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Implementation Procedure and Financial Model of Solar Mini grid at Rural Areas in Bangladesh

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Abstract

In rural areas, effective implementation of PV systems increase the quality of life, generate income, improve children education by providing good quality of light and reduce health hazard and risk of fire by reducing kerosene burning. Around 1.4 million solar home and 10,000 PV micro utility systems are installed in the rural areas of Bangladesh by February 2013 by various installers. Under the PV micro utility model, an entrepreneur installs the PV system at his own premise and shares the electricity generated with his neighbors. This paper discuss about the implementation procedure and financial model of PV Mini grid at rural areas for further expansion and upgrading of PV systems in Bangladesh. It is understood that appropriate policy towards PV micro/mini utility, initiative to available PV accessories locally within the country and proper monitoring and dedicated maintenance support can make PV micro utility program more successful in Bangladesh like SHS.

Keywords: PV Mini grid, Bangladesh, Implementation model, Recommendation for further expansion

1. Introduction

The Government of Bangladesh has its vision and policy to bring the entire country under electricity service by the year 2020 [1] currently, In Bangladesh, only about 47% of the population has access to grid electricity [2]. The present installed electricity generation capacity is about 6837.50 MW. The per capita electricity consumption in Bangladesh is 182 kWh p.a. that is still among the lowest in the world [2]. Currently, the country is facing huge electricity shortage because of high demand of electricity. Bangladesh could not increase the generation of electricity much during the last few years due to shortage of natural gas and weak policies favoring electricity production. According to the Bangladesh Power Development Board, the present peak hour shortage of electricity is around 15-20% of generation [6]. This shortage is 44 % according to the recent report of World Bank[3].

Solar photovoltaic appear to be the only appropriate options for renewable electricity generation in Bangladesh. The daily average solar radiation varies between 4 and 6.5 kWh/m^2 [4] SHS project has been implemented under Infrastructure Development Company Limited (IDCOL) and till now around 1.4 million solar home systems and 10, 000 PV MU systems are installed in Bangladesh [5]. Rural electrification through solar PV technology is popular in Bangladesh. Solar program mainly targets those areas, which have no access to conventional electricity and have little chance of connecting to the grid within 5 to 10 years.

PV systems increase the quality of life, generate income, improve children education by providing good quality of light and reduce health hazard and risk of fire by reducing kerosene burning. Effective implementation of SHS can contribute toward the poverty alleviation as well [6, 7]. These PV systems in Bangladesh are also feasible both technically and financially [8, 9]. Around 47% people have the access of electricity in Bangladesh and per capita electricity use is 183 kWh p.a. [2]. At the time, 41.2% people are poor 9.3% are very poor [10]. During field visit, users were asked about their interest to buy individual PV system. Most of the users reported that they did not want to maintain individual solar system if they have good quality source of power as they did not have grid electricity. So, it is obvious that the PV micro/mini utility system still has huge potential in the rural villages of Bangladesh. Especially in the places where there is no possibility to obtain grid electricity in the next 10-15 years. This paper discusses about the implementation procedure and financial model of PV mini grid

in Bangladesh. Recommendation for further expansion and upgrading also described with the implementation model.

2. Research Methodology

A field visit was done from October 2011 to January 2012 to collect the data from filed and field survey was followed by the interview and discussion with the different SHS and PV micro utility installer (Grameen Shakti, BRAC and RSF and CMES Bangladesh) to get the authentic data. Secondary data are also collected from related websites as well. Based on the survey future implementation model of PV mini grid in the rural areas are discussed along with the financial model. Recommendations for further expansion and up gradation are also talked about based on survey.

3. Implementation of PV mini grid in Bangladesh

Government of Bangladesh has the vision to provide electricity to all its citizens by 2021. To full fill this vision, the government has the plan to produce 500 MW power from solar energy by 2015. But this plan will not be successful without proper policy and plan about PV micro and mini grid.

Figure 1: (a) 1.8 KW PV AC systems at Jhenaidah (b) 10 kW PV project at Rangamati

Past experience of GS and CMES, suggest that it is very difficult to install and maintain PV MU systems without help from the government. There are so many risks involved such as possibility of grid electricity and users discontinuation after buying individual systems. Till now there is only policy for SHS, but no policy about solar micro and mini grid. CMES installed PV MU system at around 15 market places of Bangladesh but most of them stopped after 3 to 4 years. Only one project ran for 08 years. Availability of grid electricity and individual SHS were the main reasons of failure of those projects.

