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D7 State of the art of Solar Energy applications in Bangladesh

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Executive Summary

With about 35 percent of the rural households being electrified today, there is a large population of Bangladesh in need of modern energy services. Part of this unmet demand for electrification is now being met by the solar electrification program of Bangladesh. The government has provided the institutional framework needed for successful adoption of PV technology for electrification of rural households not being served by the grid services. Application of solar energy within Rural Electrification and Renewable Energy Development Program (REREDP) essentially complements the grid power service offered by the Rural Electrification Board (REB). This is the predominant solar application program that was initiated in 2002 with IDA loan from the World Bank and GEF grant. Under this program solar home systems are being disseminated through two institutional arrangements. Infrastructure Development Company Limited (IDCOL), which is a subsidiary of the GOB, with a mandate of disbursing loan to the private sector, is refinancing several large and small NGOs to micro-finance solar home systems. On the other hand, the Rural Electrification Board, which provides rural grid electrification service through its affiliated cooperatives provide solar electrification on a 'pay for service' basis.

Success of the ongoing program of IDCOL is being measured through the number of consumers being served through micro-financing of solar home systems by the NGOs. Under the current marketing strategy, households procure solar home systems on a hire purchase basis with a loan contract of typically 3 years. The buyer makes a comparative judgement of the quality of hardware, and services offered by any particular provider. Popularity of SHS is evident considering more than 6500 SHS being installed per month in Bangladesh. The original target of reaching 65,000 households within 5 years by IDCOL was met within 3 years. Consequently the program has received additional loans and donor grant funds from KfW, GTZ and others, in order to continue further following the ongoing scheme of operation. ADB is also planning to invest in this sector within this year. By January 2008 a total of 173,168 solar home systems has been installed under the solar program of IDCOL.

At the national level, although very marginal evidence of private investment can be found, multiple benefits have actually resulted from the solar program of REREDP. It is found that (a) the financial incentives embedded within the program has attracted the NGOs to pursue this non traditional activity, (b) SHS complements grid electrification service in the un-served areas, (c) many jobs are created in support of the industry and services, and, (d) a clean energy technology is being implemented in a broader scale. Currently there are fifteen NGOs engaged in SHS dissemination, at least five organizations that can conduct training programs for solar energy, four battery manufacturers, six cable manufacturing industries, and seven small scale manufacturers of DC lamps and controllers. In view of the active sector, there is a large potential for extending solar energy towards other developmental applications in Bangladesh.

List of Abbreviations

Ah	Ampere hour
BCSIR	Bangladesh Centre for Science and Industrial Research
BPDB	Bangladesh Power Development Board
BRAC	Bangladesh Rural Advancement Committee
BUET	Bangladesh University of Engineering and Technology
Commission	European Commission
GEF	Global Environment Facility
GHG	Greenhouse Gases
GOB	Government of Bangladesh
GOI	Government of Indonesia
GS	Grameen Shakti
IDCOL	Infrastructure Development Company Ltd.
IMF	International Monetary Fund
ISB	Independent Supervisory Body (for electricity market)
IRES	Indonesian Renewable Energy Society
KEPPRES	Presidential Decree
KUBE	General Policy on Energy (Kebijakan Umum Bidang Energi)
LGED	Local Government Engineering Department
LIPI	National Institute of Science
MJ	Mega-Joule
MNLH	Minister of State for Living Environment
MNRT	Minister of State for Research and Technology
MOA	Minister of Agriculture
MOC	Minister of Communication
MOD	Minister of Defence
MOFE	Minister of Forestry and Estate
MOIT	Minister of Industry and Trade
MPR	People's Consultative Assembly
MW	Mega Watt
NGO	Nongovernmental organization
NRSE	New and Renewable Sources of Energy
PBS	Palli Bidyut Samity (Rural Electrification Committee)
PERTAMINA	State Oil Company
PLN	State Electricity Company
PROPENAS	Five-year National Development Program
PSL	Prokaushali Sangsad Limited
PSK Tersebar	Distributed Small Power Generation
PUSKESMAS	Community Health Center (see also CHC)
PV	Photovoltaic
PVP	Photovoltaic Pump
RAPS	Remote Area Power Supply
RE	Renewable Energy
REB	Rural Electrification Board
Renstra-EBT	Strategic Plan for utilization of NRSE
REPETA	Annual Development Plan
REREDP	Rural Electrification and Renewable Energy Program
RES	Renewable Energy Sources
RES-E	Electricity generated from RES
RET	Renewable energy technology
RP	Indonesian Rupiah (Indonesian currency unit)

Rp	Rupiah, national currency in Indonesia (\$1 is about 9100 Rp)
SE	Solar Energy
RIPEBAT	Master Plan for Utilization of New and Renewable Source of Energy
SHC	Sub Health Centre
SHS	Solar Home System
SNI	Indonesian National Standard
SRE	Sustainable Rural Energy
SWH	Solar Water Heater
UNDP	United Nations Development Programme
USD	United States Dollar
Tk	Taka, national currency in Bangladesh (\$1 is equal to 69 Taka)
TWh	Tera Watt hour
W	Electric Power (Watt)
Wp	Peak Watt of Photovoltaic Panel
Wth	Thermal Power (Watt)

Acknowledgements

The RENDEV project

Renewable energy is one of the most important ingredients required to alleviate poverty, realize socio-economic and human development. However, In Bangladesh and Indonesia, efficient utilization of renewable energy resources is yet to assume commercial dimensions and widespread acceptance. As a result, reinforcing provision of sustainable energy services through training and capacity building provision and rational policy dissemination remains a priority in order to achieve poverty reduction strategies and sustainable development in the two countries.

Bangladesh and Indonesia happen to be ideal sites for solar energy production and utilization because of their geographical locations. Moreover, some remote areas are among the best sites to develop small scale solar electric generating plants. Hence the two countries should exploit this natural resource to their advantage and work together with the international donor community to gain the means and knowledge necessary for developing sustainable energy technologies.

Most rural areas of Bangladesh, where 76% of the population live, are seriously deprived of any type of electricity facilities. Also, Indonesia has been unable to extend electrical power to nearly 60 percent of its population of which most live on remote islands in Indonesia's huge archipelago of some 39,000 villages. Despite Indonesia's quest to raise rural standards of living through electrification, the government recognizes it cannot afford to supply conventional energy sources to rural areas over vast distances despite knowing that, with inaction its large and growing rural population will consume increasing amounts of inefficient forms of energy such as fossil fuels that pollute and emit greenhouse gases.

This project proposes to enlarge the outreach for rural electrification usage and to develop more renewable energy services in Bangladesh and Indonesia in order to usher a qualitative change in the economic and social life of the populations living in these areas.

The innovation in this approach is that it not only offers integrating micro-finance services with renewable energy technologies to increase market opportunities but it also allows for a bottom up development approach through incorporating the poor located in remote areas that can benefit to a remarkable extent from remarkable poverty reduction and sustainable development in these two emerging countries.

Objectives

For Bangladesh and Indonesia, as pilot areas, the main targets can be summarized as:

1. To promote development of income generating activities with renewable energy supply.
2. To build a bridge between national contexts, microfinance, micro-enterprise development, poverty and access to electricity through solar energy systems.
3. To identify measures justifying involvement of SME in the solar energy sector.
4. To create synergies among stakeholders.
5. To promote "solar energy citizenship" mobilising local energy actors.
6. To better inform stakeholders providing pro-poor sustainable renewable energy services.
7. To bring a positive impact on the quality of life in rural districts.
8. To achieve the objectives of the MDGs through sustainable energy provision.

