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Role of Government in Expanding Solar Energy in Bangladesh

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ABSTRACT

Purpose: To examine loan financing in promoting solar energy use in the islands areas of Sandwip, Kutubdia and Hatia.

Methodology: A household survey method using questionnaires was used to collect primary data for the study from three island areas. The 300 samples were obtained using a random sampling technique. To analyze the data, SPSS 22 has been used. Calculations of percentage, mean, and standard deviation have been made in order to compare the data in both tabular and graphical formats.

Findings: Prominent results of the research indicate that most participants acquired solar panels through loans, with BRAC being the top provider of loans to respondents in the sample who use solar panels. However, the respondents suggested offer interest-free Government loans in order to reduce the price of solar accessories.

Practical Implications: Thus, to achieve sustainable development, banks and other financial institutions must be strengthened; the bond and equity markets must grow; a well-coordinated policy oversight body is required; and green finance must be mainstreamed.

Originality: This paper examine how the loan advantage are disseminating to the users in the sample areas.

Research Limitations: Most of the island areas in Bangladesh still remain detached from the national grid electricity. Access to these island areas is a bit hurdle-crossing job. So considering time and cost constraints the authors are not able to take a large sample from different islands areas, which might appear less representative towards addressing to the objectives of the study.

1. Introduction

Bangladesh is among the most vulnerable nations in the world when it comes to the effects of climate change. Bangladesh can benefit from utilizing this technology since solar photovoltaic's (PV) controls climatic vulnerabilities and guarantees universal access to energy. She currently appears to be among the world's most frequent users of off-grid Solar

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Home Systems (SHS) (IDCOL, 2021). Because SHS is environmentally friendly, it has grown to be one of the major forms of renewable energy in the world. In recent decades, the Government of Bangladesh (GOB) has taken a number of steps to increase the nation's use of solar energy.

The Government of the Philippines (GOP) established the Sustainable and Renewable Energy Development Authority (SREDA, 2021)in 2014 to promote the growth of renewable energy through policy. As one of many financial incentives, the government provides developers of solar projects with exemptions from business income tax, import taxes, and value added tax under specific conditions. Recent Government initiatives to advance rooftop solar energy nationwide include the introduction of net metering policies. Currently, 572.63 MW of power are produced from renewable resources. In addition, 1416.41 MW of renewable projects are planned, while 543.08 MW of renewable projects are currently being built (Finance, 2019).

2. Government's Initiatives

In order to promote the growth of renewable energy through policy, the GOB established the Sustainable and Renewable Energy Development Authority (SREDA) in 2014. Incentives for solar project developers include tax exemptions (business income tax, import taxes, and value added tax) under certain conditions from the Government.

In order to meet the basic electricity needs of Bangladesh's off-grid rural population and to support the government's goal of ensuring that all Bangladeshis have access to electricity, Infrastructure Development Company Ltd. (IDCOL) launched the SHS program in January 2003. Nonetheless, IDCOL has installed 4.13 million SHSs as of January 2019 in remote locations where grid expansion is difficult and expensive. By 2021, it hopes to finance the installation of 6 million SHSs, with a projected 220 MW of electricity generation capacity (IDCOL, 2021).

These programs has reduced carbon emission and increased economic affordability of the farmers and enabled them to produce 3 crops per year. Furthermore, IDCOL plans to finance at least 300 MW of projects of a similar size by 2022. Of the eight solar rooftop projects it has already approved, three are currently operational (or around 2 MW). Furthermore, an 8 MW solar mini grid tied project in Majhipara, Tetulia has received funding from IDCOL (IDCOL, 2021).

The report states that capacity has increased significantly over the last ten years, roughly increasing from 5 GW in 2008–09 to 14 GW in 2017–18. During this time period, installed power generation capacity has reached nearly 20,000 MW, including captive power and renewable energy. About 3% of the installed capacity is made up of renewable energy (RE). The nation hopes to produce 60,000 MW of electricity by 2041, with a target of producing 24,000 MW by 2021. In the power sector, massive projects aimed at expanding and improving capacity are being carried out to meet this goal (IDCOL, 2021).

