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### Solar PV Program:

#### Rural electrification through solar photovoltaic (PV) technology

Rural electrification through solar PV technology is becoming more popular, day by day in Bangladesh. Solar Home Systems (SHSs) are highly decentralized and particularly suitable for remote, inaccessible areas. GS's solar program mainly targets those areas, which have no access to conventional electricity and little chance of getting connected to the grid within 5 to 10 years. It is one of its most successful programs. Currently, GS is one of the largest and fastest growing rural based renewable energy companies in the world.

SHSs can be used to light up homes, shops, fishing boats etc. It can also be used to charge cellular phones, run televisions, radios and cassette players. SHSs have become increasingly popular among users because they present an attractive alternative to conventional electricity such as no monthly bills, no fuel cost, very little repair, maintenance costs, easy to install anywhere etc.

GS installed SHSs have made a positive impact on the rural people. GS has introduced micro-utility model in order to reach the poorer people who cannot afford a SHS individually. Another successful GS venture is Polli Phone which allows people in off grid areas the facilities of telecommunication through SHS powered mobile phones. GS has developed an effective strategy for reaching people in remote and rural areas with solar PV technology. It involves:

- ◆ Soft credit through installments which makes SHSs affordable,
- ◆ Intense grass root promotion through demonstrations, fairs, meetings at the local level,
- ◆ Community involvement and social acceptance,
- ◆ Effective after sales service,
- ◆ Understanding market demand through quality products at minimum costs, product diversification, innovations to maximize benefits,

### Biogas Program:

#### Integrated rural energy and waste management system through biogas technology

In Bangladesh only 3% of the people enjoy the facility of natural gas coming to their homes through pipe lines. The lucky few mostly live in the cities. Most of the Bangladesh's rural people depend on biomass, crop residues, plant debris, animal dung and wood for fuel creating deforestation, flood, soil erosion etc. Women and children, on whom the burden of collecting fuel falls, suffer the most. They are the worst victims of indoor air pollution such as smokes in the kitchens.

GS believes that biogas technology is one of the best means to provide natural gas to the largest number of rural people. It can provide them with pollution free, efficient energy for cooking and at the same time protect them from diseases by giving them a cleaner environment. Biogas technology can be used to implement a sustainable waste management program suitable for rural areas, as wastes of all sorts are transformed into biogas or slurry.

GS has been successful in promoting and constructing both domestic and larger sizes biogas plants to rural villagers. Impact on biogas plant owners has been positive and demand is increasing day by day. All its clients are enjoying hassle free and pollution free energy for cooking and business activities. Bangladesh has the potential for developing 4 million biogas plants. GS intends to further scale up its successful pilot project and develop a 5 year action plan for expanding biogas program in Bangladesh.

GS has developed an integrated and sustainable model for expanding biogas program. The program is based on market approach. GS plays the role of a facilitator, not of a provider. GS does not provide any subsidies, but arranges for soft loans. GS depends on the goodwill of the community for its success. Key features of the program are:

- ◆ A financial mechanism based on credit, which makes biogas plants affordable to the villagers,
- ◆ A program approach - sensitive to consumer needs, providing close one to one technical assistance to them,
- ◆ Training of GS staff, local masons and users

- ◆ **Community based approach to share the cost and benefit of biogas plants,**
- ◆ **Linkage of biogas technology to emerging poultry, livestock and agriculture business,**
- ◆ **Market based approach through entrepreneurs to develop a sustainable biogas program,**

### **Organic Fertilizer Program :**

Excessive farming and use of chemical fertilizers have damaged soil fertility of Bangladesh. GS has undertaken a program to develop organic fertilizers from slurry and market these as a supplement of chemical fertilizers through entrepreneurs. Selected entrepreneurs will promote, and distribute GS developed organic fertilizers while GS will provide the required technical assistance and ensure quality control. Slurry – the byproduct of biogas has the ability to safeguard organic materials such as nitrogen, phosphorous, and potassium, which increases it's standard as a fertilizer and ensures higher agricultural production. Soil Research Department of University of Dhaka, Bangladesh Agriculture University has verified that organic fertilizers developed by GS have very little harmful ingredients. Especially, GS organic fertilizers produced from poultry litter are very good for acidic soil and helps to reduce acidity and aluminum poisoning.

