

# **The Experience of Application of Renewable Energy Technologies for Rural Electrification in Bangladesh**

By  
**Dewan A.H. Alamgir**  
General Manager  
Grameen Shakti

## **Abstract**

The paper reports the experience of two PV programs, one by Rural Electrification Board (REB) and the other one is by Grameen Shakti, a specialized renewable company in the non-government sector and an affiliated organization of the Grameen Bank. The two organizations follow two different approaches. REB has implemented a PV program in a riverine area for 750 customers. It provided various types of systems: lantern, standalone solar home systems, and battery charging facilities from central charging stations. The rural cooperative society of REB, the *Palli Biddu Samity* (PBS), acts as the Energy Services Company (ESCO). PBS owns the systems and the customers pay monthly fixed energy bills. Studies show that customers prefer standalone solar home systems, especially systems of 46 Wp or more, as against charging facilities and lantern. Customers do not like battery charging due to inconvenience and cost of carrying batteries from distant places. A significant number of batteries have been damaged due to over discharge. Since the charging stations are located at distant places, customers tend to discharge batteries beyond the recommended level and thereby damaged them. The lanterns are disliked due to inadequacy of energy and damage of batteries within very short time. However, since customers pay monthly price for energy only, this is a preferred option as opposed to buying systems. This approach has made solar energy affordable to the villagers. But this requires the ESCO to arrange huge sums of money to own the systems.

In contrast, Grameen Shakti (GS) is following the “hard approach”, that is, it sells solar home systems (SHS). However, to make the systems affordable to the customers, Grameen Shakti provides finances for purchase of SHS. Typically, a customer pays a down payment of 25% of the price of the system and the remaining amount is paid within 2 years in monthly installments including a service charge of 8% on outstanding credit. Up to January 1999, GS had sold 607 solar home systems and the installed capacity was 28 KWp. Customers use these systems for various purposes like, lighting houses, shops, offices, watching TV, operating computer and so on. The systems are functioning well. Some of the customers have enhanced income by PV systems by extending working hours and selling power to neighbors. GS usually opens an office in remote areas where either there is no grid power or coverage is very low. It has been found that easier financing is key to the growth of PV system use in rural areas where income of the households is low. There are various obstacles for expansion of PV program in rural Bangladesh, the main barrier being the high cost of PV module. To make the system affordable, customers need easier financing scheme. That requires organizations like Grameen Shakti mobilize soft finances so that they can offer easier financing terms to the customers.

Grameen Shakti has installed 2 wind-only and 4 hybrid power systems (wind/PV/diesel) in the coastal districts. The energy generated from these systems are being used in offices and residences. But the challenge is to develop strategy to make these systems financially viable.

## Introduction

The fossil fuels used for generation of electricity are depleting fast. This is more applicable in case of Bangladesh. Although there is a rising hope that Bangladesh might discover sizable quantity of fossil fuel but that may not last long given the expected growth in economic development. Besides, there is strategic consideration. Should we exhaust all our fossil fuel or keep a part of it for future generation and try to develop other alternative sources of energy for a sustainable power generation system?

The issue of sustainable development is gaining steady momentum. The renewable energies being inherently sustainable and environment friendly are gaining popularity. All developed countries and many developing countries in their energy planning have included renewable energies as important sources of energy for the next century. Many countries are planning to develop renewable energies (PV, wind, hydro) to cover 10 to 40% of their energy needs within couple of decades. However, no such effort is seen in Bangladesh.

The development of renewable sources of energy should be taken with a greater sense of urgency. Over the years significant technological advances have been achieved in the area of renewable energy technologies, especially in the field of solar photovoltaics and wind energy. In addition, for remote rural areas where the conventional grid system may not be viable, these forms of decentralized alternative energy system may be far more adaptable and well suited. This paper briefly describes the experience of rural electrification using renewable energy technology, especially PV technology. This paper also briefly reports the progress of hybrid power system using wind turbines and diesel engines.

## Rural Electrification in Bangladesh

The shortage of electrical power in Bangladesh is revealed by the fact that only 15% of the total population is served by the power generation authorities. The chances of reaching the remaining 85% of the people by conventional power may not likely to happen in near future. Up to 1993-94, 17809 villages (20.79%) out of 85,650 villages were connected with grid electricity<sup>1</sup>. Due to shortage of generation, the supply of electricity is not at all reliable. Villagers get a few hours of power supply a day, and worse, it is not available in the evening when power is needed most. That affects education, household activities and income opportunity of villagers.