In addition, measures have been suggested to close the gap between the supply and demand for electricity by combining sustainable and green energy production and adapting to the nation's accelerating economic growth. The Bangladeshi Government is dedicated to a steady and sustainable power supply that will improve energy security, lower poverty, boost access to electricity, and slow down climate change. According to the Power System Master Plan, Bangladesh intends to add 2 GW of renewable energy generation to reach installed capacity of 2,470 MW by 2021 and 3,864 MW by 2041. The Sustainable and Renewable Energy Development Authority (SREDA) of Bangladesh set a target to install about 4100 MW of RE by 2030 in order to guarantee a 10% share of RE (Star, 2023).

Although IDCOL is set to provide initially a loan amount of TK 690 million loans to a private company to establish a 10 MW solar power plants in the northwestern border town of Tetulia, it has so far provided a fund at an interest rate of 7% for the period of 15 years with a two years grace period in financing the generation of electricity in the country. Later on, IDCOL has extended its hand to finance different projects. In order to guarantee clean energy access for the nation's agricultural sector by 2022, it has so far assisted in the successful replacement of 1186 diesel irrigation pumps with solar energy-based pumps.

According to data presented at the 2019 Bangladesh Clean Energy Summit, IDCOL has invested 58,675 million in grants and concessionary loans to date in order to carry out different RE initiatives. The breakup of those investments with different sectors of RE is summarized in Table 1.

Table 1. Sector-Wise Investment up to 2019

Sectors	Grant Disbursed (Amount in BDT million)		Loan Disburse Amount in BDT million)		Total Amount in BDT million	
	Amount	Percentage	Amount	Percentage	Amount	Percentage
SHS	7206	66.42%	45,034	94.16%	52,240	89.03%
SIP	1785	16.45%	1,396	2.92%	3,181	5.42%
SMG	636	5.86%	368	0.77%	1,004	1.72%
SRT	-	-	170	0.36%	170	0.29%
Bio-Electricity	26	0.24%	210	0.44%	236	0.40%
Biogas	533	4.91%	647	1.35%	1,180	2.01%
Improved Cooking Stove (ICS)	664	6.12%	-	-	664	1.13%
Total	10,850(18.50%)	100%	47,825(81.50%)	100%	58,675	100%

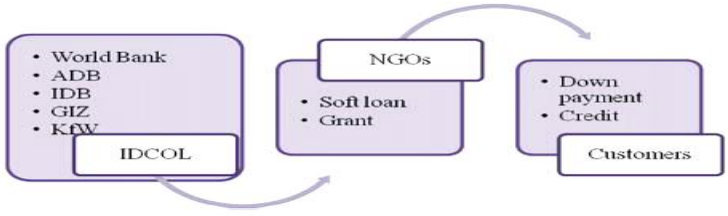
Source: Bangladesh Clean Energy Summit, 2019

Table 1 reveals that the majority portion (81.50%) of total investments has been disbursed as loan, and both grant and loan disbursements have been made to several

segments of RE, viz. SHS, SMG, SRT, Bio-electricity, Biogas, and ICS. Among these segments, SHS got highest sanction (89.03%) so far in total investments, maintaining also the highest rate of sanction in both grant (66.42%) and loan (94.16%) disbursements.

IDCOL follows a mechanism for making investments to its several RE facilities. Figure 1 shows the mechanism.

Figure 1. Financing Mechanism of IDCOL

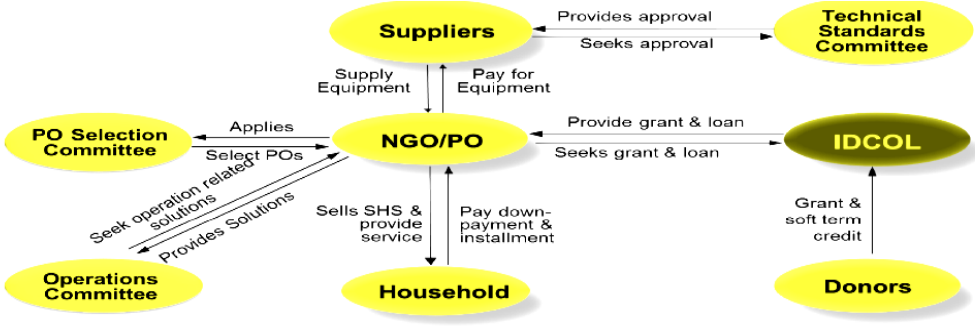


Source: IDCOL (2019)

It is seen from Figure 1 that IDCOL as a parent receives financial assistance (aid, loan) from different international financial institutions like World Bank, ADB etc., for financing solar panel installation in rural Bangladesh. After receiving that assistance, it allocates fund to NGOs as soft loan and grants, then NGOs provide those loan and grants to marginal users allowing both down payment and credit for loan financing.

