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EXTENSION OF RENEWABLE ENERGY TECHNOLOGY IN INDIA:CASE OF SOLAR HOME SYSTEM IN RURAL REGIONS

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ABSTRACT

Commitment of energy towards feasible advancement is uncontested. Since energy request is expanding, thus does the worry about climate and environmental change, sustainable power (RE) is being viewed as a device to give admittance to power and destroy neediness. Indeed, even with reformist public economy in Bangladesh, greater part of country populaces are denied from framework power. Because of weighty speculation required in foundation advancement for matrix network, a promising option is environmentally friendly power innovation (RET) that caters force and energy need of non-zapped rustic networks.

This examination explores the obstruction to RET development for creating country zap and thinks about sun oriented home framework (SHS) a case. The review included non-parametric test and writing study. Two dispersedly found towns from the areas of Noakhali and Sirajganj, were chosen for the review. A sum of 171 respondents were studied. The discoveries showed that individuals getting a charge out of various methods of procurement for SHS: full money installment and portion installment and distinguished use limitations. Plus, request side and supply-side boundaries were additionally distinguished which included absence of special movement, monetary condition and absence of mindfulness alongside monetary hindrances. Along these lines, bits of knowledge from this exploration traces strategy system for the broad reception of RET in off-framework locales.

KEYWORDS

Barriers to growth, Renewable Energy, Solar Home System, Cash Purchase, Installment purchase.

1 Introduction

Progress of modern civilization necessitates availability of Electricity. However approximately 1.317 billion global population are deprived of electricity supply, particularly, a greater majority of them resides in remote rural regions of Asia and Sub-Saharan Africa [1].

Lack of electricity has a substantial impact on the life style of rural population by constraining their social progress and economic output [2]. Hence, to stimulate rural development, widespread supply of electricity has been prioritized by Governments and policymakers [3]. In spite of growth in electricity generation from 122.43 kWh to 310 kWh over the years of 2003 to 2014 [4], still in terms of consumption of electricity, Bangladesh has been dealing with lots of challenges [5]. In fact, improving rural electrification with conventional , in a developing country like Bangladesh, necessitates expanding rural electrification through conventional grid electricity, is critical due to considerable investment needed for infrastructure establishment, insufficient power production and distribution limitations [6]. To address this, a promising alternative is renewable energy technology (RET) e.g. solar power that caters the domestic and commercial energy need of non-electrified rural communities [7].

Since Bangladesh is located in the subtropics area, between 20^0 34' and 26^0 38' North longitude and 88^0 01' to 92^0 42' East longitude, receiving 4–6.5 kW h m−2 of solar radiation per day on an average [8, 9], majority of the locations of the country gets ample solar radiation for electric power generation by utilizing photovoltaics (PV) technology [10]. Specifically, for providing affordable and sustainable energy, the RE ventures in the developing nations target the underprivileged and rural communities who incur a significant expenditure for allocating fuels for household chores and economic productivity [11]. Therefore, for purchasing solar energy technologies like Solar Home System (SHS), if the rural consumers are provided with financial services like proper loans and credits, affordability and availability of RET can be considerably developed [12].

Against these alternatives, this research attempts to explore the factors that impede the growth of renewable energy considering

SHS as a case in rural Bangladesh. With the rapidly growing population and resulting power and energy need, the electricity sector of the country needs urgent attention on the diversification of energy sources, particularly promoting the adoption of RET. This article intends to elaborate the distinction between theoretical concept of barriers to growth of RE and a perception-based analysis based on users' response to the fact.

2 Background of the research

Overview of SHS program in Bangladesh

Solar Home System (SHS) is comprised of photovoltaic (PV) device that alters sunlight into the form or energy such as electricity (Figure 1). For providing electric power to the off-grid communities living in remote and distant villages, SHS is the cost-effective technology [13].

