UN Inter-Agency Task Force on Social and Solidarity Economy

Micro-finance Interventions in Renewable Energy

Promoting Sustainable Rural Development through Solar Electrification

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Implementing the Sustainable Development Goals: What Role for Social and Solidarity Economy?

Abstract

To promote solar electrification in rural Bangladesh, a critical barrier is high installation cost of renewable energy technology in comparison to the income of poor households. In this regard, this paper aims to assess the microfinance interventions by social enterprises and NGOs in installing Solar Home System (SHS) and thus facilitate the access to solar electricity. To do this, the study focused on SHS programs in six remote villages from northern, central and southern-east regions of Bangladesh. Primary data was collected by Key Informant Interviews with professionals in renewable energy industry. Additionally, questionnaire survey was conducted with 171 households from the study locations. The research ascertains that microfinancing the installation of SHS reduces the higher up-front cost of the technology for the rural families. They can also avail socio-economic and environmental benefits of renewable energy like better in-house lighting, savings in energy expenditure and relief from indoor air pollution that occurred from burning kerosene. However, limited user awareness and lack of maintenance service were identified as challenges for expanding solar electrification in rural Bangladesh. To deal with the challenges, a framework of stake holder collaboration and holistic research is proposed in this paper for the sustainability of renewable energy ventures.

Keywords

Renewable energy, solar home system, microfinance, sustainable rural development

Bio

Tahsina Khan is currently serving as an Assistant Professor in American International-University Bangladesh, Faculty of Business Administration. Her preferred research areas include development studies and societal marketing interventions, with a recent publication "Determinants of microfinance facility for installing solar home system (SHS) in rural Bangladesh" in Energy Policy journal, published from Elsevier.

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1. Introduction

Energy is indispensable for the development modern civilization. Yet, at present, 1.317 billion people across the globe do not get access to electricity and majority of them live in the rural areas of South Asia and sub-Saharan Africa (Azimoh et al., 2016). The densely populated South Asian region is home to one-fifth of the global population in just 4% of the world land mass (Palit, 2013). This region accounts for 42% of the total number of people in the world without access to electricity (Pode, 2013). Hence, the attainment of sustainable development goals (SDG) of "affordable and clean energy" along with "environmental conservation" is indispensable in uplifting the living standard of underprivileged rural population in this region.

Bangladesh is no exception from this situation where rural electrification is one of the major challenges the country has been dealing with. In this context, this paper attempts to shed light on the following issues: (i) Can access to renewable energy technology like solar home system (SHS) improve the electricity crisis in rural areas? (ii) Can microfinance interventions address the higher upfront cost of installing SHS among the rural households? (iii) What are the development opportunities that the users derive from solar electrification? (iv) What issues should be taken care of to promote the growth of solar electrification in rural communities?

2. Solar Electrification Program in Rural Bangladesh

In Bangladesh, even with the continued economic progress (more than 6 percent growth in GDP), the national electrification status for the households is 75 percent but much lower at the rural areas, only 60 percent (BBS, 2016). Indeed, in a developing nation like Bangladesh, expanding rural electrification through conventional grid connectivity is a critical issue due to substantial investment required in infrastructure improvement, inadequate power generation and distribution constraints (Islam et al., 2014).

However, to improve electrification in rural Bangladesh, renewable energy technology (RET) offers an alternative solution for many low-demand users in the non-electrified and remote regions of the country (Komatsu et al., 2011, Laufer & Schafer, 2011). In a study, on the potential of renewable energy for electricity generation in Bangladesh, Mondal & Denich (2010) identified that a greater majority of the land area gets adequate solar radiation to generate power in the form of electricity by utilizing photovoltaics (PV) technology. This provides a window of opportunity for off-grid solar technologies like solar home system (SHS) (Palit, 2013, Khan & Khan, 2009). Especially the poor rural people are targeted by RE programs to provide them access to affordable and clean energy services —who need to spend a large portion of their income and time to allocate fuels for inefficient lighting and cooking purposes (Laufer & Schafer, 2011). Therefore, accessibility and affordability of RET can be significantly improved if people in rural communities are provided with financing services like suitable credits to afford the purchase of solar energy technologies for fulfilling their household and socio- economic needs (Abdur, 2012).

To capitalize on the development opportunities of solar electrification in rural Bangladesh, microfinancing the installation of SHS have been applied by the participating organizations in renewable energy industry in order to distribute the technology to the underprivileged rural communities (Pode, 2013). Solar Home System (SHS) consists of PV technology that converts sunlight directly into electricity (illustrated in Figure 1). SHS offers a cost-effective mode of

supplying electric power for lighting and appliances to remote off-grid households (Fahmi et al., 2014).

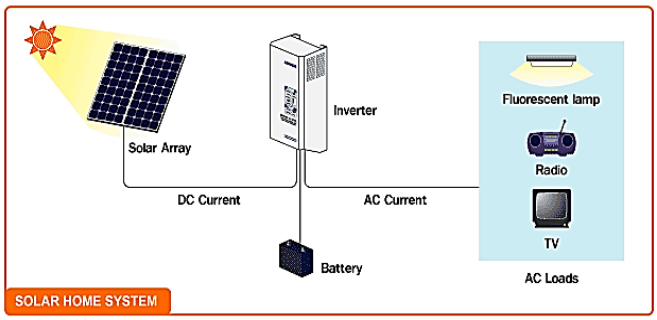

Figure 1: Electricity Generation through SHS (Source: Pode, 2013)

In Bangladesh solar electrification program has been administered by state owned Infrastructure Development Company Limited (IDCOL). Funded by local and international financing bodies, IDCOL operates the SHS program with 56 Partner Organizations (PO), commonly categorized as social enterprises, Non-Government Organizations (NGO) and Micro-finance Institutions (MFI) like Grameen Shakti, Rural Services Foundation, Srizony, TMSS, Bengal Solar etc. These organizations procure the system components (panels, batteries, charge controllers etc) and install the systems at the rural households. Most of the households buy the systems under a micro-credit arrangement with the POs. At the time of installations, households make a down payment of 10-15 percent of the system price based on the purchase terms and the rest of the amount is repaid over a 2-3 years micro-credit period.