GS has signed agreement with two organizations to manufacture and promote organic fertilizers. This is the first step towards the implementation of GS's goal to provide Bangladeshi farmers with environment friendly, high quality organic fertilizers. GS hopes to sign similar agreement with more organizations in the future. Manufacture and marketing of organic fertilizers can be a viable business in the context of Bangladesh. A 3,m3 cow dung based biogas plant can produce more than 8 thousand kilograms of slurry which is equivalent to 224 kg of urea, 1120 kg of TSP and 114 kg of mp fertilizer. An entrepreneur can earn Tk 16, 000 from selling this slurry at a minimum rate of Tk 2 per kg.

### **Improved Cook Stoves Program:**

#### **Improved cooking technology for rural women**

In rural Bangladesh, the energy consumption for cooking outstrips the demand for all other uses of energy. Grameen Shakti has launched a program to promote improved cook stoves in Bangladesh to address the high demand for biomass fuels and indoor air pollution caused by cooking on polluting, traditional stoves. In the first year, GS will train 200 women technicians who will in turn, train other women and help to market, and construct improved cook stoves for households and businesses. Potential trainees will be selected with the help of Grameen Shakti's 100 field offices. Two such trainings have already been conducted with 20 participants in each session. GS is following an innovative training approach, which focuses on practical demonstration and community participation. After the end of each session, improved cook stoves are installed in 20 households and 1 commercial institution. These stoves are constructed by the trainees and community representatives are invited to taste the food cooked on these stoves. Not only those minimum 50 participants directly enjoy the benefit of improved cook stoves and they in turn inform minimum 50 individuals each.

After the training phase, Grameen Shakti plans to undertake large-scale manufacturing of chimneys, metal grates and sell these on credit via the entrepreneurs to households and businesses. It is expected that that there will be substantial demand for improved cook stoves among households and businesses due to reduced fuel costs, ease of cooking and cleaner kitchen environments. GS plans to construct 10,000 commercial and domestic improved cook stoves over the next 3 years.

### **Grameen Technology Centers:**

#### **Diversification and scaling up GS activities through entrepreneur development**

GS has undertaken a pilot program to set up 30 Grameen Technology Centers (GTCs) in order to scale up its solar program, especially production of SHS accessories by manufacturing these locally. GTCs will also contribute to women empowerment by training them in solar energy technology applications. The trained women will become GS certified technicians. GS will help these technicians to sign annual contracts with its clients for after sales maintenance and become entrepreneurs in the future.

Nearly 20 thousand people each year are installing SHSs all over Bangladesh for business or household purposes. GS alone plans to install one million SHSs by 2015. GS envisages a future where there would be a huge demand for SHS accessories as well as maintenance services to keep the installed SHSs in working order.

GS plans to use the GTCs to meet the projected demand for repair/maintenance services and SHS

GS plans to use the GTCs to meet the projected demand for repair/maintenance services and SHS accessories at affordable costs. The planned GTCs will train a minimum of 1000 women technicians and use them to produce the accessories. They will also strengthen and expand the back-up services at the local level. GS will also use the GTCs to train 5, 000 women members from the user households. GS feels they will be able to look after the SHSs because in Bangladesh, women are responsible for managing household activities.

After completion of the first year, GS has set up 17 GTCs which have trained around 240 women technicians, nearly 300 women from user families and 1000 school children on renewable energy technologies. If the pilot program is successful GS plans to set up 105 GTCs by 2010. These GTCs will act as resource centers for developing renewable energy entrepreneurs at the local level. These resource centers will help to adapt renewable energy technologies to the Bangladeshi context and then pilot test them for and commercialization. At the same time, these GTCs will train renewable energy entrepreneurs and link them up with different technical and financial institutions.

### Wind Energy Program

Grameen Shakti is conducting research to utilize wind energy in the coastal areas of Bangladesh. GS installed 4 hybrid power stations (combination of wind turbine and diesel generator) in four cyclone shelters of Grameen Bank. The power generated from the wind turbines is connected to the four cyclone shelters. Three of which are Grameen Bank branches and one exclusively used as a cyclone shelter. Appliances powered with this system are light, Fan, water pump etc.