At present, several forms of solar electric systems are available, that are basically consisting of three major components: panels, for turning sunlight into electric energy; inverters that transform the electricity into alternating current and making it usable general household appliances (as demonstrated in figure 1); and batteries that store additional electricity generated from the device [14]. The remaining includes system parts such as wiring, circuit breakers, and support arrangements [15].

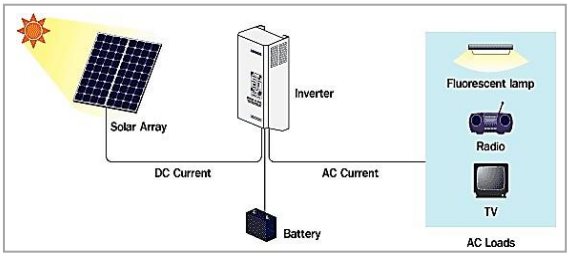

Fig. 1. Electricity Generation through SHS

From the perspective of renewable energy potential in Bangladesh, solar, biomass, biogas, wind and hydropower have been considered as the primary renewable sources [16]. Yet, at present, renewable energy represents a small share of 2.82% (presently installed RE production capacity is 601.88 MW) of the nation's electricity generation portfolio (Figure 2) [17]. By 2020, government targets to upturn this share to 10%. There is a growing body of literature highlighting the prospect and progress of solar energy for developing the energy security and sustainability in the power sector [18, 19].

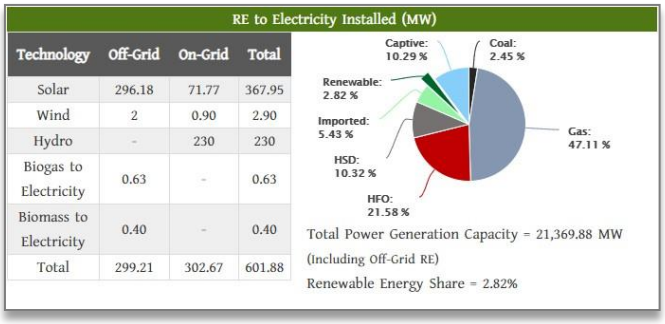

Fig. 2. Present scenario of Renewable Energy in Bangladesh

SHS program is operated through IDCOL, a state-owned utility service provider [15]. IDCOL operates the RE program with 56 partner organizations (PO) that are generally considered as non-government organizations (NGOs) and microfinance institutions (MFI), like Grameen Shakti, Srizony, Rural Services Foundation etc. [20]. From these POs, majority of the rural users install the SHS through a microfinance scheme. Thus IDCOL's RE program is benefitting around 18 million people, 12% population of the country with supply of affordable and clean energy [20]. With more than 4.5 million units of SHS installed across the nation, Bangladesh has attained global acknowledgment as a promising renewable energy market for sustainable power generation [17].

Barriers to Growth of RE in Bangladesh

Potential of RE is enormous, especially in the countries, like Bangladesh, where the share of RE is minimal and the energy access is very low [2]. Different studies found Bangladesh suitable for RE technologies. Government is pro-active in some ways; private sector, along with NGOs, is also somehow positive towards RE; nonetheless, dissemination of RE in wider scale throughout rural and urban areas is yet to be saturated [21].

The installation of a SHS with 20W capacity costs around BDT 12,000 that is corresponding to USD150-160 when the client is purchasing the system with full payment. As the capacity of the device increases, the total price of the system gets higher. With anaverage rural household income of BDT 13,353 per month (Equivalent USD178-167 nearly) [22], majority household buy the system with partial payment to get relief from the financial strain by making payment in full [12, 23]. In last couple of years,a downturn trend in the installation of SHS is evident in thecountry [24]. Hossain et al. [21] studied few reasons for such decline: insufficient financial services to finance the purchase of RET and limitations in technical and awareness initiatives.

f most of the remote rural population [25] which may have resulted in the decline. Komatsu et al., [10] and Mondal and Denich [6] identified other limitations of SHS like the system is usually suitable for low powered electronic appliances used in the rural households. Regardless of

many attractive features, solar PV systems has not been able to sustain broader acceptance in the target market arising from prevailing impediments including higher cost of installation [26, 27, 10] and lack of affordability of rural clients [12, 23].