The POs employ their local networks and proficiency in micro-credit services to have greater access and acceptability in the rural and remote regions in order to make SHS affordable to the potential users. IDCOL provides grant and soft loans as well as necessary technical assistance to the POs and POs select customers, extend loan, install the systems, and provide after sale service. With 4.13 million SHSs installed under IDCOL's RE program, at present more than 18 million people are getting solar electricity for domestic and commercial purposes (IDCOL, 2018). From this background, the solar energy program in the country has become commercial viable and socially acceptable (Komatsu et al., 2013, Hossain et al., 2017).

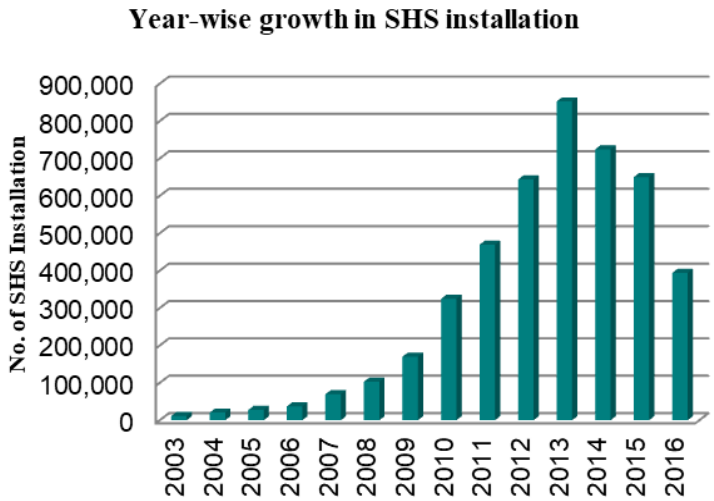

Figure 2: Growing number of SHS installation in Bangladesh (IDCOL, 2017)

3. Problem Statement

3.1 Higher installation cost of Solar Home System

In a densely populated country like Bangladesh, about 80% of the people live in rural areas. 44% of the rural population is classified as poor and a vast majority of them remain without connection to the national electricity grid as revealed from "Household Income and Expenditure Survey" by Bangladesh Bureau of Statistics in 2016 (BBS, 2016). From the perspective of resource availability and user acceptance, solar photovoltaics (PV) technology like SHS is the most viable electrification option in the country relative to the other renewable energy sources (Islam et al., 2014, Najmul & Kumar, 2013).

However, on an average the cost of installing a smaller size (e.g. 20 watt capacity) SHS is around 12,000 taka to 14,000 taka, when bought with full cash payment. The price increases as the capacity of the system gets larger in power generation capacity. On the other hand, the average monthly income in rural household is around 13,353 Taka (BBS, 2016). Thus making full cash payment for installing SHS, is beyond the purchasing power of poverty stricken rural households in the country. As such, Khan et al.., (2019) and Pode (2013) opined that more flexible financing scheme to reach greater number of rural households may further increase the adoption of SHS to uplift the living standard of remote and underserved communities.

Picture 1: SHS installed on the rooftop in rural households

3.2 Microfinance interventions in solar electrification

As discussed earlier, in order to address the lack of affordability of rural households to finance the installation of SHS, POs sell the system to the users by devising a scheme of initial cash payment (15% - 25% of the total price) followed by instalment based monthly payment to complete the remaining balance, as shown in table 1 (a copy of the SHS price catalogue is given in the Appendices section). Such credit services have been designed to enable households and small businesses owners to get the required capital to finance the installation of the system.

Table 1: SHS installation Financing Schemes

Initial Down payment for SHS installation	Service charge rate with monthly Instalment payment	Duration of instalment payment
15% of the total price	6%	36 months
25% of the total price	4%	24 months

Thus the provision of microfinance allows the rural households, with limited and strained household income, overcome the barrier of higher installation cost of RET (Kabir et al., 2010).

4. The nexus between renewable energy & sustainable rural development

Regardless of different viewpoints on the approaches to sustainable development, this research considered the concept of sustainable development to assess the benefits of solar electrification, as the concept attempts to embrace the relation between the socio-economic and environmental aspects and has gained widespread recognition (as reflected in Figure 3).

Figure 3: Three intersection circles to illustrate sustainable development (Brundtland, 1987; Hopwood et al., 2005)

Also, a conceptual clarity is observed in this approach. It makes the research investigation more straightforward by facilitating the classification of impacts of a phenomena or event into three convenient dimensions (Sikder, 2003). The escalating energy crisis in rural communities demands Government of Bangladesh to establish a long-term, reliable power supply that consequently will enhance electrification status of the country, improve living standard and mitigate climate change. In this respect, the renewable energy projects have a considerable potential in achieving these goals and thereby contributing in the sustainable development of rural communities (Khan & Arsalan, 2016, Mishra & Behera, 2016).