Today, all major stakeholders involved in the field of development recognize the effectiveness of microfinance as a powerful tool in the poverty reduction strategy in rural zones. Consequently to achieve the main objectives of the project, strategic plans should focus on the identification of the key actors and develop innovative renewable energy financial business model whilst simultaneously developing awareness of the sector and involvement of the community through provision of training and capacity building tools to ensure a coherent and widespread understanding of the sector across all segments of the population in rural areas throughout Bangladesh and Indonesia.

The work focuses primarily on the realizing the following tasks:

- Define a collaborative institutional framework in Bangladesh as well as in Indonesia gathering all the stakeholders who should play relevant roles for the promotion of renewable energy linked to microfinance mechanisms, micro enterprise (ME) and rural development.
- Develop solar energy action plans for ME development and rural development from need assessment tools with a focus on poverty implications.
- Build ME capacity and the ability to capture know-how and benefit from renewable energy resources available in terms of developing new products; operational management, optimizing energy use for business development and management.
- Speed up the rural electrification plan for the improvements of quality of life for low income people in these countries.
- Create innovative microfinance instruments and recommendations toolkits for MFI attracted by solar energy linked micro credit (MC) programmes that tackle the needs of rural population.
- Follow up activities recommendations and reports to maintain awareness for integrated renewable energy policy and incentives for MFI involvement for rural electrification and sustainable development.

Expected key results

The core result of the project will be:

Positive contribution towards national development in Bangladesh and Indonesia and particularly rural development and poverty reduction with solar energy mixed with micro enterprise development and microfinance mechanisms tailored for low income people's needs.

To achieve the objectives expected in the project several tools will be created:

1. Need assessment tools: market demand survey, feasibility study and gap analysis.
2. Development of financial model adapted for the linkage between microfinance mechanisms, ME development, solar energy demand, local energy providers and other involved partners in these countries.
3. Microfinance for solar energy toolkit (microfinance new product development)
4. Manual summarizing guidelines for solar energy end-users and micro entrepreneurs.
5. Monitoring and evaluation tools for solar energy system management.
6. Rural electrification action plan for different identified rural districts in Bangladesh and Indonesia.
7. Training and information dissemination material for the social awareness campaign and capacity building programmes on the benefit of the solar energy resources available in terms of developing new products; operational management, optimizing energy use for business development and management.

I. Introduction

This report has been prepared as a part of the study initiated under the RENDEV project to investigate the state of the art of solar energy application in Bangladesh. The research material was compiled by Prokaushali Sangsad Limited toward partial fulfilment of the partnership between PSL and Transenergie.

The objective of the study is to provide a comprehensive data on the status of solar energy application in Bangladesh. This information should assist in needs assessments for a wider photovoltaic (PV) systems dissemination. Remarkable progress in application of solar energy for rural household electrification has been documented here.

The most successful application of solar energy is through the ongoing Rural Electrification and Renewable Energy Program (REREDP) being implemented in Bangladesh. This program was initiated in 2002 with IDA loan from the World Bank and GEF grant, and currently continues with funds from KfW, GTZ, with potential funding from the ADB. Under this program solar home systems are being disseminated through two institutional arrangements. Infrastructure Development Company Limited (IDCOL), which is a subsidiary of the GOB is refinancing several large and small NGOs to micro-finance solar home systems. On the other hand, the Rural Electrification Board, which provides rural grid electrification service through its affiliated cooperatives provide solar electrification on a 'pay for service' basis. The former mechanism of dissemination has been more successful with more than 6500 households purchasing solar home systems each month using micro-financing. Multiple benefits have actually resulted from this arrangement. It is found that (a) the financial incentives embedded within the program has attracted the NGOs to pursue this non traditional activity, (b) SHS complements grid electrification service in the un-served areas, (c) many jobs are created in support of the industry and services and (d) a clean energy technology is being implemented in a broader scale.

The report provides information on the key agencies involved in solar energy projects in Bangladesh that include various government bodies, NGOs, private sector and various academic institutions. In addition to rapid application of solar technology, there has been notable growth in the number of organizations playing direct role in its dissemination. Although research and development to support solar technology has progressed in a limited scale, there is a widespread awareness among the public, the rural households in particular, on the benefits of decentralized solar home systems. The widespread network of micro-credit activities among the NGOs has been applied toward micro-financing of solar home systems. Such provision of alternative lighting solutions with a financing scheme has developed into an attractive choice for the consumers and accelerated dissemination of solar home systems. The technical solutions being marketed today and their costs are discussed in the report with identification of barriers and constraints for further scaling up. The report provides a list of laboratories testing solar equipment, agencies offering certification, prime contractors, companies, manufacturers, installers, trainers and other bodies engaged in solar projects and programs.

II. State of the solar energy market

II.1. Typology of the SE uses for rural electrification in Bangladesh

Rural electrification using solar energy has shown great potential in Bangladesh within a period of the past 10 years. In spite of the exemplary achievement of more than 300,000 service connections per year by the rural electrification cooperatives, only about 35% of the rural households are electrified today. Part of this unmet demand for electrification is now being met by the solar electrification program of Bangladesh. The government has provided the institutional framework needed by the non-government and private sector for successful adoption of the technology for electrification of rural households located in areas not being served by the grid services. Application of solar energy within Rural Electrification and Renewable Energy Development Program (REREDP) essentially complements the grid power service offered by the Rural Electrification Board (REB). This is the predominant application of solar energy in the country.

II.1.1. Role of IDCOL in Solar Electrification

IDCOL is a government owned entity entrusted for disbursement of loan funds to the private sector for various investment initiatives. Solar program of IDCOL is ongoing since 2002 with an overall national coverage. This includes all the six divisions of the country, viz. Barisal, Chittagong, Dhaka, Khulna, Rajshahi, Syhlet. The program has been streamlined to disburse discounted loans through IDCOL's partner organizations, who operate simultaneously in multiple locations. There is no area franchise or restriction on geographic coverage by any particular organization. Households procure solar home systems on a hire purchase basis with a loan contract of typically 3 years. The buyer makes a comparative judgement of the quality of hardware, and services offered by any particular provider. Popularity of SHS is evident considering more than 6500¹ SHS being installed per month in Bangladesh, as shown in Figure 1.

The development of the monthly installation rate from January 2005 until September 2007 is shown in the figure below.

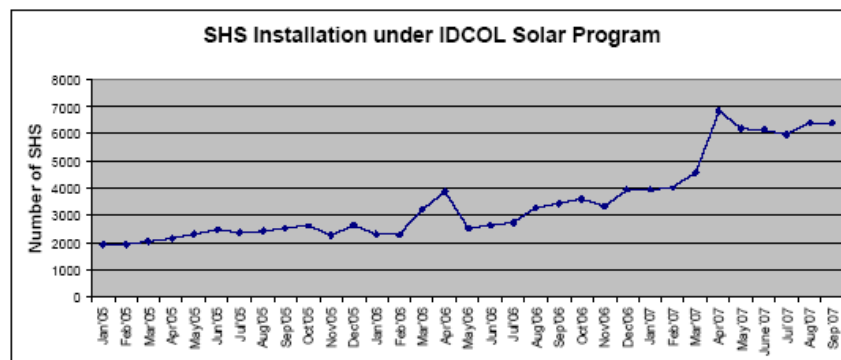


Figure 1 : SHS monthly installations, source: OC meeting protocols

IDCOL², which is a government owned company is responsible for implementation of the national solar electrification program through its fifteen partner organizations (PO). Well developed operational strategy of IDCOL has shown its merit in disbursing the IDA loan and GEF grant in the early years of program execution. Success of the ongoing program is being measured through the number of consumers being served through micro-financing of solar home systems by the POs. The original target of reaching 65,000 households within 5 years was met within 3 years. Consequently the program has received additional loans and donor grant funds from KfW, GTZ and others, in order to continue further following the ongoing scheme of operation. ADB is also planning to invest in this sector within this year. By January 2008 a total of **173,168** solar home systems have been installed under the solar program of IDCOL.