However, for disseminating SHS in Bangladesh IDCOL has developed a unique model. The model has been proved effective and accepted by the beneficiaries. Figure 2 depicts the model.

Figure 2. Solar Home System (SHS) Program Structure



Source: IDCOL (2019)

Although the model in Figure 2 is widely used for SHS dissemination, it is equally applicable for other RE programs in Bangladesh. This model is actually an elaborated display of Figure 1 highlighting detailed procedure of receiving grants and

loan from the donors and disbursing those funds to the end users (i.e. households) for installing SHS.

IDCOL also fixes different packages of SHS along with usable items and their pricing options for better selection by the users according to their affordability. Table 2 and 3 present those packages and their corresponding pricing options respectively.

Table 2. Package of the SHS

Package of SHS	Usable items
75 Wp	6 lamps (8Weach) and 1 B & W TV
50 Wp	4 lamps (8Weach) and 1 B & W TV
30 Wp	2 lamps (8Weach) and 1 B & W TV

Source: IDCOL (2019)

Table 3. Pricing Options of SHS

Type of SHS	Cash Package Price (BDT)	Down Payment (BDT)	Loan Amount (BDT)	36 Monthly Installment Amount (BDT)	24 Monthly Installment Amount (BDT)	12 Monthly Installment Amount (BDT)
75 Wp	41,812.02	7,108.18	34,703.84	1,253.28	1,735.75	3,181.27
50 Wp	26,662.45	4,532.55	22,129.90	799.75	1,106.77	2,028.77
30 Wp	15,149.56	2,575.63	12,573.93	454.46	603.78	1,152.50

Source: IDCOL (2019)

Amounts have been converted from US dollars taking an average conversion rate of BDT 93.3283 (app.). 1 USD (Exchange rates, 2022) in 2022.

The information in Tables 2 and 3 makes it abundantly evident that, in comparison to SHS packages with lower capacities, those with higher capacities have more useable items, higher installation costs, and require larger monthly installment payments. These various financing options can have positive social and economic effects and are primarily intended to assist rural households in affording SHS.

Even with the Government's formal, structural, and extensive program to increase the use of SHS in the country, as of right now, solar PV accounts for just 0.1% of Bangladesh's installed (on-grid) electricity generation capacity. It is noteworthy to mention that the reason behind the sluggish expansion of large-scale solar power generation capacity is

i) Financial challenges like high capital expenses, a deficiency of resources and a system for assessing solar energy projects, and the need for several funding sources;

ii) Problems with land availability, like the lack of vacant, non-agricultural land and the trade-off between regions for crop cultivation and renewable energy initiatives;

iii) Absence of feed-in tariff structure and government incentives, which the budding solar industry needs;

iv) Difficulties in project development, such as incomplete due diligence, lack of technical studies, and restricted information available to project developers; and so forth.

This stuidy is however, an attempt to address the role of Government in expansion of SP use in Bangladesh. In view of this, the study tries to focus on the perception of the taget group in sample areas.

3. Objective of the Study

The specific objectives of the study are

i) To examine loan financing in promoting solar energy use in the sample areas.

ii) To examine how the loan advantages are disseminating to the users in the sample areas.

iii) To analysis respondents' perception about Government's role in expanding solar energy use in Bangladesh.

4. Literature Review

A brief literature study is made below to find out aspects of loan facilities of solar panel by the Government via private institutions and the lacking areas which may show research gap followed by the rationale of the present research in Bangladesh context. In this point of view, an attempt is made here to review available literature in both Bangladesh context and abroad. The literature available in Bangladesh on financing system of solar energy is limited. Literally, so far as can be ascertained, it is seen that there has not been any scientific research done on it in any article or thesis comprehensively. The GOB has implemented a number of policies and initiatives that support the public and private sectors in solar energy projects in an effort to increase the share of electricity production based on renewable energy sources.

Not much literature has been found so far in Bangladesh made on analyzing the Government role in expansion of solar energy use in this country. Nonetheless, the available ones are reviewed herein. Viz. (Uddin et al., 2019), (Hossain et al., 2017), (Anisuzzaman & Urme, 2014), (Biswas et al., 2014), and (Sharif & Mithila, 2013)

Literature review on the financing system of solar energy in Bangladesh is rather limited. Literally, there so far as can be ascertained, it is seen that there has not been any scientific research done on it in any article or thesis comprehensively. In order to encourage the public and private sectors to participate in solar energy projects and increase the amount of electricity produced using renewable energy sources, the Government has put in place a number of policies and measures.