3 Methodology

This paper conducts a mixed method of research. Qualitative analysis was conducted focusing on prevailing scholarly works on SHS, while non-parametric statistical analysis has been conducted based on a part of a broader survey about SHS in rural Bangladesh. Since the survey result was not normally distributed (Table 1; the Shapiro-Wilk Test shows that the significant value is <0.05), non-parametric analysis has been conducted. Based on existing literature five specific problems related to SHS: higher price, less availability of SHS, technical problems of the system, lack of customer service, and lack of awareness, were identified in addition to one as 'other problem'.

TABLE 1. TEST OF NORMALITY OF SURVEY OUTCOMES

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Higher price of the SHS	.366	171	.000	.633	171	.000
Less availability of system components	.411	171	.000	.608	171	.000
Technical problem of SHS	.372	171	.000	.631	171	.000
Lack of customer service	.354	171	.000	.635	171	.000
Lack of awareness	.417	171	.000	.603	171	.000
Other problem	.489	171	.000	.495	171	.000
a. Lilliefors Significance Correction						

The responses were categorized for both cash purchase mode and instalment purchase mode, and accordingly the statistical test was run. Since financing SHS is a big challenge and during the previous two decades, the challenge is partly addressed by a significant contribution by the MFIs [28], purchase mode, i.e. cash or installment, was considered as grouping variable.

Study location & sample size selection

Two different regions: Hatiya upazila from Noakhali district (in the southern east coast of Bangladesh) and Ullapara from the district of Sirajganj district (Northern part of Bangladesh) were selected for the study to ensure variation in geography and socio-economic conditions [29].

Hatiya is an island located at the south-eastern coastal region of Bangladesh without grid connection. Due to proximity to the river and the Bay of Bengal, in rainy season the island gets flooded, thus making it difficult to find transportation and travel in nearby areas. Ullapara upazila, and Sirajganj district as a whole, has better physical connectivity and mobility compared to that of Hatiya. Although both areas lack access to grid electricity connection, in Shirajganj, the distant villages have limited access to the local grid system [30].

Shirajganj is adjacent to one of the main grid electricity transmission routes in Bangladesh. Nonetheless, due to the flow of local and regional rivers, villages for instance Boalia under Ullapara upazila suffer from lack of grid connection [31]. Because of limited accessibility and dispersed geographic environment, Hatiya is yet to be joined in the national grid. The residents of Hatiya completely rely on substitute solutions like fuel powered generators and RET such as SHS.

TABLE 2: DEMOGRAPHIC PROFILE OF THE SURVEY LOCATION

Survey Location	Shirajganj	Hatiya
Population	5,40,156	4,52,463
Area	414.43 Sq. Kilometer	2100 Sq. Kilometer
Literacy rate	68%	51.29
No. of household with SHS	10, 850	35, 210

A number of 171 household respondents from the survey locations, 92 from Hatyia and 79 from Ullapara, were surveyed. Since, a common publicly accessible database of SHS in Bangladesh is yet to develop about the users, their demography and economic conditions, non-probability sampling was employed. Those households were involved in the survey that have the SHS installation from IDCOL's POs and are using the technology for 6 months and above.

4 Results

Descriptive Statistics

Among the respondents, a greater majority argued about higher price of SHS, technical difficulties and lack of customer services. One third of the respondents identified lack of awareness and unavailability of required SHS as barriers to growth. Only one fifth of the respondents mentioned some other reasons affecting growth of SHS in rural Bangladesh (Figure 3).