In order to highlight the implications of solar electrification, it has been well documented that the emergent usage of RET has the potential to nurture environmental preservation

(Hasanuzzaman et al., 2015, Hoque et al., 2014), enhance living conditions (Asaduzzaman et al., 2013, Komatsu et al, 2013, Komatsu et al., 2011) and facilitate economic activities (Wahi & Ahsan, 2012, sovacool & Drupady, 2011) of the users. With this backdrop, as illustrated in figure 4, by microfinancing the installation of SHS, the underprivileged rural households in the country can avail socio-economic and environmental benefits of solar electrification. In view of this, this paper highlights the growing adaptation of RET to promote sustainable rural development.

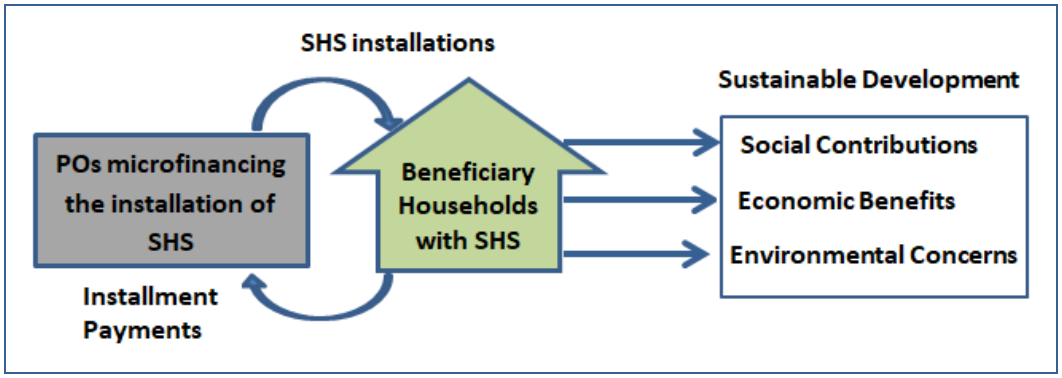

Figure 4: Conceptual Framework of sustainable rural development through solar electrification

5. Research Methodology

Rural electrification is usually subjective to socio-economic contexts and involves multilateral stakeholders (Freibe et al., 2013; Sovacool & Drupdy, 2011). Hence, in pursuing studies with interdisciplinary themes, Yin (2009) and Bennett & George (2005) opined on the necessity to implement qualitative methods of research.

5.1 Selection of the Location for the Study

Keeping the research context in mind, this study aimed to analyze the SHS interventions in remote rural areas where there is lack of electricity transmission lines or the location is off-grid, i.e. it has no connectivity from the national power system. Based on this, the research has been conducted in six remote and off-grid villages from the northern, central and southern-east coastal regions of Bangladesh as specified in the map given in Figure 5.

Table 2: Data Collection Phases

I. First Phase of data collection	• Key Informant Interview (KII) • Field observation • Personal interviews and Case study
II. Second Phase of data collection	• Questionnaire survey with the household respondents

5.2 Sample Size Selection

Table 3: Sample size in different data collection methods

Data collection method	Sample size
• KII - The participants in the KII session have been selected for interview by considering their designation, managerial position and duration of service (more than 5 years and above) in the RE industry. This research includes five KII sessions with the professionals, consultants and program managers of solar electrification (specified in the Appendices section).	**5**
• Personal Interviews with nine rural households from the selected locations to develop the case studies.	**9**
• Questionnaire survey with the household respondents (users of SHS) from the six remote and off-grid villages from the northern, central and southern-east coastal regions of Bangladesh	**171**