The Local Government Engineering Department (LGED), Bangladesh installed 1.8 KW PV AC systems at Gangutia under Shoilkupa Upozila in Jhenaidah district under SRE project from donor support (Figure1a) [11]. The project was basically a non profitable and installed for demonstration purpose. Users were paying minimal monthly rent just for the maintenance of the system. But problem arose when needed to replace battery as it involved huge cost. And, the question was that who would go for finance for this replacement. Bangladesh Power Development Board (BPDB) has installed three 10 KW project in the CHT region (Figure 1b) in Bangladesh and the purpose was again to demonstrate, and not to make profit. During field visit in one of this project at Borokal, Rangamati, it was found that users were paying only 60 BDT/month/light. Most importantly, project was out of service during the field visit due to the problem about the inverter. Local technician of the project reported that they needed to wait until new inverter arrives.

In Bangladesh, still there are many places like *char* (places within the river) and hilly areas where grid electricity will not be possible by next 15-20 years. So, the government should think of appropriate policies to implement PV micro and mini grid by private sector as like SHS under IDCOL.

The government already has plans about PV mini grid with the help of ADB as shown in figure 2. According to the model, electricity from the solar module will be sent to a controller and from which electricity will go to the grid through inverter. For night time use, access electricity from the controller will go to battery. Street lighting, houses, small industry and even water treatment plant for the rural villagers can be included as load for the grid. Prequalification of potential investors will be made and tender document will be issued to a prequalified investors. Power division will select one investor for each place through an open and competitive bidding process. Power cell will prepare bidding documents and select RAPSS (Remote Area Power Supply System) operator. RAPSS operator will be enlisted with IDCOL as partner organization (PO) to access loan and grant facilities of this program. Figure 3 shows the implementation process of solar mini grid in Bangladesh. IDCOL will receive low interest loan for mini grid from the RAPSS fund to execute this program. Government of Bangladesh will establish this fund by receiving contribution from development partners, government resources,

repayment of loan made from the RAPSS fund and any other donation from individuals, enterprises, institution, agencies, sharing development funds available in other sectors etc.