The present phase of the program will allow Shakti to gather financial and technological information for possible future expansion in other places.

### Computer Education Center

Grameen Shakti (GS) has taken the step to empower people with modern technology. That is why it launched a computer education program from 2000. The main objectives of this program is to increase the awareness of ICT among the rural people who have no opportunity to learn about computers due to the absence of grid electricity. With the help PV system GS has started this mission for the remote rural people. Shakhipur Computer Training Center is an example of such a centre

These centers create enthusiasm among different groups of people like students, teachers, professionals, businessmen, self-employed, farmers, and shopkeepers.

### Research and Development Program

The research programs have four distinct areas:

- (i) exploring ways to develop appropriate technologies and their uses,
- (ii) developing ways to popularize and making the renewable energy systems easily accessible to a large number of households and institutions,
- (iii) innovating financial services for the customers to facilitate rapid expansion of use of renewable energies,
- (iv) developing and fabricating the solar accessories (charge controller, lamps, dc to dc converters etc.) locally in order to reduce the total system cost. Grameen Shakti has already developed the following products at low cost

- \* Charge controller
- \* DC-DC Converter
- \* DC Ballast for fluorescent lamp
- \* Mobile phone charger

- ▶ Financial Methodology
- ▶ Application & Income
- ▶ Monitoring & Evaluation
- ▶ Marketing & Promotion
- ▶ Training & Capacity development

### Financial Approach :

GS is one of the first companies to successfully develop a financial mechanism to promote renewable energy technologies in rural areas on a commercial basis. This financial model has helped GS to reach break even point in 2000 and scale up its program. The model is based on the following key features :

- ◆ Payments based on installments which makes it easier for clients to pay for GS renewable energy products. This helps GS to expand its market and at the same time reduce its unit costs.
- ◆ Reduction of operating costs by locally producing all SHS accessories, except solar panels and batteries, in its production center. Decentralization of production and marketing activities has led to the development of an effective program at minimum costs
- ◆ Multiple tasks carried out by GS engineers who are not only technical engineers, but also social engineers. This also helps to keep overhead costs to the minimum.
- ◆ Feasibility and break even analysis to identify market potential of a product and develop appropriate financial packages. This helps GS to set realistic targets and reduce financial risks.

The key financial packages developed by GS till to date include :

#### \* Financing Solar Home Systems :

- ◆ The user has to pay 15% of the total price as down payment. The remaining 75% of the total cost is to be repaid within 36 months with 6% ( flat rate) service charges.
- ◆ The customer has to pay 25% of the total price as down payment. The remaining 75% of the cost is to be repaid within 24 months with 4% (flat rate) service charge
- ◆ The customer has to pay 15% of the total price >The remaining 85% of the loan amount is to be repaid through 36 post dated cheques with 5% (flat rate) service charge
- ◆ Micro-utility : The customer has to pay 10% of the total price as down payment. The remaining 90% of the loan amount is to be repaid by 42 cheques. There is no service charge  
4% discount is allowed on printed price in case of cash purchase

#### \* Financing Biogas Plants:

- ◆ The buyer pays 25% of the total cost as down payment. The remaining 75% of the cost is to be repaid through 24 monthly installments with 8% service charge ( flat rate ) within 2 years.
- ◆ The buyer can construct his plant with his own funds under the supervision of GS engineers. In this case, half of the technical and supervision fees will be paid as advance and the rest will be paid after the commissioning of the plant

### Marketing Approach :

GS as a **social entrepreneur**, is proactive in knowing and meeting the needs of the clients and ensuring they get the best services such as a through an efficient after sales service. For example, sale of SHSs surged upwards when the villagers became convinced that SHSs provide a workable solutions to their energy needs and are healthy and cost effective in the long run. GS has a very good reputation among its rural clients. Since renewable energy technologies are expensive and users only pay for a working system, GS focuses on providing excellent maintenance services including inclusive warranties. GS also motivates its rural clients to keep their commitment and ensures good practices by giving them gifts such as umbrellas for making payments on time and clocks for signing post warranty agreements with GS.