Renewable energy sources till today could not play a vital role to fill this gap due to lack of proper institutional and financial support. Bangladesh is far behind its neighbors in developing renewable energy sector. It would be of great benefit for the rural population if renewable energy alternatives could be spread.

## Photovoltaics System

**System schematic:** The photovoltaics (PV) system has very simple configuration. Sunlight is converted into electrical energy by PV modules and stored into batteries. The electrical energy is later used to run appliances. A PV system has four components: PV modules to convert sun light into electrical energy; battery to store and deliver electrical energy in usable form; charge controller to regulate level of charging and discharging to

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<sup>1</sup> Bangladesh Bureau of Statistics, Ministry of Planning, Government of Bangladesh

and from the battery; and appliances (for example, lamps, TV, any DC motor driven device, computer, telecommunication equipment).

**Benefits:** The benefits of the PV systems are as follows:

- it converts sun light, the most abundant renewable source of energy;
- it is stand-alone independent system;
- It can easily be carried to remote places;
- no monthly fuel bill;
- users can become owner of the systems;
- almost maintenance free;
- environment friendly.

**Applications:** Possible application of PV systems in Bangladesh are:

- to light houses, offices and businesses;
- to operate radio, cassette, TV
- to operate computer and telecommunication equipment;
- to lift water for irrigation and other applications;
- to operate any dc motor driven device and after inverting, any ac motor driven device.

**State of PV technology in Bangladesh:** The PV modules have been in use by various institutions for several years. Recently REB and Grameen Shakti have installed PV systems in rural areas for household applications. PV modules are imported from outside Bangladesh. Local manufacturers produce batteries. Other components like charge controllers and ballast are available from local entrepreneurs which is a very positive sign for development of renewable energy technologies. Private sector participation will accelerate innovation and cost reduction.

### **Experience of Rural Electrification Using PV Technology**

Rural electrification using PV systems is a recent phenomenon in Bangladesh. Two organizations- REB and Grameen Shakti (GS), an affiliated organization of Grameen Bank, are implementing projects to popularize PV systems as an alternative approach to rural electrification. However, they are following two different approaches – REB/PBS is selling power and GS is selling systems.

#### **PV Program of REB**

REB/Narsingdi PBS has implemented a PV project in a remote *char* of Narsingdi district. Basically, two different types of systems have been given to the rural households: (i) battery charging facility by central charging stations. Households received batteries from PBS which are charged from the charging stations for a fee; (ii) standalone PV systems have been installed at the homes of the customers. Customers pay a monthly fee for the service depending on the capacity of the system. Presently, 638 customers are receiving power from the REB project. The project has been financed by French Government grant and has used all imported hardware from France.

The main feature of REB project is that the systems are owned by REB/PBS and customers pay a fee. Systems are mainly used for lighting and watching TV. One refrigerator was placed in a health center which is operated using PV system.

Experience of REB project can be summarized as follows<sup>2</sup>: (a) customers prefer stand alone system mainly due to higher quantity of energy available from the system and for convenience, batteries need not to be brought to the charging station; (b) customers prefer relatively larger system (46 Wp and above); (c) Charging stations may be considered as a failure. Customers do not like to frequently charge batteries from charging stations. It is very inconvenient to bring batteries from far flung areas. Many batteries have been damaged due over discharge.

### **Grameen Shakti**

Grameen Shakti, an affiliated 'not for profit' organization of the Grameen Bank, has been implementing PV program for rural applications for the last 2 years. The main activity under its PV program is installation of Solar Home System (SHS) in *Mymensing, Tangail, Comilla, Khulna, Sathkhira, Rangpur and Banderban* districts.

Grameen Shakti (GS) follows the so called 'hard approach' in implementing the PV program- it sells PV systems in rural areas. GS also installs and maintains the systems. However, to make the system more easily accessible by rural households GS sells PV systems on credit. The credit system is as follows:

- (a) customers pay 25% as down payment, and
- (b) the remaining 75% is paid in monthly installments within 2 years period.

Up to January 1998, GS has installed 607 systems with 28 KWp installed capacity. Grameen Shakti has installed system in the range of 13W to 215 Wp for different applications like lighting, entertainment (TV), operating computer and cellular phone, heating soldering iron for repairing radio, TV etc. However, the applications are overwhelmingly for household purposes - lighting and entertainment. Businesses and institutions are also trying PV systems to extend their working hours at the evening.