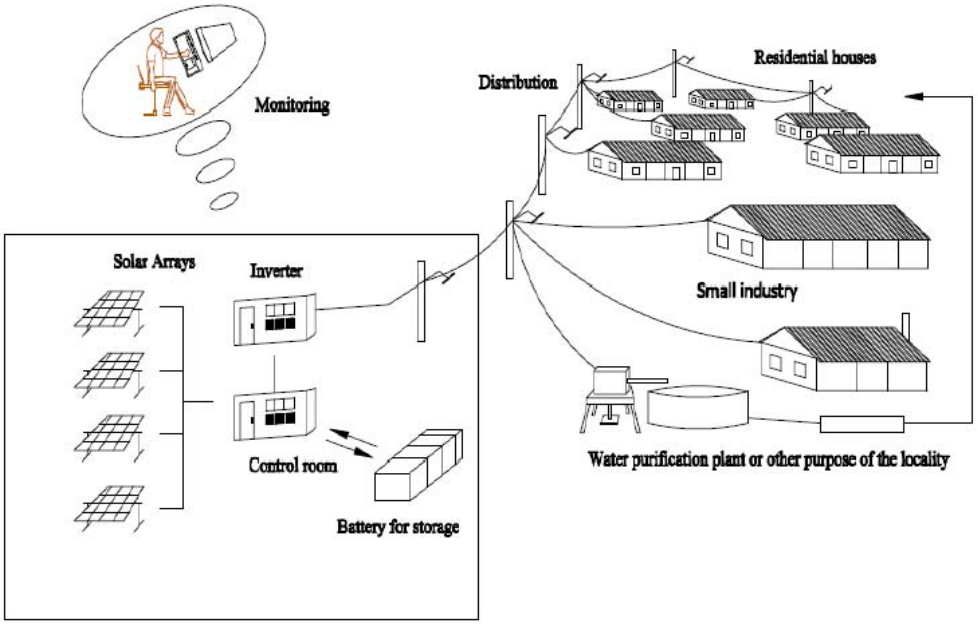

Figure 2: Solar village electrification model by using mini grid

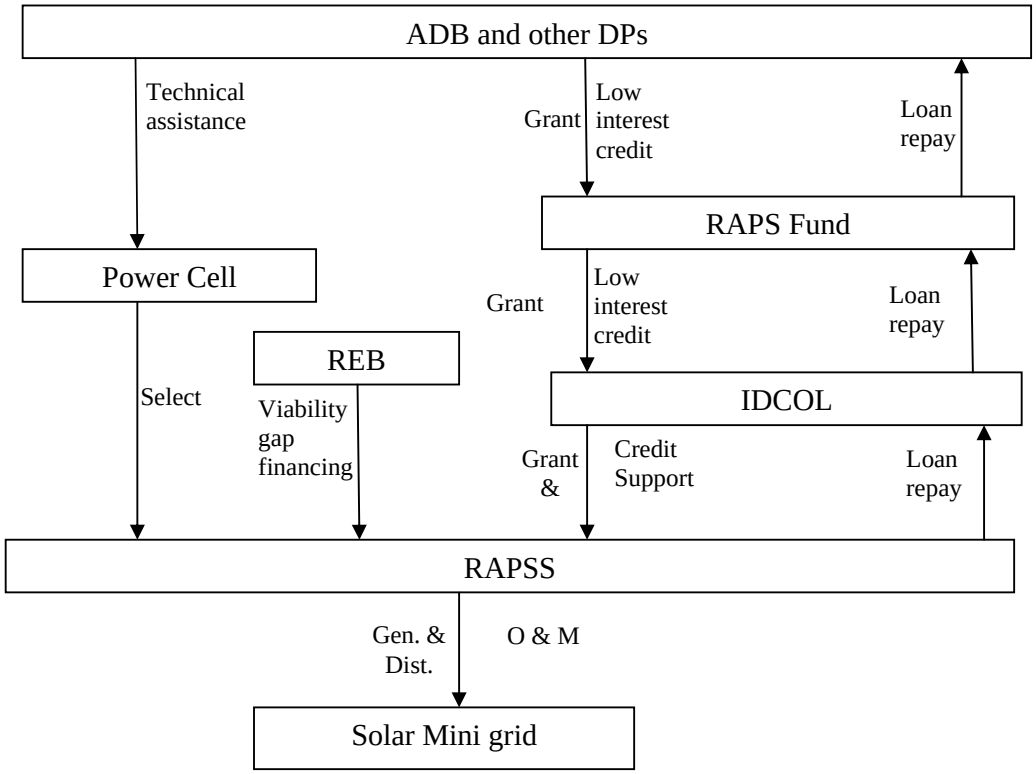

Figure 3: Solar mini grid implementation model

RAPSS operator will generate electricity and supply it to the customers as determined by the government. They will also collect the monthly bills from the customers. IDCOL will provide necessary financial and promotional support to the POs for successful implementation of the program. Besides, since the offered tariff will be higher than the average retail electricity price, the government will provide subsidy through REB. So, it is necessary to complete the feasibility study and implement the plan as early as possible. There will be another revolution about solar PV implementation in Bangladesh if this policy is successful.

4. Recommendations for further expansion and upgrading

4.1 Appropriate initiative to available PV accessories locally within the country and control cost:

Along with PV micro/mini grid, at present, the government should also think about appropriate policies to produce all the PV equipments within the country.

Currently, except for solar Panel all other equipments are produced within the country. Though in the last 5 years, the cost of PV panel has reduced significantly but the cost of PV in Bangladesh varies with dollar as panels are imported. During the last 5 years, the dollar rate increased by around 16% and that has affected the cost of PV panel. There is no company producing PV cell in Bangladesh. Some companies like Baneco Solar Energy, Ava Renewable energy, Electro Solar and Green Infinity Ltd are assembling solar module/ panels importing PV cell from China, Germany, Taiwan, India, etc. Raihm Afrooz Renewable is also trying to assemble solar panel but all these efforts could not reduce the cost of PV panel as their cost is almost same as imported panel. The government should try to help to produce PV cell within the country. On the other hand, all the equipments cost are increasing except solar PV. Battery cost increased 87.5% from year 2003 to 2007 [6]. Other cost like overhead, transportation and cost of installation has also increased significantly. So, the government should make a policy through IDCOL to make available of all the quality accessories locally and control the cost of equipments.

4.2 Different type of packages for PV MU:

There are no POs except GS in Bangladesh that offer PV MU system in the rural villages of Bangladesh. Laos is one of the good examples of solar PV application and Sunlabob is the main installer of solar PV in Laos, like GS in Bangladesh.

Sunlabob currently has three attractive packages for PV MU namely Sale, Rent and management under solar community systems. Detail on this has been described already in the section 2.1. Under these packages users can be the owner or just user and users can take the responsibility of maintenance or not. So, user cans choose according to their affordability and desire. These packages are very popular in Laos [12]. Such possibilities and options could also be made available for Bangladeshi users/customers.