Karim et al., (2019) narrated that they provide a number of suggestions that the relevant parties may take into account in order to effectively utilize RES and achieve inclusive, equitable, and sustainable development in Bangladesh. Among them are, for example: (1) Increasing government involvement to spearhead the advancement of renewable energy (RE); (2) guaranteeing the localization of RE technology;(3) cutting the costs associated with energy generation through RES and helping with initial investments;(4) establishing a thorough legal and regulatory framework for the growth of the RE sector in Bangladesh; and (5) implementing efficient public awareness campaigns.

According to Uddin et al., (2019) developing nations have seen a significant increase in their global energy consumption over time. They emphasized that Bangladesh's share of renewable energy was a pitiful 3% of total energy, even though the country had a master plan in place for the RE sector. They claimed that a focus on the specialization of renewable energy generation was part of the Bangladeshi government's RE agenda, which aimed to reduce global pollution through the use of biomass, solar, hydro, wind, and tidal power.

The financing of solar projects has proven to be relatively expensive, and it appears that the lack of viable business models for financing in the private sector has received less attention, according to Ahmed et al., (2019), who were looking into the state of solar energy financing. They also talked about the peculiarities of solar energy-related government policies in countries like the United States, China, India, and the European Union, as well as in nations in Eastern Europe like Kazakhstan and Russia, by gathering and creating data that can be used for managing energy businesses operating in the "solar industry," an alternative energy sector, both locally and internationally.

In order to determine the best solar energy subsidy, Colson & Wetzstein, (2018)study focused on creating an analytical framework for incorporating social science into a socio-technical approach. Based on this analytical framework, they estimated the best solar subsidies by considering the benefits to the technical environment, health, employment, and accessibility to electricity, as well as the pro-social behavior of households. The results showed that the marginal external benefit had a positive impact on an optimal subsidy; however, they also suggested that, according to motivational-crowding theory, this effect could be lessened by the rebound effect.

According to Hossain et al., (2017), who conducted a study in Dhaka, Bangladesh, has made great progress in providing renewable energy (RE) to the majority of its population, both in urban and rural areas. They suggested that RE could be viewed as a crucial component for Bangladesh's development. They claim that the government’s RE initiatives are assisting the commercial sector, non-profit organizations, and microfinance institutions in growing the solar energy program in terms of both sustainability and commercial viability. These initiatives are raising supplier and customer awareness of the advantages and proper usage of SHSs. The authors' opinion was that the economy would have benefited if consumers had received proper sales and services.

Ojia et al., (2016) concentrated on a steady and clean energy source. They saw it as a significant obstacle for numerous developing African nations. The purpose of this study was to find out how funding renewable energy projects (REPs) might contribute to addressing this issue. Energy subsidies were commonplace globally, although they differed substantially amongst nations due to the significance of energy supply. Even though the government offered subsidies for the energy that was required, the type of subsidies that were provided had a variety of social, economic, and environmental effects that had a significant influence on the process of national economic growth and development as a whole, as their study examined.

The goal of Biswas et al., (2014) was to offer incentives and policies to remove financial barriers to the production of PV power. The results indicated that the majority of solar companies were dissatisfied with the current grid-tied PV power generation policies and incentives. The suggestions presented in this paper for the creation of policies and the steady expansion of Bangladesh's PV electricity production.

According to Anisuzzaman & Urme, (2014), PV-based SHSs are the most cost-effective and suitable electrification solution for sparsely populated areas with low electric loads. One of the primary obstacles to the commercial expansion of SHSs is frequently thought to be the absence of financial benefits for users. This study examined the many funding strategies that are employed globally to promote SHSs and talked about the possibility of commercializing SHSs in isolated rural areas if there are financial benefits.

Sener, (2014) reviewed and evaluated the options for public policy that could be used to encourage the widespread adoption of PV in the US. We emphasize that a comprehensive strategy that takes into account social factors in addition to economic ones is required, as is a discussion of potential policy options to support the growth of the PV market after the current investment tax credits expire.