- ◆ **Intense grass root promotion:** to develop awareness about renewable energy technologies through holding demonstrations, speaking to village leaders, distributing brochures, organizing science fairs at the local level, demonstrations and workshops for policy makers etc. GS is at present
- ◆ **Community involvement & social acceptance:** through bringing local benefit. both economical and social such as (i) training and recruiting local youths as GS technicians, (ii) reaching out to women by providing them training and opportunities to make extra income, (iii) providing scholarship for children of SHS owners, (iv) protecting the environment by collecting discarded batteries, helping poultry owners get rid of their wastes through biogas technology etc .
- ◆ **Effective after sales service to guarantee and safe guard the investments made by GS clients which includes :** (i) free monthly checkups during payments of installment; (ii) post warranty service through annual maintenance

monthly checkups during payments or installment, (ii) post warranty service through annual maintenance contact with GS for solar home systems, (iii) inclusive warranty system plus a buy back system under which a buyer may return his system to GS when his area gets connected to the grid, (iv) training of users and technicians so that they can take care of their systems. GS has also taken steps to decentralize its production, marketing and repair, maintenance activities through Grameen Technology Centers to ensure that its rural clients receive better services at their doorsteps at less cost.

- ◆ **Understanding Market Demand :** This is the key to GS success and involves (i) meeting the basic needs of its rural clients and giving them quality products at minimum costs; such as choosing medium sized biogas plants for poultry owners so that they can get rid of their wastes and also meet their energy needs (ii) upgrading its existing products and developing new products such as LEDs, DC-DC converters, safety devices for black/white televisions, mobile phone chargers etc, in response to consumer demands; (iii) emphasizing innovative approaches to meet the diverse needs of rural people such as community biogas plants to reach lower income households who cannot afford a biogas plant individually, payment through slurry to make it easier for biogas plant owners to pay back, introduction of small Solar Home Systems for the low income rural households etc.
- ◆ **Tailoring services to the needs of the clients :** GS develops close relationship with clients to understand and meet their needs. For example, in its biogas program, GS engineers constructs biogas plants in close consultation with their clients and gives them the best advice. They also remain in touch with their clients to provide on the spot solutions to their problems. They provide strict quality control and ensure that the best materials are chosen and the plants are constructed as per specifications. GS engineers also hold in-depth discussions with their prospective clients to find out about their social and economical needs. For example, poultry owners are interested in larger sized biogas plants which would allow them to get rid of their poultry wastes and meet their energy needs at the same time. On the other hand, households with few livestock or poultry are more interested in domestic biogas plants which meet their household needs and at the same time sell biogas to few of the surrounding households.

### **Application & Income :**

GS believes increasing the income generation through the use of renewable energy technologies is the best way to ensure a sustainable renewable energy program. For this reason, GS has developed the following financial and technical packages :

#### ◆ **Micro-Utility Model :**

There are some very poor consumers who cannot afford a complete solar home system. In order to help such consumers, GS has introduced micro-utility system. Under this model, one entrepreneur installs the system at his own premise and share the load with some of his neighbours. Owner of the system is responsible for making installment payments to GS , more than 50% of which is covered by the rents he collects from the users of his system. Micro-utility model has become very popular in the rural market places and has helped to increase business turnover by extending business hours. More than 1000 micro-utility systems are operating in the rural market places.

Polli Phone :

#### ◆ **Community Biogas Plants :**

Bangladesh is one of the most densely populated countries of the world. Most people especially in the rural areas live either as joint families or as groups where each household joins another household, usually relatives living very near each other. GS has already identified the rural households which have the potentiality of setting up biogas plants. Joint families and relatives living near each other can share the cost and benefit of owning and operating a biogas plant. GS is also seeking to bring low income groups under its biogas program by linking them with micro-credit as well as providing them with alternative ways to pay back. For example, a farmer may be provided with livestock so he may set up a biogas plant and at the same time generate income.

