1- Major results from the survey on different variables

Variable	Result
Reason for using solar panel	Own preference 32 % Government pressure 68%
Feel the electricity crisis	Yes (29%) No (31%) Sometimes (40%)
Continuation of solar panel usage	Yes 28% No 72%
Regular electricity supply costs less han solar panel cost	Yes 23% No 41% Not sure 36%
Solar panel can reduce electricity crisis	Yes 64% No 36%
Sustainability of solar panel	Yes 25% No 47% Not sure 28%
Satisfaction with solar panel service	Yes 53% No 47%
Availability of solar panel provider	Yes 82% No 18%
Social acceptance of Solar panel	Yes 42% No 58%

The government has already taken the initiative of popularizing SHS in urban areas. Nevertheless, high installation cost, maintenance cost, difficulties in use and low capacity of the system act as barriers in this context. The scope for the business organizations would be to consider those issues for the future supply of SHS. Although the users are not satisfied with the overall performance of it, they merely have one to meet the building regulation. If this situation continues, it will not be widely used as a source of electricity in urban areas. Therefore, there will be no sustainability in the end.

In Table 2, R-value shows the correlation between dependent and independent variables. Here, the only dependent variable is the sustainability of solar panel. Independent variables include social acceptance of solar panel, availability of solar panel providers, continuation of solar panel usage, reduction of electricity crisis by solar panel, user satisfaction with solar panel service, reason for using solar panel, solar electricity usage area, cost effectiveness of solar panel, factors preventing from using solar panel, reasons for dissatisfaction with solar panel and crisis of electricity supply. If the R-value is close to **zero**, there is no correction between dependent and independent variables. However, R-value is **0.968**, which is greater

than 0.5 and very close to 1. This value demonstrates that a strong correlation exists between dependent and independent variables. Therefore, the model fits. Furthermore, R-value (0.968) can explain the dependent variable, and the significance level is greater than .05 as indicated earlier. Hence, the model is very significant.

The adjusted R-value (0.925) states that the model will provide satisfactory results for different sets of data using same variables.

4.1 Regression Analysis

Table 2- Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.968a	.937	.925	.19825

a. Dependent Variable: sustainability of solar panel
b. Predictors: (Constant), social acceptance of solar panel, availability of solar panel providers, continuation of solar panel usage, reduction of electricity crisis by solar panel, user satisfaction with solar panel service, reason for using solar panel, solar electricity usage area, cost effectiveness of solar panel, factors preventing from using solar panel, reasons for dissatisfaction with solar panel and crisis of electricity supply.

c. Table 3 displays that the calculated t-value with degrees of freedom 74 and at significance level 0.000 is **32.953**. Critical t-value with degrees of freedom 74 and at significance level 0.05 is **1.67**. The **calculated value > critical value**. The significance value is also **<0.05**, which tells the researchers to **reject** the hypothesis.

4.2 One sample t-Test for the continuation of solar panel usage:

Table 3- One-sample Test

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Continuation of solar panel usage	32.953	74	.000	1.72000	1.6160	1.8240

As the analysis **rejects** the hypothesis, usage of solar panel will not be continued. Hence, government initiative and strategy for the solar panel will not be sustainable.

5. LIMITATIONS

Despite the useful findings, this empirical study has several limitations to be acknowledged. The respondents have been chosen based on random sampling method in order to obtain a more scientific result that could be used to represent the entirety of the population. However, the respondents of this study are randomly selected from a very specific site of Dhaka city, namely Bashundhara Residential Area. Other limitations include respondents' reluctance and hesitation to provide fair opinions and assist effectively.

6. RECOMMENDATIONS

It is imperative that SHS capacity is enhanced so that it provides electricity for the entire building rather than the corridor and bathroom only. The cost of installation should be reduced as well. The government, system providers, and users must work collaboratively to expand the use of the system, which will reduce the pressure on traditional electricity sources. Manufacturers and service providers may consider the situation to broaden the market by improving the cost, quality, and capacity of the solar panel. Rather than imposing legislative laws, the government should popularize sustainable solar energy by demonstrating the benefits of using it. The governmental and organizational effort will encourage the users to believe in the SHS.

Further study can be conducted with a larger number of solar panel users in the capital city, divisional cities and district towns of Bangladesh.

7. CONCLUSION

Bangladesh is one of the most densely populated and poorest nations in the world. Lack of access to modern energy services is one of the reasons for poverty and low economic development. There has been a serious lack of proper campaign and promotional activity to popularize the solar panel system in Bangladesh. Solar energy can be a complimentary environment-friendly source of power and should play a significant role in reducing current crisis. The government can make the solar panels accepted socially by taking some initiatives that would focus on the issues discussed in this study. Since the industry for the solar panel is not highly contested, more business organizations should see commercial opportunities in it. Managers must study this uncontested market space rigorously and devise strategies to penetrate effectively. Also, they should address and resolve the problems identified by the researchers of this study in order to achieve user faith and satisfaction. This initiative will benefit them financially and socially. Indeed, the government and business firms should work collaboratively to harness the immense potential of solar panel system in Bangladesh.

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