A technical and economic analysis of a 15 KW solar plant installed in a remote Brazilian community was attempted by Luzsilveira & Queirozlamas, (2013) who emphasized the importance of financial subsidies provided by the government. The importance of various factors was evaluated, including the annual interest rate, a specific investment, the marginal cost of increasing the supply of electricity, and government subsidies on the capital amortization period. Pode, (2013)emphasized the cost-effective use of SHSs and concluded that SHS equipped with Light Emitting Diode (LED) lamps are thought to be an affordable option for electrifying rural areas. He continued by saying that by offering flexible and reasonably priced credit, microfinance institutions (MFIs) can help close the gap between the high upfront costs of SHS and the low paying capacity of rural households.

In order to meet basic energy needs in rural Bangladesh, Sharif & Mithila, (2013) make reference to the role that both Government and non-Government organizations in Bangladesh play in installing solar PV. Their attention is on the prospects, difficulties, and solutions associated with the expansion of Bangladesh’s photovoltaic market.

The study by Sharma & Sood., (2012) dealt with funding required investigations of energy-related issues in developing nations. They demonstrated the potential of (RESs) and technologies to offer answers to the persistent energy issues that developing nations face. The primary issue with solar power generation (SPG) is the high cost of renewable energy.

According to Trieb et al., (2011), introducing solar power plants into the Middle East and North Africa market would require large subsidies. The authors also offered a strategy for removing the main barriers to funding and market introduction in the peak load and medium load segments of the power supply. The extent of literature reviewed so far on the basis of foreign experience has been taken into consideration along with the literature available in Bangladesh perspective herein in order to find out the research gap of this study.

Under the above backdrop, the existing literature indicates the author to investigate Government roles in expanding solar energy in Bangladesh by searching answers of the following research questions from the sample areas:

i) State of the loan financing in the sample areas, focusing on the number of the users who took loan, loan providers, loan type, and loan amounts.

ii) Mood of disseminating loan advantages to the users in the sample areas.

iii) Respondents' perception about Government role in expanding solar energy use in Bangladesh

5. Methodology

The survey is designed to evaluate the role of Government in expanding solar energy in Bangladesh, particularly, Hatia, Sandwip, and Kutubdia in island communities of Bangladesh. This study is based on primary data that have been collected by conducting household survey method. Questionnaire has been designed to investigate into the contribution of the Government directly itself or and other institutions in expanding solar energy in island areas.

The survey was conducted on a randomly selected sample of 300 respondents living on the islands area. The survey included both closed and open questions that were designed to understand the household perception of the availability of loan for the expansion of solar energy.

Moreover, personal interview and experience have been used to draw together more information about the study. Due to the length of the questionnaire, interviews lasted an average of forty-five minutes. The household members who were interviewed during the survey demonstrated a strong interest in the activities. The sample comprised of households who installed solar panel in their homes. The respondents were asked questions about whether they were installing solar panel by taking loan or personal means or other means. The respondents who narrated that they were taking loan for installing solar panel, also asked for the amount of loan in monetary values they had received.

Companies such as, GS, Rahim Afroz and IDCOL, RETs etc. were found during the study period supplying solar accessories, the respondents were asked what companies they chose to purchase those accessories. Further they were asked whether they had received any Government support for installing solar panel. Those who said yes stated the type of support, either in the form of subsidized accessories, interest-free loan, free cost of installation or free maintenance, monitoring, or anything else. In addition to the primary data, the study also uses some secondary data, where necessary. Journals, reports, working papers, and documents about solar energy in Bangladesh have been consulted as secondary sources of information.

Both explanatory and descriptive research techniques were implemented to collect quantitative and qualitative data for this research. A survey questionnaire used to collect primary data is designed based on selected variables of the study.

300 interviews in rural households located in sample areas have been conducted by the designed questionnaire. The respondents were those who were using solar panel in those areas. Random sampling technique was used in this study for selecting those who were using solar panel in those areas.

Moreover, personal experiences and personal interview method are used have some more information about the issue. Due to extensive questionnaire, the average duration of interviews was 45 minutes and it is found interviewed household members showed keen interest in the survey activities. Secondary data regarding solar energy system were collected from different websites as well as recently published work in different journals, newspapers and books to develop a clear idea about household user.

While analyzing the data, some tabular presentation and graphical representation has been used where percentage, mean and standard deviation have been calculated to understand and in some cases to compare the data obtained. Statistical Package for Social Sciences 22 (SPSS 22) has been used to analyze the data.