II.1.2. Role of the NGOs in Solar Electrification

The national solar program has attracted several NGOs, giving them the opportunity to experience the provision of a new technology within their ongoing micro-credit collection scheme. This has also provided them access to discounted loans specially designed for dissemination of solar home systems among the population un-served by the national grid services. Therefore an alternative and parallel operational entity for rural electrification has been created in the country that is (a) decentralized through the POs, (b) guided by some regulatory framework of IDCOL, and (c) responds to the market demand. Table 1 provides a log of all the non-governmental organizations and agencies directly involved in REREDP national solar program with more details on the participating NGOs given in Chapter 3.

Table 1

Solar Home Systems Installed by NGO Partner Organizations (PO) of IDCOL under the ongoing REREDP program of Bangladesh up to January 2008³

Name of the PO	SHS installed under REREDP	Installed in Jan'08	Installed in Dec'07
Grameen Shakti	106267	4,002	4,170
BRAC Foundation	34025	813	869
RSF	9925	842	874
SRIZONY	4,833	95	88
UBOMUS	3,687	184	149
BRIDGE	2,923	214	272
COAST	1,882	42	41
IDF	1,825	57	77
CMES	1,699	30	42
Shubashati	1,621	30	33
HFSKS	1,768	119	182
TMSS	1,165	02	02
PDBF	947	30	30
Mukti	265	20	15
PMUK	259	30	29
Other	77	0	0
Total	173,168	6,510	6,873

II.1.3. Role of REB in Solar Electrification

Several rural electrification cooperatives (PBSs) are also participating in the Government's solar program. This part of solar program of REREDP implemented by the Rural Electrification Board (REB) has been progressing slowly compared to the IDCOL Program. The project is being carried out by six PBSs (Palli Bidyut Samity) parallel to their conventional grid electrification services. The main purpose is to provide solar electrification to households in non-grid areas outside their 5-year expansion plan. The arrangement is by "Pay for Service" where the equipment is owned by the PBSs and the consumers pay fixed monthly bills for 20 years according to their chosen system configuration.

The PBSs participating in the program are Sirajganj, Pabna-2, Natore-2, Cox's Bazaar, Barisal, and Sunamganj. The geographic locations of these PBSs were identified as those with highest potential for solar electrification by a nationwide market survey in 1998⁴.

Previously REB installed the country's first solar electrification for households lighting in Karimpur, Narsingdi in 1994, which had given the initial exposure of solar PV technology to the public and private sector of the country.

Table 2
Installation of SHS by REB under RERED Program

Name of PBS	No. of SHS installed upto January 2008	Approximate location in the country
Sirajgonj PBS	773	West
Pabna PBS-2,	1005	Midwest
Natore PBS-2	1162	Mid-west
Cox's Bazar PBS,	1610	East
Sunamgonj PBS,	1151	North
Barisal PBS-2	840	South

II.1.4. Role of Bangladesh Power Development Board (BPDB)

Although BPDB is primarily engaged in national power production it has taken some independent initiatives for dissemination of solar electrification in the remote and hilly locations where grid services will not be feasible in the distant future. It has installed a total of 600 nos 120Wp Solar Systems in three Upazillas (Barkal, Juraichari and Bilaichari) of Rangamati district under Extension of Solar Electrification in CHTs Project funded by using its own resources. In addition, BPDB has financed a 10kw Solar System for providing electricity in the Barkal Upazila office and its surrounding settlements.

II.1.5. Role of Local Government Engineering Department (LGED)

With support from UNDP, LGED has administered the Sustainable Rural Energy (SRE) project during 1997-2003. Nationwide several renewable energy demonstration projects were initiated under this project, which includes among others, a 1kw Solar Water Pump in Shuvalong Union of Barkal Upazila which provides water supply of about 300 families, over 32 nos Solar Home Systems (SHSs) for household application, solar lighting for Growth Centres, Solar Home Lighting in Asrayan (homeless shelter) Project in Thakurgaon and Jhenaidah. A significant activity of LGED is maintenance of a national database since 1997, called information called Renewable Energy Information Network (REIN)⁵, which was created under the Sustainable Rural Energy (SRE) project funded by UNDP.

II.2. Technical solutions marketed

There are a large number of combinations of SHS system sizes that are being marketed in Bangladesh today. Under the IDCOL program, which is the most active program in the country, the most popular system sizes installed are 30Wp, 40Wp, 50Wp, 65Wp, 75Wp, 80Wp, 85Wp, 100Wp. These systems are mainly being used for household lighting, watching television, listening to radio or cassette player, and operating video players. One of the most attractive applications of the SHS is mobile charger, which has a large market of its own. Since the above systems are affordable only for the more affluent households in the rural area, most recently IDCOL has approved smaller SHS of 16Wp to 21Wp, with special emphasis on using more energy efficient LED lamps. Although florescent tubes of various sizes have been used widely in the past, the trend is to switch to CFL lamps for higher efficiency and lumens output. Use of LED clustered lamps has also created more interest among the designers to increase the total number of lamps while reducing the system size although till now the total lumens available is low.

Typically, various combinations of hardware are being used by the NGOs, who are using the refinancing scheme of IDCOL. A list of approved material list has to be followed by all the participating organization. Annex 1 of this report lists the solar module, battery, charge controllers and lamps along with their model numbers and suppliers approved by IDCOL. This hardware meet certification requirement of IDCOL and they are qualified for the program. However, the size of the systems and its market share is also guided by the suppliers. Since the price competition is very close among the participating organizations, those with capability for independent manufacturing of the appliances take advantage of price control.

The manufacturing industry for the components of the SHS has grown reasonably well in Bangladesh during the recent past. As it can be seen from Annex 1, there are 22 different batteries approved by IDCOL, all of which are locally manufactured in the country. There are 15 different charge controllers and 12 models of lamps that are qualified for the program. The lamps are from mixed sources, most being locally manufactured, others are imported. Large number solar modules are certified for the program. All 76 models of solar modules are manufactured overseas since there is no such facility in the country. Although a large number of solar modules are listed by IDCOL, a limited number of brands is being used and imported into the country, with the largest market share being of Kyocera and British Petroleum (BP).

Another solar home program in Bangladesh being implemented by the Rural Electrification Board (REB) uses fixed design and sizes of solar equipment contrary to the IDCOL program. The scheme of operation is 'pay for service', and system sizes being marketed by this program is limited to 36Wp, 40Wp, 50Wp, and their multiples. This program uses pre-qualified hardware procured through international tender. All major components of these SHS are manufactured overseas and hence imported into the country. A list of the SHS system designs used under the REB's solar project is given in Annex-2.

There are other noteworthy applications of solar energy in Bangladesh. Although in much smaller scale, there are several independent initiatives undertaken by several agencies that include:

- (a) Application of solar PV for computers operation in remote schools by PSL.
- (b) Application of solar PV for electrification of boats by Shidhulai (NGO).
- (c) Application of solar PV for lighting cyclone shelters by LGED.
- (d) Application of PV in water pumping by Energy Systems.
- (e) Dissemination of solar lanterns for households by NGOs.
- (f) Vaccine refrigeration using solar PV by the health ministry.

II.3. Breakdown of the prices for solar home systems

Cost of various components of a SHS in the country is different from each supplier, and it depends upon the product model and specifications. With the increase in global market rates for primary metals like lead, copper and steel, the cost of SHS has increased significantly in the past year. The cost increase is shared between the consumer and system provider through reduced profit margin. A very competitive market has kept the price low which in return has its toll on the system supplier. Therefore the selling price is also variable depending upon the solar home system under consideration. In the IDCOL project, warranty requirement of the hardware is specified by the technical committee to be followed by the NGOs. However, various schemes for service coverage are adopted by the organizations based upon their capacity. Typical service period covers the timing of micro-financing period in order to ensure satisfactory collection of instalments from the households. Spare parts are also available from the system provider for damaged units in the field.