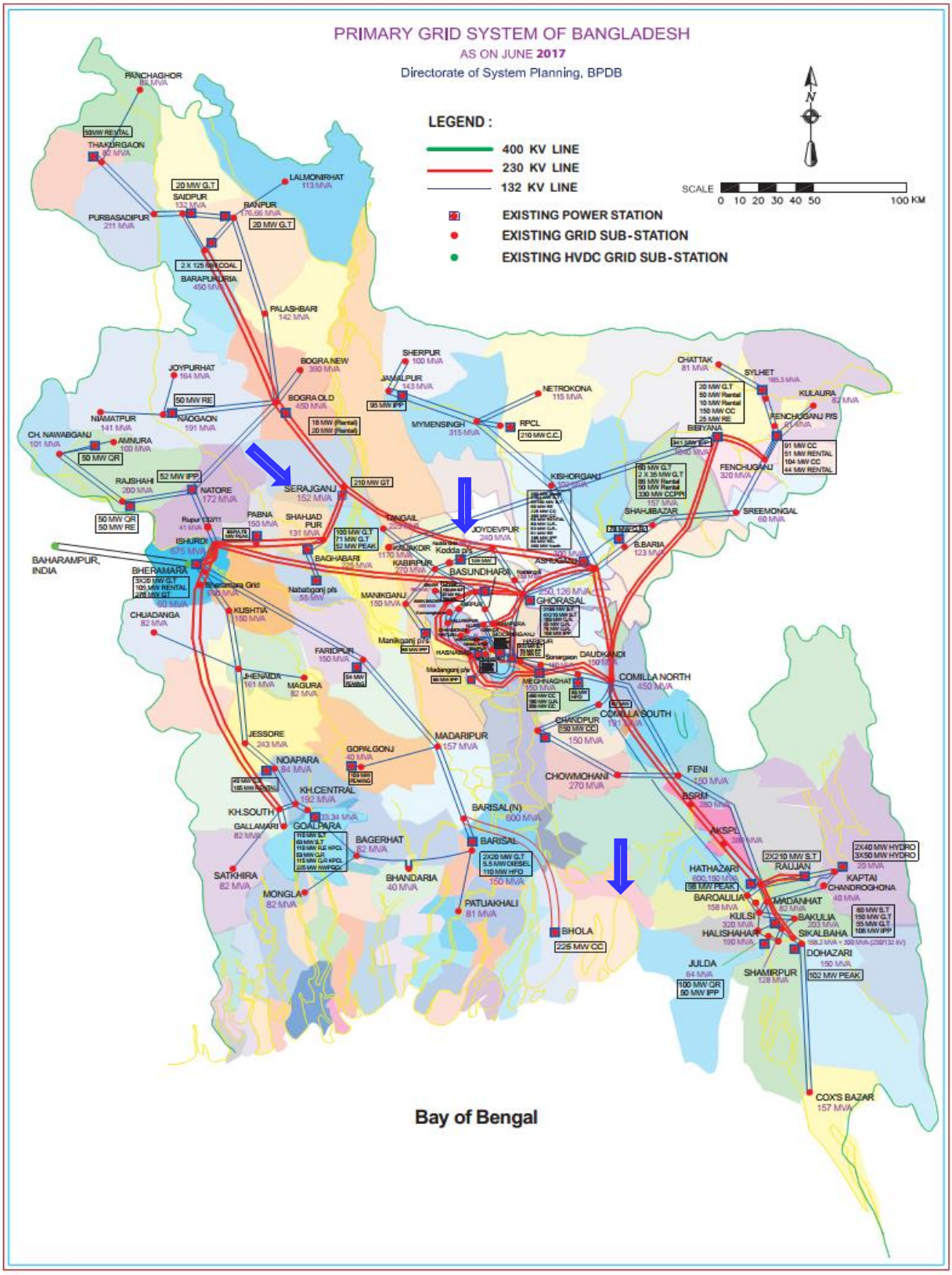

Figure 5: Selected locations for the study shown in the Map of Primary Grid System of Bangladesh, source: http://www.bpdb.gov.bd/bpdb/index.

The questionnaire for surveying the rural clients of SHS comprised of two parts. Part one included questions yielding demographic information of the respondents while part two comprised of nineteen categorical questions regarding the installation and usage of SHS.

6. Analysis & Discussion

6.1 Microfinancing the access to Solar Electricity

Table 4 summarizes the case studies developed from field observations and personal interviews with the users of SHS from the study locations. The insights from these case studies are presented here in Table 5 by specifying the household (HH) income of the participants along with the installed SHS price, capacity, usage duration and instalment payment status. Based on this observation, particularly considering column three and column five in table 4, it is evident that the price of the SHS in much higher than the household income of the respondents. This justifies the rural users preference for purchasing the RET in monthly instalment based payment schemes (Khan et al., 2019).

Picture 2: SHS user Rabeya Akter & her family (SHS on the rooftop)

Picture 3: SHS user Manik Uddin & his family (SHS on the rooftop)

Picture 4: SHS user Sajeda Khatun & her family (SHS on the rooftop)

Picture 5: SHS user Jahanara (SHS on the rooftop)

Table 4: Summary of Microfinancing the SHS Installations status based on the Case Studies

Case study on SHS users	User Location	HH Income (in Taka)	SHS Capacity	SHS Price (in Taka)	Usage duration	SHS installment (in Taka)	Monthly Kerosene cost prior to installing SHS (in Taka)
User 1	Noalkhali	15,000	50 watt	24,542	2 years above	750 (Full Paid)	2,500
User 2	Noalkhali	12,000	65 watt	42,758	3.5 years	1190 (Full Paid)	2,000
User 3	Noalkhali	12,000	30 watt	25,745	3 years	615 (Full Paid)	2,000
User 4	Noalkhali	10,000	30 watt	14,700	8 months	615 (34% paid)	2,000
User 5	Sirajganj	9,000	42 watt	24,440	4 years above	580 (Full Paid)	2,500
User 6	Sirajganj	12,000	45 watt	21,528	1 year 8 months	600 (60% paid)	2,000
User 7	Sirajganj	10,000	20 watt	16,616	2 years above	300 (Full Paid)	1,800
User 8	Gazipur	15,000	20 watt	16,615	2.5 years	300 (80% paid)	2,500
User 9	Gazipur	15,000	20 watt	16,978	4 years	300 (Full Paid)	2,000

The above case studies highlight the SHS installation scenario from the users' point of view. While, to get the insights from the POs' perspective, their credit collection status in distributing SHS was reviewed. Based on the assessment of the supervisory authority of SHS program in Bangladesh, IDCOL, the performance of POs on instalment collection efficiency for microfinancing the SHS is depicted in figure 6. Here it is identified that around 47% of the POs (21 out of 45 POs) have overall monthly payment collection efficiency of 96% and above. Also, 78% (35 out of 45) of POs of IDCOL are having an overall collection efficiency of above 86% and above, which is considered by IDCOL as an acceptable operational mode in financing the installation of SHS in the rural communities.