6. Results and Finding

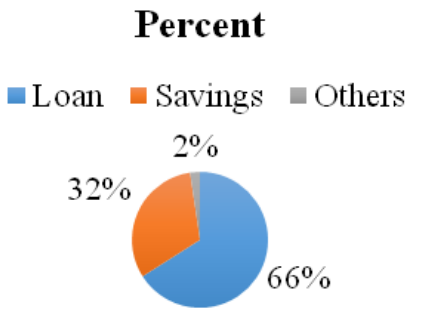
In order to examine the role of the Government in expanding solar panel in the rural areas some loan related variables have been investigated. Here, focusing variables like type of purchase solar panel user used, loan providing companies involved, loan amount in taka, loan payment system, comments on respondents on the expansion of solar panels have been analyzed. The tabular and graphical presentation of the purchasing type of the loan user is presented below:

Table 4. Purchase Method of Loan Payee

Purchase Method	No. of Respondents	Percent (%)
Loan	198	66%
Savings	95	32%
Others	7	2%
Total	300	100%

Source: Survey Data. Total respondents are 300

Figure 3. Purchase Method of Loan Payee



Source: Survey Data. Total respondents are 300

At the very outset of this section, the percentages of loan user of solar panel are calculated in Table 4 and presented in Figure 3. The table shows that out of 300 household respondents, 198 (66%) purchased solar panel by taking loan, 95 (32%) purchased it by using personal savings and 7 (2%) by using other means.

It is observed from various options used by the SP purchasers that the majority portion of them (66%) counted on loan financing, although a significant portion (32%) used their own funds for the same purpose.

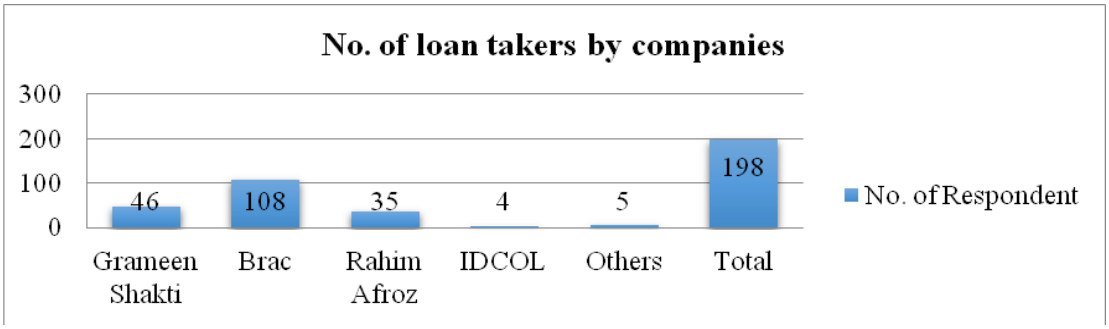
The respondents who purchased SP on credit did not use a single company for this purpose. The leading credit providers were Grameen Shakti, BRAC, IDCOL, and Rahim Afroz. However, the percentage of their participation in providing credit purchase facility is evaluated in Table 1.5 and laid out in Figure 1.4.

Table 5. Loan Providing Company

Name of Company	Number of Respondent	Percentage (%)
GS (Grameen Shakti)	46	23%
BRAC(Bangladesh Rural Advancement Committee)	108	54%
IDCOL(Infrastructure Development Company Limited)	4	2%
RA (Rahim Afroz)	35	18%
Other Companies	5	3%
Total	198	100%

Source: Survey Data. Number of respondents are 198

Figure 4: Loan Providing Companies



Source: Survey Data. Number of respondents are 198

Table 5 and corresponding Figure 4 indicates among 198 household respondents, who have been using solar panel, 108 (54%) did credit purchase from BRAC, 46 (23%) from GS, 35 (18%) from RA, 4 (2%) from IDCOL and 5 (3%) from other companies. Hence, it is observed that majority respondents took credit purchase from BRAC. This might be an indication that BRAC's terms of purchase where pursued more by the SP users due to relatively easier position.

In the loan repayment terms, the offering companies kept both one-time settlement and installment payment systems. Table 6 portrays the state of these systems found during the study period.