The sales of SHS up to January 1999 are given in Table 1:

Table 1: PV systems installed by Grameen Shakti

District	Number of Systems	Watts
Tangail	174	6,054
Mymenshingh	244	11,168
Comilla/chittangong/Banderban	46	2,407
Shatkhira	58	3,410
Khulna	37	2,087
Rangpur	4	300
Dhaka	44	2,445
<b>Total</b>	<b>607</b>	<b>27,871</b>

Source: Grameen Shakti, 1999

Besides, PV systems in some cases have also become sources of additional income. For example, some customers are extending working hours (shops, restaurants, saw mills), in another case PV system has been used to heat soldering iron. In two cases the PV system owners sell power for monthly bills to the shop owners - these are examples of micro utility companies. Although it would be great if the system

<sup>2</sup> Based on the discussion with the customers and project authorities

price could be paid from the income of the system but the number of income generating applications are small compared to household applications for improving the quality of life.

The major experiences of Grameen Shakti is rural electrification using PV systems are as follows: (a) there is no damage of battery, (b) customers are generally happy with technical performance of the systems, (c) some customers are using PV system for income generation, (d) customers usually show interest of PV systems, but the news of REB grid power brings their interest to zero; (e) the main hindrance behind slow expansion of the PV program is the very high cost of the systems.

### **Obstacles of Expansion of PV Technology in Rural Areas**

The major obstacles of rapid expansion of PV systems are as follows:

- (a) the lack of awareness about the PV technology requires long time, effort and money to familiarize the PV technology to the rural areas. Private sector companies and NGOs may find it very difficult to cover the initial cost of dissemination of the technology;
- (b) the main hindrance is the high cost of system due to high price of the PV module in international market and imposition of government taxes. This year government has removed VAT on solar modules. But the pricing policy of PV module manufacturers makes the system price very high for the rural buyers;
- (c) an alternative to reach large number of rural households could be development of an easy financing system so that the buyers can pay the system price over a longer period of time (for example, 5 to 7 years). The implementing agency automatically requires soft fund to finance the customers, but source of soft finance is so far non-existent.

### **Experience of Wind Energy Exploration in Bangladesh**

The wind data on various locations of coastal areas of Bangladesh show that there is practically no usable wind to operate wind turbines during November-February period. That rules out the possibility of using only wind turbines to sustain a particular load. The installation of hybrid systems (wind/PV/diesel) may be a technologically viable option. GS is researching with the possibility of developing wind power systems to utilize wind energy in the coastal areas of Bangladesh. The first two small wind turbines (1 KW and 300 W) were installed in *Chokoria, Chittagong*. The energy is used in an office. The loads are lamps, fan, TV.

Based on the experience in *Chittagong*, GS has recently installed 4 hybrid ( one 10 KW and three 1.5 KW wind turbines) power stations (combination of wind turbine, diesel generator and solar modules) in four cyclone shelters of Grameen Bank, in *Patuakhali* and *Barguna* districts. The objective is to provide electricity to Grameen members to start micro-enterprises in these shelters. The turbines are operating. The energy is being used in office and for residential purposes. But the challenge remains to make these systems financially viable. The present phase of the program will allow Shakti to gather financial and technological information for possible future expansion in other places.

## **Conclusions and Recommendations**

### **Conclusions**

The experience of application of PV systems for rural electrification is still limited Bangladesh. But the programs of REB and Grameen Shakti show that there is potential for PV programs that should be seriously pursued. The 50 Wp or similar system is favored by customers. The performance of the systems seems to be satisfactory. But the major hindrances are lack of awareness in the rural areas, very high cost of systems, lack of adequate fund at reasonable cost to the PV systems providers etc.

The wind energy sector is at the very early stage of development. For isolated areas the system should be hybrid type to sustain load throughout the year. The performance of the systems so far installed needs further observation. The main challenge remains to be the financial viability of the small hybrid systems.

### **Recommendations**

Based on the above discussion the following broad recommendations are made:

- (a) PV system marketing organizations should develop more flexible and easier financing schemes for the system buyers;
- (b) Government should give financial incentives to private and non-governmental organizations to come forward with innovative PV programs for rural areas;
- (c) A resource pool - Renewable Energy Fund - may be created to mobilize resources for this sector so that private and non-government sector may receive fund at a reasonable cost for expansion of renewable energy programs.