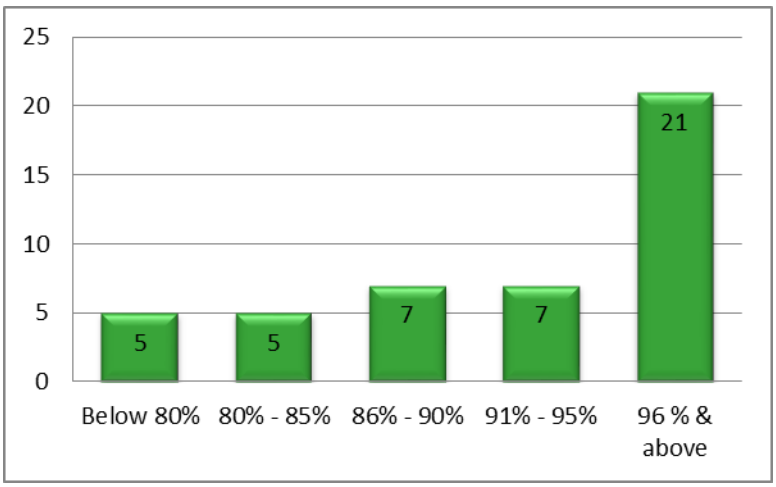

Figure 6: Overall Collection Efficiency of Instalments for Distributing SHS (ICDOL, 2017)

(Source: Working papers and periodic publications of the Operations Committee, IDCOL, 2017)

From the above discussions, it is evident that, majority of the POs have disseminated the SHS in rural Bangladesh, particularly in the off-grid and remote locations of the country, mainly through microfinance interventions to address the higher up-front cost of system.

6.2 Results from the Questionnaire Survey

Table 5: Demographic characteristics of the sample respondents

Demographic profile	Frequency	Percentage
Gender		
Male	115	67%
Female	56	33%
Education		
Up to class five	67	39.2%
Up to class eight	27	15.8%
Secondary School Certificate	51	29.8%
Higher Secondary Certificate	22	12.9%
Graduate	4	2.4%
Occupation		
Homemaker	54	31.6%
Wage earning/service	56	32.7%
Self-employed/Business	40	23.4%
Farming	10	5.8%
Others	11	6.4%
Household Income (Monthly)		
Below 10,000 (in Taka)	64	37.4%
10,000 – 15,000	70	40.4%
15,000 – 20,000	28	17%
20,000 – 25,000	4	2.3%
25,000 – 30,000	3	1.8%
30,000 & above	2	1.2%

Demographic profile	Frequency	Percentage
Family size		
2 to 4 members	49	28.7%
5 to 7 members	118	69%
8 to 10 members	4	2.3%
Capacity of Installed SHS		
Below 20 watt	16	9.4%
20 watt > 40 watt	49	28.7%
40 watt > 60 watt	43	25.1%
60 watt > 80 watt	45	26.3%
80 watt and above	18	10.5%
SHS usage duration		
Below1 year	15	8.8%
1 year – 2 years	40	23.4%
2 years – 3 years	41	24.00%
3 years – 4 years	52	30.4%
4 years – 5 years	18	10.5%
5 years & above	5	2.9%

6.2.1 Analyzing the rural households' opinions on SHS usage from questionnaire survey

The following discussion sheds light on the socio-economic and environmental implications of SHS from the users' perspective by incorporating the descriptive statistics like crosstab analysis. In this regard, by utilizing demographic variables like age, gender, family size, location and income, the users' opinions and perceptions on the benefits and constraints of SHS have been examined. In addition to this the later part of this section also highlights the problems users' face in using the technology.

Tables 6, 7 and 8 summarize and reveal the results of crosstab analysis by indicating the significance of the implications of solar home system usage in reference to the selected demographic variables mentioned above. The tables of the relevant crosstab analysis have been documented in this discussion with the Chi-Square Tests values.

Table 6: Results of Cross-Tab Analysis on Social Benefits of SHS

Demographic variable	Users' perceptions about the social implications of SHS usage	P value< .05 (Pearson Chi-Square)
Family size	we get comfort in HH chores with SHS	.000
Gender of the respondent	we get security at night with solar light	.026
SHS usage duration	children get longer study hours at night	.000
Respondent's household income	I will recommend other to use solar	.000

From table 6, in reference to the family size of the respondents, it can be stated that a greater majority of the respondents (95.9%) agreed about the fact that due to solar electricity, their family avail convenience and comfort in managing household chores. This is also significant in the Chi-Square test where the calculated p value is 0.000 ($p<0.05$).

Considering the gender of the respondents, the greater majority, around 95.9% of the respondents (63.7% strongly agreed and 32.2% moderately agreed) opined that due to availability of solar lights at night, they feel secured at night, the findings are also evident through the Chi Square test with p value is .026. This security concern at night is even more significant for the women and young girls in the remote rural localities.

Again, from the perspective of SHS usage duration, a greater number of the respondents gave their opinion (59.6% respondents strongly agreed and 33.3% respondents moderately agreed) towards the fact that with the presence of solar lights at their home, their children can study for longer hours at night, as evident from the p value of .000. In addition to this, keeping solar lights at home also gives the rural users the safety from wild animals, snakes and various harmful pests and bugs, particularly at night.

Thus, considering the household benefits derived from the SHS, respondents from different income groups, stated that (49.1% respondents strongly agreed and 44.4% respondents moderately agreed) they would like to suggest others in their neighbourhood to use the system (p value is .000).