#### ◆ **Linking biogas technology with poultry and organic fertilizer business :**

GS is linking up biogas technology with live stock and poultry business including agriculture and fisheries to develop a sustainable biogas program. Poultry firms are interested in biogas technology because it helps them to get rid of poultry wastes and at the same time meet their energy needs as well as earn extra income by selling biogas and slurry Same is true for livestock owners. Farmers would be interested in buying slurry from biogas plant owners because this reduces their farming costs and increases their yield. Many enterprises who do not have poultry or livestock are also interested in biogas plants . Others own too few poultry or live stock to construct biogas plants which would meet their energy needs. These people can buy poultry litter or cow dung from poultry and live stock owners for their biogas plants. Therefore an intermediary entrepreneur class would develop who will sell poultry litter, cow dung and slurry linking biogas technology with agriculture and live stock business

#### ◆ **Entrepreneurship Development :**

GS wants entrepreneurs to play the major role in developing and promoting diverse approaches to meet the energy needs of rural people through a decentralized energy system. At the same time GS emphasizes a standard approach which must have efficient after sales service, strict quality control and quality products at minimum costs. Development of entrepreneurs is an extension of GS's market based approach to make private enterprises a major force in the energy sector. As a first step toward this goal GS has set up GTCs which will act as resource centers to provide technical and financial assistance to entrepreneurs. Planned services to be provided through GTCs will include technical and business training for entrepreneurs, business and technical advise, onsite trouble shooting, help to link up with commercial and technical institutions for further help. GS will

onsite trouble shooting, help to link up with commercial and technical institutions for further help. GS will especially help these start-up organizations with inventory management and bulk buying which will reduce their costs significantly. GS has already trained 300 women technicians on solar technology who will soon start working as GS certified technicians. GS is also training 200 improved cook technicians who will train others as well as produce and commercialize improved cook stoves on behalf of Grammen Shakti. It is expected that many of them will soon start their own operations in a dealership arrangement with GS. These trained technicians who have also been given business training will lay the basis of developing renewable energy entrepreneurs at the rural level. It is expected that in the long run different players would enter the renewable energy field and innovative and diversified approaches would be developed to reach the people with energy.

### **Training & Capacity development**

**GS focuses on training to develop both in house and local capacity :**

- ◆ Training of users so that they can take effective care of their systems,
- ◆ Training of local technicians and masons so that cost effective and efficient after sales service is available at the doorsteps of rural clients
- ◆ Training of in-house staff both home and abroad to develop them in to both effective technical and social engineers
- ◆ Training of women technicians through Grameen Technology Centers to decentralize GS's production, marketing and repair, maintenance services

### **Monitoring & Evaluation**

#### **Impact**

**Solar Home Systems – Better Life More Income :**

Solar Home Systems ( SHSs ) has brought lighting facilities and related advantages such as mobile phones, computers, internet connection to remote, isolated areas including islands, Chittagong Hill tracts. This has brought significant improvements in the standard of livings of the people – better light for children education and household activities for women, reduced in-door air pollution, more security and income generation opportunities including reduced work load for women etc

Businesses such as rice/saw mills, grocery /tailoring shops, restaurants, market places etc with the help of SHSs have increased their income by extending working hours after dusk. ( Case 1: A Saw mill owner, Mr. Hanif has increased his business turnover because of extended business hours). Besides PV systems have opened up new opportunities for employment and income generation activities such as community television centers, electronic repairing shops, mobile phone shops etc. (Case 2: Mr Manik has increased efficiency with SHS at his electronic repair shop).

In addition women are enjoying hazardless and hassle free lighting systems in their daily life. They are getting the opportunities to earn extra income by utilizing their time after dusk by sewing, poultry farming or setting home based industries. (Case 3 : Laxmi Rani is running a successful handicraft industry with the help of SHS)

Two very successful applications of SHS are micro-utility model and SHS powered Polli-phone. Micro-utility – an initiative by GS has provided thousands of shopkeepers with extended business hours and increased business turnover by giving them the opportunity to share lights of a SHS among themselves ( Case 4 : Mr. Umar renting solar lamps to other shopkeepers) Polli Phone has created a successful synergy between women and technology - thousands of women are running profitable mobile phones business in off-grid areas; their mobile phones powered by GS installed SHSs. ( Case 5 :

Different religious institutions such as mosques, pagodas, churches are increasingly using SHSs. Different community based organizations such as health clinics, educational institutions are also using SHSs.