Typical market rates for the major components of a solar home system are as follows:

- Solar Modules: These are imported items sold in the local market at the rate of Tk. 280-300 per Wp. Japanese and Indian modules are the most widely used modules in the country.
- Battery: These are locally manufactured items with imported raw material. Finished batteries are sold at approximately 100-120 Tk. per AH.
- Cable: Local industries are manufacturing cables in the country with a selling price of 100 yards of cable for indoor wiring (40X0.0076) at the rate of about Tk. 3000/-, and 100yds of (70X0.0076) for module to controller and battery to controller at the rate of Tk. 5200/-.
- Lamps: Price of DC lamps used in SHS vary between Taka 400 to Taka 550 depending upon the model and performance rating.
- Charge controllers: Locally manufactured charge controllers can vary in price. Since the system integrators are free to bundle up the price with other hardware, accurate price on this item is difficult to obtain. Typically local charge controllers should be about Taka 500 to Taka 600, while the imported ones can range from Taka 800 to Taka 1200.

The consumer is offered a package price from the system provider which encompasses all costs associated with the system including material, transport, installation and service maintenance. The consumer is offered a cash price and an alternative price for payment in instalments for micro-financed SHS.

Table 3 shows a typical break-up of the price of a system from purchase to selling in micro-credit. The service charge is a combination of technical service and credit recovery cost over the micro-financing period. As shown in the table, the purchasing price of the hardware is reduced by the subsidy amount forwarded by the system provider. Each NGO is free to negotiate the subsidy and profit mark-up amount to make attractive offers to their customers. The down payment is also an item of choice for the consumer since the loan amount is subject to service fee and hence affects the final monthly instalment to be paid over the loan period.

Table 3
Price distribution and financing scheme of selected models of SHS (in Taka)

SHS	Model	Purchasing price	Subsidy to HH	After Grant	Profit	Sales Price	Package price	Down payment	Loan amount.	Service charge	Outstanding for 3Yr.	Monthly Instalment (3yr./36 months)
1	16Wp module 30Ah battery	10,878	600	10,278	514	10,792	11,000	2,600	8,400	1,764	10,164	282
2	21Wp module 30Ah battery	12,903	700	12,203	610	12,813	13,000	3,400	9,600	2,016	11,616	323
3	50Wp module 80 Ah battery	30,246	1,200	29,046	2,324	31,370	31,500	12,000	19,500	4,095	23,595	655
4	65Wp module 80Ah battery	33,421	1,200	32,221	2,578	34,799	34,800	12,675	22,125	4,646	26,771	744

II.4. Identification of the barriers and constraints

II.4.1. Quality problems pertaining to the national or imported material offer

Maintaining quality and performance of the SHS is a major challenge for the organizations engaged in dissemination of SHS in Bangladesh. This stems from the fact that all locally manufactured hardware depend on imported items. The charge controllers and DC lamps use imported electronics components. Therefore bulk importers can only take advantage of the better quality products from reliable sources. Usually China is the sourcing country for all electronics parts used for manufacturing charge controllers and lamp ballasts. Therefore a reliable source of such components in addition to high quality design can only ensure the best performance.

It should also be noted that designs for charge controllers for SHS and lamps have evolved in the country in the past decade on a trial and error basis. There is no dedicated large scale industry with a product line of DC lamps and small charge controllers because of the small demand. These are being manufactured in small scale for the solar market. High quality integrated circuits are still not usually being used in locally designed controllers; therefore there are limited features to take advantage of. On the other hand imported charge controllers and lamps are found to be more energy efficient while offering high end features ensuring longevity of the overall system. Although the ballast for DC lamps are mainly limited to SHS, there is a large market for high quality AC lamps, which are being manufactured in the country by several local industries. Higher price is the major constraint for using the imported higher quality lamps and charge controllers.

II.4.2. Distribution or maintenance difficulties

Markets for SHS are distributed in the remote locations of the country which are typically inaccessible for grid services, or waiting to be connected. NGOs and PBSs are disseminating the SHS to these locations using the local transportation network, which includes road and river transport. Some of the distant locations, especially in the southern coastal regions have very limited options for transport of material. Overall the system integrators are required to use the most reliable means of transport for bulk delivery of the systems to the regional offices of the NGOs. From these locations, the systems are spread over to the unit offices distributed in remote locations. Maintenance of SHS therefore remains a costly and time consuming activity for the unit offices, which are required to respond to the need of the consumers. Initial trouble shooting is typically done by the technicians and local attendants, mostly through temporary replacement of the hardware. However, maintenance of items is

done centrally through the warranty scheme of the supplier, or through the manufacturing facilities of the service providers. In remote areas where local maintenance possibility is low, frequently there are cases of bypassing of controllers which result in eventual degradation of the systems. Grameen Shakti has created service centres in some areas for maintenance of their systems, which can overcome the time lapse in providing support service to their clients.

In case of REB, the supply of material to the local PBS offices is done through their dedicated distribution network. Lack of knowledge and motivation among the operating staff in the PBSs is found to be a deterrent to the growth of solar electrification program of the REB. Since grid electrification service is the mandate and priority for REB, it is found that solar program receives lower priority among the management and staff of such organizations.

II.4.3. Appropriateness of the professional qualifications

The ongoing solar electrification program was developed (Reference: Prokaushali Sangsad Limited for The World Bank, 2001) which provided the institutional, financial and technical model for household electrification. Professional qualification of the individuals engaged in the solar electrification programs in the country are adequate for the ongoing activities, i.e household lighting in particular. Graduates from the technical education institutions in the country like Bangladesh University of Engineering and Technology (BUET), Dhaka University and other technical institutions are highly capable in the area of design of equipment and systems. The different Polytechnic institutes also produce many engineers and technicians for implementation of the programs. However, modern technologies are being developed in other parts of the world, which are the directions for the future. Therefore technical training and renewable energy project management training should be in focus for program developers.

II.4.4. Specific difficulties

A special area of focus has been the recycling of material used in the SHS, which is particularly important for the batteries being used. There is a built in process of recycling in the country through the informal network of people that collect, dismantle and re-sell the usable parts without much regard to personal and environmental safety. With the scale up of the solar programs, it is important that the recycling process be observed for correct use and disposal of material. At the moment there is one manufacturer of batteries in the country which recycles the lead in used batteries from all other factories in the country. Most recent project funded by the KfW has taken this issue under consideration, and recommendations from their study will likely be available in the near future.

A very important topic of concern is the lack of political will for renewable energy in general in the government. There is an overall shortage of power generation in Bangladesh, which affects the economic development significantly. Hence large scale power production has received much priority in the national agenda, and special focus on renewable energy has not been established by the policy makers. For example, until last year there was no duty on import of solar modules, which has been increased to 5% from this year. This has resulted in increase in price of the systems. In addition, worldwide increase in price of lead and copper has nearly doubled the price of batteries and cables, which is making even the subsidised projects non profitable for the small operators, even though there is significant demand for SHS in the country.

II.4.5. Financial and fiscal constraints

In the absence of any renewable energy policy in the country, this sector does not get any preferential treatment by the banks or other authorities like the mainstream power providers. There is a lack of awareness among the banks about demand for solar equipment, so it is difficult to get any loan for doing business in this field. In contrast, in neighbouring countries like India special incentives and provisions are made for similar projects through the taxation system.