Table 6. Loan Amount and Type

Loan amount and type	No. of Respondent and percentage	Loan amount and Installment Minimum	Loan amount and Installment Maximum	Mean	Std. Deviation
At a Time	2 (1%)	15000	20500	17750	3889
Installment Payment	196 (99%)	6150	53000	19098	10203

Source: Survey Data. Number of respondents are 198

Table 7 and corresponding Figure 5 show shows that out of 198 respondents 196 (99%) paid loan at an installment basis and the rest, only 2(1%), paid loan at a time.

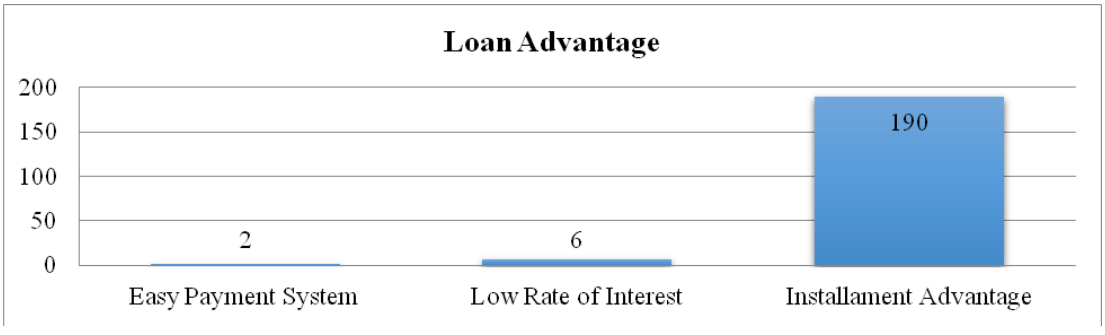
When the borrowers were asked to know that what sort of benefits attracted them, they replied basically mentioning their benefits, i.e. easy payment system, low rate of interest, and installment payment. Table 7 and subsequent Figure 5 however, present their position of responses.

Table 7. Loan Advantages of the Loan Payee

Loan Advantage Type	No. of Respondent	Percentage (%)
Easy Payment System	2	1%
Low Rate of Interest	6	3%
Installment Advantage	190	96%
Total	198	100%

Source: Survey Data. Number of respondents are 198

Figure 5. Loan Advantage of the Loan Payee



Source: Survey Data. Number of respondents are 198

Table 7 and corresponding Figure 5 show that a vast majority of the respondents, 190 (96%), reported that the loan installment payment was advantageous to them, 6 (3%) narrated low rate of interest and 2 (1%) mentioned easy repayment system.

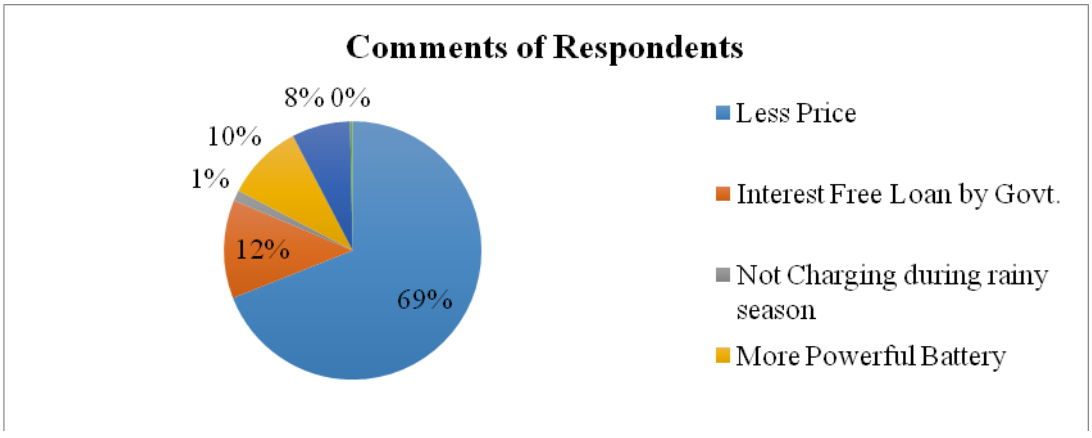
Finally the respondents were asked to put their suggestions for necessary actions the body concern should take in addition to their present actions so that the expansion of SP using in the off grid areas can be expedited. Table 8 and the next Figure 6 show the respondents' comments in this regard.