Table 7: Results of Cross-Tab Analysis on Economic Benefits of SHS

Demographic variable	Users' perceptions about the economic benefits of SHS usage	P value< .05 (Pearson Chi-Square)
Family size	saving money that was spent for kerosene	.001
	our economic situation developed for solar usage	.001
Gender of the respondent	by using solar light, we can do IGA	.000
Respondent's household income	by using solar light, we can do IGA	.000

As evident from table 7, considering the demographic variables, a significant number of respondents (74.3%) strongly agreed with the concern that by installing SHS, they can save the fuel cost incurred for purchasing kerosene used in lanterns (as evident from the p values). This is due to fact that the monetary amount for the monthly payment of SHS is comparatively lower than the average kerosene expenditure for rural families. In addition to this, after the installment payments have been completed, the clients own the SHS and thus can avail the benefits of solar electricity without any major financial commitments (Pode, 2013).

Moreover, as revealed from the KIIs and personal interviews with the SHS users that, with the availability of solar charger at their homes, they no more incur the costs to go to the local shops for getting their mobile phones charged which usually costs 50 to 100 taka per week. Thus the number of mobile phone subscribers in rural Bangladesh is rapidly growing that has been driven by the solar electrification programs carried out by the POs who distribute solar chargers along with installing SHS.

In addition to this, 40.9% of the respondents (particularly the female respondents) from different income groups mentioned that by using solar electricity, they can do some income generating

activities like making handicrafts and other handmade household items and selling those in the nearby local markets. Moreover, considering the family size of the respondents, 42.7% strongly agreed and 43.3% respondents moderately agreed with the statement that their economic condition has developed due to SHS usage. The significance of these findings is evident from the concerned p values, shown in the table 7.

Table 8: Results of Cross-Tab Analysis on Environmental Benefits of SHS

Demographic variable	Users' perceptions about the environmental implications of SHS usage	P value< .05 (Pearson Chi-Square)
Gender of the respondent Family size Occupation Respondent's household income	good in-house environment comparing with smoke from kerosene lanterns	.000

Table 8 summarizes and reveals the results of crosstab analysis by indicating the household users' opinion regarding the environmental implications of SHS. When it comes to the environmental issues, the households expressed their perceptions in terms of in-house environment and comparing the solar electricity with kerosene lanterns. Here all the households mentioned that by replacing the energy option of burning kerosene with SHS, they feel good at home. This is due to the fact that, now they do not have to suffer from the harmful smoke emitted from the kerosene based lanterns which caused several health related problems like caugh, eye troubles, also, contributed in the rise of temperature inside the house. Thus with SHS, they got relief from the hazards of kerosene. Thus, the users of SHS in the villages opined that using solar is a good idea as they get good in-house environment.

Among the available solar technologies, PVs devices appear to offer a significant potential to lessen the reliability on electricity generated from fossil fuels which is one of the major sources of GHG (Chakrabarty & Islam, 2011).

By incorporating the insights from case study analysis and survey results, in the conceptual framework of the research, the SHS interventions and its role in promoting sustainable rural development is illustrated in figure 7.