In view of the lack of public incentives, there is very little private investment in solar energy applications in Bangladesh. Most renewable projects have originated from the government agencies and hence are limited in its potential for commercialization. The most significant investment is 20 percent of the hardware cost by the NGOs participating in the IDCOL's solar program. Lack of credit from the development banks limits the scale of operation executed by the NGOs. Scaling up of the solar program is therefore limited within the larger micro-finance organizations like Grameen Shakti and larger NGOs like BRAC.

III. Technical and material skills available locally

III.1. Testing laboratories and university laboratories

There are several test laboratories in the country which perform testing of solar equipments for various purposes, including independent R&D, academic research, product certification and product development. Following is a list of test laboratories has been posted by the Renewable Energy Information Network (REIN), which is maintained by the Local Government Engineering Department (LGED):

1. Institute of Fuel Research & Development (IFRD), BCSIR
2. Renewable Energy Research Centre- University of Dhaka, Bangladesh
3. Grameen Shakti (Non Government Organization)
4. Centre for Energy Studies, Bangladesh University of Engineering & Technology (BUET)
5. Institute of Appropriate Technology (IAP),
6. Bangladesh Agricultural University
7. Khulna University of Engineering & Technology (KUET)
Department of Mechanical Engineering
8. Chittagong University of Engineering & Technology (CUET)
9. Energy System / Prokaushali Sangsad Ltd.

III.2. Certification or standardisation bodies

IDCOL standards are the only qualifier for national REREDP solar program. A technical standards committee is maintained by IDCOL for approval of hardware selection as per its requirement. For this purpose locally manufactured hardware certificates are accepted from Bangladesh University of Engineering and Technology (BUET), Bangladesh Standards and Testing Institutes (BSTI), Institute for Scientific Instrumentation (ISI) under the University Grant Commission (UGC), Renewable Energy Research Center (RERC) of Dhaka University in particular. However foreign products with international certification of standard are eligible for inclusion into the program.

Table A1.1 in Annex 1 shows a comprehensive list of hardware approved by IDCOL for its application in the national solar program. Detailed requirement and technical standards for hardware to be used in solar home systems under the IDCOL project which was first published in 2002 has been given in Annex 3. More information on the specifications for eligibility of hardware for the IDCOL project can be found in their website (www.IDCOL.org).

III.3. Engineering company, prime contractors, technical control bodies, contracting authorities

Total number of agencies in Bangladesh that are contracting solar project are very limited to a few government subsidiaries, which include:

1. Infrastructure Development Company (IDCOL)
2. Rural Electrification Board (REB)
3. Power Development Board (PDB)
4. Local Government Engineering Department (LGED)

Currently the solar component of ongoing REREDP program through IDCOL is essentially the major implementation activity for solar energy. This program has created an effective operational strategy that is successfully being executed by all the stakeholders. Description of the NGOs, with their specific area coverage, engaged in the solar home system dissemination program of IDCOL is given here. The data was collected from individuals in charge of solar program within the organizations as listed in Annex 4.

1. BRAC Foundation:

BRAC Foundation is a subsidiary of Bangladesh Rural Advancement Cooperative (BRAC) established in 1972. The geographic area coverage of the solar program of BRAC Foundation is over the entire country. BRAC has begun its solar program since 2003 and has a large potential of expansion.

2. COAST Trust:

COAST Trust working in this field since 2003. They are working in Bhola, and the seven coastal island of Bay of Bengal, including Jahiruddin, Dal Char, Char Kukuri, Char Motahar, Sakuria, Char Nizam, Monpura; Dashmina and Golachipa of Potuakhali region; Moheskhal, kutbdia and Saint Martain's Island of Cox's Bazar and Noakali region.

3. Grameen Shakti:

Grameen Shakti was established as a non-profit company in 1996 with the vision of promoting, developing and extending renewable energy technologies in the remote rural areas of Bangladesh

Grameen Shakti is presently working in all 64 districts of the country. It maintains a four steps organizational structure: Head Office, Divisional Office (6nos.), Regional Office(55nos.) and unit office(325 nos.) Apart from these 20 Grameen Technology Center are in operation.

4. TMSS:

Area Coverage: Satkhira, Bogra, Sirajgonj etc.

5. Srizony Bangladesh:

Srizony Bangladesh is a National Socio-Economic Development Organization was established in 1985 and since then it has been working for human and socio-economic development of the poor and disadvantaged people. They started Solar home system activities on June 2002 among the rural areas covering 41 upazillas od 10 districts. Their working 10 districts are Jhenidha, Magura, Khulna, Satkhira, Bagerhat, Rajbari, Patuakhali, Barguna, Pirojpur, Jhalkathi.

6. CMES:

Area Coverage: Patuakhali, Barguna, Mymensing, Gazipur, Tangail, Sirajgonj, Rongpur, Lalmonirhut, Dinajpur, Nilfamari, Rajshahi, Chapainababgonj.

7. IDF:

Integrated Development Foundation a non profit, non political and non government organization established in December 1992 with a vision to make Bangladesh poverty free and mission combating poverty in the impassable hilly region and other unnerved areas of Bangladesh.

Renewable energy Program of IDF one of the attempt of enhancing quality life of the people unserved area of the country that is not within the coverage of national grid. In this attempt in 2003, IDF with collaboration of Infrastructure Development Company Ltd (IDCOL) started its Renewable energy program from its Micro

finance Branch Raikhali Rangamati Area. Gradually the program extended more sixteen branches of its operational area and able to installed 1764 solar system by December 2007.

Presently the program is working in the area of chittagong hill tracts (Rangamati, Bandarban, Khagrachari) .Very soon the program will access to Noakhali , comilla and sylhet.The program has plan to set up a mini solar plant in future .

8. SHUBASHATI:

Subashati (a 'Bengali Word' means 'Good Habitat' or better settlement)- a registered non-profit, non-government, non-political humanitarian development organisation, have been working in the various fields of both rural and urban development in Bangladesh for over two decades. It started its Solar Project in 2000 under Sustainable Rural Energy Project of LGED funded by UNDP. It has installed a total of 600 nos 120Wp Solar Systems in three Upazillas (Barkal, Juraichari and Bilaichari) of Rangamati district under Extension of Solar Electrification in CHTs Project funded by Bangladesh Power Development Board (BPDB). Besides Shubashati has also installed a 10kw Solar System for providing electricity in the Barkal Upazila office and its surrounding settlements with financial assistance of BPDB.

Area Coverage: Satkhira, Khulna, Cox's Bazar, Rangamati.

9. UBOMUS:

Upokulio Biddutayan O Mohila Unnayana Shamity (UBOMUS) is a cooperative of rural women also known as Coastal Electrification and Women's Development Cooperative (CEWDC). UBOMUS is located in the southern coastal island called Char Montaz, and has sold 3685 SHS with micro-credit in Patuakhali, Satkhira, Khulna, Sandwip, Bhola, Borguna. The cooperative is one of the successful partners of IDCOL that manufacture and sell **DC lamps and controllers** on a commercial basis through (a) the outlet centre of the coop, (b) through the dealers, (c) with Solar Home Systems, (d) to other NGOs. It also operates 1.8 kW **Solar battery charging station** operates with a monthly fee to cover the operational costs. Under this program poor households are served with modern lighting, therefore, the material cost of battery and lamp are subsidised by the project.

10. BRIDGE:

BRIDGE was established on 1992 to create a self-reliant society with gender, class and caste equality in a pluralistic values. Their mission is to address the distressed people with the instruments needed to deal with their social, cultural, environmental, health and economic predicaments for establishing social impartiality.

BRIDGE started Solar Home System Activities in 2005. At present they are working in Khulna, Bagerhat, Satkhira, Barisal, Pirojpur region.

11. PMUK:

Padakhep Manabik Unnayan Kendra was established on 1986 as a non-political, non-profit and non-government organization committed to participate and promote national development through upgrading the socio-economic condition of the disadvantaged and underprivileged people of the society.