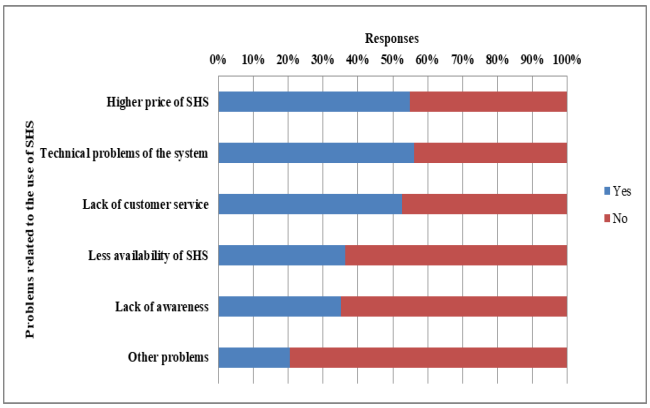

Fig. 3. Problems related to diffusion of SHS in Bangladesh

TABLE 3: RANK ANALYSIS OF ISSUES HINDERING DIFFUSION OF SHS

Issues	Purchase mode	N	Mean Rank	Sum of Ranks
Higher price of SHS	Cash purchase	63	45.79	2884.50
	Instalment purchase	108	109.46	11821.50
Less availability of SHS	Cash purchase	63	55.00	3465.00
	Instalment purchase	108	104.08	11241.00
Technical problems of the system	Cash purchase	63	51.57	3249.00
	Instalment purchase	108	106.08	11457.00
Lack of customer service	Cash purchase	63	46.43	2925.00
	Instalment purchase	108	109.08	11781.00
Lack of awareness	Cash purchase	63	57.36	3613.50
	Instalment purchase	108	102.71	11092.50
Other problem	Cash purchase	63	105.14	6624.00
	Instalment purchase	108	74.83	8082.00

Rank analysis of the responses showed that the users who purchased on instalments arrangement identified higher price of SHS, less availability, technical problems and lack of customer services as serious drawbacks for diffusion of SHS (Table 3). However, users who bought on cash payment identified other reasons (such as weather conditions, like flood, loss of home due to land erosion etc.) as more serious to the development of widespread use of SHS.

Non-parametric Analysis

From the data, it can be concluded that problems related to higher price of SHS, less availability, technical issues, lack of customer services and lack of awareness among the users who enjoyed installment purchase was statistically significantly higher than the users who purchased SHS by paying cash (p = <0.05). In against, only the other reasons hindering growth of SHS among the users who purchased through cash payment was significantly higher that the users who paid in installments.

TABLE 4: BARRIERS TO GROWTH OF SHS IN BANGLADESH

	Higher price of SHS	Technical problem of the system	Lack of customer service	Less availability of SHS	Lack of awareness	Other problem
Mann-Whitney U	868.500	1233.000	909.000	1449.000	1597.500	2196.000
Wilcoxon W	2884.500	3249.000	2925.000	3465.000	3613.500	8082.000
Z	-9.414	-8.081	-9.231	-7.510	-6.990	-5.526
Asymp. Sig. (2-tailed)	.000	.000	.000	.000	.000	.000

a. Grouping Variable: Purchase mode full cash/ instalment

5 Discussion

42% of the off-grid population in the world resides in South Asia [2]. Moreover, without any further strategic interventions and policy revisions, 1.3 billion people will remain deprived of electricity in 2030, as per the estimate of International Energy Agency [32, 33]. Along with the constraints of inadequate public budget and wide-ranging requirements like sustainable development goals (SDGs), the distribution and advancement of power generation from renewable sources have been the objective of policy makers from local and international perspective [23].

As a developing South Asian nation, Bangladesh holds a low per capita consumption of energy (310.39 kWh) [34]. In this regard, the study unfolds the barriers preventing the mass scale-up of RE in rural Bangladesh. The issues, hindering the growth of RE in Bangladesh from policy perspective, can be discussed in four major dimensions – demand and supply as well as technology and finance (Figure 4).