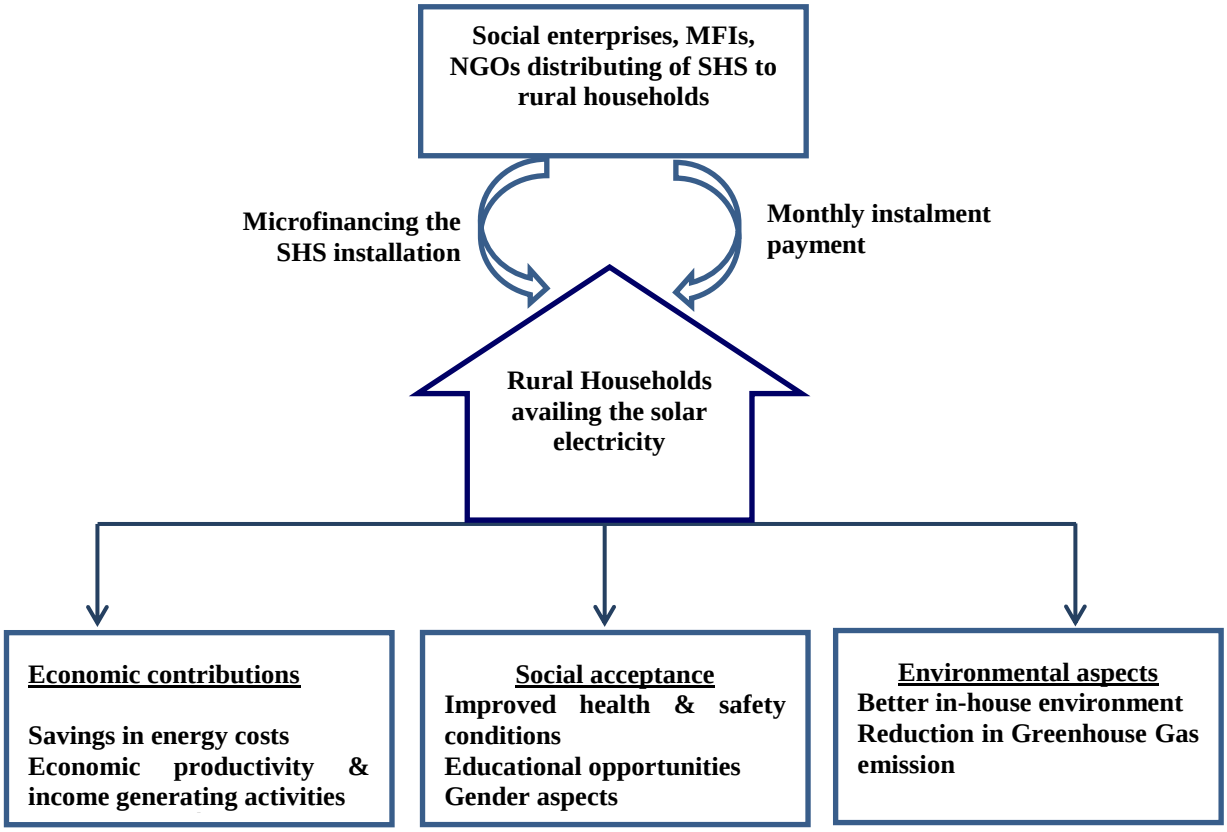

Figure 7: Sustainable Rural Development opportunities through solar electrification

6.2.2 Problems in solar electrification faced by the rural households

To shed light on the problems and challenges in the adoption of SHS, Table 10, identifies the difficulties in using the system from the users' perspective. As noticed from the table that, the technical problems in operating the SHS is the mostly observed problem among the household users, as in 64.9% cases, the respondents mentioned about trouble shooting in the system. Next problem identified in the study is lack of affordability to finance the higher upfront cost of SHS installation (as identified in 63.5% cases).

Considering the average monthly household income of rural communities, the total price of SHS is still expensive and beyond the purchasing power of poor rural customers. However, while micro-financing the SHS installation, the minimum payment required is around 3000 taka which is almost equal to one-fourth of their consumption expenditure per month (BBS 2016). Thus the higher cost of RET is still a constraint for poor rural families to purchase the system.

Table 9: Problems in SHS Adoption in Rural Households

$multiple_res Frequencies				
		Responses		Percent of Cases
		N	Percent	
Problems	problem with higher price of the SHS installation	94	21.5%	63.5%
	problem of less availability of system components	62	14.2%	41.9%
	SHS parts sometimes give trouble	96	22.0%	64.9%
	lack of customer service from the company	90	20.6%	60.8%
	lack of awareness on the proper usage of SHS	60	13.7%	40.5%
	any other problem	35	8.0%	23.6%
Total		437	100.0%	295.3%
a. Dichotomy group tabulated at value 1.				

Case Summary						
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
$multiple_res[a]	148	86.5%	23	13.5%	171	100.0%
a. Dichotomy group tabulated at value 1.						

In addition to this, in 60.8% cases, respondents have opined about the lack of availability of customer service and maintenance support from the local branch offices of the POs. Again, in 41.9% cases, less availability of solar components at the nearby shops and local markets in the remote rural locations has been found as another difficulty that the users of the system have been facing. Last but not the least, a critical barrier in the adoption of SHS among the target market is lack of awareness on RET as identified in 40.5% cases. Due to this, along with the low literacy rate among the rural population, the users of the system have limited or no knowledge on the proper application and maintenance of SHS.

7. Need for collaborative research and capacity development efforts

Considering the role played by local and international stakeholders involved in the commercialization of SHS in rural Bangladesh, it is imperative to have multidisciplinary and multilateral interventions for addressing the constraints and challenges in ensuring the sustainability of renewable energy ventures (Islam et al., 2014). The interactions among the actors in RE industry will facilitate productive dialogue between the stakeholders to develop private-public partnership (PPP) on the diffusion and commercial sustainability of solar electrification ventures in the rural communities.

Following the concept of ‘action research’ that calls for problem solving research and closer interactions between academic researchers and industry players (Wells et al., 2009, Balle et al., 2015), the framework in figure 8 proposes the development of multilateral cooperation and research interventions which, importantly, includes direct links to the RE industry as well as attainment of SDGs of- “Affordable and clean energy”, “Climate action” and “Partnerships for the goals”.