PMUK started to work on Solar Home System on October 2005. Presently they are working in Chittagong, Rangamati, Kagrachari, Bandarban, Nilfamari and Magura Region.

12. PDBF:

Area Coverage: Khulna, Satkhira, Tangail, Jamalpur, Bagerhut

13. Hilful Fuzul Samaj Kalyan Sangstha:

Hilful Fuzul Samaj Kalyan Sangstha(HFSKS) was established on 1992 with a vision to achieve sustainable development of the disadvantaged poor segment of population .

HFSKS started to work Solar Home System on 2006. They are working in the rural areas of Barisal, Jhalakati, Borguna, Kurigram, Noakhali, Chittagong, Mymensing, Jamalpur, Kisorgonj, Hobigonj, Sunamgonj, Tangail.

14. Mukti Cox's Bazar:

Mukti Cox's Bazar started the Solar Home System Business on October 2006. Their working areas are Moheskhalia, Ktubdia, Bashkhali, Ramu, Pekaw of Cox's bazaar zilla.

15. RSF:

Rural Services Foundation (RSF) has incorporated on 31 January 2006 as a 'not for profit' company with a view to provide essential services to rural people at their affordable cost. RSF was started to work on Solar Home system in the year of 2006 in order to address the issue that the rural economy does not function properly due to the shortage of electric power. They are working in Patuakhali, Shariatpur, Khulna, Comilla, Rangamati, Tangail, Nowgan, Mymensing, Jessore, Sunamgonj, Satkhira, Hobigonj and Sandwip region. They have 68 unit offices that covers 1000 nos. of villages 100 upazilla of 26 districts.

III.4. Manufacturers and installers, operators

Manufacturers of Battery:

- Rahim Afrooz Batteries Ltd
- Rimso Battery & Co.
- Abdullah Battery
- Navana Battery Ltd

Manufacturers of Charge Controller and Lamp sets

- Grameen Shakti
- Center for Mass Education in Science
- Upokulio Bidduttayan O Mohila Unnayan Samity (UBOMUS)
- MSI Technology
- Innovative
- Easy electronics
- Sun NRG

Manufacturers of Cable:

- BRB Cables Ltd
- Paradise Cables Ltd
- Eastern cables
- SINGER Cable
- Poly Cable
- MEP Cable.

III.5. Training institutions

- 1. Prokaushali Sangsad Ltd. (PSL).** Training of trainers for installation, maintenance and monitoring of solar home systems has been provided by PSL to the NGOs participating in the national solar electrification program of IDCOL. PSL has provided training to the management, staff and consumers of selected PBSs under the solar program of REB as its consultants for REB head quarters and 3 PBS locations.
- 2. Bangladesh Center for Advanced Studies (BCAS).** BCAS has provided training to the management, staff and consumers of selected PBSs under the solar program of REB as its consultants in REB head quarters and 3 PBS locations.
- 3. BUET.** With support from GTZ, technical training on solar electrification has been carried out by BUET for the NGOs of IDCOL. Under the academic environment of BUET, there are several research centres dedicated to energy studies that contribute to external solar training programs undertaken by BUET.
- 4. REB.** There is significant emphasis in REB for training staff and personnel of REB itself and its affiliated PBSs. A directorate for training operates within REB with very well developed training facility for grid electrification services. The solar electrification training and policy framework of REB is rather weak as it can be seen from the recommendations of its consultation meeting given in Annex 5.
- 5. Grameen Shakti.** A network of energy service centres are maintained by Grameen Shakti which provides training for maintenance of solar home systems.

Annexes

Annex – 1. List of hardware approved by IDCOL for the ongoing Bangladesh national solar program of REREDP

A1.1. Batteries approved for IDCOL solar program

No.	Vendor	Model	Capacity
1	RahimAfrooz	6BC 120T/2	47 Ah
2	RahimAfrooz	6BC 120T/3	71 Ah
3	RahimAfrooz	6BC 120T/5	130 Ah
4	RahimAfrooz	6BC 160T/3	100 Ah
5	RahimAfrooz	6PV 80	80 Ah
6	RahimAfrooz	6PV 55	55 Ah
7	MICRO	6 MLB 130	130 Ah
8	MICRO	6 MLB 100	100 Ah
9	MICRO	6 MLB 75	75 Ah
10	RIMSO	6RBT 120A	100 Ah
11	RIMSO	6RBT 100A	60 Ah
12	Navana	6NSP96	80 Ah
13	Navana	6NSP120	100 Ah
14	SAARC Power	YYN12V550	55 Ah
15	SAARC Power	YYN12V800	80 Ah
16	SAARC Power	YYN12V1000	100 Ah
17	SAARC Power	HPD-55T	55 Ah
18	SAARC Power	HPD-80T	80 Ah
19	SAARC Power	HPD-100T	100 Ah
20	RahimAfrooz	6PV85	85 Ah
21	Navana	6NSP130	130 Ah
22	RIMSO	6RBT N-150 98 AH	98 Ah

A1.2 Charge Controllers approved for IDCOL solar program

No.	Vendor	Model	Capacity
1	Atersa	MINO 1-12	10 A
2	STECA	Solsum 6.6	6.6 A
3	STECA	Solsum 8.8	8.8 A
4	Innovative Technologies	IT 1210F	10 A
5	Grameen Shakti	GSC 010	10 A
6	Sundaya	SSG300	10 A
7	Sundaya	SSG400	10 A
8	Easy Electronics	E 1212 VA	10 A
9	SUN`NRG	R-1006	10 A
10	Centre for Mass Education in Science	CV-1012	10 A
11	Phocos	CML 05	5 A
13	Power Fair	SC08	8 A
14	SAARC POWER	CQ1205-BD	5 A
15	SAARC POWER	CQ1210-BD	10 A

A1.3 Inverter Circuit/Fluorescent Luminaire approved for IDCOL solar program

No.	Vendor	Model	Capacity
1	Solsum	ESL 5	5 W
		ESL 7	7 W
		ESL 11	11 W
2	Grameen Shakti	GSL 01	6 W
3	Sundaya	Alight-12D06-S0-BK	8 A
4	Innovative Technologies	ITIN 1208DX	10 A
5	Innovative Technologies	ITIN 1207	10 W
6	Easy Electronics	ELS 7012	10 W
7	CEWDC	Deepti EW128	7 W
8	Centre for Mass Education in Science	CMES 1208	8 W
9	SAARC POWER (FL)	YPZ12/7.5-2U	7.5 W
10	Phocos India Solar Pvt. Ltd. (CFL)	CL1207W/C	7 W
11	Phocos India Solar Pvt. Ltd. (CFL)	CL1207W/C D	7 W
12	Energy Systems (CFL)	SZD-7E (DC)	7 W

A 1.4 Photovoltaic Modules approved for IDCOL solar program

No.	Vendor	Model	Capacity
1.	Astropower	AP 30	30 W
2.	Astropower	AP 45	45 W
3.	Astropower	AP 50	50 W
4.	Astropower	AP 55	55 W
5.	Astropower	AP 65	65 W
6.	Astropower	AP 75	75 W
7.	Astropower	AP110	110 W
8.	Astropower	AP120	120 W
9.	Astropower	APx 40	40 W
10.	Astropower	APx 45	45 W
11.	Astropower	APx50	50 W
12.	Astropower	APx65	65 W
13.	Astropower	APx75	75 W
14.	Atersa	A50	50 W
15.	Atersa	A65	65 W
16.	Atersa	A75	75 W
17.	Atersa	A110	110 W
18.	Atersa	A120	120 W
19.	British Petroleum	BP SX30	30 W
20.	British Petroleum	BP SX40	40 W
21.	British Petroleum	BP SX50	50 W
22.	British Petroleum	BP SX75	75 W
23.	British Petroleum	BP SX80	80 W
24.	British Petroleum	BP 250	50 W
25.	British Petroleum	BP 275	75 W
26.	British Petroleum	BP 340	40 W
27.	British Petroleum	BP 350	50 W
28.	CEL	PM 37 (J-27801)	37 W
29.	CEL	PM 40 (J-5786)	40 W
30.	CEL	PM 75 (I-339)	75 W
31.	ISOFOTON	I – 47	47 W
32.	ISOFOTON	I – 50	50 W
33.	ISOFOTON	I – 55	55 W