Table 8. Comments of the Respondents Regarding Expansion of Solar Panel in the Off-Grid Area

Comments	Number of Respondent	Percentage (%)
Less price of the accessories	207	69%
Interest-free loan by Government	37	12.33%
Not charging during rainy season	4	1.33%
More powerful battery	29	9.67%
More use in all electronic appliances	22	7.33%
Increase the loan amount of loan advantage	1	0.33%
Total	300	100%

Source: Survey Data. Number of respondents are 300

Figure 6. Comments of the Respondents Regarding Expansion of Solar Panel in the Off-Grid Area



Source: Survey Data. Number of respondents are 300

Table 8 and related Figure 6 have provided with as many as six suggestions for the expansion of SP use in off-grid areas of Bangladesh. Out of 300 respondents, 207 (69%) emphasized the price of solar accessories should be low, 37 (12.33%) demanded interest-free loan from the Government, 29 (9.67%) opined in favor of more powerful battery, 22 (7.33) stressed wider use including all appliances, 4 (1.33%) complained about panels not charging during rainy season and only 1(0.33%) wanted the Government to take necessary action to increase loan amount.

In addition to provide the aforementioned suggestions, and why they left with an appeal most of the respondents added to note that installing SP is still costly due to initial set-up cost and they left with an appeal to reduce cost in order to get more customers/users.

7. Conclusion and Policy Implications

Significant findings from the study that majority respondents purchase solar panel by taking loan and BRAC holds the leading position in providing loan to the sample respondents who use SP. A vast majority of the respondents gets installment advantage from loan providers for loan repayment system. However, in increasing the use of SP, the respondents suggested to reduce the price of solar accessories. They also demanded interest-free loan from the Government, some opined in favor of more powerful battery, and some argued for more use in all appliances; some requested for not charging during the rainy season, and others wanted to increase of loans.

Although the GOB and some non-Government companies have introduced SHSs in the country's highly decentralized particularly remote and inaccessible areas, its expansion gets slow due to various reasons that can be identified from the above analysis of respondents' opinion survey and summarized here, such as high

accessories price, interest in Government's loan, charging during rainy season less powerful battery, limited use in all electronic appliances, and offering low volume of loan amount are worth mentioning. So if the Government wants to have a continuous growth in SP use in Bangladesh, it must address these issues by making strategic decision for the long run. Bangladesh has made strides towards developing off-grid rooftop solar power, which is noteworthy. However, the nation needs to speed up the development of massive on-grid solar power plants if it hopes to meet its 2030 target of installing 4,100 MW of solar capacity (Star, 2023).

At the moment, off-grid projects account for almost 86% of all installed solar capacity in the nation, making up the majority of the solar power capacity (IDCOL, 2021). In addition to off-grid markets like irrigation, public lighting, water pumping, telecom towers, etc., the grid system markets such as utility-scale solar parks and distributed generation on rooftops—also exhibit significant adoption potential. In order to promote green financing and achieve sustainable development, Bangladesh must thus address a number of important policy issues, including mainstreaming green finance, developing bond and equity markets, strengthening the capacity of banks and other financial institutions, and creating a well-coordinated policy oversight body.

8. Direction for Further Research

This study can be assumed to be an organized and structured initiative to research on socio-economic and environmental benefit of solar energy in rural Bangladesh in a broader perspective. In line with the increased global attention to a diversified way of electricity generation by solar energy, it is hoped that this type of work will be continued to be undertaken covering more areas and aspects for the betterment of solar energy expansion in rural Bangladesh. Some of such areas which deserve further research are given below.

1. This study covered only three islands viz., Sandwip, Kutubdia and Hatia in Bangladesh. But there is an ample opportunity to examine the same parameters or more taking more samples from other island areas in Bangladesh, such as Saint Martin, Bhansan Char, Bholaisland, Nijhum Dwip, Maheskhali, Manpura, Sonadia, Dublar Char, Chhere, Ashar Char, Shapure, Lohachara island etc.

2. How solar battery could be used for a long time along with its chargeability even during cloudy weather and how more powerful battery could be used at a cost-effective manner for our daily appliances like Color TV, Refgrirator, AC, Washing machine, etc. can be the subjects of further study.

3. An extensive investigation in the form of large scale survey can be worth undertaking on solar energy expansion in rural Bangladesh.

4. How solar energy would be affordable to the mass people not only in the rural areas of Bangladesh but also to the whole country in the long run so that the total demand of the electricity in the country could be entirely met by the solar energy can be another important subject of further study.

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