4.3 Proper panel orientation

Improper panel orientation can reduce the panel output significantly. It was observed that in the whole country, the standard of 23^0 inclination angle was followed [13]. But the latitude of Bangladesh varies from around 20 degree 34 minute to 26 degree 38 minute [10].

Table 1: Latitude of the major places of Bangladesh with the proposed inclination angle

Place	Latitude (Google Earth, 2012)	Proposed
Rangpur	25 degree 52 minute	25 degree
Dinajpur	25 degree 37 minute	
Sylhet	24 degree 54 minute	
Mymensingh	24 degree 45 minute	
Rajshahi	24 degree 22 minute	24 degree
Gazipur	23 degree 59 minute	
Dhaka	23 degree 42 minute	
Chadpur	23 degree 13 minute	23 degree
Khulna	22 degree 49 minute	
Barishal	22 degree 42 minute	
Rangamati	22 degree 42 minute	
Bhola	22 degree 41 minute	
Chittagong	22 degree 22 minute	

The latitudes of the major places of Bangladesh are shown in table 1. The proposed inclination angle is also shown in the table. Latitude of Rangpur district is 25 degree 52 minute where as it is 22 degree 22 minutes for Chittagong. So, it is better to divide the country in to three or four zones and fix the inclination angle accordingly. IDCOL should change its regulation accordingly.

4.4 Way to use surplus energy

Three days autonomy is maintained in Bangladesh for the solar PV system design. These three days autonomy ensures electricity supply even in the rainy season and smoggy weather. But this kind weather appears only three/four times in year. Most of the time the sky is clear and sunshine hours are also reasonable. After full charging of battery, charge controller limits the current flow to the battery and a significant amount of energy is lost. Charge controller normally shows high, medium and low charge status of battery. During field visit, it was seen that, many user used small DC fan directly from battery without the permission from GS in the day time during summer when charge controller showed high charge region which was not good for battery.

Further thoughts and research are needed to use this extra energy which is otherwise lost. A little modification can be done in a charge controller so that user can use small DC fan or radio from charge controller when battery stops taking charge from controller.

4.5 Maintenance free battery

problems associated with batteries can be solved by providing maintenance free batteries. These kinds of batteries are sealed and there is no need to fill distilled water. According to manufacturers, life of maintenance free batteries is even more than the present batteries.

As cost is also similar to existing batteries, GS and other POs can go for maintenance free batteries. Most importantly, it has self protection from over discharge, so users need not send their battery for booster charge that needs normally 24 hours.

4.6 LED Lamp

Use of LED lamp in place of Fluorescent lamp could be another important improvement of PV MU systems in Bangladesh. A 50 W_p system can allow 08 (seven 2.5 W and one 5 W) LED lamps in place of current 04 fluorescent lamp.

4.7 **Proper monitoring and dedicated maintenance support**

Proper monitoring and dedicated maintenance is the key for expanding any new technology. Though most of the users were satisfied about the maintenance service, still some users were not happy about the maintenance service. Dust accumulation on panel was the common problem found in many case. Most of the market places are crowded and near roads and so dust accumulation rate in the panel were more than solar panel used at home. Mostly users of the system were not aware of that which leads to a low output of panel. After replacement, many user were found to use low quality local lamp from market which is not authorized by GS as GS bulb was a little bit costly than local bulb. Some users were also found to use inefficient mobile charger from local market without consulting with GS. Besides, corrosion in battery contact terminal was another problem found during field visit. Around 23% batteries had some corrosion in their contact terminal. Output of battery could reduce due to this. PV MU and SHS installer should provide a user manual for the client where all the dos and don'ts can be given clearly so that user can maintain the system properly. So, proper maintenance and monitoring systems should be enhanced by the system installer.

5. Conclusions

Solar home system is an established technology in Bangladesh. Around 1.4 million solar home systems are installed in the rural areas of Bangladesh. On the other hand PV micro utility systems are creating attention recently and 10,000 such systems are installed so far. Recommendations for further expansion and up gradation are discussed based on the experiences obtained from field visit. In Bangladesh, still there are many places like *char* (places within the river) and hilly areas where grid electricity will not be possible by next 15-20 years. So, the government should think of appropriate policies to implement PV micro and mini grid by private sector as like SHS under IDCOL. Bangladesh government is also thinking about PV micro and mini grid for further implementation of solar PV in Bangladesh. It was understood that appropriate policy towards PV micro utility, initiative to available PV accessories locally within the country and proper monitoring and dedicated maintenance support are the key essentials. Solar village electrification model with implementation model are

also discussed. It is suggested that KW range PV mini grid under the RAPSS can be successful for further expansion of PV systems in Bangladesh.

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