**Biogas Plants : Offering Fuel, Health and Income Solutions**

Biogas plants giving the rural people especially their women the opportunity to cook in a pollution free environment – smokeless kitchens . It has also reduced their cooking time, rescued them from the burden of collecting fuel. (Case 1 : Ruksana Parveen using biogas for cooking )

Increasing price of kerosene, diesel and other conventional energy sources has made biogas technology an attractive alternative for many rural households. Many rural households are buying biogas at Tk 500- Tk. 300 per month and finding this alternative more cost effective than traditional sources. Therefore owners of domestic size biogas plants are not only using biogas themselves, they are also selling this gas to their neighbours. They are also using the slurry to increase their agricultural yields. ( Case 2 : Haji Fazal Ali making extra income from renting biogas to others). Small businesses such as tea-stalls and small street side hotels are also renting biogas from others to meet their energy needs.

Biogas technology has become very popular among poultry owners . They are constructing medium to large sized plants to get rid of their poultry wastes and at the same time earn extra income through selling of biogas and slurry. ( Case 3: Khaled Hossein using biogas to produce energy and generate income ).

Orphanages and some industries have become interested in biogas technology to meet their energy needs and generate income. For example, Muslim Mission has constructed biogas plants on its premise and has signed agreement with GS to manufacture and promote organic fertilizers. Kber Ali, a mid scale business from Jessore manufactures bitumen as well as operating a steel work. His large factory is co-fueled by a biogas plant. Though he has a poultry farm, he buys poultry droppings and cow dung from surrounding farmers. Grameen Dnaone plans to set up biogas plants to power its rural based industry.

#### **Laying the Foundation for Rural Economic Development :**

- ◆ Rural energy technologies promoted by GS has brought efficient energy and modern facilities such as mobile phones, internet within the reach of the rural people and given the opportunity to set up modern businesses such as SHS powered mobile shops, computer centers with internet connections etc
- ◆ Bangladesh and rural communities would reduce their dependence on outside for meeting their energy needs. A cost effective and decentralized energy system would develop, implemented through renewable energy entrepreneurs following a market based approach
- ◆ Biogas technologies has boosted livestock and agro businesses by turning poultry and live stock wastes into energy which has made poultry and live stock farms energy self sufficient. Poultry / livestock business has also been connected with agriculture through the promotion of slurry which is the source of high quality organic fertilizer. Agriculture cost will come down and yield will increase from using organic fertilizers
- ◆ Many small businesses has started using biogas as an alternative source of energy. In the future, many more industries will become interested in locating at the rural level and using biogas technology to produce energy.
- ◆ Rural based manufacturing industries for the production of SHS and other renewable energy accessories would develop bringing capital flow and employment in the rural areas.
- ◆ Linkage businesses would develop such as radio, TV , mobile repairing shops, manufacture of TV, radio, mobile phone and other electronic goods parts at the rural level
- ◆ Complementary businesses would also see a boost such as construction material businesses, transportation businesses etc

#### **Developing Social Capital :**

- ◆ GS promoted renewable energy technologies has brought significant improvements in the lives of women. They have been saved from indoor air pollution, their cooking time have been reduced and they can complete their household activities faster because of better quality of life. All these have given them extra time take part in income generating activities
- ◆ Quality of live for children have improved. They can study by solar and watch TVs and listen to radios. Rural people have been connected to the outside world through TVs, videos, mobile phones and internet. This has increased their social awareness
- ◆ Many schools, madrassas are using SHS for education. They are also using biogas technology to meet their energy needs as well as generate income
- ◆ Practices hazardous to health have been reduced with subsequent decrease in health costs. Many Clinics are also using solar light for operation and other activities
- ◆ Biogas technology has laid the basis for a sustainable waste management program suitable for rural areas would be implemented as wastes of all sorts are transformed into biogas or slurry
- ◆ Practices hazardous to environment have been reduced such as cutting of trees, emission of polluting gas in the air, over use of biomass and especially use of slurry as organic fertilizers have reduced the depletion of soil nutrients.