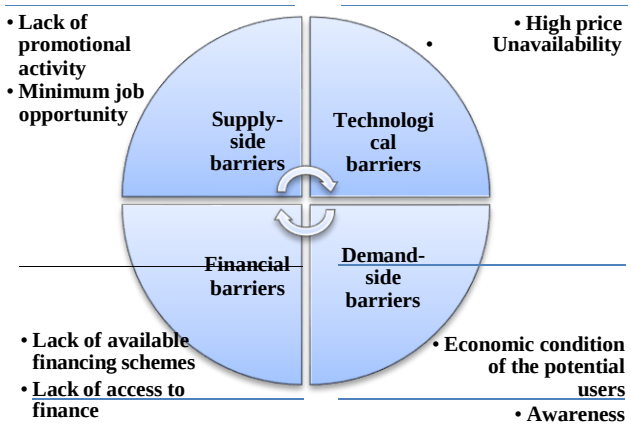

Fig. 4. Obstacles of RET growth in Bangladesh

Demand-side barriers of RET

Households with a generous amount can easily install a micro solar panel for lighting LED bulb or watching TV or charging mobile phones. However, earlier studies on the rural communities of the country showed that only the wealthier part of the society is able to install SHS [35]. In contrast, business units for example, a branch of a commercial bank can easily install a solar panel on theroof-top of the branch to adhere to the policy guidelines of the Central Bank. Hence, two aspects with demand-side management of RE is of importance: the economic condition of the users and the level of awareness.

Not all segments of the society are equally able to afford same standard of living, and hence, specific guideline should come on what level of earning should be included in the process of RE development. Awareness among the vast population is a prerequisite for growth of RET. Contribution of Grameen Shakti and BRAC for rural electrification played an important role for knowledge about the benefits from solar power, but for other renewables, like hydro, wind or biomass more campaigns are required to attract community towards RE. Different policy documents have been formed, but how to enhance awareness for RE have not been mentioned or suggested.

Supply-side barriers of RET

Suppliers of energy in Bangladesh are monitored by the BERC; however, none of the suppliers yet has installed any large-scale RE project to sell energy to the various agencies. Supply-side barriers may be discussed from three perspectives – Lack of industry review, technology and financial barriers.

There are very few studies about potential for job opportunities in the RE industry. Global estimation informed that around 115 thousand jobs are possible in the solar industry in Bangladesh, while biogas and hydropower may provide nine and five thousand, respectively [36]. However, there are no such studies from the national and local authorities in Bangladesh to encourage the industry.

RET should be financially feasible and sustainable, socially justifiable and harmonized customarily [37]. However, national level policies hardly mention and underpin the issues. Besides, there is a lack of indigenous technology. Almost all parts of SHS are imported, hence not cost effective.

Income generation opportunity and economic condition of rural population need to be developed. Since, most of the rural population still relies on agriculture, and the price they receive for the produced agricultural product is not enough, opportunity to raise peasants' income is not enough. Thus, with consistent low-income level it is difficult for the households to install SHS for a better living condition.

6 Conclusion

In the developing nations across the world, a vast majority of the population are living without supply of reliable energy. Realizing this, electricity generation and supply has been a priority for ensuring sustainability since long. Many achievements have already been enjoyed, while a decline in RE is also visible. This research made an effort to explore the issues restricting growth of RE market considering SHS as a case by implementing both non-parametric analysis based on a survey and literature review. Two dispersed locations, Hatyia and Ullapara, were selected and a survey of 171 households was conducted. Higher price, technical difficulties and lack of customer service were among the problems faced by the users. Besides, lack of awareness and availability were also identified.

However, statistically the responses are different from two different groups. This variation in perception may be usual since, two groups roughly represent two different income groups they belong. Linking literature and the survey, this research identified two sets of barriers: demand-side and supply side barriers. Economic condition and awareness in the former, and inertia, technology and finance for later were identified. Although financing barrier has somehow been minimized through microfinance facilities, yet a lot of structural changes are possible for ensuring growth of RE in Bangladesh. Further research may be carried out about the influence of each category of barriers for widespread dissemination of RE in Bangladesh. Other countries may initiate similar research and may a regional comparison be made to support regional and international policymaking.

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