34.	ISOFOTON	I – 88	88 W
35.	ISOFOTON	I - 100/12	100 W
36.	ISOFOTON	I - 110/12	110 W
37.	Kyocera	KC 40	40 W
38.	Kyocera	KC 50	50 W
39.	Kyocera	KC 60	60 W
40.	Kyocera	KC 70	70 W
41.	Kyocera	KC 80-1	80 W
42.	Kyocera	KC 120-1	120 W
43.	Siemens	SP36	36 W
44.	Siemens	SR50	50 W
45.	Shell Solar	SM 50	50 W
46.	Shell Solar	SM 55	55 W
47.	Shell Solar	SP 65	65 W
48.	Shell Solar	SP 70	70 W
49.	Shell Solar	SP 75	75 W
50.	Shell Solar	SQ 75	75 W
51.	Shell Solar	SQ 80	80 W
52.	British Petroleum	BP 375	75 W
53.	SAARC POWER	YLDJ-45	45 W
54.	SAARC POWER	YLDJ-55	55 W
55.	SAARC POWER	YLDJ-70	70 W
56.	Centennial Solar	CS50	50 W
57.	Centennial Solar	CS60	60 W
58.	Centennial Solar	CS70	70 W
59.	Centennial Solar	CS125	125 W
60.	Centennial Solar	CS130	130 W
61.	Centennial Solar	CS135	135 W
62.	Kyocera Corporation	KC40T	40 W
63.	Kyocera Corporation	KC50T	50 W
64.	Kyocera Corporation	KC65T	65 W
65.	Kyocera Corporation	KC85T	85 W
66.	SAARC POWER	YLDJ-40	40 W
67.	SAARC POWER	YLDJ-50	50 W
68.	SAARC POWER	YLDJ-75	75 W

69.	RahimAfrooz	STP040S-12/Rb	40 W
70.	RahimAfrooz	STP065S-12/Sb	65 W
71.	Centennial Solar Inc., Canada	CS50cigs	50 W
72.	Centennial Solar Inc., Canada	CS60cigs	60 W
73.	Sun Technics Energy Systems Pvt. Ltd	STIM 30	30 W
74.	Sun Technics Energy Systems Pvt. Ltd	STIM 40	40 W
75.	Sun Technics Energy Systems Pvt. Ltd	STIM 50	50 W
76.	Sun Technics Energy Systems Pvt. Ltd	STIM 75	75 W

Annex – 2 Design specifications for Solar Home Systems used by REB

There are four pre-qualified SHS for the REB solar program. The design parameters of these systems are given here.

System Design for SHS-1:

Design Criterion	Design Selection
Load option 1: 8W FTL ⁶ - 3 nos. OR Load option 2: 7W CFL ⁷ -1 nos. Black &White TV-1no. (must be rated less than 15W) Total operating hours: 4 hrs daily Days of Autonomy: 3 days	Battery Size Selection: 60 Ah No of Parallel Batteries⁸: 1no. Panel Size Selection : 40Wp No of Parallel Panels: 1no Controller: 6 Amp

System Design for SHS-2:

Design Criterion	Design Selection
Load option 1: 8W FTL- 4 nos. OR Load option 2: 8W FTL-2 nos. Black &White TV-1no. (must be rated less than 15W) OR Load option 3: 7W CFL-3 nos. Black &White TV-1no. (must be rated less than 15W) Days of Autonomy: 3 days Total operating hours: 4 hrs daily	Battery Size Selection: 70 Ah No of Parallel Batteries: 1no. Panel Size Selection : 50Wp No of Parallel Panels: 1no. Controller: 6Amp

System Design for SHS-3:

Design Criterion	Design Selection
Load option 1: 8W FTL-1 nos. 10W FTL-2 nos. Black &White TV-1no. (must be rated less than 15W) OR Load option 2: 7W CFL- 4nos. Black &White TV-1no. (must be rated less than 15W) Days of Autonomy: 3 days Total operating hours: 4 hrs daily	Battery Size Selection: 100 Ah No of Parallel Batteries: 1no. Panel Size Selection : 75Wp No of Parallel Panels: 1no. or Panel Size Selection : 40Wp No of Parallel Panels: 2nos. Controller: 8Amp Wire size: See Table 1

System Design for SHS-4:

Design Criterion	Design Selection
<p>Load option 1: 8W FTL-2 nos. 10W FTL-2 no. Black &White TV-1no. (must be rated less than 15W) OR Load option 2: 7W CFL- 5nos. Black &White TV-1no. (must be rated less than 15W)</p> <p>Days of Autonomy: 3 days Total operating hours: 4 hrs daily</p>	<p>Battery Size Selection: 120 Ah No of Parallel Batteries: 1no. Panel Size Selection : 85Wp No of Parallel Panels: 1no. or Panel Size Selection : 50Wp No of Parallel Panels: 2nos. Controller: 10 Amp Wire size: See Table 1</p>

Annex – 3 Technical Standards for Solar Home System in Bangladesh

A3.1 Solar Home System Hardware Description

- 1.1. The Solar Home System (SHS) is intended to provide the user with a convenient means of supplying power for small electrical loads such as lights, radio/cassette players or TV. A typical SHS operates at a rated voltage of 12 Vdc and provides power for fluorescent luminaries, radio/cassette players, small black and white TV or similar low-power appliance for about three to five hours a day. Additionally, other types of luminaries, 12 Vdc or lower voltage DC/DC converter outlets or a DC/AC inverter may be supplied as options. Each SHS consists of one or more photovoltaic (PV) modules, each having minimum output of 30 Wp charging a 12 Vdc lead-acid battery along with luminaries, related electronic and electrical components and mounting hardware.
- 1.2. The system should be designed to have at least three days autonomy (i.e. can run for three consecutive days without charging from the panel).
- 1.3. The SHS is packaged to provide convenient installation at a remote customer home site by a qualified technician. The system is constructed such that a user can perform routine maintenance such as adding battery water and replacing light bulbs and fuses, and a technician can easily perform system diagnostics or replace components.

A3.2 Certification Requirements

- 2.1. Products to be financed under the World Bank's and GEF PDF-B Project must have a type-test certificate from an accredited testing and certification organization like TUEV, Joint Research Centre, Factory Mutual, UL 1703, ISO 9001, ISO 14001, IEC 61215, CE marking, etc. For local products, a certification from a reputed institution like Bangladesh University of Engineering & Technology, Dhaka, is acceptable.
- 2.2. The supplier provides the most appropriate system integration, components, assembly and packaging that meet all the component specifications - Solar Home System Component Specifications' and the 'Recommended Practices' in Section 3.

A3.3 Recommended Practices

This section provides a minimum set of requirements that shall be followed in the design, specification and installation of the qualified SHS. They form a set of “Recommended Practices” which when followed will ensure adequate levels of safety, performance, reliability and system lifetime.