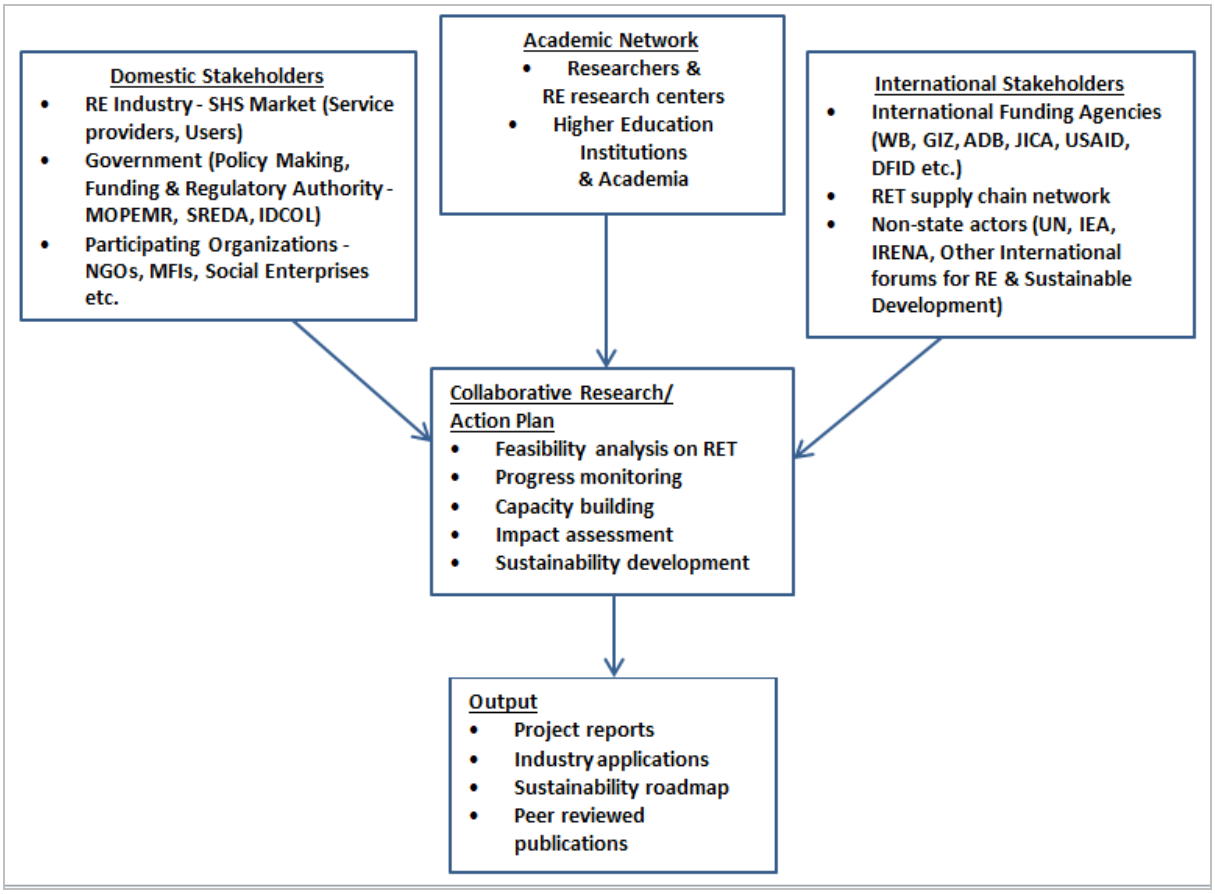

Figure 8: Proposed framework for holistic sustainability research on Solar electrification Program in Bangladesh

7.1 Capacity building and collaboration in RE industry

In order to assess the capacity development needs and learn from the success and shortcomings of the ongoing solar energy ventures by the MFIs, NGOs and other social enterprises, a holistic and participative approach is needed among the practitioners and policy makers in the SHS programs. Along with the active participations of SSE in the rural development interventions of the country, the necessity of motivating the private sector to invest in the expansion of solar electrification and RET adoption should be brought to policy maker's attention.

The private sector in Bangladesh has been playing its due role as an effective economic agent (74.55 percent of total investment in the national economy came from private sector in year 2013-2014) and this sector has been making substantial contribution to the overall economic development of the country (BBS, 2016). In addition to the electrification initiatives through RET by several MFIs and NGOs, the robust and dynamic private sector in Bangladesh can capitalize on the opportunities provided by international climate finance forums to invest in the RE industry, particularly in the solar energy projects. Yet, fewer initiatives from the private sector are evident in the country to venture in the energy and environment sector. This has been partly due to shortage of knowledge, capacity and expertise required to mobilize private actors on renewable energy development. In this regard, Public-Private-Partnership platforms can be developed to harmonize and operationalize the potential in RE industry by considering the following three interventions;

- **Awareness Development** – the SSE can play vital role by updating the private sector regarding the opportunity in the development and deployment of RET and building consensus on the role of the private sector in addressing the energy security and sustainable power generation.
- **Institutional Assessment** – Supporting Government of Bangladesh and concerned Govt. bodies with relevant information to help with an informed decision making process for selection of the right entity/entities for accreditation. This will help the social enterprises as well as private sector to facilitate their venturing in RE industry.
- **Strengthening institutional capacities** – Supporting and supervising private banks, financial institutions, non-government organizations and social enterprises to gain strategic access to and use of RE development and environment funds for implementation of green energy initiatives in the sphere of sustainable development goals.

Based on these insights from the professionals associated with the POs, it is evident that a collaborative approach is needed aiming the SSE players and other stakeholders in the RE industry to address the expansion of solar electrification in rural Bangladesh.

8. Concluding remarks

Rural electrification is an essential concern for making the development process inclusive and sustainable. Academia and policy makers, both fraternities acknowledge that the universal access to electricity is of vital importance for poverty alleviation and reduction of social inequality. In this regard, the study reveals that in a developing nation like Bangladesh, the adoption of RET is still expensive for the underprivileged rural communities. Yet, with the microfinance interventions from the MFIs, NGOs and social enterprises in the rural and underprivileged communities, people can adopt the SHS to meet their energy needs. Therefore, in spite of their financial constraints, the users place more importance on the development opportunities associated with the RET. Thus, the growth and sustainability of SHS program in the country is driven by:

(i) the strong drive among the rural population for improving their living standard,
(ii) the existence of infrastructure of MFIs and other NGOs to penetrate the remote rural areas,
(iii) the funding and technical support of domestic and international institutions for the expansion and capacity development in RE program.

Findings of the study can be an important outline for the participating organizations and supervisory institutions for developing managerial insights and technical capabilities to address the sustainability of the SHS program in rural communities. Additionally, the paper would add value to the literature on the potential of SSE to promote renewable energy for rural electrification from the context of a developing nation that sets an impressive example in resilience and innovation in the face of possible climate change adversity.

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