3.1. PV Module Installation

- a). If more than one module is used, identical models shall be used and they shall be connected in parallel.
- b). For SHS installed permanently on a structure (in contrast with portable units):
 - i. The modules must ensure water proof sealing for the solar cells.
 - ii. Modules must be framed in such a way as to allow secure connection to the module mounting structure.
 - iii. The array mounting structure will hold the photovoltaic module(s). The module(s) must be mounted on a support structure made of corrosion resistant material that assures stable and secure attachment.
 - iv. The PV array and support structure must be able to withstand wind gusts up to 160 km/hour without damage.
 - v. The structure must be mounted at a fixed angle and oriented to maximize the useful energy supplied to the user over the year (for Bangladesh, the elevation should be around 67° with the panel facing south).
 - vi. The structure will incorporate corrosion resistant hardware for all external connections.
 - vii. The modules can be roof or ground-mounted: In case of Roof-mounted modules, minimum clearance between the PV array and the roofing material must be at least 20 cm above the roofing material. It is recommended that the module mounting structure be supported on top of a pole of at least 50 cm length. Anchoring of the mounting structure must be to the building and not to the roofing material. For ground-mounted modules, a metal, concrete or treated wood pole must be used with the modules attached at the top of the pole. The modules must be at least 4 meters off the ground. The pole must be anchored in concrete or tightly packed soil at least one meter deep in the ground. The pole and mounting structure must be sufficiently rigid to prevent twisting in the wind or if large birds alight on the array.
 - viii. The panel should be mounted clear of vegetation, trees and structure so as to assure that they are free of shadow throughout day light hours during each season of the year. Furthermore, if more than one panel is mounted on a support structure the panels should not be mounted such that one panel will not shade the other panel(s).

3.2 Circuit Protection and Charge Controls

- a). Systems must include a means to protect users and system components from the following:
 - i. Battery overcharge and excessive water loss.
 - ii. Battery undercharge and excessive discharge.
 - iii. Circuit protection against short circuit of any load.
 - iv. Circuit protection against reverse polarity of module or battery.
 - v. Circuit protection against internal shorts in charge controller, inverter or other devices.
 - vi. Circuit protection against damage by the high PV open circuit voltage when it is connected to the controller without battery.
 - vii. Night time discharge of the battery due to reverse current through the array.
- b). Systems will provided appropriate protection by a charge controller incorporating a high voltage disconnect (HVD), low voltage disconnect (LVD) and circuit protection.

3.3 System Monitoring

- a). A display to indicate when the battery is in the charging mode must be provided.
- b). This device must, at a minimum, indicate when the battery condition is:
 - Suitable to operate loads
 - Energy conservation required
- c). The chosen device must come appropriately labeled such that the user does not have to refer to a manual to understand the existing battery condition.

3.4 Batteries

- a). Batteries should be selected to offer at least five years of useful life.
- b). The minimum size of the battery should be 50Ah@10 hours.
- c). The batteries can be supplied in a dry-charged condition and all chemicals and electrolyte must be supplied in accordance with battery supplier specifications. The battery and associated containers should be packaged to handle transport down rough roads.

3.5. Equipment Enclosure

- a). The batteries and charge controller should be kept in properly designed protective enclosures.
- b). The batteries must be housed in a vented compartment. All parts of the compartment subject to battery acid contact must be acid resistant. This compartment must be built strong enough to accommodate the weight of the battery. This compartment must adequately support and vent wet lead-acid batteries. Access to the battery compartment by children must be prevented.
- c). The remainder of the system components (electronics, switches etc.) must be housed in a separate compartment or enclosures which prevents the system components being affected by battery acid spills or fumes. The compartment or enclosure design must allow the internal electronic equipment to operate within acceptable operating temperature limits.
- d). The enclosure must be constructed of a durable material.

3.6. Wiring

- a) Stranded and flexible insulated copper wiring must be used.
- b) Notwithstanding the above minimum wire size requirements, all wiring must be sized to keep line voltage losses to less than 3% in each sub-circuit and to allow the circuit to operate within the ampere rating of the wire.
- c). For SHS permanently installed on a structure, all exposed wiring (with the possible exception of the module interconnects) must be in conduits or be firmly fastened to the building structure. Wiring through roofing, walls and other structures must be protected through the use of bushings. Wiring through roofing must form a water-proof seal.
- d). Field-installed wiring must be joined using terminal strips or screw connectors. Soldering or crimping in the field must be avoided if at all possible. Wire nuts are not allowed. The rated current carrying capacity of the joint must not be less than the circuit current rating. All connections must be made in junction boxes. Fittings for lights, switches, and socket outlets may be used as junction boxes where practical.

Annex – 4 List of NGOs and Persons Contacted for Information Collection

	Name	Contact Person
1.	Grameen Shakti	Mr. Kamrul Haque Assistant General Manager
2.	BRAC Foundation	Mr. Sudip Kumar Saha Senior Regional Engineer (Solar)
3.	Srizony Bangladesh	Mr. Shamsur Rahman Deputy Director
5.	COAST Trust	Mr. Md. Rafiqul Islam Coordinator – Social Business
6.	Center for Mass Education in Science (CMES)	Md. Abdul Mazed Program Organizer
7.	Integrated Development Fund (IDF)	Md. Nur Kutubul Alam Senior Program Organizer
8.	Shubashati	Ms. Reba Paul Director
9.	Upakulio Biddutayan O Mohila Unnayan Samity (UBOMUS)	M. Nasir Uddin Project Manager (Solar)
10.	Padakhep Manabik Unnayan Kendra (PMUK)	Md. Mohammad Ishaque Team Leader, Energy Program
11.	Bangladesh Rural Integrated Development for Grub-Street Economy (BRIDGE)	Mr. Zahurul Haque Bali Executive Director
12.	Hilful Fuzul Samaj Kalyan Sangstha (HFSKS)	Dr. Rafiqul Islam Managing Director
13.	Rural Services Foundation (RSF)	Engr. Md. Ruhul Quddus General Manager

Annex – 5 Recommendation of Policy Meeting for Solar Program of REB

Each solar electrification project under implementation faces different set of challenges. Summary of issues covered in the Policy Meeting for Solar Program of the Rural Electrification Board for the REB solar program are given here.

Recommendations on the REB Solar program
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Material and system related issues

1	The batteries need reliable initial charging as per instruction of the supplier. Specifically take manpower support from the supplier for proper charging of the batteries.
2	Battery chargers must be procured for each PBS.
3	Length of cable should not exceed recommended limits of the design.
4	Single wire should only be used for wiring the SHS. Connectors should be used for all joints of wires and cables entering the controller.

Operations related issues

1	Distribution of the type of SHSs should be rationalized with the survey results.
2	Warranty of battery, lamp and charge-controller should be clearly mentioned in the consumer's contract document.
3	Battery warranty card must be transferred to the consumer. The battery should be replaced by the PBS after its useful life. In case of early damage of the battery the consumer should pay as per prorated life of the battery. PBS should make provision for replacement of batteries and other components.
4	Immediate response must be arranged for SHS trouble shooting.
5	GEF funds must be made available to the GM for recruiting local support and technical staff.
6	Action need to be taken to reduce time to process application form and install the system as quickly as possible.
7	Problems with old installed system should be settled as this is acted negatively on people interest on REB solar
8	Unit office should be established in remote areas where consumer can pay their monthly installment.
9	Non-refundable 15% down payment discourages the consumer to take REB SHS.
10	Recommends that billing and maintenance of the installed SHS can be contracted out to the local NGOs or other agencies.
11	REB should have a task force for operating the solar program and oversee the daily execution of the PBSs.

Notes

¹ Source: Quarterly Report of PSE submitted to KfW July-September 2007

² Weblink: www.idcol.org

³ Reference: 59th Operations Committee Meeting of IDCOL

⁴ Market Assessment Survey of Solar PV Application in Bangladesh (1998), by Prokaushali Sangsad Limited for The World Bank.

⁵ <http://www.reein.org/>

⁶ FTL- Fluorescent tube light

⁷ CFL- Compact fluorescent light

⁸ Deep cycle tubular plate batteries have been considered